Silver Creek
Total Maximum Daily Load
For
Dissolved Zinc And Cadmium

Utah Department of Environmental Quality
Division of Water Quality

John Whitehead, Project Manager
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(Approved by EPA August 4, 2004)

Utah Department of Environmental Quality
Division of Water Quality
TMDL Section

Silver Creek Total Maximum Daily Load

Waterbody ID	**Silver Creek**
Hydrologic Unit Code	16020101
Location	Summit County
Pollutants of Concern	Dissolved Cadmium & Zinc
Impaired Beneficial Uses	Class 3A: Protected for cold water species of game fish and other cold water aquatic life
Average Annual Load Reductions	Zinc: up to 8,300 lbs/yr. at Atkinson Station Cadmium: up to 15.8 lbs./yr. at Park City Station
Defined Targets/Endpoints	Zinc 0.39 mg/l Cadmium 0.0008 mg/l (Values adjusted for hardness of 400 mg/l) Table 13 shows target annual loads for 5 stations on Silver Creek.
Implementation Strategy	Clean up or isolation of areas disturbed by historic mining activities (mine waste areas, tailings, contaminated sediments etc.)

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Silver Creek TMDL Executive Summary

(Relevant Section of TMDL Report in Parentheses)

I. Introduction

(See Section 1.0 for details)

Silver Creek Watershed - USGS Hydrologic Unit Code (HUC) #16020101

- Utah Waterbody ID # UT16020101-020 (see Figure 1)

- Located entirely within Summit County Utah

Listing & Priority: Silver Creek from the confluence with the Weber River to its headwaters is listed on Utah's 1998, 2000, and 2002 303(d) list of impaired water bodies. This waterbody is included in the "high priority" group on Utah's 303(d) list indicating a Total Maximum Daily Load (TMDL) should be completed at this time.

Water quality impairments: Zinc & Cadmium

Beneficial Uses Impaired: Class 3A – cold water species of game fish & aquatic life

II. Water Quality Standards

(See Section 2.0 for details)

R317-2-14 provides the numeric water quality standards for zinc and cadmium. Standards for zinc and cadmium are based on hardness. Pursuant to 303 (d) listing methodology now used by Utah, the **chronic water quality standards** are used for this TMDL. Using a hardness of 400 mg/l, the chronic water quality standards for zinc and cadmium are 0.39 mg/l and 0.0008 mg/l respectively.

III. Water Quality Standards Target

(See Sections 2.0 & 3.0 for details)

The hardness adjusted chronic water quality standards for zinc and cadmium will be used as the targets or endpoints for this TMDL.

Pollutant of Concern	Hardness Adjusted Chronic Water Quality Standard Target
Zinc	0.39 mg/l
Cadmium	0.0008 mg/l

IV. Significant Sources
(See Section 6.0 for details)

Historical evidence indicates the source of metals of concern in this watershed are from historical mining activities in the Park City area. Most of the mining activity occurred within the upper watershed, primarily within Empire Canyon. Tailings from these mines were stored onsite or removed to another location, typically downstream. Significant source areas for zinc and cadmium are identified on Figure 22 and summarized in the following table:

Description	Owner
Upper Watershed Sources	United Park City Mines
Prospector Square	Park City Municipal Corporation
Silver Maple Claims	BLM
Flood Plain Tails	United Park City Mines
Richardson Flats	United Park City Mines
Meadow Area	Various Private Land Owners

V. Technical Analysis
(See Section 7.0 for details)

Data are presented in Section 4.0 showing average concentrations and flows for bi-monthly periods at each "key" sampling location. Table 7 presents a summary of flows, concentrations and loads at key stations for each of these bi-monthly periods. Sections 9.0 and 10.0 provide the Best Management Practices (BMPs) that can be used to remedy the widespread nonpoint sources of metals in the Silver Creek Watershed. Literature values for the effectiveness of each BMP are provided in Table 14. Utilizing the removal efficiencies for each BMP, reductions in zinc and cadmium loading values are calculated along with anticipated stream concentrations after BMP implementation. Completion of scheduled BMPs is expected to achieve and maintain the TMDL endpoints for Silver Creek.

VI. Margin of Safety & Seasonality
(See Sections 4.0 & 5.0)

There is significant variability in the existing flow and chemical data set for this TMDL which lends uncertainty to the loading analysis. Additionally, there is uncertainty in the actual degree of success that implementation of the BMPs identified to address nonpoint sources will achieve. Accordingly, the Margin of Safety to address these sources of uncertainty for this TMDL will include the following components:

- An **explicit margin of safety of 25%** is utilized in the allocation calculations for the Silver Creek TMDL
- **Ongoing Monitoring** Program will be implemented
- Use of the maximum hardness of 400 mg/l in calculating the hardness adjusted Water Quality Standards that are used as the endpoint for this TMDL (use of actual hardness would have resulted in higher values for the Water Quality Standards)

Seasonal analysis of the data is described in section 4.0. Statistical analysis determined that bimonthly partitioning of the data best reflects the seasonal nature of the data.

VII. TMDL
(See Section 8.0 for details)

Table 12 provides the zinc and cadmium allocations for each key monitoring station in the Silver Creek Watershed. The reduction needed for each of the key stations varies from 48% to 86% for zinc and 31% to 92% for cadmium.

VIII. Allocation
(See Section 8.0 for details)

Section 8.0 and Table 12 include the allocation for zinc and cadmium between non-point sources, the one point source in the watershed and the margin of safety.

Waste Load Allocation calculations are included in Section 8.0 for the Silver Creek Water Reclamation Facility. Effluent limits for zinc (0.30 mg/l) and cadmium (0.0008 mg/l) are proposed to assure that the hardness adjusted chronic water quality standards used as endpoints for this TMDL are met in the stream after mixing with wastewater effluent. These effluent limits will not be required until significant progress is made on the non-point source pollution problems in the Silver Creek Watershed.

IX. Public Participation
(See Section 12.0 for details)

Section 12.0 provides the description of the rather extensive public involvement and participation for this TMDL. The Upper Silver Creek Watershed Stakeholders Group has held regular meetings since March 20, 2001. Several public meetings have been held to allow for public input and comment on this TMDL. A formal 30 day comment period was also provided for public comment on the draft TMDL.

Acronyms List

ac	Acre
AFY	Acre-feet per year
BLM	Bureau of Land Management
BMPs	Best Management Practices
$CaCO_3$	Calcium Carbonate
Cd	Cadmium
CF	Conversion Factor
cfs	Cubic Feet per Second
CV	Coefficient of Variation
DEQ	Department of Environmental Quality
DWQ	Division of Water Quality
EE/CA	Engineering Evaluation/Cost Analysis
HUC	Hydrologic Accounting Unit
in	Inches
LA	Load Allocation
lb	Pounds
lb/day	Pounds per Day
lb/mi	Pounds per Mile
mg/l	milligrams per liter
MOS	Margin of Safety
NPS	Non-Point Source
PIP	Project Implementation Plan
RAO	Response Action Objective
STORET	STOrage and RETrieval (water quality, biological, physical data)
TMDL	Total Maximum Daily Load
UPCM	United Park City Mines
UPDES	Utah Pollution Discharge Elimination System
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WLA	Waste Load Allocation
WRF	Water Reclamation Facility
Zn	Zinc

1.0 INTRODUCTION

1.1 Watershed Description

Silver Creek is a smaller tributary of the Weber River. The Weber River originates in Summit County near Reids Peak (11,708 ft) in the western end of the Uinta Mountain range and flows approximately 125 miles generally to the Northwest to the Great Salt Lake at approximately 4200 ft. elevation. Much of the watershed is included in the rugged Uinta and Wasatch Mountain ranges. The Ogden River, the major tributary to the Weber River, lies within Weber County and enters the Weber River approximately 12 miles upstream from its mouth. The other major tributaries to the Weber River are East Canyon Creek, Lost Creek, Chalk Creek, and Beaver Creek. Two smaller tributaries that can affect the water quality of the Weber River are Echo Creek and Silver Creek.

The Geology of the Watershed is complex and composed principally of sedimentary deposits. Mountainous portions of the watershed are comprised of more faulted and fractured rocks while lower portions of the drainage basin closer to the Great Salt Lake are alluvial and lacustrine deposits.

The Silver Creek watershed boundaries are defined by the USGS Hydrologic Accounting Unit (HUC) #16020101 and Utah Waterbody ID # UT16020101-020 (see Figure 1). The Silver Creek watershed is located entirely within Summit County.

Climate

Due to substantial differences in elevation within the watershed, precipitation patterns are markedly different throughout the watershed. Average annual precipitation ranges from 15 to 30 inches with the highest mountainous areas receiving the highest precipitation totals. As is the case with many western watersheds, annual precipitation totals vary dramatically. Snow accumulation and melt is a very significant feature in terms of the annual hydrologic cycle for this watershed.

Average maximum temperatures are in the mid eighties (highest in July) and average minimum temperatures are in the low teens (lowest in January).

Land Use

Land uses are quite varied throughout the watershed. High mountain areas are used for a variety of recreational and grazing purposes. There are several ski resorts and golf courses, as well as numerous agricultural land uses. Portions of the watershed are undergoing extensive growth from residential and commercial development. The agricultural uses are declining as the basin develops and becomes more urbanized.

Demographics

The population of Summit County was 32,236 in 2002. The county's average annual rate of growth from 1990 to 2000 was 6.7%, the fastest rate of any county in Utah. Park City is the largest city in the county with a population of 7,371 (Census 2000). Median age is 33.3 years, average household size is 2.87 people per household, per capita income (the highest in the state

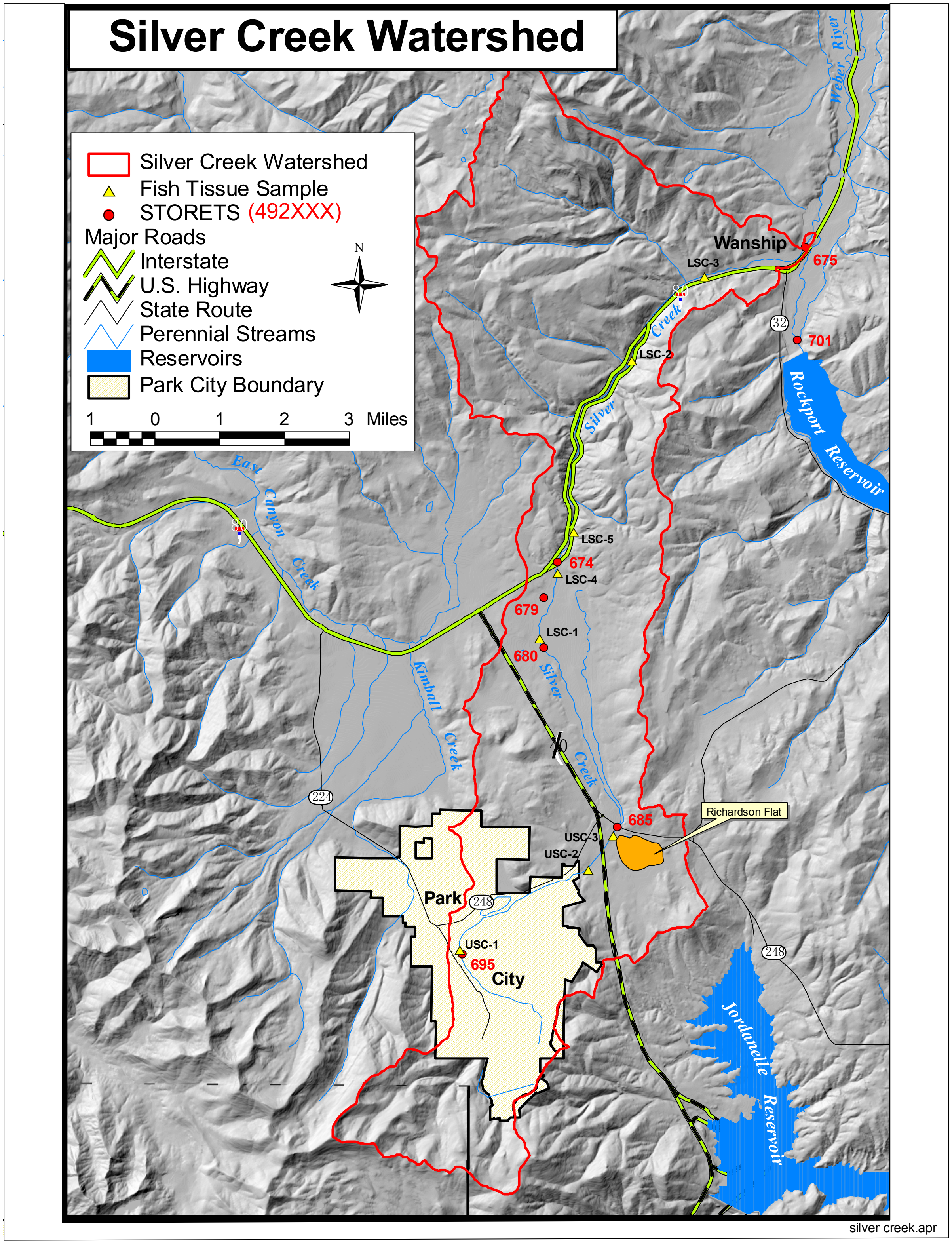

Figure 1: Silver Creek Watershed TMDL Study Area

of Utah) in 2001 was $42,102, unemployment rate in 2001 was 8.8%. Services and trade sectors accounted for nearly 56% of the county's nonagricultural employment – a figure consistent with the county's high specialization in tourism-related industries.

1.2 Water Budget

Hydrologic data are extremely limited and inconsistent within the Silver Creek watershed. These inadequacies make the preparation of a detailed water budget for the basin very difficult. As a result, this section presents the data that are available, and recognizes the need for additional monitoring of the watershed to better understand flows in streams, irrigation canals, and groundwater.

Weather Data

There are three weather stations in the vicinity of the Silver Creek watershed; located at Park City, Wanship Dam, and Silver Lake Brighton. Figure 2 shows the location of these stations.

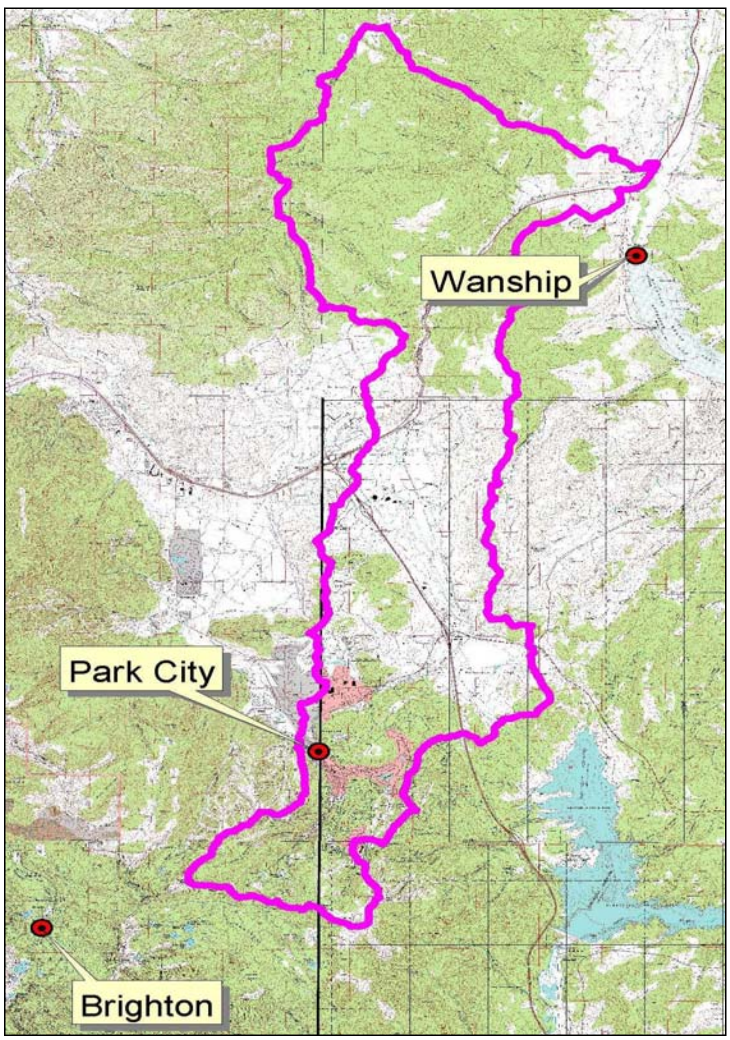

Figure 2: Weather Stations

Data for Normal Precipitation and Normal Potential Evapotranspiration were obtained for these three stations. Table 1 shows the area of influence for each of the weather stations, based on linear partitioning.

Table 1: Weather Station Areas of Influence

Station	Area (ac)	Percent of Watershed
Brighton	100	0.3%
Park City	13,778	45.4%
Wanship	16,443	54.2%
Total	**30,321**	**100 %**

Using these areas, monthly composite values for Normal Precipitation and Normal Potential Evapotranspiration were calculated. These values are shown in Table 2.

Table 2: Composite Watershed Weather Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (in)	Total (AFY)
Total Precip (in)	1.56	1.25	1.52	1.63	1.63	1.13	1.66	1.33	1.91	1.45	1.78	1.71	18.55	47,000
Potential ET (in)	0.76	1.13	2.07	3.53	5.23	6.59	7.56	6.57	4.43	2.68	1.15	0.71	42.41	107,000

It is noteworthy to mention the relatively high value of Normal Annual Potential Evapotranspiration (shown in acre-feet per year), which is more than two times the Normal Annual Precipitation in the watershed. While this value does not represent true evaporation, it does reflect the dry climate of the watershed and the high potential for evaporation losses.

Flow Data

Flow data for each of the STORET sampling locations were typically recorded as water quality samples were taken. A hydrologic profile showing how average annual flow increases from the top of the watershed to the outlet is shown in Figure 3.

Figure 4 shows seasonal trends in flow for each of the key stations for each bimonthly period. Peak flows occur at Wanship in the second bimonthly period (March to April), while the other locations have their peak flow during the third bimonthly period (May to June).

The key stations included in the flow analysis and water quality analysis are listed in Table 3.

Table 3: Key Stations

Key Station Description	STORET Number
Park City	492695
Richardson Flat	492685
Above Atkinson	492680
Silver Creek WRF	492679
Atkinson	492674

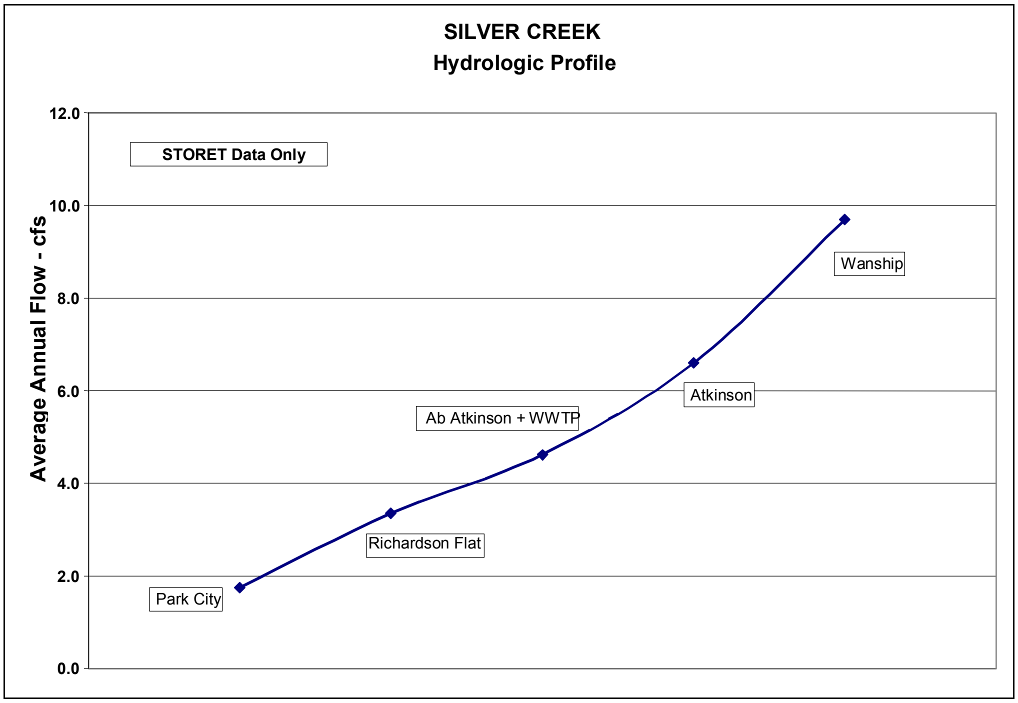

Figure 3: Silver Creek Hydrologic Profile

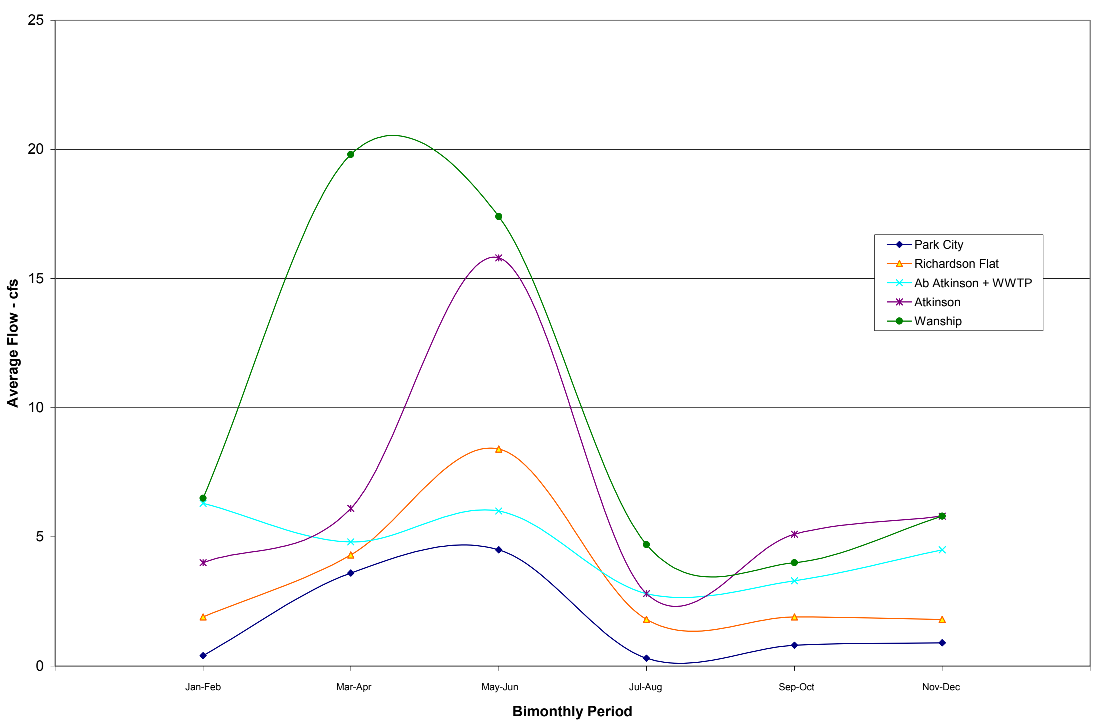

Figure 4: Silver Creek Annual Flow Patterns

Watershed Outlet
Flows at the Wanship sampling location (above the confluence with the Weber River) average 10 cfs. This corresponds to an average of approximately 7,000 acre-feet per year (AFY) leaving the watershed and entering the Weber River. Outflow from the watershed is approximately seven times less than the total amount of water coming into the watershed through precipitation, suggesting that the majority of the water exiting the system does so through mechanisms such as evapotranspiration, groundwater recharge etc.

