UPPER CLEAR CREEK WATERSHED PLAN

Revised Final Report – 319 Grant #OE FAA WQC05000024
(With Incorporated Revisions 1 through 3)

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On Behalf of:

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TDS Project Number 0405M

August 16, 2006

Technical Memorandum

Date: August 16, 2006

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From: Tim Steele, TDS Consulting Inc.

Subject: Revised Final Report, Upper Clear Creek Watershed Plan – Phase-I Tasks with revisions 1 through 3, UCCWA 319 Grant #OE FAA WQC05000024
TDS Project No. 0405M

As discussed between Chris Crouse and Bill McKee, the subject revised final report text and Appendix E (WORD files) are attached, incorporating the three (3) revisions to the previous "final" report dated September 27, 2005. This text file is provided to Chris Crouse, Project Administrator, along with files for the title sheet, figures, and tables, and appendices. My understanding is that Chris will convert the various parts of the UCC Watershed Plan into a pdf file for general dissemination and use. Please give me a call or send me an e-Mail if you have questions or need additional information.

Files: UCC319/UCCWatershedPlanText(RevFinal).doc; tables, figures; and Appendix E (skeleton TMDL; separate WORD file).

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Acronyms

AMLP	abandoned mine land program (USFS)
ARAR(s)	applicable or relevant and appropriate requirement(s)
ARD	acid-rock drainage
BHCCSD	Black Hawk/Central City Sanitation District
BMP(s)	best management practice(s)
CC	Clear Creek (mainstem stream)
CCW*F*	Clear Creek Watershed Forum
CCWF	Clear Creek Watershed Foundation
CDLG	Colorado Division of Local Government
CDM	Camp Dresser & McKee (Superfund Site investigations)
CDMG	Colorado Division of Minerals and Geology
CDOT	Colorado Department of Transportation
CDOW	Colorado Division of Wildlife

Acronyms (concluded)

CDPHE	Colorado Department of Public Health & Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSM	Colorado School of Mines
CWA	Clean Water Act
EE/CA	engineering evaluation and cost analysis
HMWMD	Hazardous Materials & Waste Management Division (of CDPHE)
lbs/d	pound(s) per day
LRCWE	Leonard Rice Consulting Water Engineers (UCCWA library)
ug/L	micrograms per liter
mg/L	milligrams per liter
MOS	margin of safety
NFCC	North Fork Clear Creek
NPS	nonpoint source
OSCs	on-site coordinators (USFS-AMLP)
PA	preliminary assessment (USFS-AMLP)
(P)COC	(potential) contaminant of concern
PAI(s)	potentially affected interest(s)
PRG(s)	preliminary remediation goal(s)
PRP	potentially responsible party
PS(s)	point source(s)
RAO	remedial action objective
ROD	Record of Decision
SFCC	South Fork Clear Creek
SLCs	Standley Lake Cities
SOW	scope of work
SS(s)	stream segment(s)
START	Superfund Technical Assistance Response Team (USEPA)
SDWA	Safe Drinking Water Act
TM(s)	trace metal(s)
Temp Mod(s)	temporary modifications (standards)
Tt-RMC	Tetra Tech – Rocky Mountain Consultants
TVS(s)	table value standard(s)
UCC	upper Clear Creek (mainstem stream or watershed)
UCCWA	Upper Clear Creek Watershed Association
US	underlying (equation-based) standard; ultimate target(s), site-specific
USACOE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
WFCC	West Fork Clear Creek
WQCD	Water Quality Control Division (of CDPHE)
WQS(s)	water-quality standard(s)
WTP(s)	water-treatment plant(s)
WWTP(s)	wastewater treatment plant(s)
WY	water year (beginning on October 1 and ending on September 30)

Upper Clear Creek Watershed Plan
319-Grant Final Report – Phase-1 Work Tasks

Executive Summary

Clear Creek supplies water to over 300,000 residents in the metropolitan Denver area. Adopted beneficial uses for these segments include aquatic-life cold-water class 1, recreation class 1a, water-supply, and agricultural uses. Ambient concentrations of trace metals adversely impact aquatic life in several of the watershed's streams, as well as potentially in drinking-water supplies downstream. The metals in watershed's streams originate primarily from nonpoint sources, including numerous abandoned or inactive mines, mine/mill tailings, and waste-rock piles located throughout the watershed. Many, but not all, of these sources have been remediated or are scheduled to undergo remediation through Superfund (CERCLA) or other funding sources.

Several stream segments (SSs) in the Clear Creek watershed are on the CDPHE's proposed 2006 303(d) list of impaired waters; most of these segments have been listed since 1998. Five of these segments are the subject of the Section-319 grant request for the upper Clear Creek watershed considered in this study report: SS 2 (mainstem Clear Creek from Silver Plume to the Argo Tunnel), SS 9a (Fall River), SS 9b (Trail Creek), SS 11 (mainstem Clear Creek from the Argo Tunnel to Farmers Highline Canal), and SS 13(b) (lower reach of North Fork Clear Creek). All but one of these stream segments (SS 9a being the exception) are listed for exceedances of the zinc (Zn) standard; segments 2, 9a, 9b, and 13b are in nonattainment of the copper (Cu) standard, and segments 9b, 11, and 13(b) exceed the cadmium (Cd) standard. The water-quality standards for these stream segments currently consist of various table value standards, site-specific standards, and/or temporary modifications, depending on the segment.

The overall goal of this Upper Clear Creek Watershed Plan is to provide a basic framework for the development of nonpoint-source controls such that currently applicable or ultimate (underlying) stream standards for key trace metals of concern can be met. This initial (Phase-I) Plan addresses five of the nine USEPA-recommended elements (called herein watershed-plan components); a subsequent study-phase is proposed to complete the Watershed Plan for remaining elements and for other water-quality variables of concern.

An extensive compilation and assessment of streamflow trace-metals data from several sources were completed in order to quantify the non-attainment of various current stream standards as well as to develop and compare conditions with seasonal (high-flow/low-flow) stream standards for the several stream segments of concern (Table 1-1). The delineation of non-attainment of the proposed seasonal standards is given in Table 1-3 and accompanying Figure 1-2.

Highlights of this Phase-I project effort for this Upper Clear Creek Watershed Plan are summarized by watershed-plan component as follows:

Identification of trace-metals sources and causes that potentially need to be controlled.— Fortunately, a number of technical field investigations and studies have been completed in this watershed. Through resultant data and information, the numerous sources and causes of elevated key trace-metals concentrations have been inventoried and summarized for this Plan (see Section 2 and associated tables). As a critical part of this inventory and summary, prioritization and ranking of more critical sources have been included for consideration in subsequent watershed-plan components' analyses.

Estimation of trace-metals loads reductions from planned CERCLA work and additional NPS measures.—High-priority areas identified in the watershed for consideration of remediation for achieving WQ stream-standard targets consist of the North Fork Clear Creek subwatershed and Virginia Canyon (see Section 3). Moderate-priority areas consist of the Georgetown-to-Idaho Springs area and the Silver Plume area, both along the mainstem Clear Creek (including key tributaries). Overall effective TMs loads' reduction in the mainstem Clear Creek in downstream stream-segment (SS) 11 is estimated to be more than 80 percent for Cu and in the range of 30-50 percent for Zn. Estimated removal rates for Cd are suspect, due to small source-generated loads and inability to depict relative mobility of this TM relative to Cu and Zn, that are more affected by stream-channel sediments.

Needed NPS management measures needed to implement the trace-metals loads reductions.— Further evaluation was made of NPS-management measures, with the goal of meeting existing or ultimate stream standards (Section 4). This evaluation was conducted on the basis of individual stream segments and the previously identified seasonal water-quality standards' exceedances. Given the anticipated TMs loads reductions, ambient low-flow stream standards would be attained for SS 2 (Cu; upper Clear Creek), SS 13b (Cd, Cu, and Zn; North Fork Clear Creek), and SS 11 (Zn; lower Clear Creek). Stream standards would not be achieved for SS 2 (Zn, low-flow season), SS 9a (Cu, Fall River, high-flow season), and SS 9b (Cd, Cu, and Zn, Trail Creek, high-flow season). For the more-stringent ultimate (underlying) stream standards, only the Cu target for SS 2 (upper Clear Creek) would be attaianed, and all other standards would not be fulfilled assuming the currently planned remedial actions for reducing TMs loads (Section 4).

Preliminary estimates of technical and financial (costs) assistance needed to implement this Plan.— For the Superfund's OU4 preferred remediation alternative (4B, involving predominately the North Fork Clear Creek subwatershed), capital costs of $11.8 million and O&M costs of nearly $11.5 million (annualized at $926,000/year) were estimated. Preliminary engineering-design work for high-priority components is currently proposed. For the Virginia Canyon area, remediation work is underway during the 2005 summer season. For completed remediation projects and several proposed future efforts, estimated costs were included in UCC-WAG (2001, Table B-1). Various sources of technical support and financial assistance have been inventoried (Section 10).

Enhancement of public understanding of this conceptual Plan through public meeting(s) and continued participation in selection/design of NPS implementation measures.-- A presentation overview of this Plan's findings and recommendations is planned as part of the *Clear Creek Watershed Forum 2005 – Creating a Sustainable Future*, scheduled for September 27, 2005. A wide audience is being sought for participating in this Forum. During work-group sessions at this Forum, the general public and various stakeholders will have the opportunity to express opinions on materials presented as well as to help to prioritize various watershed concerns. Appendix F *(pending)* of this Plan will provide details of the results of this scheduled Forum, and it will be summarized in Section 5.

Recommended TMs-related actions, based upon results documented to date in this Watershed Plan, include the following:

- Further WQ characterization of Trail Creek is warranted (Sections 1 and 3). The existing data are limited and it appears that this tributary is a significant TMs contributor to the mainstem Clear Creek (SS 2 and downstream).
- Further characterization of TMs loads contributed from a set of waste-rock piles representing a range of mineralogy, areal location, age, and other conditions. This would improve or provide a technically-sound basis for estimating TMs load reductions. Priority should be given to high-ranked areas of Virginia Canyon and the North Fork Clear Creek (Section 3). Remediation of waste-rock piles in other subwatersheds also might be considered (such as for Gilson Gulch).
- Re-evaluation of assumed TMs-loads reductions for PSs (treatment facilities) and waste-rock piles (see previous item), as well as other critical NPS areas.
- Additional monitoring-related work, including source-area site characterizations, might be considered (Section 4).
- Further evaluation of review/assessment work and TMs-reduction comparisons reported in this Plan should be made with relevant profiles developed by various Medine modeling studies (Section 4).

As was mentioned previously, this Plan currently includes only the Phase-I work tasks identified in the 319-grant award under a proposal submitted by the Upper Clear Creek Watershed Association (UCCWA) and approved under this contract by the CDPHE-WQCD. The remaining USEPA watershed-plan elements not yet addressed by this Plan should be completed; UCCWA plans to take action on including these aspects in the Plan during 2006. In addition, because this Plan focuses on stream standards and associated impaired segments involving only trace-metals concentrations, the Plan should be enhanced to address other water-resources and water-quality issues facing UCCWA and the watershed's stakeholders.

Current Status and Analysis of Baseline Data

The objective of this 319-Grant component has two aspects: (a) to compare current water quality conditions with the existing underlying water-quality standards (WQSs); and (b) to assess instream instream biological conditions versus ambient trace-metals levels for selected stream reach(es) of the upper Clear Creek watershed. These two aspects comprise 319-Grant Tasks 1 and 2, respectively. Task 2 is scheduled for completion in December 2005.

<u>Trace-Metals Data Analysis *(Task 1)*</u>

In this initial work task, existing available data for hardness and dissolved species of zinc, copper, and cadmium were used in an assessment of seasonality of the data and of a comparison of 85^{th}-percentile values for these selected trace metals (TMs) relative to applicable stream standards. The data assessment focused on the following WQCD stream segments:

- 2 – mainstem Clear Creek, Silver Plume to Argo Tunnel
- 5 – West Fork Clear Creek, from Woods Creek to confluence with Clear Creek
- 9a – Fall River
- 9b – Trail Creek
- 11 – mainstem Clear Creek, Argo Tunnel to Golden, and
- 13b – North Fork Clear Creek, from BH water-supply intake to confluence with Clear Creek.

It should be noted that the original stream segment 9 was divided into two separate segments (9a and 9b, as described above), as a result of recent stream-standards deliberations (WQCC, 2004, p. 2) and to accommodate special water-quality conditions in Trail Creek. Two additional stream segments are currently listed on the CDPHE-WQCD 303(d) List:

- 3a – South Fork Clear Creek, and
- 3b – Leavenworth Creek.

However, water-quality conditions and compliance with applicable stream standards for these two stream segments have not been considered in this assessment at the same level of detail as for the above-named stream segments. This is because they are not included within the scope of the current 319 grant, nor do they involve WWTPs that are considered point sources of water-quality constituents of concern. Rather, they are in the upper part of the watershed and involve mining-related TMs sources. Finally, other trace-metals species included on the currently applicable 303(d) List are not included, such as dissolved manganese, dissolved lead, and total iron. This is in adherence to the 319-Grant scope of work (SOW) (UCCWA, 2004b).

Available Water-Quality and Streamflow Data

Existing and available water-quality and associated streamflow data were used for this assessment. Period-of-record (POR) data at 26 sampling locations through 2004 from the following monitoring programs were considered and used (Table 1.1):

1. UCCWA/SLCs monitoring program since 2/94 – up to 17 sites (CC-xx), of which 11 sites characterized the stream segments of interest (two other sites for SSs 3a and 3b were of secondary interest);
2. CDOW monitoring program – 12 sites (09xx) involving three of the stream segments;
3. BHCCSD monitoring program, starting in 12/00 – two NFCC sites; and
4. CDPHE site-specific investigation for Trail Creek – one year of data at one site (5673).

For the UCCWA/SLCs monitoring program, streamflows associated with discrete samples analyzed for the variables of interest have been measured or estimated through inter-station correlations (TDS project file, updated on 12/8/04). Otherwise, streamflows are not available for the water-quality data from the other three monitoring programs. Flow conditions during sampling surveys are an important consideration, in evaluating effects of hydrologic variations, both seasonally and year-to-year.

Approaches

Using the hydrologic (water-quality and streamflow) data described above, graphic and statistical analyses were made. The forms of analysis consisted of the following:

- Site-specific data-compiled average values for the available periods of record,
- An evaluation of seasonality in hardness data, accompanied by streamflows (if available);
- Aggregated-data statistics (averages, number of values, and 85th percentiles) for data from all monitoring sites combined for each stream segment; and
- Comparison of the appropriate statistics with applicable stream standards – either table value standards (TVSs), temporary modifications (WQCC, 2004), or other narrative standards.

For the seasonality evaluation, most data for monitoring sites in the watershed exhibited a clear delineation into two distinct periods:

- a low-flow, high-concentration period (7 months from October through April); and
- a high-flow, relative lower concentration period (5 months from May through September).

Streamflow and/or water-quality conditions for the transition months (mostly April and October) occasionally did not fit this delineation; however, the norm was this 7-month/5-month split for most hydrologic conditions and years. Moreover, this seasonality split in general was consistent with that proposed and used for two stream segments in the watershed as part of the OU4 RI/FS investigations (Tt-RMC, 2004).

From this assessment, then water-quality statistics calculated from available monitoring-site data sets were compared with applicable stream standards.

Results

POR average TMs (and major cations and hardness) concentrations, along with average streamflows (where available) are summarized in Table 1.2. It should be noted that this compilation of average conditions includes data only for the UCCWA/SLCs sites. This compilation of averages in on a site-by-site basis. These averages are indicated graphically as in a generalized watershed profile (from an upstream (left) to downstream (right) direction) in Figure 1.1. On the right-hand side of this summary table, the two seasonal-period average streamflows and hardness concentrations are indicated. For the three TMs of interest (Cd, Cu, and Zn) to this assessment and for hardness, averages for the data from other monitoring programs have been added to the watershed stream profiles. Tributary values are inserted in between mainstem sites.

Using the results of the previous summary and considering the water-quality data for the monitoring sites besides the UCCWA/SLCs monitoring program, the seasonal patterns in hardnesses and streamflows are given in the numerous time-series plots in Appendix A (Figures A-1 for UCCWA/SLCs sites and A-2 for CDOW and BHCCSD sites).

The more useful concluding part of this data assessment then was the comparison, segment by segment, of average hardnesses and associated TMs concentrations, calculated as averages and 85th percentile values. The 85th percentile values of TMs are calculated, using the average hardness concentrations derived from the data for any given stream segment. These then are compared to the appropriate currently existing stream standards. These comparisons are given in tabular form (Table 1.3) and also in graphic form (Figure 1.2).

Discussion

The data assessment presents strong evidence in support of seasonal hardness-based standards (Appendix A). The delineation into the two seasons (7-month, low-flows/high-concentrations) and 5-month, higher-flows/lower-concentrations) may be deliberated, based upon the findings of this assessment. However, in general, average low-flow seasonal hardnesses are 50 to 100 percent higher than average higher-flow seasonal hardnesses. It is during the low-flow season that most of the exceedances of 85th-percentile values exceed applicable standards:

- Zinc, in the cases of stream segments 2, 13b, and 11 are very prominent (Figure 1.2); and
- Copper, in the cases of stream segments 2 and 13b, which are less prominent;
- Cadmium, only for stream segment 13b, with the 85th percentile (6.1 ug/L) only slightly exceeding the temporary modification (6.0 ug/L) (Table 1.3).

For the stream segments of interest, the higher-flow season comparisons, as would be expected, are fewer. Exceedances for all three TMs of concern (Cd, Cu, and Zn) occur for this season for Trail Creek (stream segment 9b); however, these exceedances are based upon quite limited data (1-year equivalent). Otherwise, Cu 85th-percentile exceedances are noted for stream segments 9a (Fall River), and 11 (mainstem Clear Creek from Argo Tunnel to Golden).

It is noteworthy that TMs exceedances for the North Fork Clear Creek (SS 13b) occur only during the low-flow season (Table 1.3); whereas, the reverse is the case for Trail Creek (SS 9b). The situation for Trail Creek is not expected nor is it explainable at this time.

The Cu 85th-percentile values for both seasons calculated from available data for SS 11 (mainstem Clear Creek from Argo Tunnel to Golden) are within the 17-ug/L Cu chronic standard (non-TVS) applicable to this stream segment.

Some additional observations include POR time trends regarding the following may warrant some consideration in future, more detailed data assessments of TMs and associated standards:

- Increasing HRD values, especially during wintertime periods, and numerous sites; and
- Increasing pH values (shift of about 0.7 std. unit over a 11-year period) at the two lower monitoring sites for the North Fork Clear Creek (CC-45 and CC-50), based upon UCCWA/SLCs data included in the watershed's water-quality database.

Recommendations

1. All available water-quality data from the various sources through December 2004 have now been incorporated into the data assessment and calculation of statistics and standards.
2. Streamflows should be estimated at sites currently having no flow information, through installation and recording of stage levels, discharge measurements (as frequently as possible), and complemented through interstation correlations.
3. Additional monitoring data are recommended for Trail Creek, to evaluate in greater detail seasonality (including effects of flows) and year-to-year variability. This aspect has been included as part of the "routine" UCCWA/USEPA monitoring program during 2005.
4. For stream segment 11 (lower mainstem Clear Creek), the dissolved-zinc's 85th percentile (475 ug/L) exceeds the temporary modification (year-round value of 339 ug/L) for the low-flow season (Figure 1.2A), using the full period-of-record data set. However, using data only since April 1998 (beginning of Argo-adit treatment operations), the D-Zn's 85th percentile value decreases to 384 ug/L; this still exceeds the temporary modification value of 339 ug/L. Thus, this re-calculation confirms that the exceedance is not driven entirely from the historical (pre-4/98) conditions reflected by the historical data and that further D-Zn load reduction is required in order to achieve this target. The load reduction is even greater to meet the underlying standard for D-Zn (TVS of 124 ug/L, based upon an average low-flow hardness concentration of 106 mg/L (using the entire period-of-record data; this value increases only slightly (109 ug/L) using only the post-4/98 data).

Biological Assessment (Task 2)

[Notes: Field investigations scheduled for September 27-28, 2005 (Tammy Schneck, Aquatic Associates, Inc., oral commun., 6/10/05, 7/25/05, and updated 9/21/05). With time allowed for analysis of field investigations, the tentative target date for completion of this Task was shifted to mid-March 2006. Therefore, a realistic schedule for adding aspects of this Task was early April 2006. This section (provided on 4/26/06) constitutes the third revision to the 9/27/05 version of the UCC Watershed Plan.]

The primary purpose of this Plan component is to provide a baseline characterization of biological conditions in the upper Clear Creek watershed. Based upon available historical data and recent study results, several biological indicators are linked with three trace metals of concern: copper, zinc, and cadmium. Some data results are not yet available or have not been processed; however, these are referenced here for a future enhancement of the ambient biological characterization completed for this Plan.

Estimated brown-trout populations have been made by the CDOW since 1988 (Woodling and Ketterlin, 2002, Table 8; Shannon Albeke, CDOW, written commun., 3/1/06). A useful depiction of these data for eight sites along the mainstem Clear Creek sites is given as a time series in Figure 1-3. The sites are numbered by CDOW in an upstream-to-downstream order. In addition to these mainstem Clear Creek sites, CDOW has collected fish data for two major tributaries (WFCC and NFCC) as well as at a downstream Clear Creek location (Tunnel #1). In this latter case, the site has been included in only some of the fish surveys, with no data collected since the spring of 2000.

Figure 1-3 indicates the annual variability for these eight sites for the fall-season sampling surveys. The first five sites (#s 1 through 5) are located along stream segment 2; whereas, the remaining three sites (#s 6 through 7.5) are along stream segment 11. Several observations are as follows:

1. Sites 1 and 2 in the upper part of the watershed exhibit consistently the highest average numbers of brown trout per acre.
2. Most sites exhibited increasing brown-trout numbers during the period from 1998 through 2002; then numbers decreased to levels still above values prior to 1998.
3. For recent years, site 3 numbers tend to be lower than site 4 values.
4. For sites 5 through 7.5, the annual brown-trout average numbers exhibit similar time-series patterns, with maximum numbers occurring during 2002 (an extremely below-normal flow year).

These fish-data results should be kept in mind when later assessing the corresponding trace-metals conditions along these same reaches of the mainstem Clear Creek (see below).

Figure 1-4 exhibits the numbers of brown trout per acre without the young-of-the-year fish (that is, including only fish with lengths greater than 115 mm). These data, currently available only for the 2001-2004 period, indicate similar patterns with those given in Figure 1-3. However, the 2002 numbers are distinctly different, with the adult fish numbers being considerably lower when compared with the other three years.

Nonetheless, the general patterns of reduced numbers in an upstream-to-downstream direction along the mainstem Clear Creek is indicated, at least for the upper three or four sites.

It is generally known that trace-metals concentrations tend to increase from upsteam to downstream along the mainstem Clear Creek, at least to the Kermitts site CC-40 (TDS Consulting Inc., 2002a, Figures 38 and 47). Trace-metals upstream-to-downstream profiles (Figure 1-5, copper; Figure 1-6 for zinc; and Figure 1-7 for cadmium) along the mainstem Clear Creek clearly indicate the inverse relationship between brown-trout numbers (2001-2004 averages) and dissolved TMs concentrations. However, some anomalous conditions occur:

1. CDOW site 3 (0949) exhibits a pronounced reduction in brown-trout numbers relative to only slight increases in TMs concentrations.
2. There is some recovery in average fish numbers at CDOW site 4 (0943), despite the increased TMs concentrations compared to the upstream site 3.
3. Beginning at CDOW site 5 and downstream, the fish numbers remain low (compared with upstream numbers) and associated TMs concentrations are relatively high (Figures 1-5 through 1-7).

In late September 2005, Aquatics Associates, Inc. (2006) conducted a macroinvertebrate survey at five sites involving West Fork Clear Creek (3 sites) and the mainstem Clear Creek upstream and downstream of the confluence of WFCC (sites CC-25 and CC-26, respectively). The results of several biological indicators from this study were compared with TMs concentrations for the 10/13/05 sampling survey. TMs data are available only for three of the five biological-sampling sites. However, these reflect the relative impacts of the WFCC on this part of the mainstem Clear Creek.

The comparisons are made using various biological indicators provided by the AAI (2006) study as follows:

1. EPT Index (EPT richness), indicating sensitivity to metals pollution (Figure 1-8). Site CC-25, with an EPT Index value below 21, exhibits metals-related impairment. This principally involves the relatively high zinc concentrations in this part of stream segment 5. The EPT Index in Clear Creek below WFCC (site CC-26) is beneficially impacted by the low TMs concentrations from that tributary.
2. The Metals Tolerance Index (MTI) indicate the inverse pattern (Figure 1-9), with the MTI values being higher for metals impairment. For all WFCC sites, the MTI values are less than 3.0, indicating non-impairment. In contrast, the MTI values for the mainstem Clear Creek sites (CC-25 upstream of WFCC; CC-26 downstream of WFCC), indicate a greater degree of impairment, with the MTI value at site CC-25 exceeding 5.0.
3. The Hilsenhoff Biotic Index (HBI) measures macroinvertebrate community responses to organic pollution. Higher values indicate higher pollution. In the AAI (2006) study, all HBI values were less than 6.0. The highest value (4.99 at site CC-25) may be impacted by the Town of Georgetown's WWTP discharge upstream.

4. Macroinvertebrate species diversity is used to assess overall stream "health" and is used in conjunction with other biological indicators. Higher values of diversity are better. No values were less than 1, indicating stressed communities. Values of 3.3 or better indicate non-impairment due to metals. Only one site (CC-25) exhibited a diversity (2.76) less than this threshold. This may be attributable to the relative high zinc concentrations at this location in the mainstem Clear Creek.

The Plan advocates seasonal hardness-based TVSs for trace metals of concern (that is, those listed on CDPHE's current 303(d) list for Clear Creek segments. This approach is supported by the seasonality exhibited in streamflow and hardness data (TDS Consulting Inc., 2004, Figures A-1 for UCCWA data and Figure A-2 for CDOW data).

As future considerations to the Plan's biological assessment, the following recommendations are provided:

1. Refinement of the CDOW fish data (specifically, historical and recent data for brown-trout populations without young-of-the-year numbers, Figure 1-4) would be useful to compare with the total numbers.
2. It is understood that the historical CDOW macroinvertebrate data (Woodling and Ketterlin, 2002, Table 4) and more recent data through 2003 collected by CDOW used a sampling technique that has been replaced by an improved method (since 2004). Hence, pre-2004 data have not been incorporated into this biological assessment.
3. The 2005 macroinvertebrate data are not yet available (Shannon Albeke, CDOW, written commun., 3/1/06) and the 2004 and 2005 macroinvertebrate data metrics need to be calculated. Once these are available, it is recommended that site-by-site links of the resultant metric be made with available TMs data.
4. The quarterly CDOW TMs data for 2005 are not yet available (Shannon Albeke, CDOW, written commun., 3/1/06); these data should be added to the CDOW data set and then used for expanding the biological assessment/TMs linkages.

With these near-term biological-assessment enhancements, this section should be revised and expanded to incorporate these missing data.

Source Identification (Watershed-Plan Component 1)

For this component, causes and sources of TMs contamination in streams of the upper Clear Creek watershed are inventoried, using available information from the literature and associated data. Focus of this component (comprised of Tasks 3 and 4 of the 319 Grant for development of a Watershed Plan) is made on those TMs' sources/causes that can be controlled and remediated to achieve existing water-quality standards (WQSs). Some narrative descriptions are provided below; related source listings and water-quality characterization summaries are provided in attached Excel-file worksheets.

Numerous source areas already remediated in the upper Clear Creek watershed have been included in this compilation, based upon the available technical literature and associated notes/observations from CDPHE, DMG, and CSM representatives interviewed for the two tasks in this watershed-plan component. This aspect will be useful in evaluating anticipated load-reductions estimated in subsequent 319-Grant tasks for this phase, as well as judging the performance effectiveness of various treatment technologies.

CERCLA Control Actions *(Task 3)*

The various identified CERCLA-related control actions tabulated; the mine-related sources are summarized in Table 2-2; whereas, a few WWTP-related discharges sampled during various RI/FS investigations are given in Table 2-3. Some supplemental data and information are provided in the following paragraphs.

Severson (1991, p. 29) reported on pre-treatment (October 1985) concentrations for pre-treatment conditions at the Argo Tunnel adit for selected water-quality variables of interest to this assessment (no results for cadmium; assumed to be less than detectible analytical concentrations):

Constituent (units)	*Argo Tunnel*	*CC Upstream*	*CC Downstream*
Copper (lg/L)	5,400	18	14
Zinc (lg/L)	9,600	190	430

[Notes: Add effective TMs loadings removal since 4/98 for Argo WWTP; cite references. Ron Abel, CDPHE-HMWMD is to send TDS a data file with post-treatment Argo discharges (hopefully with flows) and perhaps an update of upstream vs. downstream WQ conditions in the mainstem Clear Creek. These data will be useful for subsequently planned 319-Grant tasks.]

Lewis (1995) documented data results for 3 sampling surveys (July 1994. March 1995, and June 1995) in the North Fork Clear Creek drainage. The data are included in Table 2-2, along with earlier and subsequent sampling-survey results included in various reports.

Medine (1996) followed up the previous investigation with a fall (late-October) 1995 sampling survey, which included point sources of contamination for both the mainstem Clear Creek and NFCC. Again, these results are included in the summary Table 2-2.

UCC-WAG (2001, Table 4, p. 25) reported zinc loadings provided by Medine (1995) for a number of point sources along the NFCC (sequenced below in an upstream-to-downstream order) and included a relative ranking (by Holly Flineau, formerly with USEPA) for the following sites:

Location (Code)	*Diss-Zn Load (lbs/d)*	*Rank (1=worst; 8 best)*
Chase Gulch	0.76	6
Gregory Incline	6.6	3
Gregory Gulch *	0.63	7
NPS between Gregory Incline/National Tunnel	n/a	8
National Tunnel	2.2	5
Unknown sources, Black Hawk	3.0	4
NPS between BHCCSD WWTP and Russell Gulch	n/a	8
Russell Gulch	dry	
NPS below Russell Gulch	n/a	8
NFCC at CC confluence	8.0	2
NFCC alluvium	42	1
Total	**63**	

*Footnotes: n/a, negligible; * partly/totally remediated since 1994 sampling.*

Wildeman and others (2003b) characterized a total of 29 mine-waste piles and sediments in Gilpin County, principally in Russell Gulch and its tributaries (in the NFCC sub-watershed). Then, a priority-ranking system was used for determining relative importance of remediation of the various sites included in this investigation. This CSM study was patterned after that completed earlier for Virginia Canyon (Herron and others, 2001). In this earlier assessment, Wildeman and others (2003a) developed a decision tree for assessing aquatic toxicity of mine wastes. Selected assessment results for the Russell Gulch study are summarized for the seven identified "high-priority" sites as follows:

Location	*Size, yd^3*	*Cd, ug/L*	*Cu, ug/L*	*Zn, ug/L*	*Score*
Niagra	11,000	<2	7,926	1,798	4.08/5
Baltimore	n/a	9	3,095	950	4.04/5
Solution Gold	spread out	77	2,160	15,321	4.00/5
Extenuate	n/a	15	21,688	2,069	4.00/5
Old Jordan	n/a	27	208	5,913	3.92/5
Centennial	small	3	610	546	3.88/5
Mattie May	n/a	5	5,073	2,641	3.83/5

CDPHE (1998, Table 01010-5, p. 01010-8) reported groundwater-quality characterization data for monitoring wells in proximity of the Big Five Mine Waste Reclamation project:

Well	*Date*	*Cd (ug/L)*	*Cu (ug/L*	*Zn (ug/L)*
BF01	11/25/85	43.0	2,410	10,500
BF01	2/12/86	29.0	1,830	9,380
BF01	6/15/86	31.4	1,640	8,640
BF03A	7/14/87	115	15,000	17,300
BF04	7/10/87	17.0	180	4,610
BF06	7/15/87	105	2,850	11,000

This remediation project is near complete (Jim Lewis, CDPHE-HMWMD, oral commun., 1/19/05); remaining work involves characterization, removal, and disposal of iron-oxide sludges in a pond (western part of Idaho Springs) and construction of a pipe conveyance to the Argo Tunnel through the Town of Idaho Springs (along Colorado Blvd.). CDPHE-HMWMD and USEPA are overseeing the first aspect; whereas, CDOT is completing the second aspect. This remaining work is scheduled for the 2005 construction season.

Lewis (2001, Figure 26; 2002a, Figure 24) documented results of the 5/01 and 10/01 sampling surveys of surface waters and groundwaters of Virginia Canyon and the Clear Creek and alluvium both upgradient/upstream and downgradient/downstream of Virginia Canyon. These field surveys in general concluded that TMs loads from this source (Virginia Canyon) would more effectively be accomplished through a slurry (cutoff) wall reaching bedrock in the Canyon, coupled with piping of intercepted flows for conveyance to the Argo WWTP. Estimated loadings for TMs of interest are summarized as follows:

Location (SW or GW)	*Date*	*Cd (lb/d)*	*Cu (lb/d)*	*Zn (lb/d)*
VC-SW-1, mouth of Canyon	5/01	0.07	1.40	14.0
	10/01	0.02	0.41	4.21
VC-MW-1A, lower Canyon	5.01	0.02	0.23	3.26
	10/01	0.03	4.49	4.90

However, reducing this water flux from Virginia Canyon into the Clear Creek alluvium might have an additional benefit of decreasing D-Zn loadings to Clear Creek in this area by 50 lb/d, assuming a 50-percent reduction of the 111 lb/d loading differential between upstream (site SW-7A) and downstream (site SW-7B) monitoring results for 5/01 (Lewis, 2001, p. 46). The comparable 10/01 loading differential in Clear Creek was less (23.4 lb/d), due to the lower flows at this time of year (Lewis, 2002, p. 32).

An investigation of soil and sediment samples from abandoned mine areas of the NFCC sub-watershed was conducted by the USACOE (2003), in accordance with two Site Work Plans (USACOE, 2002a; 2002b). Results of water-leachate analyses are given for a number of source areas (USACOE, 2003, Table 2), which are incorporated herein by reference.

Point sources (mine-tunnel discharges; tailings/waste-rock piles) were identified and characterized in previous Superfund investigations and associated RODs (Table 2-1) (USEPA, 1987; USEPA & CDPHE, 1991; 2004). RMC (2002, Table 2.3-1) summarized the various CERCLA-related monitoring surveys conducted during the 1985-through-2001 period. Selected TMs data for characterization of various point sources have been included in this review (Table 2-2). Finally, some additional monitoring was conducted during May 2002 as part of the OU4 investigations to characterize selected point sources (Tt-RMC, 2004a, Appendix A)

Other Nonpoint Sources & Causes of Contamination *(Task 4)*

The USEPA (1994) reported on a sampling survey completed during April 4, 1994, of the McClelland (previously covered under the OU3 ROD) and Aorta Tunnels:

Location	*Diss-Cd*	*Diss-Cu*	*Diss-Zn*	*Flow (cfs)*
CC above McClelland	<0.5 ug/L	<5 ug/L	131 ug/L	27.2
	0.000 lb/d	n/a	192.1 lb/d	
McClelland Tunnel outfall	14.3 ug/L	46 ug/L	3013 ug/L	0.060
(see Table 2-2)	0.046 lb/d	n/a	9.7 lb/d	
McClelland below wetland	12.9 ug/L	<5 ug/L	2243 ug/L	0.032
	0.022 lb/d	n/a	3.9 lb/d	
CC below McClelland	<0.5 ug/L	<5 ug/L	112 ug/L	31.9
	0.000 lb/d	n/a	192.6 lb/d	

Location	*Diss-Cd*	*Diss-Cu*	*Diss-Zn*	*Flow (cfs)*
North Empire Ck ab Aorta	1 ug/L	239 ug/L	155 ug/L	0.011
	0.001 lb/d	n/a	0.092 lb/d	
Aorta Tunnel discharge	1 ug/L	370 ug/L	756 ug/L	0.017
(see Table 2-2)	0.001 lb/d	n/a	0.69 lb/d	
North Empire Ck bl Aorta	1 ug/L	220 ug/L	533 ug/L	0.082
	0.006 lb/d	n/a	2.36 lb/d	

Footnote: n/a = not calculated.

A second sampling survey (10 surface-water samples and four mine adits/waste-rock pile) was conducted by the CDPHE's (1995, Figure 2 and Tables 5-1, 5-2, and 5-4) HMWMD for the North Empire and Lion Creeks Project area on May 26, 1994. Concentrations and loadings for Cd and Zn were included in this survey (Cd concentrations were nondetectible at less than 0.0050 ug/L). This indicated the re-deposition of the Minnesota mill tailings in Lion Creek, which since have been remediated. Mine adit-discharge characteristics from this survey were reported as follows:

Location	*Flow (cfs)*	*Diss-Cu*	*Diss-Zn*
M-1 Minnesota Mine	0.011	550 ug/L	900 ug/L
(see Table 2-2)		0.03 lb/d	0.05 lb/d
M-2 Aorta Mine	0.023	470 ug/L	660 ug/L
(see Table 2-2)		0.06 lb/d	0.08 lb/d

Sares (undated, Table 1) reported water-quality data results for two sampling surveys involving the Little Bear Mine. Samples were unfiltered; therefore, TMs concentrations and loadings for the mine-adit portal are for total species:

Date	*Flow (gpm)*	*Tot-Cd*	*Tot-Cu*	*Tot-Zn*
11/08/91	n/a	52	540	13,000
10/26/95	1.1	51	460	n/a

Note: n/a = not measured or not analyzed.

A useful site-comparison index was developed by the Orphan Sites Steering Committee (1996, p. 6) for 11 potential orphan-mine sites in the Clear Creek watershed. Several of the indexing criteria used (specifically, size (giving approx. volume of material), proximity to water, and erosion) are relevant to site characterization (comparing with other studies/field investigations) and eventual remediation prioritization. These sites' water-quality characteristics for TMs of interest in this assessment are summarized for these orphan-mine sites as follows:

Mine-Site Area (POR)	*Cd, ug/L*	*Cu, ug/L*	*Zn, ug/L*	*HRD, mg/L**
Boomerang Gulch (1986)	342	5,340	92,350	81
Buckley (1985-86) #	96	405	4,280	130
Donna Juanita (1979-88)	3.1	86.2	820	81
E. Williams Mine Dump @	5.7	147	1,280	130
Gregory (Gulch) #3 (85-86)	96	405	4,280	130
Keystone (1985-86)	17.5	65.5	2,515	130
Nevada Gulch Sites (85-86)	269	1,645	44,300	130
Pittsburgh (1985-86)	4.1	165	785	130
Sans Souci (1986) @	5.7	147	1,280	130
Trail Creek Sites (1979-88)	3.1	86.2	820	81
Va. Canyon Sites (1985-86)	450	10,500	84,100	81

*Notes: * Assumed (not measured) HRD values. # Located in Gregory Gulch. @ Both located in Chase Gulch.*

CWT Corporation (2002) inventoried 41 mine-dump sites (source areas) for possible remediation in the Russell Gulch areas; this report also extracted characterization and prioritization of numerous source areas in Virginia Canyon by the CDMG (Herron and others, 2001). Using the CSM decision-matrix (ranking) system for determining priorities for site remediation, five Russell Gulch sites and 16 Virginia Canyon mine-dump sites were selected for priority reclamation (Appendix B, Part II). However, some of the Virginia Canyon sites ranked as "Priority 1" by Herron and others (2001) did not correspond with the CWT Corporation (2002) ranking scheme.

A final non-CERCLA site with minimal characterization is the Alice Glory Hole drainage in the upper part of Fall River. Data collected by the CDMG (Jim Herron, written commun., 1/21/05 and 1/26/05) included characterization of this source area (Table 2-2). In addition, this CDMG data sets for the two surveys (May and October 2001) provided reconnaissance-level characterization for nearby streams: Little Creek and Silver Creek, both upper tributaries of Fall River.

Summary

In this source-area inventory compilation, both mine-related and WWTP discharges to streams of the Clear Creek watershed have been considered. Highlights are as follows:

- Historical and recent sampling-survey results from numerous investigations (see reference lists and Tables 2-2 and 2-3;
- Characterization and priority-ranking of 205 mine-related source areas in Virginia Canyon (Herron and others, 2001), combined with 41 sites in the Russell Gulch area (CWT Corporation, 2002) and a more recent characterization and prioritization of mine-related source areas in Russell Gulch (Wildeman and others, 2003);
- Compilation of TMs characteristics of WWTPs in the upper Clear Creek watershed (limited for all facilities except that monitoring by the BHCCSD);
- Consideration of several mine-site studies characterizing specific source areas in the watershed (examples include Aorta Mine, Alice Glory Hole, Minnesota Mine, and Lion Creek).

These compilations and characterization of TMs and flows (where available and applicable) from source areas and mine discharges will be used in subsequent tasks for evaluation of TMs-related source-load reductions to achieve various water-quality targets.

Estimated TMs Loads Reductions (Watershed-Plan Component 2)

For this component, estimated reductions in TMs loads from various point sources impacting streams of the upper Clear Creek watershed are inventoried and evaluated, using available information from the literature and associated data. Focus of this component (consisting of Task 5 of the current 319 Grant for development of a Watershed Plan) is made on those TMs' sources/causes that can be controlled and remediated to achieve existing water-quality standards (WQSs) for dissolved species of cadmium (Cd), copper (Cu), and zinc (Zn) – the contaminants of concern (CoCs) for this assessment. Some narrative descriptions are provided below; related source listings and water-quality characterization summaries are provided in attached Excel-file worksheets.

Primary information sources for this task were several modeling assessments completed by Medine (1992; 1999; 2001; 2003), the recently completed Superfund OU4 RI/FS (Tt-RMC, 2002; 2004a; 2004b), and the OU4 record-of-decision (ROD) (CDPHE and USEPA, 2004). For this assessment, some source areas already remediated (some only in part) in the upper Clear Creek watershed are considered, based upon the available technical literature and associated notes/observations from CDPHE, DMG, and CSM representatives interviewed for the two tasks (3 and 4) in a previous watershed-plan component. This aspect will be useful in evaluating the estimated load-reductions, as well as judging the performance effectiveness of various treatment technologies.

In this Watershed-Plan component (Task 5), an attempt was made to do the following:

- Tabulate all identified, contributing mine-related TMs sources (both point and nonpoint) from various previous studies/investigations, in order to minimize the possibility of not considering a source of TMs of concern;
- Screen out these numerous sources, relative to past remediation, relative TMs contributions (based upon available information and data), and other factors;
- Identify "higher"-priority sources for detailed TMs loads evaluation or need for further characterization and/or monitoring.

The Task-5 results then provide the basis for further stream-standards assessment to be completed in subsequent tasks under this 319 Grant.

Analysis of TMs Load Contributions

Cuffin and Chafin (2002, Table 13) provided an estimate of TMs loads from the upper part of the Clear Creek watershed above the Town of Georgetown affecting the mainstem Clear Creek. In this USGS investigation, loads were estimated for inflows to Georgetown Lake (based upon data over a 12-month period during 1997-1998). These are as follows (also reported in UCC-WAG, 2001, Table 10):

Trace Metal	***Inflow Load (lbs/d)****	***Notes***
Cd	0.28	Net load to Georgetown Lake = 21.4 lbs/yr*.
Cu	0.43	New loss from Georgetown Lake (outflow>inflow)
Zn	90.0	Net load to Georgetown Lake = 3750 lbs/yr*.

* *Converted from reported values as kg/yr.*

This study concluded that the principal contributing area of TMs (using Zn as an indicator variable) is the upper mainstem of Clear Creek (87 percent of the total load, UCC-WAG, 2001, Table 11); whereas, relatively smaller load contributions were from South Fork Clear Creek (12 percent) and Silver Gulch (1 percent). This conclusion confirms the investigations regarding load contributions from the Burleigh Tunnel and stream alluvium (including the Diamond Mine) in the Silver Plume area.

Tt-RMC (2004b, Section 1.2.4) distinguishes between TMs-load impacts during low flows (LF) and high flows (HF). Specific focus of this RI/FS investigation is on conditions in stream segments 13b and 11; however, some consideration is given regarding conditions upstream (stream segments 5 and 2). A synopsis of source loadings to the NFCC system based upon this primary reference is provided herein:

- During low flows, the Gregory Incline is the largest point-source of TMs (Tt-RMC, 2004b, Figure 1-5); next in decreasing order are Gregory Gulch, the Quartz Hill Tunnel, and the National Tunnel. These combined TMs loads contribute about 2/3rds of the NFCC loads during low-flow, with the remainder being non-point-source loads, such as groundwater inflow and TMs released from stream sediments.
- During high flows, the principal TMs loads contributions to the NFCC stream system are from Gregory Gulch and Russell Gulch; combined, these gulches account for up to 2/3rds of the total TMs loading, with Gregory Gulch contributing about twice the load of Russell Gulch (Tt-RMC, 2004b, Figure 1-6).
- During "very high" flows, the estimated TMs loads from Russell Gulch exceeds those from Gregoary Gulch and all other sources (Tt-RMC, 2004b, Figure 1-7).

Ambient TMs loads reported in Tt-RMC (2004b) were updated using results reported by TDS (2004). In addition, the split of months between high-streamflow and low-streamflow seasons was adjusted to be compatible with the hardness-based analysis completed under Task 1 (see Section 2 of this Plan). This indicated that the month of September most frequently was closer to characteristics of high flows (rather than low flows, as assumed by Tt-RMC (2004b). Updated TMs loads were lower than that reported by Tt-RMC (2004b). This was principally due to the fact that updated loads included the two lowest flow years of record (2002 and 2004 water years). The following tabular summary from Tt-RMC's (2004b, p. 1-7) has been updated later in this section.

		Avg Load	***(lbs/d)***	***percent***
Trace Metal	***Flow Regime***	***CC-40***	***CC-50***	***NFCC Contribution***
D-Zn	High	290	126	30
	Low	100	40.3	29
D-Cu	High	14.9	5.2	26
	Low	3.7	0.83	18
*D-Cd **	*High*	*1.53*	*0.43*	*22*
	Low	*0.45*	*0.14*	*24*

** TDS (2004) did not include cadmium; thus, these have been estimated based upon the other TMs ratios.*

Using this same sampling-site representation, CC-40 is considered representative of stream segment 11; whereas, CC-50 is considered representative of stream segment 13b. Regarding upstream conditions and the watershed as a whole, the largest TMs contributors to Clear Creek are NFCC, WFCC, and Virginia Canyon. WFCC contributes about four times the flow of NFCC; however, TMs loads of NFCC are larger, as indicated below (adapted from Tt-RMC, 2004b, p. 1-8, using more recent and updated (through the 2004 WY) results from TDS Consulting Inc. (2004)).

Variable (lbs/d) [POR]	*WFCC (CC-20)*	*NFCC (CC-50)*
Average HF loads		
D-Cu	2.6 (2.4)	6.9 (5.2)
D-Zn	29.3 (24.4)	157 (126)
Average LF loads		
D-Cu	0.41 (0.46)	0.63 (0.83)
D-Zn	3.7 (4.2)	36.8 (30.0)

Note: Also, see Table 3-4, which includes the values in parentheses.

For another high-priority remediation area (Appendix Table C-2), the groundwater/storm-runoff loads from Virginia Canyon to Clear Creek are relatively less (Tt-RMC, 2004b, p. 1-8).

Date/Event	*D-Cu Load (lbs/d)*	*D-Zn Load (lbs/d)*
High-Flow Event Loads		
August 2001	<1	111
Low-Flow Event Loads		
October 1995	3.1	11
May 2001	<1	20

From the above extracted information and data, this information will help screen the numerous identified sources (both point and nonpoint). For identified high-priority sources, an attempt is now made to evaluate the extent of remediation accomplished by previous projects and then the anticipated levels of remediation for future (many planned) projects.

Proposed CERCLA Remediation *(Task 5)*

Relative rankings of CERCLA investigations, culminating with the recent OU4 RI/FS determinations (Tt-RMC, 2004b), are provided by Table 3-3. This ranking is considered in this analysis as the principal reference source for relative ranks. However, these are to be compared with other non-CERCLA TMs sources from both point sources as well as nonpoint sources in the watershed (see section below on Other Considerations).

Using these previously-determined estimates of load sources, then the “challenge” in this task’s component was to develop realistic (technically based, as much as possible, and economically reasonable) TMs load-reduction estimates. The results of this effort then will be used to determine levels of improvement of stream water quality (in terms of the TMs of concern) and extent to which stream-standard targets can be achieved.

The recently completed CERCLA (OU4) investigation results summarized in Table 3-3 then is combined with other information sources and studies for a comprehensive tabulation of various (past and ongoing) point and nonpoint sources affecting water quality of streams of the upper Clear Creek watershed. This combined-information-source summary is given in Appendix Table C-2. In this summary, the various sources are segregated by watershed subarea and also are prioritized. In several cases (unranked and low-ranked priority subareas), the sources are listed for information only; these involve either stream segments not addressed by this current study or involve source areas (with a few expections) that have already been remediated. The exceptions may well be addressed in this study, because of continuing TMs contributions. However, these will be considered under the prioritized ranks assumed.

A conceptual schematic of TMs' sources and loads-reduction processes considered in this assessment is given in Figure 3-2. Based upon the screening-process results, two high-rank and two moderate-rank priority areas have been delineated (Table 3-5):

1. Area 7 (high) -- **Virginia Canyon** groundwater and storm-event TMs contributions from numerous mines and waste-rock piles in this subwatershed, affecting the lower part of stream segment 2 and downstream into stream segment 11;
2. Area 8 (high) – The **North Fork Clear Creek** tributary subwatershed, that has been the principal focus of the recent OU4 RI/FS project (Tt-RMC, 2004a; 2004b) as well as other studies;
3. Area 2 (moderate) – The **Silver Plume area** affecting the upper part of stream segment 2 and including major source contributions of zinc; and
4. Area 5 (moderate) – The various identified **Georgetown-to-Idaho Springs area**, contributing sources along the mainstem Clear Creek (affecting stream segment 2).

An exception (addition) to the above four "prioritized" areas for primary study focus involves selected sources continuing to contribute TMs to West Fork Clear Creek (stream segment 5; Area 4 (low rank). Some further analysis will be made of ongoing TMs contributions from mine-related sources (some partly or completed remediated) around the Empire area. The Henderson Mine (Phelps Dodge Corporation) has over the years improved TMs concentrations in the West Fork Clear Creek primarily with its upgraded water-treatment facilities. Because this stream segment is listed on the 303(d) list, it is included in this study to assess the extent to which TMs exceedences can be decreased to achieve more stringent WQ targets (even though seasonally-based TMs stream standards are not exceeded for the constituents of concern in this study; see below).

Based upon the proposed seasonal hardness-based standards proposed in this study, priority TMs loads reductions are evaluated for impaired stream segments under this proposed plan (see Section 1, p. 1-3 and Figure 1.2). Other considerations and assumptions for this evaluation need to be kept in mind (see next section). Following are the TMs loads and anticipated reductions that are thought to be achievable (Table 3-6):

1. Area 6 -- **Virginia Canyon** *(high priority)*, directly affecting the lower part of stream segment 2.—The reference site for stream TMs loads in the lower part of the mainstem Clear Creek is site CC-40 (Kermitts). In-stream (Clear Creek) TMs loads during the HF season are 3-to-4 times those during the LF season. TMs loads generated within the Canyon are the largest of any priority area for the LF season and are second (to North Fork Clear Creek) for the HF season, for two of the three TMs of concern (Cu and Zn). As indicated in Table 3-6, estimated TMs loads' reductions vary by season and with specific TMs; estimated reductions range between 8 percent (Cd, LF season) up to 56 percent (Cu, LF season). Remediation strategies currently in progress for Virginia Canyon involve capture of groundwater flows from the Canyon for conveyance to the Argo treatment facility for removal of TMs. This work in progress (J.D. Lewis, CDPHE-HMWMD, oral commun., 1/17/05) will have less beneficial impact on TMs contributed to Canyon streams via snowmelt runoff and summer thunderstorms eroding numerous waste-rock piles in this area (Herron and others, 2001; CWT Corporation, 2002). Additional remediation is expected to be achieved through removal on *in-situ* encapsulation/reclamation of these piles.

2. Area 7 – **North Fork Clear Creek** *(high priority)*, directly affecting stream segment 13b.—This area was the primary focus of the recently completed OU4 RI/FS investigations (Tt-RMC, 2004a; 2004b). Identification of mining-related sources and associated TMs loadings are derived from this principal reference source, along with other NFCC data and modeling studies. TMs loads generated from several mine-impacted subareas are being proposed for remediation through collection, pumping, and treatment at a new water-treatment facility near Black Hawk (Tt-RMC, 2004b; CDPHE and USEPA, 2004). TMs loads' reductions from these subareas should be relatively high; these are estimated to be comparable with those for the Virginia Canyon area (Table 3-6). For a second categorical area for the North Fork Clear Creek subwatershed, the Russell Gulch area has been delineated for remediation, principally through sediment controls (Medine, 2003; Tt-RMC, 2004b). Therefore, it is estimated that TMs loads' reductions achieved would be substantially lower (Table 3-6) than for the subareas upstream in the NFCC subwatershed.

3. Area 2 – **Silver Plume area** *(moderate priority)*, directly affecting the upper part of stream segment 2.—For this area in the upper part of the Clear Creek watershed, the Burleigh Tunnel is a principal contributor of TMs to the stream (see Appendix Table C-2 and a previous Table 2-2 (from the previous Tasks 3 and 4 deliverable). Loads of Cd and Cu from this area are minimal; a relatively greater contribution of Zn exists (in the range of 21-23 lbs/d; see Table 3-6). The percent Zn removal during the LF season is estimated at 19 percent; this is substantially less (3 percent) during the HF season, when the in-stream flows are

considerably higher (using site CC-25 as a reference site, with an average of 23.1 cfs for LF and 165 cfs for HF, respectively).