Remaining Uncertainties
The following items remain unknown in this hydrologic system:

- Contribution of groundwater (inflow or outflow) to various stream reaches and/or trans-basin flow
- Watershed evaporation
- Locations and flows of irrigation diversions
- Effective precipitation

1.3 Water Quality Impairment

The Silver Creek from the confluence with the Weber River to its headwaters is listed on Utah's 1998, 2000, and 2002 303(d) list of impaired water bodies. This waterbody is included in the "high priority" group on Utah's 303(d) list indicating a Total Maximum Daily Load (TMDL) should be completed at this time.

Water quality concerns in the Silver Creek Watershed are focused on two metals; zinc and cadmium. All indications suggest that the metals of concern in this watershed are from historical mining activities in the Park City area. Elevated concentrations of zinc and cadmium were the cause for Silver Creek being assessed as not fully supporting its Class 3A beneficial use.

1.4 Effects of Zinc and Cadmium

Zinc

Zinc is one of the most commonly used metals in the world. Its major uses are for galvanizing steel, producing alloys, and for serving as an ingredient in rubber, ceramics, and paints. Toxic concentrations of zinc compounds cause adverse changes in the morphology and physiology of fish. Acutely toxic concentrations may induce cellular breakdown of the gills and clogging of the gills with mucous. Chronically toxic concentrations of zinc compounds cause general enfeeblement and widespread histological changes to many organs. Growth and maturation are also retarded. (U.S. EPA, 1980). Some fish accumulate zinc in their bodies if they live in water containing zinc.

Increased zinc concentrations will also adversely impact macroinvertebrate populations in a stream. Macroinvertebrates, which are a necessary component of the fish food chain, have been shown to exhibit adverse impacts at zinc concentrations similar to those concentrations at which fish begin to exhibit adverse impacts. (U.S. EPA, 1980). In humans, ingestion of large amounts of zinc, can cause stomach cramps, nausea, and vomiting. Zinc can also can cause anemia, pancreas damage, and lower levels of high-density lipoprotein cholesterol—the good form of cholesterol.

Cadmium

Cadmium is a highly toxic heavy metal with the ability to easily form complexes with other metals and elements. Cadmium is widely used in industry for metal coating, pigments and paints, batteries, in solder alloys, etc. The internalization of cadmium into an animal's physiological system can cause serious damage to tissue and organs. In vertebrates, cadmium accumulates in the liver and kidneys. There is strong evidence for bioaccumulation but the potential for biomagnification is uncertain.

Cadmium is a minor nutrient for plants at low concentrations but is toxic to fish and other aquatic life at concentrations slightly higher. Cadmium causes behavior, growth, and physiological problems in aquatic life at sublethal concentrations. Cadmium has been shown to have an undesirable toxic effect on humans and animals at low concentrations and is injurious to plant life. Effects on humans are to cause cramps, nausea, vomiting and diarrhea. Cadmium tends to concentrate in the liver, kidneys, pancreas and thyroid of humans.

2.0 WATER QUALITY STANDARDS

The Silver Creek watershed is listed on the State of Utah's 303(d) list as impaired for zinc and cadmium. Beneficial use 3A, protected for cold-water fish and other cold-water species, is identified as impaired. Water quality data and analysis are discussed in Sections 3 and 4. Data for the following constituents were gathered to quantify and evaluate this impairment:

- Total and Dissolved Cadmium
- Total and Dissolved Zinc
- Total Dissolved Solids
- Total Suspended Solids
- pH

Data for total dissolved solids and total suspended solids were gathered because metals such as zinc and cadmium are often present within these solids. Values for all of these constituents are sufficient to provide a good understanding of existing water quality impairments present in this area. Data for the constituents were gathered from the Utah Division of Water Quality (DWQ) and from the Environmental Protection Agency (EPA). Data beginning in January 1990 through 2002 were obtained for monitoring stations located on or near Silver Creek.

2.1 Water Quality Targets and Endpoints

Water quality standards for zinc and cadmium were obtained from the State of Utah, Rule R317-2-14. This rule states that the standards for zinc and cadmium are dependent on the hardness of the water. Hardness is used as a surrogate for a number of water quality characteristics which affect the toxicity of metals. Increasing hardness has the effect of decreasing the toxicity of metals. Water quality criteria to protect aquatic life may be calculated at different concentrations of hardness measured in milligrams per liter (mg/l) as calcium carbonate ($CaCO_3$). (EPA, National Recommended Water Quality Criteria 2002, www.epa.gov/waterscience/pc/revcom.pdf.)

Table 4 shows the equations provided by the State of Utah to calculate these standards.

Table 4: Water Quality Standard Calculations

	Chronic
Zinc	$e^{(0.8473(\ln(hardness))+0.884)}$
Cadmium	$e^{(0.7409(\ln(hardness))-4.719)}$

The average hardness measured in the Silver Creek watershed was found to be 484 mg/l. The equations shown in Table 4 that were used to calculate hardness adjusted water quality standards for zinc and cadmium are only considered valid up to a hardness of 400 mg/l. The use of a maximum hardness of 400 mg/l for calculating hardness adjusted water quality standards for metals is in accordance with Utah's Water Quality Standards R317-2-14. Utah's use of a maximum hardness of 400 was specifically recommended by Region 8 EPA in a letter to the Division dated Dec. 20, 2001. The National Recommended Water Quality Criteria: 2002 (EPA 822-R-02-047 Nov. 2002) also specifically address this issue. At high hardness values such as those in Silver Creek, there is concern that the hardness and related inorganic water quality characteristics do not correlate as well as when hardness values are below 400. Limited data are available to quantify the relationship between hardness and toxicity. Therefore, a hardness of 400 mg/l was used for the purpose of establishing the water quality standards for zinc and cadmium with the exception of where seasonal hardness values dropped below 400 mg/l (see section 4.3). Because the calculated water quality standard increases as hardness increases, using this lower value for hardness results in a more conservative (stricter) standard. Table 5 shows the resulting water quality endpoints that were used in this analysis.

Table 5: Water Quality Endpoints For Silver Creek

Constituent	Chronic (mg/l)
Zinc	0.39
Cadmium	0.0008

*Based on hardness of 400 mg/l $CaCO_3$

The chronic Water Quality Standard is used in the Silver Creek TMDL based on Utah's recent adoption of chronic criteria for listing waters in the 303(d) process (March 27, 2003 letter from Don Ostler, to Bruce Zander, EPA Region 8).

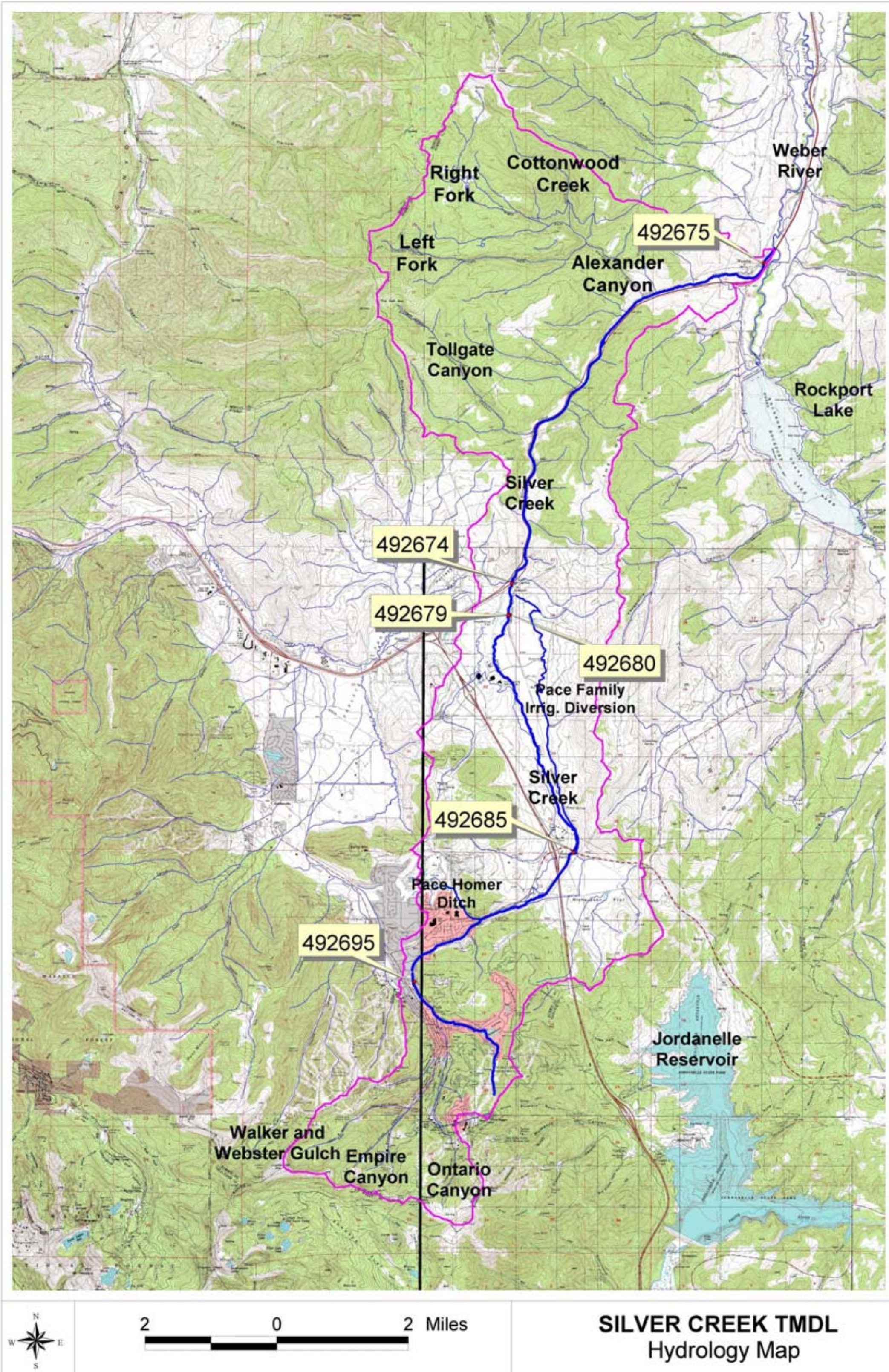

Figure 5: Silver Creek Hydrology Map

3.0 WATER QUALITY DATA

3.1 Sources of Data

In order to assess the quality of the water in Silver Creek and to quantify the impairment of the stream with respect to zinc and cadmium, several sources of data were considered. These data sources were collected by different government agencies and are summarized below and in Appendix A of this report.

STORET

STOrage and RETrieval (STORET) is a repository for water quality, biological, and physical data, and it is used by state environmental agencies, EPA and other Federal agencies, universities, private citizens, and many others. This data was collected by the Utah Division of Water Quality over a twelve-year period between 1990 and 2002, and covers the reach of Silver Creek from the Weber River at Wanship upstream to a station located near Bonanza Drive in Park City (see Figure 5). Not all of the sampling stations were sampled consistently throughout this period.

USGS

USGS conducted two separate studies on Silver Creek, one in 2000 and another in 2002. The USGS sampling locations cover the same reach of the stream as do the STORET stations.

USEPA

In the Year 2000, USEPA sampled during the Spring, Summer, and Autumn periods in the reach of the stream from the vicinity of Richardson Flats upstream to the headwaters of Silver Creek.

3.2 Data Limitations

As with most studies of this nature, there has not been continuous sampling conducted throughout the watershed over the 13 year time period analyzed. The sampling has included different time spans, non-uniform sampling within the time spans, and inconsistent flow measurements. Sometimes flow measurements were made concurrently with water quality sampling, and at other times no flow measurements were made. There do not appear to be any data points where only flow measurements were made.

Figure 6 shows the sampling performed for dissolved zinc at the STORET locations. Only two sampling locations have data for the entire time span of the study. Most locations have data limited to shorter time periods.

Generally there are small populations of data for most time periods. This necessitated the clustering of the individual data points. The purpose of the clustering was to be able to compute statistically reliable parameters for each time interval within the year. Because the standard error of estimate of the mean value for populations is approximately proportional to the inverse of the square root of the number of data points, it is important to have a minimum number of data points in order to reasonably estimate the mean value for the population. Therefore, the time interval for clustering was expanded until such time as the minimum number of data points per interval was in the range of 4 to 5. In order to accomplish this objective, it was necessary to cluster the data into two-month intervals. That is to say, the data within each two-month period was considered to be of the same population. Therefore, for characterizing Silver Creek water quality, both water quality data and flow data were clustered into six two-month intervals for the purpose of calculating mean values, and from these values determining annual patterns.

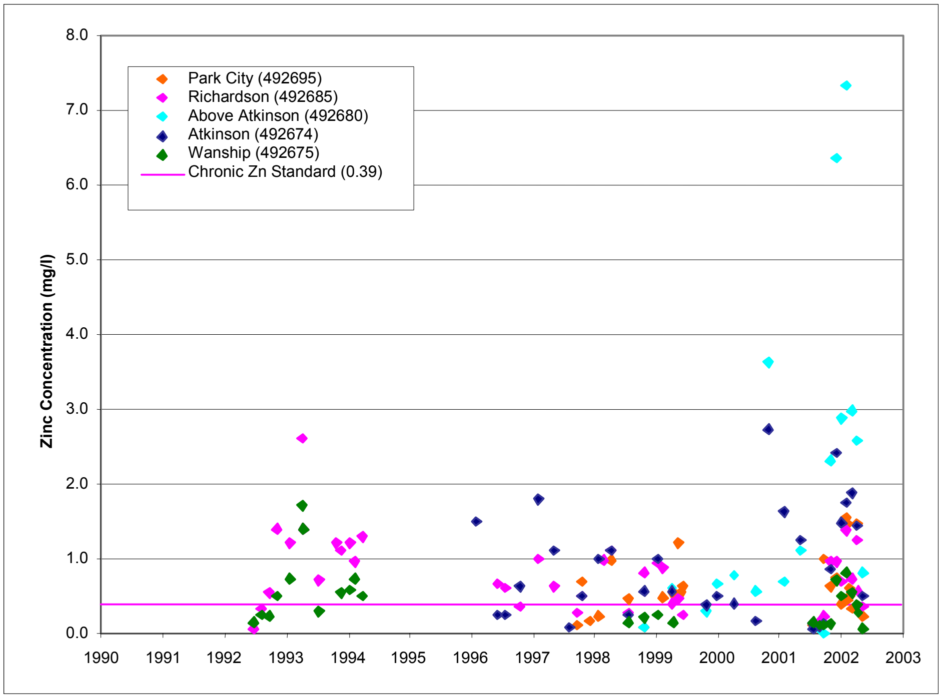

Figure 6: STORET Zinc Data Scatter Plot

Because of the inconsistency of flow and water quality sampling data, flow and concentration data were separated. Independent estimates of means for each data set were then calculated. Estimates of loadings were then calculated using the mean values for flow and concentration for each bi-monthly cluster.

The analysis completed for the TMDL utilized only dissolved values for analysis. There were only 7 instances where total zinc and cadmium values were available.

3.3 Key Sampling Locations

Because of the longer time period embodied in the STORET data (13 years), the focus was on this data set. This data set was used for the principal analysis in this study. The USGS and USEPA data were overlaid and used for verification. There are nine STORET stations on Silver Creek in the reach between Park City and the confluence with the Weber River. There are no STORET stations above Park City. Of these nine STORET locations, five are selected as “key”. In addition to these, the Silver Creek Water Reclamation Facility was included, because of it’s potential as being a source of pollutant loadings. Table 6 shows these stations, their period of record, and the reasons why some were not used.

Table 6: Key STORET Locations

STORET	Description	Key Station	Period of Record	Comments
492674	Silver Creek In Atkinson	Yes	1996-2002	
492675	Silver Creek In Wanship Ab. Weber R.	Yes	1992-2002	
492676	Silver Creek 2 Miles North of Atkinson	No	Prior to 1990	Not Sampled 1990-2002
492677	Silver Ck at I-80	No	Prior to 1990	Not Sampled 1990-2002
492679	Silver Creek WWTP	No	1998-2002	Not on Silver Creek
492680	Silver Creek Ab. Atkinson	Yes	1998-2002	
492685	Silver Creek Below Richardson Flats	Yes	1992-2002	
492695	Silver Creek Ab. Prospector Square	Yes	1997-2002	
492697	Park Meadow Drain Ck. Ab. Silver Creek	No	1998-1999	Not on Silver Creek

The USGS and USEPA sampling stations used for this report are summarized in Table 7. The original study station designations as well as nearby STORET locations (in parentheses in each header) are presented.

Table 7: USGS, EPA Sampling Locations and Corresponding STORET Sites

Above Atkinson (492680)		
USGS	2002	SCS-6000 Silver Creek Above Silver Creek WWTP
Atkinson (492674)		
USGS	2000	Silver Creek At Atkinson
USGS	2002	SCS-6500 Silver Creek At Atkinson (Below WWTP)
Park City (492695)		
USEPA	2000	USC-8, State Sample Site
USGS	2000	Silver Creek At Bonanza Dr.
Richardson (492685)		
USEPA	2000	USC-1, Rail Tressel @ U248
USEPA	2000	USC-2, Culvert @ U248
USEPA	2000	USC-3, Upstream RR Tressel
USGS	2000	Silver Creek Above Richardson Flats
USGS	2002	SCS-5500 Silver Creek Below Richardson Flats - USGS 2002
Wanship (492675)		
USGS	2000	Silver Creek At Wanship
USGS	2002	SCS-7000 Silver Creek @ Wanship

4.0 DATA ANALYSIS RESULTS

4.1 Zinc and Cadmium Standards

Water quality standards for zinc and cadmium are discussed in Section 2.0. A review of the data shows 57% (131 of 230) of the zinc values included in the data set (Appendix A) exceed the hardness adjusted water quality standard of 0.39 mg/l. Similarly, 52% (117 of 226) of the cadmium values observed exceed the hardness adjusted water quality standard of 0.0008mg/l.

4.2 Water Quality and Flow Results by Location

This section presents average concentrations and flows for each of the "key" sampling locations during each of the six bi-monthly periods. A summary of findings is provided followed by three figures showing bi-monthly zinc concentrations, bi-monthly cadmium concentrations, and bi-monthly flow.

Park City

Zinc concentrations are lowest during the fourth period (July, August) and the highest during the first period (January, February). Water quality standards for zinc are exceeded during the first half of the year. Concentrations reach 1.5 times the standard. Flows are relatively low, and are greatest during the second and third periods (March through June).

Cadmium concentrations are lowest in the fourth and fifth periods (July through October) and highest in the second period (March through April). Concentrations exceed the chronic standard throughout the year.

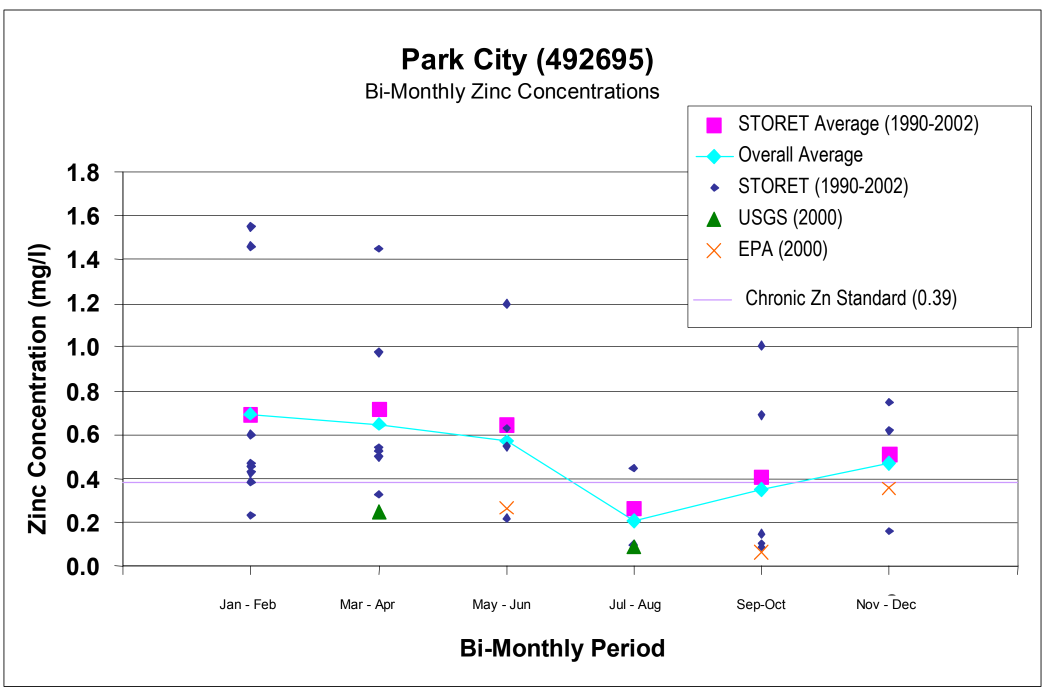

Figure 7: Park City Bi-Monthly Zinc

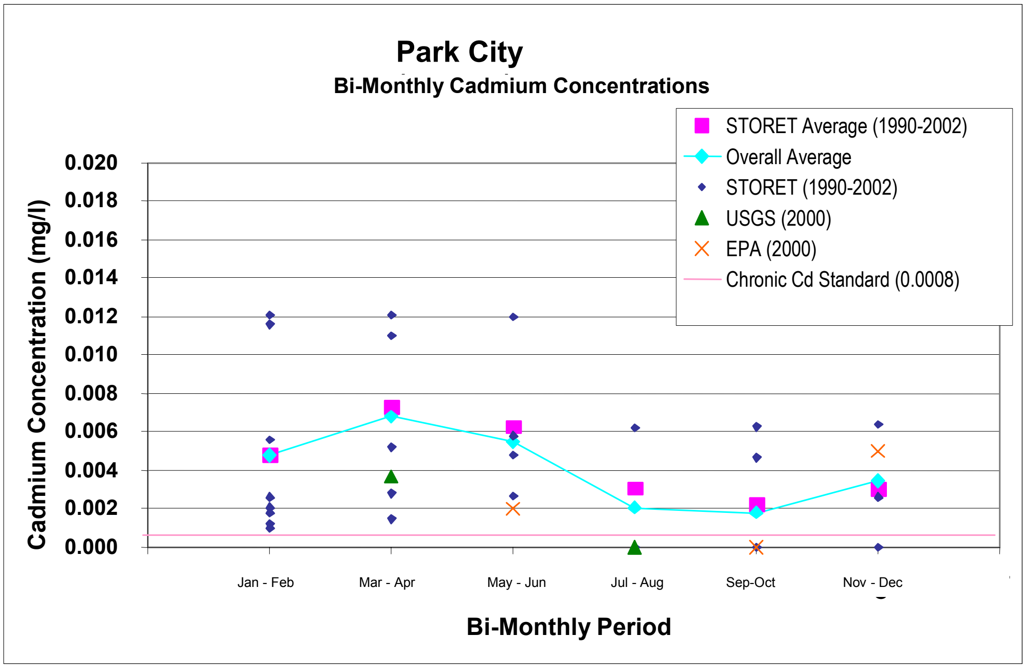

Figure 8: Park City Bi-Monthly Cadmium

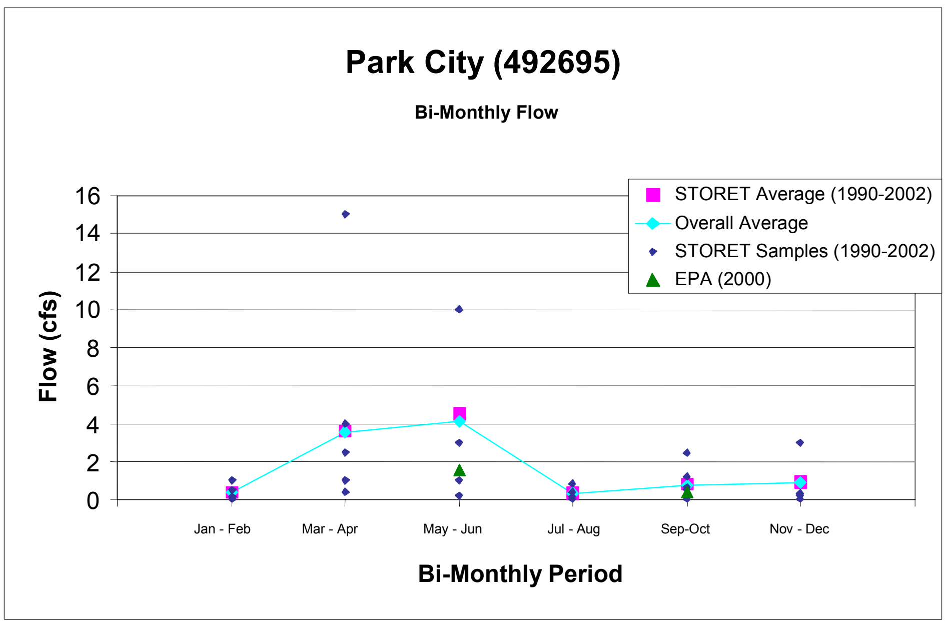

Figure 9: Park City Bi-Monthly Flow

Richardson

Zinc concentrations were found to be highest during the Winter and early Spring (Nov. through April) and lowest during the Summer and Fall months. On average, water quality standards for zinc are exceeded throughout the year, with concentrations reaching two times the standard. Flows peak in the third and fourth periods (from March to June).