4. Area 5 – **Georgetown-to-Idaho Springs area** along mainstem Clear Creek *(moderate priority)*, directly affecting much of stream segment 2 (also consideration is given in this area of stream segments 9a (Fall River, HF D-Cu exceedance) and 9b (Trail Creek, HF exceedances for all three TMs of concern).—Major TMs contributors for this area were judged to be (1) Trail Creek and (2) the Big Five Tunnel. Data were too limited to incorporate the estimated lower TMs loads generated from the McClelland Tunnel and the Rockford Tunnel in this preliminary assessment (Tables 2-2 and 3-5). Partial remediation has already occurred for the Big Five Tunnel. Specific recommended actions for remediation actions for this and for Trail Creek remain to be implemented. Estimated TMs loads' reductions for the two primary sources in this area are estimated to be less than 10 percent.

5. Other Source Areas/Stream Segment Addressed – lower tributaries of West Fork Clear Creek (Area 4) and cumulative downstream effects on stream segment 11.-- These aspects are considered in this analysis, because of the WFCC impacts on downstream stream segments 2 and 11 along the mainstem Clear Creek and of the cumulative impacts of all upstream conditions on stream segment 11. For the proposed seasonally-based stream standards, no exceedances are noted directly for stream segment 5, West Fork Clear Creek (see Table 1-1).

Other Considerations and Assumptions

Expected (realistic) TMs-load reductions that can be achieved for remediated waste-rock piles is in the order of 50 percent (R.L. Jones, oral commun., 2/11/05). This estimate serves as the basis for calculating reductions in TMs loads from this source category (specifically applicable to Virginia Canyon, Russell Gulch, and other tributaries (gulches) in the North Fork Clear Creek subwatershed). This overall load-reduction estimate may well vary with mineralogy, location, trace metal of concern, and pile size, as well as consideration of other factors. However, information for this form of discrimination is not readily available; hence, this provisional estimate of load reduction is used to demonstrate the feasibility of developing load-reduction estimates for subsequent long-term beneficial stream WQ impacts in the upper Clear Creek watershed.

Mine-related adit-water sources subjected to state-of-the-art treatment technologies achieve 99+ percent removal efficiencies for TMs of concern. This has been demonstrated by the Argo treatment facility operations, through post-treatment monitoring (see Table 3-1 and Figure 3-1). Based upon the OU4 ROD (USEPA and CDPHE, 2004) and its preferred alternative, a level of treatment of 90 percent TMs load removal has been assumed for waste streams anticipated to be treated in this or a similar facility.

For purposes of this assessment, a "margin-of-safety" (MOS) has been factored in for the net estimated load reductions through water-treatment facilities (such as Argo) or on-site remediation. This factor is imposed, primarily because of a range of processes inherent in the watershed and in the stream-channel system (such as entrained TMs-laden sediments; possibility some variability among the TMs of concern) that offset partly the closer-in load reductions for point sources and NPS areas. For purposes of incorporating this MOS consideration and to lend some conservatism to this provisional loads-reduction assessment given in this study, a MOS factor of 0.8 in all cases has been assumed. Investigations including chemical characterization of stream sediments in the watershed indicate presence and persistence of TMs-laden sediments in stream channels; this process continues to contribute TMs to the streams' water column, even after upstream PS/NPS remediation. Further field investigations may result subsequent changing of this factor, either for the overall watershed (as presently assumed) or varied to account for site-specific conditions for any given stream reach or PS/NPS load reduction through remediation. Hence, it should be kept in mind in reviewing the results of this assessment that these considerations have been incorporated in the TMs load reductions estimated for high- and moderate-priority areas discussed above.

In reviewing the preliminary TMs loads' estimates (Table 3-6), it is very apparent that loads generated from primary sources identified in this assessment are greater than calculated TMs loads at selected key streamflow locations. Thus, another process that needs to be considered is the interaction between the stream's water column and stream-channel sediments. This process is considered under the heading of "TMs sediments" in Table 3-6; the values indicated are estimated TMs loads contributed to the stream (at a given reference monitoring site) that thereby tends to offset remedial actions for TMs removal upstream. These as well as other factors (% removal; MOS adjustment) need to be reviewed and evaluated in more detail.

Reviews of previous modeling work by Medine (1997a; 1997b; 1998; 1999a; 1999b) are provided by UCC-WAG (2001, Appendix D) and Tt-RMC (2004a, Section 5.3.2). Review of an earlier modeling application (Medine, 1992) is pending. More recent model applications to TMs conditions and potential remediation in the NFCC have been completed (Medine, 2001; 2003). Some evaluation of these reviews as well as an assessment of relevance to current remediation recommendations (including those in CDPHE and USEPA, 2004) has been made, and this critical review/analysis effort will be completed in subsequent 319-Grant tasks (specifically, ongoing Tasks 6 and 7).

Finally, this assessment maintains the parallel for analysis in distinguishing between a 7-month low-flow (LF) season and a 5-month high-flow (HF) season. This is done to provide for a more direct comparison with ambient water-quality conditions and associated seasonal hardness-based standards (see Section 1). This seasonal delineation is critical in subsequent work anticipated for this study's Tasks 6, 7, and 8.

Summary and Recommendations

In this assessment of anticipated levels of TMs load reduction, highlights are as follows:

- High-priority areas for consideration of remediation for achieving WQ stream standard targets consist of the North Fork Clear Creek subwatershed and Virginia Canyon. These areas impact the lower part of stream segment 2 (mainstem Clear Creek) and stream segment 13b (North Fork Clear Creek), as well as the downstream stream segment 11 along the mainstem Clear Creek (Argo to Golden).
- Moderate-priority areas for consideration of remediation consist of the Georgetown-to-Idaho Springs area and the Silver Plume area, both along the mainstem Clear Creek and directly impacting WQ conditions in stream segment 2 and then also the downstream Clear Creek stream segment 11.
- Overall, in the mainstem Clear Creek in downstream stream segment 11, estimated effective TMs loads' removal is estimated to be above 80 percent for Cu and in the range of 30-50 percent for Zn. Estimated removal rates for Cd are suspect, due to small source-generated loads and inability to depict relative mobility of this TM relative to Cu and Zn, that are more affected by channel sediments.
- For these areas, and with consideration of selected possible projects in upstream areas (specifically, Empire area and upper Fall River), remediation actions and associated TMs load reductions are estimated in a preliminary manner. In many cases, data and information are limited. More detailed characterization and monitoring data are recommended (see below).
- With these Task-5 results, subsequent work tasks for this study will evaluate expected probability of achieving WQ targets, and preliminary cost estimates will be evaluated from available sources and/or estimated.

Based upon the work completed to date as a result of this study, recommendations include the following:

- Further WQ characterization of Trail Creek is warranted. The existing available data are limited (CDPHE, 1 year at site 5673; other intermittent samples), and it appears this tributary is a significant TMs contributor to the mainsteam Clear Creek (stream segment 2).
- Further characterization of TMs loads contributed from a set of waste-rock piles representing a range of mineralogy, areal location, age, and other conditions. This would improve or provide a technically-sound basis for estimating TMs load reductions (and hence, remediation benefits to compare to costs). Priority should be given to waste-rock pile characterization in high-ranked areas of Virginia Canyon and the North Fork Clear Creek (to enhance on previous work in the former area by CDMG (Herron and others, 2001) and CCWF (CWT Corporation, 2002) and in this latter area by CSM (Wildeman and others, 2003b) and by Medine (2001; 2003).
- Re-evaluation of the assumed TMs-loads reductions for PSs (treatment facilities) and waste-rock piles, as well as NPS areas.
- Re-evaluation of the MOS and sediment-contributing factors, to account to stream-sediment chemistry and other natural processes inherent in the watershed.

- Completion of review/evaluation work and comparison of the preliminary TMs loads-reduction results reported herein with relevant profiles developed by various Medine modeling studies (as referenced above and citations below).

Nonpoint-Source Management Measures (Watershed-Plan Component 3)

For this study component, further evaluation was made of NPS-management measures, with the goal of meeting existing (ambient/temporary-mod standards) or ultimate (TVS) WQSs (Task 6) and CERCLA-related NPS control measures (Task 7b). An evaluation of non-CERCLA-related NPS controls (Task 7a; Appendix D) remains to be completed. These parts of the assessment are built upon and enhance the work completed as a part of the previous watershed-plan component 2 (Task 5), that primarily addressed CERCLA and other PS-based loadings reductions. Finally, a comparison is made between in-stream concentrations anticipated from projected TMs-load reductions and underlying WQSs (Task 8), and a conceptual plan for future nonpoint-source controls (analogous to a "skeleton" TMDL) is developed (Task 9 and Appendix E, respectively).

Planned NPS Load Reductions to Meet Existing Water-Quality Standards *(Task 6)*

For this project-study task, an assessment is made (in a preliminary manner) regarding the extent to which estimated TMs load reductions (see Task 7a/7b below) will either fulfill or at least lower the exceedance probability of applicable water-quality stream standards. This assessment is limited to the several TMs of concern in this study (D-Cd, D-Cu, and D-Zn) and also the stream segments of the upper Clear Creek watershed identified as still impaired (that is, not meeting applicable WQSs), based upon the proposed seasonal HF/LF delineation of streamflow conditions. These entail stream segments 2, 9a, 9b, 13b, and 11. Segments 2 and 11 involve the upper and lower mainstem Clear Creek segments of the watershed, respectively. Segments 9a and 9b are tributaries to upstream segment 2, and segment 13b is tributary to downstream segment 11 (Tt-RMC, 2004b, Figure 2-1).

The approach to this assessment is to "build" on the compilation and evaluation of TMs sources (both PS and NPS) that have been identified in the watershed (see previous Chapter 3 and section on Task-7 analysis below). Then, in this section (Task 6), the ability to meet applicable WQSs considering ongoing/planned remediation is evaluated.

Table 4-1 – Estimated Loadings Reductions (Percent), Applicable Stream Segments with Exceedances and for Specific Season of Year

Segment/Season/Rank[1]	*D-Cadmium*	*D-Copper*	*D-Zinc*	*Notes/description:*
SS 2, Low Q HR	*n/a*	56%	16%	Virginia Canyon
SS 2, Low Q MR	*n/a*	0%	19%	Silver Plume
SS-9a, High Q	*n/a*	??	*n/a*	Fall River (no project)[2]
SS-9b, High Q	0%	0%	0%	Trail Creek (SS 2)[3]
SS 13b, Low Q HR	29%	51%	19%	OU4, Water Treatment
SS 13b, Low Q HR	2%	2%	2%	OU4, NPSs/Sediments
SS 11, Low Q	*n/a*	*n/a*	33%	*See all other items*

Notes: 1 – Only impaired stream segments and seasons are considered (see Tables 1-3 and 3-6). Low Q = low-flow season; high Q = high-flow season. HR=high rank; MR=moderate rank.
2 – Only Alice Glory Hole is identified; some CDMG-supervised remediation has occurred (Herron, 2001); however, no more remediation in this subwatershed is currently planned. 3 – No remediation is planned.

The applicable stream standards for these sets of conditions, compared to ambient TMs concentrations, are given in Table 4-2.

Based upon previous loadings-reductions estimates (see Section 3 and associated Table 3-6), the following reductions for the TMs of interest in this study and for delineated season/stream-segment impaired conditions are estimated in a preliminary manner:

Table 4-2 – Comparison of Ambient Water Quality vs. Currently Applicable Temporary Mods (in ug/L) with Exceedances and for Specific Season of Year

Trace-Metal (TM) Concentrations:	*Ambient (85th %)*	*TempMod Std*	*Ambient (85th %)*	*TempMod Std*	*Ambient (85th %)*	*TempMod Std*
Segment/Season[1]	*D-Cd*	*D-Cd*	*D-Cu*	*D-Cu*	*D-Zn*	*D-Zn*
SS 2, Low Q	--	--	9.6	8.1	363	257
SS-9a, High Q[2]	--	--	15.8	11.0	--	--
SS-9b, High Q[2]	5.1	4.6	167	148	1082	1068
SS 13b, Low Q	6.1	6.0	67.8	64.0	1905	1864
SS 11, Low Q	--	--	--	--	479	339

Notes: 1 – Unshaded (--) cells indicate that ambient TMs concentrations are less than the applicable stream standard.
2 – No project work is envisioned at this time; further investigation is warranted.

This tabular summary indicates that the greatest discrepancies involve D-Zn for stream segments (SSs) 2 and 11 (41 percent exceedance of ambient concentration over the applicable standard) and D-Cu (nearly 44 percent exceedance) for stream segment 9a. In all other cases, the differences are less than 15 percent.

For discussion purposes, the same form of comparison also can be made for ambient TMs concentrations (85th percentiles) versus the more-stringent hardness-based table value standards (TVSs), as given as follows (Table 4-3):

Table 4-3 – Comparison of Ambient Water Quality vs. Table Value Standards (in ug/L) with Temporary-Mod Exceedances and for Specific Season of Year

Trace-Metal (TM) Concentrations:	*Ambient (85th %)*	*TVS*	*Ambient (85th %)*	*TVS*	*Ambient (85th %)*	*TVS*
Segment/Season[1]	*D-Cd*	*D-Cd*	*D-Cu*	*D-Cu*	*D-Zn*	*D-Zn*
SS 2, Low Q	--	--	9.6	7.9	363	103
SS-9a, High Q[2]	--	--	15.8	2.3	--	--
SS-9b, High Q[2]	5.1	2.2	167	8.6	1082	113
SS 13b, Low Q	6.1	3.9	67.8	16.9	1905	221
SS 11, Low Q	--	--	--	--	479	124

Notes: 1 – Unshaded (--) cells indicate that ambient TMs concentrations are less than the applicable stream standard.
2 – No project work is envisioned at this time; further investigation is warranted.

This delineation of conditions (by stream segment and season) has been based upon the updated analysis of TMs of concern to this study (Cd, Cu, and Zn), using a more extensive data set (in terms of data sources, periods of record, and sampling-site locations) than was used in the OU4 RI/FS (Tt-RMC, 2004b). Nonetheless, for comparison purposes, the results of the analysis of preliminary remediation goals (PRGs) identified in this latter project and ability to meet these for TMs of concern in this study for stream segments 13b (NFCC) and 11 (lower mainstem Clear Creek) are summarized in the following Table 4-4 *(Note: Compare this summary with Tables 3-1 and 4-5)*:

Table 4-4 –ARARs and PRGs (in ug/L) for Stream Segments 13b and 11

Trace-Metal Conc. (ug/L)	*Flow Regime*	*NFCC SS 13b*	*PRG met w/ OU4 action?*	*Mainstem CC SS 11*	*PRG met w/ OU4 action?*
D-Cadmium	HF	1.9	Yes	1.4	Yes
	LF	3.5	Yes	2.3 *(2.9)*	Yes
D-Copper	HF	7.4	No	5.2	No
	LF	15.1 *(64)*	Yes	9.2 *(17)*	Yes
D-Zinc	HF	381	Yes	200	Yes/No*
	LF	675 *(740)*	Yes	300	Yes/No*

Source: Extracted from Tt-RMC (2004b, pp. 5-9 and 5-68); only TMs of concern to this study are included.
Notes: * = Met at lower part of stream segment (near Golden) but not just below the confluence with NFCC.
Shaded cells indicate those conditions (TMs and season) identified as exceeding standards (see Table 4-1)
The less stringent ARARs are shown in parentheses, if not identical with the PRG values (Tt-RMC, 2004b, p. 2-7).

It should be kept in mind that the OU4-RI/FS investigation defined the HF and LF seasons slightly different from those used in this study. The month of September was included by Tt-RMC in the low-flow season. However, it was concluded in the current study that the TM-characteristics (and flows) were more comparable to high flows than to low flows. Hence, this study uses a 7-month/5-month (LF/HF) seasonal-flow delineation as opposed to Tt-RMC's 8-month/4-month LF/HF delineation. This should not make much difference, in that the Tt-RMC's data sets (TDS Consulting Inc., 2000) included no sampling results for the month of September. It should be noted that this data set and associated assessment has been updated (TDS Consulting Inc., 2004), including correction of the factor for computation of TM loads.

Now a segment-by-segment analysis is made of the results of planned remedial actions and associated reductions of TMs loads. Table 4-5 gives the "bottom-line" regarding attainment of applicable stream standards for the appropriate flow-season of concern. In general, stream segments (SSs) 2, 13b, and 11 have non-attainment conditions only for the LF season; whereas, tributary stream segments 9a and 9b have non-attainment conditions for the HF season.

<u>*SS 2, upper mainstem Clear Creek*</u>.—The analysis focused on low-flow (LF) seasonal conditions; for the HF season, all currently applicable WQSs are attained. Primarily with the anticipated TMs-loads reductions due to collection, conveyance, and treatment of Virginia Canyon flows, D-Cu concentrations in the lower part of this stream segment should be reduced from an 85^{th}-percentile value of 9.6 ug/L down to 4.2 ug/L (LF season). For this CoC, a 56-percent reduction is estimated, with the removal of 2.1 lbs/d

of D-Cu from the Virginia Canyon flows. However, despite a 16.1-lbs/d D-Zn load removal by the Virginia Canyon water treatment in the Argo facility, this removal is insufficient to attain the desired level of D-Zn concentration to the existing Temp Mod level of 257 ug/L.

<u>*SS 9a, Fall River*</u>.—D-Cu is the CoC during the HF season. Herron (2001) describes the conditions focusing on the so-called St. Marys Project for TMs remediation of adverse impacts of a glory hole and mill tailings. Specifically, a Cu source was identified by sampling during the spring-runoff period (associated with the HF season delineated for this study). No further remediation currently is planned, and the non-attainment of the HF D-Cu Temp Mod value of 11 ug/L still needs to be addressed.

<u>*SS 9b, Trail Creek*</u>.—The situation for this tributary drainage is similar to that described previously for the Fall River. However, less is known concerning PSs and NPS areas within this subwatershed. Stream-characterization data for Trail Creek are quite limited. The TMs Temp Mods designated for this stream were based upon a single-year of data collected by the CDPHE-WQCD during 2002-2003. A few intermittent samples have been collected through other programs (see Table 2-2); however, these were not considered in developing the Temp Mods. Beginning in 2005, samples for TMs analyses are being collected at UCCWA/SLCs' site CC-31 on Trail Creek near its confluence with the mainstem Clear Creek.

<u>*SS 13b, North Fork Clear Creek*</u>.— With the proposed OU4-related remediation of key drainages in NFCC (specifically, Gregory Incline, Gregory Gulch, and the National Tunnel), currently applicable Temp Mods for D-Cd and D-Zn and an ambient-based standard for D-Cu all are attained for the seasonal LF period.

<u>*SS 11, lower mainstem Clear Creek*</u>.—The attainment of the D-Zn WQS for this lower Clear Creek stream segment is determined by upstream remediation efforts, that are described previously and elsewhere in this study document. The currently applicable D-Zn standard is attained through implementation of these planned upstream projects, based upon the estimation methods used in this study analysis.

Table 4-6 gives the "bottom-line" regarding attainment of possible ultimate, more strigent TVS-based stream standards for the appropriate flow-season of concern. In general, only the D-Cu WQS target of 7.9 ug/L for SS 2 would be fulfilled. In all other cases, that is, stream segments (SSs) 2, 13b, and 11 LF-season conditions only would not fulfill these more stringent WQS. Moreover, tributary stream segments 9a and 9b, with no current plans for remediation and with non-attainment HF-season conditions for currently applicable WQS, would not fulfill the more stringent TVS target values.

<u>NPS Control Measures – CERCLA-Related *(Task 7b)*</u>

In this section, anticipated NPS control measures are described, principally on the basis of the various CERCLA (Superfund) records of decision (RODs) and their associated recommended remedial actions. The most recent ROD for OU4 (CDPHE and USEPA,

2004) culminates the overall planned remedial actions and in general complements those actions recommended in previous RODs for the Central City/Black Hawk Superfund site. This section and the next section (for non-CERCLA actions) are critical to try to "fill the gap" for attaining those WQSs not fulfilled by PS flow collection/conveyance to water treatment plants for removal of TMs (see Table 3-6).

<u>*Overview of Medine's Various Model Applications*</u>
Medine (1997a) pointed out an important distinction between the mainstem Clear Creek and NFCC regarding physical/chemical conditions affecting TMs characterization and associated NPS controls. In the mainstem Clear Creek, stream sediments consist principally of gravels, cobbles, and larger-grained materials in the stream channel and bottom. In contrast, NFCC stream sediments have a substantially larger proportion of sands and finer materials. Hence, TMs attenuation by adsorption is a more significant process in the relatively finer-grained sediments of NFCC compared to the mainstem Clear Creek.

With this critical distinction in mind, Medine has completed several WASP4/META4 model applications for evaluating various remediation alternatives for both streams. These now will be evaluated from the standpoint of NPS-control aspects, along with supplemental information on NPS-control measures obtained from the CDMG.

Some of the earliest of Medine's model simulation results were included in the OU3 ROD (USEPA and CDH, 1991, Appendix A). Model-simulated stream profiles were developed for the no action and several alternatives, including the preferred alternative. For the mainstem Clear Creek stream profiles (SSs 2 and 11), the preferred alternative for TMs remediation were estimated to be substantially less (less than 100 ug/L and between 2-3 ug/L, respectively, for Zn and Cu) than the applicable WQSs for that time (280-300 ug/L for Zn and 10-17 ug/L for Cu). The model-simulated preferred-alternative stream profiles for the North Fork Clear Creek were not so positive: (1) Zn, about 1750 ug/L in the lower reach below Gregory Gulch vs. an applicable standard of 500 ug/L; and (2) Cu, between 80-100 ug/L below Gregory Gulch vs. an applicable standard of 64 ug/L Then some additional model-simulation profiles were provided in Medine (1992) for the Phase-II RI for NFCC and using Zn as an indicator variable for evaluating the potential effectiveness of various remedial alternatives. This model application addressed the concern of water diversions (100 gpm and 750 gpm, respectively) proposed by Central City and Black Hawk in this subwatershed upstream from Black Hawk. These potential diversions would result in TMs increases downstream, because of loss of low-concentration (dilution) flows. It is noteworthy in these early model applications that low-flow and high-flow scenarios were analyzed separately; this is consistent with the seasonal WQS-development promoted by this current 319-grant study.

Several interim Medine-model analyses were conducted during the 1997-through-2001 period (see reference list for report citations). These model applications in general used data for the 1994-1995 period (Medine, 1995; 1996). These model applications were useful to compare pre-Argo conditions on the mainstem Clear Creek and also to note the benefit of adding benthic (channel-sediment) compartments to the model structure

(Medine, 1997b, Figure 1; Medine, 1997a, Figure 1). Two of the three TMs of concern to this study were provided as stream profiles (D-Zn and Z-Cd) in the 1997 Medine documents..

The WASP4/META4 model application for the mainstem Clear Creek (Medine, 1997b) used October 1995 data to assess changes since the Phase-II RI (approximately in the year 1989). This assessment concluded that the mainstem Clear Creek water quality had not changed; whereas, significantly lower TMs concentrations were noted for WFCC and its tributary, Woods Creek. For D-Zn concentrations in SS 2, the initial contribution of the Burleigh Tunnel was noted (site SW-26, 682 ug/L), with downstream dilution by South Fork Clear Creek, West Fork Clear Creek, and other tributaries. Some D-Zn concentration increase was noted at the lower end of SS2, probably influenced by Trail Creek and the Big 5 waste-rock piles (unreclaimed at that time) (Medine, 1997b, Figure 3). The Argo Tunnel contributed substantial D-Zn loads at this time prior to the construction/operation of the water-treatment facility. For SS 11 during Octrober 1995, D-Zn concentrations were relatively constant through the reach, ranging between 565 and 582 ug/L. The D-Cd profile was similar in relatively pattern for SSs 2 and 11 but with expected lower concentrations (Medine, 1997b, Figure 5). *[Note: No stream profile was completed for D-Cu concentrations.]*

For a similar model-application (WASP4/META4 Version 2) for North Fork Clear Creek, March 1995 data were used (Medine, 1997a). Three remediation scenarios were evaluated, with increasing degree of areal coverage and assuming an active-treatment effectiveness of 95 percent. The remediation impacts then are given in a series of NFCC reach profiles: D-Zn, Medine (1997a, Figure 9); and D-Cd, Medine (1997a, Figure 11). *[Note: No stream profile was completed for D-Cu concentrations, although a pre-remediation profile comparing data with model-simulation results was provided as Figure 6 in the report.]*

Then some model-simulation applications (WASP4/META4 Version 3) were made to assess of effects of sediment and pH controls in the NFCC subwatershed (Medine, 1999a). The March 1995 data again were used, and seven remedial alternatives were evaluated (REM A through REM G). Resultant comparative stream profiles were in terms of T-Zn and T-Cd (rather than dissolved species); thus, they are not directly comparable for this study. Also, in this document, load-reduction efficiencies were assumed as follows:

- Point-source treatment, 95 percent,
- Groundwater capture and treatment, 90 percent, and
- Incapsulation/removal of TMs-laced sediments and tailings, range between 50-75 percent.

For his most stringent remediation alternative analyzed in this investigation (REM G), an overall TMs-removal effectiveness of 80 percent was assumed (Medine, 1999a, p. 4). This study concluded that NFCC TMs-concentrations would be reduced by 80 percent and 75 percent, respectively, for D-Zn and D-Cd (Medine, 1999a, p. 14). In addition, he investigated the benefits of adjusting alkalinity and pH at the Black Hawk WWTP as well as at the Argo water-treatment facility. Then, this model version (3) was further modified to perform dynamic pH simulations (Medine, 1999c); however, NFCC stream profiles were provided only for total TMs (Zn and Cd) species.

Medine's (2001) study evaluated the significance of contaminated sediments in several tributary drainages of NFCC. In comparisons with applicable WQSs, TMs contributed by various subdrainages were ranked. No model was applied for this assessment.

Overview of OU4 RI/FS Remediation Effectiveness
A recent model-application assessment was completed by Medine (2004) for the NFCC subwatershed, as part of the OU4 RI/FS project (Tt-RMC, 2004b, Appendix E). The OU4 preferred alternative was modeled approximately as "Scenario 4B". This entailed collection and treatment of National Tunnel and Gregory Incline discharges, with discharge of the treated effluent back into NFCC near the downstream limits of Black Hawk, combine with an 80-percent reduction of sediment loads principally contributed by Russell Gulch and Gregory Gulch to the NFCC subwatershed system. In all model runs, the WASP4/META4 Version 4 model was used. NFCC stream profiles for the model calibration are provided (Medine, 2004, Figures 20, 22, and 24) for D-Zn, D-Cu, and D-Cd, respectively, using November 2001 LF and WQ conditions. Verification model runs then were made, using May 2002 (depicting LF despite time of year) sampling-survey results (Medine, 2004, Figures 28 and 30) for D-Zn and D-Cu, respectively. The high-flow model calibration used data from the June 1997 sampling survey (Medine, 2004, Figures 39, 41, and 43) for D-Zn, D-Cu, and D-Cd, respectively. Based upon acceptance of the model "fits" to the NFCC data sets noted previously, the various remedial scenarios then were depicted as reach profiles for LF (Medine, 2004, Figures 54, 56, and 58) and for HF (Medine, 2004, Figures 66, 68, and 70) for D-Zn, D-Cu, and D-Cd, respectively. In these latter model-simulation runs, then, the estimated TMs-concentration reductions in NFCC are depicted. The plots are difficult to discern the absolute levels of concentrations; however, the stream-reach patterns appear reasonable, in conjunction with the remedial alternatives assumed in the set of scenarios.

NPS Control Measures – Non-CERCLA-Related *(Task 7a)*

[Notes: R.L. Jones' inputs to this subtask are to be provided in Appendix D (it still is presumed that this contribution is in progress; see TDS guidance, with brief meetings with R.L. on 3/3, 25, and 29); scheduled draft-document due date was 3/18/05, but this deadline was not met. Further queries (May-September 2005) have produced no results.]

Other Factors to Consider

Additional NPS controls will be required to address TMs-standards exceedances for Fall River/Trail Creek (HF season) vs. for other SSs (LF season) (Table 4-5). Continued evaluation of feasibility and costs of such controls will be address in subsequent 319-grant tasks.

Summary and Recommendations (Tasks 6 and 7b)

In this watershed-plan assessment component, the numerous TMs-load-reduction measures and controls were reviewed and evaluated, and highlights of findings are as follows:

- For attaining existing applicable stream standards for the designated TMs of concern and using the seasonal (HF/LF) approach, the following conclusions were made (Table 4-5):
    - Stream standards would be attained for the following stream segments and TMs – SS 2, Cu; SS 13b, Cd, Cu, and Zn, and SS 11, Zn (all LF season);
    - Stream standards would not be attained for SS 2 (Zn, LF season), SS 9a (Cu, HF season), or SS 9b (Cd, Cu, and Zn, HF season). In this latter case, the limited TMs-characterization data for setting Temp Mods resulted in this non-attainment when splitting one year of monthly data into the two (HF/LF) seasons.
- In order to comply with possible ultimate stream standards (lower, more stringent concentrations, calculated from hardness-based TVSs), the following observations were made (for the same TMs of concern and considering the same seasonal approach) regarding currently proposed remedial actions for reducing TMs loads (Table 4-6):
    - Only the stream standard for Cu in SS 2 would be attained, assuming remediation levels anticipated for water conveyance/treatment of TM-impaired flows principally from the Virginia Canyon area;
    - All other TVS-based ultimate stream standards would not be fulfilled using the currently planned remedial actions for reducing TMs' loads.

Based upon the work completed to date as a result of this study, recommendations include the following:

- Additional monitoring-related work might be considered, comprised of the following aspects:
    - Greater detail on waste-pile characterizations (areal and volumetric dimensions and leachate analyses), with relatively greater priority given to those located in the Virginia Canyon area and along tributaries of North Fork Clear Creek;
    - Continued TMs-related (water-quality and streamflow) systematic monitoring at key designated sites throughout the watershed (Lewis, 2005), with possible modifications in site coverage and frequency; and
    - Site-specific remedial-design and engineering-evaluation/cost analysis (EE/CA) efforts for selected source areas in Virginia Canyon (J.D. Lewis, oral communication, 3/28/05 and following up the OU4 ROD recommendations (R.J. Abel, oral communication, 3/28/05).
- Site-characterization investigations need to be continued for the upper Fall River area (Alice Glory Hole and associated mill tailings; Herron, 2001) to assess the feasibility and reasonableness of bringing Cu concentrations during the HF season to fulfill the applicable WQS for that CoC.

- Site-characterization investigations need to be developed for the Trail Creek tributary area, in order to see what specific TMs sources might be controlled, with consideration of modification of HF seasonal Temp Mods for TMs of concern.
- Further evaluation of review/assessment work and TMs-reduction comparisons reported herein with relevant profiles developed by the various Medine (as referenced above and citations below) modeling studies.

<u>Comparison – Loads Reductions vs. Underlying Water-Quality Standards *(Task 8)*</u>

Based upon results provided in Tables 4-5 and 4-6; a "streamlined version of estimated fulfillment of stream standards, based upon the loads reductions formulated in this assessment, is provided in Table 4-7 as follows:

Table 4-7 – Summary of Ability of Potential TMs Loads Reductions to Attain Applicable Stream Standards (Temporary Mods) and Ultimate Targets (TVSs or Site-Specific Standards)[1]

Stream Segment	*Condition (Low Flow/High Flow)*	*Attainment of D-Cd Standard*	*Attainment of D-Cu Standard*	*Attainment of D-Zn Standard*
2	LF Temp Mod	—[2]	Yes, 4.2/8.1	No, 305/257
	LF US[3]	—	Yes, 4.2/7.9	No, 305/103
9a	HF Temp Mod	--	No, 15.8/11.0	--
	HF US	--	No, 15.8/2.3	--
9b	HF Temp Mod	No, 5.1/4.6	No, 167/148	No, 1082/1068
	HF US	No, 5.1/2.2	No, 167/8.6	No, 1082/113
13b	LF Temp Mod	Yes, 4.6/6.0	Yes, 33.4/64.0	Yes, 1548/1864
	LF US	No, 4.6/3.9	No, 33.4/16.9	No, 1548/221
11	LF Temp Mod	--	--	Yes, 323/339
	LF US	--	--	No, 323/124

1 Extracted from previous Tables 4-5 and 4-6.
2 -- = No comparison with stream standard applies (not applicable), because it is judged attainable.
3 US = underlying (former/ultimate, equation-based) standard/target (see Table 1-3). *[Note: These often are site-specific.]*

Consideration is given to a spreadsheet indicating the linkages among the various listed stream segments (impaired, 303(d)-listed): SSs 2, 9a, 9b, 11 and 13b. In this manner, the interactions with load reductions upstream can be reflected in downstream stream segments in a more explicit manner. The TM variable D-Zn is used as an indicator of this spatial comparison (Table 4-8) relative to various WQ targets. Note the unknown sources of zinc associated with SS 2, in contrast to the losses in SS 11, primarily judged to be due to stream-channel sediment interactions and secondarily the result of stream diversions upstream from monitoring site CC-60 on the mainstem Clear Creek. The stream profiles given in Table 4-8 characterize current conditions; the estimated load reductions would affect the indicated D-Zn loads at many of the calculation points (mainstem Clear Creek, tributaries, or other sources/losses).

A key question in this watershed-planning process is what does it take (in load reductions) in order to meet all targets (underlying/ultimate WQSs, as well as the assumption that the site-specific Zn standard would apply to all stream segments that are being considered in this assessment). *[TDS Note: KF comment during discussions on 6/2/05, AB notes on 7/8/05.]* Throughout this discussion, it will be assumed that the seasonal (LF/HF) hardness-based standards would be the basis for calculation of TVSs for either season, depending upon the trace metal, stream segment of concern, and estimated load reduction. The following "what-if" response to this question is provided with Figures 4-1 and 4-2, Table 4-8, and as follows on a segment-by-segment basis:

SS 2, upper mainstem Clear Creek.—The data assessment concluded that the in-stream D-Cu concentration targets (both applicable and ultimate standards) would be attained for the critical low-flow season. Primarily, with the proposed remediation in Virginia Canyon and, secondarily, proposed elsewhere along this stream segment, the ambient upstream-to-downstream trend of increasing D-Cu would benefit from projected D-Cu load reduction throughout the stream segment, estimated to total nearly 57 percent (Table 4-1). In contrast, the D-Cu load reductions needed to attain targets are less: 17 percent to fulfill the applicable standard and 18 percent to fulfill the ultimate standard (Tables 4-5 and 4-6, respectively).

The more critical issue for this stream segment involves D-Zn concentrations. The 85th percentile value for D-Zn concentration is 364 ug/L, compared with a temp mod of 257 ug/L and a TVS of 103 ug/L. Estimated D-Zn load reductions, based in large part to currently available projects, are estimated to be slightly more than 16 percent (Table 4-1). In comparison, over 29 percent D-Zn load reduction is needed to attain the applicable standard (257 ug/L, Table 4-5) and nearly 72 percent D-Zn load reduction is needed to attain the ultimate target TVS (103 ug/L, Table 4-6). In conclusion for this stream segment, further efforts for seasonal LF load reduction of D-Zn are needed.

SS 9a, Fall River; and SS 9b, Trail Creek.—The situation for these tributary drainages are similar. Both streams would not be in compliance with the high-flow seasonal-based targets – both applicable and ultimate (Tables 4-5 and 4-6, respectively). Some remediation (discussed elsewhere in this document) has been completed in the Alice area of the Fall River. No more remediation is proposed, however, for either the Fall River area or along Trail Creek. In conclusion, further efforts for seasonal HF load reductions of trace metals of concern currently are needed to attain WQSs targets for these stream segments. Also, LF load reductions in these tributaries would tend to benefit the lower part of SS 2 and the entire SS 11 along the mainstem Clear Creek.

SS 13b, North Fork Clear Creek.— As indicated previously, with the proposed OU4-related remediation of key drainages in the NFCC, the applicable Temp Mods for D-Cd and D-Zn and an ambient-based standard for D-Cu all are attained for the seasonal LF period. However, the ultimate targets (TVSs) would not be attained during the LF season, with the estimated load reductions from this assessment that are planned to be implemented. Specifically, for the LF period, the following load reductions would be needed for ultimate targets (Table 4-6): D-Cd, 36 percent load reduction; D-Cu, 75 percent load reduction; and D-Zn, 88 percent load reduction. By comparison, estimated (primarily OU4) load reductions for these variables are judged to be 25, 51, and 19 percent, respectively (Table 3-6). It is noteworthy that this assessment is more conservative (less optimistic) than the preliminary remediation goals and judged attainment reported for the OU4 RI/FS (see Table 4-4). Part of the reason for this under-attainment of PRGs may be not considering some remedial measures proposed in the OU4 study, especially for the Russell Gulch area and other NPS controls (Table 3-6). Thus, some uncertainty in the conclusions made herein may be revised and updated, based upon the ultimate detailed design and implementation of remedial measures in the

NFCC subwatershed. The result might be achieving more effective load reductions than estimated herein. For D-Zn, an additional 0.8 lbs/d may be needed to achieve the LF applicable standard, and about 32 lbs/d load removal would be needed to achieve the underlying standard (ultimate target, TVS). In the latter case, such a level of removal would have significant benefits in attained the underlying D-Zn standard in SS 11 on the mainstem Clear Creek (see below and Table 4-8).

<u>SS 11, lower mainstem Clear Creek</u>.—The attainment of the D-Zn stream standard is made for the applicable standard (339 ug/L) but not for the underlying standard (ultimate target, 124 ug/L. In order to achieve the latter target, the load reduction would have to be increased from nearly 33 percent to over 74 percent. Note, however, the interaction with upstream stream segments. Specifically, as noted previously, implementing the NFCC load reductions, principally due to the OU4 remedial projects, would achieve a substantial part of the estimated D-Zn load reduction for this stream segment (an estimated 32.5 lb/d of the 38.5 lbs/d needed; see Table 4-8). Further remedial measures upstream (SS 2) in combination that those proposed for SS 13b would probably result in attainment of the underlying standard (ultimate target) of 124 ug/L for this lower stream segment.

For these last two stream segments (SSs 13b and 11), it is perhaps noteworthy why WQSs targets and loads reductions developed herein differ in some cases from the PRGs reported by the OU4 RI/FS (Tt-RMC, 2004b, Chapter 5). Two contributing factors consist of the following (see, in particular, OU4-FS subsections 5.2.1.2 and 5.2.2.2 in Tt-RMC, 2004b):

- This WQ data assessment for this study incorporated more of the UCCWA-SLCs data as well as data from other sources for these stream segments (namely, BHCCSD and CDOW data) for the period of record through 2004.
- The WQ data assessment for this study assumed a slightly different split in HF and LF seasons, based upon characteristics of water-quality data sources, some of which were not considered in the OU4 analysis, which determined a seasonal split more on flow conditions. Specifically, WQ data for the month of September (provided by BHCCSD for SS 13b and by CDOW for SSs 13b and 11, as well as for other SSs), more aptly fit into a HF period rather than LF.
- As a result of the above aspects, TMs statistics and average hardness concentrations differ between the two investigations.

Thus, it should be recognized that any comparative analysis for attainment of WQSs in the upper Clear Creek watershed (or any watershed, for that matter) is dataset-dependent and that further evaluation of seasonal periods and of relevant associated data may be warranted.

In summary, attainment of WQSs for individual stream segments should take into account the interactive nature of the segments; that is, the extent to which load reductions achieved for upstream/tributary stream segments will benefit the lower stream segment of the mainstem Clear Creek. As a consequence, this watershed's pending TMDLs need to be evaluated holistically within the framework of the entire watershed's stream system.

Conceptual Plan for Future NPS Controls *(Task 9)*

Outline this plan in this section; a skeleton TMDL has been developed for stream segments of interest in this study (see Appendix E). A key issue is how to consider the one draft TMDL in process (CDPHE, 2002a), with accompanying review comments (UCCWA, 2002), along with the other pending stream segments currently without any formulated TMDLs.

It is anticipated that the skeleton TMDL (Appendix E) for the upper Clear Creek watershed in fact is a series of TMDLs for each of the impaired (303(d)-listed) stream segments in the watershed. The content of Appendix E was discussed at a 6/2/05 meeting of the 319-Grant Subcommittee, and the preparation of this, based upon discussion results, is pending.

Identification of critical areas (stream reaches and associated trace-metals characteristics).—This aspect has been addressed by the previous section, on a stream-segment by stream-segment basis. As concluded above, remedial measures for upper parts of the watershed will over the long term benefit lower stream segments in the watershed, and this situation needs to be taken into account in a holistic approach to TMDL assessments for identified stream segments judged to be impaired for one or more trace metals.

Watershed NPS protection/control goals.—In general, as pointed out in UCC-WAG (2001, chapters 11, p. 51), point sources are easier to identify and to remediate but require treatment in perpetuity. Hence, O&M costs of waste-stream facilities in the watershed (such as the Argo Tunnel) theoretically are infinite. Consideration of passive-treatment options (Tt-RMC, 2004b, Appendix B) were evaluated for several major acid-rock drainage point sources in the NFCC subwatershed; implementation of one or more of these options or construction of another waste-stream treatment facility in this subwatershed (the OU4 preferred action as provided in the ROD: CDPHE-USEPA, 2004) will all contribute to load reductions for the areas selected for consideration and located within this subwatershed. However, other waste-rock pile and mill-tailings areas within the NFCC subwatershed as well as along the mainstem CC have been identified and need to be considered in the overall load reductions to achieve WQS targets (applicable or ultimate). This latter component comprises nonpoint sources that are the subject of this part of the Plan.

Mining-related nonpoint sources (such as waste rock dumps and piles and mill tailings), although inherently diffuse and frequently more difficult to characterize, generally can benefit by some form of remediation. This may involve *in-situ* encapsulation of wastes, commonly with but sometimes without consolidation of waste material, along with stabilization of the encapsulated wastes in order to reduce (but not eliminate) erosion of these materials over geologic time. Use of best management practices (BMPs, see below) both during construction of wastes to be encapsulated and over a finite post-construction period is technically recommended. However, one alternative, given unfavorable conditions or small amounts of wastes spread over a relatively large area, may involve moving the waste materials to another location, possibly a waste-disposal site, where conditions are more conducive to minimize erosion of materials or transport of contaminants via surface runoff or subsurface groundwater flows.

The types of mining-related NPS controls incorporated into the OU4-Superfund preferred alternative are indicative of the remedial structural measures that warrant consideration. These have been listed in the ROD (CDPHE and USEPA, 2004, Section 12.2.1) under the category of sediment controls and include the following:

- Removal of selected mine waste piles, with waste materials trucked to an on-site repository for disposal.
- Capping of mine waste piles and adjacent areas.
- Stabilization of stream channels adjacent to capped waste piles.
- Construction of “run-on” ditches (essentially to convey relatively uncontaminated water around and away from contaminant sources, according to R.J.Abel, CDPHE-HMWMD, oral commun., 6/21/05) upgradient from waste piles or mill tailings.
- Construction of sediment dams in selected streams impacted by upgradient waste piles.

The OU4-Superfund selected remedy (Alternative 4B) includes these so-called Tier-2 sediment controls in the proposal remedial actions for its cleanup plan. Details are incorporated herein by reference and are provided in Tt-RMC (2004b).

Non-Superfund characterization and/or remedial measures that might be categorized as mining-related NPS controls have been implemented in the upper Clear Creek watershed. Examples that have been completed or are underway include, but are not limited to, the following (see UCC-WAG, 2001; Herron, 2001; CDPHE, 2003):

- Minnesota Mine tailings remediation (above Empire; completed)
- Big Five tailings remediation (along mainstem Clear Creek, completed); mine-adit pond drained and back-filled, near completion)
- Virginia Canyon north of Idaho Springs (characterization completed), remedial work (Superfund-supported) overseen by CDPHE-HMWMD (summer 2005)
- Alice Mine (Glory Hole) (upper Fall River subwatershed, completed by CDMG)
- Gilson Gulch north of Idaho Springs (CCWF Phase-1 characterization ongoing).

An example of a “lesson-learned” remedial investigation involved a constructed wetland for the Burleigh Tunnel (UCC-WAG, 2001, Chapter 4 giving details of the #3 priority for remediation and in Subsection 14.2, pp. 66-67). Examples of innovative remediation approaches are given by the BASX water-treatment system (UCC-WAG, 2001, Section 14.3, pp. 67-68) and discussion of Alternative 4A in Tt-RMC (2004b) promoting trace-metals reduction/removal through precipitation as sulfides in sulfate-reducing bioreactors (SRBRs) by creating reducing conditions created by an orgnic media. With this technology, the media periodically would have to be excavated and disposed of at an on-site mine-waste repository or off-site.

Skeleton TMDL (impaired, listed stream segments.—Guidance details for this aspect is given in Appendix E of this watershed-plan document.

Recommended best management practices (BMPs).—Mine-related structural BMPs in general are designed to control the volume and discharge rate of contaminated runoff as well as reduce the magnitude of pollutants. In addition, structural BMPs can be designed to collect and convey uncontaminated water around waste-rock piles, mill tailings, and other mine-contaminated materials and areas. Examples of structural BMPs include, but are not limited to, sediment detention/retention basins, areas for water infiltration into the subsurface materials, grassed swales for reducing flow velocities and inducing percolation into underlying soils, and constructed wetlands. Mining-related structural BMPs can deal with old mine-adit discharges or other subsurface flows from waste-rock piles and mill tailings. Also, BMPs can collect surface-water runoff from small land areas or can be installed in flowing streams (such as on-channel or off-channel sedimentation basins) to allow suspended sediments laden with contaminants (principally, trace metals are of concern) to settle out and be removed from waters subsequently released from such ponds. For sustainable BMP operations, maintenance of structural facilities, such as detention/retention ponds, is critical, and dredged material has to be disposed of in a manner that it is not re-introduced into the hydrologic environment.

UCC-WAG (2001, Section 3.5, p. 31) discusses the use of sediment "traps" for controlling (trace-metals') contaminated sediments. This formed the basis of selected Medine (1995; 2001) modeling studies in the NFCC subwatershed; the remediation strategy was to collect (primarily with sedimentation basins) metals-rich sediments and to dispose of these sediments at locations removed from stream channels (preferably at a nearby repository). The basic concept entailed construction of relatively low dams across small stream channels, in order to reduce water-flow velocities and to allow suspended sediments to settle behind these dams. Then, materials deposited behind each dam would have to be removed periodically to remove this contaminant source from the hydrologic system. Two variations of this basic concept involved (1) dams across the mainstem NFCC, and (2) dams constructed across smaller tributary streams of the NFCC. The Tier-2 sediment-control aspects of the Preferred Alternative (4B) of the OU4 RI/FS incorporated this concept for the smaller subdrainage tributaries of NFCC. This is preferred to larger and higher dams, because of SEO regulatory restrictions and also associated failure risks of larger structures (UCC-WAG, 2001, p. 31). Easy maintenance of such structures (that is, access by backhoes or front loaders for removal of sediments and road haulage by trucks) is a key factor.

Mining-related nonstructural BMPs are generally operating procedures to improve runoff quality by minimizing the generation and accumulation of pollutants on the land surface at or near their sources. An example would be reduction before transport of contaminants in stormwater runoff. These BMPs are often referred to as "good housekeeping" techniques. Also included in this category are public awareness, regulatory controls, and monitoring programs to assess BMPs' effectiveness.

Conceptual NPS-Control Plan Implementation

Plan implementation includes follow-up practices in addition to the physical constructing of structural BMPs or applying non-structural BMPs. One such component involves design and execution of a hydrologic and water-quality monitoring program. Another component involves recent, ongoing, and near-term efforts by the CDPHE-HMWMD, CDMG, and the CCWF to execute various remediation projects. Examples applicable to the upper Clear Creek watershed include, but are not limited to, the following:

- Virginia Canyon, CDPHE-HMWMD (Jim Lewis), waste-pile remediation (consolidation and capping), summer 2005
- OU4, CDPHE-HMWMD (Ron Abel), preliminary engineering design (funds from USEPA, RFP to be released on/about July 7, 2005, seeking A-E proposals and selection
- Big Five, CDMG (check?) (Jim Herron), draining of pond, diversion/collection of mine-adit flows into Clear Creek (current) and planned for Argo treatment facility
- CCWF (Ed Rapp), *provide project information here for 2005 work*
- *CDMG other (Jim Herron), add as appropriate pending project work for 2005*

Funding opportunities.-- This critical aspect (Task 10) is included later in this Watershed Plan (see Section 10). Information will be obtained from, but not limited to, the following sources: UCC-WAG (2001, Chapter 13), CDPHE-HMWMD, USEPA, CDMG, and CCWF.

Public awareness and participation.--This involves pending Task 11, including matching in-kind contributions and final 319-Grant workshop presentation scheduled for a specific workshop session. A joint session of the Clear Creek Watershed Foundation (CCWF, Ed Rapp) and the Clear Creek Watershed *F*orum (CCW*F*, Carl Norbeck) tentatively has been scheduled for Tuesday, September 27, 2005. An overview of the components addressed to date in this Watershed Plan is to be included. This will be provided by Dr. T.D. Steele, with assistance and inputs from other 319-Grant Subcommittee members. *[Note: Any resultant comments, responses, and action items are to be documented after the Clear Creek Watershed Forum presentation (Section 11 and Appendix F, pending)]*

Recommendations for Phase-II work.—*[Note: A follow-up 319 Grant proposal, ca. 11/15/05, is possible and may be considered in late 2005.]* However, recent discussions focused upon the remaining four watershed-plan components for completion during 2006. Another key aspect of the Watershed Plan to be addressed is the inclusion of other water-quality issues. In particular, nutrients (N- and P-species) emanating from the watershed and affecting beneficial water use, both within the watershed and external to it (that is, Standley Lake as well as downstream uses) (ASI, 1993; Tetra Tech, Inc., 1994). A decision will need to be made regarding what is justifiable regarding applying for a Phase-II 319 grant, what should be funded internally within UCCWA, and what should be proposed for possible other funding sources. Another water-quality issue involves generation and transport of suspended sediments via streams in the watershed.

Information/Education Component (Watershed Plan Component 5)

Task 11 – Summary of Comment Forms, from Clear Creek Watershed Forum held on September 27, 2005. Seven comment forms were received; see items a-g below:

1. Does this *Watershed Plan* meet your expectations? Please explain your answer.

a. *Needs to include the Gem waste-rock consolidation site and also indicate a high priority for Gilson Gulch. Any improvement to water quality of the watershed's streams requires a place to put the mine-waste materials (that is, a repository).*

b. *The **Plan** is good! The **Plan** is great!*

c. *Very good.*

d. *Too bad Task 2 schedule was delayed for this initial version of the **Plan**.*

e. *Expectations were met for the most part, except items mentioned in Question 2.*

f. *Only with respect to metals loading. A **Watershed Plan** should include growth issues with regard to water quality, nutrient loading, sediment loading, fisheries, recreation, water-supply development, transmountain diversions, transportation development, etc.*

g. *No comment provided.*

2. In your opinion, does anything need to be added? For example, should nutrients and/or regionalization of wastewater treatment facilities be addressed?

a. *Add the results from sustainability part of this Forum.*

b. *Regionalization should certainly be addressed in the next phase.*

c. *Recommend adding WWTP effluent data (nutrients/trace metals).*

d. *Remaining elements of **Plan** recommended by USEPA. Add nutrient-species characterization—similar to trace metals assessment.*

e. *Nutrients should be added to the **Plan** along with a description of land uses associated with stream loading and treatment plants contributing to Clear Creek watershed streams.*

f. *No comment provided.*

g. *It would help to look at the spatial distribution of loads during each sampling period. Are loads conserved or is some natural attenuation occurring? This question was answered at the end of the presentation, but it is not clear if the information is included in the report.*

3. Any other comments, suggestions or recommendations?

a. *The **Plan** needs to discuss an analysis process for local sustainability. Perhaps a "gaming theory" analysis of various scenarios might be useful. Need to put some academic rigor to the problem.*

b. *Funding must be forthcoming.*

c. *Too bad other wastewater management entities did not choose to participate.*

d. *Continue stakeholder outreach. Develop a series of fact sheets dealing with various aspects of the **Watershed Plan**.*

e. *No comment provided.*

f. *No comment provided.*

g. *No comment provided.*

Schedule for Implementation of NPS Management Measures (Phase II)

[Note: This updated section was added as a Phase-II effort for updating Section 6 (Component 7) of the Upper Clear Creek Watershed Plan.]

1. See CDPHE-WQCD-NPS, 2005, Sections 7.1 and 7.2
2. Worksheet #25 – Selecting Possible Implementation Tools
    a. Water-quality monitoring program (see below, Section 9; component 6)
    b. Biological monitoring program – to date, CDOW annual fish shocking and biological assessment(s); also see pending Task 2 with link to TMs
    c. Predictive models
    d. Inventory list, mapping, and surveys (various)
    e. Geographic information systems (GIS); Clear Creek County information base
    f. Risk assessment
    g. TMDLs (see other parts of Watershed Plan, including Appendix E)
    h. Wasteload or load allocations
    i. Best management practices (BMPs)
    j. Trading program (see CCWF proposals on this critical topic)
    k. Reservoir management (Standley Lake); needs further evaluation
    l. Riparian corridor management
    m. Site-specific research programs
    n. Local government regulation and management
    o. Regional planning (DRCOG; counties' master plans)
    p. State/watershed-control regulations, stream-standards regulations, and discharge permits
    q. Federal water-quality regulation (that is, Clean Water Act with amendments)
    r. Other Federal programs (Superfund/CERCLA)
    s. Public outreach and education (see Watershed Plan's Task 11 and workshop results)
3. Worksheet #26 – Draft (TMDL) Implementation Plan Matrix
    a. Develop a watershed goal statement
    b. Identify management objective(s) for the watershed
    c. Identify information and educations activities or a program (see also Task 11)
    d. Identify the monitoring component and associated activities (see Section 9 below)
    e. Describe implementation activities

4. Assuming availability of $2M/year for 5 years, the following projects and activities are planned:

2006------------------2007-------------------2008---------------------2009---------------2010
Upper Virginia Canyon-------------------------|
Gilson Gulch--|
Russell Gulch--|
Trail Creek--|
USFS and other targets of opportunity------------------|

[Note: This 2006 Addendum to the Upper Clear Creek Watershed Plan is to highlight the importance of several near-term, high-priority mining-related remediation projects.]

The implementation of these selected remediation projects, designated herein as "high priority", will help towards achieving the attainment of current as well as ultimate water-quality standards (targets) specified by the CDPHE, the regulatory agency responsible to set these in coordination with the USEPA and the watershed's stakeholder. The Watershed Plan provides a detailed inventory of known nonpoint sources as well as some estimate of associated trace-metals loadings. These aspects, along with comparison with current and ultimate stream standards, serve as the basis for prioritizing remediation projects as well as for estimating anticipated benefits of remediation for achieving loads reductions for those contaminants of concern included on the current 303(d) list of impaired stream segments.

The remedial-action priorities being considered over the near term focus on trace-metals loads reductions that benefit the attainment goals (water-quality stream standards) for stream segments 2 and 11 of the upper Clear Creek watershed. The schedule for attainment of water-quality goals in these segments is by the year 2012. *[Notes: Although applicable stream standards are set for year-round conditions, the Plan proposes to modify this aspect to set standards for discrete high-flow and low-flow seasons of the year for streams in this watershed. However, pending approval of this concept does not affect the overall intent of attainment of water-quality targets through remediation as described in the Plan. Finally, the interlinkages between stream segments should be recognized; specifically, load reductions through remedial actions benefiting upstream stream segments also will benefit stream segments that are directly downstream.]* Accordingly, five projects are described in some detail in this Addendum that should benefit in part achieving this attainment goal. These have been designated in currently proposed or planned projects and involve the following mines, subwatersheds, or areas:

- Gilson Gulch subwatershed,
- Castleton Mine Dump (upper Virginia Canyon),
- Trail Creek subwatershed,
- The Maude Monroe Mine and Juanita Mine west of Idaho Springs, and
- North Empire Creek subwatershed.

The Watershed Plan's current screening-process results (see Plan's pp. 3-4 through 3-6) delineated and discussed in detail two high-rank and two moderate-rank priority areas recommended for near-term remedial actions. Descriptions of the rationale and other aspects of each of these proposed or planned projects, all but one of which are located within these priority-ranked areas, are given in the following sections. Remediation of the Gilson Gulch subwatershed is now added, for the reasons given above and due to the more recent waste-pile/flow characterization results, as referenced below.

<u>Gilson Gulch Subwatershed</u>

A remediation-related characterization and feasibility study for this subwatershed has been completed (TDS Consulting Inc., 2005). Conditions in this subwatershed adversely impact water-quality conditions in the upper part of stream segment 11 (mainstem Clear Creek below the Argo discharge). In this investigation, waste-rock piles were characterized geochemically and flowing stream reaches and adits were sampled. A hazard-ranking system used elsewhere for assessing mining impacts led to a prioritization of which piles should be remediated through effective use of BMPs. This study served as the basis for the PIP for this subwatershed (CCWF, 2006) currently awaiting approval by the CDPHE and USEPA. Using zinc as the trace-metal indicator, the Watershed Plan identified stream segment 11 as not achieving ultimate (underlying TVS) standard, even with upstream planned remediation actions (see Plan's Table 4-6). The Plan hadn't identified this area for its initial ranking, primarily because little study had been done in the Gilson Gulch subwatershed until the characterization and feasibility study, completed at about the time of the Plan itself. It now is bettwe known the potential trace-metals loads contributions from this subwatershed, and the proposed Gilson Gulch PIP will result in further TMs loads reductions to increase the incremental load reduction (estimated additional 40-percent reduction needed for zinc) to achieve the water-quality attainment targets.

Castleton Mine Dump
The CDMG has completed a feasibility study of the Virginia Canyon subarea (Herron and others, 2001). This initial study identified the Castleton Mine Dump area as one of the highest priority areas needed for remediation (CDMG, 2006). This comprehensive study then was supplemented by another CCWF study (CWT Corporation, 2002). Virginia Canyon adversely impacts the lower reach of stream segment 2 (mainstem Clear Creek above the Argo discharge). Some remediation work was completed in this subwatershed during 2005. Ambient levels of copper and zinc for this impaired stream segment of the upper Clear Creek watershed currently do not achieve the low-flow TVS standards (see Plan's Table 1-3). As in the previous case, when using zinc as the trace-metals indicator, significant additional TMs reductions are needed in order for this stream segment to overcome its non-attainment of the zinc target (see Plan's Table 4-6). The proposed radiation of the Castleton Mine Dump piles will benefit the overall remedial-action strategy being implemented by the CDMG.

Trail Creek Subwatershed
Impaired water-quality conditions in Trail Creek resulted it to be included as one of two major TMs loads contributors to the lower part of stream segment 2 (mainstem Clear Creek). The other named major contributor, the Big Five Tunnel, already has been remediated through recent (2005) clean-up actions. Tailings in the Trail Creek subwatershed were mentioned in the Superfund ROD but not in the OU (UCC-WAG, 2001, Table 17) as a candidate for CERCLA-supported remediation. The Trail Creek subwatershed has been characterized using more limited data than available for other monitoring sites in the upper Clear Creek watershed. Intermittent historical data for Trail Creek are have been tabulated (see Plan's Table 2-2, 8 samples). An initial year's data collected by the CDPHE provided a seasonal water-quality characterization and resulted in this stream being added to its 303(d) list for several trace metals (Cd, Cu, Pb, Mn, and Zn). Moreover, it has been designated as a separate stream segment (9b) because of its impaired quality. Beginning in 2005, Trail Creek near its confluence with the mainstem

Clear Creek (site CC-31) has been added to the UCCWA-USEPA supported TMs monitoring-program component; these recent data confirm the characterization provided by the earlier CDPHE data. Beginning in 2006, a supplemental TMs-characterization study has been implemented (Crouse, 2006), with support of the CCWF. The focus of this study involves Trail Creek and the lower reach of stream segment 2 and upper segment of stream segment 11 (mainstem Clear Creek segments), and this water-quality/hydrologic data-collection study, supplementing the UCCWA-USEPA program, will provide useful information on streamflows and water-quality conditions for this subwatershed. It is planned (by CCWF) to develop a technical and cost proposal for the Trail Creek subwatershed, using the data and information outlined above, for the next round of the NPS 319-grant process, given the priority and knowledge of the need for remedial action..

<u>Maude Monroe and Donna Juanita Mines</u>
The Donna Juanita Mine tailings were identified in UCC-WAG (2001, Table 17). Unfortunately, any data have not been compiled for the Maude Monroe Mine and are quite limited for the Danna Juanita Mine (see Plan's Section 2, p. 2-5, for TMs/HRD characterization). However, these mines are located within a "moderate-rank" priority area for remediation in the Watershed Plan (see pp. 3-4 and 3-6). Recently implemented remedial action involving principally the Big Five Tunnel and pond, along with Trail Creek remediation, are estimated to result in TMs loads reduction of less than 10 percent. Obviously, additional remediation in the lower reach of stream segment 2 (mainstem Clear Creek) is critical for attainment of overall attainment of water-quality targets for this stream segment as well as stream segment 11 downstream (see Plan's Table 4-6). Accordingly, watershed stakeholders have identified these mines for near-term remedial-action consideration.

<u>North Empire Creek Subwatershed</u>
The Aorta Tunnel discharge and the North Empire Creek subwatershed in general have been characterized by the USEPA (1994) as well as the CDPHE (1995). Highlights of these initial characterization studies have been incorporated into the Watershed Plan (see Plan's Table 2-2 and Section 2, p. 2-4, for TMs/HRD characterization). Some remediation has taken place at the Minnesota Mine site on Lion Creek. Although the North Empire Creek is included in an unlisted stream segment 6 (tributary of West Fork Clear Creek), it impacts the lower reach of West Fork Clear Creek as well as stream segments 2 and 11 downstream in the mainstem Clear Creek. Accordingly, watershed stakeholders have identified this subwatershed for near-term future consideration of remedial actions for reduction of TMs loads.

Interim and Measurable Milestones and Surrogate Measures (Phase II)

[Note: This updated section was added as a Phase-II effort for updating Section 7 (Component 8) of the Upper Clear Creek Watershed Plan.]

1. See CDPHE-WQCD-NPS, 2005, Section 7.4
2. Worksheet #27 – List Possible Measures of Success
    a. Measures of success categories: chemical, physical, biological, and watershed
    b. Each success-measure category has specific topics to be considered
    c. For each measure, describe interim and long-term measures
    d. Look also for each creative approaches to measure success
3. Worksheet #28 –Developing Criteria to Measure Process and Success
    a. From the previous worksheet (#27 above), for each indicator to measure progress, develop either a target value or a goal and interim targets (short-term, medium-term, and long-term)
    b. Develop a worksheet with this matrix for each management objective identified
4. To achieve watershed sustainability improvements, outreach activities of the various watershed stakeholder groups, are being designed to provide jurisdictions, agencies, and developers with the information and templates to make sustainability-informed decisions regarding environmental restoration and protection activities and development practices.

    Regarding measurement of watershed sustainability improvements, for decisions to be made in favor of sustainable practices, compelling qualitative and/or quantitative data and information must be provided to decision makers. These metrics can then be applied to the various project activities to document the spatial extent of the improvement practice

    Accomplishments will be reported at various stakeholder meetings in a format that will encourage the broader application of specific sustainability practices both in the Upper Clear Creek Watershed. It is a widely recognized principle that once a precedent or model is in place, others will replicate that approach. Near-term and long-term milestones for these aspects are given as follows:

    2006-2007 economic/ecologic metrics modeling
    2007-2010 scenario evaluation based on water-quality measurements and socio-economic impacts

Criteria for Achieving TMs Loads Reductions (Phase II)

[Note: This updated section was added as a Phase-II effort for updating Section 8 (Component 9) of the Upper Clear Creek Watershed Plan.]

1. See CDPHE-WQCD-NPS, 2005, Sections 5.5 and 6.2.
2. Worksheet #23 — Documenting Management Measures and Constraints
    a. This worksheet includes estimating load reductions from each management measure.
    b. Load estimates are made by constituent of concern or stressor; this can be a range estimate such as high, medium, or low or in units of per acre per year.
    c. A description of each management measure should be developed. This describes what it is and what it does or should do.
3. Worksheet #24 — List Best Management Practices (BMPs) Used In Watershed
    a. What erosion control measures are used to limit erosion of soil from disturbed areas at a construction site?
    b. What sediment control measures are used to limit transport of sediment to off-site or into downstream receiving waters?
    c. What drainageway protection and runoff management measures are used to protect streams and other drainage ways?
    d. What other management practices are in watershed?
    e. A check-off list of construction, temporary, or permanent BMPs is provided in this worksheet.
4. BMPs applicable to remediation of abandoned mines are described in a report prepared by CDMG (2002).
5. The quantification of pollutant loads and load reductions is a key component of the data analyses and characterizations for any watershed plan (Section 5.5). Since 2000, trace-metal-load calculations have been made at key monitoring site locations in the Upper Clear Creek Watershed (TDS Consulting Inc., 2000, 2002 through 2006).
6. In other parts of this ***Watershed Plan,*** water-quality targets have been identified and ongoing or planned remediation projects have been used to estimate whether or not these targets are attainable.
7. CCWF (2002) completed a restoration action strategy and program for the Upper Clear Creek Watershed which led to the development of the USEPA (2003) Action Memorandum. This agreement formed the basis of CCWF's mission and subsequent project activities in the watershed. Proposed specific actions are listed in Section V of the USEPA (2003) Action Memorandum.
8. An appendix to the CCWF (2002) document was a "baseline" healthy-stream profiles for selected "critical" (that is, 303(d) listed) stream segments by CCC (2002). This was an evaluation of existing watershed conditions (using available water-quality data from monitoring programs). The purpose is to allow a consistent approach for evaluating watershed changes as mine-related remediation progresses. This has been visualized as a 10-year program and is conceptualized as a "target-zone approach".

Monitoring Component (Watershed-Plan Component 6)

[Note: This modified section was added as a Phase-II effort for updating Section 9 (Component 6) of the Upper Clear Creek Watershed Plan.]

1. For the 1994-2004 period, the TMs monitoring component for the upper Clear Creek watershed was linked to the overall water-quality monitoring program coordinated with the Standley Lake Cities and with analytical support from the USEPA (Clear Creek Watershed/Standley Lake Monitoring Committee, 2004; USEPA, 1999).
2. Historical basic TMs data for the watershed under this monitoring component were reported in an appendix to the Clear Creek Watershed Management Agreement's (2002) 2001 Annual Report. In addition, these data have been used for a series of watershed studies [Abel and Steele (2003); CCC (2006); Huyck and others (1999); Steele (2000); Steele and others (1996; 1998; 2000); and TDS Consulting Inc. (2000; 2002; 2002a; 2002b; 2003; 2003a; 2004; 2004a; 2005 *(this Watershed Plan)*; 2006); Upper Clear Creek Watershed Advisory Group (2001); USEPA & CDPHE (1997a)].
3. The UCCWA-SLCs 2005 monitoring program included a reduced TMs component, when compared with the previous (1994-2004) period of record. A high-flow (HF) sampling survey was completed on 5/26/05, and a low-flow (LF) sampling survey was completed on 10/13/05). Each survey includes collecting samples at 17 sites (see SAP). This schedule is in contrast with the 8 field sampling surveys completed in previous years, with four surveys each for the HF and LF seasons. A monitoring site for Trail Creek (CC-31) and the Argo discharge (CD-01/-02) has been added (at the request of TDS) for inclusion in this monitoring-program component.
4. With analytical support from USEPA, UCCWA (through TDS) supported continuing the six sampling-survey dates during 2005 and 2006 not included in the reduced TMs monitoring-program component (item 3 above). Samples are collected at 10 of the 17 sites included in this component, with additional samples collected at Trail Creek (CC-31) and the Argo Treatment Facility discharge (site CC-99, sometimes coded as samples with ID#s CD-01/-02). TDS with field assistants completed sampling surveys for 2/10/05, 4/05/05, and 6/15/05. In a transition mode, TDS assisted USEPA-ESAT field staff in the next sampling survey, completed on 7/18/05. ESAT then conducted the 8/16/05 and 12/1/05 field data-collection surveys, to complete the TMs program component for the 2005 calendar year. A similar strategy for this monitoring component is being implemented during 2006 (see item 8 below).
5. CDOW (Shannon Albeke) has indicated that their WQ-sampling program component for 2005 has been reduced to a quarterly schedule (from a monthly sampling schedule for previous years) for its Clear Creek watershed program. The fish study again is scheduled for low-flow conditions in the late summer/fall period of 2005.
6. The USGS stream-gaging program may undergo modifications, beginning with the 2006 water year (WY, starting on October 1, 2005). Prioritization-ranking and recommendations are discussed in a technical memorandum submitted to UCCWA (TDS Consulting Inc., 2005b).
7. The mainstem Clear Creek at Kermitts gage (site CC-40) will continue to operate during the 2006 water year, with financial support through UCCWA from several sources.

8. The UCCWA-SLCs 2006 monitoring program (see item 3 above) will in general be consistent with the 2005 program, with supplemental data obtained at three sites (CC-49, CC-50, and CC-59) using automatic-sampler instrumentation.
9. Additional information, action items, and recommendations, resulting from 1/12/06 after-UCCWA meeting regarding the 2006 monitoring program are as follows:
    a. USEPA (Mike Holmes, with use of ESAT or follow-on contractor) will continue its 2005 support of the TMs component of the monitoring program.
    b. A subcommittee (tentatively, T.D. Steele, M.W. Crouse, Vicki Coppage, along with representation by CDPHE-HMWMD, SLC, and hopefully CDOW) will revise, as needed, the UCC Monitoring Plan referenced in annual watershed-agreement reports to the CDPHE-WQCC. Coordination to try to obtain consensus of the various monitoring-program components will be sought through this action item.
    c. Details of the trace-metals component for 2006 include the following aspects:
        i. Sampling for six field surveys at 11 monitoring sites – CC-15, CC-20, CC-25, CC-26, CC-30, CC-31, CC-34, CC-40, CC-45, CC-50, and CC-60. Planned field-sampling survey dates are 2/6/06 *(completed)*, 4/4/06, 7/10/06, 8/15/06, and 12/7/06. USEPA will prepare chain-of-custody (CoC) forms for these surveys and the field sampling and processing will be conducted by the USEPA contractor (currently, ESAT).
        ii. USEPA laboratory analyses for TMs consistent with recent years.
        iii. Sampling by the USEPA contractor for Trail Creek (CC-31) for the two UCCWA-SLC surveys that doesn't include this site – tentatively scheduled for 5/25 (high-flow) and for 10/18 (low-flow).
        iv. Sampling for all eight sampling surveys at selected wastewater treatment plants (WWTPs) in the watershed: tentatively, Georgetown, Idaho Springs, and Black Hawk/Central City Sanitation District. Vicki Coppage (Golden) and USEPA-ESAT (Mike Holmes at USEPA Region VIII, in conjunction with Marti McComb, USEPA and/or Kelly Head at the Laboratory) will coordinate with each other to ensure that WWTP sample coverage for TMs for the sampling surveys is accomplished for those WWTPs agreeing to participate during 2006.
        v. T.D. Steele will continue to update TMs data files and transmit these to interested parties, including regulatory contacts (WQCD, USEPA).
        vi. Pending continuing funding support, TDS Consulting Inc. will complete a 2006 Trace-Metals Assessment Addendum, once TMs data are made available (at least through 10/06), for period-of-record comparison of seasonal and year-to-year loads and concentrations for six monitoring sites and for five selected TMs (Pb, Mn, Zn, Cu, and Zn). This proposed addendum would be completed on/before 2/07.
    d. It is recommended that the staff gage be retained at the Fall River sampling site (CC-30) and that one be installed at the Trail Creek sampling site (CC-31) for tracking seasonal flow variations and to obtain streamflow estimates. A special TMs-related study of this subarea of the watershed is being funded by the CCWF and is scheduled for implementation (CCC, 2006).

Sources of Technical and Financial Assistance (Watershed-Plan Component 4)

Potential funding sources (Non-CERCLA NPS Control Efforts, Task 10) for addressing the watershed's water-quality concerns and/or mining-related impacts include, but are not limited to, the following:

1. National USEPA "Targeted-Watershed" Grant.—CCWF has submitted proposals to this program in the past; no application has been successful, however.
2. USEPA Regional Applied Research Effort (RARE) Grant Program.—Annual solicitation through Region 8 the promotes scientific interaction between USEPA's ORD labs and centers (Mike Holmes, USEPA, oral commun., 7/27/05). The annual submittal date for preliminary project proposals is August 1 (2005), with awards funding between 4-6/06.
3. Colorado Watershed Protection Fund (Program Grant).—This fund was established by the 2002 Colorado General Assembly (SB 02-087). The grant program is administered jointly by the Colorado Water Conservation Board (CWCB) and the Water Quality Control Commission (WQCC) of the CDPHE. The two grant categories are: (1) project grants; and (2) planning grants. Application evaluation criteria also are provided. For each annual cycle, the deadline for application submittal is April 30th, and grant awards are made on September 30th.
4. USEPA Region VIII Consolidated Funding Process (CFP) Grant.—CCWF has submitted proposals to this program in the past; however, no application has been successful.
5. Watershed Protection Approach Funding Matrix (CCW*F*, 1993, 9-p. Appendix).—This was developed by participants of the spring-1992 USEPA-OWOW conference for exploring options for funding watershed-protection activities.
6. CDPHE-WQCD Nonpoint Source Program (NPS) 319 Grant.—UCCWA has obtained 310 grants for a QUAL2E model application (Phase III) and for preparation of a Watershed Plan (5 of 9 elements). A Phase-2 Watershed Plan grant application may be considered for preparation/submittal in November 2005.
7. DMG-CCWF and CSM-EPICS Projects
8. [Molson] Coors Brewing Company – 2005 Clear Creek Forum (CC*F*) Grant
9. Phelps Dodge-Henderson Mine – Grant/Match In-Kind.—During 2005, PD-Henderson provided a supplemental contribution to UCCWA ($5K).
10. U.S. Forest Service (USFS) Grant (funds from USEPA; administered through Clear Creek County).
11. Superfund (through CDPHE-HMWMD)
12. USEPA Brownfields
13. NREL High-Altitude Demonstration Project
14. Supplemental Environmental Projects (SEPs) – in lieu of fines
    - Example, Iowa Tank Lines spill
    - Others – add as available
15. Metals trading for credit (see CCWF trading proposal, submitted to USEPA)?
16. Franklin Mine Bond (for reclamation work within permitted area)

17. Donations of money or land/easements/rights-of-way
18. Partnering with Trout Unlimited (and others?)
19. Clear Water Act (CWA) Section 104(b)(3).--Assessment and Watershed Protection Support, includes all levels of government and private organizations. Resources (funds) also may be used for Interagency Agreements (IAGs) and contract support. Another aspect is termed as Water-Quality Cooperative Agreements [66.4631]; these involve unique investigations, special one-time studies, pilots and demonstrations to implement NPDES-related activities. The 1- to 2-year demonstration projects should support NPDES implementation, development/implementation of BMPs for stormwater, and overflow/stormwater discharge-control programs in general.
20. CWA Section 104(g).—Small community outreach; inventive grants to develop or expand small-community outreach programs. These are intended to encourage the establishment or enhancement of state small-community outreach programs.
21. Safe Drinking Water Act (SDWA) Section 1443(a)(1).—Small Public Water-System Supervision [66.432]. Focus is on state drinking-water programs (program costs, technical assistance, laboratory capability, enforcement, and data management.
22. SDWA Section 1442(b).—Wellhead Protection (WHP); these are demonstration projects aimed as assisting (small) municipalities to design and implement a wellhead protection program. Eligible activities include delineation of WHP areas, identifying sources of contamination, public education, development of ordinances for WHP, WHP contamination-source surveys, and GIS mapping of WHP areas.
23. Colorado Division of Local Government (CDLG), Department of Local Affairs.—Technical Assistance, Colorado Water Needs (Categorization) List (CDLG, 1998a) and Colorado Sewer Needs (Categorization) List (CDLG, 1998b). These list cities, towns, special districts, and unincorporated communities that supply water or operate and/or manage wastewater systems or need such systems. Criteria used to categorize each community's needs are (a) immediate or (b) longer-term/emerging. These lists are updated quarterly by a committee formed in 1979 at the Governor's request.
24. Assessment of funding vehicles (Mulhern MRE, Inc., 1994) prepared for the Chatfield Basin Authority.

UCC-WAG (2001, Chapter 13 and Table B-1) provided a useful summary of costs estimates for various proposed remediation projects throughout the upper Clear Creek watershed. In selected cases, updated investigations have provided more realistic costs. An example is the OU4 RI/FS completed under the auspices of the CDPHE-HMWMD (CDPHE and USEPA, 2004). For this Superfund's preferred remediation alternative (4B, involving predominately projects in the North Fork Clear Creek subwatershed), capital costs of $11.8 million and O&M costs of nearly $11.5 million (present value, annualized $926,000) were estimated. Preliminary engineering-design work for high-priority components of this alternative is currently proposed. For the Virginia Canyon area (extraction costs only, $514,000, according to CDM (1991)), remediation work is underway during the 2005 summer season.

Public Outreach – Summary of 319-Grant Workshop

An overview presentation of the Phase-I tasks completed in fulfillment of this 319 grant was provided by Dr. Steele of TDS Consulting Inc. at the Clear Creek Watershed Forum 2005 on September 27, 2005. The report's title sheet, table of contents, and executive summary were included as a handout in the *F*orum packet. At the conclusion of this presentation, *F*orum participants were asked to provide questions and comments on the material provided by this overview on comment forms included in the workshop (Forum) handout packet. The Project Administrator, Ms. Chris Crouse, has summarized questions and comments from submitted comment forms (see Section 5)

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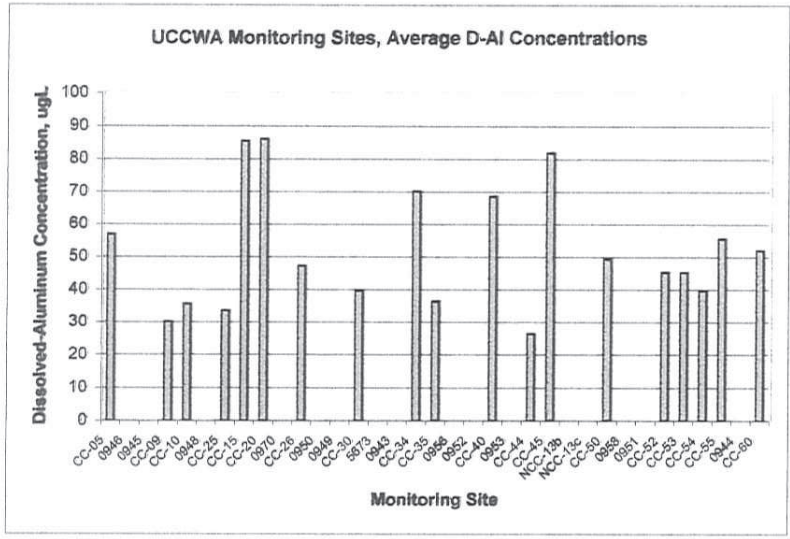
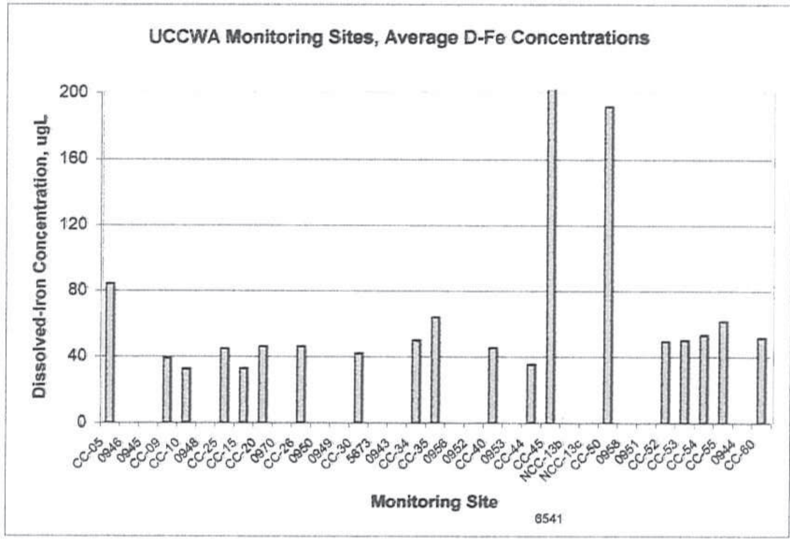
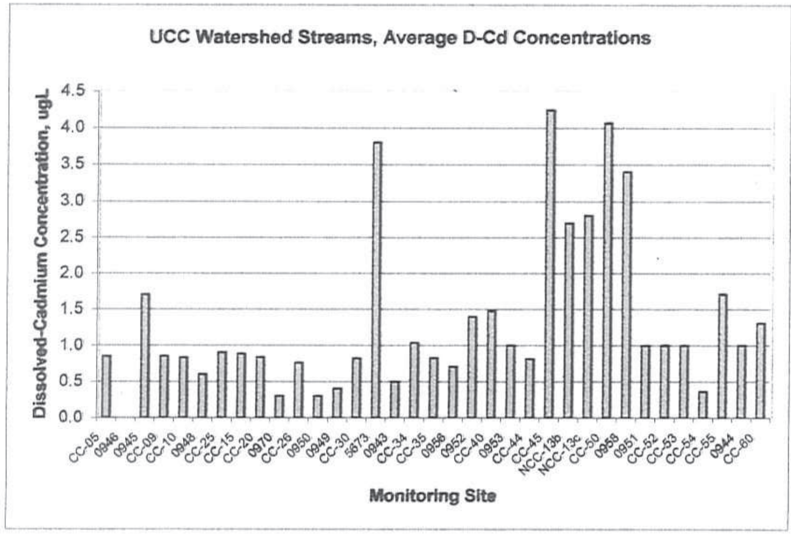
Figure 1-1 -- Average D-TMs Concentrations, Upper Clear Creek Watershed Monitoring Sites







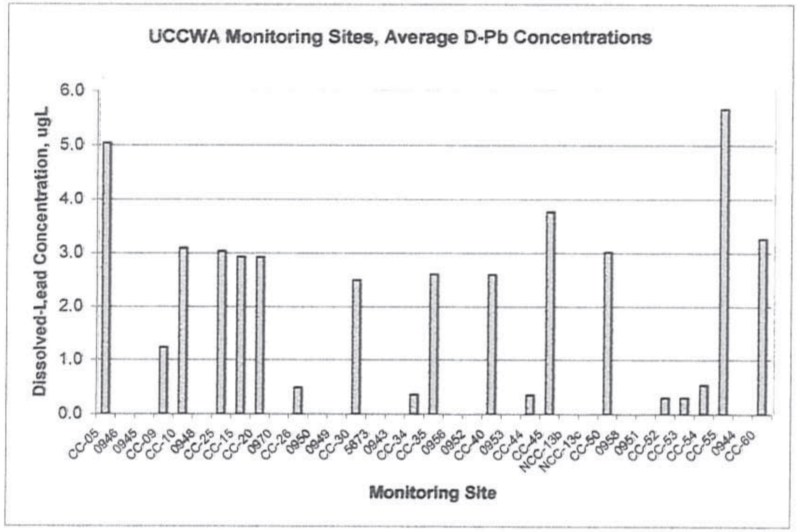


Figure 1-1 -- Average D-TMs Concentrations, Upper Clear Creek Watershed Monitoring Sites

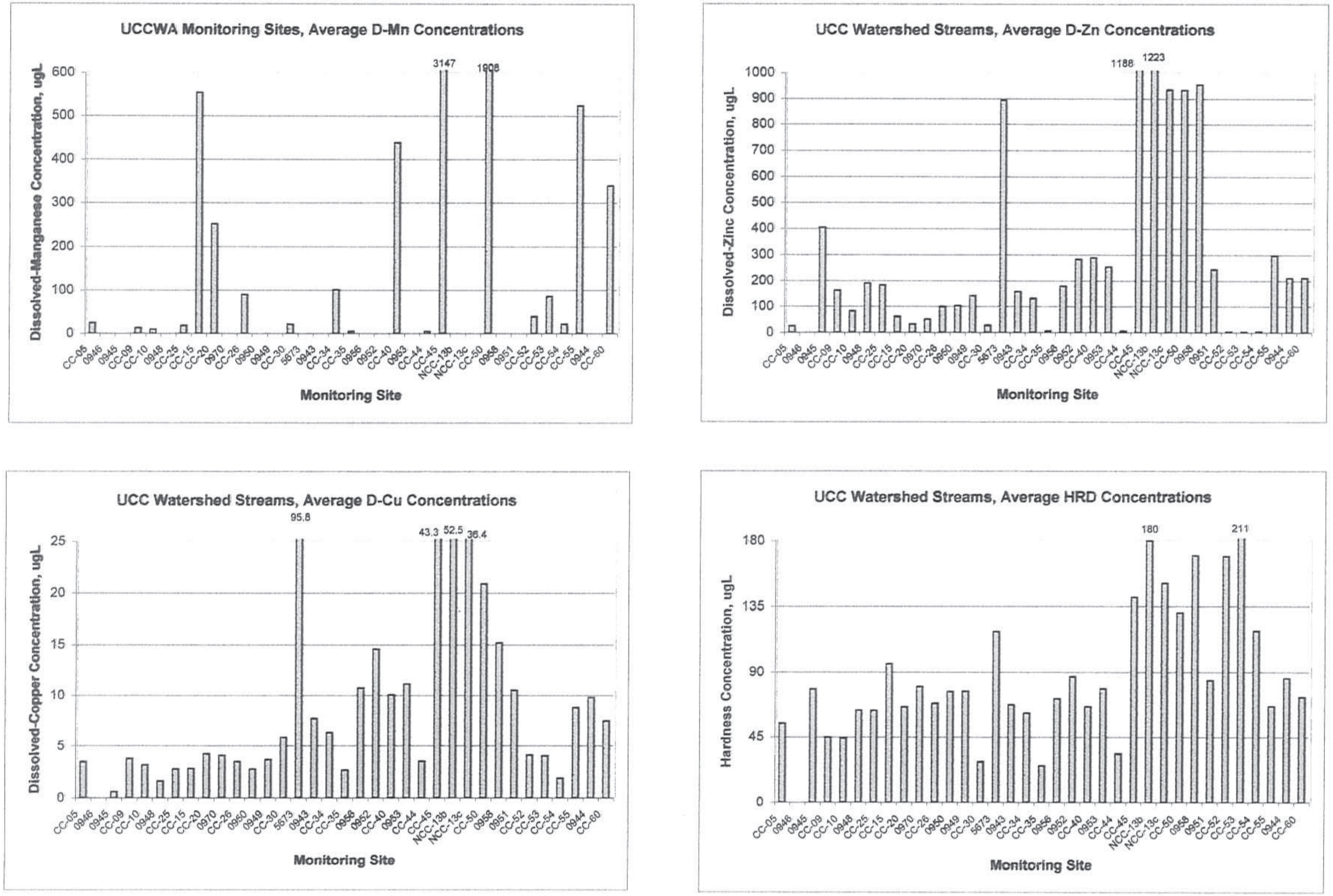
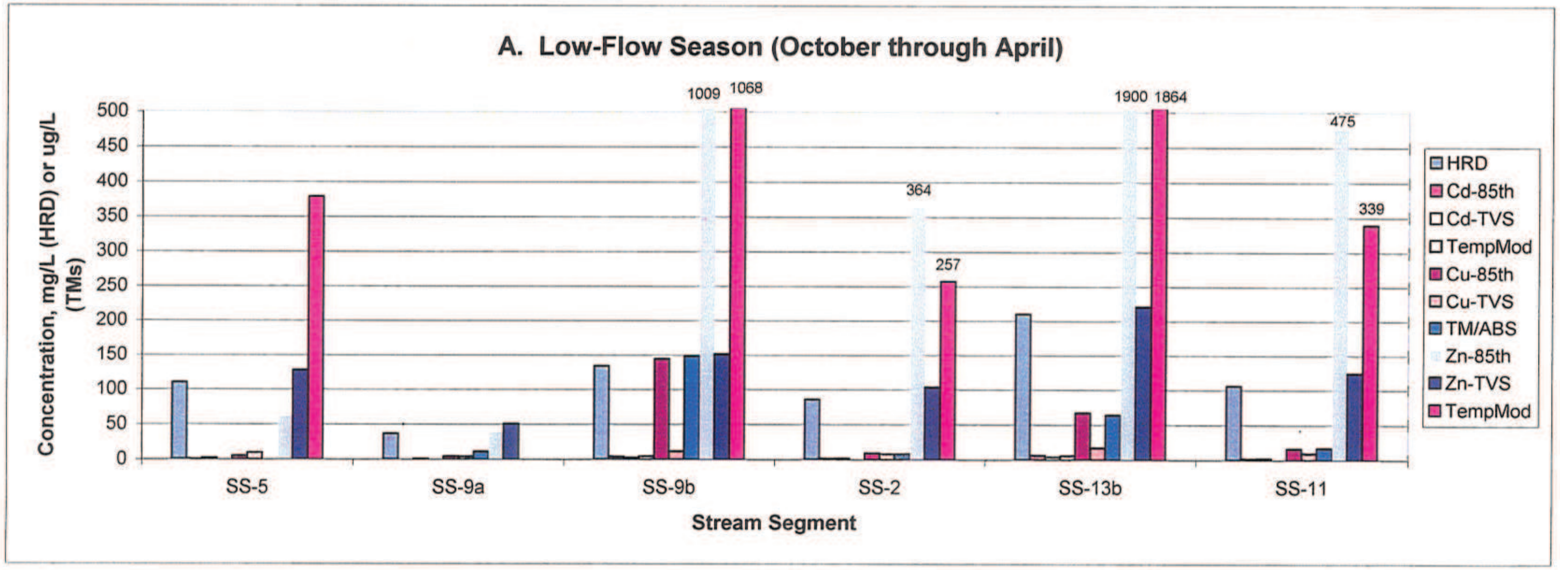


Figure 1-2 -- Comparison of Selected Seasonal Trace-Metals Standards by Segment



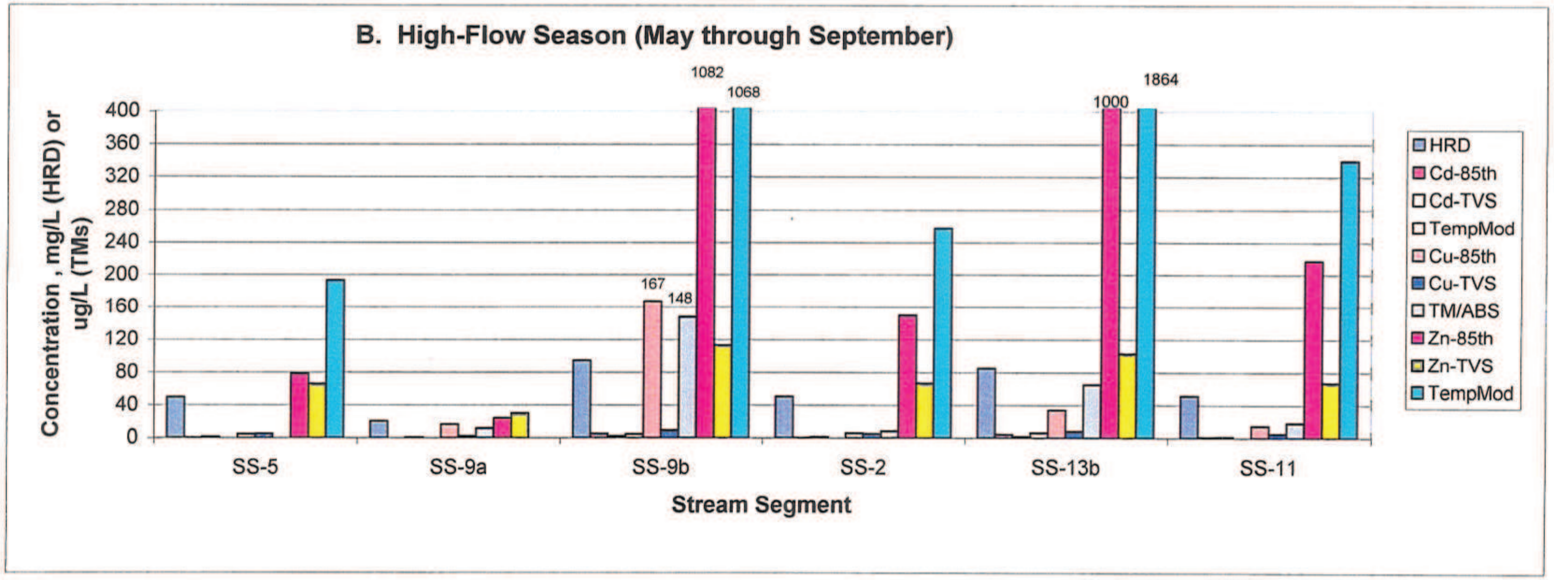
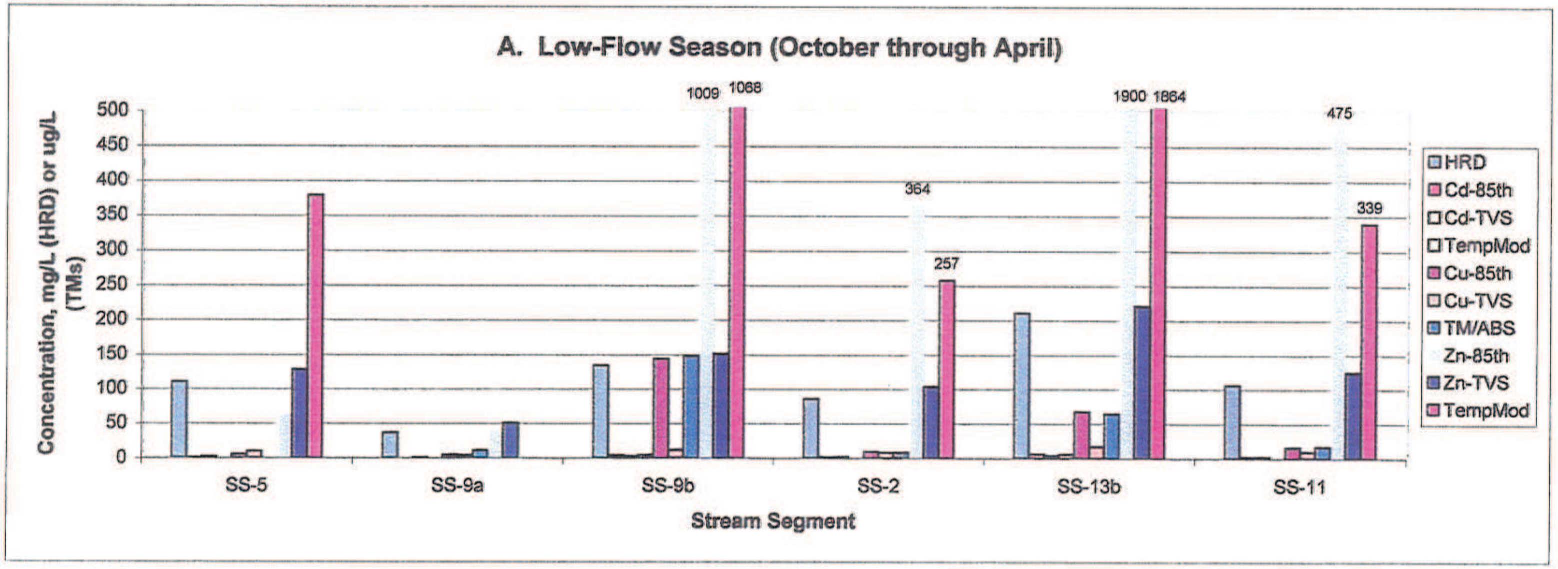
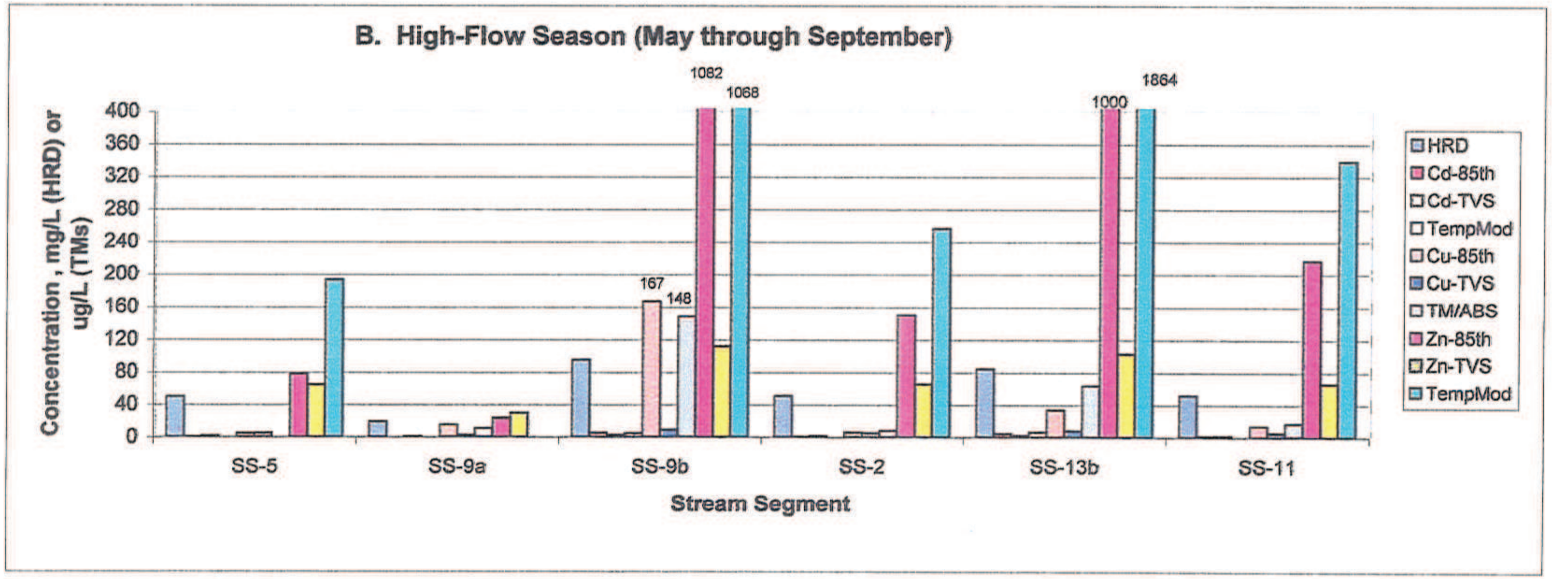
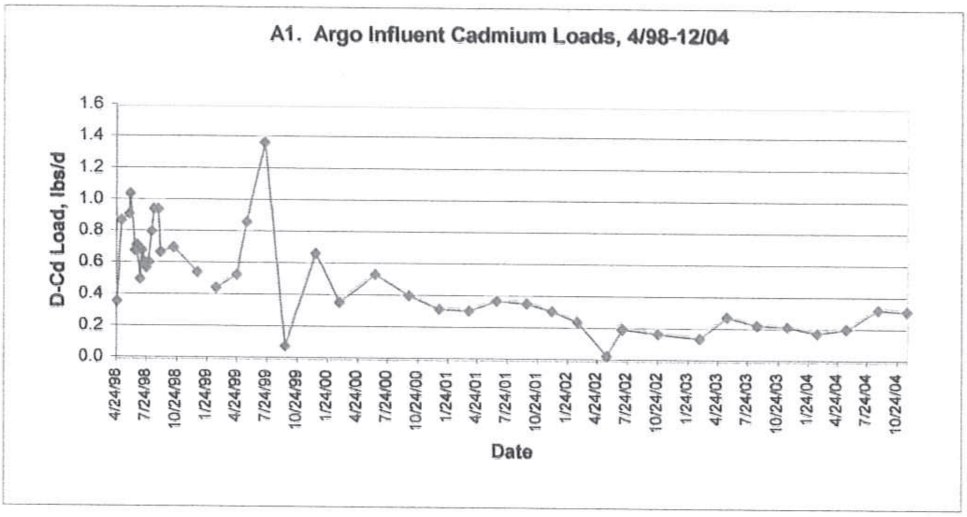


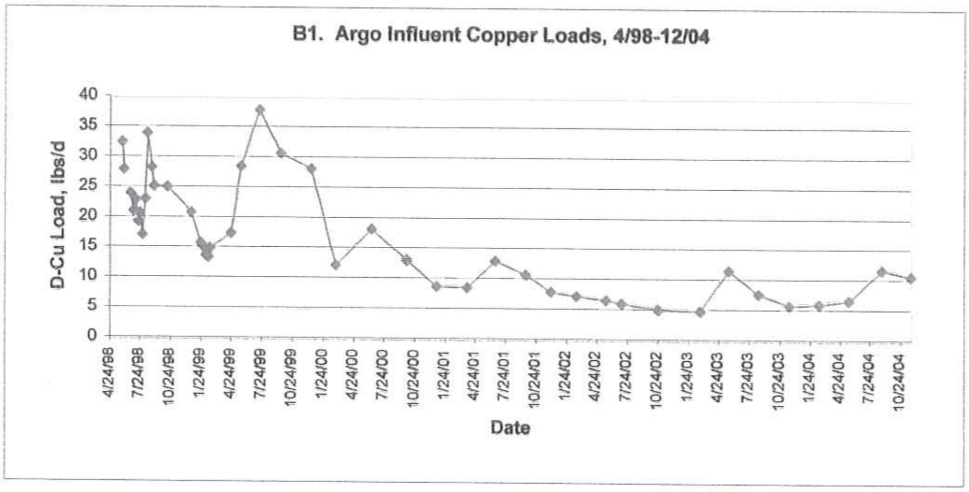
Figure 1-2 -- Comparison of Selected Trace-Metals Statistics by Segment

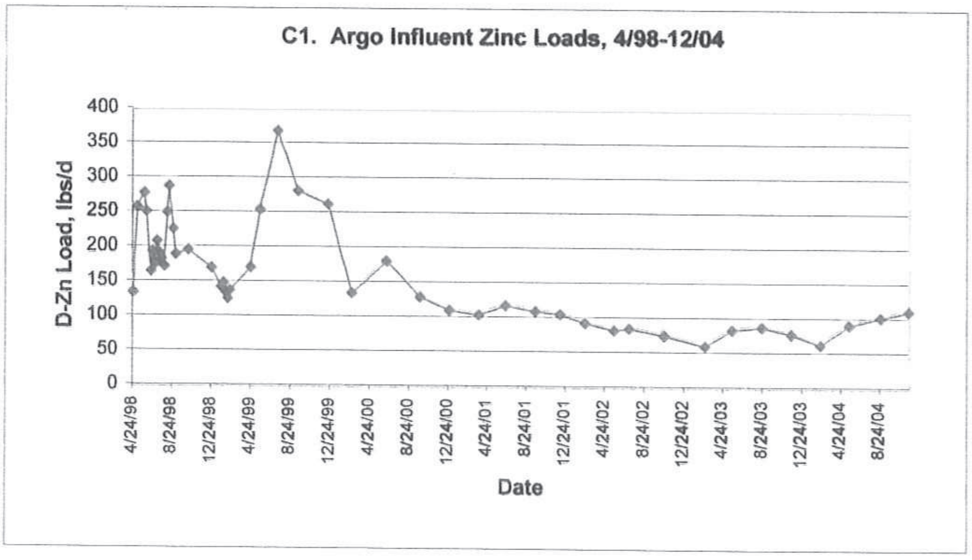




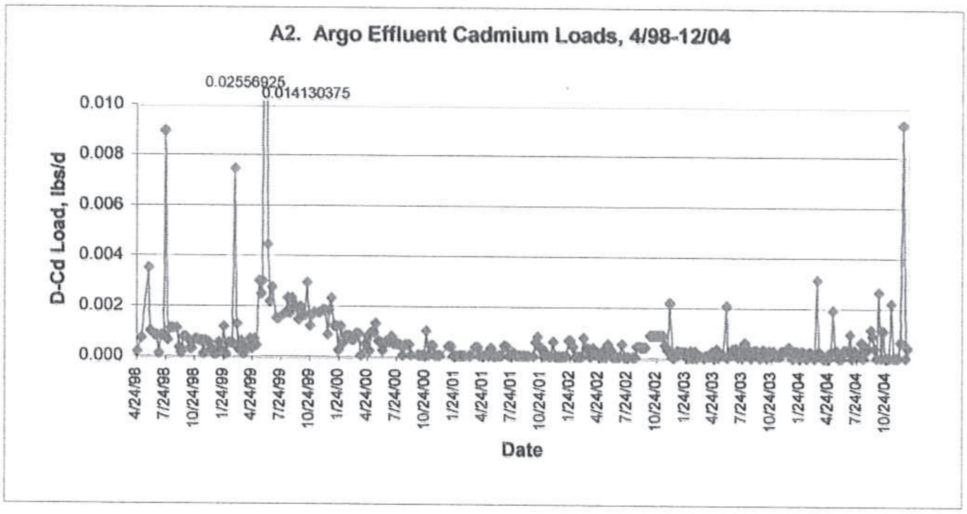
Argo-Related Trace-Metals (TMs) Loads

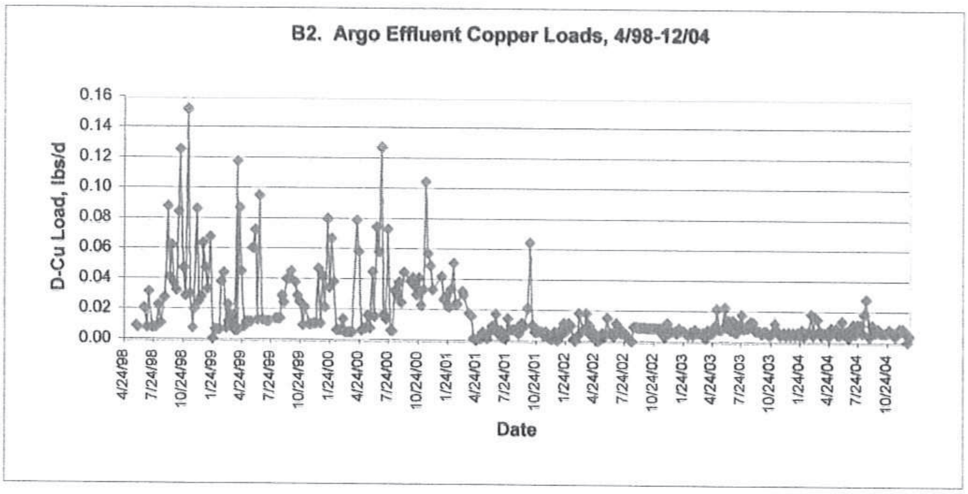


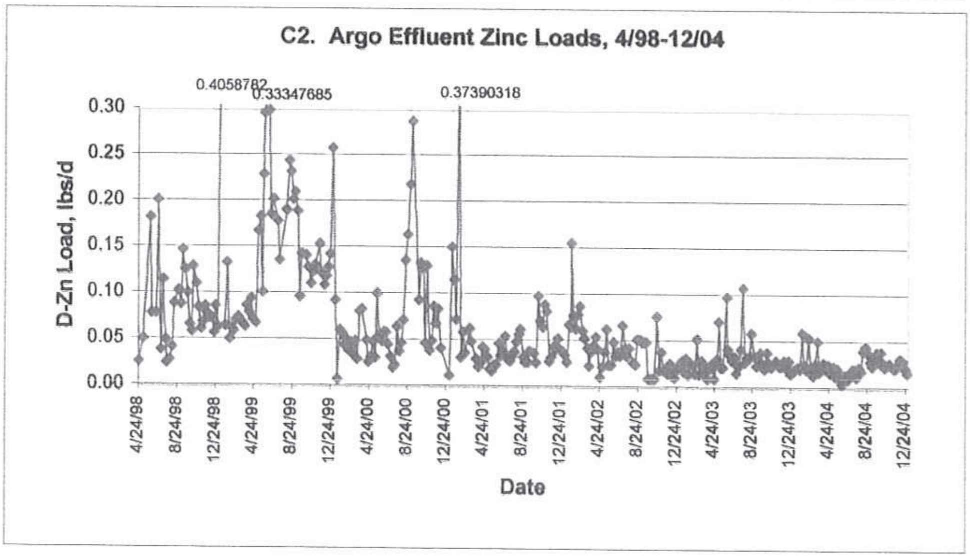




Argo-Related Trace-Metals (TMs) Loads







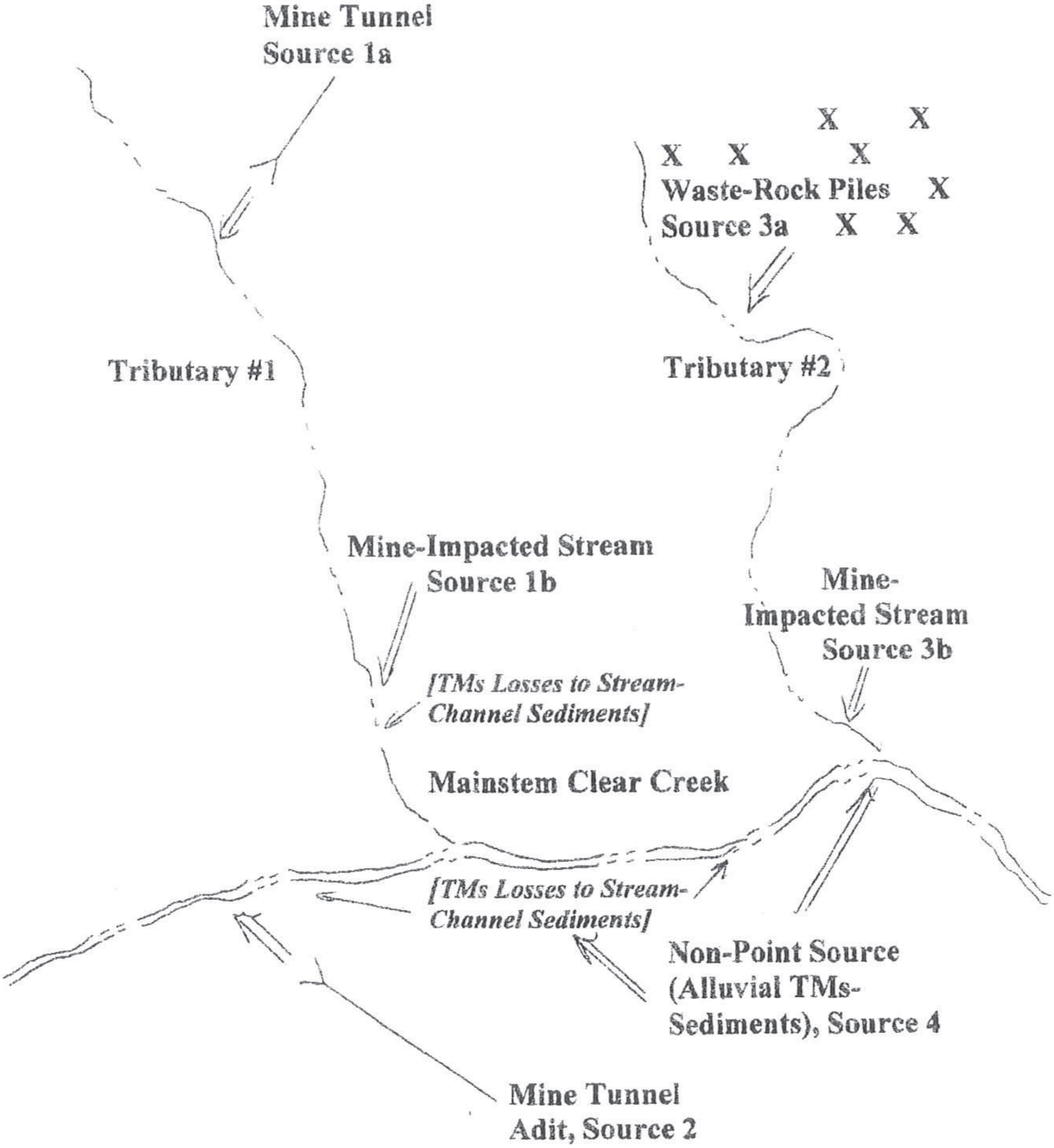


Figure 3-2 – Conceptual Schematic for Estimation of TMs-Loads' Reduction through Remediation