Cadmium concentrations are highest in the second period (March through April). Chronic water quality standards are typically exceeded most of the year.

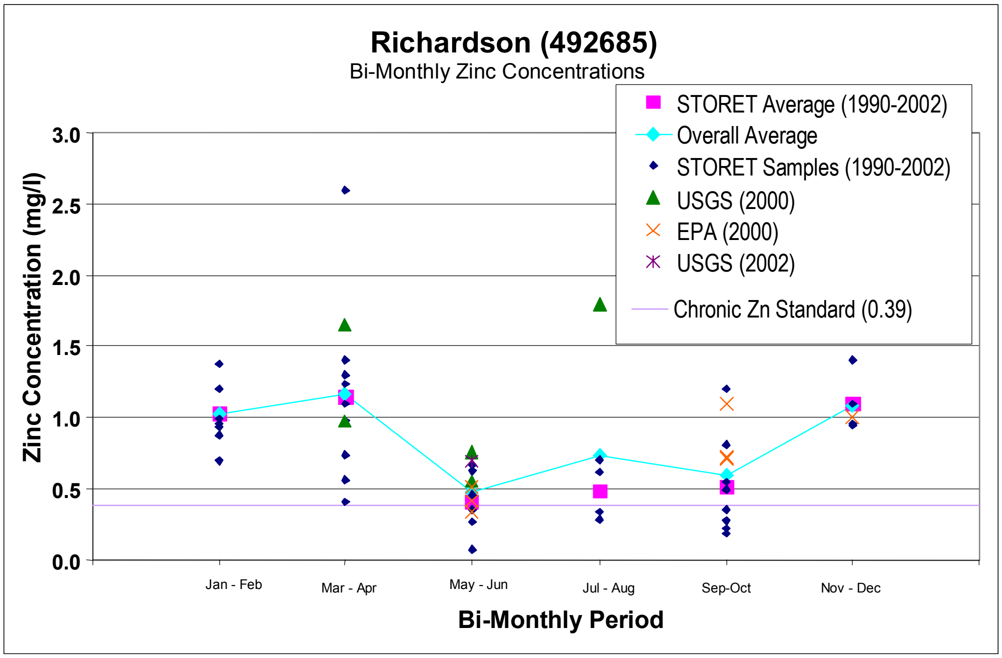

Figure 10: Richardson Bi-Monthly Zinc

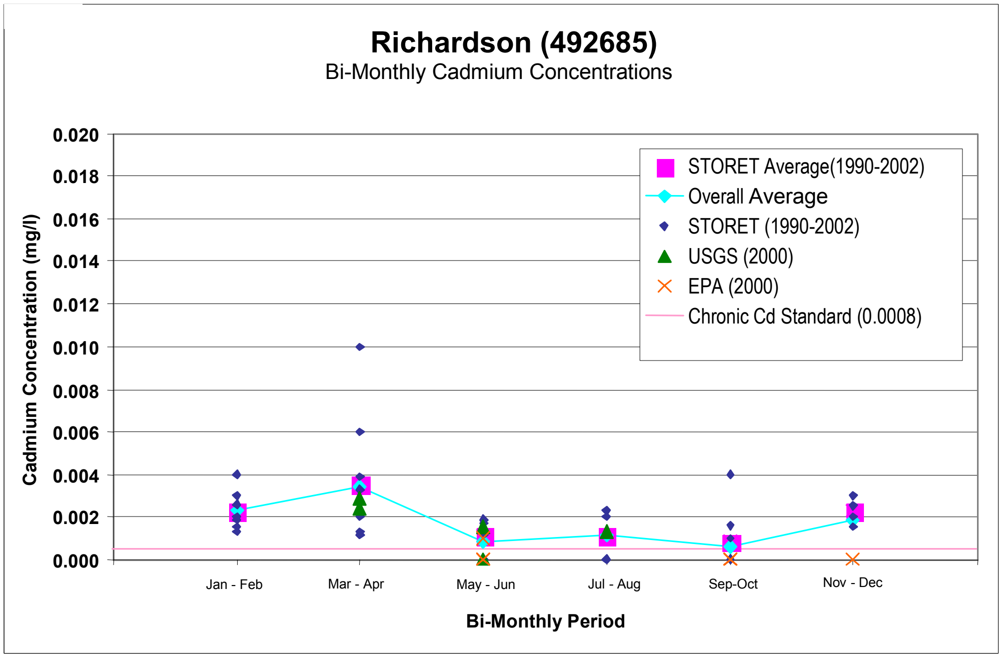

Figure 11: Richardson Bi-Monthly Cadmium

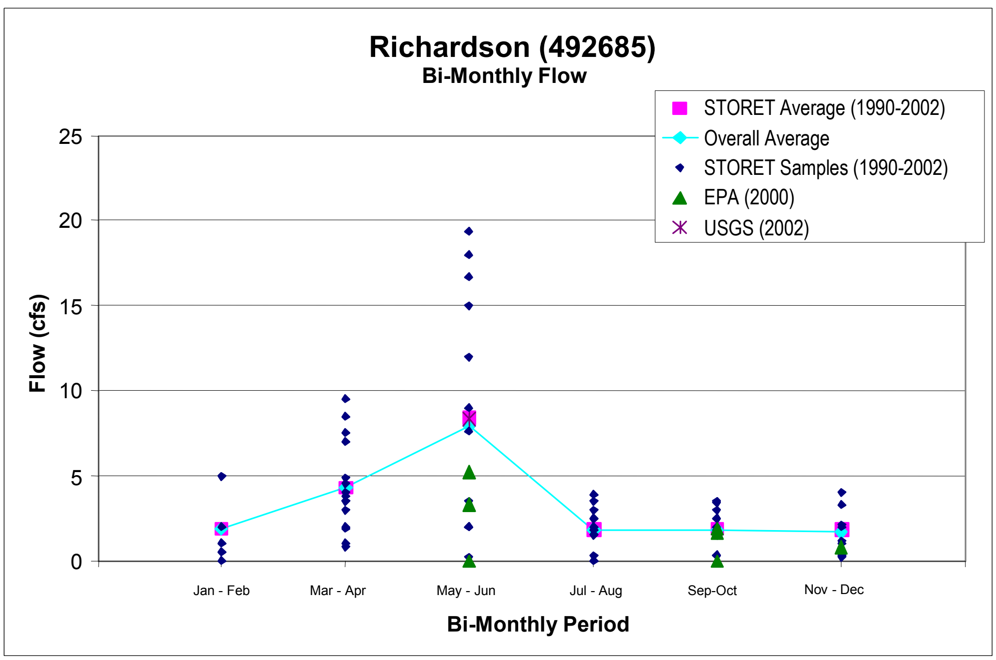

Figure 12: Richardson Bi-Monthly Flow

Above Atkinson

Zinc concentrations are highest during the Winter months (Nov. through Feb.) and lowest during late Summer and Fall (Sept. through Oct.). Water quality standards for zinc are exceeded for most of the year. Zinc concentrations reach up to six times the chronic standard. Flow fluctuates during the year with the highest flows during late Winter and early Summer. During the irrigation season, a significant flow is typically diverted into the Pace Family Irrigation Diversion. This diversion takes water from Silver Creek just below Richardson Flat and returns between the Atkinson and Above Atkinson water quality sampling stations.

Cadmium concentrations are the highest during the Winter months (November through February). Late Summer and early Autumn months (July through October) have never had values above the detection limit. Chronic water quality standards are typically exceeded during the rest of the year.

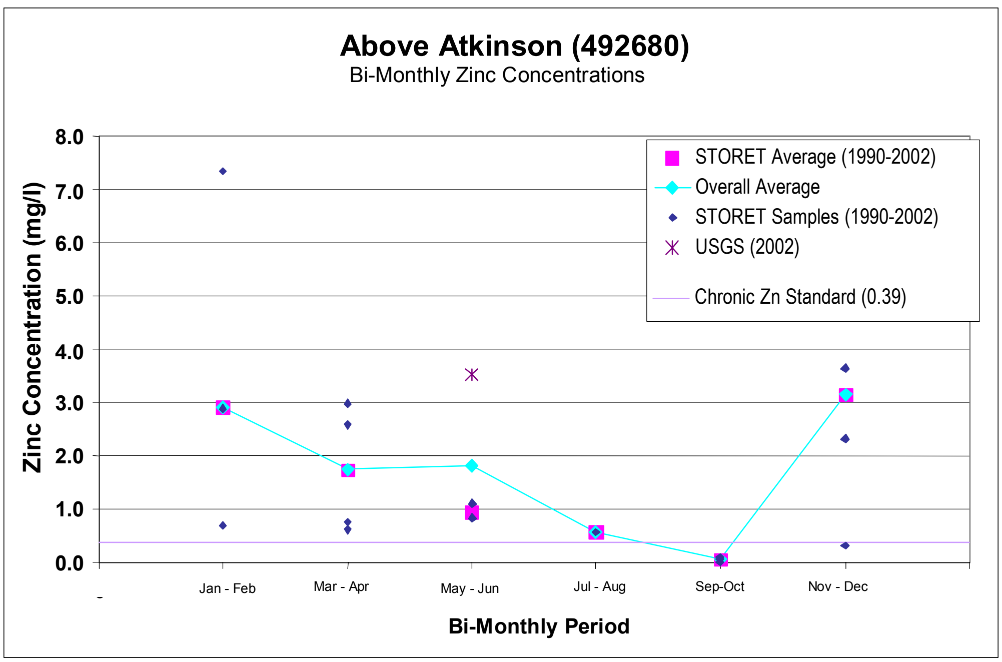

Figure 13: Above Atkinson Bi-Monthly Zinc

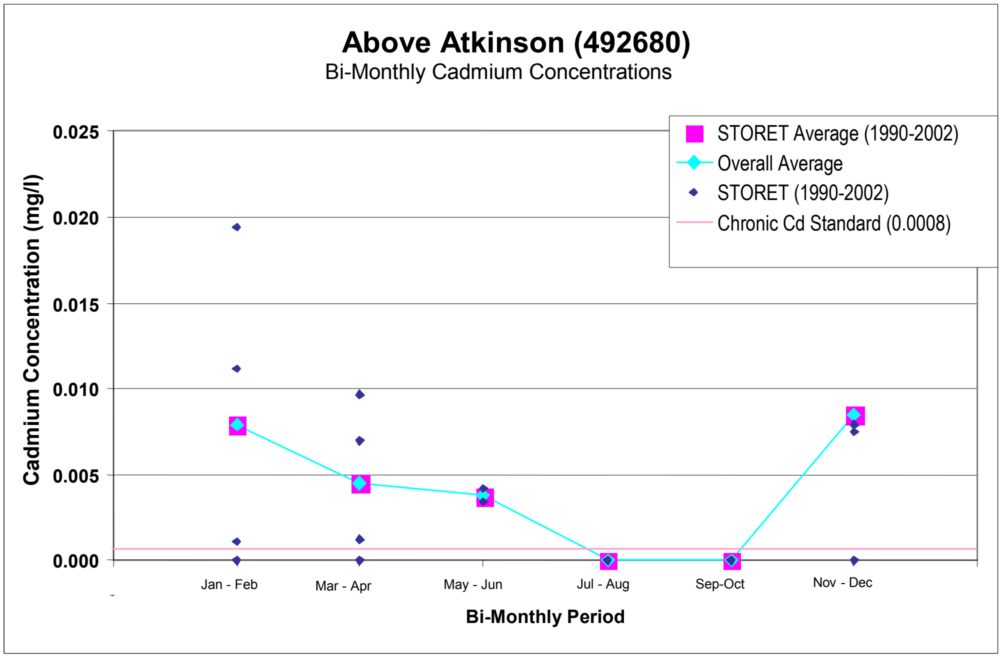

Figure 14: Above Atkinson Bi-Monthly Cadmium

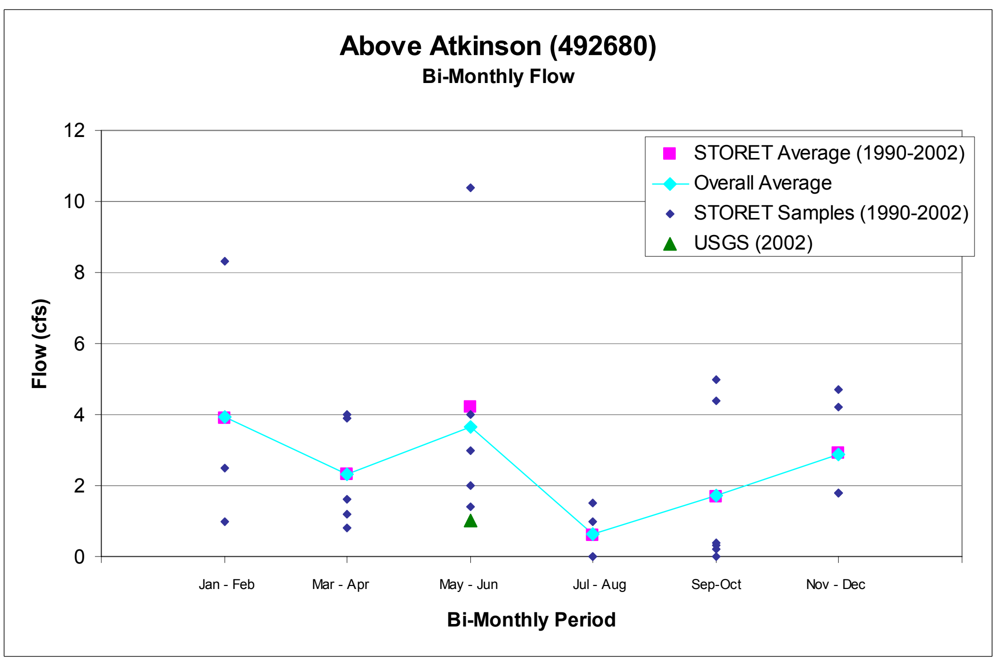

Figure 15: Above Atkinson Bi-Monthly Flow

Atkinson

Zinc concentrations are highest during the Winter months (November through February) and lowest during the late Summer months (July and August). Water quality standards for zinc are typically exceeded from November through June. Average zinc concentration reach three times the chronic zinc standard. Flows are the highest during the months of May and June.

Cadmium concentrations are lowest during the late Summer and early Autumn. Average concentrations are generally above chronic water quality standards.

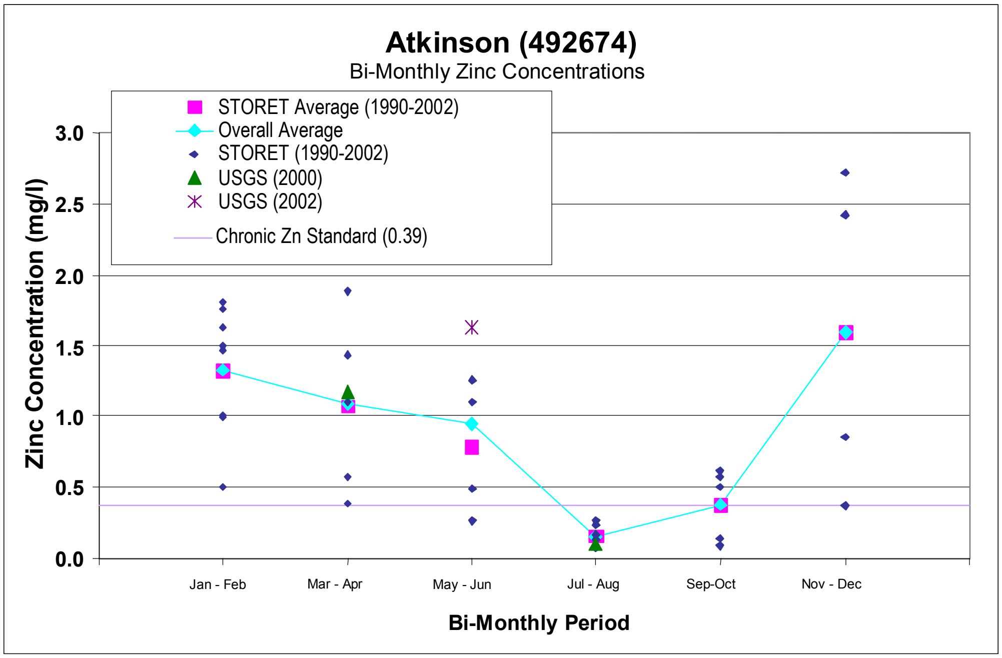

Figure 16: Atkinson Bi-Monthly Zinc

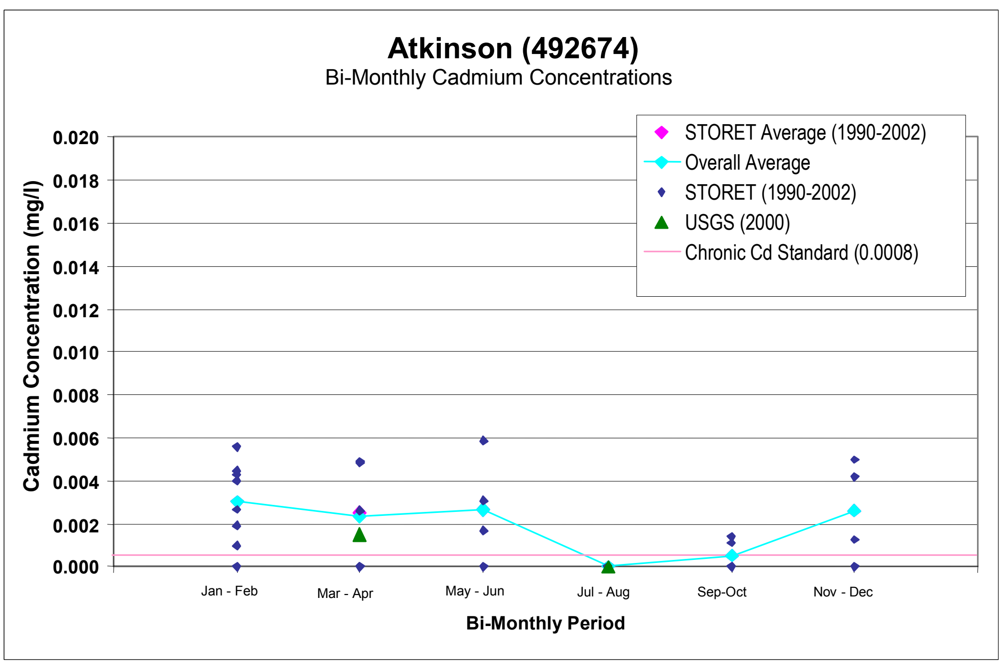

Figure 17: Atkinson Bi-Monthly Cadmium

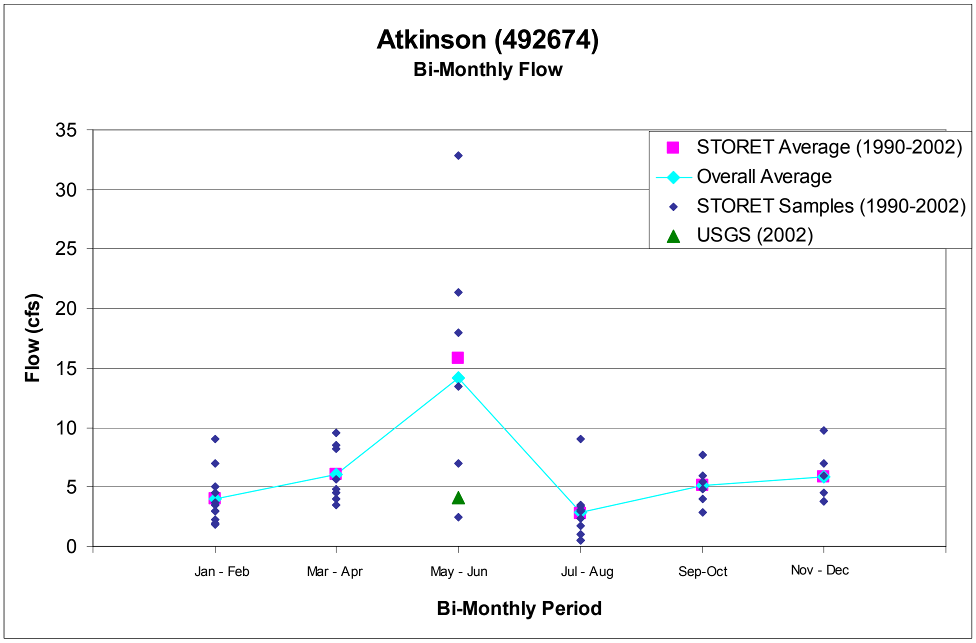

Figure 18: Atkinson Bi-Monthly Flow

Wanship

Zinc concentrations are highest during the Winter and Spring months (Nov. – April). Flows are highest during the Spring and early Summer months (May and June).

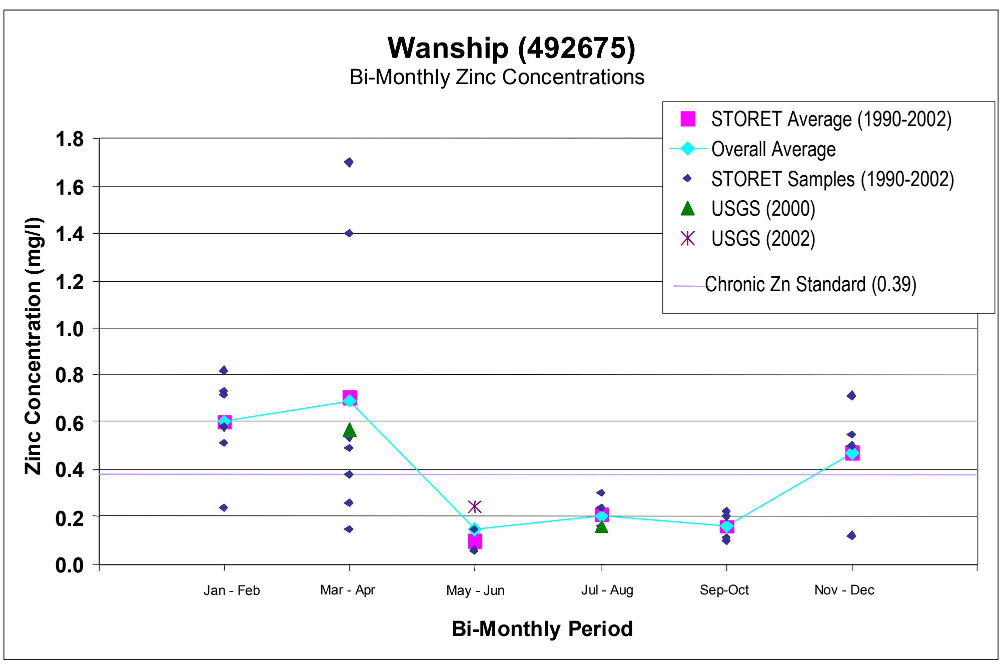

Figure 19: Wanship Bi-Monthly Zinc

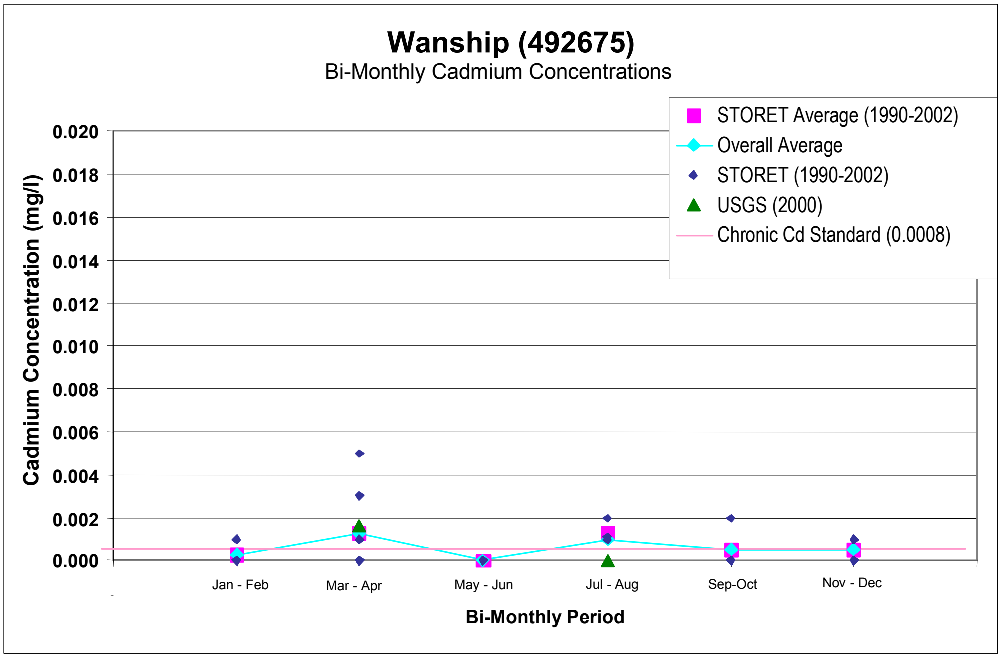

Figure 20: Wanship Bi-Monthly Cadmium

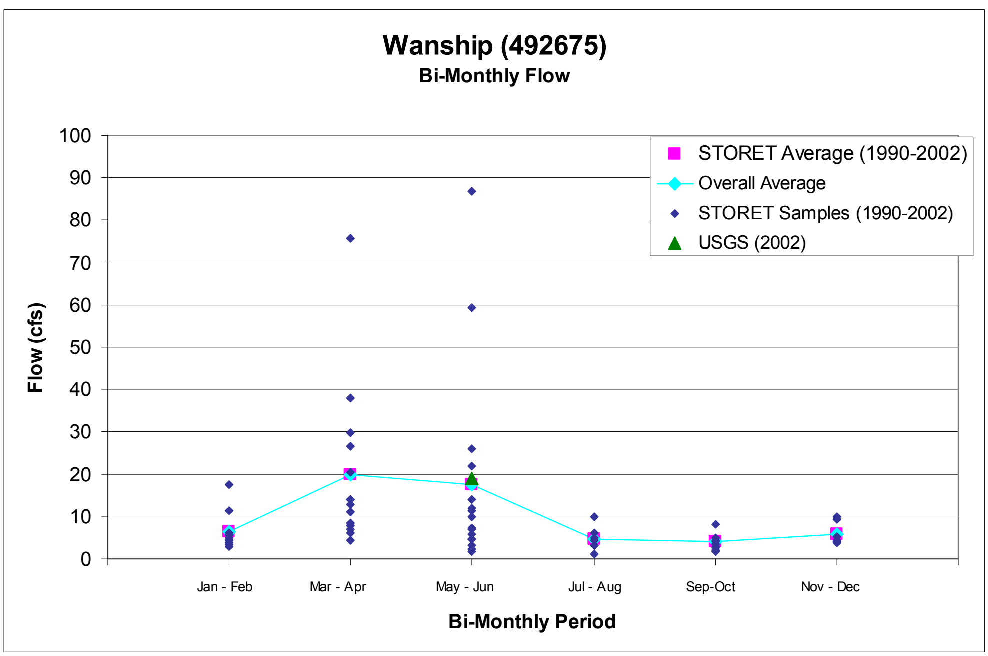

Figure 21: Wanship Bi-Monthly Flow

4.3 Hardness

Seasonal analysis of hardness data for each of the five key sampling locations indicates that there is significant variation by season at all stations except 492685 (Richardson Flat). Appendix B includes graphical representation of the seasonal variation by station. While the sufficiency of the data set does not allow a concise conclusion, there appears to by a general pattern that involves lower hardness values during spring runoff (March-July) than during more base flow conditions (August –February). This seasonal variation results in two stations (492695 – Park City and 492675 – Wanship) that demonstrate hardness values that are significantly below the hardness value of 400 used to calculate TMDL target values. Sections 8.1 and 8.2 include a discussion of how TMDL target levels were modified to accommodate seasonal variation for these two stations in order to assure stream water quality standards are maintained throughout the year at these two stations.

4.4 Zinc and Cadmium Loading

Table 8 summarizes the zinc and cadmium loading for the reach of Silver Creek between Park City and the confluence with the Weber River. Values for each bi-monthly period for each of the five key stations are shown. The average flows for each period along with the average dissolved zinc and cadmium concentrations for the period are used to compute average daily loads shown in the table. Another column, showing the load, presents totals for each bi-monthly period. Summing these bi-monthly numbers results in an annual load. The annual load for each station has been rounded to the nearest 1,000 pounds per year for zinc and to the nearest one pound per year for cadmium. This rounding is consistent with the statistical parameters developed for flow and concentration.

Table 8: Summary of Flows, Concentrations, and Loads by Key Station

Period	Average Flow (cfs)	Average Dissolved Zinc (mg/l)	Average Dissolved Zinc Load (lb/day)	Dissolved Zinc Load (lb)	Average Dissolved Cadmiuim (mg/l)	Average Dissolved Cadmium Load (lb/day)	Dissolved Cadmium Load (lb)
Park City (492695)							
Jan-Feb	0.4	**0.70**	1.4	85	**0.0048**	0.01	0.6
Mar-Apr	3.6	**0.65**	12.4	759	**0.0068**	0.13	7.9
May-Jun	4.1	**0.57**	12.6	771	**0.0055**	0.12	7.4
Jul-Aug	0.3	0.21	0.4	23	**0.0021**	0.00	0.2
Sep-Oct	0.7	0.35	1.4	85	**0.0018**	0.01	0.4
Nov-Dec	0.9	**0.47**	2.2	136	**0.0035**	0.02	1.0
			Annual Load:	**2,000***			**18****
Richardson (492685)							
Jan-Feb	1.9	**1.03**	10.4	616	**0.0023**	0.02	1.4
Mar-Apr	4.3	**1.17**	27.1	1,655	**0.0034**	0.08	4.8
May-Jun	7.9	**0.47**	20.0	1,220	**0.0008**	0.03	2.1
Jul-Aug	1.9	**0.74**	7.4	458	**0.0011**	0.01	0.7
Sep-Oct	1.9	**0.60**	6.0	365	0.0006	0.01	0.4
Nov-Dec	1.7	**1.08**	9.7	590	**0.0018**	0.02	1.0
			Annual Load:	**5,000***			**10****
Above Atkinson (492680)							
Jan-Feb	3.9	**2.90**	61.5	3,627	**0.0079**	0.17	9.9
Mar-Apr	2.3	**1.73**	21.6	1,321	**0.0045**	0.06	3.4
May-Jun	3.6	**1.81**	35.5	2,168	**0.0038**	0.07	4.5
Jul-Aug	0.6	**0.57**	1.9	118	0.0000	0.00	0.0
Sep-Oct	1.7	0.05	0.5	28	0.0000	0.00	0.0
Nov-Dec	2.9	**3.15**	48.6	2,964	**0.0085**	0.13	8.0
			Annual Load:	**10,000***			**26****
Silver Creek WWTP (492679)							
Jan-Dec	2.2	0.14	1.7	598	0.0000	0.00	0.0
			Annual Load:	**600**			
Atkinson (492674)							
Jan-Feb	4.0	**1.33**	28.8	1,701	**0.0030**	0.07	3.8
Mar-Apr	6.1	**1.09**	35.7	2,180	**0.0023**	0.08	4.6
May-Jun	14.2	**0.95**	72.7	4,432	**0.0027**	0.21	12.6
Jul-Aug	2.8	0.15	2.3	142	0.0000	0.00	0.0
Sep-Oct	5.1	0.38	10.5	641	0.0005	0.01	0.8
Nov-Dec	5.8	**1.59**	49.9	3,045	**0.0026**	0.08	5.0
			Annual Load:	**12,000***			**27****
Wanship (492675)							
Jan-Feb	6.5	**0.60**	20.9	1,235	0.0003	0.01	0.6
Mar-Apr	19.8	**0.69**	73.5	4,486	**0.0013**	0.14	8.4
May-Jun	17.5	0.15	14.2	864	0.0000	0.00	0.0
Jul-Aug	4.7	0.20	5.1	317	**0.0010**	0.03	1.6
Sep-Oct	4.0	0.16	3.4	209	0.0005	0.01	0.7
Nov-Dec	5.8	**0.47**	14.8	903	0.0005	0.02	1.0
			Annual Load:	**8,000***			**12****

*** Rounded to the nearest 1,000 lbs per year**
**** Rounded to the nearest 1 lb per year**
Red Bold Type **indicates Exceedence of Chronic Water Quality Standard**

Table 9 presents the coefficients of variation for flow, zinc concentration, and cadmium concentration at each of these key locations.

Table 9: Coefficients of Variation

Location	Dissolved Zinc	Dissolved Cadmium	Flow
Park City	77%	93%	182%
Richardson	58%	108%	112%
Ab. Atkinson	108%	125%	99%
Silver Ck. WRF	50%	n/a	39%
Atkinson	80%	113%	95%
Wanship	87%	152%	137%

The coefficient of variation is determined as the standard deviation of the population divided by its mean value. This is a measure of how tightly the data are clustered around the mean value. Lower numbers indicate that most of the data points are located close to the mean, while higher numbers indicated a wider spread of data points. The Above Atkinson and Silver Creek WRF sampling stations have the highest and lowest coefficients of variation, respectively, for zinc concentration. Thus, more confidence may be placed in the mean zinc value at the WRF than in the mean value at the Above Atkinson Station.

The only Point Source in the watershed is the Silver Creek Water Reclamation Facility. Average annual loads for this facility are also shown in Table 8. The average zinc concentration and average flow for the water reclamation facility are 0.14 mg/l and 2.2 cfs, respectively. These levels result in an estimated average loading of 1.7 pounds per day or 598 pounds per year. There are no recorded samples in the data where cadmium is above the detection limit. This results in a calculated cadmium load of zero pounds per year.

Table 10 shows the incremental loading between each of the five key stations. Also shown are the estimated distances, in miles, between each of the key stations as well as the incremental loading rate in pounds per year per mile of stream.

Table 10: Incremental Loading Results

Location	Dist. (mi)	Incremental Zinc Load (lb)	Zinc Load Rate (lb/mi)	Incremental Cadmium Load (lb)	Cadmium Load Rate (lb/mi)
Park City	2.6	2,000	770	18	6.9
Richardson	3.4	3,000	900	-8	-2.4
Ab. Atkinson	4.1	5,000	1,200	16	3.9
Atkinson	0.5	2,000	4,000	1	2.0
Wanship	7.5	-4,000	-500	-15	-2.0

For zinc, it is of interest to note that between Park City and Richardson the annual loading rate is 900 pounds per year per mile of stream. Between Richardson and Above Atkinson the loading rate is in the same range, 1,200 pounds per year per mile. Between the two Atkinson stations (0.5 miles) the annual incremental load amounts to 2,000 pounds for a loading rate of approximately 4,000 pounds per year per mile of stream. Between Atkinson and Wanship, the zinc loading actually decreases by 4,000 pounds per year. This decrease is likely associated with precipitation/sedimentation of zinc and incorporation of those materials into the sediments of that reach. This results in a loading rate of -500 pounds per year per mile of stream. While it is interesting to consider loading in a pounds per mile perspective, it is also important to recognize which stream reaches contribute the most loads. The segment between Richardson and above Atkinson is the largest source area in the watershed contributing some 5000 lbs/yr.

For Cadmium, there is a loss of load between Park City and Richardson. Between Richardson and the Above Atkinson location, there is a gain of 16 pounds per year. A minor increase in load occurs progressing towards the Atkinson location. Similar to zinc, there is a significant loss of cadmium load in the reach between Atkinson and Wanship, likely due to sedimentation.

4.4 Water Quality Overview

Zinc

An analysis of Table 8 (page 30) leads to three important conclusions concerning Silver Creek zinc concentrations:

- Zinc concentrations tend to be the highest during periods of late Winter and Spring runoff.
- Elevated concentrations of zinc occur throughout the reaches of Silver Creek between Park City and Wanship.
- The highest concentrations of zinc were found at Above Atkinson, where bi-monthly averages were over five times the chronic water quality standard for four of the six bimonthly periods.

Calculated loadings by stream reach point to potential remediation priorities. The largest load increments are in the reaches between Richardson and Atkinson; they amount to 7,000 pounds per year. Next in priority would be between Park City and Richardson with incremental load amounts of about 3,000 pounds per year.

Lastly, annual load at Park City is about 2,000 pounds. However, careful consideration must also be given to the sequence of clean up from an upstream to downstream order to insure that upstream sources do not contaminate areas downstream that have been addressed earlier. This issue will be covered in detail in Section 10.0, Project Implementation Plan.

Between Park City and Richardson, the incremental load amounts to about 3,000 pounds per year. Therefore, the focus of attention as far as remediation should be in the reach of Silver Creek between Park City and Atkinson.

Continued improvement in the upper watershed associated with active mine reclamation and resort development will likely continue to reduce the exposure of surface waters to mining impacted areas and should reduce metal concentrations in this portion of the watershed. Areas in the watershed that are currently being developed include the upper watershed area and the East side of the meadow area (Figure 22). It is expected that all future development activities will avoid contaminated areas and, as a result, it is expected that these areas will not contribute zinc or cadmium load to Silver Creek.

The reach of Silver Creek between Atkinson and Wanship shows a decrease of approximately one-third in zinc loadings. This is probably associated with precipitation/sedimentation, which suggests that the zinc is still present and could be mobilized by high flow events or a change in water chemistry. However, the historic data set that encompasses more than 10 years does not indicate that accumulated metals are being released in disproportionate quantities. Assuming that clean-up and remediation take place in the upper and central portion of the watershed, additional remediation in the lowest reach of the stream would be a last priority, undertaken if this reach appears problematic following watershed work upstream.

Cadmium

Some 52% of the cadmium observations exceeded the chronic water quality standard. Clean up priorities for cadmium based on loading analysis should be targeted at the stream reach above the Park City monitoring station and between Richardson and Atkinson.

4.5 Zinc and Cadmium Geochemistry Overview

Many heavy metals become more water soluble under acid conditions and can move downward with water through the soil, and in some cases move to aquifers, surface streams, or lakes. If these ions are found in high concentrations, their toxicity is dependent on water hardness, pH, temperature and the presence of other dissolved substances.

The distribution and transport of zinc in water, sediment and soil are dependent upon the species of zinc present and the characteristics of the environment. The solubility of zinc is primarily determined by pH. At acidic pH values, zinc may be present in the aqueous phase in its ionic form. Zinc may precipitate at pH values greater than 8.0. It may also form stable organic complexes. The formation of such complexes can increase the mobility and/or solubility of zinc.

Cadmium is also naturally present in soil but in a predominantly insoluble and harmless form. However, through pollution-formed pH-decreasing agents like acid-rain, the cadmium in the soil may convert into a soluble form, become available to plants and enter the food chain.

5.0 MARGIN OF SAFETY

5.1 Assumptions

All data for the analysis in this TMDL study was provided by the Utah Department of Environmental Quality (DEQ), Division of Water Quality (DWQ). DWQ adheres to the *DEQ DWQ Quality Assurance Quality Control Manual* to ensure proper sampling and data validation from sampling through analysis. All samples are analyzed by Department of Health Division of Laboratory Services (a.k.a. State Health Lab) which is EPA certified on its procedures. Quality assurance procedures (i.e. blank and duplicate samples) are strictly adhered to and enforced.

Seasonal trends and data scatter are such that it would be virtually impossible to demonstrate statistically valid long term trending. Therefore, it was assumed that there were no significant long term trends in the data.

5.2 Margin of Safety

A discussion of the statistical methods used to analyze the Silver Creek water quality and flow data is included in Appendix B. As pointed out in this appendix, although the statistical analysis resulted in satisfactory results, there remain significant uncertainties in the estimates of representative concentrations and loadings based on the variability of the existing data. In recognition of this uncertainty the Margin of Safety for this TMDL will include the following components:

- An explicit margin of safety of 25% is utilized in the allocation calculations for the Silver Creek TMDL.
- Ongoing Monitoring Program will be implemented.
- Use of the maximum hardness of 400 in calculating the hardness adjusted Water Quality Standards that are used as the endpoint for this TMDL (use of actual hardness would have resulted in a higher values for the Water Quality Standards).

6.0 SOURCES

6.1 Known Sources of Contaminants

Existing data were adequate for determining contaminant loading between data sampling points along Silver Creek (contaminant loading is presented in pounds per mile of stream rather than by responsible parties in Section 4.3). However, sufficient data are unavailable to adequately allocate contribution of contaminants by specific site. Further, there are numerous smaller source areas not specifically listed in Table 11 that undoubtedly contribute zinc and cadmium to the creek. Table 11 identifies the major land owners within the various major source areas of Silver Creek. Figure 22 identifies the major contaminated areas, which are referred to as source areas.

Table 11 : List of Known Sources

Description	Owner
Upper Watershed Sources	United Park City Mines
Prospector Square groundwater drain	Park City Municipal Corporation
Silver Maple Claims	BLM
Flood Plain Tailings	United Park City Mines
Richardson Flats	United Park City Mines
Meadow Area	Various Private Land Owners

All indications suggest that the metals of concern in this watershed are from historical mining activities in the Park City area. Most of the mining activity occurred within the upper watershed, primarily within Empire Canyon. Tailings from these mines were stored onsite or removed to another location, typically downstream.

Several downstream locations were used to further reduce and process the discarded mine tailings in an attempt to remove additional metals. The lower reaches of the stream have significant amounts of mine tailings that are easily detected by the casual observer. These locations include, but are not limited to, Silver Maple Claims, Richardson Flats, Flood Plain Tailings and the Meadow area.

Contamination mechanisms vary from site to site but are generally attributed to surface or ground water contact with mining related metals contamination. The upper watershed, due to its overall steepness, is characterized by relatively high flow velocities and concentrations that have a tendency to carry sediments and other materials to receiving waters, in this case Silver Creek and its tributaries. Contaminated areas that are exposed or saturated by shallow ground water will contribute to metals loading in the stream channels.

The Upper watershed source area includes discharges from two mining tunnels, the Judge and Spiro Tunnels. The majority of these flows are captured for use in the Park City Municipal drinking water system. Zinc concentrations for these tunnels have been reported at 0.81 mg/l for the Judge and 0.22 mg/l for the Spiro Tunnel (NPDES Form 2A October 2002). Estimated zinc loads from the respective tunnel flows that actually enter Silver Creek are less than 100 lbs. per year from the Judge Tunnel and 300 lbs. per year from the Spiro Tunnel. These values are not significant when contrasted with the upper watershed zinc loads that are estimated at 2000 lbs. per year.

The Prospector Drain is also a significant source of metals to the creek in the upper part of the watershed. Available information suggests that this is a shallow groundwater drain installed to lower ground water tables in the Prospector Square area. The annual load from the drain cannot be estimated with complete accuracy since there is no data on flows from the drain during the spring runoff season. An estimate of loads from the drain assuming spring flows from the drain would be 30% higher than the base flows that have been measured results in an annual load estimate of 2,230 lbs/yr of zinc and 13.5 lbs/yr. of cadmium. These values will be further refined when a full year's worth of flow data is obtained.