Figure 4-1 -- Ambient Conditions vs. Dissolved-Zinc WQs

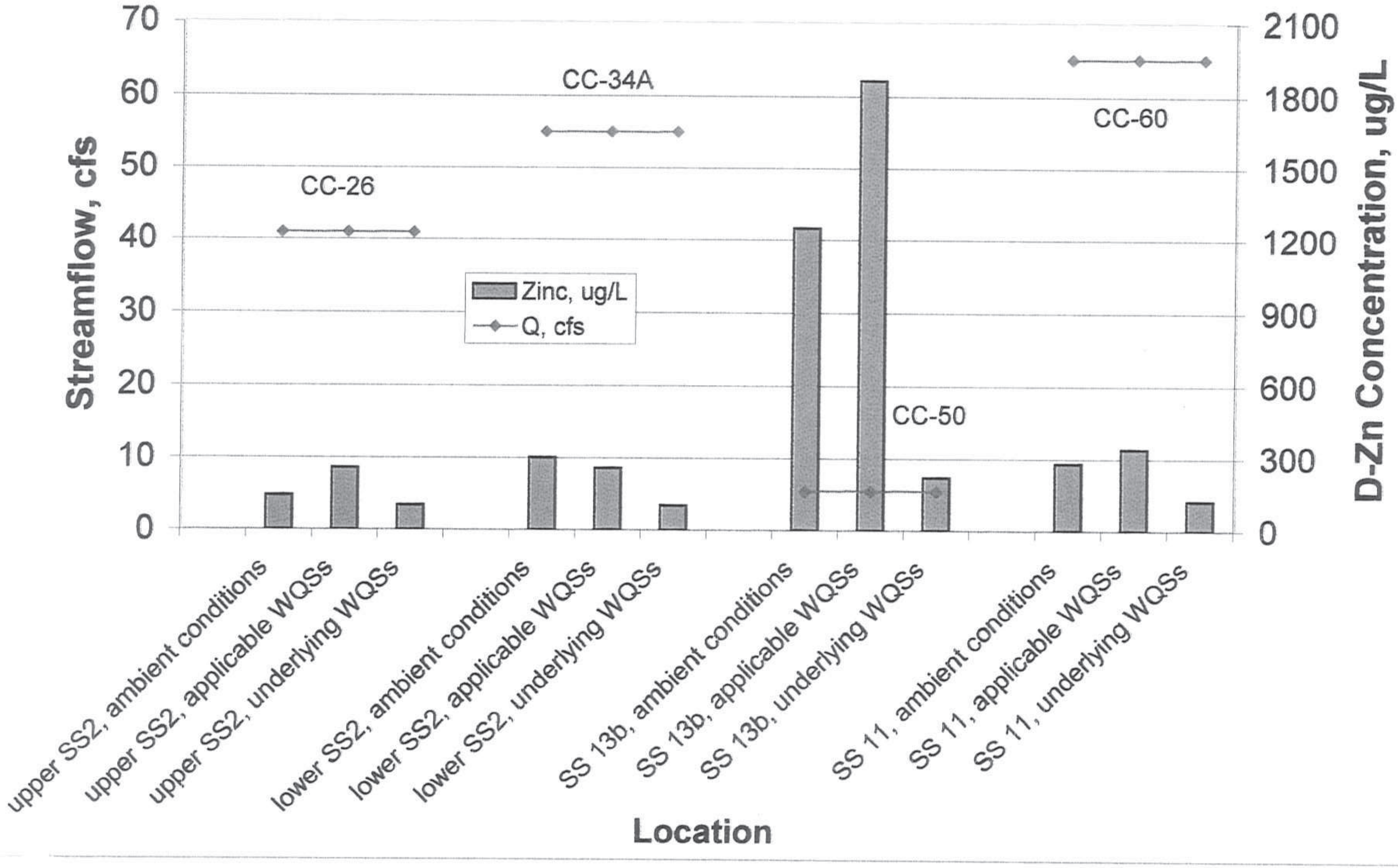
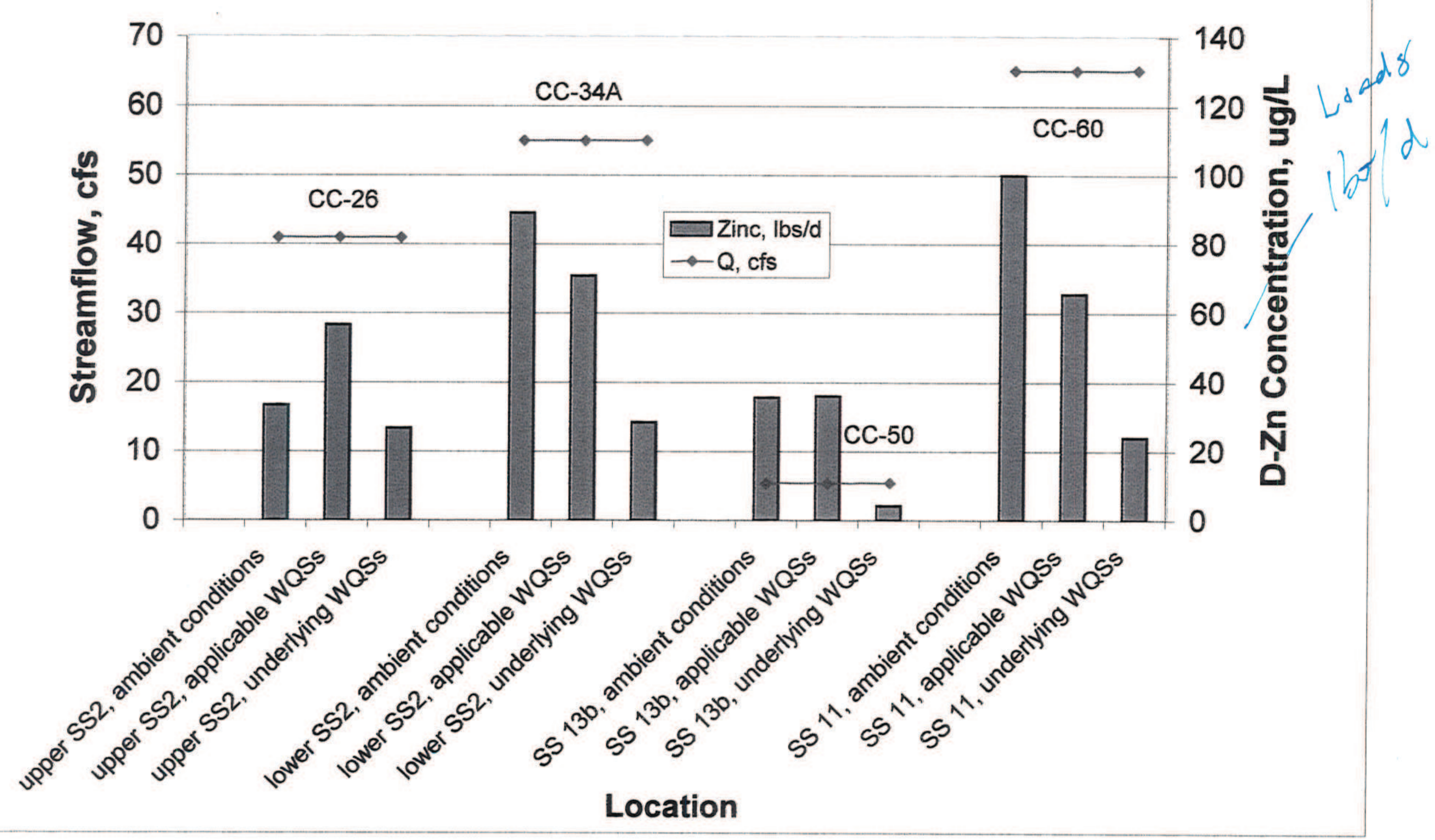


Figure 4-2 -- Ambient Conditions vs. Dissolved-Zinc Loads



Upper Clear Creek Watershed – Water-Quality Monitoring Sites and WQCD Water-Quality Stream Segments

Segment	*Description*	*Site(s)*	*Listed TMs*
1	Mainstem Clear Creek at Bakerville	CC-05	
	CC at Bakerville (CDOW 0.1)	0946	
2	CC @ Georgetown Loop RR (CDOW 0.5)	0945	*D-Cu, D-Zn*
	CC bl Georgetown (CDOW 1)	0948	
	Mainstem Clear Creek (ab WFCC)	CC-25	
	Mainstem Clear Creek (bl WFCC)	CC-26	
	CC bl US 40 (CDOW 2)	0950	
	CC bl Spring Gulch (CDOW 3)	0949	
	CC ab Idaho Springs (CDOW 4)	0943	
	Mainstem Clear Creek (ab Chicago Ck)	CC-34	
	CC at Riverside Park (Id.Spgs.CDOW 5)	0956	
3a	South Fork Clear Creek	CC-10	*D-Zn*
3b	Leavenworth Creek	CC-09	*D-Cu, D-Zn*
4	Upper West Fork Clear Creek	n/a	
7	Woods Creek	n/a	
6	All tribs except 4 & 7 (upper WF)	n/a	
8	Lions Creek	n/a	
5	West Fork Clear Creek @ Berthoud Falls	CC-15	*D-Cu, D-Zn*
	West Fork Clear Creek at mouth	CC-20	
	WFCC at confluence (CDOW site)	0970	
9a	Fall River, including all tributaries	CC-30	*D-Cu, D-Zn*
9b	Trail Creek, incl. all tributaries (CDPHE)	5673	*D-Cd/Cu/Pb/Mn/Zn*
10	Chicago Creek, including all tributaries	CC-35	

Upper Clear Creek Watershed -- Water-Quality Monitoring Sites and WQCD Water-Quality Stream Segments

Segment	Description	Site(s)	Listed TMs
11	CC at Dump (Id.Spgs.CDOW 6)	0952	*D-Cd/Cu/Zn*
	Mainstem Clear Creek at Kermitts	CC-40	
	CC at Gravel Pit (bl KermittsCDOW 7)	0953	
	CC at Braided Channel (CDOW 7.5)	0951	
	Mainstem CC below Beaver Brook	CC-55	
	CC at Tunnel #1 (CDOW 8)	0944	
	Mainstem CC above Church Ditch Divrs	CC-60	
12	All tributaries to 11 except 13A/13B	CC-54/-52/-53	
13a	Upper NFCC & tribs. ab WS intake	CC-44	
	NFCC ab Black Hawk's Pump Station	NCC-13a	
13b	North Fork Clear Ck ab BHCCSD WWTP	CC-45	*D-Cd/Mn/Zn/Cu; T-Fe*
	NFCC ab existing BHCCSD WWTP	NCC-13b	
	NFCC near new BHCCSD WWTP	NCC-13c	
	North Fork Clear Creek at mouth	CC-50	*Aq Life Use*
	CC at confluence (CDOW site)	0958	
	[UCCWA "watershed management" stops here]		
14a	Mainstem CC, Farmers Highline Canal to Denver Water conduit #16	n/a	*Aq Life Use*
14b	Mainstem CC, Denver Water conduit to Youngfield Street	n/a	*Aq Life Use*
15	Mainstem CC, Youngfield to S.Platte	n/a	*Aq Life Use* *fecal coliform*

Codes:
UCCWA = Upper Clear Creek Watershed Association
SLCs = Standley Lake Cities (Northglenn, Westminster, Thornton)
UCCWA/SLCs sites, indicated as "CC-xx" (xx is numeric code).
CDOW = Colorado Division of Wildlife
BBCCSD = Black Hawk/Central City Sanitation District (NCC sites)
n/a = no monitoring sites available for this assessment; not applicable
Blue shaded stream segments = those included in this 319 assessment.
Green-shaded stream segments = added to this 319 assessment (optional).

Status: *1/5/04 Updated*

Table 1-2

SummaryTable 2 -- Summary of Average D-TMs and Hardness Concentrations, Upper Clear Creek Watershed Monitoring Sites

Note: not updated for 12/04 results.

Site ID		Mo	Ni	K	Se	Ag	Na	Th	V	Zn	Hrd	Q	Site ID	HRD @ Low-Q		HRD @ High-Q	
CC-05	**Average Concentrations:**	**4.0**	**13.1**	**1.0**	**14.7**	**0.9**	**9.12**	**21.4**	**5.0**	**25.0**	**54.5**	**53.0**	CC-05	**75.4**	**11.3**	**37.7**	**97.3**
Segment 1	*Number of Analyses:*	*45*	*84*	*49*	*83*	*81*	*49*	*26*	*8*	*84*	*72*	*88*	Segment 1	*31*	*42*	*38*	*42*
CC-09	**Average Concentrations:**	**3.1**	**4.8**	**0.6**	**8.6**	**0.2**	**1.85**			**164**	**44.9**	**13.6**	CC-09	**57.9**	**2.6**	**34.1**	**23.8**
Segment 3b	*Number of Analyses:*	*37*	*45*	*37*	*45*	*45*	*37*			*45*	*45*	*46*	Segment 3b	*20*	*20*	*22*	*22*
CC-10	**Average Concentrations:**	**3.9**	**9.1**	**1.2**	**14.7**	**0.8**	**1.94**	**21.4**	**4.0**	**81.7**	**44.2**	**16.7**	CC-10	**53.8**	**3.5**	**35.6**	**30.7**
Segment 3a	*Number of Analyses:*	*47*	*86*	*51*	*85*	*83*	*51*	*26*	*8*	*86*	*75*	*88*	Segment 3a	*34*	*42*	*38*	*42*
CC-25	**Average Concentrations:**	**3.9**	**9.1**	**1.0**	**14.6**	**0.8**	**5.57**	**21.4**	**4.0**	**184**	**63.2**	**108**	CC-25	**77.3**	**24.3**	**51.1**	**197**
Segment 2	*Number of Analyses:*	*47*	*86*	*51*	*85*	*83*	*51*	*26*	*8*	*86*	*75*	*88*	Segment 2	*34*	*42*	*38*	*42*
CC-15	**Average Concentrations:**	**30.0**	**9.2**	**7.1**	**14.7**	**0.8**	**34.2**	**21.4**	**4.0**	**60.8**	**96.0**	**41.7**	CC-15	**149.5**	**9.9**	**52.3**	**76**
Segment 5	*Number of Analyses:*	*47*	*85*	*51*	*84*	*82*	*51*	*26*	*8*	*85*	*73*	*88*	Segment 5	*32*	*42*	*38*	*42*
CC-20	**Average Concentrations:**	**12.0**	**9.5**	**3.4**	**14.7**	**0.8**	**20.0**	**21.4**	**4.0**	**32.1**	**66.0**	**101**	CC-20	**93.5**	**20.7**	**42.4**	**184**
Segment 5	*Number of Analyses:*	*47*	*86*	*51*	*85*	*83*	*51*	*26*	*8*	*86*	*75*	*88*	Segment 5	*34*	*42*	*38*	*42*
CC-26	**Average Concentrations:**	**4.7**	**8.2**	**2.0**	**7.7**	**0.2**	**10.9**	**0.9**		**99**	**68.3**	**171**	CC-26	**88.9**	**41.7**	**50.0**	**312**
Segment 2	*Number of Analyses:*	*37*	*54*	*42*	*54*	*54*	*42*	*8*		*54*	*54*	*56*	Segment 2	*25*	*26*	*26*	*26*
CC-30	**Average Concentrations:**	**3.8**	**9.3**	**1.0**	**14.3**	**0.8**	**2.83**	**20.3**	**4.0**	**27.9**	**27.9**	**28.8**	CC-30	**37.2**	**6.5**	**20.1**	**52**
Segment 9a	*Number of Analyses:*	*46*	*85*	*50*	*84*	*81*	*50*	*25*	*7*	*85*	*74*	*88*	Segment 9a	*34*	*42*	*37*	*42*
CC-34	**Average Concentrations:**	**3.8**	**2.6**	**1.8**	**8.9**	**0.2**	**9.8**			**132**	**61.2**		CC-34	Insufficient data values - ST			
Segment 2	*Number of Analyses:*	*13*	*13*	*13*	*13*	*13*	*13*			*13*	*13*		Segment 2				
CC-35	**Average Concentrations:**	**3.9**	**9.3**	**1.0**	**14.4**	**0.8**	**3.00**	**20.3**	**4.0**	**7.2**	**25.2**	**23.2**	CC-35	**28.4**	**5.9**	**22.6**	**41**
Segment 10	*Number of Analyses:*	*44*	*83*	*48*	*82*	*80*	*48*	*25*	*7*	*83*	*72*	*88*	Segment 10	*32*	*42*	*37*	*42*
CC-40	**Average Concentrations:**	**4.5**	**10.0**	**2.0**	**14.2**	**0.7**	**13.3**	**20.3**	**4.0**	**289**	**66.1**	**269**	CC-40	**91.3**	**61.8**	**44.7**	**487**
Segment 11	*Number of Analyses:*	*46*	*85*	*50*	*84*	*82*	*50*	*25*	*7*	*85*	*73*	*88*	Segment 11	*33*	*42*	*37*	*42*
CC-44	**Average Concentrations:**	**3.1**	**3.8**	**1.1**	**8.7**	**0.2**	**5.21**			**5.6**	**33.4**	**16.2**	CC-44	**47.5**	**6.0**	**29.4**	**24.8**
Segment 13a	*Number of Analyses:*	*30*	*35*	*30*	*35*	*35*	*30*			*35*	*34*	*43*	Segment 13a	*12*	*18*	*31*	*31*
CC-45	**Average Concentrations:**	**4.3**	**25.6**	**2.2**	**16.5**	**0.9**	**20.6**	**21.6**	**4.0**	**1188**	**141**	**21.5**	CC-45	**226**	**5.8**	**70.7**	**37.8**
Segment 13b	*Number of Analyses:*	*47*	*85*	*51*	*85*	*83*	*51*	*26*	*8*	*86*	*75*	*88*	Segment 13b	*34*	*42*	*38*	*42*
CC-50	**Average Concentrations:**	**4.2**	**20.2**	**5.1**	**16.3**	**0.8**	**24.7**	**21.6**	**4.0**	**934**	**131**	**24.0**	CC-50	**193**	**5.0**	**78.7**	**44.8**
Segment 13b	*Number of Analyses:*	*47*	*86*	*51*	*85*	*83*	*51*	*26*	*8*	*86*	*75*	*88*	Segment 13b	*34*	*42*	*38*	*42*
CC-52	**Average Concentrations:**	**3.0**	**2.7**	**2.4**	**10.1**	**0.2**	**16.6**			**4.0**	**170**		CC-52	Insufficient data values - ST			
Segment 12	*Number of Analyses:*	*22*	*22*	*22*	*22*	*22*	*22*			*22*	*22*		Segment 12				
CC-53	**Average Concentrations:**	**3.0**	**2.8**	**2.4**	**10.0**	**0.2**	**16.2**			**3.2**	**211**		CC-53	Insufficient data values - ST			
Segment 12	*Number of Analyses:*	*21*	*21*	*21*	*21*	*21*	*21*			*21*	*21*		Segment 12				
CC-54	**Average Concentrations:**	**3.3**	**8.8**	**1.8**	**6.0**	**0.1**	**12.9**			**3.6**	**118**		CC-54	Insufficient data values - ST			
Segment 12	*Number of Analyses:*	*7*	*14*	*7*	*14*	*14*	*7*			*14*	*14*		Segment 12				
CC-55	**Average Concentrations:**	**8.2**	**14.3**	**2.5**	**21.5**	**1.6**	**11.4**	**21.6**	**4.0**	**297**	**66.2**		CC-55	**96.3**		**40.0**	
Segment 11	*Number of Analyses:*	*10*	*41*	*14*	*40*	*38*	*14*	*26*	*8*	*41*	*30*		Segment 11	*14*		*16*	
CC-60	**Average Concentrations:**	**4.4**	**9.8**	**2.2**	**14.6**	**0.8**	**14.3**	**21.6**	**4.0**	**211**	**72.6**	**264**	CC-60	**102**	**62.8**	**47.4**	**475**
Segment 11	*Number of Analyses:*	*47*	*86*	*51*	*85*	*83*	*51*	*26*	*8*	*86*	*75*	*88*	Segment 11	*34*	*42*	*38*	*42*

Table 1-2

Summary of Average POR Selected D-TMs and Hardness Concentrations, Upper Clear Creek Watershed Monitoring Sites

Note: not updated for 12/04 results.

Site ID		Al	Sb	As	Ba	Be	Cd	Ca	Cr	Co	Notes	Cu	Fe	Pb	Mg	Mn
CC-05	**Average Concentrations:**	**56.9**	**40.1**	**14.7**	**39.3**	**1.4**	**0.8**	**14.84**	**3.1**	**2.0**		**3.5**	**84.2**	**5.0**	**4.2**	**24.5**
Segment 1	*Number of Analyses:*	*84*	*10*	*83*	*43*	*9*	*84*	*78*	*50*	*44*		*84*	*84*	*84*	*79*	*84*
CC-09	**Average Concentrations:**	**30.2**		**4.5**	**37.1**		**0.9**	**12.12**	**1.6**	**1.1**		**3.8**	**38.8**	**1.2**	**3.56**	**12.9**
Segment 3b	*Number of Analyses:*	*45*		*45*	*37*		*45*	*45*	*37*	*37*		*45*	*45*	*45*	*45*	*45*
CC-10	**Average Concentrations:**	**35.7**	**40.1**	**14.5**	**32.3**	**1.4**	**0.8**	**11.87**	**2.9**	**1.9**		**3.2**	**32.5**	**3.1**	**3.56**	**9.7**
Segment 3a	*Number of Analyses:*	*86*	*10*	*85*	*45*	*9*	*86*	*81*	*52*	*46*		*86*	*86*	*85*	*81*	*86*
CC-25	**Average Concentrations:**	**33.6**	**40.1**	**14.4**	**43.5**	**1.4**	**0.9**	**15.79**	**2.9**	**1.9**		**2.8**	**44.7**	**3.0**	**5.18**	**18.2**
Segment 2	*Number of Analyses:*	*86*	*10*	*85*	*45*	*9*	*86*	*81*	*52*	*46*		*86*	*86*	*86*	*81*	*86*
CC-15	**Average Concentrations:**	**85.4**	**40.1**	**13.7**	**10.8**	**1.4**	**0.9**	**33.00**	**2.9**	**1.9**		**2.8**	**32.5**	**2.9**	**2.94**	**553**
Segment 5	*Number of Analyses:*	*85*	*10*	*84*	*45*	*9*	*85*	*80*	*52*	*46*		*85*	*85*	*85*	*80*	*85*
CC-20	**Average Concentrations:**	**85.9**	**40.1**	**14.6**	**19.5**	**1.4**	**0.8**	**21.13**	**2.9**	**2.1**		**4.3**	**46.1**	**2.9**	**3.10**	**252**
Segment 5	*Number of Analyses:*	*86*	*10*	*84*	*45*	*9*	*86*	*81*	*52*	*46*		*86*	*86*	*86*	*81*	*86*
CC-26	**Average Concentrations:**	**47.2**	**0.6**	**5.4**	**35.5**		**0.8**	**19.72**	**2.6**	**1.1**		**3.5**	**46.1**	**0.5**	**4.65**	**89.9**
Segment 2	*Number of Analyses:*	*54*	*1*	*54*	*37*		*54*	*54*	*42*	*37*		*54*	*54*	*54*	*54*	*54*
CC-30	**Average Concentrations:**	**39.7**	**40.1**	**14.1**	**18.7**	**1.5**	**0.8**	**7.31**	**2.8**	**1.9**		**5.9**	**41.9**	**2.5**	**2.18**	**21.2**
Segment 9a	*Number of Analyses:*	*85*	*9*	*84*	*44*	*8*	*85*	*80*	*51*	*45*		*85*	*85*	*85*	*80*	*85*
CC-34	**Average Concentrations:**	**70.2**		**5.0**	**31.1**		**1.0**	**17.26**	**1.1**	**1.0**		**6.3**	**50.0**	**0.4**	**4.4**	**101**
Segment 2	*Number of Analyses:*	*13*		*13*	*13*		*13*	*13*	*13*	*13*		*13*	*13*	*13*	*13*	*13*
CC-35	**Average Concentrations:**	**36.4**	**40.1**	**14.2**	**23.4**	**1.5**	**0.8**	**7.25**	**3.0**	**1.9**		**2.7**	**64.0**	**2.6**	**1.72**	**5.3**
Segment 10	*Number of Analyses:*	*83*	*9*	*82*	*42*	*8*	*83*	*78*	*49*	*43*		*83*	*83*	*83*	*78*	*83*
CC-40	**Average Concentrations:**	**68.5**	**40.1**	**13.9**	**30.9**	**1.5**	**1.5**	**18.45**	**2.9**	**2.0**		**10.1**	**45.3**	**2.6**	**4.90**	**438**
Segment 11	*Number of Analyses:*	*85*	*9*	*84*	*44*	*8*	*85*	*80*	*51*	*45*		*85*	*85*	*85*	*80*	*85*
CC-44	**Average Concentrations:**	**26.4**		**4.6**	**30.7**		**0.8**	**9.04**	**1.7**	**1.1**		**3.5**	**35.2**	**0.3**	**2.64**	**5.2**
Segment 13a	*Number of Analyses:*	*35*		*35*	*30*		*35*	*35*	*30*	*30*		*35*	*35*	*35*	*35*	*35*
CC-45	**Average Concentrations:**	**81.8**	**40.1**	**14.6**	**30.0**	**1.4**	**4.2**	**38.56**	**3.2**	**15.7**		**43.3**	**6541**	**3.8**	**12.38**	**3147**
Segment 13b	*Number of Analyses:*	*86*	*10*	*85*	*45*	*9*	*86*	*81*	*52*	*46*		*85*	*86*	*86*	*81*	*86*
CC-50	**Average Concentrations:**	**49.3**	**40.1**	**14.4**	**26.2**	**1.4**	**4.1**	**35.63**	**3.2**	**7.1**		**20.9**	**192**	**3.0**	**10.81**	**1908**
Segment 13b	*Number of Analyses:*	*86*	*10*	*85*	*45*	*9*	*86*	*81*	*52*	*46*		*85*	*86*	*86*	*81*	*86*
CC-52	**Average Concentrations:**	**45.3**		**5.4**	**77.7**		**1.0**	**50.98**	**2.2**	**1.0**		**4.2**	**49.3**	**0.3**	**10.20**	**39.1**
Segment 12	*Number of Analyses:*	*22*		*22*	*22*		*22*	*22*	*22*	*22*		*22*	*22*	*22*	*22*	*22*
CC-53	**Average Concentrations:**	**45.3**		**5.3**	**68.1**		**1.0**	**63.80**	**2.3**	**1.0**		**4.1**	**50.1**	**0.3**	**12.66**	**85.5**
Segment 12	*Number of Analyses:*	*21*		*21*	*21*		*21*	*21*	*21*	*21*		*21*	*21*	*21*	*21*	*21*
CC-54	**Average Concentrations:**	**39.7**		**3.4**	**56.3**		**0.4**	**35.55**				**1.9**	**53.1**	**0.5**	**7.24**	**21.7**
Segment 12	*Number of Analyses:*	*14*		*14*	*7*		*14*	*14*				*14*	*14*	*14*	*14*	*14*
CC-55	**Average Concentrations:**	**55.5**	**40.1**	**25.2**	**24.6**	**1.4**	**1.7**	**18.82**	**6.3**	**5.4**		**8.8**	**61.6**	**5.7**	**5.2**	**523**
Segment 11	*Number of Analyses:*	*41*	*10*	*40*	*8*	*9*	*41*	*36*	*15*	*9*		*41*	*41*	*41*	*36*	*41*
CC-60	**Average Concentrations:**	**51.9**	**40.1**	**14.4**	**31.0**	**1.4**	**1.3**	**20.37**	**2.9**	**2.0**		**7.5**	**51.5**	**3.3**	**5.40**	**340**
Segment 11	*Number of Analyses:*	*86*	*10*	*85*	*45*	*9*	*86*	*81*	*52*	*46*		*86*	*86*	*86*	*80*	*86*

Comparison of Seasonal Stream Standards and 85th-Percentile Trace-Metals Concentrations, by Stream Segment

SS-2	Low-Q; 7-mo HRD	Sorted by stream segment				High Q, 5-mo HRD	Sorted by stream segment			
Statistics:	Hrd	Date	Cd	Cu	Zn	Hrd	Date	Cd	Cu	Zn
Mean	85.8	# samples	0.73	4.5	237	50.1	# samples	0.33	3.1	106
# Values	440	479	462	459	459	371	414	390	390	389
85th %iles	WFCC	D-Zn	1.15	9.6	364	WFCC	D-Zn	0.56	5.7	150
TVSs	SiteSpStd	191	2.0	7.9	104	SiteSpStd	122	1.3	5.0	65.8
TempMod				8.1	257				8.1	257
SS-3a	Low-Q; 7-mo HRD	Sorted by stream segment				High Q, 5-mo HRD	Sorted by stream segment			
Statistics:	Hrd	Date	Cd	Cu	Zn	Hrd	Date	Cd	Cu	Zn
Mean	53.7	# samples	0.3	1.4	73.7	35.9	# samples	0.1	1.7	89.3
# Values	35	44	42	42	42	40	44	44	44	44
85th %iles	WFCC	D-Zn	0.5	4.0	90.1	WFCC	D-Zn	0.3	4.1	116
TVSs	SiteSpStd	129	1.4	5.3	69.8	SiteSpStd	91.9	1.0	3.7	49.4
TempMod					100					100
SS-3b	Low-Q; 7-mo HRD	Sorted by stream segment				High Q, 5-mo HRD	Sorted by stream segment			
Statistics:	Hrd	Date	Cd	Cu	Zn	Hrd	Date	Cd	Cu	Zn
Mean	57.2	# samples	0.2	0.5	198	34.2	# samples	0.1	2.2	134
# Values	21	22	21	21	21	24	24	24	24	24
85th %iles	WFCC	D-Zn	0.5	1.3	225	WFCC	D-Zn	0.4	5.1	179
TVSs	SiteSpStd	136	1.5	5.6	73.5	SiteSpStd	88.3	1.0	3.6	47.4
TempMod					220					220
SS-5	Low-Q; 7-mo HRD	Sorted by stream segment				High Q, 5-mo HRD	Sorted by stream segment			
Statistics:	Hrd	Date	Cd	Cu	Zn	Hrd	Date	Cd	Cu	Zn
Mean	110	# samples	0.14	2.7	46.4	49.6	# samples	0.18	2.5	49.5
# Values	126	165	156	156	155	121	147	143	143	141
85th %iles			0.24	5.2	61.4			0.31	4.6	78.0
TVSs			2.4	9.7	128			1.3	4.9	65.2
Mod TVS:	Site-Specific Zn equation (replace standard TVS):				236	Site-Specific Zn equation (replace standard TVS):				121
SS-9a	Low-Q; 7-mo HRD	Sorted by stream segment				High Q, 5-mo HRD	Sorted by stream segment			
Statistics:	Hrd	Date	Cd	Cu	Zn	Hrd	Date	Cd	Cu	Zn
Mean	36.8	# samples	0.02	1.9	28.5	19.9	# samples	0.09	6.8	26.6
# Values	36	42	43	43	43	39	44	43	43	43
85th %iles	WFCC	D-Zn	0.00	4.4	38.7	WFCC	D-Zn	0.00	15.8	24.0
TVSs	SiteSpStd	94.1	1.1	3.8	50.7	SiteSpStd	56.1	0.7	2.3	30.1
TempMod				11					11	
SS-9b	Low-Q; 7-mo HRD	Sorted by stream segment				High Q, 5-mo HRD	Sorted by stream segment			
Statistics:	Hrd	Date	Cd	Cu	Zn	Hrd	Date	Cd	Cu	Zn
Mean	134	# samples	3.7	95.9	966	94.8	# samples	3.8	95.6	794
# Values	7	7	7	7	7	5	5	5	5	5
85th %iles	WFCC	D-Zn	4.2	144	1009	WFCC	D-Zn	5.1	167	1082
TVSs	SiteSpStd	279	2.8	11.5	152	SiteSpStd	208	2.2	8.6	113
TempMod			4.6	148	1068			4.6	148	1068
SS-11	Low-Q; 7-mo HRD	Sorted by stream segment				High Q, 5-mo HRD	Sorted by stream segment			
Statistics:	Hrd	Date	Cd	Cu	Zn	Hrd	Date	Cd	Cu	Zn
Mean	106	# samples	1.3	11.2	331	50.8	# samples	0.7	9.1	149
# Values	239	308	301	301	300	239	267	254	254	254
85th %iles	WFCC	D-Zn	1.9	15.9	475	WFCC	D-Zn	1.0	13.8	217
TVSs	SiteSpStd	229	2.3	9.4	124	SiteSpStd	123	1.4	5.0	66.5
TempMod	AmbBased			17	339	AmbBased			17	339
SS-13b	Low-Q; 7-mo HRD	Sorted by stream segment				High Q, 5-mo HRD	Sorted by stream segment			
Statistics:	Hrd	Date	Cd	Cu	Zn	Hrd	Date	Cd	Cu	Zn
Mean	210	# samples	4.3	38.6	1386	84.6	# samples	2.4	20.4	593
# Values	136	199	196	194	196	126	168	165	165	165
85th %iles	WFCC	D-Zn	6.1	67.2	1900	WFCC	D-Zn	4.0	33.7	1000
TVSs	SiteSpStd	405	3.9	16.9	221	SiteSpStd	189	2.0	7.8	103
TempMod	AmbBased	# Zn=740	6.0	64	1864			6.0	64	1864

Comparison of WQCD Stream Standards and 85th-Percentile Trace Metals Concentrations, by Stream Segment

SS-2	Low-Q; 7-mo HRD		Sorted by stream segment			High Q, 5-mo HRD		Sorted by stream segment		
Statistics:	Hrd	Date	Cd	Cu	Zn	Hrd	Date	Cd	Cu	Zn
Mean	85.8	# samples	0.73	4.5	237	50.1	# samples	0.33	3.1	106
# Values	440	479	462	459	459	371	414	390	390	389
85th %iles			1.15	9.6	364			0.56	5.7	150
TVSs			2.0	7.9	103			1.3	5.0	65.6
TempMod				8.1	257				8.1	257
SS-3a	Low-Q; 7-mo HRD		Sorted by stream segment			High Q, 5-mo HRD		Sorted by stream segment		
Statistics:	Hrd	Date	Cd	Cu	Zn	Hrd	Date	Cd	Cu	Zn
Mean	53.7	# samples	0.3	1.4	73.7	35.9	# samples	0.1	1.7	89.3
# Values	35	44	42	42	42	40	44	44	44	44
85th %iles			0.5	4.0	90			0.3	4.1	116
TVSs			1.4	5.3	70			1.0	3.7	49
TempMod					100					100
SS-3b	Low-Q; 7-mo HRD		Sorted by stream segment			High Q, 5-mo HRD		Sorted by stream segment		
Statistics:	Hrd	Date	Cd	Cu	Zn	Hrd	Date	Cd	Cu	Zn
Mean	57.2	# samples	0.2	0.5	198	34.2	# samples	0.1	2.2	134
# Values	21	22	21	21	21	24	24	24	24	24
85th %iles			0.5	1.3	225			0.4	5.1	179
TVSs			1.5	5.6	73			1.0	3.6	47
TempMod					220					220
SS-5	Low-Q; 7-mo HRD		Sorted by stream segment			High Q, 5-mo HRD		Sorted by stream segment		
Statistics:	Hrd	Date	Cd	Cu	Zn	Hrd	Date	Cd	Cu	Zn
Mean	110	# samples	0.14	2.7	46.4	49.6	# samples	0.18	2.5	49.5
# Values	126	165	156	156	155	121	147	143	143	141
85th %iles			0.24	5.2	61.4			0.31	4.6	78.0
TVSs			2.4	9.7	128			1.3	4.9	65.0
Site-Specific Zn equation (replace standard TVS):					379					193
SS-9a	Low-Q; 7-mo HRD		Sorted by stream segment			High Q, 5-mo HRD		Sorted by stream segment		
Statistics:	Hrd	Date	Cd	Cu	Zn	Hrd	Date	Cd	Cu	Zn
Mean	36.8	# samples	0.02	1.9	28.5	19.9	# samples	0.09	6.8	26.6
# Values	36	42	43	43	43	39	44	43	43	43
85th %iles			0.00	4.4	38.7			0.00	15.8	24.0
TVSs			1.1	3.8	50.5			0.7	2.3	30.0
TempMod				11					11	
SS-9b	Low-Q; 7-mo HRD		Sorted by stream segment			High Q, 5-mo HRD		Sorted by stream segment		
Statistics:	Hrd	Date	Cd	Cu	Zn	Hrd	Date	Cd	Cu	Zn
Mean	134	# samples	3.7	95.9	966	94.8	# samples	3.8	95.6	794
# Values	7	7	7	7	7	5	5	5	5	5
85th %iles			4.2	144	1009			5.1	167	1082
TVSs			2.8	11.5	151			2.2	8.6	113
TempMod			4.6	148	1068			4.6	148	1068
SS-11	Low-Q; 7-mo HRD		Sorted by stream segment			High Q, 5-mo HRD		Sorted by stream segment		
Statistics:	Hrd	Date	Cd	Cu	Zn	Hrd	Date	Cd	Cu	Zn
Mean	106	# samples	1.3	11.2	331	50.8	# samples	0.7	9.1	149
# Values	239	308	301	301	300	239	267	254	254	254
85th %iles			1.9	15.9	475			1.0	13.8	217
TVSs			2.3	9.4	124			1.4	5.0	66
TempMod	AmbBased			17	339				17	339
SS-13b	Low-Q; 7-mo HRD		Sorted by stream segment			High Q, 5-mo HRD		Sorted by stream segment		
Statistics:	Hrd	Date	Cd	Cu	Zn	Hrd	Date	Cd	Cu	Zn
Mean	210	# samples	4.3	38.6	1386	84.6	# samples	2.4	20.4	593
# Values	136	199	196	194	196	126	168	165	165	165
85th %iles			6.1	67.2	1900			4.0	33.7	1000
TVSs			3.9	16.9	221			2.0	7.8	102
TempMod	AmbBased # Zn=740		6.0	64	1864			6.0	64	1864

Table 2-1 -- Superfund OU4 RI/FS and ROD updated information on CERCLA sources and control actions (Task 3)

Source: Tt-RMC (2004a): Background: OU3 ROD, 9/91; OU4 ROD, 9/04.
Table 1.4-1 -- CC Contaminant Source Areas, Previous RODs; Figure 1.4-1 for site locations.

Sequence #	*Source Area*	*OU-ROD*	*Remediation*	*Comments/Status*
Category A: Mine Tunnel Discharges				
MT-01	Burleigh	OU3	N	Pilot passave (wetlands) treatment discontinued; overland untreated Qs to Clear Creek.
MT-02	McClelland	OU3	#	# No action in ROD; overland untreated Qs to Clear Creek.
MT-03	Rockford	OU3	#	# No action in ROD; overland untreated Qs to Clear Creek.
MT-04	Big Five	OU1,3	N	Interim action waiver of ARARs.
MT-05	Argo	OU1,3	Y	WWTP on-line, 4/98.
MT-06	Quartz Hill	OU1,3	N	No action taken; decision deferred to OU4; Qs piped to NFCC.
MT-07	Gregory Incline	OU1,3	N	Limited action taken, decision deferred to OU4; Qs piped to NFCC.
MT-88	National	OU1,3	N	Limited action taken, decision deferred to OU4; Qs piped to NFCC.
Category B: Non-Point Sources (Idaho Springs Area)				
NPS	Virginia Canyon	OU3	N*	*CDPHE-HMWMD remediation in progress (AMEC contract).
Category C: Tailings/Waste-Rock Piles				
MW-9	Urad	OU3	Y	Remediated; increased Qs treatment.
MW-10	Empire	OU3	N	No action taken.
MW-11	Lion Creek (Minnesota Mine)	OU3	Y	Consolidated and capped.
MW-12	McLelland	OU3	Y	Graded/capped along CC; some material not identified as Superfund priority exists near tunnel portal.
MW-13	Black Eagle	OU3	Y	Graded and capped.
MW-14	Big Five	OU2, 3	Y	Graded and capped; retaining walls; storm controls.
MW-15	Argo	OU2, 3	N	Some runoff controls in place; additional work is ongoing.
MW-16	Little Bear Creek	OU3	Y	Removed.
MW-17	Boodle Mill	OU3	Y	Contained.
MW-18	Quartz Hill	OU2, 3	N	No action taken.
MW-19	Gregory Gulch #2	OU3	Y	Two areas addressed: Prometheus (removal); Viento Vista (removal).
MW-20	Gregory Gulch #1	OU3	Y	Three areas addressed: Eureka removal; Central City containment; Gold Rush treatment/containment.
MW-21	Chase Gulch #1	OU3	Y	Removed.
MW-22	Chase Gulch #2	OU3	N	No action taken.
MW-23	Golden Gilpin	OU3	N	Removed/retaining walls at south 1/2; no action taken at north 1/2.
MW-24	Gregory Incline	OU2, 3	Y	Removed (small amount remains underneath paved parking lot).
MW-25	National (Tunnel)	OU2, 3	Y	Removed.
MW-26	North Clear Creek	OU3	Y	Capped.
MW-27	Clay County	OU3	Y	Capped.

Selected Water-Quality Characteristics, Mine-Impacted Source Areas

Sources: *Bell (1999, Tables 14, 16, 17, and 20); J. Herron, written commun., 1/21/05; RMC (2002, Table 2.3-2)*
Lewis (1995; 2001a; 2001b); Medine (1996); Tt-RMC (2004a, Appendix A). BDL/U = below detection limit.

ID	*Description*	*Source*	*Date*	*Flow, cfs*	*pH*	*D-Cd, ug/L*	*D-Cu, ug/L*	*D-Zn, ug/L*	*Source/Notes*	
Mainstem Clear Creek Sub-Watershed										
SS-55	Silver Plume Mine	PhsIIAddm	Apr-89							
SS-56	Terrible Mine	PhsIIAddm	Apr-89							
SS-81	Johnny Bull Mine	PhsIIAddm	Apr-89		8.0	--	--	<20		
SW-27	Burleigh Tunnel	Phase II	6/13/89	0.100		48.0	4.0	21100	*Lewis (1995); Bell (1999)*	HF
	Burleigh Tunnel		6/13/89						*Bell (1999,App.B,T.24)2X*	
SW-27	Burleigh Tunnel	Phase II	9/20/89	0.072		76.0	0.5	50200	*Lewis (1995); Bell (1999)*	HF
SW-27	Burleigh Tunnel	RemDsgn	4/21/92	0.05		111	8.6	60700	*Lewis (2003, Table 1); ??*	LF
SW-27	Burleigh Tunnel	CDM	Dec-93	0.08				63000	*Lewis (2003, Table 1)*	LF
SW-27	Burleigh Tunnel	USEPA	10/29/95	0.065	7.50	242	4.3	1020	*Medine (1996)*	LF
SW-27	Burleigh Tunnel	USEPA	6/3/97	--	7.39	144	8.56	56010	*Bell (1999)*	HF
SW-27	Burleigh Tunnel	USEPA	7/5/97	0.115	7.48	136	6.9	65400	*Bell (1999)*	HF
SW-27	Burleigh Tunnel	CDPHE	Oct-97	0.07				89000	*Lewis (2003, Table 1)*	LF
SW-27	Burleigh Tunnel	CDPHE	Oct-99	0.07				81000	*Lewis (2003, Table 1)*	LF
SW-27	Burleigh Tunnel	CDPHE	Sep-00	0.06				52000	*Lewis (2003, Table 1)*	HF
SW-27	Burleigh Tunnel	CDPHE	Oct-01	0.07				51000	*Lewis (2003, Table 1)*	LF
SW-201	Ashby Tunnel	RemDsgn	Dec-93 ??					??	*Lewis (2003)-Zn, 0.0008 lb/d*	
SW-31	Lion Creek	Phase II	6/13/89	1.70		1.1	192	164	*Lewis (1995); Bell (1999)*	
SW-31	Lion Creek	Phase II	9/18/89	0.280		2.7	508	674	*Lewis (1995); Bell (1999)*	
M-1	Minnesota Mine	CDPHE	5/26/94	0.011		< 5	550	900	*CDPHE (1995)*	
	Aorta Tunnel dsch	USEPA	4/4/94			1	220	533	*USEPA (1994)*	
M-2	Aorta Mine	CDPHE	5/26/94	0.023		< 5	470	660	*CDPHE (1995)*	
SW-53	McClelland Tunnel	Phase II	6/15/89	0.051		19.9	114	3970		HF
SW-53	McClelland Tunnel	Phase II	9/18/89	0.027		14.0	24.0	3360	**Q, 9/19?*	HF
	McClelland Tunnel		9/19/89			18	154	5310	*Bell (1999, App. B, T.32)*	HF
	McClelland outfall	USEPA	4/4/94			14.3	46	3013	*USEPA (1994)*	LF
(CC-)SW-53	McClelland Tunnel	CDPHE	11/6/01	0.07	6.47	13.9	7.4	3220	*Lewis (2001b)*	LF
SW-53	McClelland Tunnel	CDPHE	5/22/02	0.067	6.46	13.4	15.7	2920		HF
SW-17	Rockford Tunnel	Phase II	6/12/89	0.024		11.3	710	3750	*Lewis (1995); Bell (1999)*	HF
SW-17	Rockford Tunnel	Phase II	9/19/89	0.010		14.0	1260	5050	*Lewis (1995); Bell (1999)*	HF
	Rockford Tunnel		9/19/89			14	1261	5139	*Bell (1999, App. B, T.32)*	HF
(CC-)SW-17	Rockford Tunnel	CDPHE	11/6/01	0.011	3.41	20.0	2180	3990	*Lewis (2001b)*	LF
SW-17(O)	Rockford Tunnel	USEPA	10/27/95	0.015	3.36	24.4	1390	3720	*Medine (1996)*	LF
SW-17(O)	Rockford Tunnel	USEPA	4/14/97	0.028	3.52	17.2	1420	3400	*Bell (1999)*	LF
SW-17(O)	Rockford Tunnel	USEPA	5/28/97	--	3.57	6.39	711	1573	*Bell (1999)*	HF
SW-17	Rockford Tunnel	CDPHE	5/22/02	0.010	3.44	13.9	1470	3420	*Tt-RMC (2004a)*	HF
#2 diss	Alice Glory Hole	CDMG-JH	May-01	0.047	2.65	BDL	19633	884	*Jim Herron (1/21/05)*	
#2 diss	Alice Glory Hole	CDMG-JH	October-01	0.001	3.28	35.6	20221	1401	*Jim Herron (1/26/05)*	
SW-40	Trail Creek	Phase I	2/18/86			11	528	2760	*Bell (1999, App. B)*	LF
SW-14	Trail Creek	Phase II	6/12/89	1.40		4.0	49.5	680	*Lewis (1995); Bell (1999)*	HF
	Trail Creek		6/12/89			3.7	85	655	*Bell (1999, p. 30)*	HF
SW-14	Trail Creek	Phase II	9/19/89	0.280		3.0	63.0	880	*Lewis (1995); Bell (1999)*	HF
	Trail Creek		9/19/89			3	71	929	*Bell (1999, Table 30)*	HF
	Trail Creek		9/19/89						*Bell (1999,App.B,T.32)2X*	
SW-14	Trail Creek	USEPA	Oct-95			5.6	173	1071	*Bell (1999, Table 30)*	LF
	Trail Creek	USEPA	10/27/95	0.339	5.86	5.5	176	1122	*Medine (1996); Bell (1999)*	LF
SW-14	Trail Creek	USEPA	Apr-97			4.3	105	911	*Bell (1999, Table 30)*	LF
	Trail Creek	USEPA	4/14/97	0.390	5.83	4.2	87.3	944	*Bell (1999)*	LF
SW-14	Trail Creek	USEPA	Jun-97			2.84	97.2	466	*Bell (1999, Table 30)*	HF
	Trail Creek	USEPA	6/2/97	--	7.21	2.76	55.7	480	*Bell (1999, App. B)*	HF
SW-14	Trail Creek	CDPHE	11/5/01	0.13	7.41	3.8	74.4	870	*Lewis (2001b)*	LF
CC-31	Trail Creek	USEPA	2/10/05			4.21	168	1160	*USEPA data trans., 4/4*	LF
SW-24	Big Five Tunnel	Phase I	10/30/85			56	3040	20840	*Bell (1999, App. B)*	LF
SW-023	Big Five Tunnel	Phase I	2/19/86			96	2740	18840	*Bell (1999, App. B)*	LF
SW-023	Big Five Tunnel	Phase I	5/19/86			58	2900	18800	*Bell (1999, App. B)*	HF
SW-12	Big Five Tunnel	Phase II	6/13/89	0.037		27.0	690	9100	*Lewis (1995); Bell (1999)*	HF

Selected Water-Quality Characteristics, Mine-Impacted Source Areas

Sources: *Bell (1999, Tables 14, 16, 17, and 20); J. Herron, written commun., 1/21/05; RMC (2002, Table 2.3-2)*
Lewis (1995; 2001a; 2001b); Medine (1996); Tt-RMC (2004a, Appendix A). BDL/U = below detection limit.