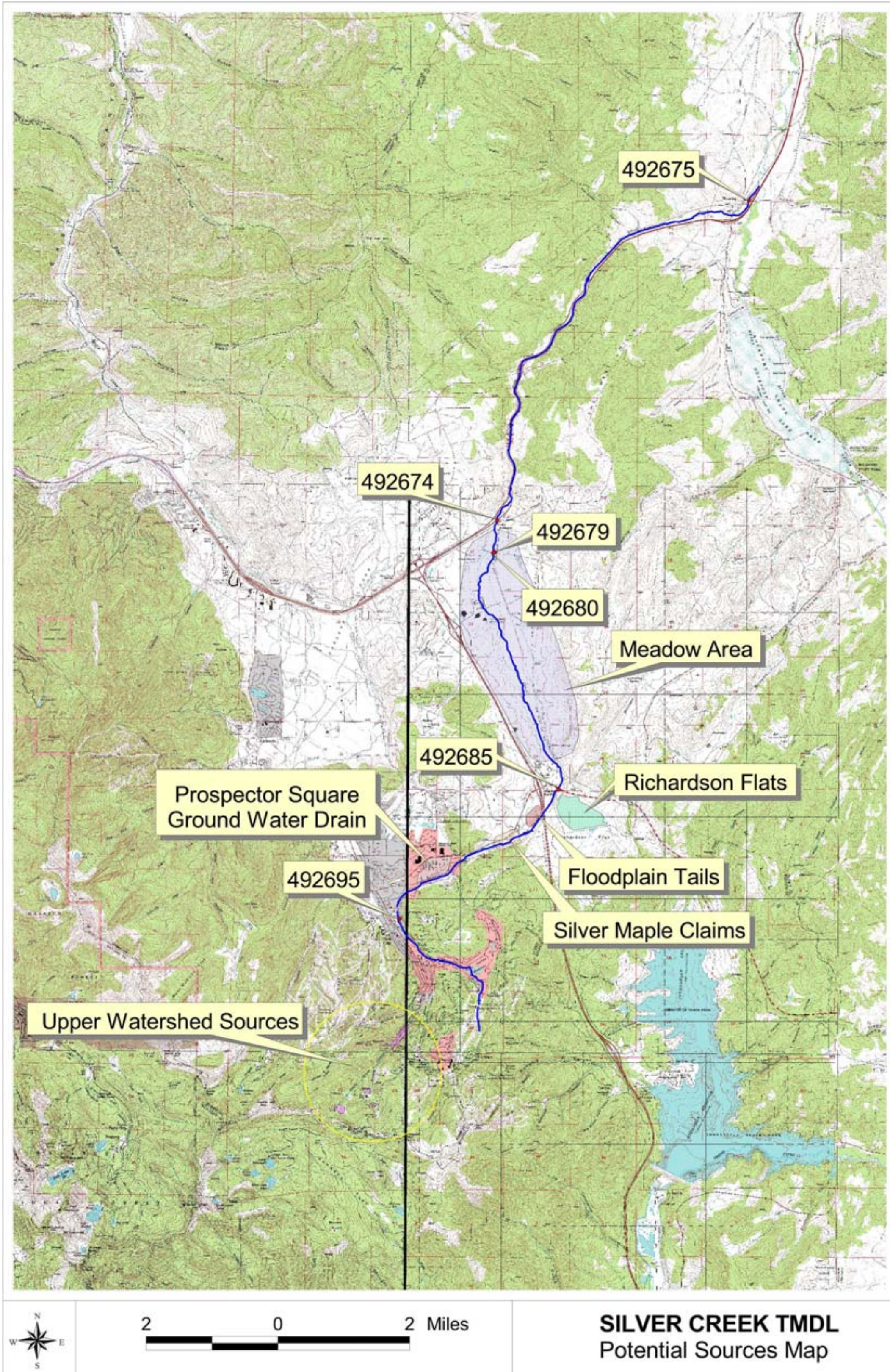

Figure 22: Silver Creek Contaminant Source Map

As the terrain flattens, flow velocities in the stream and from runoff events decrease and begin to deposit the sediments from the upper watershed. Increased sediment deposition leads to increased contamination at these locations (Park City, Silver Maple Claims, Meadow area).

The middle to lower reaches (Flood Plain, Richardson Flats, Meadow area) are substantially flatter than the upstream reaches. These areas were used for tailing reprocessing and disposal. The landscape is littered with mounds of contaminated mine tailings. The meadow area from just below Richardson Flat to Atkinson is nearly completely covered with tailings. The stream channel runs through tailings for a stretch of approximately 4 miles in this meadow area. The contamination processes that are visually apparent include direct storm water runoff to the creek, direct stream contact with tailings and shallow ground water contact with tailings. The ground water table is fairly high and is believed to exchange freely with water in Silver Creek, thus increasing the contaminant load in the stream.

The Silver Creek WRF is a relatively small source of zinc loading currently as it contributes approximately only 598 of the 12,000 lbs per year of zinc passing the Atkinson Station (See Table 8). This represents 5 percent of the total load at Atkinson. Additionally, none of the samples for zinc obtained at the WRF in the 12-year period of this study exceeded the water quality standard for zinc. However, once best management practices are implemented in Silver Creek, the relative contribution of the WRF will become more significant. If growth projections for the WRF are met, the discharge volume will grow from a current value of 1.4 MGD to 2.0 MGD in the next 10 years. This would result in the WRF contributing some 628 lbs. of zinc annually to a combined load at Atkinson after BMP implementation of 4,810 lbs. (13% of the combined load)

Cadmium levels have consistently been below the detection limit, indicating that the WRF does not appear to be a contributor of cadmium to Silver Creek.

The last stream reach (to Wanship) has no tailings or other sources of contaminants besides sediment loads within the stream. This reach is the only section of stream that exhibits reducing levels of contaminants, again probably due to contaminants being adsorbed or precipitated.

Table 12: Source Information

Stream Reach	Source(s)	Owner(s)	Supporting Studies
Above Park City	Upper Watershed	United Park City Mines	Empire Canyon Innovative Assessment Report, DEQ, DERR, 2001 Empire Canyon Draft EECA, United Park City Mines, 2003 USGS WRI 03-4296, 2003; (Silver Maple Claims Loading Study) Data Interpretation Report Upper Silver Creek Watershed, EPA, 2001
Park City to Richardson Flat	Prospector Square Silver Maple Claims Flood Plain Tails Richardson Flat	Park City Municipal BLM United Park City Mines United Park City Mines	Richard Flat RI/FS, United Park City Mines, 2003 USGS WRI 03-4296, 2003; (Silver Maple Claims Loading Study) BLM Silver Maple Site Investigation, 2003 Silver Maple Wetland Functional Assessment, Dynamac, 2003 Macroinvertebrate Study of Silver Maple Claims Area, Univ. of Utah, 2003 Geoprobe Coring Study; Silver Maple Claims Area, Dynamac, 2003 Data Interpretation Report Upper Silver Creek Watershed, EPA, 2001
Richardson Flat to Wanship	Meadow Area	Various Private Land Owners	Lower Silver Creek Innovative Assessment, DEQ, DERR, 2002 USGS WRI 03-4296, 2003; (Silver Maple Claims Loading Study) Data Interpretation Report Upper Silver Creek Watershed, EPA, 2001

6.2 Future sources

United Park City Mines is actively reclaiming mining related disturbed areas in preparation for development construction planned for the upper watershed. Continued improvement in the upper watershed associated with resort development will likely continue to reduce the exposure of metal contaminated materials and should reduce metal concentrations in this portion of the watershed. Areas in the watershed which are currently being developed include the upper watershed area and the East side of the meadow area. It is expected that all future development activities will avoid contaminated areas and, as a result, it is expected that these areas will not contribute zinc or cadmium load to Silver Creek.

7.0 TECHNICAL ANALYSIS

Establishing a relationship between the in-stream water quality targets and source loading is a critical component of the TMDL development. Identifying the cause and effect relationship between pollutant loads and the water quality response is necessary to evaluate the loading capacity of the receiving water bodies. The loading capacity is the amount of pollutant that can be assimilated by the water body while still attaining and maintaining water quality standards. This section discusses the existing and estimated loadings for zinc and cadmium in the Silver Creek watershed.

7.1 Estimation of Existing Load

Estimation of existing loads for zinc and cadmium were calculated using monitoring stations as described in Section 3.3 (Tables 6 & 7). STOrage and RETrieval (STORET) data was collected by the Utah Division of Water Quality over a thirteen-year period between 1990 and 2002, and covers the reach of Silver Creek from the Weber River at Wanship upstream to a station located near Bonanza Drive in Park City. Not all of the sampling stations were sampled consistently throughout this period. USGS conducted two separate studies on Silver Creek, one in 2000 and another in 2002. The USGS sampling locations cover the same reach of the stream as do the STORET stations. In the Year 2000, USEPA sampled during the Spring, Summer, and Autumn periods in the reach of the stream from the vicinity of Richardson Flats upstream to the headwaters of Silver Creek.

7.2 Comparison of Existing Load and Loading Capacity

A water hardness of 400 mg/l was used for establishing the water quality standards for zinc and cadmium. Target annual loads were calculated using hardness adjusted water quality standards. For zinc, the resulting water quality endpoint is 0.39 mg/l. For cadmium, the resulting water quality endpoint is 0.0008 mg/l.

Data are presented in Section 4.0 in the form of average concentrations and flows for bi-monthly periods at each "key" sampling location. Table 7 presents a summary of average flows, concentrations and loads at key stations for each of these bi-monthly periods. This presentation allows for a seasonal analysis of the data for this TMDL. It is apparent that the period from November through February generally is the most critical from a metals concentration perspective with concentrations at their peak during this four month period. This pattern is evident in virtually all of the key stations analyzed. Accordingly, this four month period will be considered the most critical in achieving and maintaining water quality standards for Silver Creek.

In order to achieve the reductions desired, a list of Best Management Practices (BMPs) was developed for the cleanup and/or isolation of mining contaminated materials from stream flows. BMPs are discussed in Section 9.0. Removal efficiencies and costs for BMPs are discussed in Section 10.0. Utilizing the removal efficiencies for each BMP, reductions in zinc and cadmium loading values are calculated along with anticipated stream concentrations after BMP implementation. Completion of scheduled BMPs is expected to achieve and maintain the TMDL endpoints for Silver Creek. Ongoing monitoring as BMPs are implemented will allow verification of progress made toward meeting the endpoints identified for this TMDL.

8.0 TMDL

The purpose of the TMDL report is to provide an estimate of the acceptable load or the degree to which the current pollutants need to be decreased to attain the defined endpoints. This process is based on the following equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

Where:
- WLA = Waste Load Allocation (for point sources – Water Reclamation Facility)
- LA = Load Allocation (for non-point sources) = (target concentration) x (average flow)
- MOS = Margin of Safety = 25%

Table 13 summarizes the TMDL data for both zinc and cadmium. Data presented is in the form of annual load reduction needed and percent reduction required to attain the TMDL endpoints.

Table 13: Zinc and Cadmium Load Allocations / Reductions

Zinc								
Location	Current Avg. Flow (cfs)	Current Annual Load (lbs/yr) [1]	TMDL Target Annual Load (lbs/yr) [2]	Annual NPS Load Allocation (lbs/yr)	Waste Load Allocation (lbs/yr) [3]	Margin Of Safety (lbs/yr) [4]	Overall Annual Reduction Needed (lbs/yr)	% Annual Reduction
Park City	1.7	1,859	870 [5]	652	0	217	989	65%
Richardson	3.2	4,905	2,443	1,832	0	611	2,462	63%
Above Atkinson	2.5	10,226	1,909	1,432	0	477	8,317	86%
Atkinson	6.3	12,142	4,810	1,778	1,830	1203	7,332	70%
Wanship	9.7	8,014	5,535 [5]	2,322	1,830	1384	2,479	48%

1. Current Load = sum of Bimonthly loads in Table 7
2. Using zinc concentration of 0.39 mg/l
3. WLA for Silver Creek WWTP includes 2 MGD @ 0.30 mg/l
4. Margin of Safety is 25%
5. Target loads were adjusted at Park City to accommodate seasonally lower hardness levels during spring and fall flow periods. Target loads were also adjusted at the Wanship station to accommodate lower hardness levels during spring runoff

Cadmium								
Location	Current Avg. Flow cfs	Current Annual Load (lbs/yr) [1]	TMDL Target Annual Load (lbs/yr) [2]	Annual NPS Load Allocation (lbs/yr)	Waste Load Allocation (lbs/yr) [3]	Margin Of Safety (lbs/yr) [4]	Overall Annual Reduction Needed (lbs/yr)	% Annual Reduction
Park City	1.7	17.6	1.8 [5]	1.3	0.0	0.4	15.8	92%
Richardson	3.2	10.3	4.8	3.6	0.0	1.2	5.5	65%
Above Atkinson	2.5	25.8	3.7	2.8	0.0	0.9	22.1	89%
Atkinson	6.3	26.8	9.4	2.4	4.6	2.4	17.4	74%
Wanship	9.7	12.3	11.3 [5]	3.8	4.6	2.8	1.0	31%

1. Current Load = sum of Bimonthly loads in Table 7
2. Using cadmium concentration of 0.0008 mg/l
3. WLA for Silver Creek WWTP includes 2 MGD @ 0.0008 mg/l
4. Margin of Safety is 25%
5. Target loads were adjusted at Park City to accommodate seasonally lower hardness levels during spring and fall flow periods. Target load were also adjusted at the Wanship station to accommodate lower hardness levels during spring runoff

8.1 Zinc

All of the stations indicate TMDL reductions for zinc are required. The greatest reduction (86%) is needed in the stream reach between Richardson and Above Atkinson (Meadow Area on Figure 22). However, all stream reaches except between Atkinson and Wanship require reductions of 63% or greater.

Two stations (492695 – Park City and 492675 – Wanship) demonstrated seasonal variation in hardness values. Station 492695 exhibited lower hardness values during the March through June and in the September through December time periods. Station 492675 exhibited lower hardness values during the spring runoff period of March through June. Both of these instances showed average hardness values that were significantly below the 400 hardness standard used for calculating TMDL targets (see Appendix B for details). Accordingly, the zinc TMDL target concentrations for these two stations were calculated using the lowest bi-monthly average hardness values. This resulted in lower endpoints for these two stations of 0.26 mg/l and 0.29 mg/l respectively for stations 492695 and 492675 in order to be sufficiently protective. These lower endpoints were used to calculate the annual TMDL target loads shown in Table 12.

8.2 Cadmium

TMDL reductions are required for cadmium at all stations based on the newly adopted water quality standard. The greatest reduction (92%) is needed above the Park City station (492695). All stream reaches except between Atkinson and Wanship need load reductions of 65% or greater.

The cadmium TMDL target for the Park City and Wanship stations were adjusted downward in similar fashion to the zinc values to accommodate for seasonally lower hardness values as explained in section 8.1. The endpoints used for these two stations to calculate the annual TMDL target loads shown in Table 12 were 0.00053 mg/l and 0.00059 mg/l respectively for stations 492695 and 492675.

8.3 Silver Creek Water Reclamation Facility

The Silver Creek WRF is a relatively small source of zinc loading currently contributing approximately only 598 of the 12,000 lbs per year of zinc passing the Atkinson Station (See Table 8). This represents 5 percent of the total load at Atkinson. Additionally, none of the samples for zinc obtained at the WRF in the 12-year period of this study exceed the chronic water quality standard for zinc. If growth projections for the WRF are met, the discharge volume will grow from a current value of 1.4 MGD to 2.0 MGD in the next 10 years with an ultimate buildout at 4.3 MGD. The source of zinc in the Silver Creek WRF effluent is from the drinking water supply for Park City. As growth continues in the Snyderville Basin area, new sources of drinking water will not have the background zinc concentrations currently evident in the drinking water supply. Existing sources are at maximum production and will not contribute any added water to the drinking water supply. New water sources will most probably come from waters not impacted by historic mining.

Projected zinc concentrations and annual loads from the WRF using estimated average zinc effluent concentrations, assuming new sources of drinking water have little if any metals, are shown in Table 14.

The flows from the Silver Creek WRF provide significant dilution of zinc concentrations in Silver Creek. As the plant effluent flows grow and zinc concentrations are reduced, via increased inflows from source waters without measurable zinc values, this dilution impact will increase. The WRF provides a positive impact on water quality in Silver Creek in regards to metal concentrations.

Table 14. Growth Projections; Silver Creek WRF

Silver Creek WRF			
	WRF Flows (MGD)	Zn (mg/l)	Load (lbs./yr.)
Current 2003	1.4	0.14	598
Est. by 2010	2	0.103	628
Max Build-out	4.3	0.054	708

A flow weighted mixing model was utilized to derive the required effluent limits for the Silver Creek WRF for zinc. The following inputs and assumptions were included in this analysis:

- A realistic growth component was incorporated into the analysis by utilizing the WRF's growth projections. The current flow average for the plant of 1.4 MGD is expected to grow to 2.0 MGD over the next 10 years.
- The historical effluent concentration of zinc and cadmium from the WRF of 0.14 mg/l and below detection level respectively, will be reduced given that new sources of drinking water will come from sources not contributing metals and that the plant processes currently utilized should not change even if the average flows increase some 30% (1.4 MGD to 2.0 MGD).
- The effluent limit established must result in the downstream concentrations after mixing of the stream and the WRF effluent achieving the chronic water quality standards.
- The zinc and cadmium loads from non-point sources will be reduced by 90% from implementation of best management practices (BMPs) outlined in sections 9.0 and 10.0.
- An explicit margin of safety of 25% is included to provide assurance that the uncertainty in the existing data set and effectiveness of the BMP implementation in meeting the 90% reduction goal are accounted for.

Zinc - Figure 23 depicts the required effluent concentration for zinc for the six seasons used for seasonal analysis. The most restrictive season of the year from a concentration perspective is the November through February time frame. The flow weighted mixing model results shown in Figure 23 indicate that the Nov/Dec time period effluent limit of 0.30 mg/l is the most stringent result over the entire year. If a 0.30 mg/l effluent limit is met for zinc throughout the year by the WRF, the downstream concentration of zinc after mixing with the stream should consistently achieve the hardness adjusted chronic water quality standard of 0.39 mg/l.

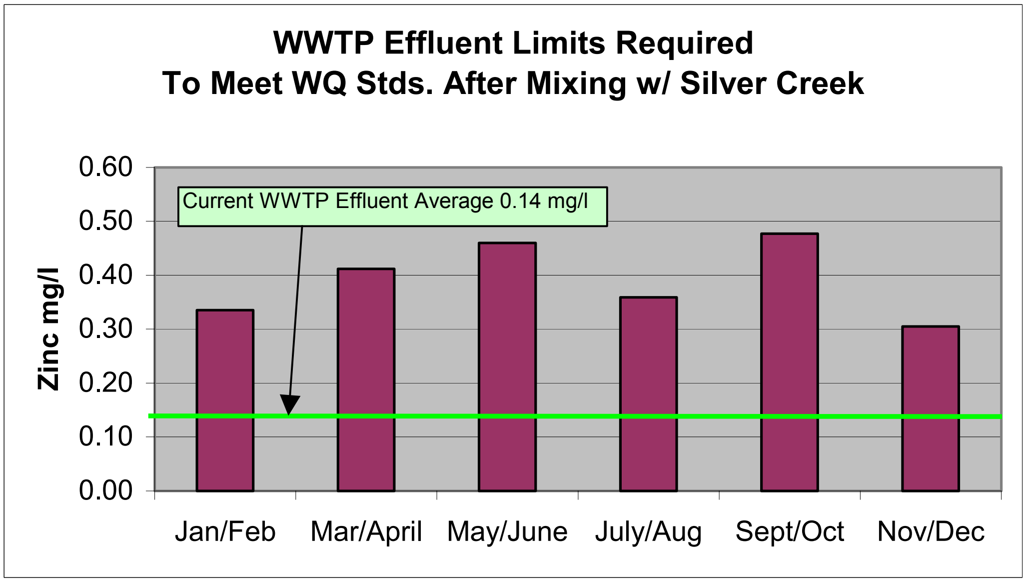

Figure 23: Silver Creek WRF Zinc Effluent Limit Needed to Achieve Water Quality Standards in Silver Creek after Mixing

Cadmium - The historical WRF effluent data for cadmium shows that virtually all of the values are below the detection limit. In order to be protective of the stream, an effluent limit that at least meets the new water quality standard should be imposed. It is unlikely that measurable contributions of cadmium will be detected from the Water Reclamation Facility.

Effluent Limit Implementation - The time-frame for including the proposed effluent limits for the Silver Creek WRF is not urgent given that currently, the non-point source loads dwarf the point source contribution. The current zinc loads from NPS sources will undoubtedly take 5 to 10 years for completion of the BMPs needed to address the NPS loads. Accordingly, the effluent limits for the Silver Creek WRF need not be in place until the NPS loads have been reduced by at least 75% of the target value through implementation of BMPs. Using zinc as the constituent of interest, this would translate into a load reduction of 7,670 lbs. needed at the "above Atkinson" station (or a total load of 2,556 lbs. of zinc measured at above Atkinson) to trigger the need for point source effluent limits to be in place.

9.0 BEST MANAGEMENT PRACTICES

The following sections describe Best Management Practices (BMPs) for the cleanup and/or isolation of mining contaminated materials from stream flows. The list is not all inclusive as specific site conditions may change, requiring changes to the specific BMPs, or additional BMPs not listed herein.

In general, there are two types of BMPs: source controls and treatment controls. Source controls focus on minimizing or eliminating the source of contamination so that contaminants are prevented from entering the stream system. Treatment controls are designed to remove a contaminant after it has entered the stream system.

A third type of BMP, ordinances, are discussed briefly within each control description and again in Section 10.0, Project Implementation Plan (PIP).

9.1 Source Control BMPs

Slope Protection
Slope protection BMPs are designed to minimize and protect exposed soil surfaces to help reduce erosion and the associated discharge of sediment to nearby streams. Sample slope protection BMPs include mulching, hydromulching, geotextile, matting, topsoiling, vegetating, and permanent surfacing. The use of cutoff ditches or swales at the top of the slopes is encouraged to keep runoff from entering the slope protection area.

Storm Runoff Routing
Storm runoff is responsible for carrying contaminated sediments from a contaminated site to the affected stream either by direct surface run-off or by percolating into the soil and eventually into the stream via groundwater. BMPs included in this category are measures designed to divert run-off from entering the site, keep run-off from leaving the site, or divert run-off away from sensitive sites. Sample BMPs include temporary sediment trapping measures (silt fencing, straw bales), swales/ditches, berms, dikes, and storm drain systems.

Isolation Measures
Isolation measures require that contaminated soils be isolated either onsite or removed to a "secure location." Isolating contaminated soils would include capping (above and below) with an impervious surface, i.e. clay, to prevent groundwater infiltration of contaminated run-off (percolation), diversion of run-off, and removal or enclosure (pipe) of stream channel through isolated area.

Additionally, contaminated sediments within the stream channels may have to be removed and relocated to a secure site if sediment transport is a concern. Sealing the stream channel with clay, bentonite, or other impervious material may keep contaminated stream flows from entering the ground water or contaminated groundwater from entering the stream flows.

Temporary Erosion Control

New construction activities will require permitting from the local, State, or Federal jurisdiction. Each jurisdiction should require an approved erosion control plan for stormwater pollution control. Sites within Park City jurisdiction that involve contaminated soils are subject to Park City's Landscaping and Maintenance of Soil Cover ordinance (Chapter 15 Title 11 Park City Municipal Code) that requires contaminated soils be addressed prior to construction. Temporary erosion control measures include silt fencing, hay bales, diversion ditches, temporary sedimentation/debris basins, channel protection (riprap, matting), and vegetative buffers. Some temporary measures, i.e. diversion ditches, may become part of the permanent erosion control measures.

9.2 Treatment Control BMPs

Water Treatment BMPs

Treatment BMPs are designed to remove contaminants/pollutants from flows (either run-off or stream) and return treated water to the receiving water, in this case Silver Creek. BMPs in this category include water/sediment separators, treatment wetlands, enhanced wetlands.

10.0 PROJECT IMPLEMENTATION PLAN

The Silver Creek TMDL water quality study has been a joint effort with numerous stakeholders. One of the significant regulatory programs involved along with the Utah Division of Water Quality is the EPA and State Superfund (CERCLA) programs. Given the historical mining wastes that are the primary sources for the water quality impairment, an approach that is similar to a Superfund RI/FS process is appropriate for this study. This TMDL lays out the endpoints or water quality goals for the watershed along with loading allocations needed to achieve the identified endpoints. However, it is beyond the scope of this TMDL to provide a detailed plan or program for clean up measures associated with historical mining in this watershed. The detailed analysis of clean up options and remedies along with determination of responsible parties, possible funding sources, and scheduling of clean up operations is best handled using a cooperative watershed approach and following most of the functional steps used in the Superfund arena.

Accordingly, the Implementation Measures that follow are only a very rough outline of possible approaches to remedy the water quality pollution present in Silver Creek. In this case, the PIP focuses on reducing the chronic levels of zinc and cadmium as listed in Table 13 (Section 8.0). Some of the approaches presented herein are worst case scenarios from a cost perspective and are in all likelihood too high to be considered. Much work is needed to identify the various alternatives for clean up, assign costs, assess feasibility and make a final determination. Accordingly, the detailed clean up plan and implementation for the Silver Creek Watershed will be handled by the EPA and State Superfund programs.

Funding to accomplish the proposed clean up options poses a very challenging obstacle given that there is little if any federal monies from the Superfund program for this type of clean up. It will be incumbent upon stakeholders and members of the community to creatively locate funding sources and make certain that the priority and order of clean up projects is conducted in the most cost effective manner possible.

The following sections describe implementation measures, contaminant removal efficiencies, order of magnitude costs, and a broad-based implementation schedule.

10.1 Implementation Measures

The following implementation measures should be undertaken to successfully achieve the endpoints identified:

- *Slope Protection (stabilization)* – slopes containing contaminated mine tailings should be stabilized to prevent infiltration of water and dispersal of contaminants from run-off. Slope stabilization measures were discussed in Section 9.0.
- *Storm runoff routing* – The BMPs included in this category are measures designed to collect sediment produced onsite, divert run-on from entering the site, keep runoff from leaving the site, or divert runoff away from sensitive areas or certain site activities. Examples of measures are swales, berms, and detention/retention ponds.
- *Isolation measures* – areas that have been identified as containing contaminated mine tailings should be isolated to prevent further contamination of Silver Creek, ground

water, and surrounding soils. Isolation measures will be dictated by the extent of the contamination as well as physical characteristics of the contaminated area. Measures can range from construction of diversion swales/ditches to re-route run-off, to removal of contaminated material and remediation of contaminated site. At a minimum, erosion control measures should be established to prevent run-off from entering and contaminated sediments from leaving contaminated sites.

- *Treatment Measures* – Contaminated flows can effectively be treated with the use of man-made or naturally occurring wetlands, i.e. Silver Maple Claims. Flows can be routed into wetlands with the appropriately designed inlet/outlet structures to ensure adequate retention time for the biological removal of contaminants in the water column. Off–site or tributary flows, i.e. storm run-off, can be treated using local storm water programs, i.e. UPDES. Storm water can be managed using proper erosion control measures, following guidelines as established by the state and Federal governments, and ensuring that storm water controls are being applied as necessary.
- *Ordinances* – Local and State ordinances require the use of erosion control measures during construction or other disturbance activities. The Park City Landscaping and Maintenance of Soil Cover ordinance (LMSC) requires that contaminated soils, at construction sites, be isolated either by capping onsite or removal to an approved site.

Table 15 describes the types of BMPs recommended and contaminant removal efficiencies within each BMP category.

Table 15: Best Management Practices – Description and Removal Efficiencies

BMPs	Description	Removal Efficiency	References
Slope Protection (Stabilization)			
topsoil	Imported topsoil placed at a minimum depth of 1 foot, sometimes seeded and treated to promote growth of vegetation.	84%	Strock, 1998; Georgia Stormwater Manual; Idaho BMPs
Geotextile or matting	Matting or fabric placed on steeper slopes for erosion control and to promote vegetation growth.	80%	Georgia Stormwater Manual; Idaho BMPs
revegetation	Seeding or placement of seed/mulch/compost mixture to promote vegetation growth and slope stabilization.	84%	Strock, 1998; Georgia Stormwater Manual; Idaho BMPs
hard surfacing	Pavement or other impermeable surface to prevent infiltration of water to contaminated soils.	100%	Georgia Stormwater Manual
Storm Runoff Routing			
grading to ensure positive drainage	Site grading to deter storm water from pooling on or entering contaminated site.	84%	Strock, 1998; Georgia Stormwater

BMPs	Description	Removal Efficiency	References
			Manual; Idaho BMPs
Diversion ditches or berms	Ditches/swales/berms or other grading features to encourage water from entering contaminated sites or divert water to containment area within contaminated site.	84%	Strock, 1998; Georgia Stormwater Manual; Idaho BMPs
storm drain system	Use of storm drain system, i.e.: inlets, pipes, basins to route and contain runoff.	100%	N/A
detention/retention basins	Use of detention/retention basins to contain runoff onsite, possible allow sediments to settle out and be removed.	80%	Georgia Stormwater Manual; Idaho BMPs
Isolation Measures removal of contaminated soils	Removal of contaminated soils to approved "isolated" area.	100%	N/A
onsite capping of contaminated soils	Capping of contaminated soils on site using clay, topsoil, etc.	84%	Strock, 1998
clay-lined ditch or pipe	Using "sealed" ditch or pipe to convey stream flows. Sealed ditch or pipe will prevent infiltration to groundwater and possibly addition of further flows from storm runoff.	100%	N/A
Water Treatment wetland	Enhancement or creation of wetland either within the stream channel or off channel for the removal of heavy metals using select plant species.	>99%	Bolis, 1991
sediment basin	Use of sedimentation or stilling basin to allow sediments to settle out. Sediments can be removed from basin using excavating equipment and transported to an "isolated" site for final disposal.	80%	Strock, 1998; Georgia Stormwater Manual; Idaho BMPs
Ordinances Erosion Control during construction activities	NPDES, Local and State ordinance mandate temporary and permanent erosion control activities for all new construction. Disturbed areas shall be addressed to ensure that no sediment laden runoff is allowed to leave site.	80%	Georgia Stormwater Manual; Idaho BMPs
Park City Soil Landscaping and Maintenance of Soil Cover ordinance	Soil testing, capping & isolation or removal to a permitted storage facility.	80 – 100%	Park City LMSC Ordinance

BMPs	Description	Removal Efficiency	References
Superfund	Designation of a Superfund site would require full cleanup of that site. Cleanup could include removal or capping of contaminated soils.	Site specific requirements	CERCLA cleanup standards

N/A: Not Applicable

Further data gathering and analysis will more effectively identify contaminated areas and applicable BMPs to manage these areas. Management schedules can also be developed once further data have been gathered and there has been review of this document by stakeholders and the public.

10.2 Implementation Measures by Site

The following are site specific BMPs for the Silver Creek watershed. Sites are listed sequentially from headwater downstream.

Empire Canyon (Daly West Mine, Alliance Mine)
The following information was taken from the *Draft Engineering Evaluation/Cost Analysis for Empire Canyon, EPA ID No. 0002005981, March 2003.* (Draft EE/CA)

The Draft EE/CA established two response action objectives (RAOs) for Empire Canyon:
1. Isolation of surface water from mine wastes in the Empire Canyon Site.
2. Minimizing the potential for human exposure to elevated lead and arsenic concentrations on recreational trails.

The recommended response action for the site is a combination of:
1. Waste isolation with onsite repository; and
2. Waste isolation on UPCM property (Richardson Flat), removal and offsite disposal.

Waste isolation involves isolating surface water from mine wastes using the following methods:
- Excavating stream channels and reconstructing using riprap or culverts (Empire and Walker Webster stream channels).
- Lining sections of stream channels with clay liners to keep water on surface (no infiltration).
- Recreational trails containing contaminated soils will be covered with clean material. Some trail sections may be rerouted.
- The Daly West mine dump will be recontoured and covered with clean material. Some surface water flow in the vicinity of the mine dump will be re-routed to minimize contact with contaminated materials.
- Cut-off ditches will be placed upstream from the Daly West mine dump to intercept runoff from above the site.
- Surface water from the Empire, Daly Draw, and Walker Webster channels will be directed into a culvert and away from contaminated materials.

Mine waste removal and disposal:

- Approximately 4,500 linear feet of stream channel will be remediated.
- Approximately 2,500 linear feet of recreational trail will be remediated.
- Portions of the Alliance and Daly West mine dumps will be re-graded and capped with clean material.
- Excavated materials will be placed in an on site clay lined repository at the Daly West mine or transported offsite to Richarson Flat where it will be contained within a tailings impoundment.

The Draft EE/CA identifies the preferred alternative as being highly effective through the use of erosion control/storm water routing measures, topsoil and revegetation, clay lined channels, pipe culverts, and contaminated soil removal.

Daly West Mine (site inspection 11/8/2002)
The Daly West Mine is located on the ski area within several hundred feet of a chair lift. The site has been graded to promote drainage of run-off away from contaminated soils. Diversion ditches have been excavated to intercept and divert run-off away from contaminated soils. Portions of the area have been covered with topsoil and revegetated. Part of a parking lot has been paved , essentially covering and protecting the tailings.

Recommendations for this area include: analyze diversion ditches to determine the need for channel linings to prevent erosion by high water velocities; soil cover at a minimum of one foot depth; seed and treat soil to promote growth of vegetation; ensure that all drainage is diverted away from site.

Mine Office Area (site inspection 11/8/2002)
The area around the mine office is steeply sloped, unvegetated, and otherwise exposed to the elements. Some of the tailings have been covered by parking area and some topsoil. There is evidence of active erosion from run-off.

Recommendations include: regrading and covering the yard area with one foot of soil ensuring positive drainage away from the tailings, regraded area should be revegetated; the outer slope of the embankment (composed of mine spoil) should be regraded to a stable slope of 2H:1V, covered with a minimum of one foot of soil, limed, fertilized and revegetated; the roadside ditch (at the toe of regraded slope) may carry the run-off from the area to a sediment basin/wetland prior to its discharge into the area stream.

Empire Canyon (site inspection 11/8/2002)
Empire Canyon consists of a fairly large steep side slope covered by mine tailings. The stream channel is located a short distance from the toe of the slope. Rip rap has been placed within the channel for protection. Currently there is no run-off diversion, erosion control, vegetation or other form of slope protection.

Recommendations for this site range from onsite slope stabilization to removal of contaminated soils to a “secure” site.

- *Slope stabilization:* Slopes are fairly steep and would consequently not accept a layer of topsoil without extensive erosion control measures and constant maintenance. A more permanent surface would be required, i.e. shotcrete or gunnite. A diversion swale at the top of the slope to intercept and re-route run-off would also be required.
- *Removal of soils:* A secure location would have to be prepared prior to soil relocation. Securing a site would involve rerouting all runoff and placing an impermeable seal to prevent leachate from percolating and entering groundwater.
- *Stream isolation:* Stream reaches where contaminated run-off may come in contact with the stream could be isolated either by piping the stream at that location or providing diversion ditches at the toe of the slope to intercept contaminated run-off. Stream piping would take into consideration major flood events, seasonal flow variations, environmental permitting, and aesthetics. Diversion ditches at the toe of the slope would have to route water to a treatment facility prior to discharge to the stream. The treatment facility could be a separator or sedimentation basin. Treatment facilities typically have area and maintenance requirements.

Prospector Square (site inspection 11/8/2002)
Prospector Square is a developed area of Park City. It is home to several hotels, condominiums, restaurants, shopping complexes and single family homes. Shallow ground water is drained from Prospector Square via buried pipe directly to an open water pond (sub-surface) upstream of the Silver Maple Claims area. Current BMPs include the Park City LMSC ordinance and the wetland complex. The Park City ordinance requires that developers address contaminated soils prior to construction. Contaminated soils are “capped” onsite to prevent offsite transport of pollutants. The soil cap must be vegetated and maintained.

Recommended BMPs include: rerouting of the drainage pipe from Prospector Square away from Silver Creek to a constructed wetland area for treatment. The water from the treatment wetland will eventually make its way back to Silver Creek; enhance the existing wetland complex by enlarging the emergent marsh areas and by planting heavy metal removing plant species. Enhancement should also include site monitoring and maintenance. Additionally, ensuring that the Park City LMSC ordinance is enforced and that proper erosion control measures are employed during construction and other earth disturbing activities.

Silver Maple Claims (site inspection 11/8/2002)
Silver Maple Claims is located downstream of Park City and is comprised of a large wetland complex. The wetland complex includes open water and emergent marsh areas. Source of water into this area has been determined to be Silver Creek, groundwater, and ground water drainage from the Prospector Square area of Park City.

Wetlands, specifically wetland vegetation, have been shown to effectively remove heavy metals from water. Proper management of the wetland complex at Silver Maple Claims will ensure continued removal of contaminants from Silver Creek. Rerouting of the drainage pipe from Prospector Square should reduce the amount of contaminants flowing downstream to Silver Maples Claims.

Recommended BMPs include: removal of contaminated tailings and construction of water control structures to manage surface flows from wetland complex to wetland complex.

Contaminated water within each wetland will become continuously cleaner as it is routed through the wetland complexes prior to discharge into the creek; enhance the existing wetland complexes by enlarging the emergent marsh areas and by planting heavy metal removing plant species. Enhancement should also include site monitoring and maintenance. Additionally, ensuring proper erosion control measures are employed during construction and other earth disturbing activities.

Flood Plain Tailings (site inspection 11/8/2002)
The flood plain tailings site is located on the north side of Silver Creek, between the Rail Trail and the access road to Richardson's Flat. The site is characterized by "perched" wetlands and scrub-shrub vegetation. The source of water for the wetlands appears to be surface and ground water flowing from the west to the creek.

Recommended BMPs include: either removal of contaminated tailings and or construction of water control structures to manage surface flows from wetland complex to wetland complex and possibly to a constructed wetland area for treatment. Contaminated water within each wetland will become continuously cleaner as it is routed through the wetland complexes prior to discharge into the creek; enhance the existing wetland complexes by enlarging the emergent marsh areas and by planting heavy metal removing plant species. Enhancement should also include site monitoring and maintenance.

Richardson Flat (site inspection 11/8/2002)
At this time, it is believed that Richardson Flat is a potential contributor of contaminants to Silver Creek. Groundwater data including flows, flow direction, and contaminant concentrations is currently being collected and will be assessed by others in the future.

Above Atkinson (site inspection 11/8/2002)
The topography of the area is fairly flat for a 4-6 mile reach. The area is characterized by a slightly meandering stream channel, fairly wide vegetated flood channel, and widespread tailing deposits that includes some mounds of mine tailings. The stream channel runs through tailings for a stretch of approximately 4 miles in this meadow area. Anecdotal evidence suggests that tailings from the mines were brought to this area in an attempt to further extract valuable materials. One of the largest recovery operations in this area was the Big Four mill, in operation from approximately 1915 to 1918. The mill site has a large concentration of tailings depositions. There are currently no BMPs in place.

Recommended BMPs include: removal of all contaminated materials to a secure location; stabilizing and isolating contaminated materials onsite. This may not be practicable due to the large geographic extent of the area covered by the tailings. Additionally, groundwater contributes to the flows in Silver Creek through this reach. Isolating the tailings may affect groundwater flows; "seal" the creek bed using clay, bentonite, or some other material thus preventing flow to or from Silver Creek. Again, sealing the creek may adversely affect flows if ground water is isolated from the creek.

Other items to take into account when considering applicable BMPs are current irrigation practices. Numerous diversions exist along Silver Creek that allow farmers/ranchers to access water for irrigation and livestock use. The number of diversions and amount of water drawn from the creek are unknown at this time. Also unknown is whether diverted water has had adverse effects on surrounding soils or groundwater.

More data, i.e. groundwater, irrigation practices, soil analysis is required to effectively address the BMPs for this stretch of Silver Creek.

Silver Creek Water Reclamation Facility
Silver Creek WRF has historically been in compliance with state water quality standards for zinc and cadmium. Zinc values have averaged 0.14 mg/l and cadmium has never been detected at the site. It is expected that future patterns will be similar to historical ones. Cadmium levels should remain below the laboratory detection limit of 0.001 mg/l.

Below Atkinson (site inspection 11/8/2002)
This section of Silver Creek, as discussed in Section 4.4, does not appear to contribute to contaminant levels in the creek. BMPs implemented upstream from this section should have positive effects in contaminant levels. No BMPs are recommended at this time aside from continued monitoring.

10.3 Implementation Measures Efficiencies and Costs

Tables 16 and 17 present the BMP effectiveness and projected removal of zinc and cadmium for the five stream reaches of Silver Creek.

Table 16: BMP Effectiveness – Zinc removal

Stream Reach	Stream Reach Length (miles)	Zinc Annual Load (lbs)	Zinc Annual Load Reduction Needed (lbs)	Proposed BMP Removal Efficiency	Projected Zinc Total Removal (lbs)
Above Park City	2.6	1,859	989	80 - 100 %	1,487
Park City to Richardson Flat	3.4	4,905	2,642	85 – 99%	4,169
Richardson Flat to Above Atkinson	4.1	10,226	8,317	85 – 100%	8,692
Above Atkinson to Atkinson	0.5	12,142	7,332	85 – 100%	10,320
Atkinson to Wanship	7.5	8,014	2,479	[1]	2,479 [1]

1. Removal estimates in this reach are based on upstream reductions already achieved.

Table 17: BMP Effectiveness – Cadmium removal*

Stream Reach	Stream Reach Length (miles)	Cadmium Annual Load (lbs)	Cadmium Annual Load Reduction Needed (lbs)	Proposed BMP Removal Efficiency	Projected Cadmium Total Removal (lbs)
Above Park City	2.6	17.6	15.8	80 - 100 %	14
Park City to Richardson Flat	3.4	10.3	5.5	85 – 99%	8.7
Richardson Flat to Above Atkinson	4.1	25.8	22.1	85 – 100%	21.9
Above Atkinson to Atkinson	0.5	26.8	17.4	85 – 100%	22.8
Atkinson to Wanship	7.5	12.3	1.0	[1.]	1.0 [1.]

1. Removal estimates in this reach are based on upstream reductions already achieved.
*The same BMPs will be used for Cadmium as will be used for Zinc.

Costs
The following item costs and assumptions were used for calculating costs of BMP implementation:

*Excavation = $4/cu.yd.	Excavation is to a depth of 4 feet and includes hauling materials to a maximum distance of 5 miles.
**Topsoil = $15.50/cu.yd.	Topsoil includes materials and spreading. All excavated areas will be topsoiled at a depth of 6" to 8".
*Lined Ditch = $50/ft.	Ditch/stream liner will be concrete or clay.
*36" Pipe Culvert = $60/ft	Includes placement.
*48" Pipe Culvert = $88/ft	Includes placement.
***Wetland Creation = $3/sq.ft.	Includes earthwork and vegetation

*Utah Department of Transportation - Statewide Standard Item Average Prices and Total Quantities 2002
**Local Park City costs. For purposes of calculations, $15.50/cu.yd = $2.60/sq.yd @ 6" depth.
***Brodie, 1993

For purposes of cost estimating, it is assumed that Silver Creek will either be placed in a lined ditch or in a 48" pipe culvert. A 48" pipe should accommodate anticipated flows, storm events etc., can overflow into the irrigation system and be retained at the irrigation holding pond to the north.

All contaminated soil will be excavated and removed to an approved repository (Richardson Flat). All disturbed areas shall be regraded and covered with 6 to 8 inches of topsoil.

Costs are summarized by stream reach below and presented in Table 18. All costs are based on estimated area and length measurements taken from readily available maps.

Table 18: Proposed BMPs, Efficiencies, and Costs

Reach	BMPs Proposed	BMP Efficiency (% contaminant removal)	BMP Cost
Above Park City (Empire Canyon)	Slope Protection Stabilization; Storm Runoff Routing; Isolation Measures	80 - 100 %	$1.17 million*
Park City to Richardson Flat	Slope Protection Stabilization; Storm Runoff Routing; Isolation Measures; Water Treatment; Ordinances	85 - 99 %	$8.33 million to $9.01 million
Richardson Flat to Above Atkinson	Storm Runoff Routing; Isolation Measures	85 – 99 %	$101.72 million to $102.54 million
Above Atkinson to Atkinson	Storm Runoff Routing; Isolation Measures	85 - 100 %	$9.58 million to $9.68 million
Atkinson to Wanship	None	n/a	n/a

*Cost estimate from Draft Empire Canyon EE/CA
n/a = not applicable

Above Park City
Cost estimates for this portion were calculated in the Draft Empire Canyon EE/CA at approximately $1.7 million.

Park City to Richardson Flat
Silver Maple Claim and Flood Plain Tails are included in this section.

The stream reach from Park City to Richardson Flat is approximately 3.4 miles in length. Isolation of the stream would require a pipe culvert or lined ditch/stream channel.

Lined ditch/stream = (3.4 miles)($50/ft) = $897,600.00
or 48" pipe culvert = (3.4 miles)($88/ft) = $1,579,776.00

The BLM proposes to move contaminated tailings from the Silver Maple Claim site to an approved repository. The area containing contaminated soils is approximately 60 acres is size. Approximately 387,197 cubic yards of material would be excavated and moved.

Excavation = (387,197 cu.yd.)($4.00/cu.yd.) = $1,548,788.00
Top soil = (290,398 sq.yd.)($2.60/sq.yd.) = $755,034.80
Excavation and Topsoil Total = $2,303,822.80

Contaminated tailings from the Floodplain Tails site would be moved to an approved repository. The area containing contaminated soils is approximately 130 acres is size. Approximately 838,927 cubic yards of material would be excavated and moved.