ID	Description	Source	Date	Flow, cfs	pH	D-Cd, ug/L	D-Cu, ug/L	D-Zn, ug/L	Source/Notes	
Mainstem Clear Creek Sub-Watershed - cont.										
	Big Five Tunnel		6/13/89						Bell (1999,App.B,T.24)2X	
SW-12	Big Five Tunnel	Phase II	9/19/89	0.031		38.0	627	6730	Lewis (1995); Bell (1999)	HF
	Big Five Tunnel		9/19/89			24	607	6749	Bell (1999, App. B, T. 32)	HF
SW-12	Big Five Tunnel	RemDsgn	4/21/92			52.0	3230	11900		LF
SW-12	Big Five Tunnel	USEPA	4/14/97	0.006	2.71	23.4	1530	9120	Bell (1999)	LF
SW-12	Big Five Tunnel	USEPA	10/27/95	0.008	2.67	53.0	7570	1310	Medine (1996)	LF
(CC-)SW-12	Big Five Tunnel	CDPHE	11/7/01	0.04	3.19	238.0	1500	9160	Lewis (2001b)	LF
SW-12	Big Five Tunnel	CDPHE	5/22/02	0.047	3.45	21.5	1170	8500	Tt-RMC (2004a)	HF
SW-19	Virginia Canyon ?		10/30/85			1340	58600	304000	Bell (1999, App. B)	LF
SW-26	VC above CC		10/30/85			800	17120	158400	Bell (1999, App. B)	LF
SW-26	VC above CC		5/19/86			1236	3200	228000	Bell (1999, App. B);Znx1K	HF
CDMG-2	VC above CP/VA	CDMG	8/17/00	0.89	2.70	48.9	3955	7440	Herron and others (2001)	HF
CDMG-3	VC below CP/VA	CDMG	8/17/00	1.19	2.87	64.1	4433	6856	Herron and others (2001)	HF
CDMG-4	VC ab TwoBrothers	CDMG	8/17/00	1.23	3.15	22.7	1200	3083	Herron and others (2001)	HF
CDMG-6	VC ab Robinson Gl	CDMG	8/17/00	1.84	2.84	1090	12260	176400	Herron and others (2001)	HF
CDMG-9	VC bl Robinson Gl	CDMG	8/17/00	1.96	3.15	441	10290	88010	Herron and others (2001)	HF
CDMG-15	VC bl Boomerang	CDMG	8/17/00	3.31	3.31	349	4026	50700	Herron and others (2001)	HF
CDMG-22	VC at pavement end	CDMG	8/17/00	4.82	3.90	313	2137	40050	Herron and others (2001)	HF
SW-020	Argo at portal	Phase I	1985							
SW-020	Argo at portal	Phase I	2/19/86			256	9160	86800	Bell (1999, App. B)	
SW-020	Argo at portal	Phase I	6/3/86			244	12120	85000	Bell (1999, App. B)	
SW-020	Argo at portal	PhsI Addm	Apr-87							
SW-06	Argo Tunnel	Phase II	6/12/89	0.53		120	5100	41000	Lewis (1995); Bell (1999)	
	Argo Tunnel		6/13/89			240	10200	82000	Bell (1999, App. B, Table 24)	
SW-06	Argo Tunnel	Phase II	9/19/89	0.41		123	4780	41300	Lewis (1995); Bell (1999)	
	Argo Tunnel		9/19/89			109	4803	41536	Bell (1999, App. B, Table 32)	
SW-06	Argo Tunnel	USEPA	10/26/95	0.563	2.87	203	7740	5300	Medine (1996)	
SW-06	Argo Tunnel	USEPA	6/2/97	--	2.69	158	6477	52847	Bell (1999, App. B)	
CC-99a	Argo Adit*(treated)	USEPA	8/13/02			< 5	< 25	12.1	TDS (2002)	
CC-99a	Argo Adit*(treated)	USEPA	2/10/05			<2	10.2	<5	USEPA data trans., 4/4	

* Note: Excel file from Ron Abel, CDPHE-HMWMD for post-treatment discharge WQ is available (1/27/05).

ID	Description	Source	Date	Flow, cfs	pH	D-Cd, ug/L	D-Cu, ug/L	D-Zn, ug/L	Source/Notes	
NFCC Sub-Watershed										
SS-15	Chase Gulch	Phase II RI	Apr-89		7.4	--	--	60		LF
SW-47	Chase Gulch	Phase II	6/19/89	0.810		1.9	16.0	557	Lewis (1995); Bell (1999)	HF
SW-47	Chase Gulch	Phase II	9/19/89	0.050	?	?	?		Lewis (1995); Bell (1999)	HF
	Chase Gulch		9/19/89			12	22	5500	Bell (1999, App. B, T.32)	HF
WQ-6	Chase Gulch	CCWDP	92-94							
NCC-SW-29	Chase Gulch*	CDPHE	7/26/94	0.5	7.6	0.9	4.3	280	Lewis (1995)	HF
SW-47	Chase Gulch	USEPA	10/25/95	0.186	6.98	15.6	11.0	4209	Bell (1999)	LF
SW-47	Chase Gulch	USEPA	4/11/97	--	7.60	5.2	14.6	1530	Bell (1999)	LF
SW-47	Chase Gulch	USEPA	6/2/97	--	7.65	1.15	7.51	252	Bell (1999, App. B)	HF
NCC-SW-29	Chase Gulch	CDPHE	11/19/01			5.11	6.77	1790	Lewis (2001b)	LF
NCC-SW-29	Chase Gulch	CDPHE	5/21/02	0.310	7.68	4.79	6.92	1621	Tt-RMC (2004a)	HF

* Stream represented by an adjacent sample, 3/26/95; 6/7/95.

ID	Description	Source	Date	Flow, cfs	pH	D-Cd, ug/L	D-Cu, ug/L	D-Zn, ug/L	Source/Notes	
SW-46	Gregory Incline	Phase II	6/19/89	--		12.0	750	19000	Lewis (1995); Bell (1999)	HF
SW-46	Gregory Incline	Phase II	9/18/89	--		15.0	376	5470	Lewis (1995); Bell (1999)	HF
NCC-SW-27	Gregory Incline	CDPHE	7/22/94	0.23	5.4	7.0	301	5310	Lewis (1995)	HF
NCC-SW-27	Gregory Incline	CDPHE	3/21/95	0.31	6.1	8.3	272	4743	Lewis (1995)	LF
SW-27	Gregory Incline		3/21/95			4.0	315	5620	Bell (1999, App. B, T.49)	LF
NCC-SW-27	Gregory Incline	CDPHE	6/7/95	119	6.5	47.4	5579	8070	Lewis (1995)	HF
SW-27	Gregory Incline		6/7/95			44	5631	8334	Bell (1999, App. B., T.54)	HF
SW-46	Gregory Incline	USEPA	10/25/95	0.543	4.02	27.0	2580	8640	Medine (1996)	LF
SW-46	Gregory Incline	USEPA	4/11/97	0.223	5.19	15.2	755	6580	Bell (1999)	LF
SW-46	Gregory Incline	USEPA	6/2/97		4.96	16.5	1096	7177	Bell (1999)	HF
NCC-SW-27	Gregory Incline	CDPHE	11/16/01			11.8	799	5650	Lewis (2001b)	LF
NCC-SW-27	Gregory Incline	CDPHE	5/21/02	0.214	4.88	7.38	354	4962	Tt-RMC (2004a)	HF
SW-016	Quartz Hill Tunnel	Phase I	1985							
SW-016	Quartz Hill Tunnel	Phase I	Feb-86							LF
SW-016	Quartz Hill Tunnel	Phase I	5-6/1986							HF
SW-50	Quartz Hill Tunnel	Phase II	6/15/89	0.013 Q, 6/20?		480	32000	100000	Lewis (1995); Bell (1999)	HF
	Quartz Hill Tunnel		6/20/89						Bell (1999, App.B,T.28)2X	
SW-50	Quartz Hill Tunnel	Phase II	9/18/89	0.004		564	51900	111000	Lewis (1995); Bell (1999)	HF
NCC-SW-23	Quartz Hill Tunnel	CDPHE	7/28/94	0.007	2.6	727	48900	138000	Lewis (1995)	HF
SW-23	Quartz Hill Dischrg		7/28/94			721	48923	138945	Bell (1999, App. B, T. 43)	HF

Selected Water-Quality Characteristics, Mine-Impacted Source Areas

Sources: *Bell (1999, Tables 14, 16, 17, and 20); J. Herron, written commun., 1/21/05; RMC (2002, Table 2.3-2)*
Lewis (1995; 2001a; 2001b); Medine (1996); Tt-RMC (2004a, Appendix A). BDL/U = below detection limit.

ID	Description	Source	Date	Flow, cfs	pH	D-Cd, ug/L	D-Cu, ug/L	D-Zn, ug/L	Source/Notes	
NCC-SW-23	Quartz Hill Tunnel	CDPHE	3/22/95	0.01	3.0	620	42400	140000	*Lewis (1995)*	LF
NCC-SW-23	Quartz Hill Tunnel	CDPHE	6/8/95	0.18	2.4	316	57520	51244	*Lewis (1995)*	HF
NCC-SW-23	Quartz Hill Tunnel	CDPHE	11/19/01			872	42200	156000	*Lewis (2001b)*	LF
SW-014	Gregory Gulch	Phase I	7/18/85			48	38	7360	*Bell (1999, App. B)*	HF
SW-014	Gregory Gulch	Phase I	Feb-86							LF
SW-014	Gregory Gulch	Phase I	5/20/86			104	1526	16500	*Bell (1999, App. B)*	HF
SW-014	Gregory Gulch	Phsl Addm	Apr-87							LF
SS-32	Gregory Gulch	Phase II RI	Apr-89		5.6	--	--	1700		LF
SS-88	Gregory Gulch	Phase II RI	Apr-89		5.1	--	--	2150		LF
SE-44	Gregory Gulch	Phase II	6/12/89	0.400	**Q, 6/19?*	*12.5*	*25.0*	500	*Lewis (1995); Bell (1999)*	HF
SE-44	Gregory Gulch	Phase II	8/11/89	0.044	**Q, 9/18/?*	710	2210	89900	*Lewis (1995); Bell (1999)*	HF
	Gregory Gulch		8/11/89			715	2326	95150	*Bell (1999, App. B, T.28)*	HF
NCC-SW-20	Gregory Gulch	CDPHE	7/22/94	0.02	4.0	37.0	1180	5790	*Lewis (1995)*	HF
NCC-SW-20	Gregory Gulch	CDPHE	3/21/95	0.27	6.1	47.8	895	4975	*Lewis (1995)*	LF
SW-20	Gregory Gulch		3/21/95			53	911	6035	*Bell (1999, App. B, T.49)*	LF
NCC-SW-20	Gregory Gulch	CDPHE	6/7/95	11	3.8	84.0	1987	13006	*Lewis (1995)*	HF
SW-20	Gregory Gulch		6/7/95			92	2091	14414	*Bell (1999, App. B, T.54)*	HF
SW-44	Gregory Gulch	USEPA	10/25/95	0.017	3.37	168	4720	26390	*Bell (1999, App. B)*	LF
SW-44	Gregory Gulch	USEPA	4/11/97	0.446	7.25	13.3	51.0	1490	*Bell (1999)*	LF
SW-44	Gregory Gulch	USEPA	6/2/97	--	4.29	64.2	1256	10149	*Bell (1999, App. B)*	HF
NCC-SW-20	Gregory Gulch	CDPHE	11/16/01			17.9	392	3060	*Lewis (2001b)*	LF
NCC-SW-20	Gregory Gulch	CDPHE	5/21/02	0.029	5.49	22.9	856	3780	*Tt-RMC (2004a)*	HF
SW-007	National Tunnel	Phase I	7/18/85			15	352	14000	*Bell (1999, App. B)*	HF
SW-008	National Tunnel		10/31/85			10	16	11580	*Bell (1999, App. B)*	LF
SW-007	National Tunnel	Phase I	2/19/86			*9*	118	13100	*Bell (1999, App. B)*	LF
SW-007	National Tunnel	Phase I	5-6/1986							*HF*
SW-007	National Tunnel	Phsl Addm	Apr-87							*LF*
SW-41	National Tunnel	Phase II	6/20/89	0.045		*12.5*	110	5700	*Lewis (1995); Bell (1999)*	HF
	National Tunnel		6/20/89						*Bell (1999,App.B,T.28)2X*	
SW-41	National Tunnel	Phase II	9/18/89	0.054		17.0	77.0	7760	*Lewis (1995); Bell (1999)*	HF
NCC-SW-17	National Tunnel	CDPHE	7/26/94	0.07	6.3	4.9	39.4	5860	*Lewis (1995)*	HF
NCC-SW-17	National Tunnel	CDPHE	3/21/95	0.12	6.6	3.5	11	4990	*Lewis (1995)*	LF
SW-17	National Tunnel		3/21/95			*3.5*	73	5339	*Bell (1999, App. B, Table 4*	LF
NCC-SW-17	National Tunnel	CDPHE	6/7/95	0.15	3.2	98.0	11487	29455	*Lewis (1995)*	HF
SW-17	National Tunnel		6/7/95						*Bell (1999,App.B,T.54)2X*	
SW-41	National Tunnel	USEPA	10/25/95	0.159	5.39	10.2	442	8120	*Medine (1996)*	LF
SW-41	National Tunnel	USEPA	4/11/97	0.089	6.51	5.1	30.7	6420	*Bell (1999)*	LF
SW-41	National Tunnel	USEPA	6/2/97	--	6.37	10.9	137	8302	*Bell (1999)*	HF
NCC-SW-17	National Tunnel	CDPHE	11/14/01			6.33	79.5	7340	*Lewis (2001b)*	LF
NCC-SW-17	National Tunnel	CDPHE	5/21/02	0.072	6.61	4.72	55.8	6532	*Tt-RMC (2004a)*	HF
NCC-SW-13	East Williams Adit	CDPHE	7/26/94	0.005	7.3	2.2	U	932	*Lewis (1995)*	HF
NCC-SW-13	East Williams Adit	CDPHE	3/26/95?	0.006	6.6	24	69	2346	*Lewis (1995)[convertQ?]*	LF
NCC-SW-13	East Williams Adit	CDPHE	6/7/95?	0.668	7.3	4.1	66	932	*Lewis (1995)[convertQ?]*	HF
NCC-SW-13	East Williams Adit	CDPHE	11/4/01			0.71	<4	236	*Lewis (2001b)*	LF
NCC-SW-13	East Williams Adit	CDPHE	5/21/02	0.009	7.40	0.84	<3	399	*Tt-RMC (2004a)*	HF
SW-04	Russell Gulch	Phase I	10/30/85			6	24	1340	*Bell (1999, App. B)*	LF
SS-04	Russell Gulch*	Phase II RI	Apr-89	0.02	7.2			900		LF
SW-38	Russell Gulch	Phase II	6/19/89	0.067						HF
NCC-SW-7	Russell Gulch	CDPHE	3/26/95?	0.37	6.8	4.5	10	1220	*Lewis (1995)*	LF
NCC-SW-7	Russell Gulch	CDPHE	6/7/95?	25	4.2	43.9	1856	6565	*Lewis (1995)*	HF
SW-38	Russell Gulch	USEPA	10/25/95	0.219	6.88	10.6	100	2230	*Bell (1999)*	LF
SW-38	Russell Gulch	USEPA	4/11/97	1.52	7.43	3.6	30.2	952	*Bell (1999)*	LF
SW-38	Russell Gulch	USEPA	6/2/97	--	4.86	31.3	1054	6143	*Bell (1999)*	HF
NCC-SW-7	Russell Gulch	CDPHE	11/14/01						*Lewis (2001b)*	LF
NCC-SW-7	Russell Gulch	CDPHE	5/21/02	0.023	7.53	0.84	6.08	291	*Tt-RMC (2004a)*	HF

* *Site was dry, 9/19/89; 7/12/94.*

Selected Water-Quality Characteristics, Wastewater Treatment Facilities

Sources: Lewis (2002b); BHCCSD (Lynn Venters, 1/13/05); TDS Consulting Inc. (2002)

ID	Description	Source	Date	Flow, gpm	pH	D-Cd, ug/L	D-Cu, ug/L	D-Zn, ug/L	Source/Notes
Mainstem Clear Creek Sub-Watershed									
CC-15a	Eisenhower CDOT	USEPA	8/12/02			<1	<5	11.0	*TDS (2002)*
CC-1a	Loveland Ski Area	USEPA	8/12/02			<1	9.8	20.0	*TDS (2002)*
CC-3a	Georgetown	USEPA	8/12/02			<1	<5	22.2	*TDS (2002)*
CC-14a	Henderson WWTP	ACZ Labs	8/21/02			0.2	5	60	*TL (PD, 6/26/02)*
SW-20G	CCCSD-WWTP	CDPHE	11/6/01			<0.2	22.9	46.8	*Lewis (2002b)*
CC-7a	Central Clear Creek	USEPA	8/12/02			<1	20.5	57.1	*TDS (2002)*
CC-8a	St. Mary's	USEPA	8/12/02			<1	24.9	20.3	*TDS (2002)*
CC-12a	Idaho Springs	USEPA	8/12/02			<1	5.7	61.7	*TDS (2002)*
NFCC Sub-Watershed									
SS-09	BHSTP	Phase II RI	Apr-89		6.6	--	--	1200	
SW-15A	BH/CC POTW		3/21/95			<6	66	345	*Bell (1999, App. B, Tabl*
SW-15A	POTW Outfall		6/7/95			**19**	**180**	**3406**	*Bell (1999, App. B, Tabl*
NCC-SW-15A	BHSTP	CDPHE	11/4/01		?	?	?		*Lewis (2002b)*
NCC-SW-15A	BH/CCSD-WWTP	CDPHE	5/21/02	0.579	7.27	<0.2	7.7	101.7	*Tt-RMC (2004a)*
CC-13a	Black Hawk/CC	USEPA	8/12/02			<1	7.1	80.9	*TDS (2002)*
CC-13a	BHCCSD-WWTP	BHCCSD	11/20/00			<5	11	71	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	12/6/00		6.95		11	79	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	1/3/01			<5	10	65	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	2/2/01			<5	8	97	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	2/7/01		7.45	<5	8	85	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	2/8/01				8	90	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	3/2/01			<5	<5	93	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	3/6/01				<5	100	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	3/7/01			<5	<10	88	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	4/3/01			<5	<7	86	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	4/4/01			<5	<5	100	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	4/11/01				<5	78	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	5/1/01			<5	<25	98	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	5/2/01		6.98	<5	<10	310	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	5/9/01				<25	140	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	6/4/01			<5	<22	110	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	6/6/01			<5	12	100	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	6/12/01				10	100	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	7/2/01			<5	14	120	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	7/5/01		7.00	<5	<25	110	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	7/10/01				13	98	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	8/1/01		7.01	<5	11	89	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	8/1/01			<5	11	93	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	8/7/01				11	93	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	9/4/01			<5	10	100	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	9/12/01				9	100	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	10/3/01			<5	12	110	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	10/8/01			<5	<5	<5	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	10/10/01				<5	64	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	11/1/01			<5	<25	91	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	11/7/01		7.38	<5	<25	98	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	11/9/01				17	86	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	12/3/01			<5	7	76	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	12/5/01		6.77	<5	<25	84	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	12/11/01				<5	90	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	1/4/02			<5	7	78	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	1/8/02				6	74	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	1/13/02				17	130	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	1/14/02			<1	17	81	*Lynn Venters (1/13/05*

Selected Water-Quality Characteristics, Wastewater Treatment Facilities

Sources: *Lewis (2002b); BHCCSD (Lynn Venters, 1/13/05); TDS Consulting Inc. (2002)*

ID	*Description*	*Source*	*Date*	*Flow, gpm*	*pH*	*D-Cd, ug/L*	*D-Cu, ug/L*	*D-Zn, ug/L*	*Source/Notes*
CC-13a	BHCCSD-WWTP	BHCCSD	1/15/02			<5	<25	82	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	2/5/02			<5	9	75	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	2/6/02			<5	<25	66	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	2/11/02				7.4	75	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	3/1/02			<5	<25	84	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	3/6/02			<5	<5	80	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	3/7/02				5.8	76	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	4/2/02			<5	<5	79	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	4/10/02		7.27	<5	<5	79	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	4/12/02				9	89	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	4/26/02			<5	15	70	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	5/1/02			<5	<5	110	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	5/3/02			<5	7	92	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	5/5/02				<5	88	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	6/5/02		6.87	<5	<5	91	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	6/7/02			<5	14	110	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	6/12/02				17	62	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	7/1/02			6	<5	95	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	7/3/02			16	9	94	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	7/8/02				8	97	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	7/17/02			<5	<5	87	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	8/5/02			<5	<5	100	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	8/7/02		6.72	<5	<5	92	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	8/12/02				<5	92	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	9/4/02			<5	<5	110	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	9/8/02			<5	7	120	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	9/13/02				<5	130	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	10/2/02		7.21	<5	9	140	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	10/4/02			<5	9	140	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	10/9/02				18	130	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	10/17/02			<5	10	90	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	11/1/02			<5	15	120	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	11/6/02		7.01	<5	6	130	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	11/8/02				<5	140	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	12/2/02			<5	5	100	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	12/4/02		7.11	<5	<5	100	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	12/13/02			<5	<5	100	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	1/3/03			<5	5	90	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	1/8/03		6.97	<5	<5	93	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	1/27/03			<5	10	130	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	2/5/03		6.81	<5	9	130	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	2/10/03			<5	<6	130	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	2/14/03				<5	130	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	3/5/03		7.04	<5	<5	100	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	4/2/03		7.33	<5	<5	140	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	4/4/03			<5	<5	140	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	4/14/03				8	170	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	5/7/03		6.86	<5	10	180	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	5/12/03				10	180	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	6/2/03			<5	8	160	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	6/4/03			<5	<5	160	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	6/11/03				5	160	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	7/2/03		6.96	29	11	130	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	7/16/03				12	160	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	7/23/03			<5	10	110	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	8/4/03			<5	7	130	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	9/3/03		6.98	<5	<5	80	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	9/5/03			<5	7	110	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	9/9/03			<5	8	99	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	10/1/03		7.01	<5	6	5	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	10/6/03			<5	<5	68	*Lynn Venters (1/13/05*
CC-13a	BHCCSD-WWTP	BHCCSD	10/15/03			<5	7	81	*Lynn Venters (1/13/05*

Selected Water-Quality Characteristics, Wastewater Treatment Facilities

Sources: *Lewis (2002b); BHCCSD (Lynn Venters, 1/13/05); TDS Consulting Inc. (2002)*

ID	Description	Source	Date	Flow, gpm	pH	D-Cd, ug/L	D-Cu, ug/L	D-Zn, ug/L	Source/Notes
CC-13a	BHCCSD-WWTP	BHCCSD	10/17/03			<5	7	81	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	11/5/03			<5	<5	83	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	11/7/03			<5	6	79	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	11/9/03			<5	5	95	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	12/1/03			<5	5	82	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	12/3/03		7.20	<5	8	77	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	12/9/03			<5	<5	95	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	1/5/04			<5	<5	80	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	1/7/04		7.05	<5	7	96	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	1/9/04			<5	15	100	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	1/14/04			<5	5	85	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	2/2/04			<5	<5	70	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	2/4/04		6.91	<5	<5	82	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	2/9/04			<5	9	84	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	2/29/04			<5	7	55	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	3/3/04		7.48	<5	8	65	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	4/7/04		7.01	<5	6	110	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	4/12/04			<5	5	86	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	5/3/04			<5	11	110	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	5/4/04		6.93	<5	13	90	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	5/21/04			<5	7	100	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	6/2/04		6.82	<5	<5	21	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	6/3/04			<5	8	120	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	6/7/04			<5	7	75	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	6/9/04			<5	8	95	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	6/16/04			<5	6	86	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	7/2/04			<5	6	100	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	7/7/04		6.57	<5	12	100	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	7/9/04			<5	7	100	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	8/4/04		6.83	<5	13	93	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	8/6/04			<5	13	92	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	8/9/04			<5	10	80	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	9/1/04		7.80	<5	<5	90	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	9/3/04			<5	<5	84	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	9/8/04			<5	<5	94	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	10/1/04			<5	6	120	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	10/6/04			<5	8	100	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	10/11/04			<5	6	85	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	10/13/04			<5	5	150	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	10/31/04			<5	7	120	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	11/3/04		7.27	<5	7	96	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	12/1/04		7.21	<5	<5	88	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	12/3/04			<5	<5	110	Lynn Venters (1/13/05
CC-13a	BHCCSD-WWTP	BHCCSD	12/8/04			<5	<5	86	Lynn Venters (1/13/05

Table 3-1 -- Loads-Comparison Summary

Argo Treatment vs. Mainstem Clear Creek Trace Metals:

		Concentrations, mg/L:		Concentrations, mg/L:		Concentrations, mg/L:		Concentration, mg/L:	
Variable:	Qs, cfs	Inf Cd Conc	Eff Cd Conc	Inf Cu Conc	Eff Cu Conc	Inf Zn Conc	Eff Zn Conc	Inf Hard	Eff Hard
Average	**0.51**	**0.15**	**0.00025**	**4.99**	**0.006**	**48.9**	**0.021**	**1141**	**860**
# Values	*342*	*43*	*330*	*44*	*333*	*47*	*331*	*7*	*318*

		Inf Cd Load	Inf Cu Load	Inf Zn Load
Average Value	*lbs/d*	**0.51**	**17.0**	**162**
# Values		*43*	*44*	*47*
Avg Q,gpm	230			

Source: Excel file named ArgoQsWQ(TDSrev)

		Eff Cd Load	Eff Cu Load	Eff Zn Load
Average Value	*lbs/d*	**0.00080**	**0.019**	**0.063**
# Values		*330*	*333*	*331*
Percent Reduction (remain):		0.16%	0.11%	0.04%
(in TMs loads)		**99.84%**	**99.89%**	**99.96%**

Receiving-Water (mainstem Clear Creek), ambient conditions (Appendix Table C-1):

CC-60	*Flow*	*D-Zn #*	*D-Cu #*
Pre-Argo	**240**	**8847**	**463**
#months	*42*	*42*	*42*
Pre-Argo, lbs/d		***295***	***15.4***
Post-Argo	**183**	**5112**	**198**
#months	*78*	*78*	*78*
Post-Argo, lbs/d		***170***	***6.60***
Pre- vs. Post-	*76%*		

CC-40	*Flow*	*D-Zn #*	*D-Cu #*
Pre-Argo	**248**	**10927**	**484**
#months	*42*	*42*	*42*
Pre-Argo, lbs/d		***364***	***16.1***
Post-Argo	**180**	**5602**	**263**
#months	*78*	*78*	*78*
Post-Argo, lbs/d		***187***	***8.75***
Pre- vs. Post-	*73%*		

Check Loadings (use these values):

Pre-Argo	Load sum	371571	19463
#days (1278), lbs/d		***291***	***15.2***
Post-Argo	Load sum	398712	15441
#days (2375), lbs/d		***168***	***6.50***
Pre- vs. Post-		*58%*	*43%*
CC-60			
Difference in TMs loads:		-123	-8.73
Reduction in Argo TMs:		*-161.8*	*-16.94*

Check Loadings (use these values):

Pre-Argo	Load sum	458951	20343
#days (1278), lbs/d		***359***	***15.9***
Post-Argo	Load sum	436980	20481
#days (2375), lbs/d		***184***	***8.62***
Pre- vs. Post-		*51%*	*54%*
CC-40			
Difference in TMs loads:		-175	-7.29
Reduction in Argo TMs:		*-161.8*	*-16.94*

Note: This evaluation confirms that loads reductions cannot be assumed conservatively; that is, effects/contributions of other TMs sources need to be considered.

Past, Ongoing, and Future Mine-Cleanup Sites

WAG ID	Site Name	Stream Location	Notes:
A. Completed			
1	Urad	WFCC	
2	Lion Creek	WFCC	
3	McClelland pile	mainstem CC	see McClelland (34) & Rockford (35) drainages
4	Black Eagle Mill Tailings	Chicago Creek	
5	Little Bear pile	Soda Creek	near Idaho Springs; USFS land
6	Argo Tunnel water treatment	mainstem CC	***see separate detailed TDS assessment***
7	Argo tailings pipe	mainstem CC	Rosa Gulch runoff
8	Golden Gilpin tailings	NFCC	partly completed; see 22 below
9	Chase Gulch #1	NFCC	see Chase Gulch #2 (21)
10a	Gregory Incline tailings	NFCC	
10b	Gregory Incline collection pipe/blowout	NFCC	
11a	Gregory Gulch #1 tailings (Eureka)	NFCC	
11b	Gregory Gulch #1 tailings (Central City)	NFCC	
11c	Gregory Gulch #1 tailings (Gold Rush)	NFCC	
12a	Gregory Gulch #2 tailings (Prometheus)	NFCC	
12b	Gregory Gulch #2 tailings (Viento Vista)	NFCC	
13a	National Tunnel waste rock	NFCC	see 25 below
13b	National Tunnel collection pipe/blowout	NFCC	see 25 below
14	Clay County tailings	NFCC	
15	North Clear Creek tailings	NFCC	
16	Boodle Mill tailings	NFCC	
17a	Big Five tailings	mainstem CC	
B. Superfund-Listed (RODs), pending clean-up [update with OU4 ROD]			
17b	Big Five Tunnel	mainstem CC	passive-treatment experiment ended
18	Burleigh Tunnel	mainstem CC	passive-treatment failed (Tt investigation?)
19	Virginia Canyon groundwater	mainstem CC	CDPHE-HMWMD current project (AMEC)
20	Argo tailings	mainstem CC	Doug Jamison (CDPHE-HMWMD), check status
21	Chase Gulch #2	NFCC	see Chase Gulch #1, see 9 above; OU4 ROD
22	Golden Gilpin tailings	NFCC	remainder to be completed; see 8 above
23	Gregory Incline water treatment	NFCC	OU4 ROD
24a	Quartz Hill tailings	NFCC	
24b	Quartz Hill water treatment	NFCC	
25	National Tunnel water treatment	NFCC	see 13a/13b above
C. Projects not included for Superfund remediation (pending consideration)			
26	Diamond Mine drainage	mainstem CC	Silver Plume area; proximity of Burleigh Tunnel
27	Waldorf Mine tailings	SFCC	
28	North Empire waste-rock pile	WFCC	
29	Aorta Mine drainage	WFCC	
30	Empire tailings	WFCC	
31	Joe Reynolds tailings	Silver Creek	upper Fall River (CDMG, see Alice Glory Hole (category D)
32	Elida tailings	mainstem CC	on/along Spring Gulch
33	Red Elephant	mainstem CC	
34	McClelland drainage	mainstem CC	see 3 above
35	Rockford drainage	mainstem CC	passive-treatment failed; link to McClelland?
36	Trail Creek tailings	Trail Creek	CDPHE-WQCD SS 9b (new); need monitoring data
37	Donna Juanita tailings	mainstem CC	
38	Alma Lincoln tailings	mainstem CC	
39	Two Brothers	Virginia Canyon	historical
40	Waste-rock piles, including Little Six	Virginia Canyon	see CWT (2003); Herron and others (2001)
41	Franklin	Gilson Gulch	historical
42	Nevadaville tailings	NFCC	above Gregory Gulch; OU4?
43	Gregory Gulch #3 tailings	NFCC	OU4?
44	North Clear Creek dredge site	NFCC	OU4?
45	North Clear Creek in-stream sediments	NFCC	OU4?
D. Other (non-WAG)			[add as needed]
	Alice Glory Hole		CDMG (Jim Herron); RL (partial remediation)
	Minnesota Mine tailings		Check post-project (why not category A?) [RL]

Source: UCC-WAG (2001, Table 17) [possibly needs updating]

Table 3-3 -- Source TMs Loads and Rankings

Source: *Tt-RMC, 2004a, Tables 4.3-17a (high flow) and 4.3-17b (low flow)).* *Note: See load-reduction aspects in Appnedix Table C-2.*

A1. Low-Flow Conditions, Combined Mainstem Clear Creek and North Fork Clear Creek Sources:

Overall Rank	*Source Description*	*D-Cd Load lbs/d*	*Rank*	*D-Cu Load lbs/d*	*Rank*	*D-Zn Load lbs/d*	*Rank*	Notes/Cross-References	*Table 2-1*	*Appendix B*	*OU4 ROD*
1	Gregory Incline	0.033	2	2.6	1	12.9	2	NFCC	OU2,3		OU4
2	Virginia Canyon Groundwater	0.050	1	1.81	2	15.5	1	CC	OU3-NPS	WAG #1	HMWMD
3	Gregory Gulch	0.033	2	0.5	4	3.9	7	NFCC	OU-3 (1/2)		OU4
4	Quartz Hill Tunnel	0.026	6	1.6	3	5.5	5	NFCC	OU1,3 (2)		
5	National Tunnel	0.004	14	0.1	7	4.2	6	NFCC	OU1,3 (2)		OU4
6	NPS, Gregory Gulch area	0.010	10	0.005	16	2.2	10	NFCC	*OU3*	WAG #2	
7	NPS, Silver Gulch reach	0.006	12	0.103	6	1.6	11	NFCC	*OU3*	WAG #2	
8	NPS, (old) WWTP area	0.032	4	0.06	9	3.1	9	NFCC	*OU3*	WAG #2	
9	Big Five Tunnel	0.003	15	0.233	5	0.9	15	CC	OU1,3		
10	Chase Gulch	0.012	8	0.012	13	3.7	8	NFCC	OU-3 (1/2)		
11	NPS, McClelland Tunnel area	0.010	9	-0.03	20	12.7	3	CC			
12	Russell Gulch	0.006	11	0.04	11	1.4	12	NFCC			OU4
13	McClelland Tunnel	0.005	13	0.003	17	1.2	13	CC	OU3		
14	Rockford Tunnel	0.002	16	0.094	8	0.4	17	CC	OU3		
15	NPS, Russell Gulch area	-0.029	24	0.035	12	-14.0	25	NFCC	*OU3*	WAG #2	
16	NPS, CC downstream Chicago	0.030	5	-0.12	23	-5.5	23	CC			
17	East Williams Tunnel	0.002	17	0.006	15	0.2	19	NFCC			
18	NPS, Smith Hill Gulch area	0.021	7	-0.04	21	11.7	4	NFCC	*OU3*	WAG #2	
19	BH/CCSD WWTP effluent	0.0006	18	0.049	10	0.3	18	NFCC			
20	NPS, CC downstream Trail Ck	0.000	20	0.01	14	1.0	14	CC			
21	NPS, Golden Gilpin area	0.0003	19	-0.00004	18	0.6	16	NFCC	*OU3*	WAG #2	
22	NPS, downstream of Silver Ck	-0.030	25	-0.02	19	-9.7	24	CC			
23	NPS, Black Hawk area	-0.010	22	-1.45	25	-2.5	21	NFCC	*OU3*	WAG #2	
24	NPS, Gregory Incline area	-0.004	21	-0.33	24	-0.9	20	NFCC	*OU3*	WAG #2	
25	NPS, Bates Gulch area	-0.024	23	-0.05	22	-4.6	22	NFCC	*OU3*	WAG #2	

A2. High-Flow Conditions, Mainstem Clear Creek and North Fork Clear Creek Sources (separate):

Overall Rank	*Source Description*	*D-Cd Load lbs/d*	*Rank*	*D-Cu Load lbs/d*	*Rank*	*D-Zn Load lbs/d*	*Rank*	Notes/Cross-References		
1	Russell Gulch	5.92	1	250	1	885	1	NFCC		
2	Gregory Gulch	2.49	2	59	2	386	2	NFCC		
3	Quartz Hill Tunnel	0.17	3	29	3	28	3	NFCC		
4	National Tunnel	0.04	4	4.7	4	13	4	NFCC		
5	Gregory Incline	0.01	6	0.4	5	7.0	5	NFCC		
6	BH/CCSD WWTP effluent	0.03	5	0.28	6	5.3	6	NFCC		
7	Chase Gulch	0.0002	7	0.01	7	0.8	7	NFCC		
8	East Williams Tunnel	0.00001	8	0.0001	8	0.03	8	NFCC		
1	North Fork Clear Creek	4.11	1	40	1	766	1	CC		
2	West Fork Clear Creek	0.83	2	4	2	43	2	CC		
Others -- not ranked above regarding OU4:										
	Burleigh Tunnel					20.91		CC	CDPHE	WAG #3; Lewis (2003)
	Diamond Mine							CC		WAG #3
	Waldorf Mine							SFCC		
	Alice Glory Hole							Fall River	CDMG	J. Herron (1/05 e-Mails).
	Trail Creek									
	TMs-treatment sludge repository							??		WAG #4

Table 3-4 -- Stream Trace-Metals Loadings

Low-Streamflows:				High-Streamflows:			
POR-CC25							
Averages:	***Flow***	***D-Zn #***	***D-Cu #***	Averages:	***Flow***	***D-Zn #***	***D-Cu #***
per month	23.1	919	6.1		165	3469	47.1
lbs/day		30.6	0.20			116	1.6
POR-CC20							
Averages:	***Flow***	***D-Zn #***	***D-Cu #***	Averages:	***Flow***	***D-Zn #***	***D-Cu #***
per month	20.0	110	12.2		152	879	78.0
lbs/day		3.7	0.41			29.3	2.6
POR-CC26							
Averages:	***Flow***	***D-Zn #***	***D-Cu #***	Averages:	***Flow***	***D-Zn #***	***D-Cu #***
per month	39.6	1021	16.2		293	4213	126
lbs/day		34.0	0.54			140	4.2
Check-Sum CC25+CC20							
Averages:	***Flow***	***D-Zn #***	***D-Cu #***	Averages:	***Flow***	***D-Zn #***	***D-Cu #***
per month	43.1	1029	18.3		317	4348	125
lbs/day		34.3	0.61			145	4.2

Low-Streamflows:				High-Streamflows:			
Post-Argo							
Averages:	***Flow***	***D-Zn #***	***D-Cu #***	Averages:	***Flow***	***D-Zn #***	***D-Cu #***
per month	23.6	763	7.5		137	2565	40.2
lbs/day		25.4	0.25			85.5	1.3
Post-Argo							
Averages:	***Flow***	***D-Zn #***	***D-Cu #***	Averages:	***Flow***	***D-Zn #***	***D-Cu #***
per month	21.2	127	13.9		136	733	72.8
lbs/day		4.2	0.46			24.4	2.4
Post-Argo							
Averages:	***Flow***	***D-Zn #***	***D-Cu #***	Averages:	***Flow***	***D-Zn #***	***D-Cu #***
per month	40.5	859	17.7		240	3029	116
lbs/day		28.6	0.59			101	3.9
Check-Sum CC25+CC20							
Averages:	***Flow***	***D-Zn #***	***D-Cu #***	Averages:	***Flow***	***D-Zn #***	***D-Cu #***
per month	44.8	889	21.5		272	3298	113
lbs/day		29.6	0.72			110	3.8

Low-Streamflows:				High-Streamflows:			
POR-CC40							
Averages:	***Flow***	***D-Zn #***	***D-Cu #***	Averages:	***Flow***	***D-Zn #***	***D-Cu #***
per month	59.0	3836	109		407	12549	664
lbs/day		128	3.6			418	22.1
POR-CC50							
Averages:	***Flow***	***D-Zn #***	***D-Cu #***	Averages:	***Flow***	***D-Zn #***	***D-Cu #***
per month	5.59	1104	19.0		35.1	4698	208.5
lbs/day		36.8	0.63			157	6.9
POR-CC60							
Averages:	***Flow***	***D-Zn #***	***D-Cu #***	Averages:	***Flow***	***D-Zn #***	***D-Cu #***
per month	64.6	3044	82		397	11143	583
lbs/day		101	2.7			371	19.4
Check-Sum CC40+CC50							
Averages:	***Flow***	***D-Zn #***	***D-Cu #***	Averages:	***Flow***	***D-Zn #***	***D-Cu #***
per month	64.6	4940	128.2		443	17247	872
lbs/day		165	4.3			575	29.1

Low-Streamflows:				High-Streamflows:			
Post-Argo							
Averages:	***Flow***	***D-Zn #***	***D-Cu #***	Averages:	***Flow***	***D-Zn #***	***D-Cu #***
per month	59.3	3005	112		329	8713	448
lbs/day		100	3.7			290	14.9
Post-Argo							
Averages:	***Flow***	***D-Zn #***	***D-Cu #***	Averages:	***Flow***	***D-Zn #***	***D-Cu #***
per month	5.95	1208	25		27.8	3773	156
lbs/day		40.3	0.83			126	5.2
Post-Argo							
Averages:	***Flow***	***D-Zn #***	***D-Cu #***	Averages:	***Flow***	***D-Zn #***	***D-Cu #***
per month	69.0	2780	89		322	7882	331
lbs/day		92.7	3.0			263	11.0
Check-Sum CC40+CC50							
Averages:	***Flow***	***D-Zn #***	***D-Cu #***	Averages:	***Flow***	***D-Zn #***	***D-Cu #***
per month	65.2	4213	136.5		357	12487	603
lbs/day		140	4.5			416	20.1

Source: Adapted from TDS Consulting Inc. (2004).

Table 3-5 -- Summary of Priority Sources of TMs Loads

Note: Cross-Reference Table 2-2 for details of calculations (pending LF/HF delineations for several PSs).

Stream Segment 2 *Average TMs Loads (lbs/d):* *LF = low-flow season (October through April); HF = high-flow season (May through September).*

POR

	SW-27	Burleigh Tunnel		Avg Q, cfs
Avg Conc	121.9	5.84	52719	0.075
# samples	*D-Cd*	*D-Cu*	*D-Zn*	Avg Loads
11	**0.049**	**0.002**	**21.3**	**lbs/d**
# values	*7*	*7*	*12*	

LF

	SW-27	Burleigh Tunnel		Avg Q, cfs
Avg Conc	58.8	2.15	57620	0.068
# samples	*D-Cd*	*D-Cu*	*D-Zn*	Avg Loads
6	**0.021**	**0.001**	**20.9**	**lbs/d**
# values	*6*	*6*	*6*	

HF

	SW-27	Burleigh Tunnel		Avg Q, cfs
Avg Conc	80.8	3.99	48942	0.087
# samples	*D-Cd*	*D-Cu*	*D-Zn*	Avg Loads
5	**0.038**	**0.002**	**22.9**	**lbs/d**
# values	*5*	*5*	*5*	

POR

	SW-53	McClelland Tunnel		Avg Q, cfs
Avg Conc	15.6	60.2	3632	0.054
# samples	*D-Cd*	*D-Cu*	*D-Zn*	Avg Loads
6	**0.005**	**0.017**	**1.1**	**lbs/d**
# values	*6*	*6*	*6*	

POR

	SW-17(O)	Rockford Tunnel		Avg Q, cfs
Avg Conc	15.1	1300	3755	0.016
# samples	*D-Cd*	*D-Cu*	*D-Zn*	Avg Loads
8	**0.001**	**0.11**	**0.33**	**lbs/d**
# values	*8*	*8*	*8*	

POR

	SW-14	Trail Creek		Avg Q, cfs
Avg Conc	4.5	130	981	0.508
# samples	*D-Cd*	*D-Cu*	*D-Zn*	Avg Loads
12	**0.012**	**0.36**	**2.7**	**lbs/d**
# values	*12*	*12*	*12*	

LF

	SW-14	Trail Creek		Avg Q, cfs
Avg Conc	5.7	191	1280	0.286
# samples	*D-Cd*	*D-Cu*	*D-Zn*	Avg Loads
6	**0.005**	**0.29**	**2.0**	**lbs/d**
# values	*6*	*6*	*6*	

HF

	SW-14	Trail Creek		Avg Q, cfs
Avg Conc	3.2	70.2	682	0.840
# samples	*D-Cd*	*D-Cu*	*D-Zn*	Avg Loads
6	**0.01**	**0.32**	**3.1**	**lbs/d**
# values	*6*	*6*	*6*	

POR

	SW-12	Big Five Tunnel		Avg Q, cfs
Avg Conc	61.7	2249	11604	0.028
# samples	*D-Cd*	*D-Cu*	*D-Zn*	Avg Loads
12	**0.009**	**0.34**	**1.8**	**lbs/d**
# values	*12*	*12*	*12*	

LF

	SW-12	Big Five Tunnel		Avg Q, cfs
Avg Conc	86.4	3268	11862	0.02
# samples	*D-Cd*	*D-Cu*	*D-Zn*	Avg Loads
6	**0.008**	**0.32**	**1.1**	**lbs/d**
# values	*6*	*6*	*6*	

HF

	SW-12	Big Five Tunnel		Avg Q, cfs
Avg Conc	37.1	1229	11347	0.04
# samples	*D-Cd*	*D-Cu*	*D-Zn*	Avg Loads
6	**0.008**	**0.25**	**2.3**	**lbs/d**
# values	*6*	*6*	*6*	

POR

	SW-26	VC above CC		Avg Q, cfs
Avg Conc	570	11722	106294	2.2
# samples	*D-Cd*	*D-Cu*	*D-Zn*	Avg Loads
10	**6.7**	**137**	**1246**	**lbs/d**
# values	*10*	*10*	*10*	*No LF Qs*

LF

	SW-26	VC above CC		Avg Q, cfs
Avg Conc	1070	37860	231200	*0.04*
# samples	*D-Cd*	*D-Cu*	*D-Zn*	Avg Loads
2	**0.23**	**8.2**	**49.8**	**lbs/d**
# values	*2*	*2*	*2*	

HF

	SW-26	VC above CC		Avg Q, cfs
Avg Conc	446	5188	75067	2.18
# samples	*D-Cd*	*D-Cu*	*D-Zn*	Avg Loads
8	**5.2**	**60.8**	**880**	**lbs/d**
# values	*8*	*8*	*8*	

Table 3-5 -- Summary of Priority Sources of TMs Loads

Stream Segment 13a *Average TMs Loads (lbs/d):* *LF = low-flow season (October through April); HF = high-flow season (May through September).*

POR

	SW-47	Chase Gulch		Avg Q, cfs
Avg Conc	5.8	11	1755	0.37
# samples	D-Cd	D-Cu	D-Zn	Avg Loads
10	0.012	0.022	3.5	lbs/d
# values	8	8	9	

POR

	SW-46	Gregory Incline		Avg Q, cfs
Avg Conc	18.0	1567	7463	20.1
# samples	D-Cd	D-Cu	D-Zn	Avg Loads
12	1.9	169	807	lbs/d
# values	12	12	12	

LF

	SW-46	Gregory Incline		Avg Q, cfs
Avg Conc	13.3	944	6247	0.22
# samples	D-Cd	D-Cu	D-Zn	Avg Loads
5	0.02	1.1	7.2	lbs/d
# values	5	5	5	

HF

	SW-46	Gregory Incline		Avg Q, cfs
Avg Conc	21.3	2012	8332	23.9
# samples	D-Cd	D-Cu	D-Zn	Avg Loads
7	2.7	259	1071	lbs/d
# values	7	7	7	

POR

	SW-23	Quartz Hill Tunnel		Avg Q, cfs
Avg Conc	614	46263	119313	0.043
# samples	D-Cd	D-Cu	D-Zn	Avg Loads
7	0.14	10.7	27.5	lbs/d
# values	7	7	7	

POR

	SW-44	Gregory Gulch		Avg Q, cfs
Avg Conc	146	1364	17785	1.53
# samples	D-Cd	D-Cu	D-Zn	Avg Loads
19	1.20	11.2	146	lbs/d
# values	15	15	17	

LF

	SW-44	Gregory Gulch		Avg Q, cfs
Avg Conc	60.0	1394	6543	0.24
# samples	D-Cd	D-Cu	D-Zn	Avg Loads
9	0.08	1.8	8.6	lbs/d
# values	5	5	7	

HF

	SW-44	Gregory Gulch		Avg Q, cfs
Avg Conc	189	1350	25655	2.87
# samples	D-Cd	D-Cu	D-Zn	Avg Loads
10	1.3	9.3	176	lbs/d
# values	10	10	10	

POR

	SW-41	National Tunnel		Avg Q, cfs
Avg Conc	16.9	883	9727	0.095
# samples	D-Cd	D-Cu	D-Zn	Avg Loads
17	0.009	0.45	5.0	lbs/d
# values	11	15	15	

LF

	SW-41	National Tunnel		Avg Q, cfs
Avg Conc	6.8	110	8127	0.12
# samples	D-Cd	D-Cu	D-Zn	Avg Loads
7	0.004	0.07	5.4	lbs/d
# values	5	5	7	

HF

	SW-41	National Tunnel		Avg Q, cfs
Avg Conc	23.3	1751	11087	0.065
# samples	D-Cd	D-Cu	D-Zn	Avg Loads
7	0.01	0.61	3.9	lbs/d
# values	10	10	10	

POR

	SW-13	East Williams Adit		Avg Q, cfs
Avg Conc	6.4	67.5	969	0.17
# samples	D-Cd	D-Cu	D-Zn	Avg Loads
5	0.006	0.06	0.90	lbs/d
# values	9	6	9	

POR

	SW-38/7	Russell Gulch		Avg Q, cfs
Avg Conc	14.4	440	2455	3.9
# samples	D-Cd	D-Cu	D-Zn	Avg Loads
10	0.30	9.2	51.4	lbs/d
# values	7	7	8	

LF

	SW-38/7	Russell Gulch		Avg Q, cfs
Avg Conc	4.1	27.4	1107	0.53
# samples	D-Cd	D-Cu	D-Zn	Avg Loads
2	0.01	0.1	3.2	lbs/d
# values	4	4	5	

HF

	SW-38/7	Russell Gulch		Avg Q, cfs
Avg Conc	25.3	972	4333	8.36
# samples	D-Cd	D-Cu	D-Zn	Avg Loads
4	1.1	43.8	195	lbs/d
# values	3	3	3	

Table 3-6 -- Estimated TMs Loads Reductions

High Rank
Reference:

Area 6 -- Virginia Canyon (groundwater/storm events)
Table 3-4; Table 3-5; and Appendix Table C-2.

LF	D-Cd	D-Cu	D-Zn	Avg Loads	Notes:
Input (gross):	0.23	8.2	49.8	lbs/d	(1)
% reduction:	90%	90%	90%		(2)
	0.21	7.3	44.8		
MOS adjust:	40%	40%	40%		(2)
TMs removed	0.08	2.9	17.9		
TMs sediments	*0.04*	*0.88*	*1.8*		
TMs to stream	0.15	5.2	31.9		
SS 2 TMs lds	D-Cd*	D-Cu	D-Zn	CC-40	
Pre-Treatment	*0.54*	3.7	100		(3)
Post-Treatment	*0.50*	1.6	83.9		
% load reduction	8%	56%	16%		

Stream Segment 2 (lower-part contributor and impacting SS11 downstream)
2 Categories: (a) mines; (b) waste-rock piles.

HF	D-Cd	D-Cu	D-Zn	Avg Loads	Notes:
Input (gross):	5.2	60.8	880	lbs/d	(1)
% reduction:	50%	50%	50%		(2)
	2.61	30.4	440		
MOS adjust:	40%	40%	40%		(2)
TMs removed	1.0	12.2	176		
TMs sediments	*0.73*	*6.7*	*88.0*		
TMs to stream	4.2	48.6	704		
SS 2 TMs lds	D-Cd*	D-Cu	D-Zn	CC-40	
Pre-Treatment	2.2	14.9	290		(3)
Post-Treatment	*1.9*	9.4	202		
% load reduction	14%	37%	30%		

High Rank
Reference:

Area 7 -- North Fork Clear Creek (w/ tributaries)
Table 3-4; Table 3-5; and Appendix Table C-2.

LF	D-Cd	D-Cu	D-Zn	Avg Loads	Notes:
A. Upstream WT					
Gregory Incline	0.02	1.1	7.2	lbs/d	(1)
Gregory Gulch	0.08	1.8	8.6	lbs/d	(1)
National Tunnel	0.004	0.07	5.4	lbs/d	(1)
Input (gross):	0.10	3.0	21.2	lbs/d	(5)
% reduction:	90%	90%	90%		
	0.09	2.70	19.1		
MOS adjust:	40%	40%	40%		(2)
TMs removed	0.04	1.1	7.6		
TMs sediments	*0.00*	*0.76*	*0.8*		
TMs to stream	0.06	1.92	13.6		
SS 13b TMs loads	D-Cd*	D-Cu	D-Zn	CC-50	
Pre-Treatment	*0.12*	0.63	36.8		(3)
Post-Treatment	*0.09*	0.31	29.9		
% load reduction	29%	51%	19%		
LF	D-Cd	D-Cu	D-Zn	Avg Loads	Notes:
B. Downstream					
Russell Gulch	0.01	0.1	3.2	lbs/d	(1)
Other NPSs				lbs/d	(8)
Input (gross):	0.01	0.1	3.2	lbs/d	(6)
% reduction:	50%	50%	50%		
	0.01	0.04	1.59		
MOS adjust:	40%	40%	40%		(2)
TMs removed	0.002	0.02	0.63		
TMs sediments	*0.00*	*0.00*	*0.03*		
TMs to stream	0.01	0.06	2.5		
SS 13b TMs loads	D-Cd*	D-Cu	D-Zn	CC-50	
Pre-Remediation	*0.12*	0.63	36.8		(3)
Post-Remediation	*0.12*	0.62	36.2		
% load reduction	2%	2%	2%		

Stream Segment 13b (and impacting SS 11 downstream)
2 Categories: (a) mines; (b) waste-rock piles.

HF	D-Cd	D-Cu	D-Zn	Avg Loads	Notes:
Gregory Incline	2.7	259	1071	lbs/d	(1)
Gregory Gulch	1.3	9.3	176	lbs/d	(1)
National Tunnel	0.01	0.61	3.9	lbs/d	(1)
Input (gross):	4.0	269	1251	lbs/d	(5)
% reduction:	60%	60%	60%		
	2.4	161	751		
MOS adjust:	10%	10%	10%		(2)
TMs removed	0.24	16.1	75.1		
TMs sediments	*0.19*	*12.9*	*37.5*		
TMs to stream	3.8	253	1176		
SS 13b TMs loads	D-Cd*	D-Cu	D-Zn	CC-50	
Pre-Treatment	*1.3*	6.9	157		(3)
Post-Treatment	*1.3*	3.7	119		
% load reduction	4%	47%	24%		
HF	D-Cd	D-Cu	D-Zn	Avg Loads	Notes:
Russell Gulch	1.1	43.8	195	lbs/d	(1)
Other NPSs				lbs/d	(8)
Input (gross):	1.14	43.8	195	lbs/d	(6)
% reduction:	30%	30%	30%		
	0.34	13.1	58.5		
MOS adjust:	20%	20%	20%		(2)
TMs removed	0.07	2.6	11.7		
TMs sediments	*0.05*	*2.1*	*3.5*		
TMs to stream	1.07	41.1	183		
SS 13b TMs loads	D-Cd*	D-Cu	D-Zn	CC-50	
Pre-Remediation	*1.3*	6.9	157		(3)
Post-Remediation	*1.3*	6.4	149		
% load reduction	2%	8%	5%		

Table 3-6 -- Estimated TMs Loads Reductions

Moderate Rank — Area 2 -- Silver Plume Area (west to east)
Reference: Table 3-4; Table 3-5; and Appendix Table C-2.