Excavation = (838,927 cu.yd.)($4.00/cu.yd.) = $3,355,708.00
Top soil = (629,195 sq.yd.)($2.60/sq.yd.) = $1,635,907.00

Excavation and Topsoil Total = $4,991,615.00

Wetland at Silver Maple Claims Complex
The Wetland is sized based on the maximum daily metal load (Zn and Cd) of 12.73 lbs/day (5774 gms/day) and metal removal capacity of 4.3 gms/day/m^2 of wetland surface area . Wetland area required is approximately 0.34 acres (1342 m^2).

(0.34 acres)(43560 sq. ft./acre)($3.00/sq.ft.) = $44,431.00

Wetlands at Flood Plain Tailings
The Wetland is sized based on the maximum daily metal load (Zn and Cd) of 27.18 lbs/day (12,329 gms/day) and metal removal capacity of 4.3 gms/day/m^2 of wetland surface area . Wetland area required is approximately 0.71 acres (2867 m^2).

(0.71 acres)(43560 sq. ft./acre)($3.00/sq.ft.) = $92,782.80

Richardson Flat to Above Atkinson
The stream reach from Richardson Flat to Above Atkinson is approximately 4.1 miles in length. Isolation of the stream would require a pipe culvert or lined ditch/stream channel.

Lined ditch/stream = (4.1 miles)($50/ft) = $1,082,400.00
or 48" pipe culvert = (4.1 miles)($88/ft) = $1,905,024.00

The area containing contaminated soils is approximately 2621 acres in size. Moving contaminated tailings material to an approved repository would involve the excavation of 16,914,070 cubic yards of material.

Excavation = (16,914,070 cu.yd.)($4.00/cu.yd.) = $67,656,280.00
Top soil = (12,685,540 sq.yd.)($2.60/sq.yd.) = $32,982,404.00
Excavation and Topsoil Total = $100,638,684.00

Above Atkinson to Atkinson
The stream reach from Above Atkinson to Atkinson is approximately 0.5 miles in length. Isolation of the stream would require a pipe culvert or lined ditch/stream channel.

Lined ditch/stream = (0.5 miles)($50/ft) = $132,000.00
or 48" pipe culvert = (0.5 miles)($88/ft) = $232,320.00

The area containing contaminated soils is approximately 246 acres in size. Moving contaminated tailings material to an approved repository would involve the excavation of 1,587,519 cubic yards of material.

Excavation = (1,587,519 cu.yd.)($4.00/cu.yd.) = $6,350,076.00
Top soil = (1,190,631 sq.yd.)($2.60/sq.yd.) = $3,095,640.60

Excavation and Topsoil Total = $9,445,716.60

*The preceding list of implementation measures and costs does not include possible wetland mitigation costs associated with the Army Corps of Engineers 404 permitting process. These costs would need to be developed on a project by project basis as more detailed planning is undertaken.

10.4 Implementation Schedule

Empire Canyon EE/CA - Fall 2003, clean up begins late Fall 2003, Spring 2004
BLM/Silver Maple Claim – Draft EE/CA Fall 2004, clean up begins following resolution of Prospector Drain treatment.
Richardson Flat – Decision document late 2003/early 2004 (EPA Action Memo regarding use of site for repository)
Prospector Square – new soils ordinance Fall 2003, ongoing monitoring (water in pipe) through Summer 2004.

All cleanup and containment of contaminated sites should be complete by 20014, assuming a ten year cleanup period beginning January 2004. Implementation is subject to adequate funding.

11.0 TMDL EVALUATION AND MONITORING PLAN

An ongoing water quality monitoring program will be required to assess the affect of clean up and remediation work in the Silver Creek watershed. It is anticipated that as clean up progresses, metal concentrations in the water column will decrease proportionately. Since there is a degree of uncertainty regarding the actual effectiveness of any non-point source clean up, actual monitoring of water quality is the best measure of success. The table below outlines the monitoring program planned for Silver Creek over the next 5 years. The program establishes an intensive program every 5th year with quarterly monitoring in the intervening years. The Division of Water Quality will undertake the sampling and analysis responsibilities for this program.

Table 19: Division of Water Quality Monitoring Program for Silver Creek

Station	Storet No.	Frequency	No. of Samples	Parameters
SILVER CREEK AT CITY PARK ABOVE PROSPECTOR SQUARE	492695	2004 - 2007 Schedule B; 2003 & 2008 Schedule A	4 for Schedule A; 16 for Schedule B	Chemistry Type 2; Metals Type 3; Nutrient Type 9
SILVER CREEK AT US40 CROSSING EAST OF PARK CITY	492685	same as 492695	same as 492695	same as 492695
SILVER CREEK ABOVE ATKINSON	492680	same as 492695	same as 492695	same as 492695
SILVER CREEK WRF	492679	same as 492695	same as 492695	same as 492695
SILVER CREEK AT FARM CROSSING IN ATKINSON	492674	same as 492695	same as 492695	same as 492695
ALEXANDER CREEK AT HIGHWAY CROSSING	492670	same as 492695	same as 492695	same as 492695
SILVER CREEK AT WANSHIP ABOVE CONFLUENCE WITH WEBER RIVER	492675	same as 492695	same as 492695	same as 492695

Frequency

A. Biweekly March thru July; snowmelt to low flow (approx 9 events); monthly during low flow (approx August - Feb; 7 events.)

B. Quarterly

Parameters

Chemistry Type 2: Bicarbonate, Carbonate, Chloride, Hydroxide, pH, Specific Conductance, Sulfate, Total Alkalinity, Total Dissolved Solids, Total Hardness, Total Suspended Solids, and Turbidity**.**

Metals Type 3: Dissolved Aluminum, Arsenic, Barium, Cadmium, Chromium, Copper, Iron, Lead, Manganese, Mercury, Selenium, Silver, Zinc, Calcium, Magnesium, Potassium, Sodium

Nutrient Type 9: Ammonia, Dissolved Nitrite & Nitrate, Total Phosphorus, Total Dissolved Phosphorus

Results from the monitoring program will be reviewed annually and any adjustments needed to the program will be made.

12.0 PUBLIC PARTICIPATION

12.1 Public Participation Meetings

A public participation meeting was held on September 13, 2001 at the Miners Hospital Community Center in Park City, Utah. The public was notified of the meeting through the local news media. In addition, a letter of invitation was sent to local stakeholders and citizens to inform them of the public meeting. This meeting was designed to provide information and education on the TMDL process.

A public meeting was held on August 19, 2003 at the Empire Canyon Day Lodge at the Deer Valley Lodge at the Deer Valley Ski Resort in Park City, Utah. The purpose of the meeting was to present the Engineering Evaluation / Cost Analysis (EE/CA) required for cleanup work to begin in Empire Canyon. Details of the TMDL study were discussed at the public meeting.

12.2 Subcommittees and Groups

Throughout this project, the Upper Silver Creek Watershed Stakeholders Group functioned as the nucleus for the Technical Advisory Committee or Steering Committee. Several meetings were held by this group to discuss the development of the Silver Creek TMDL. Specifically, this committee was comprised of individuals that represent the interests of stakeholders in the Silver Creek watershed, including environmental engineering consultants, potential responsible parties, and representatives from state and federal government regulatory agencies.

The Upper Silver Creek Watershed Stakeholders Group was formed to investigate environmental issues related to hazardous substances in the Silver Creek Watershed and the Park City area. To provide a public information service and forum, the Upper Silver Creek Watershed Stakeholders Group operates a website: http://www.silvercreekpc.org. At the website, the public can learn more about the Silver Creek TMDL and can express opinions to the stakeholder group.

The Upper Silver Creek Watershed Stakeholders Group represents a wide range of interests that not only include community leaders, residents, and landowners, but also federal, state, and local governments. This stakeholder group is intended to provide a forum for discussion, not to create a voting or decision-making body. Membership is not closed and may be expanded beyond the membership listed below:

- Tom Bakaly, City Manager, Park City
- Kerry Gee, United Park City Mines
- Ty Howard, Utah Department of Environmental Quality
- John Whitehead, Utah Department of Environmental Quality
- Sally Elliot, Historic Preservation and Prospector Park
- Dana Williams, Mayor, Park City
- Bruce Waddell, US Fish and Wildlife Service
- Steve Jenkins and Pat Cone, Summit County
- Jim Christiansen, US Environmental Protection Agency
- Bob Wells, Deer Valley Mountain Resort

- Brian Strait, Park City Mountain Resort
- Mike Nelson and Tim Ingwell, Bureau of Land Management
- John Knudsen, Utah State Parks Division
- Chuck Hollingshead, Citizens for Responsible Growth
- Michael Luers, Snyderville Basin Water Reclamation District

Following the project kickoff meeting on March 20, 2001, the Upper Silver Creek Watershed Stakeholders Group held several meetings that included discussion of the development of the Silver Creek TMDL.

On March 18, 2003, the Upper Silver Creek Watershed Stakeholders Group held a meeting to discuss the completion of the Silver Creek TMDL.

On May 13, 2003, the Upper Silver Creek Watershed Stakeholders Group held a meeting to update the group on the efforts by the various entities involved – BLM, UPCM/EPA, DWQ (TMDL), Park City Municipal Corporation.

On July 8, 2003, the Upper Silver Creek Watershed Stakeholders Group held a meeting to discuss the status of the Empire Canyon EE/CA, Park City Soils Ordinance, and other documents recently released as part of the Silver Creek project.

On February 24, 2004 the Upper Silver Creek Watershed Stakeholders Group held a meeting. An overview of the draft TMDL for Silver Creek was presented to the committee.

The formal 30 day public comment period for the draft TMDL concluded on March 8, 2004. The 30 day comment period was advertised in the Salt Lake Tribune and Park Record newspapers. The draft TMDL was also posted on the Division of Water Quality's web site for ease in accessing the draft document. Comments received and the corresponding responses are provided in Appendix C.

13.0 REFERENCES

Bolis, Judith L., Thomas R. Wildeman, and Ronald R. Cohen. National Meeting of the American Society for Surface Mining and Reclamation, Durango, Colorado, May 14-17, 1991. "The Use of Bench Scale Permeameters for Preliminary Analysis of Metal Removal from Acid Mine Drainage by Wetlands"

Brodie, Gregory A., Thomas Wildeman, Gregory Brodie, James Gusek. "Staged, Aerobic, Wetlands-Based Acid Drainage Treatment Systems Design, Construction, and Operations." Wetland Design for Mining Operations-Section II, BiTech Publishers, Ltd. 1993.

Brough, Griffin, Richardson, Stevens. Utah Weather Guide. Published by Society for Applied Climatology, West Jordan, Utah. Printed by Brigham Young University Printing Service, Provo, Utah. 1983.

Georgia Stormwater Management Manual. Volume 2 (Technical Handbook).

Idaho Division of Environmental Quality, Watershed and Aquifer Protection Bureau, July 1997. *Catalog of Storm Water Best Management Practices For Idaho Cities and Counties*.

Kimball, Briant, Kevin Johnson, Robert L. Runkel, and Judy Steiger; "Quantification of Metal Loading to Silver Creek Through the Silver Maple Claims Area, Park City, Utah, May 2002"; USGS Water-Resources Investigation Report 03-4296, Salt Lake City, 2003.

"Stream, Lake, Estuary, and Ocean Pollution" Nemerow, Nelson L. 2nd Edition. 1991. Page 245

Strock, Nevil, Pennsylvania Department of Environmental Protection, October 1998. "Reclamation and Re-vegetation" Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania.

Tillia, Ann M, Utah Department of Environmental Quality. Division of Environmental Response and Remediation, September 25, 2002. *.Innovative Assessment Analytical Results Report Lower Silver Creek.*

United States Environmental Protection Agency, April 2001. *2001 Update of Ambient Water Quality Criteria for Cadmium.* EPA-822-R-01-001

United States Environmental Protection Agency, May 4, 2001. *Data Interpretation Report Upper Silver Creek Watershed Surface Water/Stream Sediment Monitoring 2000.*

United States Environmental Protection Agency internet website. http://www.epa.gov/owow/tmdl

Utah Department of Environmental Quality, Division of Water Quality. *Utah Administrative Code Rule R317-2. Standards of Quality for Waters of the State. January 6, 2004*

Utah Department of Environmental Quality, Division of Water Quality internet website. http://waterquality.utah.gov

Appendix A

Silver Creek Water Quality Data

Station	Site Description	Date	Cadmium (mg/l)	Zinc (mg/l)	Flow (cfs)
1001	USC-1, Rail Tressel @ U248	5/15/2000	0.000	**0.410**	5.2
1001	USC-1, Rail Tressel @ U248	9/27/2000	0.000	**0.720**	1.9
1001	USC-1, Rail Tressel @ U248	11/7/2000	0.000	**1.000**	0.8
1002	USC-2, Culvert @ U248	5/15/2000	0.000	0.330	
1002	USC-2, Culvert @ U248	9/27/2000	0.000	**0.710**	
1003	USC-3, Upstream RR Tressel	5/15/2000	**0.001**	**0.510**	3.3
1003	USC-3, Upstream RR Tressel	9/27/2000	0.000	**1.100**	1.7
1004	USC-32, Duplicate of USC-3	5/15/2000	**0.001**	**0.520**	
1005	USC-4, Diversion Ditch 50'	5/15/2000	0.000	0.000	0.1
1005	USC-4, Diversion Ditch 50'	9/27/2000	0.000	0.055	0.1
1005	USC-4, Diversion Ditch 50'	11/7/2000	0.000	0.100	0.1
1006	USC-5, N. Old Road to R.F.	5/15/2000	**0.001**	**0.950**	
1006	USC-5, N. Old Road to R.F.	9/27/2000	0.000	**2.000**	
1007	USC-6, Below Silvermaple	5/15/2000	0.000		
1007	USC-6, Below Silvermaple	9/27/2000	0.000	**0.640**	
1007	USC-6, Below Silvermaple	11/7/2000	0.000	**1.400**	
1008	USC-7, Above Silvermaple	5/15/2000	0.000	0.092	1.0
1008	USC-7, Above Silvermaple	9/27/2000	0.000	**0.460**	0.1
1008	USC-7, Above Silvermaple	11/7/2000	**0.007**	**2.100**	
1009	USC-8, State Sample Site	5/15/2000	**0.002**	0.270	1.6
1009	USC-8, State Sample Site	9/27/2000	0.000	0.067	0.4
1009	USC-8, State Sample Site	11/7/2000	**0.005**	0.360	
1010	USC-9, DV @ Confluence	5/16/2000	**0.021**	**1.100**	1.5
1010	USC-9, DV @ Confluence	9/27/2000	0.000	0.037	0.7
1011	USC-10, DV E. of Rd. Going S.	5/16/2000	0.000	0.120	1.8
1011	USC-10, DV E. of Rd. Going S.	9/27/2000	0.000	0.056	0.4
1012	USC-11, Emp.Cyn. @ culvert	5/16/2000	0.000	0.100	
1013	USC-12, Ont. Cyn. Merge w/Emp.	5/16/2000	**0.001**	**0.600**	0.1
1014	USC-13, Emp. Cyn. @ flow drain	5/16/2000	**0.044**	**5.300**	0.0
1015	USC-14, Flume Lower Ont. Cyn.	5/16/2000	**0.009**	**0.590**	0.1
1016	USC-15, Flume Emp. Cyn. Iron Gate	5/16/2000	**0.029**	**4.400**	0.1

1017	USC-17, Abv. Flume adj. Jude Tunnel	5/16/2000	0.000	0.011	0.0
1018	USC-25, Woodside Gulch	5/16/2000	0.000	0.040	
1019	USC-JT, Judge Tnl. Up. Daly#1 Shaft	5/16/2000	**0.002**	**0.730**	
1020	Empire 1, Upper Empire Canyon	5/16/2000	0.000	0.078	
1021	Ruby 1, Ruby Chairlift	5/16/2000	0.000	0.049	
1022	Ruby 2, Gulch North of Daly West	5/16/2000	**0.002**	0.130	
1023	USC-RC, Resort Center	5/22/2000	0.000	0.055	
1024	LBA, LittleBell Above	5/31/2000	0.000	0.027	
1025	LBB, LittleBell Below	5/31/2000	0.000	0.065	
1026	GET, Great East Tunnel	5/31/2000	0.000	0.053	
1027	TC-1, T. Cyn. Next to shaft dump	6/5/2000	**0.036**	**2.900**	
1028	CT-1, Comstock Tunnel	6/5/2000	**0.008**	**1.700**	
1029	USC-7, State Split	9/27/2000	0.000	**0.406**	
1030	USC-30	9/27/2000	0.000	**0.640**	
1031	Iron Horse 1	9/27/2000	0.000	0.065	
1032	Iron Horse 2	9/27/2000	0.000	0.059	
1033	Bonanza Dr.	9/27/2000	0.000	0.067	
1034	Ross 1	9/28/2000	0.000	0.033	
1035	DV-3	9/28/2000	0.000	0.045	
3001	Silver Creek Above Richardson Flats - USGS 2000	3/14/2000	**0.002**	**0.970**	
3001	Silver Creek Above Richardson Flats - USGS 2000	4/24/2000	**0.003**	**1.650**	
3001	Silver Creek Above Richardson Flats - USGS 2000	5/16/2000	0.000	**0.550**	
3001	Silver Creek Above Richardson Flats - USGS 2000	6/12/2000	**0.002**	**0.760**	
3001	Silver Creek Above Richardson Flats - USGS 2000	8/16/2000	**0.001**	**1.800**	
3002	Silver Creek At Atkinson - USGS 2000	3/10/2000	**0.002**	**1.170**	
3002	Silver Creek At Atkinson - USGS 2000	8/16/2000	0.000	0.100	
3003	Silver Creek At Wanship - USGS 2000	3/13/2000	**0.002**	**0.570**	
3003	Silver Creek At Wanship - USGS 2000	8/21/2000	0.000	0.160	
3004	Silver Creek At Bonanza Dr. - USGS 2000	3/10/2000	**0.004**	0.250	
3004	Silver Creek At Bonanza Dr. - USGS 2000	8/16/2000	0.000	0.090	
4001	SCS-5000 Silver Creek Above Richardson Flats - USGS 2002	5/1/2002		**0.729**	5.8
4002	SCS-5500 Silver Creek Below Richardson Flats - USGS 2002	5/1/2002		**0.694**	8.3

4003	SCS-6000 Silver Creek Above Silver Creek WWTP - USGS 2002	5/1/2002		**3.520**	1.0
4004	SCS-6500 Silver Creek At Atkinson (Below WWTP) - USGS 2002	5/1/2002		**1.630**	4.2
4005	SCS-7000 Silver Creek @ Wanship - USGS 2002	5/1/2002		0.243	19.0
492674	SILVER CK AT FARM XING IN ATKINSON	1/22/1991			3.7
492674	SILVER CK AT FARM XING IN ATKINSON	7/3/1991			0.5
492674	SILVER CK AT FARM XING IN ATKINSON	10/30/1991			
492674	SILVER CK AT FARM XING IN ATKINSON	1/22/1992			2.3
492674	SILVER CK AT FARM XING IN ATKINSON	4/15/1993			8.2
492674	SILVER CK AT FARM XING IN ATKINSON	4/28/1993			8.5
492674	SILVER CK AT FARM XING IN ATKINSON	5/11/1993			32.8
492674	SILVER CK AT FARM XING IN ATKINSON	5/27/1993			21.4
492674	SILVER CK AT FARM XING IN ATKINSON	7/20/1993			1.0
492674	SILVER CK AT FARM XING IN ATKINSON	10/27/1993			4.8
492674	SILVER CK AT FARM XING IN ATKINSON	2/17/1994			3.0
492674	SILVER CK AT FARM XING IN ATKINSON	4/19/1994			3.5
492674	SILVER CK AT FARM XING IN ATKINSON	6/14/1994			7.0
492674	SILVER CK AT FARM XING IN ATKINSON	8/9/1994			1.7
492674	SILVER CK AT FARM XING IN ATKINSON	11/15/1994			3.8
492674	SILVER CK AT FARM XING IN ATKINSON	1/12/1995			1.8
492674	SILVER CK AT FARM XING IN ATKINSON	4/6/1995			4.8
492674	SILVER CK AT FARM XING IN ATKINSON	8/15/1995			3.5
492674	SILVER CK AT FARM XING IN ATKINSON	11/21/1995			7.0
492674	SILVER CK AT FARM XING IN ATKINSON	2/1/1996	**0.004**	**1.500**	5.0
492674	SILVER CK AT FARM XING IN ATKINSON	6/13/1996	0.000	0.260	2.5
492674	SILVER CK AT FARM XING IN ATKINSON	8/1/1996	0.000	0.240	3.0
492674	SILVER CK AT FARM XING IN ATKINSON	10/22/1996	**0.001**	**0.620**	5.4
492674	SILVER CK AT FARM XING IN ATKINSON	2/4/1997	**0.006**	**1.800**	7.0
492674	SILVER CK AT FARM XING IN ATKINSON	5/14/1997	**0.006**	**1.100**	18.0
492674	SILVER CK AT FARM XING IN ATKINSON	8/6/1997	0.000	0.074	9.0
492674	SILVER CK AT FARM XING IN ATKINSON	10/21/1997	0.000	**0.500**	6.0
492674	SILVER CK AT FARM XING IN ATKINSON	1/29/1998	**0.001**	**1.000**	2.0

492674	SILVER CK AT FARM XING IN ATKINSON	4/14/1998	**0.003**	**1.100**	4.0
492674	SILVER CK AT FARM XING IN ATKINSON	7/23/1998	0.000	0.260	3.4
492674	SILVER CK AT FARM XING IN ATKINSON	10/29/1998	**0.001**	**0.570**	4.0
492674	SILVER CK AT FARM XING IN ATKINSON	1/22/1999	**0.002**	**0.990**	9.0
492674	SILVER CK AT FARM XING IN ATKINSON	4/14/1999	0.000	**0.570**	5.6
492674	SILVER CK AT FARM XING IN ATKINSON	11/3/1999	0.000	0.370	4.5
492674	SILVER CK AT FARM XING IN ATKINSON	1/6/2000	0.000	**0.500**	3.5
492674	SILVER CK AT FARM XING IN ATKINSON	4/13/2000	0.000	0.387	4.5
492674	SILVER CK AT FARM XING IN ATKINSON	8/24/2000	0.000	0.173	3.0
492674	SILVER CK AT FARM XING IN ATKINSON	11/1/2000	**0.004**	**2.720**	9.8
492674	SILVER CK AT FARM XING IN ATKINSON	1/30/2001	**0.003**	**1.630**	3.5
492674	SILVER CK AT FARM XING IN ATKINSON	5/16/2001	**0.003**	**1.260**	13.4
492674	SILVER CK AT FARM XING IN ATKINSON	7/20/2001	0.000	0.129	0.5
492674	SILVER CK AT FARM XING IN ATKINSON	8/1/2001	0.000	0.073	2.4
492674	SILVER CK AT FARM XING IN ATKINSON	9/6/2001	0.000	0.093	2.9
492674	SILVER CK AT FARM XING IN ATKINSON	10/4/2001	0.000	0.135	7.7
492674	SILVER CK AT FARM XING IN ATKINSON	11/8/2001	**0.001**	**0.849**	6.0
492674	SILVER CK AT FARM XING IN ATKINSON	12/11/2001	**0.005**	**2.420**	3.8
492674	SILVER CK AT FARM XING IN ATKINSON	1/9/2002	**0.005**	**1.470**	4.5
492674	SILVER CK AT FARM XING IN ATKINSON	2/5/2002	**0.004**	**1.760**	3.0
492674	SILVER CK AT FARM XING IN ATKINSON	3/21/2002	**0.005**	**1.880**	9.5
492674	SILVER CK AT FARM XING IN ATKINSON	4/11/2002	**0.005**	**1.430**	
492674	SILVER CK AT FARM XING IN ATKINSON	5/16/2002	**0.002**	**0.491**	
492674	SILVER CK AT FARM XING IN ATKINSON	8/13/2002			3.1
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	1/17/1990			5.6
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	2/15/1990			3.6
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	4/5/1990			8.6
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	5/17/1990			7.3
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	6/19/1990			3.3
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	9/6/1990			2.7
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	10/10/1990			2.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	12/11/1990			4.3