LF	D-Cd	D-Cu	D-Zn	Avg Loads	Notes:
Input (gross):	0.021	0.001	20.9	lbs/d	(1)
% reduction:	60%	60%	60%		
	0.01	0.0005	12.6		
MOS adjust:	50%	50%	50%		(2)
TMs removed	0.006	0.0002	6.3		
TMs sediments	0.00	0.00	0.31		
TMs to stream	0.01	0.0005	14.7		

SS 2 TMs loads	D-Cd*	D-Cu	D-Zn	CC-25	
Pre-Treatment	0.06	0.20	30.6		(3)
Post-Treatment	0.06	0.20	24.6		
% load reduction	4%	0%	19%		

Stream Segment 2 (upper)
Dominant Input: Burleigh Tunnel

HF	D-Cd	D-Cu	D-Zn	Avg Loads	Notes:
Input (gross):	0.038	0.002	22.9	lbs/d	(1)
% reduction:	40%	40%	40%		
	0.02	0.0007	9.1		
MOS adjust:	40%	40%	40%		(2)
TMs removed	0.006	0.0003	3.7		
TMs sediments	0.00	0.00	0.73		
TMs to stream	0.03	0.0016	19.2		

SS 2 TMs loads	D-Cd*	D-Cu	D-Zn	CC-25	
Pre-Treatment	0.51	1.6	116		(3)
Post-Treatment	0.51	1.6	113		
% load reduction	0%	0%	3%		

Moderate Rank — Area 5 -- Georgetown-to-Idaho Springs (incl. tributaries)
Reference: Table 3-4; Table 3-5; and Appendix Table C-2.

LF	D-Cd	D-Cu	D-Zn	Avg Loads	Notes:
App. Table C-2	0.029	0.74	7.5	lbs/d	
Trail Creek	0.005	0.29	2.0	lbs/d	
Big Five Tunnel	0.008	0.32	1.1	lbs/d	
Input (gross):	0.013	0.61	3.1	lbs/d	(1)
% reduction:	50%	50%	50%		
	0.01	0.31	1.6		
MOS adjust:	40%	40%	40%		(2)
TMs removed	0.003	0.12	0.62		
TMs sediments	0.00	0.07	0.03		
TMs to stream	0.01	0.49	2.5		

SS 2 TMs loads	D-Cd*	D-Cu	D-Zn	CC-26	
Pre-Treatment	0.12	0.54	34.0		(3)
Post-Treatment	0.12	0.49	33.4		
% load reduction	1%	9%	2%		

Stream Segment 2 (lower) and 9b (Trail Creek)
Dominant Input: Trail Creek & Big Five Tunnel

HF	D-Cd	D-Cu	D-Zn	Avg Loads	Notes:
App. Table C-2	0.14	3.6	29.9	lbs/d	
Trail Creek	0.01	0.32	3.1	lbs/d	
Big Five Tunnel	0.008	0.25	2.3	lbs/d	
Input (gross):	0.022	0.57	5.4	lbs/d	(1)
% reduction:	40%	40%	40%		
	0.01	0.23	2.2		
MOS adjust:	40%	40%	40%		(2)
TMs removed	0.004	0.09	0.87		
TMs sediments	0.00	0.06	0.61		
TMs to stream	0.02	0.48	4.6		

SS 2 TMs loads	D-Cd*	D-Cu	D-Zn	CC-26	
Pre-Treatment	0.96	4.2	140		(3)
Post-Treatment	0.96	4.2	140		
% load reduction	0%	1%	0%		

Total TMs Loads Removed (Stream Segment 11):

LF	D-Cd	D-Cu	D-Zn	Avg Loads
TMs removed	0.13	4.2	33.1	
TMs sediments	0.05	1.7	2.9	
TMs to stream	0.25	7.7	65.1	

SS 11 TMs loads	D-Cd*	D-Cu	D-Zn	CC-60	
Pre-Treatment	0.11	3.0	92.7		(3)
Post-Treatment	0.03	0.56	62.5		(4)
% load reduction	75%	81%	33%		

Total TMs Loads Removed (Stream Segment 11):

HF	D-Cd	D-Cu	D-Zn	Avg Loads
TMs removed	1.4	31.0	267	
TMs sediments	1.0	21.7	130	
TMs to stream	9.1	343	2087	

SS 11 TMs loads	D-Cd*	D-Cu	D-Zn	CC-60	
Pre-Treatment	0.41	11.0	263		(3)
Post-Treatment	0.02	1.8	126		(4)
% load reduction	94%	84%	52%		

Notes:
* D-Cd loads in streams estimated from pro-rated concentrations, using D-Cu results (TDS Consulting Inc., 2004).

(1) See Table 3-5.
(2) See text discussion.
(3) See Table 3-4.
(4) Probable rounding/estimation errors, D-Cd.
(5) National Tunnel, relatively insignificant contributions of D-Cd & D-Cu (D-Zn, HF).
(6) Combined water stream, Gregory Incline and Gregory Gulch.
(7) Negative load reduction (D-Cu) infers other, unaccountable losses of this TM.
(8) To be estimated in Task 7 (R.L Ventures assigned work task).

Table 4-5 -- Attainment of Applicable Standards, Upper Clear Creek Impaired Segments

TempMods	Stream Segment	Units:	ug/L or lbs/d	Units:	ug/L or lbs/d	
SS #	Description	TM CoC	Ambient	Reduction	Std/Projected	Notes and discussion
2	upper mainstem CC	D-Cu Conc.	9.6	15.6%	8.1	See Table 1-3. CC-25/CC-26, LF Cu in compliance; see Tables 3-4 & 3-6.
	LF season	D-Cu Load	3.7	56.8%	1.6	Target lbs/d; CC-40 is suggested as reference point (for lower SS 2)
	Ambient/Projected:	D-Cu Conc.	9.6	56.8%	4.2	Load reduction, 2.1 lbs/d Cu, from proposed Virginia Canyon remediation
						Cu-load reduction is estimated to be achieved (Table 3-6).
		D-Zn Conc.	363	29.2%	257	See Table 1-3. CC-25/CC-26, LF Zn not in compliance with WQS.
		D-Zn Load	100	16.1%	83.9	Target lbs/d; CC-40 is suggested as reference point (for lower SS 2)
	Ambient/Projected:	D-Zn Conc.	363	16.1%	305	Load reduction, 16.1 lbs/d Zn, from proposed Virginia Canyon remediation
						Zn-load reduction is estimated not to achieve temporary mod (Table 3-6).
9a	Fall River	D-Cu Conc.	15.8	30.4%	11.0	See Table 1-3. CC-30, HF Cu not in compliance with WQS target.
	HF season	D-Cu Load		0.0%		Target lbs/d; CC-40 is suggested as reference point (for SS 2)
	Ambient/Projected:	D-Cu Conc.	15.8	0.0%	15.8	*No additional TMs load reduction is proposed (Herron, 2001; CDPHE, 2003).*
						Maintain ambient conditions for time being; future remediation is recommended.
9b	Trail Creek	D-Cd Conc.	5.1	9.8%	4.6	See Table 1-3. CDPHE 5673, HF Cd not in compliance with WQS target.
	HF season	D-Cd Load		0.0%		*No TMs load reduction is proposed at this time. See Virginia Canyon loads.*
	Ambient/Projected:	D-Cd Conc.	5.1	0.0%	5.1	Load reduction, 0.04 lbs/d Cd, from proposed Virginia Canyon remediation.
						Maintain ambient conditions for time being; future remediation is recommended.
		D-Cu Conc.	167	11.4%	148	See Table 1-3. CDPHE 5673, HF Cu not in compliance with WQS target.
		D-Cu Load		0.0%		*No TMs load reduction is proposed at this time. See Virginia Canyon loads.*
	Ambient/Projected:	D-Cu Conc.	167	0.0%	167	Load reduction, 2.1 lbs/d Cu, from proposed Virginia Canyon remediation
						Maintain ambient conditions for time being; future remediation is recommended.
		D-Zn Conc.	1082	1.3%	1068	See Table 1-3. CDPHE 5673, HF Zn not in compliance with WQS target.
		D-Zn Load		0.0%		*No TMs load reduction is proposed at this time. See Virginia Canyon loads.*
	Ambient/Projected:	D-Zn Conc.	1082	0.0%	1082	Load reduction, 16.1 lbs/d Zn, from proposed Virginia Canyon remediation
						Maintain ambient conditions for time being; future remediation is recommended.
13b	North Fork Clear Ck	D-Cd Conc.	6.1	1.6%	6.0	See Table 1-3. CC-50, LF Cd in compliance with WQS target.
	LF season	D-Cd Load	0.12	25.0%	0.09	Target lbs/d; CC-50 is suggested as reference point (for SS 13b)
	Ambient/Projected:	D-Cd Conc.	6.1	25.0%	4.6	Load reduction, 0.03 lbs/d Cd, from OU4 remediation
						Cd-load reduction is estimated to be achieved (Table 3-6).
		D-Cu Conc.	67.8	5.6%	64.0	See Table 1-3. CC-50, LF Cu in compliance with WQS target.
		D-Cu Load	0.63	50.8%	0.31	Target lbs/d; CC-50 is suggested as reference point (for SS 13b)
	Ambient/Projected:	D-Cu Conc.	67.8	50.8%	33.4	Load reduction, 0.32 lbs/d Cu, from OU4 remediation
						Cu-load reduction is estimated to be achieved (Table 3-6).
		D-Zn Conc.	1905	2.2%	1864	See Table 1-3. CC-50, LF Zn in compliance with WQS target.
		D-Zn Load	36.8	18.8%	29.9	Target lbs/d; CC-50 is suggested as reference point (for SS 13b)
	Ambient/Projected:	D-Zn Conc.	1905	18.8%	1548	Load reduction, 6.9 lbs/d Zn, from OU4 remediation
						Zn-load reduction is estimated to be achieved (Table 3-6).
11	lower mainstem CC	D-Zn Conc.	479	29.2%	339	See Table 1-3. CC-60, Zn in compliance with WQS target.
	LF season	D-Zn Load	92.7	32.6%	62.5	Target lbs/d; CC-60 is suggested as reference point (for SS 11)
	Ambient/Projected:	D-Zn Conc.	479	32.6%	323	Load reduction, 30.2 lbs/d Zn, from upstream remediation
						Zn-load reduction is estimated to be achieved (Table 3-6).

Table 4-6 -- Attainment of TVS Values, Upper Clear Creek Watershed Impaired Stream Segments

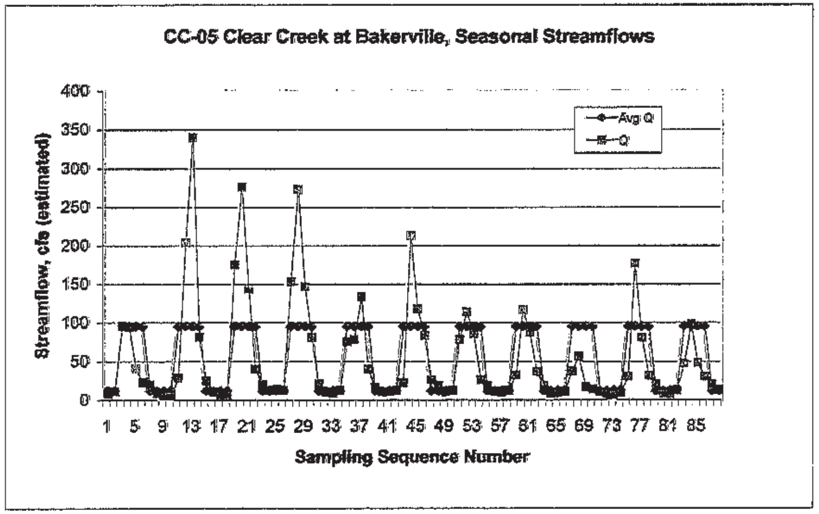
TVSs SS #	Stream Segment Description	Units: TM CoC	ug/L or lbs/d Ambient	Units: Reduction	ug/L or lbs/d TVS/Projected	Notes and discussion
2	upper mainstem CC	D-Cu Conc.	9.6	17.7%	7.9	See Table 1-3. CC-25/CC-26, Cu in compliance; see Tables 3-4 & 3-6.
	LF season	D-Cu Load	3.7	56.8%	1.6	Target lbs/d; CC-40 is suggested as reference point (for lower SS 2)
	Actual (est):	D-Cu Conc.	9.6	56.8%	4.2	Load reduction, 2.1 lbs/d Cu, from proposed Virginia Canyon remediation
						Cu-load reduction is estimated to be achieved (Table 3-6).
		D-Zn Conc.	363	71.6%	103	See Table 1-3. CC-25/CC-26, Zn not in compliance with WQS target (TVS).
		D-Zn Load	100	16.1%	83.9	Target lbs/d; CC-40 is suggested as reference point (for lower SS 2)
	Actual (est):	D-Zn Conc.	363	16.1%	305	Load reduction, 16.1 lbs/d Zn, from VC remediation
						Zn-load reduction is estimated not to achieve TVS target value (Table 3-6).
9a	Fall River	D-Cu Conc.	15.8	85.4%	2.3	See Table 1-3. CC-30, HF Cu not in compliance with WQS target (TVS).
	HF season	D-Cu Load		0.0%		Target lbs/d; CC-40 is suggested as reference point (for lower SS 2)
	Actual (est):	D-Cu Conc.	15.8	0.0%	15.8	*No additional TMs load reduction is proposed (Herron, 2001: CDPHE, 2003).*
						Maintain ambient conditions for time being; future remediation is recommended.
9b	Trail Creek	D-Cd Conc.	5.1	56.9%	2.2	See Table 1-3. CDPHE 5673, HF Cd not in compliance with WQS target (TVS).
	HF season	D-Cd Load		0.0%		*No TMs load reduction is proposed at this time. See Virginia Canyon loads (SS#2)*
	Actual (est):	D-Cd Conc.	5.1	0.0%	5.1	Load reduction, 0.04 lbs/d Cu, from proposed Virginia Canyon remediation
						Maintain ambient conditions for time being; future remediation is recommended.
		D-Cu Conc.	167	94.9%	8.6	See Table 1-3. CDPHE 5673, HF Cu not in compliance with WQS target (TVS).
		D-Cu Load		0.0%		*No TMs load reduction is proposed at this time. See Virginia Canyon loads (SS#2)*
	Actual (est):	D-Cu Conc.	167	0.0%	167	Load reduction, 2.1 lbs/d Cu, from proposed Virginia Canyon remediation
						Maintain ambient conditions for time being; future remediation is recommended.
		D-Zn Conc.	1082	89.6%	113	See Table 1-3. CDPHE 5673, HF Zn not in compliance with WQS target (TVS).
		D-Zn Load		0.0%		*No TMs load reduction is proposed at this time. See Virginia Canyon loads (SS#2)*
	Actual (est):	D-Zn Conc.	1082	0.0%	1082	Load reduction, 16.1 lbs/d Zn, from proposed Virginia Canyon remediation
						Maintain ambient conditions for time being; future remediation is recommended.
13b	North Fork Clear Ck	D-Cd Conc.	6.1	36.1%	3.9	See Table 1-3. CC-50, LF Cd is not in compliance with ultimate WQS target (TVS).
	LF season	D-Cd Load	0.12	25.0%	0.09	Target lbs/d; CC-50 is suggested as reference point (for SS 13b)
	Actual (est):	D-Cd Conc.	6.1	25.0%	4.6	Load reduction, 0.03 lbs/d Cd, from OU4 remediation
						Cd-load reduction is estimated not to achieve TVS target value (Table 3-6).
		D-Cu Conc.	67.8	75.1%	16.9	See Table 1-3. CC-50, LF Cu is not in compliance with ultimate WQS target (TVS).
		D-Cu Load	0.63	50.8%	0.31	Target lbs/d; CC-50 is suggested as reference point (for SS 13b)
	Actual (est):	D-Cu Conc.	67.8	50.8%	33.4	Load reduction, 0.32 lbs/d Cu, from OU4 remediation
						Cu-load reduction is estimated not to achieve TVS target value (Table 3-6).
		D-Zn Conc.	1905	88.4%	221	See Table 1-3. CC-50, LF Zn is not in compliance with ultimate WQS target (TVS).
		D-Zn Load	36.8	18.8%	29.9	Target lbs/d; CC-50 is suggested as reference point (for SS 13b)
	Actual (est):	D-Zn Conc.	1905	18.8%	1548	Load reduction, 6.9 lbs/d Zn, from OU4 remediation
						Zn-load reduction is estimated not to achieve TVS target value (Table 3-6).
11	lower mainstem CC	D-Zn Conc.	479	74.1%	124	See Table 1-3. CC-60, LF Zn is not in compliance with ultimate WQS target (TVS).
	LF season	D-Zn Load	92.7	32.6%	62.5	Target lbs/d; CC-60 is suggested as reference point (for SS 11)
	Actual (est):	D-Zn Conc.	479	32.6%	323	Load reduction, 30.2 lbs/d Zn, from upstream remediation
						Zn-load reduction is estimated not to achieve TVS target value (Table 3-6).

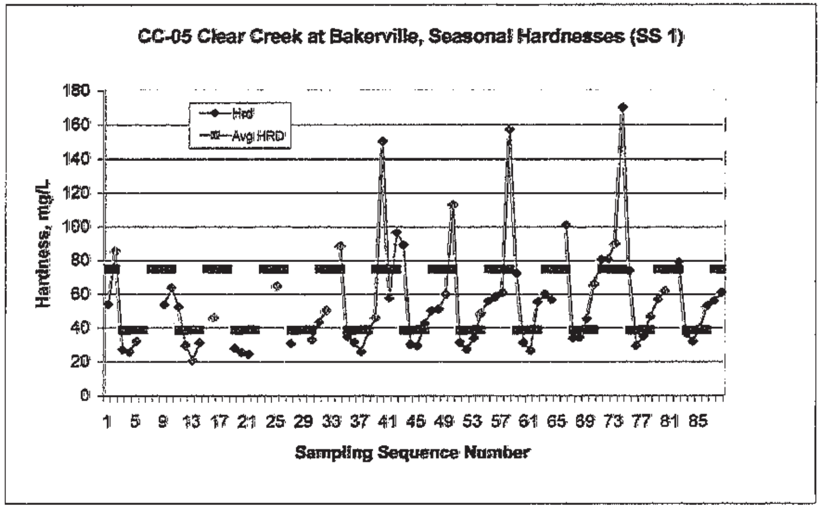
Table 4-8 -- Clear Creek Stream Profiles, Streamflow and Zinc

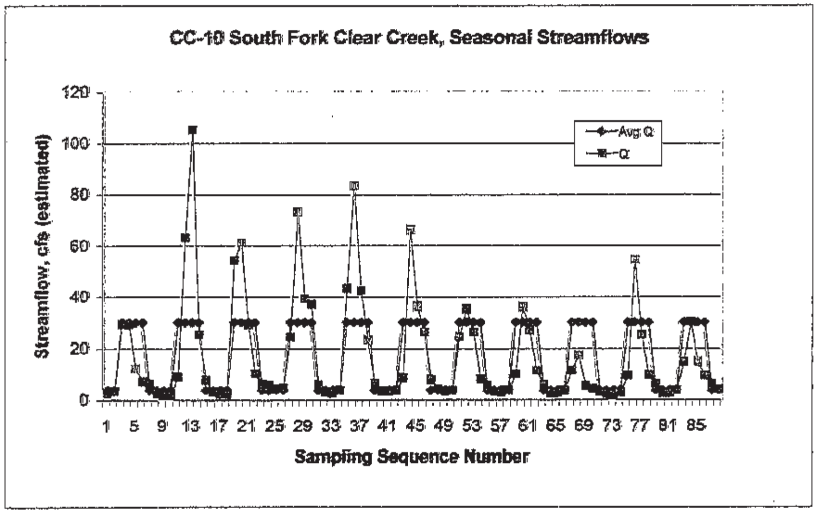
Low-Flow Zn-load/concentration profiles -- upper Clear Creek watershed													Notes and comments (supporting information and data):
			Ambient (no remediation)				Est. load reductions		Ultimate reductions #		Est. load reductions		# = in order to achieve former (underlying) standards
Headwaters		SS #2	Upper mainstem CC		Oct-April	CC-26*	*Applicable Standards*		*Underlying Standards*		*WFCC Site-Spec Std*		Joint contribution of mainstem (CC-25) & WFCC (CC-20)
				Q, cfs	Conc,ug/L	Load, #/d	Conc,ug/L	Load, #/d	Conc,ug/L	Load, #/d	Conc,ug/L	Load, #/d	
	Zn loads	CC-26		40.9	143.5	33.3	257	56.6	103	22.7	191	42.1	Qs and loads averaged between sample Qs and LF monthly-load Qs.
Tributary		SS #9a	Fall River		Oct-April	CC-30							use 1994-2004 POR
				Q, cfs	Conc,ug/L	Load, #/d							
	Zn loads	estimated		6.5	28.5	0.95							
		Additional Zn load needed applies to HF exceedance.											
Tributary		SS #9b	Trail Creek		Oct-April	CC-31							note: limited (CDPHE, 1-yr) data
				Q, cfs	Conc,ug/L	Load, #/d							
	Zn loads	estimated		1.0	894	4.8							*calculated load, using averages: flows estimated*
		Additional Zn load needed applies to HF exceedance.											*See TM 5, Appendix Table C-2, D-Zn LF load = 7.5 lbs/d.*
Tributary		SS #2	Chicago Creek		Oct-April	CC-35							use 1994-2004 POR
				Q, cfs	Conc,ug/L	Load, #/d							
	Zn loads	estimated		6.0	5.9	0.20							
Downstream		SS #2	Upper mainstem CC		Oct-April	Add above							add Fall River/Trail Creek/Chicago Creek.
				Q, cfs	Conc,ug/L	Load, #/d							
Subtotal	Zn loads	cumulative		54.4	134.1	39.3	257	75.3	103	30.2	191	55.9	back-calculate equivalent concentration from load & Q.
													At this location, the ultimate Zn standard probably is not attained.
Virginia Canyon		SS #2	Virginia Canyon inflow		Oct-April								
				Q, cfs	Conc,ug/L	Load, #/d							
				0.04	231284	49.8							Average from literature data/sources (see TM5, Table 3-3)
						(60% high?)							Table 3-5; see Lewis (2001; 2003a); compare 31.9 lbs/d (Table 3-6).
Mine Discharge		SS #2	Argo Treated Effluent		Oct-April								add Argo Tunnel (post-treatment, 4/98+)
				Q, cfs	Conc,ug/L	Load, #/d							use CDPHE data; compare with other data
	Zn loads	estimated		0.51	21	0.1							
SS #2	Zn loads	cumulative		55.0	301.3	89.1							adjusted for Argo Tunnel inflow (treated)
		Cross-check values:		*51.2*	*363*	*100*	257	70.8	103	28.4	191	52.6	Tables 4-5 and 4-6, applicable & ultimate standards, respectively
Unknown	Zn loads	PSs/NPSs		6.1	1285	42.2			*[due to low HRD]*		*[due to low HRD]*		This represents flow and Zn load from unknown sources (SS #2).
	Compare to below:			*61.1*	*Check OK*	*131.3*		83.9		83.9		83.9	
		Additional Zn load needed to be removed to attain std.:						13.1		55.5		31.3	For applicable standard, 15% reduction estimated; 29% needed.
Upstream		SS #11	Lower mainstem CC		Oct-April	CC-40							
				Q, cfs	Conc,ug/L	Load, #/d							
	Zn loads	compare		61.1	396.5	131.3							check balance with previous cumulation
Tributary		SS #13b	North Fork CC		Oct-April	CC-50							
				Q, cfs	Conc,ug/L	Load, #/d							
	Zn loads	CC-50		5.4	1249.5	35.6							
		Cross-check values:		*3.6*	*1905*	*36.8*	1864	36.0	221	4.3	405	7.8	Tables 4-5 and 4-6, applicable & ultimate standards, respectively
		Additional Zn load needed to be removed to attain std.:						0.8		32.5		28.2	Stream standard (temporary mod) achieved; however, FS is not.
Subtotal	Zn loads	cumulative		66.5	466	165.9							
Unknown	Zn loads	channel losses		-1.4	8877	-65.9							mainstem alluvial system, Clear Creek, some diversions as well
	Compare to below:			*65.1*	*Check OK*	*100.0*							interactions with suspended/bottom sediments in stream channel
Downstream		SS #11	Lower mainstem CC		Oct-April	CC-60							
				Q, cfs	Conc,ug/L	Load, #/d							
	Zn loads	cumulative		65.1	279.5	100.0							add CC-40 and NFCC (CC-50); deduct losses
	Zn loads	CC-60											
		Cross-check values:		*36.0*	*479*	*92.7*	339	65.6	124	24.0	229	44.3	Tables 4-5 and 4-6, applicable & ultimate standards, respectively
	Compare (adjusted):			*65.1*	*Check OK*	*92.7*		62.5		62.5		62.5	*US = underlying (former) standard, based upon TVS calculation.*
		Additional Zn load needed to be removed to attain std.:						-3.1		38.5		18.2	Stream standard (temporary mod) achieved; however, US is not.

Note: Gray-shaded values are cross-checks for specific monitoring sites indicated.

Figure A-1 -- Seasonality in Hardness Values and Streamflows, UCCWA/SLCs Sites







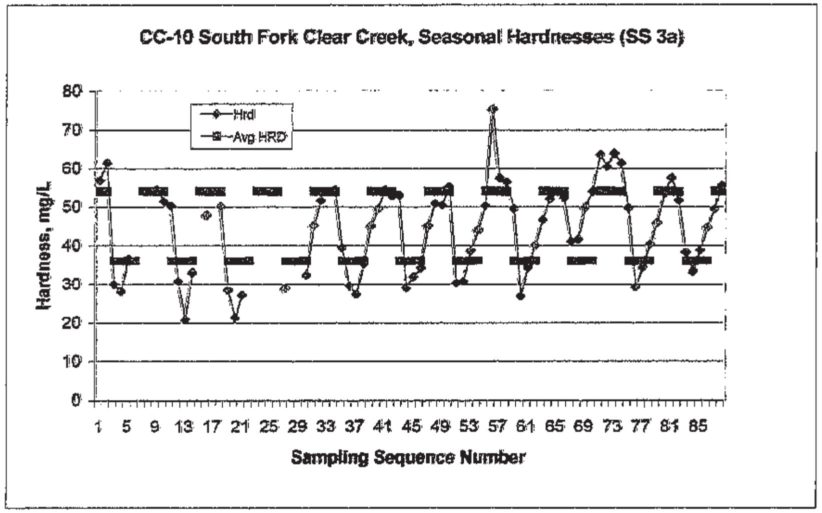
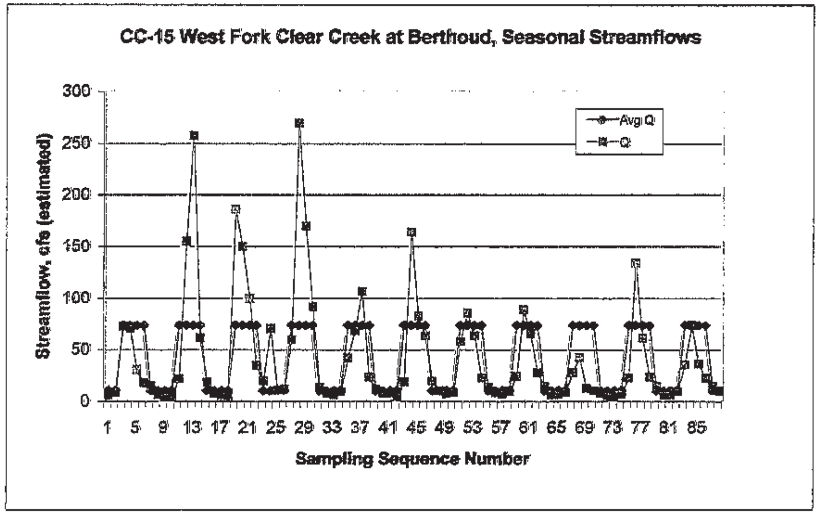
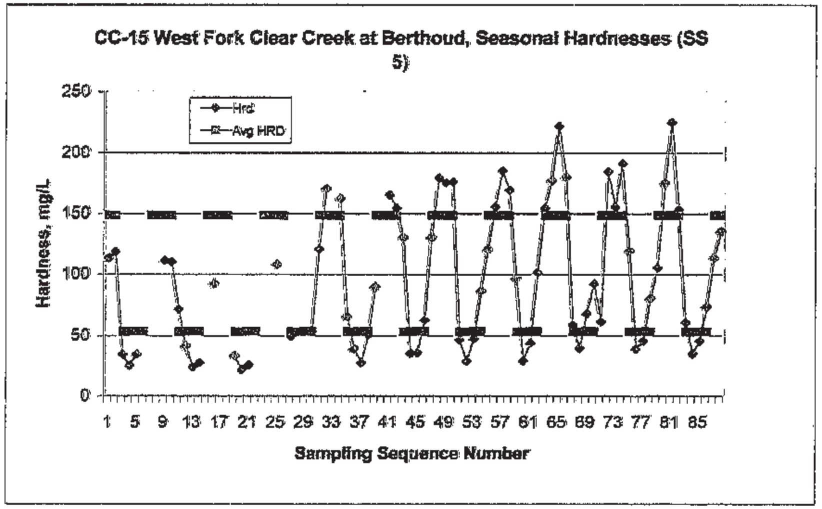
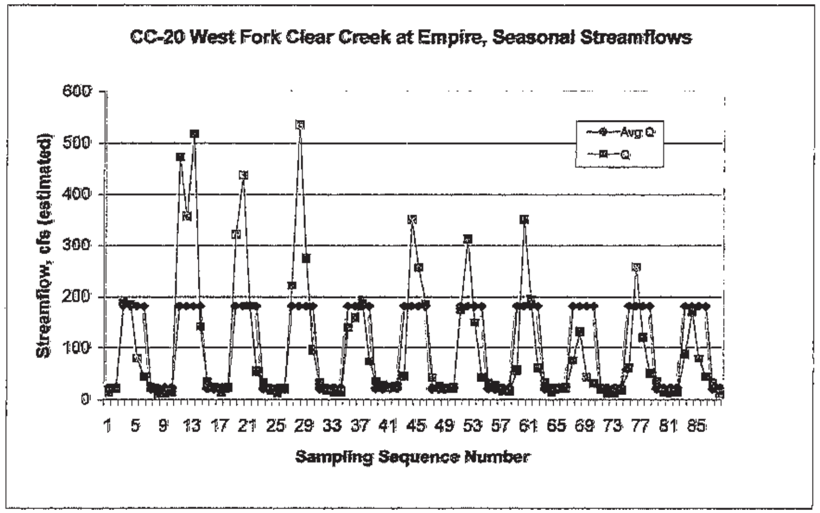


Figure A-1 -- Seasonality in Hardness Values and Streamflows, UCCWA/SLCs Sites







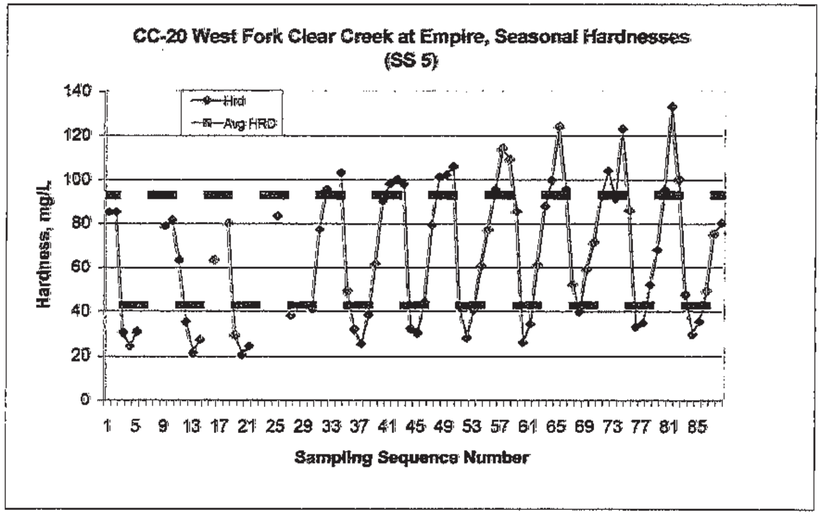
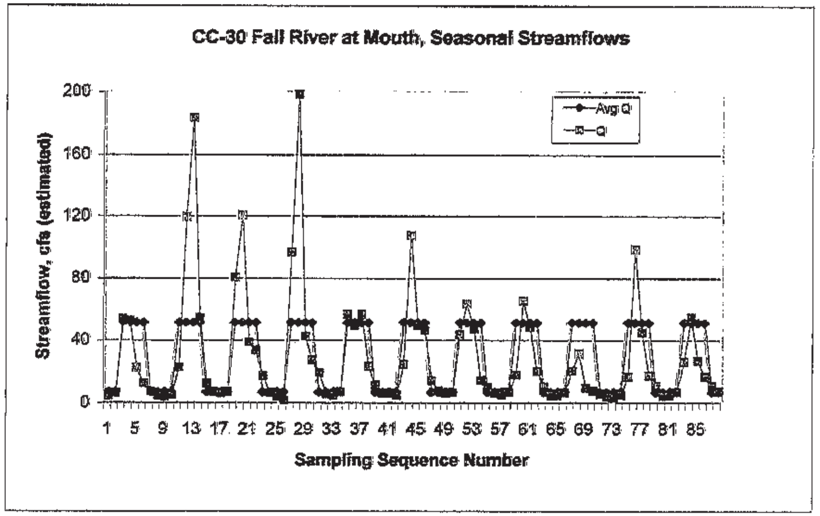
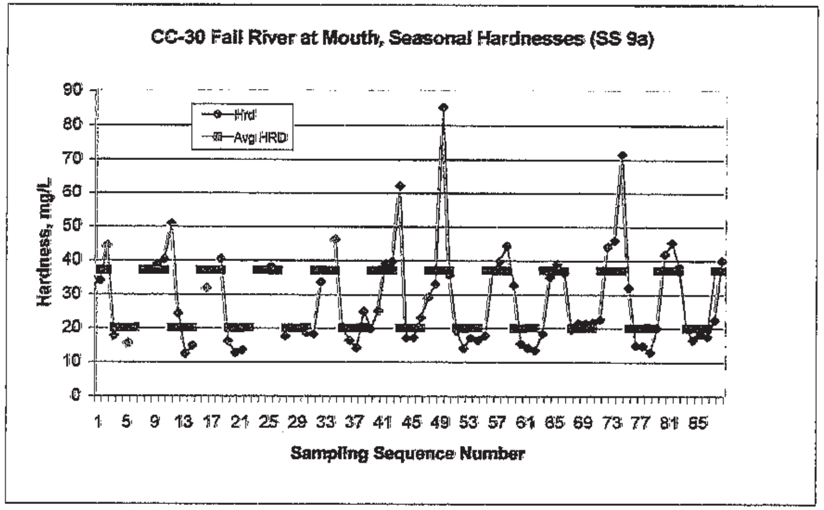
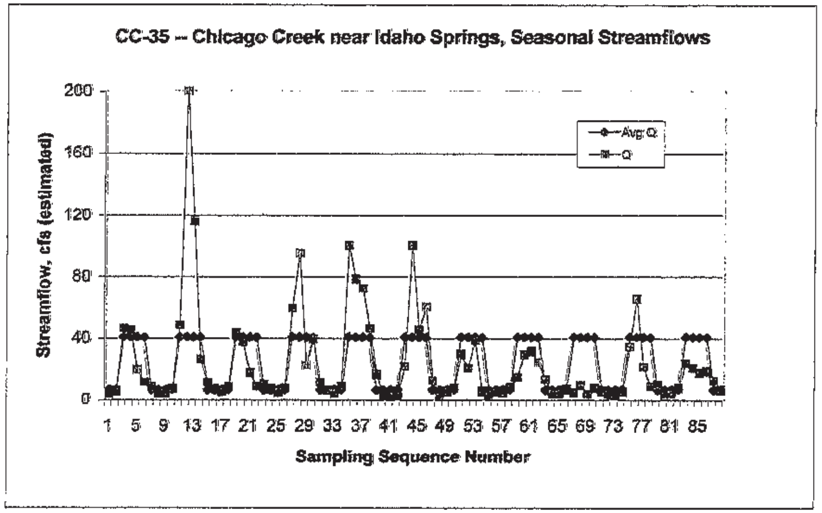


Figure A-1 -- Seasonality in Hardness Values and Streamflows, UCCWA/SLCs Sites







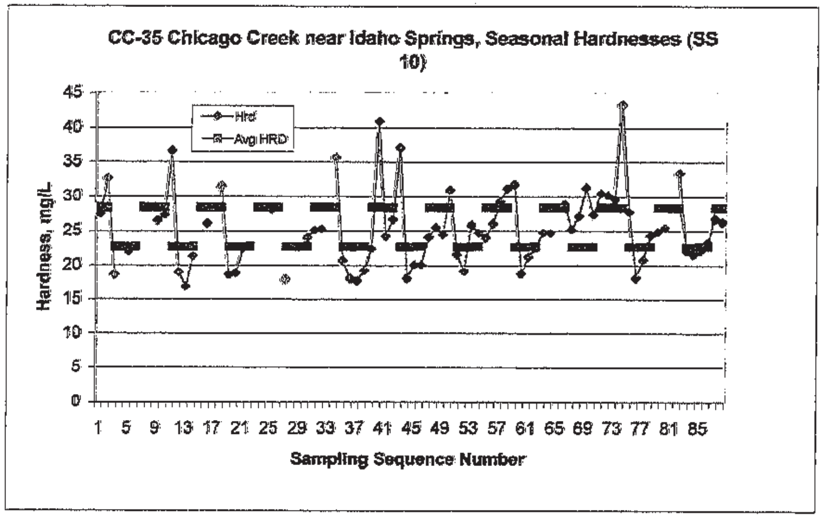
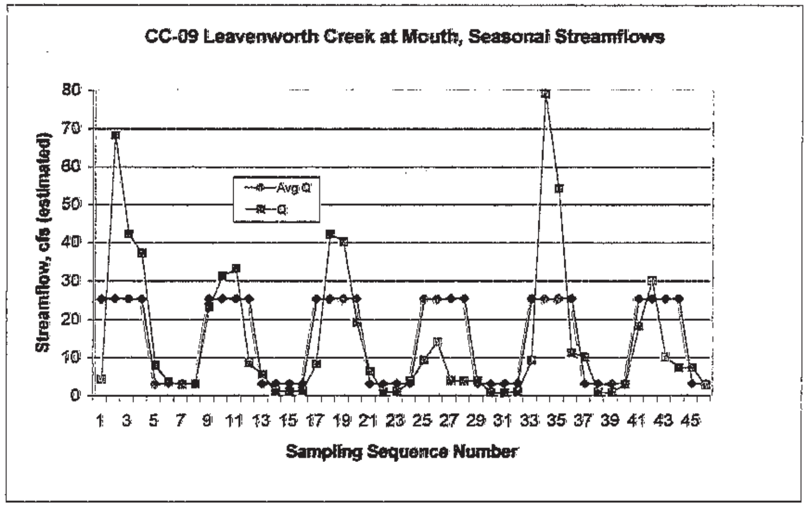
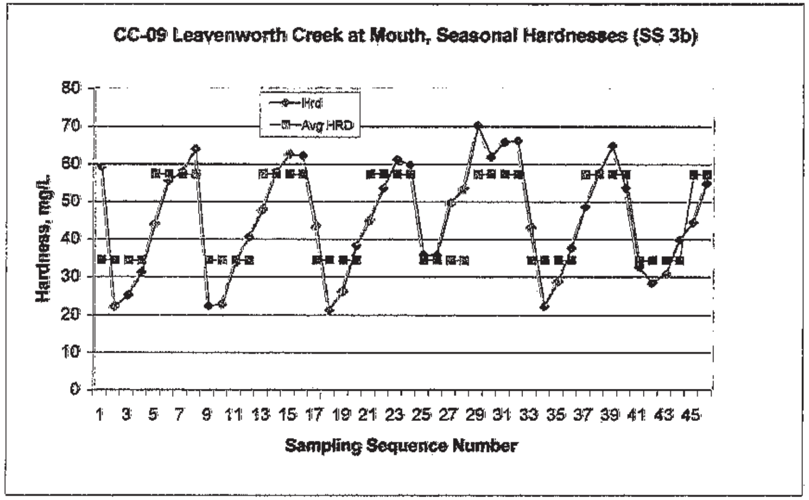
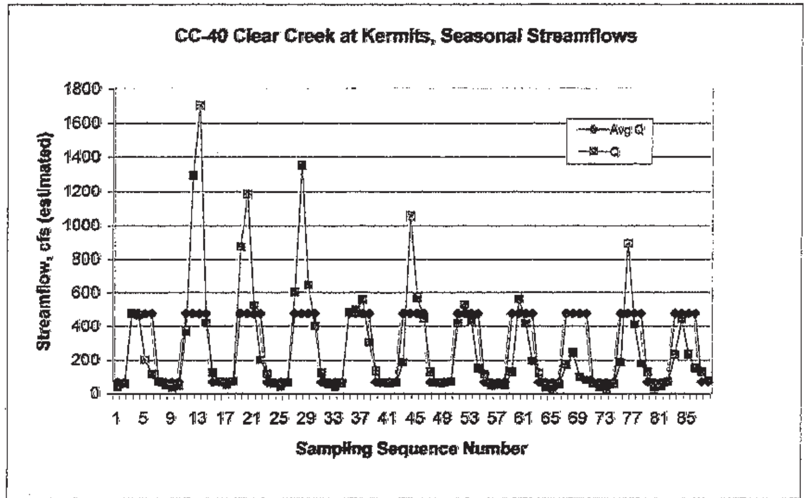


Figure A-1 -- Seasonality in Hardness Values and Streamflows, UCCWA/SLCs Sites







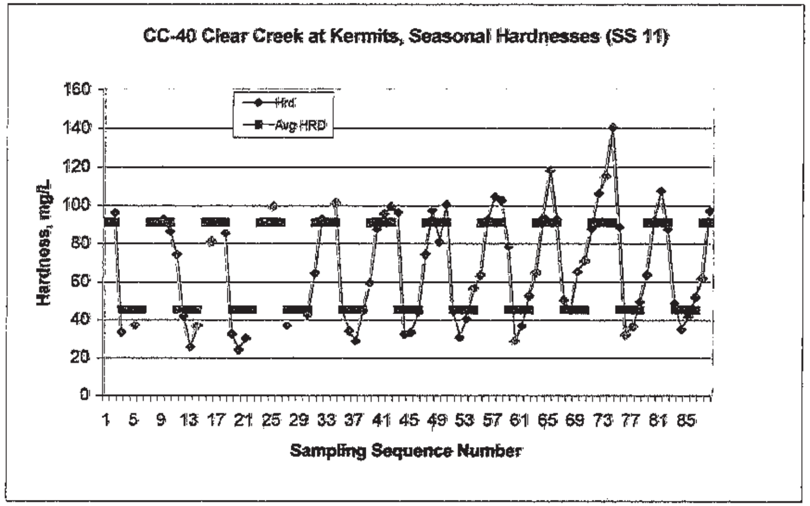
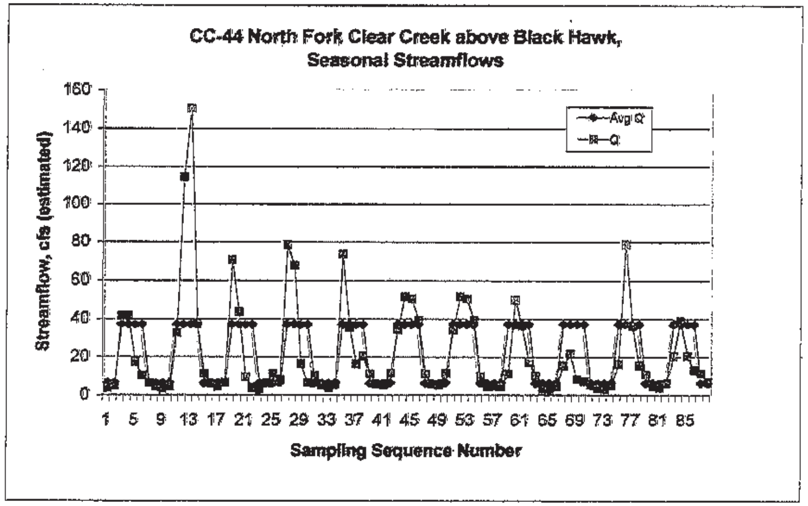
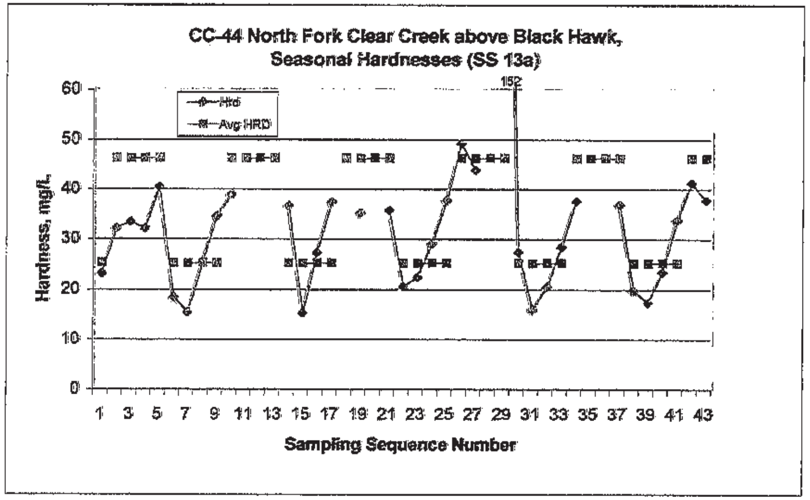
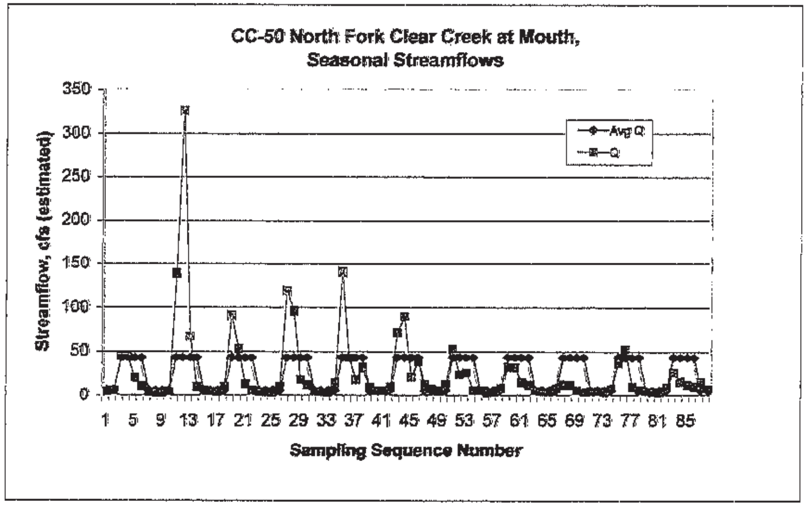


Figure A-1 -- Seasonality in Hardness Values and Streamflows, UCCWA/SLCs Sites







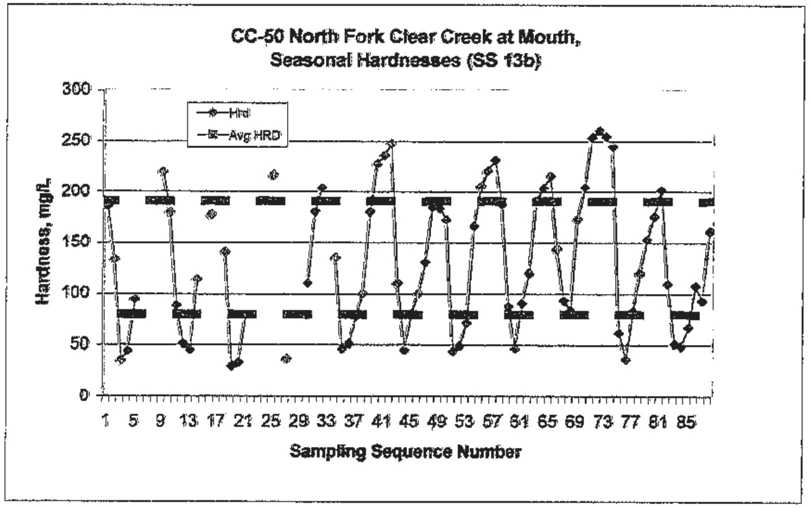
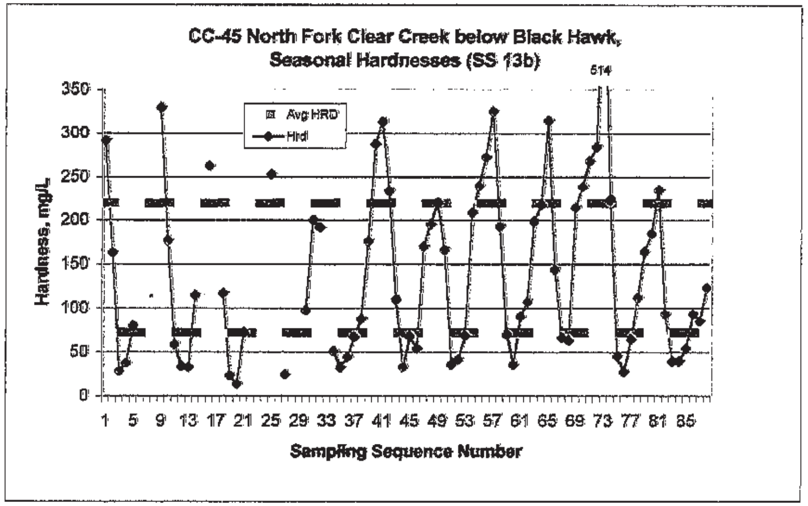
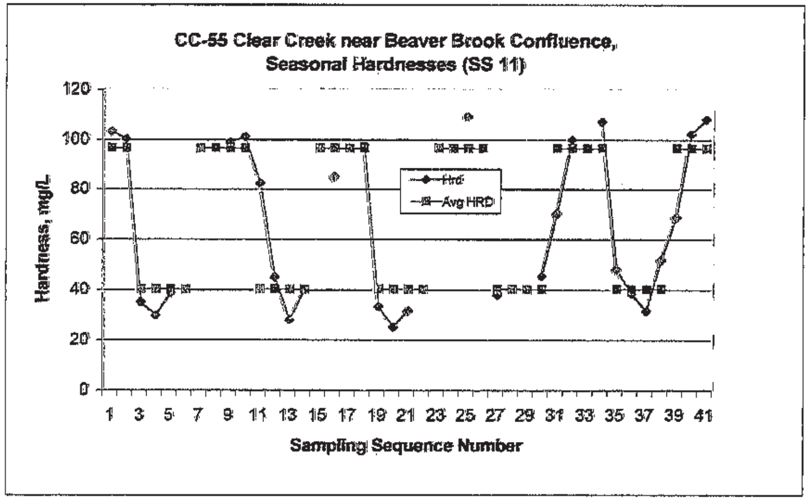
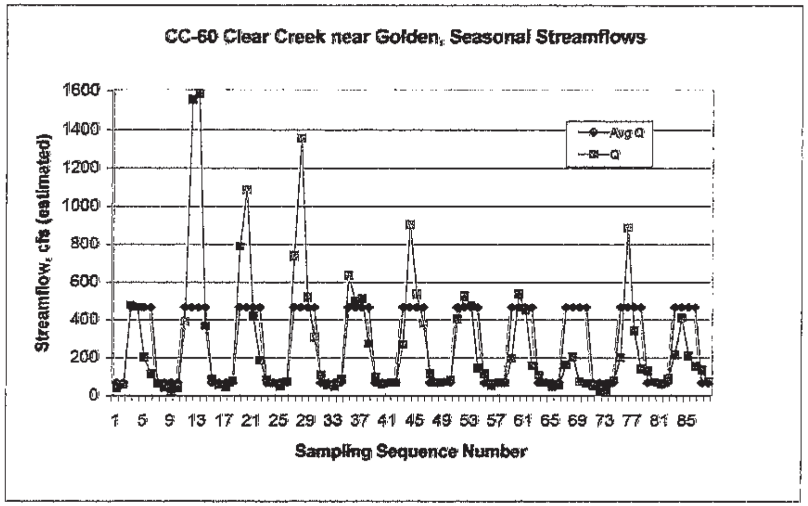


Figure A-1 -- Seasonality in Hardness Values and Streamflows, UCCWA/SLCs Sites







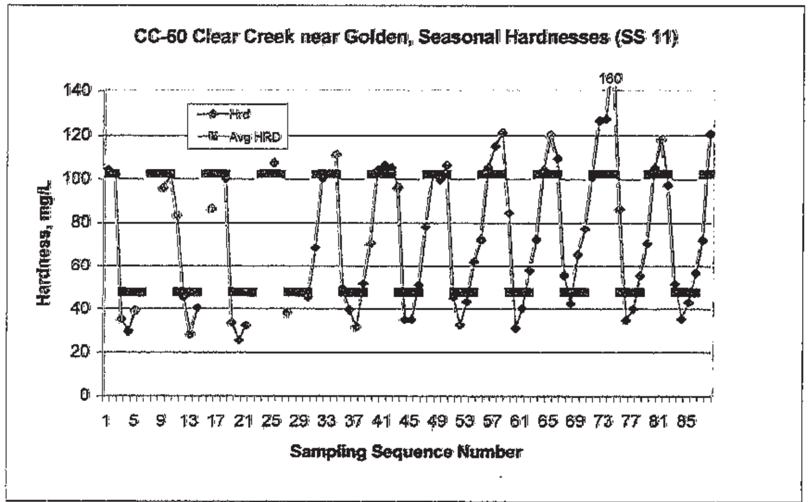
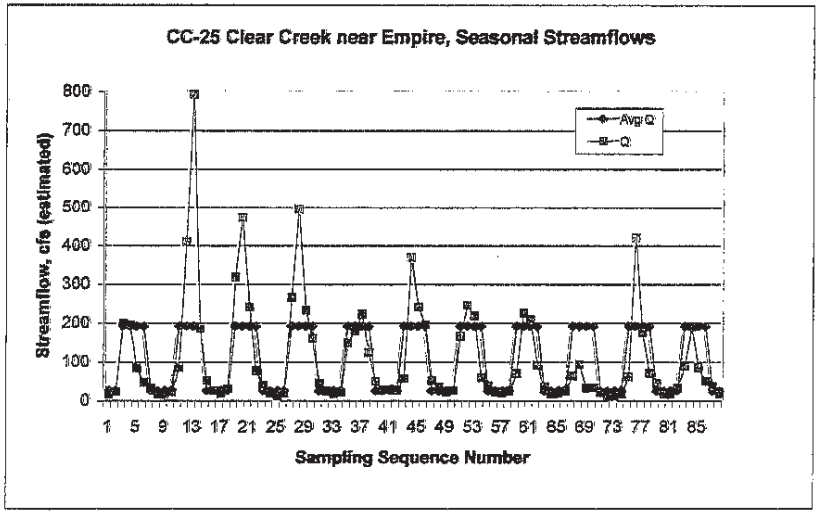
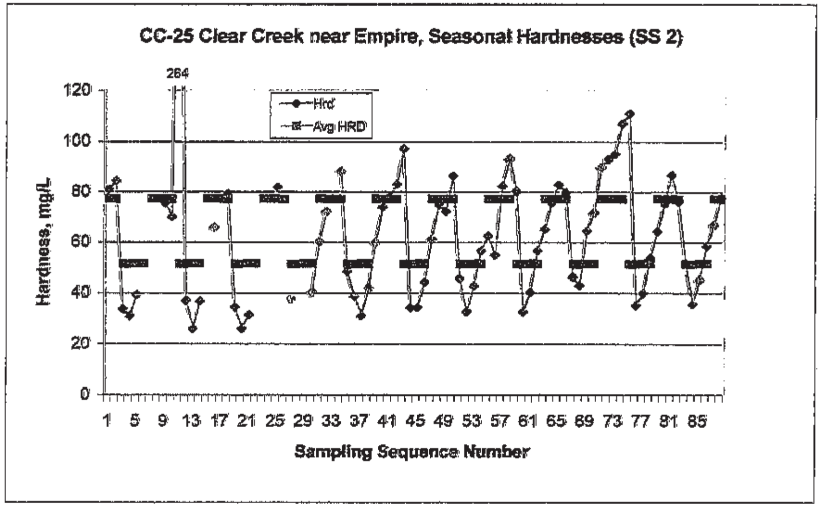
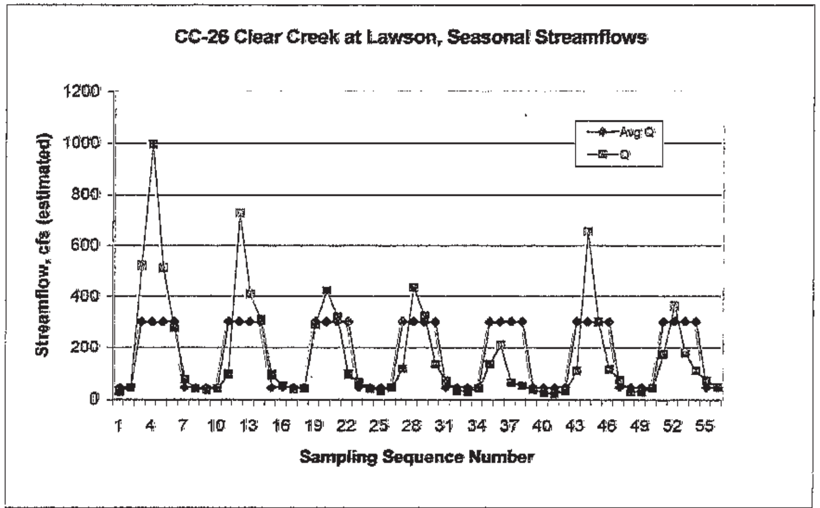


Figure A-1 -- Seasonality in Hardness Values and Streamflows, UCCWA/SLCs Sites







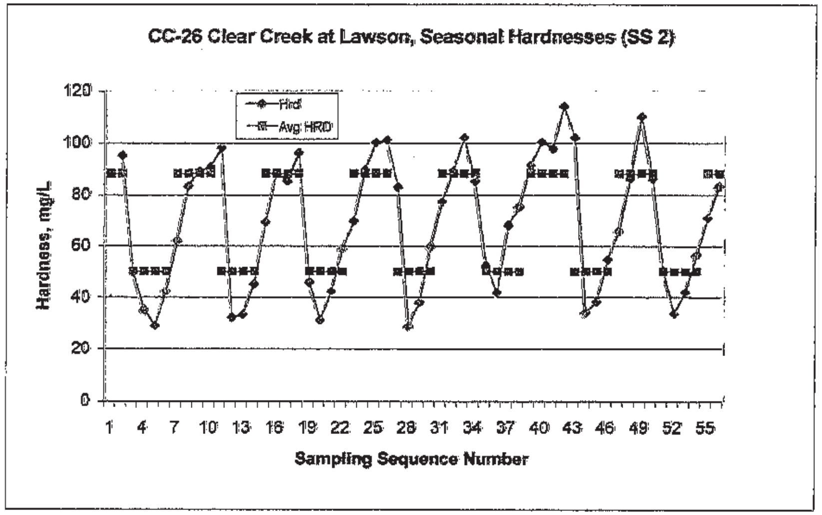
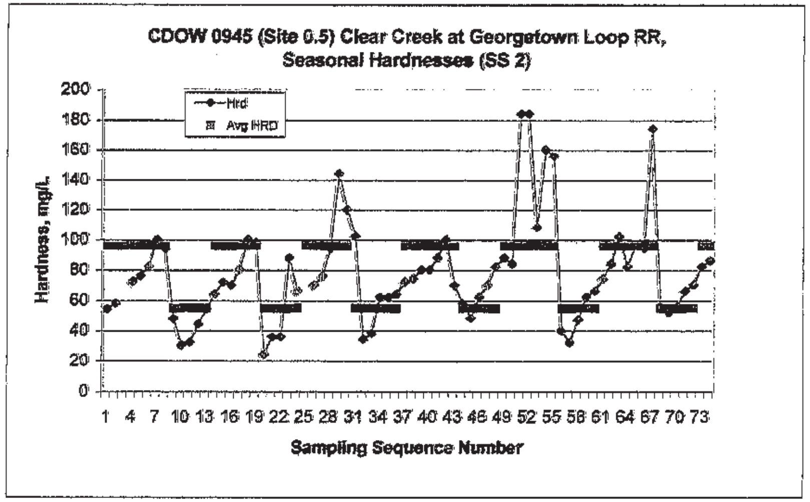
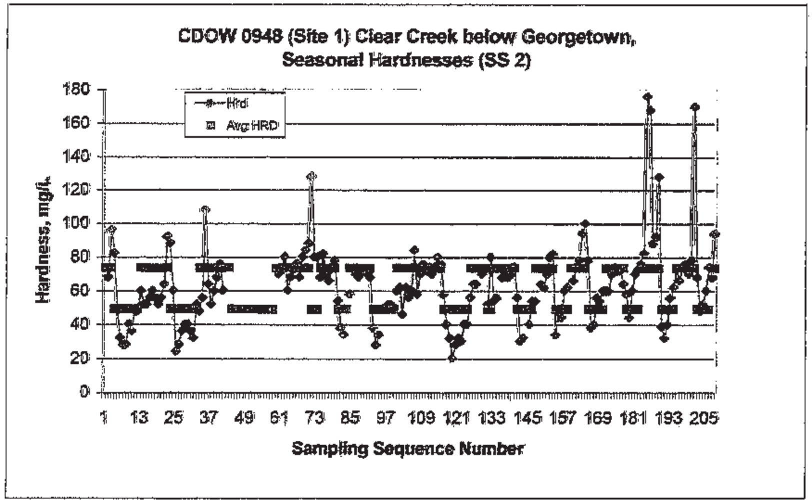
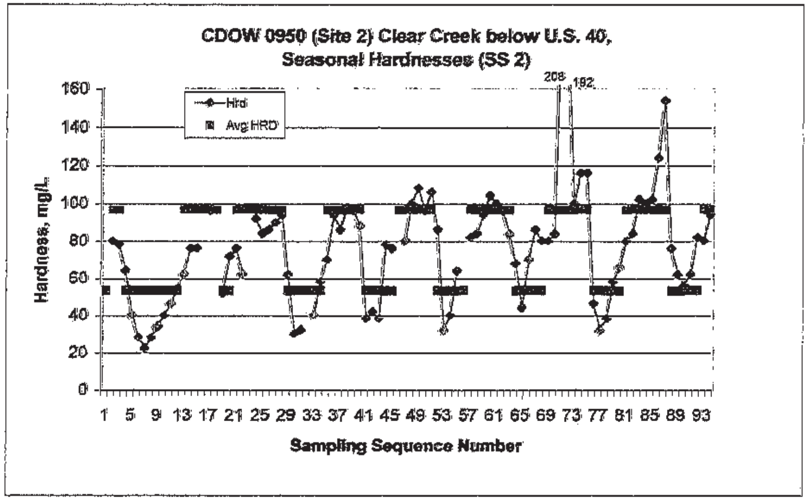


Figure A-2 -- Seasonal-Hardness Time Series, CDOW Sites







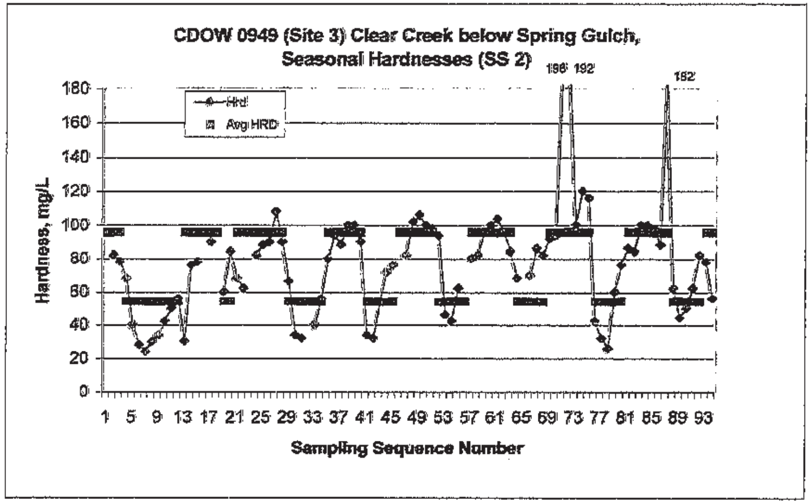
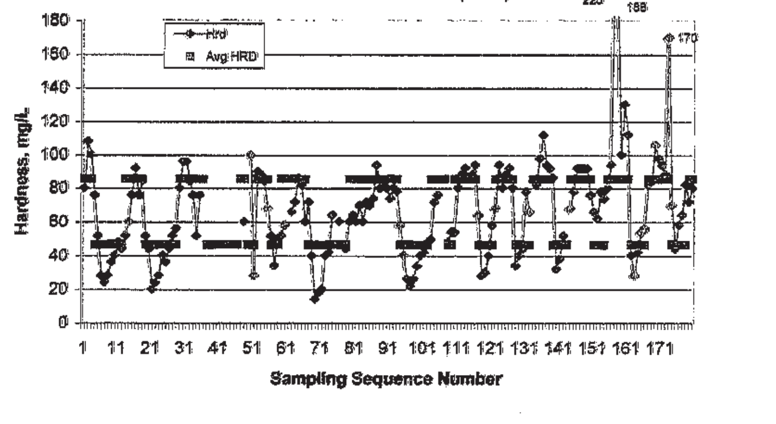
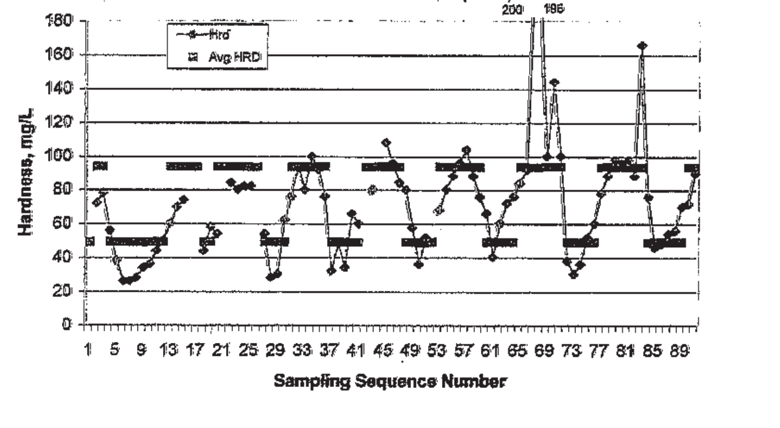


Figure A-2 -- Seasonal-Hardness Time Series, CDOW Sites

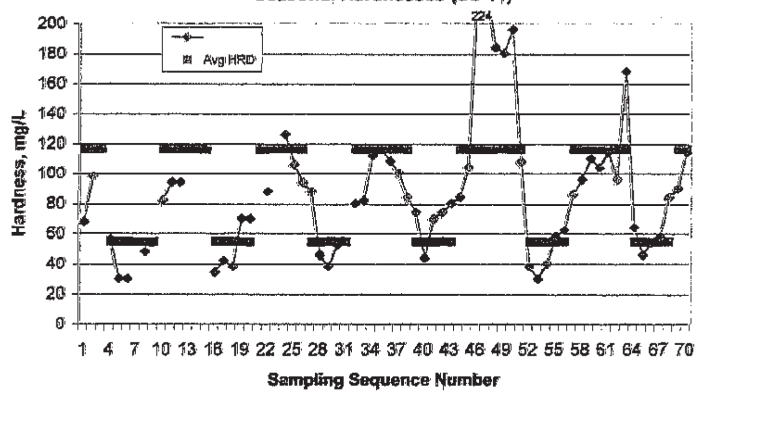
CDOW 0943 (Site 4) Clear Creek above Idaho Springs, Seasonal Hardnesses (SS 2)



CDOW 0956 (Site 5) Clear Creek at Riverside Park, Seasonal Hardnesses (SS 2)



CDOW 0952 (Site 6) Clear Creek at Dump (Idaho Springs), Seasonal Hardnesses (SS 11)



CDOW 0953 (Site 7) Clear Creek at Kermitts, Seasonal Hardnesses (SS 11)

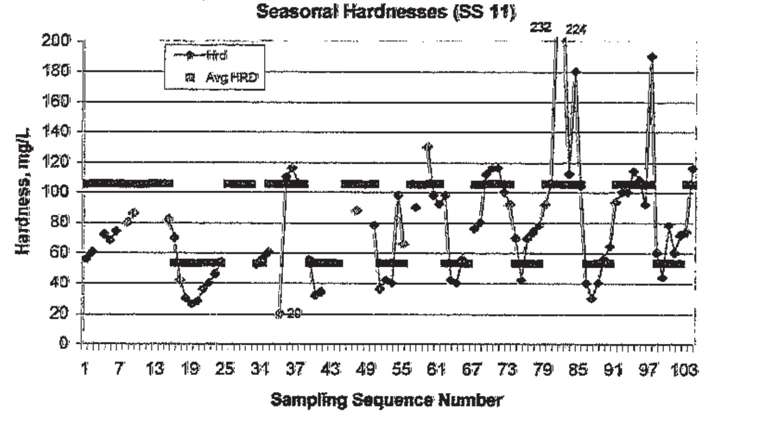
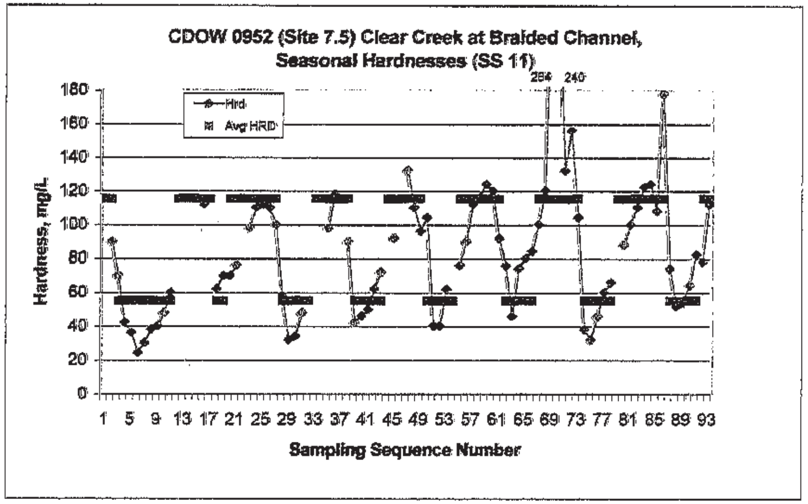
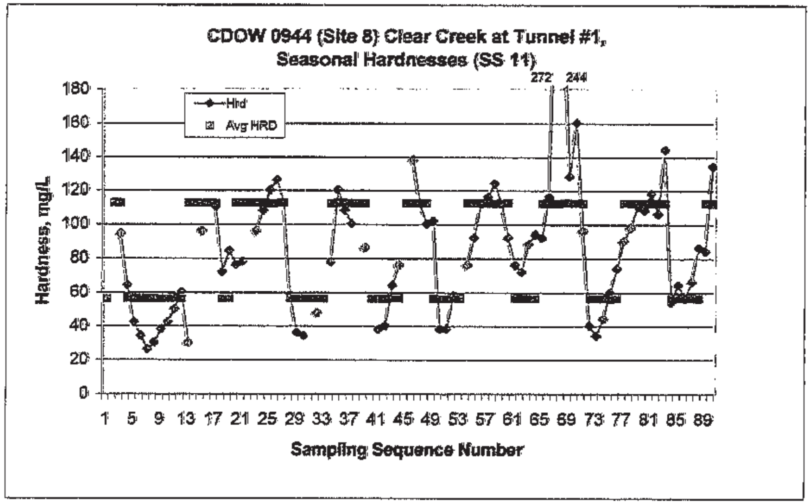
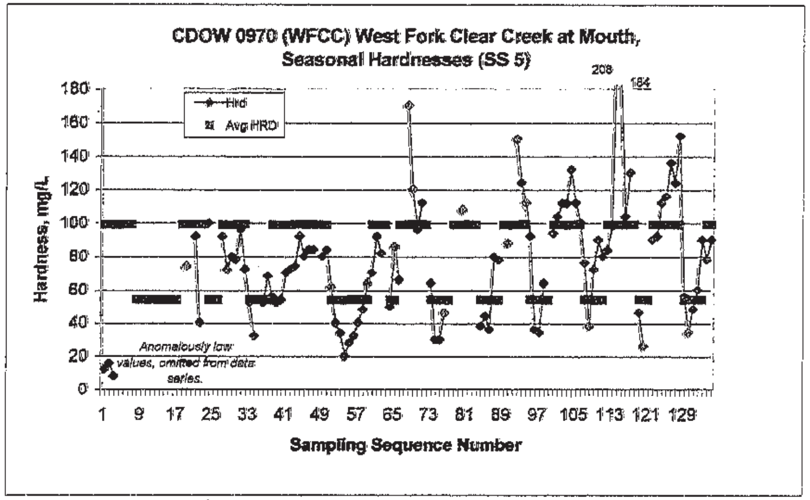


Figure A-2 -- Seasonal-Hardness Time Series, CDOW Sites







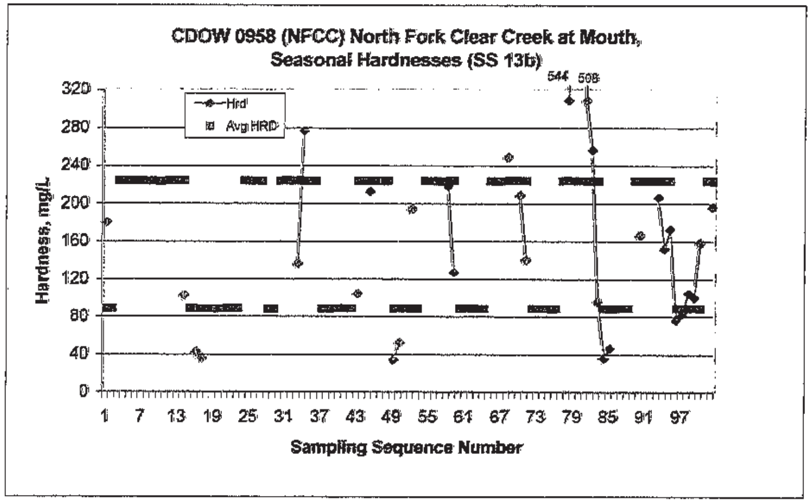
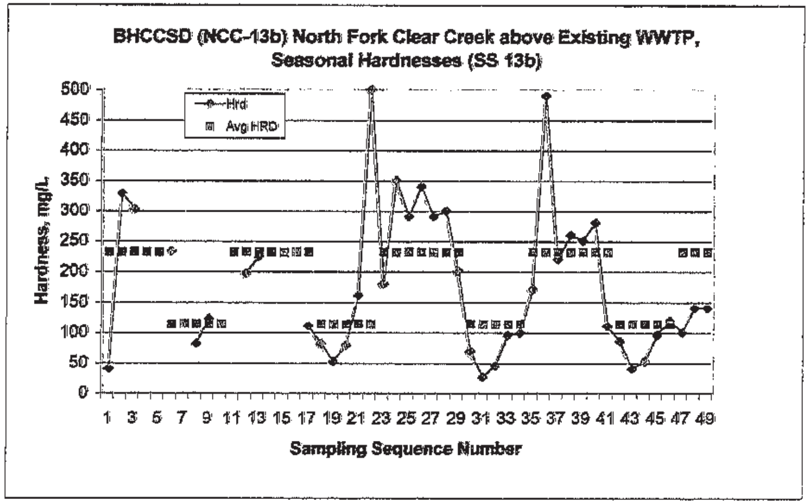
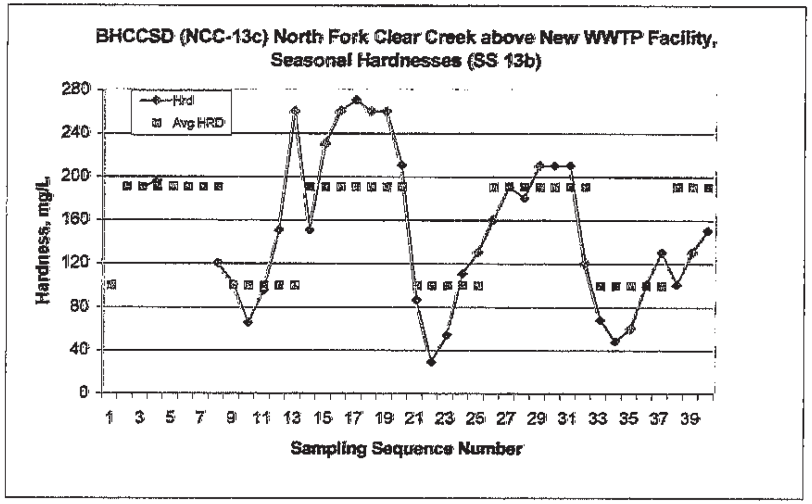
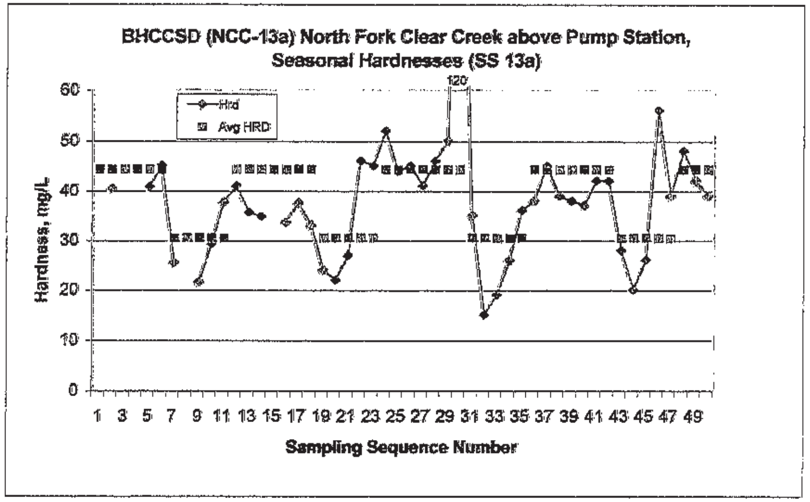
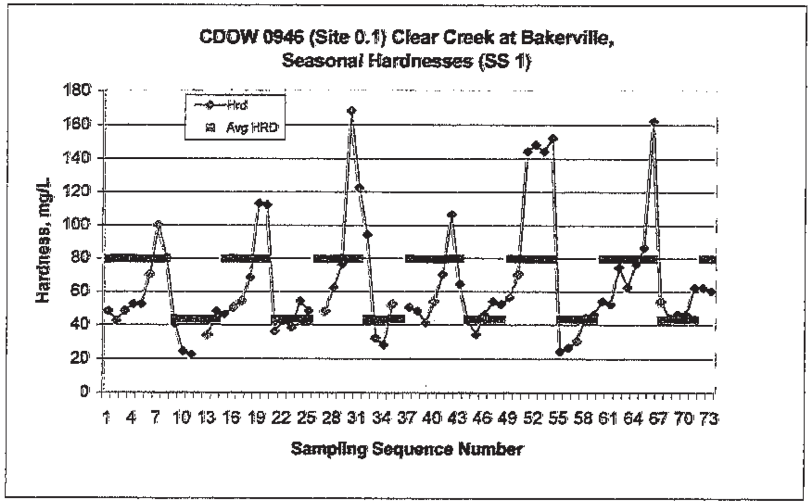


Figure A-2 -- Seasonal-Hardness Time Series, CDOW Sites









Supplemental Information -- Mine-Site Characterization, Prioritization, and Remediation

Part I: Miscellaneous Notes Source: UCC-WAG (2001), Appendix B

GSC = Good Samaritan Clause.
Prepared for 319-Grant Tasks 3 and 4.

Location (relative to CDOW monitoring sites):

Upstream from CDOW Site #1 (0948), below Georgetown

Burleigh Tunnel; Diamond Mine; NPSs @ Silver Plume (see below); Anglo Saxon/Capital Prize dumps; Commonwealth (mill tails under I-70); Boston Mine; Mineral Chief Mine; Georgetown Reservois (TMs sink); SFCC (Waldorf Mine).

			Impacts:	Costs:	
Listed in OU3 ROD:					
MT-01	Burleigh	Passive wetland (failed 1995) Awaiting final ROD	Zn, 20 lbs/d; Mn	Actual:	$480,000
Not listed in OU3 ROD:					
UCC-WAG Priority #3	Diamond Mine	Drainage; pipe to Burleigh for treatment Possible impacts on NPSs in Silver Plume area	Zn, TMs, pH		
	Waldorf	Cap pile (USFS action?) Drainage flows through small wetland Historical preservation issues SFCC currently meets stream standards (see Task 1)	TMs SS 3a; 3b -- note exceedances		

Upstream from CDOW Site #2 (0950), below U.S. 40 (WFCC)

WFCC: Henderson (improved water treatment); North Empire Mine, Minnesota Mine (done); Aorta drainage; Empire tailings (see below); Marshall-Russell (drainage under CDOT maintenance yard); CDOT maintenance yard.

Not listed in OU3 ROD:					
MW-10?	North Empire (Tailings)	RI rank of 4 (worse than National Tunnel) In North Empire Creek (6 ac); Fix: cap.	TMs; cap; Pull out of stream	Estimated	$340,000
	Aorta Drainage	Fix: Passive-wetlands treatment	pH; TMs	Design paid by Coors. Construction awaits GSC.	
MW-10	Empire Tailings	Tailings are in WFCC; partly armored by boulders (10 ac); RI rank of 4 (worse than National Tunnel) Fix: cap	TMs; sediment		

Upstream from CDOW Site #3 (0949), above Spring Gulch

Red Elephant groundwater/dump and mill at NW end of Lawson in CC (most of dump removed); Silver Creek with Joe Reynolds; American Sisters, and Nabob (last two not in stream bed); Ohio Golch (only minor mining); Clear Creek mill and tainings pond (mostly under I-70); McLelland drainage (tailings stabilized); Spring Gulch (mostly dry and not much mining); and Elida mill tailings.

Not listed in OU3 ROD:			
	Joe Reynolds	Pull out of stream and cap; tailings are in Silver Creek (2.5 ac); RI rank of 3.5 (worse than National Tunnel)	TMs; sediment
	Elida	Pull out of stream and cap; tailings on NE side of Spring Gulch (N side of CC, 1 ac); RI rank of 3-3.5	TMs; sediment

Supplemental Information -- Mine-Site Characterization, Prioritization, and Remediation

	Red Elephant	Assess impacts; stabilize as needed Much of dump removed; some still in CC/ under CC (bridge) crossing	TMs; sediment	
w/ MT-02?	McClelland Drainage	Passive wetland considered; delayed by lack of GSC Noted in the ROD (OU3?); but not an OU	TMs (Zn, 0.81 lb/d); pH (with Rockford)	
Upstream from CDOW Site #4 (0943), below Fall River above Idaho Springs				
Alice Mine (on Fall River; DMG has done a partial cleanup); Rockford drainage; Trail Creek tailings.				
Listed in OU3 ROD:				
MT-03	Rockford	Not an OU; passive wetlands	TMs (Zn, 0.81 lb/d)	Wetland (failed): Actual: $176,000
	Trail Creek Tailings	Not an OU; remove/pull out of stream; cap Tailings in Trail Creek (2.5 ac); exceed SSs; no fish On Orphan Sites list	TMs; sediment (Zn, 1.4 lb/d)	
Upstream from CDOW Site #5 (0946), Riverside Park in Idaho Springs				
Donna Juanita; Alma Lincoln; Big Five dump and drainage; Chicago Creek (Black Eagle capping done); Soda Creek (Little Bear removal done); Vigainia Canyon (including Two Brothers and Boomerang Canyon); Virginia Canyon groundwater				
Listed in OU3 ROD:				
MT-4; MW-14 ??	Big Five	Passive wetlands (research stopped; complex institutional problems)		
UCC-WAG Priority #1	Virginia Canyon GW	Collect/extract groundwater; pipe to Argo WWTP	Zn (75-365 lbs/d); pH; TMs	Estimated $514,000 [only for extraction; max. of 36 lbs/d Zn; not incl. piping/trtmt.]
Not listed in OU3 ROD:				
	Donna Juanita	Assess impacts; pull out of stream; armor or cap Tailings are in CC/eroding; Zn increasing in general area.	TMs; sediment	
	Alma Lincoln	Assess impacts; pull out of stream; armor or cap RI: tailings not in floodplain/stream; toe is in CC/eroding.	TMs; sediment	
	Two Brothers (historical)	Assess impacts; pull out of stream; cap Above Little Six; RI rank of 2 (drainage size)	TMs; sediment (storm-related)	
	Virginia Canyon [see GW component]	Assess impacts; pull out of stream; cap or remove piles. RI rank of 2 (due to drainage size). Little Six piles, ASARCO, one pile (Orphan Site prog.)	TMs; sediment (storms and runoff)	Actual: $50,000
Upstream from CDOW Site #6 (0952), below Argo at Dump below Idaho Springs				
Argo Tunnel (done); pipe to convey Rosa Gulch runoff under Argo tailings (done); and Argo tailings.				
Listed in OU3 ROD:				
MW-5	Argo Tailings	Cap or collect drainage/treat	TMs; sediment	
UCC-WAG Priority #4	*Sludge Repository*	*Locate/construct a repository for mine wastes for sludges produced by mine-drainage WTPs.*	*TMs*	

Supplemental Information -- Mine-Site Characterization, Prioritization, and Remediation

Upstream from CDOW Site #7 (0953), at Kermitts (I-70 and U.S.Highway 6)
Gilson Gulch (Franklin Mine); Runoff from I-70 via Johnson Gulch is below this site.
Not listed in OU3 ROD:

	Franklin Mine (historic)	Assess impacts; stabilize as needed Up Gilson Gulch east of Argo; TMs-rich sediments eroding into Idaho Springs from historical and permitted mining areas.	TMs; sediment		

Upstream from CDOW Site #7.5 (0951), braided channel, 1.5 mi below NFCC confluence
NFCC: Chase Gulch tailings, Golden Gilpin tailings (partly done); Gregory Incline tailings (done); Chregord Incline drainage; Boodle Mill tailings; Nevadaville tailings; Quartz Hill tailings; Gregory Gulch tailings (mostly done); Clay County tailings (done); National Tunnel wasterock (done); NFCC tailings (done); National Tunnel drainage; and Quartz Hill drainage. Mainstem CC: Runovv from I-70 and U.S. Highway 6.
Listed in OU3 ROD:

MW-21	Chase Gulch #1 (9/99)	Removal to offsite	Sediment	Actual:	$75,000
MW-22	Chase Gulch #2 (12/01)	Cap or culvert plus institutional controls	TMs; sediment	Estimated New (est): Estimated	$74,000 $75,000 $21,000
MW-23	Golden Gilpin (2001)	Remove or cap remainder	TMs; sediment		
MW-24	Gregory Incline	Active treatment; awaiting Final (OU4) ROD	TMs; pH; Zn, 6.6 lb/d	Estimated [with National Tunnel]	$1,201,000
MW-24	National Tunnel	Active treatment; awaiting Final (OU4) ROD	TMs; pH; Zn, 2.2 lb/d	[see Gregory Incline]	
MW-18?	Quartz Hill (2001)	Stabilize	TMs; sediment	Estimated	$64,000
MW-18?	Quartz Hill	Active treatment; awaiting Final (OU4) ROD	TMs; pH		
Not listed in OU3 ROD:					
	Nevadaville	Assess impacts; stabilize/removal as needed Above Gregory Gulch; some in stream; all in floodplain (2-4 ac); eroding TMs and sediment into Gregory Gulch.	TMs; sediment		
	Gregory Gulch #3	Pull ouf of stream; cap or remove Estimated 6,000 yd3 of waste; on Orphan Sites list.	TMs; sediment		
	NCC Dredge	Locate; assess impacts; stabilize and cap. Toe in NFCC below Black Hawk (10 ac); location unclear.	TMs; sediment	Phseli FS	$219,000
NFCC (entire) UCC-WAG Priority #2	NCC Sediments	In-stream sediments; assess impacts; stabilize as neede Large volume of contaminated sediments in stream bed. Sulfides and oxides will continue to contaminate stream.	TMs; sediment		

Upstream from CDOW Site #8 (0944), west of Tunnel #1 on U.S. Highway 6
Soda Creek (includes Beaver Brook), minor propspects and septic systems; mainstem dredge piles (probebly minor impacts)
No projects are listed for this segment; it is assumed that cleanup of upstream segments will improve this one; east of Colorado Mineral Belt.

Supplemental Information -- Mine-Site Characterization, Prioritization, and Remediation

Part II: Source Areas with prioritization rankings

Sources: Herron and others (2001); CWT Corporation (2002) *[also see Wildeman and others (2003)]*

Prepared for 319-Grant Task 4. # of inventoried/ranked sites: 205 sites, Herron and others (2001, Table 1)
41 sites, CWT Corporation (2002)

Virginia Canyon Source Areas (Priority = 1)

CDMG Site	*Description*	*Size, yd3*	*CWTCosts*
#1	Williams and Rio Grande		$18,630
#2	Crown Point & Virginia		*see #1*
#4	Castleton Mine		$303,907
#9	Trio Tunnel		$327,414
#13	Windsor Castle Shaft		$51,750
#14	Upper Lake Tunnel		$20,700
#15*	Two Brothers		n/a
#25*	Rattler Tunnel		n/a
#28*	Fopxhall Tunnel		n/a
#41	Brighton Mine		$499,636
#42*	Bride Tunnel		n/a
#45	Inter Ocean Mine		$5,175
#53	Casino Mine		$232,225
#67	Doves Nest Mine		$540,767
#108*	Little Emma Mine		n/a
#144	Inter Ocean Mine		$138,193
#197*	Bald Eagle Mine		n/a
Added sites cited in CWT Corporation (2002, Executive Summary):			
#12	Diamond Joe Mine (CDMG Priority 2)		$329,666
#82	Adit North of Bald Eagle (CDMG Priority 2)		$24,041

** Cited in Herron and others (2001); not in CWT Corporation (2002):*
#s 15, 42, 84, 108, and 197 – ranked Priority 1 by Herron and others.
Note: Herron et al. (2001), 17 Priority-1 sites. **Total Cost** $2,492,104

Russell Gulch Source Areas (Priority = 1)

CWT Site	*Description*	*Size, yd3*	*CWTCosts*
#31	New Brunswick Claim	1700	n/a
#35@	Hampton Claim (@ Priority 2)	1000	n/a
#36	Tiger Claim	30000	n/a
#37	Meeker Claim (1)	400	n/a
#42	Martin Claim	400	n/a
Note: The above-named sites total $2.488M remediation.			
Note: CWT Corp. (2002), remediation sites.		**Total Cost**	$2,487,927
Other CWT sites ranked Priority 1 (excluded for $ cutoff):			
#6	Lillian #3 Percent	30000	
#16	Niagara Claim&	3000-11000	
#17	Not on a Claim	1300	
#19	Lotus Claim	7500	
#20	West Saratoga	5000	
#21	Church Placer Claim	5000	
#33	Golden Claim	1800	
#34	Powers Claim	4000	
#38	Meeker Claim (2)	6000	
#39	Little Raven Claim	5000	
#40	Alva Adams Claim	3000	
#41	Golden Claim	20000	

Total Priority 1 sites = 16; Priority 2 sites = 14.
Note: CSM score ranking: 4.08/5 (Wildeman and others).

Source: **TDS Consulting Inc. (2004b); monthly/annual D-TMs load summaries, sites CC-40 and CC-60.**
Period of Record (POR): 10/94-9/04 *10 years (120 months); 42 pre-Argo vs. 78 post-Argo.*

CC-60: Mo-Yr	(cfs) Flow	Loadings (lbs/mo) D-Zn #	D-Cu #
Oct-94	59.0	1831	48
Nov-94	49.0	1112	46
Dec-94	39.4	782	41
Jan-95	29.3	1059	40
Feb-95	25.9	1004	35
Mar-95	36.3	1363	48
Apr-95	50.9	2114	70
May-95	269	**35201**	813
Jun-95	**1522**	**66410**	**4206**
Jul-95	**1203**	**29989**	**3845**
Aug-95	373	12140	249
Sep-95	182	9823	198
Oct-95	79.4	6094	122
Nov-95	64.0	5100	101
Dec-95	41.3	3493	69
Jan-96	36.5	2541	52
Feb-96	42.3	2602	54
Mar-96	51.8	5504	58
Apr-96	85.2	3671	88
May-96	504	10184	903
Jun-96	**987**	16693	1350
Jul-96	454	7666	344
Aug-96	160	6456	151
Sep-96	121	5248	152
Oct-96	83.1	3923	129
Nov-96	61.5	5179	86
Dec-96	51.8	4902	73
Jan-97	53.4	4680	57
Feb-97	54.5	4055	39
Mar-97	55.4	3030	55
Apr-97	76.8	2585	106
May-97	440	14381	1108
Jun-97	**1385**	**40710**	**3036**
Jul-97	536	12818	742
Aug-97	281	7932	366
Sep-97	146	5655	141
Oct-97	101	4704	84
Nov-97	74.1	5579	59
Dec-97	50.2	4180	41
Jan-98	46.6	3331	128
Feb-98	45.1	2482	60
Mar-98	57.4	3365	71
Apr-98	123	6089	136
May-98	495	15602	660
Jun-98	625	13306	733
Jul-98	470	5670	279
Aug-98	267	8502	436

CC-40 Mo-Year	(cfs) Flow	Loadings (lbs/mo) D-Zn #	D-Cu #
Oct-94	65.0	3458	80
Nov-94	49.6	3286	50
Dec-94	43.2	3296	41
Jan-95	34.1	2562	50
Feb-95	30.5	2052	46
Mar-95	43.1	2486	58
Apr-95	49.9	3005	73
May-95	221	41249	1099
Jun-95	**1325**	**74623**	**3251**
Jul-95	**1398**	**37526**	**2861**
Aug-95	441	18634	1105
Sep-95	189	12184	461
Oct-95	116	10497	294
Nov-95	75.6	6887	157
Dec-95	60.8	5811	122
Jan-96	54.6	5351	130
Feb-96	46.2	4267	104
Mar-96	49.4	5024	77
Apr-96	85.2	7688	118
May-96	549	11714	632
Jun-96	1086	18289	1053
Jul-96	557	10657	285
Aug-96	195	5527	132
Sep-96	140	6145	180
Oct-96	112	6625	208
Nov-96	63.1	6898	185
Dec-96	47.4	5848	154
Jan-97	37.9	4485	65
Feb-97	35.0	3678	13
Mar-97	43.9	4121	54
Apr-97	78.8	5307	148
May-97	363	12102	932
Jun-97	1294	**36733**	**3844**
Jul-97	607	16035	904
Aug-97	330	12868	511
Sep-97	165	8178	259
Oct-97	110	6402	183
Nov-97	66.8	7300	125
Dec-97	51.1	6339	102
Jan-98	42.5	5109	72
Feb-98	36.8	3888	48
Mar-98	44.3	4815	77
Apr-98	66.1	5803	120
May-98	337	13219	585
Jun-98	608	5004	588
Jul-98	520	8199	445
Aug-98	304	12966	663

Source: **TDS Consulting Inc. (2004b); monthly/annual D-TMs load summaries, sites CC-40 and CC-60.**

Period of Record (POR): 10/94-9/04 *10 years (120 months); 42 pre-Argo vs. 78 post-Argo.*

CC-60:	*(cfs)*	*Loadings (lbs/mo)*	
Mo-Yr	***Flow***	***D-Zn #***	***D-Cu #***
Sep-98	145	5128	184
Oct-98	105	3722	122
Nov-98	78.0	4399	112
Dec-98	59.3	3710	80
Jan-99	55.1	3277	98
Feb-99	57.2	2754	104
Mar-99	52.3	2461	106
Apr-99	89.9	5785	120
May-99	399	**58597**	140
Jun-99	**870**	**37865**	185
Jul-99	516	11684	564
Aug-99	535	20531	1160
Sep-99	198	7540	338
Oct-99	122	4581	183
Nov-99	98.1	6270	185
Dec-99	89.6	6335	175
Jan-00	74.3	4661	133
Feb-00	67.3	3448	103
Mar-00	64.2	2734	104
Apr-00	126	3637	204
May-00	462	***7961***	872
Jun-00	590	5995	558
Jul-00	273	1726	53
Aug-00	162	1577	120
Sep-00	136	1990	108
Oct-00	103	1816	84
Nov-00	76.0	2459	63
Dec-00	65.9	2736	57
Jan-01	63.4	2782	84
Feb-01	54.4	2180	70
Mar-01	51.5	1496	77
Apr-01	77.8	1678	124
May-01	376	6089	591
Jun-01	547	6598	439
Jul-01	361	3811	241
Aug-01	165	2667	156
Sep-01	130	2281	118
Oct-01	96.0	1906	86
Nov-01	67.0	2144	51
Dec-01	58.9	2310	44
Jan-02	49.2	2561	60
Feb-02	42.1	2083	46
Mar-02	38.7	1072	54
Apr-02	66.0	1541	79
May-02	138	1963	115
Jun-02	195	1823	158

CC-40	*(cfs)*	*Loadings (lbs/mo)*	
Mo-Year	***Flow***	***D-Zn #***	***D-Cu #***
Sep-98	166	6444	269
Oct-98	126	4892	178
Nov-98	81.9	5004	151
Dec-98	61.6	4174	123
Jan-99	50.8	3359	114
Feb-99	48.7	2847	109
Mar-99	53.0	3363	202
Apr-99	74.2	6292	336
May-99	329	***54283***	1426
Jun-99	945	***39518***	1791
Jul-99	598	15743	632
Aug-99	526	25445	1316
Sep-99	213	9991	495
Oct-99	125	6062	29
Nov-99	83.6	5084	203
Dec-99	62.6	4100	183
Jan-00	46.5	2778	126
Feb-00	53.5	2822	126
Mar-00	57.8	3589	181
Apr-00	106	5581	319
May-00	468	8285	875
Jun-00	581	5744	489
Jul-00	282	3442	55
Aug-00	157	1549	138
Sep-00	128	2289	135
Oct-00	86.3	1993	98
Nov-00	54.2	1902	69
Dec-00	48.6	2057	68
Jan-01	50.0	2357	88
Feb-01	46.2	2008	77
Mar-01	42.3	1790	73
Apr-01	59.4	2062	103
May-01	331	8214	533
Jun-01	540	6508	400
Jul-01	369	5175	252
Aug-01	193	3921	209
Sep-01	136	2931	147
Oct-01	104	2482	116
Nov-01	61.6	2166	74
Dec-01	32.7	1432	43
Jan-02	29.7	1503	39
Feb-02	30.9	1437	37
Mar-02	33.8	1278	57
Apr-02	65.3	2107	104
May-02	137	2031	128
Jun-02	215	2394	178

Source: **TDS Consulting Inc. (2004b); monthly/annual D-TMs load summaries, sites CC-40 and CC-60.**

Period of Record (POR): 10/94-9/04 *10 years (120 months); 42 pre-Argo vs. 78 post-Argo.*

CC-60:	***(cfs)***	***Loadings (lbs/mo)***	
Mo-Yr	***Flow***	***D-Zn #***	***D-Cu #***
Jul-02	86.7	579	72
Aug-02	59.3	385	49
Sep-02	48.2	580	44
Oct-02	51.5	857	52
Nov-02	36.8	1166	33
Dec-02	26.6	1049	24
Jan-03	28.0	1113	26
Feb-03	24.5	884	21
Mar-03	40.3	2115	57
Apr-03	131	6314	196
May-03	437	11898	687
Jun-03	887	12624	911
Jul-03	361	3204	127
Aug-03	156	1157	104
Sep-03	138	2197	127
Oct-03	106	2287	109
Nov-03	71.2	2532	60
Dec-03	65.1	2618	54
Jan-04	59.4	2515	41
Feb-04	58.4	2320	37
Mar-04	59.9	1887	80
Apr-04	92.6	2562	135
May-04	225	4365	441
Jun-04	325	3177	311
Jul-04	251	2959	224
Aug-04	144	2258	168
Sep-04	97.0	1577	95

CC-60	***Flow***	***D-Zn #***	***D-Cu #***
Pre-Argo	**240**	**8847**	**463**
#months	*42*	*42*	*42*
Pre-Argo, lbs/d		***295***	***15.4***
Post-Argo	**183**	**5112**	**198**
#months	*78*	*78*	*78*
Post-Argo, lbs/d		***170***	***6.60***

Check Loadings (use these values):

Pre-Argo Load sum	371571	19463
#days (1278), lbs/d	***291***	***15.2***
Post-Argo Load sum	398712	15441
#days (2375), lbs/d	***168***	***6.50***

CC-40	***(cfs)***	***Loadings (lbs/mo)***	
Mo-Year	***Flow***	***D-Zn #***	***D-Cu #***
Jul-02	103	1546	88
Aug-02	73.9	1257	73
Sep-02	61.3	754	58
Oct-02	57.6	1846	99
Nov-02	38.7	1551	64
Dec-02	29.6	1394	51
Jan-03	26.1	1414	38
Feb-03	25.8	1281	33
Mar-03	35.5	5317	102
Apr-03	85.2	9598	217
May-03	420	12832	681
Jun-03	912	13696	984
Jul-03	427	5080	293
Aug-03	186	2968	184
Sep-03	176	4741	234
Oct-03	103	3073	148
Nov-03	67.9	2959	101
Dec-03	47.2	2289	74
Jan-04	42.4	2305	72
Feb-04	42.6	2181	68
Mar-04	43.3	1894	75
Apr-04	67.4	2587	114
May-04	221	4654	390
Jun-04	345	3961	343
Jul-04	267	4272	233
Aug-04	141	3416	243
Sep-04	94.8	2494	122

CC-40	***Flow***	***D-Zn #***	***D-Cu #***
Pre-Argo	**248**	**10927**	**484**
#months	*42*	*42*	*42*
Pre-Argo, lbs/d		***364***	***16.1***
Post-Argo	**180**	**5602**	**263**
#months	*78*	*78*	*78*
Post-Argo, lbs/d		***187***	***8.75***

Check Loadings (use these values):

Pre-Argo Load sum	458951	20343
#days (1278), lbs/d	***359***	***15.9***
Post-Argo Load sum	436980	20481
#days (2375), lbs/d	***184***	***8.62***

Source: TDS Consulting Inc. (2004). *Note: 2004 TMs load addendum, completed for CCWF.*

Source: Adapted from Table 3-3, with input from R.L. Jones (oral commun., 2/11/05).

Overall Rank	Source Description	D-Cd Load lbs/d	Est. Load Reduction	D-Cu Load lbs/d	Est. Load Reduction	D-Zn Load lbs/d	Est. Load Reduction	Notes/assumptions: (include % removals)
Low Rank	**Area 1 -- West of Silver Plume (west to east)**				Stream Segment 1			*Not considered in Phase-I 319*
Table 2-2	Silver Plume Mine	n/a		n/a		n/a		
Table 2-2	Johnny Bull Mine	n/a		n/a		n/a		
RL	Silver Leaf	n/a		n/a		n/a		
Table 2-2	Terrible Mine	n/a		n/a		n/a		
RL	Smuggler	n/a		n/a		n/a		
RL	Seven Thirty	n/a		n/a		n/a		
RL	Mendota	n/a		n/a		n/a		
Moderate	**Area 2 -- Silver Plume Area (west to east)**				Stream Segment 2 (upper)			
Table 2-2	Burleigh Tunnel					20.91		*Estimated from 4 samples (Tasks 3/4 Table 2-2); confirm with Lewis (1997; 2003).*
Table 2-2	Diamond Mine							*No point-source data are known to exist.*
Table 2-2+	Ashby Tunnel	?		?		0.0008		*Estimated from 1 sample (Tasks 3/4 Table 2/2) -- add 12/93 TM load (Lewis, 2003).*
RL	Payrock							*No point-source data are known to exist.*
Unranked	**Area 3 -- South Fork Clear Creek/Leavenworth Creek**				Stream Segments 3a/3b			*Not addressed in this Phase-I 319*
USEPA	Waldorf Mine							
USFS	Dibbens Smelter							*Specify later in Phase II investigations.*
Low Rank	**Area 4 -- West Fork Clear Creek (near Empire)**				Stream Segment 5			*Not consider Henderson Mine*
Table 2-2	Lion Creek							*Estimated from 2 samples (Lewis, 1995) -- see Table 2-2 (Tasks 3/4).*
Table 2-2	Minnesota Mine (see previous)							*Estimated from 1 sample (CDPHE, 1995) - see Table 2-2 (Tasks 3/4).*
Table 2-2	Aorta Tunnel (Mine discharge)							*Estimated from 2 samples (USEPA, 1994; CDPHE, 1995) -- see Table 2-2 (Tasks 3/4).*
2T-HF	West Fork Clear Creek	0.83		4		43		*Tt-RMC (2004a, Table 4.3-17a)*
Moderate	**Area 5 -- Georgetown-to-Idaho Springs (incl. tributaries)**				Stream Segment 2 (lower) and 9b (Trail Creek)			
RL	Anglo Saxon	n/a		n/a		n/a		*No point-source data are known to exist.*
RL	Commonwealth	n/a		n/a		n/a		*No point-source data are known to exist.*
RL	Marshall Russell Tunnel	n/a		n/a		n/a		*No point-source data are known to exist.*
RL	Bellview Hudson	n/a		n/a		n/a		*No point-source data are known to exist.*
RL	Joe Reynolds	n/a		n/a		n/a		*No point-source data are known to exist.*
RL	American Sisters	n/a		n/a		n/a		*No point-source data are known to exist.*
RL	Nabob	n/a		n/a		n/a		*No point-source data are known to exist.*
13-LF	McClelland Tunnel	0.005		0.003		1.2		*Tt-RMC (2004a, Table 4.3-17b)*
Table 2-2								
11-LF	NPS, McClelland Tunnel area	0.010		-0.03		12.7		*Tt-RMC (2004a, Table 4.3-17b)*
14-LF	Rockford Tunnel	0.002		0.094		0.4		*Tt-RMC (2004a, Table 4.3-17b)*
Table 2-2	Alice Glory Hole (Fall River)							*CDMG remediation (not water)*
Table 2-2	Trail Creek - LF	0.029		0.74		7.5		*Limited CDPHE (& other) monitoring; added to 2005 program; using also 4 samples.*
Table 2-2	Trail Creek - HF	0.14		3.6		29.9		*Note: This Clear Creek tributary constitutes Stream Segment 9b.*
20-LF	NPS, CC downstream Trail Ck	0.000		0.01		1.0		*Tt-RMC (2004a, Table 4.3-17b)*
RL	Alma Dump							
9-LF	Big Five Tunnel	0.003		0.233		0.9		*Tt-RMC (2004a, Table 4.3-17b)*
16-LF	NPS, CC downstream Chicago	0.030		-0.12		-5.5		*Tt-RMC (2004a, Table 4.3-17b)*
High Rank	**Area 6 -- Virginia Canyon (groundwater/storm events)**				Stream Segment 2 (lower-part contributor)			2 Categories: (a) mines; (b) waste-rock piles.
2-LF	Virginia Canyon Groundwater	0.050		1.81		15.5		*Tt-RMC (2004a, Table 4.3-17b)*
Tasks 3/4	Virginia Canyon SW+GW, LF	0.05		4.9		17.3		*Lewis (2001; 2002a)*
Tasks 3/4	Virginia Canyon SW+GW, HF	0.09		1.63		9.11		*Lewis (2001; 2002a)*
#1	Williams and Rio Grande							*CDMG Site, Priority #1; see Tasks 3/4, Appendix B.*
#2	Crown Point & Virginia							*CDMG Site, Priority #1; see Tasks 3/4, Appendix B.*
#4	Castleton Mine							*CDMG Site, Priority #1; see Tasks 3/4, Appendix B.*
#9	Trio Tunnel							*CDMG Site, Priority #1; see Tasks 3/4, Appendix B.*
#13	Windsor Castle Shaft							*CDMG Site, Priority #1; see Tasks 3/4, Appendix B.*
#14	Upper Lake Tunnel							*CDMG Site, Priority #1; see Tasks 3/4, Appendix B.*
#15*	Two Brothers							*CDMG Site, Priority #1; see Tasks 3/4, Appendix B.*
#25*	Rattler Tunnel							*CDMG Site, Priority #1; see Tasks 3/4, Appendix B.*
#28*	Fopxhall Tunnel							*CDMG Site, Priority #1; see Tasks 3/4, Appendix B.*
#41	Brighton Mine							*CDMG Site, Priority #1; see Tasks 3/4, Appendix B.*
#42*	Bride Tunnel							*CDMG Site, Priority #1; see Tasks 3/4, Appendix B.*
#45	Inter Ocean Mine							*CDMG Site, Priority #1; see Tasks 3/4, Appendix B.*
#53	Casino Mine							*CDMG Site, Priority #1; see Tasks 3/4, Appendix B.*
#67	Doves Nest Mine							*CDMG Site, Priority #1; see Tasks 3/4, Appendix B.*
#108*	Little Emma Mine							*CDMG Site, Priority #1; see Tasks 3/4, Appendix B.*
#144	Inter Ocean Mine							*CDMG Site, Priority #1; see Tasks 3/4, Appendix B.*
#197*	Bald Eagle Mine							*CDMG Site, Priority #1; see Tasks 3/4, Appendix B.*
#12	Diamond Joe Mine							*CDMG Site, Priority #2; see Tasks 3/4, Appendix B.*

Source: Adapted from Table 3-3, with input from R.L. Jones (oral commun., 2/11/05).

Overall Rank	*Source Description*	*D-Cd Load lbs/d*	*Est. Load Reduction*	*D-Cu Load lbs/d*	*Est. Load Reduction*	*D-Zn Load lbs/d*	*Est. Load Reduction*	*Notes/assumptions: (include % removals)*
#62	Adit North of Bald Eagle							*CDMG Site, Priority #2; see Tasks 3/4, Appendix B.*
High Rank	**Area 7 -- North Fork Clear Creek (w/ tributaries)**				Stream Segment 13b			*Note: Listed upstream to downstream order.*
21-LF	NPS, Golden Gilpin area	0.0003		-0.00004		0.6		*Tt-RMC (2004a, Table 4.3-17b)*
10-LF	[redacted]	0.012		0.012		3.7		*Tt-RMC (2004a, Table 4.3-17b); Medine (2001, Table 9, #1/18); UCC-WAG (2001, Table 7,*
7-HF	Chase Gulch	0.0002		0.01		0.8		*Tt-RMC (2004a, Table 4.3-17a)*
	[redacted]							*Medine (2001, Table 9, #6/18), tributary of Chase Gulch; UCC-WAG (2001, Table 7)*
								Medine (2001, Table 9, #2/18), tributary of Chase Gulch; UCC-WAG (2001, Table 7)
								Medine (2001, Table 9, #5/18), tributary of Chase Gulch; UCC-WAG (2001, Table 7)
								Medine (2001, Table 9, #3/18), tributary of Chase Gulch; UCC-WAG (2001, Table 7)
1-LF	Gregory Incline	0.033		2.6		12.9		*Tt-RMC (2004a, Table 4.3-17b)*
5-HF	Gregory Incline	0.01		0.4		7.0		*Tt-RMC (2004a, Table 4.3-17a)*
24-LF	NPS, Gregory Incline area	-0.004		-0.33		-0.9		*Tt-RMC (2004a, Table 4.3-17b)*
4-LF	Quartz Hill Tunnel	0.026		1.6		5.5		*Tt-RMC (2004a, Table 4.3-17b)*
3-HF	Quartz Hill Tunnel	0.17		29		28		*Tt-RMC (2004a, Table 4.3-17a)*
3-LF	Gregory Gulch	0.033		0.5		3.9		*Tt-RMC (2004a, Table 4.3-17b)*
6-LF	NPS, Gregory Gulch area	0.010		0.005		2.2		*Tt-RMC (2004a, Table 4.3-17b)*
2-HF	[redacted]	2.49		59		386		*Tt-RMC (2004a, Table 4.3-17b); Medine (2001, Table 9, #4/18; UCC-WAG (2001, Table 7)*
23-LF	NPS, Black Hawk area	-0.010		-1.45		-2.5		*Tt-RMC (2004a, Table 4.3-17b)*
5-LF	National Tunnel	0.004		0.1		4.2		*Tt-RMC (2004a, Table 4.3-17b)*
4-HF	National Tunnel	0.04		4.7		13		*Tt-RMC (2004a, Table 4.3-17a)*
19-LF	BH/CCSD WWTP effluent	0.0006		0.049		0.3		*Tt-RMC (2004a, Table 4.3-17b)*
6-HF	BH/CCSD WWTP effluent	0.03		0.28		5.3		*Tt-RMC (2004a, Table 4.3-17a)*
8-LF	NPS, (old) WWTP area	0.032		0.06		3.1		*Tt-RMC (2004a, Table 4.3-17b)*
17-LF	East Williams Tunnel	0.002		0.006		0.2		*Tt-RMC (2004a, Table 4.3-17b)*
8-HF	East Williams Tunnel	0.00001		0.0001		0.03		*Tt-RMC (2004a, Table 4.3-17a)*
7-LF	NPS, Silver Gulch reach	0.006		0.103		1.6		*Tt-RMC (2004a, Table 4.3-17b)*
22-LF	NPS, downstream of Silver Ck	-0.030		-0.02		-9.7		*Tt-RMC (2004a, Table 4.3-17b)*
18-LF	NPS, Smith Hill Gulch area	0.021		-0.04		11.7		*Tt-RMC (2004a, Table 4.3-17b)*
12-LF	**Russell Gulch**	0.006		0.04		1.4		*Tt-RMC (2004a, Table 4.3-17b); Medine (2001, Table 9, #9/18); UCC-WAG (2001, Table 7,*
1-HF	Russell Gulch	5.92		250		886		*Tt-RMC (2004a, Table 4.3-17a)*
#31	New Brunswick Claim							*CWT Site Priority #1*
#35@	Hampton Claim (@ Priority 2)							*CWT Site Priority #1*
#36	Tiger Claim							*CWT Site Priority #1*
#37	Meeker Claim (1)							*CWT Site Priority #1*
#42	Martin Claim							*CWT Site Priority #1*
#6	Lillian #3 Percent							*CWT Site Priority #1*
#16	Niagara Claim&							*CWT Site Priority #1*
#17	Not on a Claim							*CWT Site Priority #1*
#19	Lotus Claim							*CWT Site Priority #1*
#20	West Saratoga							*CWT Site Priority #1*
#21	Church Placer Claim							*CWT Site Priority #1*
#33	Golden Claim							*CWT Site Priority #1*
#34	Powers Claim							*CWT Site Priority #1*
#38	Meeker Claim (2)							*CWT Site Priority #1*
#39	Little Raven Claim							*CWT Site Priority #1*
#40	Alva Adams Claim							*CWT Site Priority #1*
#41	Golden Claim							*CWT Site Priority #1*
16-LF	NPS, Russell Gulch area	-0.029		0.035		-14.0		*Tt-RMC (2004a, Table 4.3-17b)*
25-LF	NPS, Bates Gulch area	-0.024		-0.05		-4.6		*Tt-RMC (2004a, Table 4.3-17b)*
17-HF	North Fork Clear Creek	4.11		40		766		*Tt-RMC (2004a, Table 4.3-17a) [overall total]*
Unranked	**Area 8 -- Other/Miscellaneous Sources**							
	TMs-treatment sludge repository							

Notes: LF = low flow; HF = high flow. *Where no distinction is made, assume HF = LF for purposes of this preliminary assessment.*
LF assumed to apply to 7-month period: October through April.
HF assumed to apply to 5-month period: May through September.

Appendix D – NPS Reductions and Controls *[R.L. Notes, Task 7b, in preparation? See guidance from TDS dated 2/17/05. No information nor deliverable has been received to date.]*

Appendix E

Integrated Total Maximum Daily Load (TMDL) Assessment for the Upper Clear Creek Watershed, Selected Impaired Stream Segments Clear Creek and Gilpin Counties, Colorado

Conceptual TMDL Document – September 27, 2005 [revised final]

TMDL Areal Coverage	Entire Upper Clear Creek Watershed
State (CDPHE) Watershed/WBIDs	COSPCL02, 05, 09a, 09b, 11, and 13b
Relevant Stream Segments	2, 5, 9a, 9b, 11, and 13b
Water-Quality Variables Addressed	Dissolved Cadmium, Copper, and/or Zinc
Use Classification/Designation	Varies by Stream Segment (see below)
Water-Quality Targets	Varies by Stream Segment (see below)
TMDL Goal	Attain/Maintain Aquatic Life Classifications

EXECUTIVE SUMMARY

The upper Clear Creek watershed is a medium-sized watershed, located completely within the U.S. Geological Survey's hydrologic unit code 10190004 and is west of the Denver metropolitan area, Colorado. Clear Creek is tributary to the South Platte River, and several of the watershed's stream segments are included on the most recent (2004; 2006 draft) 303(d) lists for impaired water quality. These stream segments are the subject of this holistic-watershed total maximum daily load (TMDL) assessment. The listings for each segment include one or more trace metals, concentrations of which impair each segment's cold-water Class I aquatic-life classification. A draft TMDL for this watershed's stream segment 2 (CDPHE, 2002) was prepared but has not been finalized.

The purpose of this "conceptual" TMDL is to provide CDPHE-WQCD and UCCWA stakeholders with a technical framework from which to develop the necessary TMDL assessment(s) for listed stream segments in the upper Clear Creek watershed. The ***Upper Clear Creek Watershed Plan*** includes much of the data compilation and statistical/graphical analyses, source-loadings inventories, and loads-reductions estimates needed for this TMDL effort. Subsequent TMDL-assessment investigations thus will benefit from this document as well as the ***Upper Clear Creek Watershed Plan***.

I. INTRODUCTION

Section 303(d) of the Federal Clean Water Act requires states to develop total maximum daily loads (TMDLs) for waters at levels necessary to achieve and to maintain assigned water-quality standards. TMDLs involve calculations of the amount of pollutants that a waterbody can receive, yet continue to attain water-quality standards.

A TMDL is the sum of three components: (1) a waste load allocation (WLA), the part of the pollutant load associated with point-source discharges; (2) the load allocation (LA), the part of the pollutant load attributed to natural background and/or non-point sources;

and (3) a margin of safety (MOS). Any given TMDL also may include an allocation reserved to accommodate future growth or economic-development changes in the watershed.

The TMDL may be expressed as:

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

TMDL development is required for any pollutant that exceeds the assigned numeric standard within a waterbody, in this case, any designated stream segment of a watershed. Stream segments that are in non-attainment of stream standards are considered to be impaired and are identified on Colorado's 303(d) List of Impaired Waters. TMDLs that address impaired segments identify the allowable (allocated) pollutant load that should result in the attainment of a given stream standard associated with that pollutant. Stream segments of the upper Clear Creek watershed that are included on the 2006 "For Sure" Colorado 303(d) list for non-attainment of trace metals and associated aquatic life-standards include:

2 – mainstem Clear Creek between Silver Plume and Idaho Springs (Argo),
9a – Fall River,
9b – Trail Creek,
11 – mainstem Clear Creek between the Argo discharge and the Farmers Highline Canal diversion near Golden, and
13b – North Fork Clear Creek between the Black Hawk water intake and its confluence with Clear Creek

[Note: Stream segments 3a and 3b are not included in the current watershed plan.]

Stream segment 5 (West Fork Clear Creek between the confluence with Woods Creek and its confluence with Clear Creek) also was on Colorado's 2002 303(d) list but was "de-listed" by the USEPA for zinc, upon the recommendation of the CDPHE-WQCC and approval by the USEPA (2005). It is still listed for copper (Cu) (CDPHE, 2004). Despite its change in status, it is considered in the ***Upper Clear Creek Watershed Plan***. It is recommended that this conceptual TMDL consider these designated stream segments and the linkages between water-quality conditions and necessary loads reductions inherent between upstream and downstream stream segments.

II. GEOGRAPHICAL EXTENT

The upper Clear Creek watershed includes the following towns: Silver Plume, Georgetown, Berthoud, Empire, Lawson/Dumont, Idaho Springs, and Central City/Black Hawk. Streams in the watershed or associated alluvial groundwaters supply drinking water to nearly 400,000 residents within the watershed and in the Denver metropolitan area, as well as water for several industries. A major transportation route, I-70, transects the watershed. The Loveland ski area is located at the headwaters of Clear Creek. During seasonal high streamflows, rafting of the mainstem Clear Creek is an important recreational activity, along with fishing during seasonally higher flows.

Although 80-percent owned by the U.S. Government (principally, the U.S. Forest Service), the watershed has been impacted by a large number of minerals-exploration pits, mine workings (shafts and waste-rock piles), and mills (several with associated tailings). The only major molybdenum mine currently operating within the watershed is the Henderson Mine owned and operated by Climax Molybdenum Company, a subsidiary of the Phelps Dodge Corporation.

The upper part of the Clear Creek watershed is upstream from a long-term USGS located on Clear Creek near the City of Golden (USGS gage 06719505 Clear Creek at Golden). At this streamflow gage, the drainage area of the upper watershed is 400 square miles, including the following major tributaries: South Fork Clear Creek, West Fork Clear Creek, Fall River, Chicago Creek, and North Fork Clear Creek. There are also a number of minor tributaries. Stream segments included in the upper Clear Creek watershed are 1 through 13; stream segments 3, 9, and 13 are separated into 3a/3b, 9a/9b, and 13a/13b, respectively. This conceptual TMDL addresses impairment in terms of listed trace metals for stream segments 2, 5, 9a, 9b, 11, and 13b (Figure E-1).

III. WATER-QUALITY STANDARDS

Three categories of water-quality standards should be considered: (1) currently applicable standards, including several temporary modifications (so-called "temp mods"); (2) ultimate underlying standards; and (3) a site-specific standard for zinc that currently applies to West Fork Clear Creek (stream segment 5). This latter standard, resulting in a zinc target level in between the applicable standards and underlying standards, is judged protective of the aquatic-life standards for that stream segment and possibly for other stream segments in the watershed.

An important concept developed in the ***Upper Clear Creek Watershed Plan*** is the recommended use of seasonal WQ standards. Specifically, the watershed's streams indicate WQ characteristics during a 5-month high-flow season (months of May through September) that are substantially distinct from a 7-month low-flow season (months of October through April). The seasonal nature and year-to-year variability of streamflows throughout the watershed are indicated by period-of-record monthly streamflows at selected USGS streamflow gages (Figure E-1).

IV. PROBLEM IDENTIFICATION

Aquatic-life impairment of stream segment 2 was the focus of a draft TMDL (CDPHE, 2002; Woodling and others, 1998; Woodling and Ketterlin, 2002). The listed trace metals associated with the 2004 CDPHE 303(d) list are the focus of the ***Upper Clear Creek Watershed Plan*** associated with this appendix (see Table 1-1). The various trace metals of concern vary with stream segment. The seasonal stream water-quality standards involve three critical trace metals: cadmium, copper, and zinc. *[Note: Other trace metals, specifically lead and manganese, are involved in the newly designated stream segment 9a (Trail Creek) but are not addressed in the current Watershed Plan.]*

For this conceptual TMDL assessment, the interrelationship between various stream segments is a critical aspect. In particular, upstream load reductions will benefit downstream stream segments; this is important in setting trace-metals-load allocations.

V. WATER-QUALITY GOALS

Three levels of water-quality goals have been addressed in the current ***Upper Clear Creek Watershed Plan*** (see Table 1-3):

- Applicable (current) stream standards, often involving temporary modification Type-iii trace-metals standards or ambient-based standards;
- Underlying stream standards, involving seasonal hardness-based table-value-standards calculations; and
- A possible application of a negotiated zinc-adjusted table-value standard (resulting in de-listing of this trace metal) for the lower reach of West Fork Clear Creek (stream segment 5) to other stream segments in the watershed.

Segment-by-segment trace-metals load reductions have been estimated, based upon available data and information regarding a number of remediation projects (completed, ongoing, or planned) (see Section 3 and associated Table 3-6). Using dissolved-zinc as an indicator variable, the quantity of Zn still needed to be removed (besides ongoing and planned remediation projects) has been estimated for critical stream segments in the upper Clear Creek watershed (see Table 4-8).

VI. INSTREAM CONDITIONS

Streamflow and associated trace-metals-quality conditions have been evaluated in considerable detail in a recent trace-metals data assessment (TDS Consulting Inc., 2004) and the Upper Clear Creek Watershed Plan (TDS Consulting Inc., 2005). In general, water-quality sampling surveys have been conducted systematically (bimonthly during low flows; monthly during high flows) since February 1994, and a USGS streamflow-gaging program was implemented starting in October 1994. Over time, changes in monitoring sites have occurred: Beginning in 2005, a reduction in the WQ monitoring program occurred (generally, discontinuing all but single high-flow/low-flow sampling surveys during May and October). For the trace-metals component in this latter case, sampling surveys for 12 sites in the watershed continued for the eight-survey schedule and was supported by the USEPA for analytical services (since February 2005) and field-sampling support (since July 2005).

Based upon the past ten years of streamflow records at several gages operating on streams in the watershed, the following observations are useful:

1. The 1995-water year streamflows were the highest for the period of record at most of the stream gages.
2. The 2002-water year streamflows were the lowest for the ten-year period of record; 2004-water year streamflows were the second lowest.

3. Approximately 84 percent of the flow volume in the watershed's streams occurs during the five-month high-flow period, with the remaining (16 percent) occurring during the seven-month low-flow period.

Based upon 14 years of trace-metals records, the following are noteworthy:

1. Trace-metals concentrations in part are affected by streamflows, with relatively high concentrations occurring during the 1995 water year and lower concentrations noted during recent years (since 2000). Concentrations also in part are positively impacted by recent remedial reclamation and water-treatment programs.
2. Trace-metals concentrations at downstream sites in the watershed have benefited from remedial activities, especially with regard to the Argo treatment facility (since 4/98) reducing trace-metals loads discharging into the mainstem Clear Creek.
3. Seasonal variations in hardness vary inversely with seasonal streamflows; that is, hardness concentrations are lower during higher flows and are higher during low flows (see Appendix Figures A-1 and A-2).
4. Within any given stream segment, hardness and trace-metals concentrations may vary greatly at different monitoring sites along the segment. For trace metals, this is indicated by the following two examples:
    a. For stream segment 2, where the upper part exhibits higher dissolved-zinc concentrations that are reduced (diluted) primarily by flows from West Fork Clear Creek. Also, stream segment 2 exhibits gradually increasing dissolved-copper concentrations along this mainstem Clear Creek segment, caused by copper-contributing sources especially downstream from the West Fork Clear Creek confluence (TDS Consulting Inc., 2002, Figure 47).
    b. Trace metals concentrations are higher in the mid-part of stream segment 13a, due to mining-related sources (TDS Consulting Inc., 2002, Figure 48).

VII. WATER SUPPLIES, TREATMENT, AND CONTAMINANT SOURCES

This section provides information regarding permitted public water supplies in the watershed, permitted point-source discharges (wastewater treatment plants), and generally aspects of mine-related activities impacting water quality.

Permitted Public-Water Supplies

Public-Water Supply Entity *	ID No.	Stream Segment
Loveland Basin/Valley Ski Area	210015/6	1, headwaters of Clear Creek
Town of Silver Plume	110035	1, headwaters of Clear Creek
Town of Georgetown	110015	2, upper mainstem Clear Creek
Climax – Henderson Mine	210001	?, tributary of West Fork Clear Creek
Town of Empire	110010	5, West Fork Clear Creek *(check?)*
Mill Creek Park WIA	210017	2, upper mainstem Clear Creek

Town of Idaho Springs	110020	2, tributary to mainstem Clear Creek
City of Central	124171	13a, tributary to upper NFCC (?)
Town of Black Hawk	124147	13a, NFCC; 11, lower Clear Creek
Lookout Mountain Water District	110026	11, tributary of lower Clear Creek
City of Golden	130040	11, lower mainstem Clear Creek
Molson-Coors Brewing Company	230020	11, lower mainstem Clear Creek

*Source: Gary Karst, CDPHE-WQCD, written commun., 8/18/05. * Several others are not listed.*

Permitted Point-Source Discharges

Facility Permit Name	CDPS Permit No.	Facility Owner	Stream Segment
Clear Creek Skiing Corporation WWTP	CO-0040835	Clear Creek Ski Corp.	1, headwaters of mainstem Clear Creek
Eisenhower Tunnel WWTP	CO-0026069	Colorado Department of Transportation	1, headwaters of mainstem Clear Creek
Georgetown WWTP	CO-0027961	Town of Georgetown	2, upper mainstem Clear Creek
Henderson Mine WWTP	CO-0041467	Climax Molybdenum Corp., a subsidiary of Phelps Dodge	7, upper West Fork Clear Creek
Empire WWTP	COG-584065	Town of Empire	5, lower West Fork Clear Creek
Central Clear Creek SD WWTP	COG-584055	Central Clear Creek Sanitation District	2, upper mainstem Clear Creek
St. Marys WWTP	CO-0023094	AAA (operator); Frederick Huff, Attorney	9a, Fall River
Shwayder Camp WWTF	COG-588009	Shwayder Camp, Zim S.A. Zimmerman, Director	2, tributary to upper mainstem Clear Creek
Idaho Springs WWTP	CO-0041068	Town of Idaho Springs	11, lower mainstem Clear Creek
Clear Creek High School WWTP	CO-0046574	Clear Creek County School District	11, tributary to lower mainstem Clear Creek
BHCCSD WWTP (new facility)	CO-0046761	Black Hawk/Central City Sanitation District	13b, North Fork Clear Creek

Source: Bill McKee, CDPHE-WQCD, written commun., 8/2/05.

Non-Point Sources

Most of the trace-metals loading into streams of the upper Clear Creek watershed are from historical mining-related activities that have been inventoried and are listed in the ***Upper Clear Creek Watershed Plan*** (Table 3-2, Appendix B, and Appendix Table C-2). For categorization purposes, trace-metals contributions from mine-related waste-rock piles and mill tailings are considered non-point sources.

VIII. TECHNICAL ANALYSIS

Even though the highest trace-metals loads occur during times of seasonal high flows, the most critical time related to instream dissolved-trace-metals concentrations is typically during low-flow conditions in the winter and early spring (CDPHE, 2002). This latter period is when there is the least water available for dilution of acid-mine drainage and contaminated groundwater trace-metals loads.

Attainment of applicable, underlying, or other numeric standards and the associated control of general trace-metals loads during low-dilution seasons is the key towards achieving acceptable instream dissolved-trace-metals concentration. This conceptual TMDL assessment is intended to characterize the gross trace-metals-loads reductions needed to attain dissolved-cadmium, -copper, and -zinc standards (as appropriate, for a given stream segment) during critical low-flow conditions and to apportion that necessary reduction among the various contributing point and non-point source components.

Point-Source Contributions

In order to assess the impact of point-source dischargers to instream dissolved-trace-metals levels, critical discharge conditions for these point sources should be designated. Available dissolved-trace-metals data for the various wastewater-treatment facilities in the upper Clear Creek watershed are limited (see TDS Consulting Inc., 2002b). Detailed facility-effluent data covering both pre-operational and post-operational periods are available for the Argo treatment facility (TDS Consulting Inc., 2005, Figure 3-1).

Non-Point Source Contributions

Remediation activities relating to non-point source contributions may include, but not be limited to, the following (CDPHE, 2002):

1. Capping or other remediation actions or best-management practice controls involving mine-related waste-rock piles.
2. Residential well assessment and alternative drinking-water supplies.
3. Passive (wetlands) treatment, such as tested for the Burleigh Tunnel.
4. Collection of NPSs and trace-metals-impacted groundwater resources in the Idaho Springs (and possibly upstream) area for treatment and trace-metals removal.

Antidegradation Requirements

Many stream segments (stream segments 5, 7, 8, 11, 12, and 13b) in the upper Clear Creek watershed are designated as use-protected or "non-reviewable" waters. For the other stream segments (1 through 4, 9a and 9b, 10, and 13a), antigradation requirements may be applicable for the formulation of point-source effluent-discharge limits. However, several of these latter stream segments have no existing wastewater discharges.

IX. TMDL ALLOCATIONS BY STREAM SEGMENT

Waste-Load Allocations

For the relevant trace metals of concern in a given segment, the estimated ongoing/planned load reductions have been estimated on a stream segment-by-segment basis. Next, comparisons are made using these load reductions to assess whether or not the various target levels are achieved in terms of applicable, underlying, or other water-quality stream standards. Finally, in terms of zinc as an indicator trace metal, the additional load reduction needed to meet specific water-quality standards targets is assessed, in the case that the most stringent standard is not met with only the ongoing/planned remediation work. All aspects of these three parts of the WLA process have been extracted from the appropriate parts of the ***Upper Clear Creek Watershed Plan***.

The estimated trace-metals load reductions for key input components are indicated in Table 4-1, with the two major, and high-priority, subareas with anticipated significant trace-metals load reductions being: (1) Virginia Canyon (ongoing), and (2) OU4 water treatment (planned). In addition, planned zinc load reduction in the Silver Plume area results in comparably lower zinc levels in stream segment 2 (Table 4-1). The non-point source and sediment controls for North Fork Clear Creek (stream segment 13b) are small (2 percent in each case) relative to the relative load reductions expected to be achieved through water treatment. The zinc-load reduction in stream segment 11 (lower mainstem Clear Creek) reflects the remediation projects anticipated for upstream stream segments 2 and 13a (Table 3-6).

The ability of potential trace-metals loads reductions to fulfill the applicable or underlying water-quality standards targets is summarized in the ***Upper Clear Creek Watershed Plan*** (Table 4-7), which was based upon a detailed and prioritized inventory of potential and existing sources (Section 3). In the North Fork Clear Creek subwatershed, a series of WASP4-META4 model applications was conducted by Dr. A.J. Medine, under contract with the USEPA (UCC-WAG, 2001, Appendix B; TDS Consulting Inc., 2005, pp. 4-5 through 4-7). For the four highest-priority areas within the entire watershed, the following trace-metals reductions are anticipated (TDS Consulting Inc., 2005, Table 3-6):

1. Area 6 – Virginia Canyon (high priority), directly affecting the lower part of stream segment 2. Estimated TMs-loads reductions for the low-flow season are: 8 percent for cadmium, 56 percent for copper, and 16 percent for zinc.
2. Area 7 – North Fork Clear Creek (high priority), directly affecting stream segment 13b. Estimated trace-metals-loads reductions for the low-flow season associated with water-treatment remediation activities for Gregory Incline, Gregory Gulch, and the National Tunnel are: 29 percent for cadmium, 51 percent for copper, and 19 percent for zinc. A second categorical area of the North Fork Clear Creek subwatershed, the Russell Gulch area, has been delineated for remediation, principally through

sediment controls. For Russell Gulch, estimated trace-metals-loads reductions for the low-flow season are 2 percent for each trace metal of concern (cadmium, copper, and zinc). These are substantially less effective than the water-treatment remediation activities recommended for Gregory Incline, Gregory Gulch, and the National Tunnel.

3. Area 2 – Silver Plume area (moderate priority), directly affecting the upper part of stream segment 2. Estimated trace-metals-loads reductions for the low-flow season are: 4 percent for cadmium, 0 percent for copper (low concentration/load), and 19 percent for zinc.
4. Area 5 – Georgetown-to-Idaho Springs area (moderate priority), directly affecting most of stream segment 2. Estimated trace-metals-loads reductions for the low-flow season are: 1 percent for cadmium, 9 percent for copper, and 2 percent for zinc. These estimates are exclusive of the reductions envisioned for other areas affecting this stream segment (see above).
5. Stream segment 11 – The cumulative downstream trace-metals-loads reductions affect this mainstem Clear Creek stream segment rather than any area-specific remediation activities proposed for this part of the watershed. Given this rationale, the cumulative estimated trace-metals-loads reductions for the low-flow season are: 75 percent for cadmium, 81 percent for copper, and 33 percent for zinc (Table 3-6).

Given these anticipated (estimated) trace-metals-load reductions, the attainment of applicable and underlying TMs stream standards are summarized in Tables 4-5 and 4-6 of the ***Upper Clear Creek Watershed Plan***. Attainment vs. non-attainment conditions is summarized as follows:

Table E-1 – Summary of Ability of Potential Trace-Metals Loads Reductions to Attain Applicable Stream Standards (Temporary Mods) and Underlying Targets (Table-Value Standards or Site-Specific Standards)[1]

Stream Segment	*Low Flow/High Flow Condition*	*Attainment of D-Cd Standard*	*Attainment of D-Cu Standard*	*Attainment of D-Zn Standard*
2	LF Temp Mod	—[2]	Yes, 4.2/8.1	[redacted]
	LF US[3]	—	Yes, 4.2/7.9	[redacted]
9a	[redacted]	--	[redacted]	--
	[redacted]	--	[redacted]	--
9b	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]
13b	LF Temp Mod	Yes, 4.6/6.0	Yes, 33.4/64.0	Yes, 1548/1864
	LF US	[redacted]	[redacted]	[redacted]
11	LF Temp Mod	--	--	Yes, 323/339
	LF US	--	--	[redacted]

1 Extracted from Tables 4-5 and 4-6 of the Upper Clear Creek Watershed Plan.
2 -- = No comparison with stream standard applies (not applicable), because it is judged attainable.
3 US = underlying (former/ultimate, equation-based) standard/target (see Table 1-3). *[Note: These often are site-specific.]*
4 D-Cd, dissolved cadmium; D-Cu, dissolved copper; and D-Zn, dissolved zinc.

The non-attainment situation for stream segment 2 tributaries designated as separate stream segments (9a -- Fall River; 9b -- Trail Creek) have not been considered further in this Watershed-Plan assessment for the following reasons:

1. No remediation projects are currently proposed for these subareas.
2. In the case of Trail Creek, the stream standards as well as data for computing table-value standards and 85th percentiles are based upon a single 12-month period of data only.
3. No high-flow exceedances are noted for any of the currently applicable trace-metals stream standards (TDS Consulting Inc., 2005, Table 1-3). *[Note: This commonly is not the conclusion for underlying standards.]*

If attainment of underlying stream standards for stream segments 2, 13b, and 11 are addressed in some future evaluation, then these tributary high-flow non-attainment conditions need to be considered.

The final step in this aspect of the TMDL assessment is to estimate the additional trace-metals-loads reduction needed to fulfill attainment of specified water-quality standards targets (applicable, underlying, or other stream standards). This is assessed using zinc as an indicator trace-metal variable. The additional zinc-load reductions needed to achieve the various zinc targets are calculated as given in Table 4-8 of the ***Upper Clear Creek Watershed Plan***. Consideration of the site-specific dissolved-zinc chronic standard developed for West Fork Clear Creek (accepted by CDPHE-WQCC and USEPA) was included, assuming that it would be applicable for other stream segments in the upper Clear Creek watershed.

It may be beneficial to make this "incremental" additional load-reduction assessment in reverse order (from downstream to upstream). For stream segment 11's applicable dissolved-zinc stream standard, the anticipated load reduction (32.6 percent) results in a concentration of 323 ug/L, which is below the temporary-modification standard target of 339 ug/L. However, to attain the underlying (TVS) zinc standard of 124 ug/L, another 38.5 lbs/d Zn would have to be removed during the low-flow season. To attain the West Fork Clear Creek-accepted zinc standard (229 ug/L, using a hardness average of 106 mg/L), less than half this additional removal of zinc load (18.2 lbs/d) would have to be removed.

For stream segment 13b, the anticipated dissolved-zinc load reduction (18.8 percent, resulting in a modified concentration of 1548 ug/L) attains the zinc temp mod of 1864 ug/L but is not sufficient for attaining the other two, more stringent targets (underlying: 221 ug/L or West Fork Clear Creek: 405 ug/L, based upon an average hardness of 210 mg/L). For attainment of these during the low-flow season, additional zinc loads would have to be removed: 32.5 lbs/d or 28.2 lbs/d, respectively. In comparing these loads removal with those needed to attain targets for SS 11, it is apparent that this removal is nearly sufficient (84 percent of what is needed) to attain the underlying stream standard and is more than sufficient to achieve the West Fork Clear Creek-equivalent stream standard. If more stringent targets for North Fork Clear Creek are met, then the additional zinc load reduction downstream in stream segment 11 would be considerably less (only 6.0 lbs/d) to attain the ultimate stream standard.

In order to attain the applicable stream standard (257 ug/L) for stream segment 2, the zinc load reduction during the low-flow season needs to increase from the currently estimated 16.1 percent to 29.2 percent. To achieve the more stringent standards, 55.5 lbs/d more dissolved-zinc load would need to be removed to attain the ultimate stream standard of 103 ug/L, and 31.3 lbs/d would need to be removed to attain the equivalent West Fork Clear Creek stream standard of 191 ug/L at an average low-flow hardness concentration of 85.8 mg/L. Attainment of any of these targets would eliminate the need for zinc-loads reduction in downstream stream segment 11. All stream segment 11 stream-standards targets theoretically could be met through upsteam remediation and resultant zinc-loads removals at the levels indicated for stream segment 2 to attain this segment's stream standards.

Margin of Safety

The margin of safety for protection of the previous dissolved trace-metals stream standards is inherent in the conservative levels determined for the waste-load allocation for each discharge. In calculating planned trace-metals loads reductions, a margin-of-safety factor was included (see Table 3-6) to add some degree of conservatism. For the low-flow stream-segments cases, this factor was assumed to be 40 percent for all trace metals. In other words, for each total load reduction, 40 percent of each estimated trace-metal load was assumed not to actually be removed but would remain as a stream input. Follow-up monitoring that will indicate whether or not the recommended controls are protective of aquatic-life use.

These proposed waste-load allocations should give ample protection for the impaired stream segments of the upper Clear Creek watershed and yet allow for discharges or changes in upstream D-TMs loads. The waste-load allocations assigned to key tributaries of the mainstem Clear Creek steam segments (2 and 11) also should be protective. The actual trace-metals-loads levels from certain tributaries (namely, North Fork Clear Creek and Virginia Canyon over the near term; Trail Creek over the long term) may be reduced even further as the appropriate remediation projects proceed towards implementation.

X. PUBLIC INVOLVEMENT

Stakeholder involvement constitutes an essential element of the so-called "watershed-protection approach" (CCWF, 1993, Fact Sheet, 2 p.). Accordingly, comments on the ***Upper Clear Creek Watershed Plan*** were solicited from Clear Creek Watershed Forum 2005 participants and are summarized in the Plan. Public participation and community involvement for any TMDL assessments in the upper Clear Creek watershed should incorporate the identified stakeholders active in the Upper Clear Creek Watershed Association (UCCWA) as well as the Clear Creek Watershed Forum (CCWF).

During the 1994-2001 period, the Upper Clear Creek Watershed Advisory Group (UCC-WAG, 2001) was instrumental in advising the various regulatory agencies on local interests, priorities, and opinions regarding mining-related remediation needs throughout the watershed. Through a series of USEPA TAG-funded grants over this period, UCC-WAG members and technical staff held meetings with watershed stakeholders, completed a series of newsletters and fact sheets, and prepared a final report summarizing its findings over its period of work and support activities. This effort was useful in the later-completed OU4 RI/FS project, culminating in a recent record of decision (ROD) (USEPA and CDPHE, 2004) for this final CERCLA (Superfund) remedial effort in the watershed.

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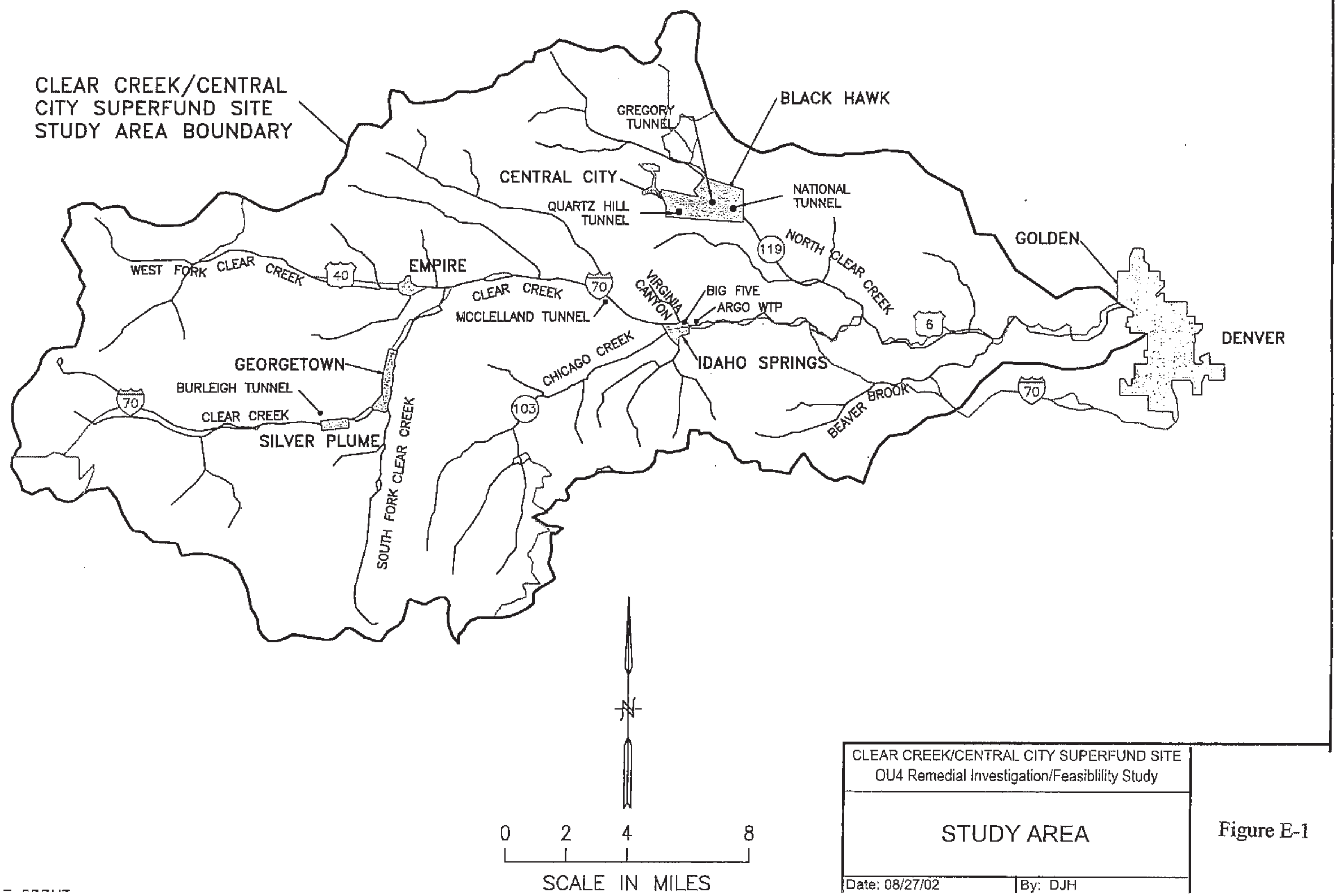

CLEAR CREEK/CENTRAL CITY SUPERFUND SITE
OU4 Remedial Investigation/Feasiblility Study

STUDY AREA

Date: 08/27/02 | By: DJH

Figure E-1

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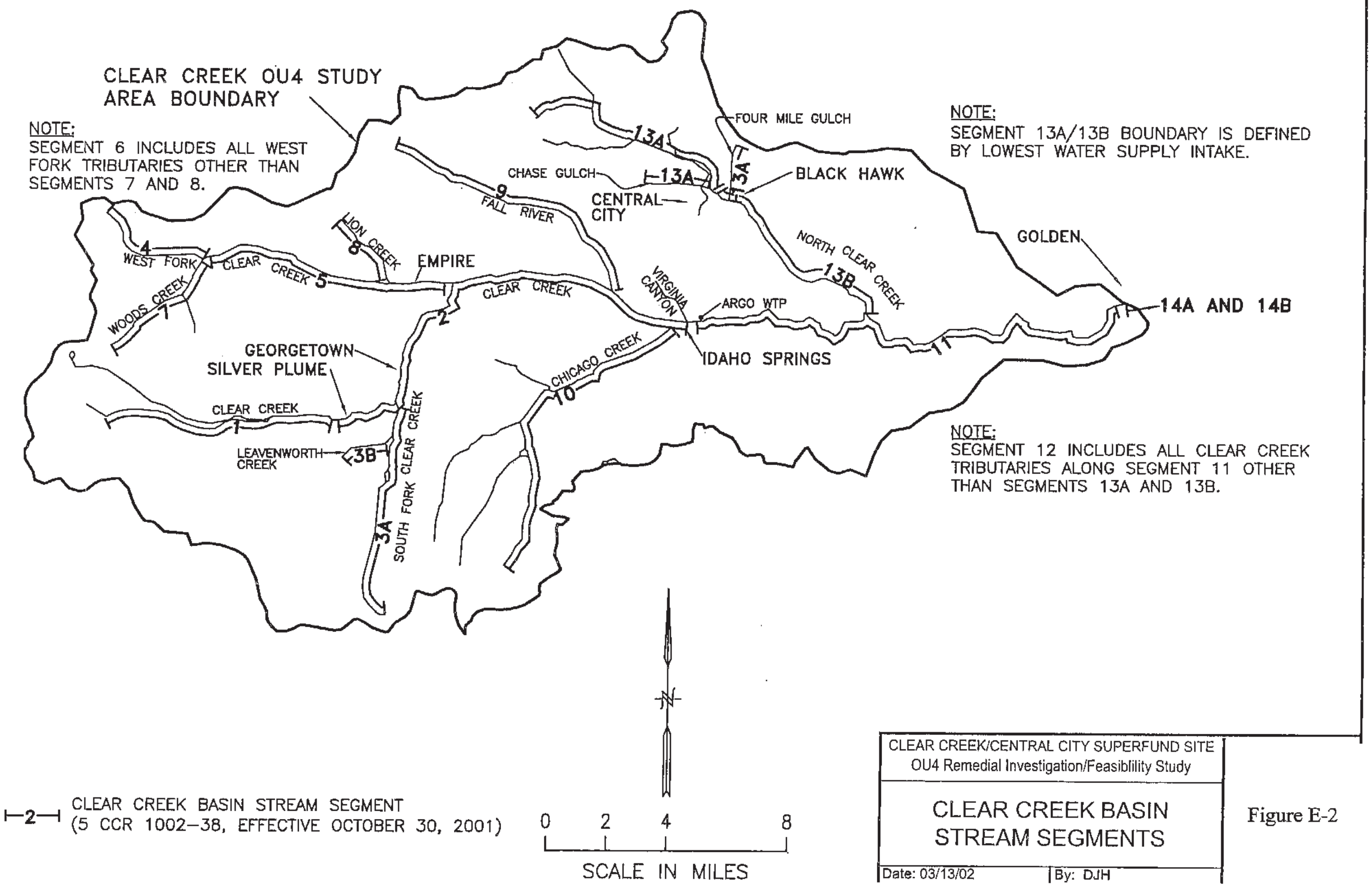

CLEAR CREEK/CENTRAL CITY SUPERFUND SITE
OU4 Remedial Investigation/Feasibility Study

CLEAR CREEK BASIN STREAM SEGMENTS

Date: 03/13/02 | By: DJH

Figure E-2

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Technical Memorandum

Date:	May 11, 2006	
To:	Anne Beierle, UCCWA Chair Ed Rapp, CCWF President	e-Mail: abeierle@ci.golden.co.us e-Mail: ccwfountation@clearcreekwireless.com
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From:	Tim Steele, TDS Consulting Inc.	
Subject:	**Upper Clear Creek Watershed Plan • September 2005** ***(Revision 2)*** ***2006 Addendum – Remedial Action Priorities***	

This Addendum to the **Upper Clear Creek Watershed Plan** highlights the importance of several near-term, high-priority mining-related nonpoint source (NPS) remediation projects. The implementation of these projects is intended to achieve attainment of current as well as ultimate water-quality standards (targets) by the year 2012. The **Watershed Plan** provides a detailed inventory of known NPSs as well as some estimate of associated trace-metals loadings. These aspects, along with comparison with current and ultimate stream standards, serve as the basis for prioritizing remediation projects as well as for estimating anticipated benefits of remediation for achieving loads reductions for those contaminants of concern included on the current 303(d) list of impaired stream segments. Related work is currently ongoing for various projects identified in the OU4 RI/FS in the North Fork Clear Creek subwatershed by the CDPHE (2006) and this critical, high priority remediation is incorporated herein by reference.

The remedial-action priorities being considered for the near-term in this Addendum focus on trace-metals loads reductions that benefit the attainment goals (water-quality stream standards) for the lower reach of stream segment 2 (mainstem Clear Creek downstream from West Fork Clear Creek) and all of segment 11 in the upper Clear Creek watershed. It is our belief that implementation of high-priority NPS projects will result in attainment of water-quality goals in these segments and that this might be achieved through priority actions (both Superfund OU4 and 319-grant projects) by the year 2012.

Although applicable stream standards are set for year-round conditions, the **Plan** also discusses potential future modifications to the standards for discrete high-flow and low-flow seasons of the year for streams in this watershed. This, however, does not affect the overall intent of attainment of water-quality targets through remediation as described in the **Plan**. The linkages between stream segments should be recognized; specifically, load reductions through remedial actions benefiting upstream stream segments also will benefit stream segments that are directly downstream.

Accordingly, five projects are described in some detail in this Addendum that should facilitate achieving this attainment goal in the main stem of Clear Creek. These have been designated in currently proposed or planned projects and involve the following mines, subwatersheds, or areas:

1. Gilson Gulch Subwatershed,
2. Castleton Mine Dump (upper Virginia Canyon),
3. Trail Creek Subwatershed,
4. Maude Monroe and Donna Juanita Mines, and
5. North Empire Creek Subwatershed.

The **Watershed Plan's** screening process results (see **Plan** pp. 3-4 through 3-6) delineated and discussed in detail two high-rank and two moderate-rank priority areas recommended for near-term remedial actions. As noted above and in the **Plan**, the current ongoing OU4-remediation project is high priority and will support attainment in stream segment 11 and 13b. (It is noted that additional NPS clean-up in the North Fork, possibly supported by 319 grant money or other funding, will also be needed to fully achieve current water quality standards in segment 13b.) Descriptions of the rationale and other aspects of each of these other proposed or planned projects being included to further support attainment goals, all but one of which are located within these priority-ranked areas, are given in the following sections. Remediation of the Gilson Gulch subwatershed is now added as a top priority, for the reasons given above and due to the more recent waste-pile/flow characterization results, as referenced below.

1. Gilson Gulch Subwatershed

A remediation-related characterization and feasibility study for this subwatershed was completed in 2005 by TDS Consulting Inc. Conditions in this subwatershed adversely impact water-quality conditions in the upper part of stream segment 11 (mainstem Clear Creek below the Argo discharge). In this investigation, waste-rock piles were characterized geochemically and flowing stream reaches and adits were sampled. A hazard-ranking system used elsewhere for assessing mining impacts led to a prioritization of which piles should be remediated through effective use of BMPs. This study served as the basis for the PIP for this subwatershed (CCWF, 2006) currently awaiting approval by the CDPHE and USEPA. Using zinc as the trace-metal indicator, the **Watershed Plan** identified stream segment 11 as not achieving ultimate (underlying TVS) standard, even with upstream planned remediation actions (see **Plan** Table 4-6). The **Plan** hadn't identified this area for its initial ranking, primarily because little study had been done in the Gilson Gulch subwatershed until the characterization and feasibility study, which was completed at about the time of the **Plan** itself. It now is better known the potential trace-metals loads contributions from this subwatershed, and it has been included in the Plan's schedule for implementation of NPS management measures (TDS Consulting Inc., 2006, p. 6-1). The proposed Gilson Gulch PIP will result in further TMs loads reductions to increase the incremental load reduction (estimated additional 40-percent reduction needed for zinc) to achieve the water-quality attainment targets.

2. Castleton Mine Dump

The CDMG has completed a feasibility study of the Virginia Canyon subarea (Herron and others, 2001). This initial study identified the Castleton Mine Dump area as one of the highest priority areas needed for remediation (CDMG, 2006). This comprehensive study was supplemented by another CCWF study in 2002. Virginia Canyon adversely impacts the lower reach of stream segment 2 (mainstem Clear Creek above the Argo discharge). Some remediation work was completed in this subwatershed during 2005. Ambient levels of copper and zinc for this impaired stream segment of the upper Clear Creek watershed currently do not achieve the low-flow TVS standards (see **Plan** Table 1-3). As in the previous case, when using zinc as the trace-metals indicator, significant additional TMs reductions are needed in order for this stream segment to overcome its non-attainment of the zinc target (see Plan's Table 4-6). The proposed remediation of the Castleton Mine Dump piles will benefit the overall remedial-action strategy for NPS attainment.

3. Trail Creek Subwatershed

Impaired water quality conditions in Trail Creek warrant it to be included as one of two major TMs loads contributors to the lower part of stream segment 2 (mainstem Clear Creek). The other named major contributor, the Big Five Tunnel, has already been remediated through 2005 Superfund clean-up actions. Tailings in the Trail Creek subwatershed were mentioned in the Superfund ROD, but not in the OU (UCC-WAG, 2001, Table 17) as a candidate for CERCLA-supported remediation. The Trail Creek subwatershed has been characterized using more limited data than available for other monitoring sites in the upper Clear Creek watershed. Intermittent historical data for Trail Creek have been tabulated (see **Plan** Table 2-2, 8 samples). An initial year's worth of data collected by the CDPHE provided a seasonal water-quality characterization and resulted in this stream being added to its 303(d) list for several trace metals (Cd, Cu, Pb, Mn, and Zn). Moreover, it has been designated as a separate stream segment (9b) because of its impaired quality. Beginning in 2005, Trail Creek near its confluence with the mainstem Clear Creek (site CC-31) has been added to the UCCWA-USEPA supported TMs monitoring-program component; these recent data confirm the characterization provided by the earlier CDPHE data. Beginning in 2006, a supplemental TMs-characterization study has been implemented (Clear Creek Consultants, Inc., 2006), funded by the CCWF. Copper from this source is believed to be a major contributor to current attainment problems in the vicinity of Idaho Springs. The focus of this study involves Trail Creek and the lower reach of stream segment 2 and upper segment of stream segment 11 (mainstem Clear Creek segments), and this water-quality/hydrologic data-collection study, supplementing the UCCWA-USEPA program, will provide useful information on streamflows and water-quality conditions for this subwatershed. CCWF is currently developing a technical and cost proposal for the Trail Creek subwatershed, using the data and information outlined above.

4. Maude Monroe and Donna Juanita Mines

The Donna Juanita Mine tailings were identified in UCC-WAG (2001, Table 17). Unfortunately, any data have not been compiled for the Maude Monroe Mine and are quite limited for the Donna Juanita Mine (see **Plan** Section 2, p. 2-5, for TMs/HRD characterization). However, these mines are located within a "moderate-rank" priority area for remediation in the **Watershed Plan** (see pp. 3-4 and 3-6). Recently implemented remedial action involving principally the Big Five Tunnel and pond, along with Trail Creek remediation, are estimated to result in TMs loads reduction of less than 10 percent. Obviously, additional remediation in the lower reach of stream segment 2 (mainstem Clear Creek) is critical for attainment of overall attainment of water-quality targets for this stream segment as well as stream segment 11 downstream (see **Plan** Table 4-6). Accordingly, watershed stakeholders have identified these mines for near-term remedial-action consideration. There is a partial remediation proposed for this area to place a retaining wall along the stream as a Supplemental Environmental Project (SEP) in lieu of fines for the spill of petroleum products and subsequent fish kill at Dumont by the Iowa Tank Lines. This partial remedial action is scheduled for late summer 2006.

5. North Empire Creek Subwatershed

The Aorta Tunnel discharge and the North Empire Creek subwatershed in general have been characterized by the USEPA (1994) as well as the CDPHE (1995). Highlights of these initial characterization studies have been incorporated into the **Watershed Plan** (see **Plan** Table 2-2 and Section 2, p. 2-4, for TMs/HRD characterization). Some remediation has taken place at the Minnesota Mine site on Lion Creek. A repair of this prior work has been authorized and funded by EPA Region 8 and the USFS for the summer 2006. As a component of this repair further monitoring and characterization will be accomplished on Lion and North Empire Creeks by CCWF. Although the North Empire Creek is included in an unlisted stream segment 6 (tributary of West Fork Clear Creek), it impacts the lower reach of West Fork Clear Creek as well as stream segments 2 and 11 downstream in the mainstem Clear Creek. Accordingly, watershed stakeholders have identified this subwatershed for near-term future consideration of remedial actions for further reduce TMs loads. An analysis by Clear Creek Consultants, Inc. (2004) indicates that this subwatershed is highly susceptible to event-mean concentrations of total phosphorous and total suspended solids three orders of magnitude higher than adjacent subwatersheds, due to rock and tailing concentrations of phosphates and rock degradation.

In summary, this *2006 Addendum – Remedial Action Priorities* to attain stream standards through NPS trace metals reductions in Clear Creek segments 2 and 11 has been approved by a majority of UCCWA voting members and is hereby incorporated into the original **2005 Upper Clear Creek Watershed Plan** notebooks. The attainment objective date is year 2012 considering implementation and completion of the high-priority projects (both Superfund OU4 and additional NPS projects for North Fork Clear Creek subwatershed and NPS-319-Grant projects for other areas) benefiting water-quality conditions for stream segments 2 and 11 (mainstem Clear Creek).

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Additional References:

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Clear Creek Watershed Foundation (CCWF), 2006 *(pending approval)*, Gilson Gulch Orphan Mine/Orphanage Remediation: Project Implementation Plan (based upon NPS Project Proposal dated 11/15/05), Submitted to CDPHE-WQCD, March 16, 6 p. and 8 attachments.

Colorado Department of Public Health and Environment (CDPHE), 2006, Clear Creek/Central City Superfund Site, Sediment Control and Mine Remediation Project P-8609-S: Scope of Work, Hazardous Materials and Waste Management Division (HMWMD), Exhibit A to Contract with Tetra Tech, Inc., 10p.

Colorado Division of Minerals and Geology (CDMG), 2006 *(pending approval)*, Castleton Mine Dump Remediation: Project Implementation Plan (based upon NPS Project Proposal dated 11/15/05), Submitted to CDPHE-WQCD, March 29, 7^{+} p. and attachments.

U.S. Environmental Protection Agency (USEPA), 2005a, Sustained Commitment Needed to Further Advance Watershed Approach: Internet Website, http://www.epa.gov/oig/reports/2005/20050921-2005-P-00025.pdf

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