492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	2/20/1991			11.5
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	5/8/1991			26.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	6/27/1991			4.8
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	8/8/1991			3.2
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	10/8/1991			4.5
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	11/26/1991			9.4
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	1/30/1992			4.3
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	3/18/1992			6.2
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	4/21/1992			4.3
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	6/24/1992	0.000	0.150	1.7
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	8/6/1992	**0.001**	0.240	1.2
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	9/24/1992	**0.002**	0.220	1.8
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	11/5/1992	0.000	**0.500**	5.3
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	1/21/1993	0.000	**0.720**	3.8
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	4/1/1993	**0.005**	**1.700**	38.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	4/15/1993	**0.003**	**1.400**	6.9
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	4/29/1993			26.7
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	5/11/1993			22.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	5/27/1993			7.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	6/9/1993			5.8
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	7/20/1993	**0.002**	0.300	3.3
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	8/24/1993			6.2
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	9/23/1993			4.9
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	10/27/1993			8.3
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	11/23/1993	**0.001**	**0.550**	3.7
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	1/12/1994	**0.001**	**0.580**	2.9
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	2/17/1994	**0.001**	**0.730**	4.4
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	3/23/1994			14.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	4/5/1994	0.000	**0.490**	13.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	4/20/1994			11.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	5/3/1994			14.0

492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	5/17/1994			10.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	6/2/1994			4.7
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	6/14/1994			2.2
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	7/22/1998	**0.001**	0.156	5.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	8/27/1998			10.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	10/1/1998			4.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	10/29/1998	0.000	0.200	5.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	12/17/1998			10.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	1/21/1999	0.000	0.240	5.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	2/18/1999			6.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	3/26/1999			29.9
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	4/16/1999	0.000	0.150	8.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	4/29/1999			75.6
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	5/14/1999			86.9
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	6/3/1999			59.3
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	6/17/1999			12.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	8/1/2001	**0.001**	0.147	4.3
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	9/6/2001	0.000	0.109	3.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	10/4/2001	0.000	0.102	3.5
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	11/6/2001	0.000	0.123	4.0
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	12/11/2001	**0.001**	**0.712**	4.2
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	1/9/2002	0.000	**0.508**	17.6
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	2/5/2002	0.000	**0.820**	
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	3/21/2002	**0.001**	**0.537**	13.9
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	4/11/2002	0.000	0.383	20.6
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	4/25/2002	0.000	0.262	
492675	SILVER CK AT WANSHIP AB CNFL / WEBER R	5/16/2002	0.000	0.058	11.5
492679	SILVER CREEK WWTP	1/18/1990			1.5
492679	SILVER CREEK WWTP	1/25/1990			
492679	SILVER CREEK WWTP	4/5/1990			1.4
492679	SILVER CREEK WWTP	5/17/1990			0.9
492679	SILVER CREEK WWTP	6/19/1990			1.2

492679	SILVER CREEK WWTP	9/6/1990			2.0
492679	SILVER CREEK WWTP	10/10/1990			0.5
492679	SILVER CREEK WWTP	12/11/1990			0.6
492679	SILVER CREEK WWTP	1/22/1991			1.6
492679	SILVER CREEK WWTP	2/20/1991			2.1
492679	SILVER CREEK WWTP	5/8/1991			1.1
492679	SILVER CREEK WWTP	7/3/1991			1.7
492679	SILVER CREEK WWTP	8/8/1991			1.5
492679	SILVER CREEK WWTP	10/8/1991			1.4
492679	SILVER CREEK WWTP	10/30/1991			
492679	SILVER CREEK WWTP	11/26/1991			1.3
492679	SILVER CREEK WWTP	1/22/1992			
492679	SILVER CREEK WWTP	1/30/1992			1.5
492679	SILVER CREEK WWTP	3/18/1992			2.5
492679	SILVER CREEK WWTP	4/21/1992			1.2
492679	SILVER CREEK WWTP	6/24/1992			1.8
492679	SILVER CREEK WWTP	8/6/1992			2.5
492679	SILVER CREEK WWTP	9/24/1992			2.2
492679	SILVER CREEK WWTP	11/5/1992			1.5
492679	SILVER CREEK WWTP	1/21/1993			1.9
492679	SILVER CREEK WWTP	4/1/1993			4.0
492679	SILVER CREEK WWTP	4/15/1993			2.6
492679	SILVER CREEK WWTP	4/28/1993			2.6
492679	SILVER CREEK WWTP	5/11/1993			2.5
492679	SILVER CREEK WWTP	5/27/1993			2.2
492679	SILVER CREEK WWTP	6/9/1993			0.0
492679	SILVER CREEK WWTP	7/20/1993			2.0
492679	SILVER CREEK WWTP	8/24/1993			2.6
492679	SILVER CREEK WWTP	9/22/1993			2.0
492679	SILVER CREEK WWTP	10/27/1993			1.7
492679	SILVER CREEK WWTP	11/23/1993			1.2

492679	SILVER CREEK WWTP	1/12/1994			2.0
492679	SILVER CREEK WWTP	2/17/1994			1.9
492679	SILVER CREEK WWTP	4/19/1994			1.9
492679	SILVER CREEK WWTP	6/14/1994			1.5
492679	SILVER CREEK WWTP	8/9/1994			2.6
492679	SILVER CREEK WWTP	9/20/1994			0.8
492679	SILVER CREEK WWTP	11/15/1994			1.2
492679	SILVER CREEK WWTP	1/12/1995			2.9
492679	SILVER CREEK WWTP	2/15/1995			2.1
492679	SILVER CREEK WWTP	4/6/1995			2.5
492679	SILVER CREEK WWTP	5/16/1995			2.7
492679	SILVER CREEK WWTP	8/15/1995			2.2
492679	SILVER CREEK WWTP	9/28/1995			1.5
492679	SILVER CREEK WWTP	11/21/1995			2.8
492679	SILVER CREEK WWTP	2/1/1996			2.6
492679	SILVER CREEK WWTP	3/6/1996			4.0
492679	SILVER CREEK WWTP	4/17/1996			2.8
492679	SILVER CREEK WWTP	6/13/1996			2.8
492679	SILVER CREEK WWTP	8/1/1996			1.7
492679	SILVER CREEK WWTP	9/12/1996			1.2
492679	SILVER CREEK WWTP	10/22/1996			1.1
492679	SILVER CREEK WWTP	12/4/1996			1.4
492679	SILVER CREEK WWTP	2/4/1997			2.2
492679	SILVER CREEK WWTP	3/25/1997			2.3
492679	SILVER CREEK WWTP	7/10/1997			1.7
492679	SILVER CREEK WWTP	8/6/1997			1.9
492679	SILVER CREEK WWTP	9/25/1997			1.3
492679	SILVER CREEK WWTP	10/21/1997			2.0
492679	SILVER CREEK WWTP	12/11/1997			1.2
492679	SILVER CREEK WWTP	1/29/1998	0.000	0.110	2.3
492679	SILVER CREEK WWTP	3/5/1998			2.2

492679	SILVER CREEK WWTP	4/14/1998	0.000	0.330	2.9
492679	SILVER CREEK WWTP	7/23/1998	0.000	0.136	2.3
492679	SILVER CREEK WWTP	8/27/1998			4.8
492679	SILVER CREEK WWTP	10/1/1998			2.0
492679	SILVER CREEK WWTP	10/29/1998			2.4
492679	SILVER CREEK WWTP	12/17/1998			1.5
492679	SILVER CREEK WWTP	1/22/1999			1.7
492679	SILVER CREEK WWTP	2/18/1999			3.1
492679	SILVER CREEK WWTP	4/14/1999	0.000	0.150	1.7
492679	SILVER CREEK WWTP	4/29/1999			2.4
492679	SILVER CREEK WWTP	5/14/1999			2.2
492679	SILVER CREEK WWTP	6/3/1999			1.9
492679	SILVER CREEK WWTP	6/17/1999			2.0
492679	SILVER CREEK WWTP	11/3/1999			
492679	SILVER CREEK WWTP	1/6/2000			2.5
492679	SILVER CREEK WWTP	2/24/2000			2.5
492679	SILVER CREEK WWTP	4/13/2000			2.1
492679	SILVER CREEK WWTP	6/13/2000			0.6
492679	SILVER CREEK WWTP	8/24/2000			1.1
492679	SILVER CREEK WWTP	9/26/2000			1.1
492679	SILVER CREEK WWTP	11/1/2000			1.4
492679	SILVER CREEK WWTP	1/30/2001			3.0
492679	SILVER CREEK WWTP	5/16/2001			2.8
492679	SILVER CREEK WWTP	7/20/2001			2.7
492679	SILVER CREEK WWTP	8/1/2001	0.000	0.099	1.5
492679	SILVER CREEK WWTP	9/6/2001	0.000	0.097	2.6
492679	SILVER CREEK WWTP	10/4/2001	0.000	0.101	2.2
492679	SILVER CREEK WWTP	11/8/2001	0.000	0.120	1.8
492679	SILVER CREEK WWTP	12/11/2001	0.000	0.089	2.8
492679	SILVER CREEK WWTP	1/9/2002	0.000	0.085	2.6
492679	SILVER CREEK WWTP	2/5/2002	0.000	0.083	2.9
492679	SILVER CREEK WWTP	2/20/2002			4.6

492679	SILVER CREEK WWTP	3/21/2002			3.2
492679	SILVER CREEK WWTP	4/11/2002	0.000	0.187	3.2
492679	SILVER CREEK WWTP	4/25/2002	0.000	0.194	
492679	SILVER CREEK WWTP	5/16/2002			2.2
492679	SILVER CREEK WWTP	6/26/2002			2.6
492679	SILVER CREEK WWTP	8/13/2002			3.1
492680	SILVER CK AB ATKINSON	1/25/1990			
492680	SILVER CK AB ATKINSON	4/5/1990			1.6
492680	SILVER CK AB ATKINSON	5/17/1990			4.0
492680	SILVER CK AB ATKINSON	6/19/1990			1.4
492680	SILVER CK AB ATKINSON	9/6/1990			0.0
492680	SILVER CK AB ATKINSON	10/10/1990			4.4
492680	SILVER CK AB ATKINSON	12/11/1990			1.8
492680	SILVER CK AB ATKINSON	2/20/1991			8.3
492680	SILVER CK AB ATKINSON	5/8/1991			3.0
492680	SILVER CK AB ATKINSON	8/8/1991			
492680	SILVER CK AB ATKINSON	10/8/1991			5.0
492680	SILVER CK AB ATKINSON	7/23/1998			1.0
492680	SILVER CK AB ATKINSON	10/29/1998	0.000	0.087	0.4
492680	SILVER CK AB ATKINSON	4/14/1999	**0.001**	**0.600**	3.9
492680	SILVER CK AB ATKINSON	11/3/1999	0.000	0.300	1.8
492680	SILVER CK AB ATKINSON	1/6/2000	0.000	**0.670**	
492680	SILVER CK AB ATKINSON	4/13/2000	0.000	**0.765**	1.3
492680	SILVER CK AB ATKINSON	8/24/2000	0.000	**0.568**	1.5
492680	SILVER CK AB ATKINSON	11/1/2000	**0.008**	**3.630**	4.7
492680	SILVER CK AB ATKINSON	1/30/2001	**0.001**	**0.694**	
492680	SILVER CK AB ATKINSON	5/16/2001	**0.003**	**1.100**	10.4
492680	SILVER CK AB ATKINSON	8/1/2001			0.0
492680	SILVER CK AB ATKINSON	9/6/2001	0.000	0.054	0.3
492680	SILVER CK AB ATKINSON	10/4/2001	0.000	0.000	0.2
492680	SILVER CK AB ATKINSON	11/8/2001	**0.008**	**2.320**	4.2
492680	SILVER CK AB ATKINSON	12/11/2001	**0.019**	**6.350**	1.8

492680	SILVER CK AB ATKINSON	1/9/2002	**0.011**	**2.880**	2.5
492680	SILVER CK AB ATKINSON	2/5/2002	**0.019**	**7.340**	1.0
492680	SILVER CK AB ATKINSON	3/21/2002	**0.007**	**2.970**	0.9
492680	SILVER CK AB ATKINSON	4/11/2002	**0.010**	**2.580**	4.0
492680	SILVER CK AB ATKINSON	5/16/2002	**0.004**	**0.808**	2.0
492680	SILVER CK AB ATKINSON	8/13/2002			0.0
492685	SILVER CK AT US40 XING E OF PARK CITY	7/3/1991			
492685	SILVER CK AT US40 XING E OF PARK CITY	10/30/1991			
492685	SILVER CK AT US40 XING E OF PARK CITY	11/26/1991			4.0
492685	SILVER CK AT US40 XING E OF PARK CITY	1/30/1992			
492685	SILVER CK AT US40 XING E OF PARK CITY	3/18/1992			1.9
492685	SILVER CK AT US40 XING E OF PARK CITY	4/21/1992			3.5
492685	SILVER CK AT US40 XING E OF PARK CITY	6/24/1992	0.000	0.069	0.3
492685	SILVER CK AT US40 XING E OF PARK CITY	8/6/1992	0.000	0.330	0.3
492685	SILVER CK AT US40 XING E OF PARK CITY	9/24/1992	**0.001**	**0.540**	0.3
492685	SILVER CK AT US40 XING E OF PARK CITY	11/5/1992	**0.002**	**1.400**	2.1
492685	SILVER CK AT US40 XING E OF PARK CITY	1/21/1993	**0.002**	**1.200**	
492685	SILVER CK AT US40 XING E OF PARK CITY	4/8/1993	**0.010**	**2.600**	9.5
492685	SILVER CK AT US40 XING E OF PARK CITY	4/15/1993	**0.006**	**1.400**	4.9
492685	SILVER CK AT US40 XING E OF PARK CITY	4/28/1993			7.0
492685	SILVER CK AT US40 XING E OF PARK CITY	5/11/1993			18.0
492685	SILVER CK AT US40 XING E OF PARK CITY	5/27/1993			19.4
492685	SILVER CK AT US40 XING E OF PARK CITY	6/9/1993			16.7
492685	SILVER CK AT US40 XING E OF PARK CITY	7/20/1993	**0.002**	**0.700**	3.9
492685	SILVER CK AT US40 XING E OF PARK CITY	8/24/1993			3.0
492685	SILVER CK AT US40 XING E OF PARK CITY	9/22/1993			3.4
492685	SILVER CK AT US40 XING E OF PARK CITY	10/27/1993	**0.004**	**1.200**	2.5
492685	SILVER CK AT US40 XING E OF PARK CITY	11/23/1993	**0.003**	**1.100**	1.2
492685	SILVER CK AT US40 XING E OF PARK CITY	1/12/1994	**0.004**	**1.200**	
492685	SILVER CK AT US40 XING E OF PARK CITY	2/17/1994	**0.002**	**0.960**	2.0
492685	SILVER CK AT US40 XING E OF PARK CITY	3/23/1994			8.5

492685	SILVER CK AT US40 XING E OF PARK CITY	4/5/1994	**0.002**	**1.300**	3.5
492685	SILVER CK AT US40 XING E OF PARK CITY	4/19/1994			4.5
492685	SILVER CK AT US40 XING E OF PARK CITY	5/3/1994			9.0
492685	SILVER CK AT US40 XING E OF PARK CITY	5/17/1994			2.0
492685	SILVER CK AT US40 XING E OF PARK CITY	6/2/1994			7.6
492685	SILVER CK AT US40 XING E OF PARK CITY	6/14/1994			2.0
492685	SILVER CK AT US40 XING E OF PARK CITY	8/9/1994			1.8
492685	SILVER CK AT US40 XING E OF PARK CITY	11/15/1994			0.3
492685	SILVER CK AT US40 XING E OF PARK CITY	1/12/1995			1.0
492685	SILVER CK AT US40 XING E OF PARK CITY	4/6/1995			3.8
492685	SILVER CK AT US40 XING E OF PARK CITY	8/15/1995			1.5
492685	SILVER CK AT US40 XING E OF PARK CITY	11/21/1995			3.3
492685	SILVER CK AT US40 XING E OF PARK CITY	1/24/1996			5.0
492685	SILVER CK AT US40 XING E OF PARK CITY	6/13/1996	**0.002**	**0.670**	2.0
492685	SILVER CK AT US40 XING E OF PARK CITY	8/1/1996	**0.002**	**0.610**	2.5
492685	SILVER CK AT US40 XING E OF PARK CITY	10/22/1996	0.000	0.350	1.8
492685	SILVER CK AT US40 XING E OF PARK CITY	2/3/1997	**0.003**	**0.990**	5.0
492685	SILVER CK AT US40 XING E OF PARK CITY	5/14/1997	**0.002**	**0.620**	12.0
492685	SILVER CK AT US40 XING E OF PARK CITY	8/6/1997			0.0
492685	SILVER CK AT US40 XING E OF PARK CITY	9/25/1997	0.000	0.270	3.0
492685	SILVER CK AT US40 XING E OF PARK CITY	10/21/1997	0.000	**0.490**	3.5
492685	SILVER CK AT US40 XING E OF PARK CITY	1/29/1998			0.0
492685	SILVER CK AT US40 XING E OF PARK CITY	3/5/1998	**0.003**	**0.970**	2.0
492685	SILVER CK AT US40 XING E OF PARK CITY	4/14/1998	**0.003**	**1.100**	3.0
492685	SILVER CK AT US40 XING E OF PARK CITY	7/23/1998	0.000	0.280	3.5
492685	SILVER CK AT US40 XING E OF PARK CITY	8/27/1998			2.0
492685	SILVER CK AT US40 XING E OF PARK CITY	10/1/1998			2.0
492685	SILVER CK AT US40 XING E OF PARK CITY	10/29/1998	**0.002**	**0.810**	1.5
492685	SILVER CK AT US40 XING E OF PARK CITY	12/17/1998			2.0
492685	SILVER CK AT US40 XING E OF PARK CITY	1/22/1999	**0.002**	**0.930**	
492685	SILVER CK AT US40 XING E OF PARK CITY	2/18/1999	**0.003**	**0.880**	1.0

492685	SILVER CK AT US40 XING E OF PARK CITY	3/26/1999			3.5
492685	SILVER CK AT US40 XING E OF PARK CITY	4/14/1999	**0.001**	**0.400**	1.0
492685	SILVER CK AT US40 XING E OF PARK CITY	4/29/1999			7.5
492685	SILVER CK AT US40 XING E OF PARK CITY	5/14/1999	**0.002**	**0.460**	
492685	SILVER CK AT US40 XING E OF PARK CITY	6/3/1999			15.0
492685	SILVER CK AT US40 XING E OF PARK CITY	6/17/1999	0.000	0.260	3.5
492685	SILVER CK AT US40 XING E OF PARK CITY	8/1/2001			0.0
492685	SILVER CK AT US40 XING E OF PARK CITY	9/6/2001	0.000	0.175	0.3
492685	SILVER CK AT US40 XING E OF PARK CITY	10/4/2001	0.000	0.224	0.4
492685	SILVER CK AT US40 XING E OF PARK CITY	11/8/2001	**0.002**	**0.952**	0.2
492685	SILVER CK AT US40 XING E OF PARK CITY	12/11/2001	**0.003**	**0.956**	1.0
492685	SILVER CK AT US40 XING E OF PARK CITY	1/9/2002	**0.002**	**0.686**	0.5
492685	SILVER CK AT US40 XING E OF PARK CITY	2/5/2002	**0.001**	**1.380**	0.5
492685	SILVER CK AT US40 XING E OF PARK CITY	3/21/2002	**0.001**	**0.735**	0.8
492685	SILVER CK AT US40 XING E OF PARK CITY	4/11/2002	**0.004**	**1.240**	4.0
492685	SILVER CK AT US40 XING E OF PARK CITY	4/25/2002	**0.001**	**0.555**	
492685	SILVER CK AT US40 XING E OF PARK CITY	5/16/2002	**0.001**	0.351	2.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	8/6/1997			0.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	9/25/1997	0.000	0.110	0.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	10/21/1997	**0.005**	**0.690**	1.2
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	12/11/1997	0.000	0.160	0.2
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	1/29/1998	**0.001**	0.230	0.5
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	4/14/1998	**0.011**	**0.980**	1.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	7/23/1998	**0.006**	**0.450**	0.4
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	8/27/1998			0.8
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	10/1/1998			0.1
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	10/29/1998	0.000	0.087	0.5
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	12/17/1998			0.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	1/21/1999			0.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	2/18/1999	**0.006**	**0.470**	0.5
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	3/26/1999			2.5

492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	4/14/1999	**0.011**	**0.540**	1.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	4/29/1999	**0.005**	**0.530**	15.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	5/14/1999	**0.012**	**1.200**	10.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	6/3/1999	**0.005**	**0.550**	10.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	6/17/1999	**0.006**	**0.630**	3.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	8/1/2001	0.000	0.097	0.1
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	9/6/2001	0.000	0.147	0.6
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	10/4/2001	**0.006**	**1.010**	2.4
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	11/8/2001	**0.003**	**0.616**	3.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	12/11/2001	**0.006**	**0.754**	0.3
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	1/9/2002	**0.003**	**0.392**	1.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	2/5/2002	**0.002**	**0.456**	0.5
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	2/11/2002	**0.012**	**1.550**	0.1
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	2/14/2002	**0.012**	**1.460**	0.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	2/18/2002	**0.001**	**0.432**	0.1
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	2/21/2002			0.1
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	2/25/2002	**0.002**	**0.600**	1.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	3/6/2002	**0.002**	**0.496**	1.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	3/21/2002	**0.003**	0.328	0.4
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	4/11/2002	**0.012**	**1.450**	4.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	5/16/2002	**0.003**	0.223	3.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	6/6/2002			1.0
492695	SILVER CK @ CITY PARK AB PROSPECTOR SQUARE	6/27/2002			0.2
492697	PARK MEADOW DRAIN CK FROM GOLF COURSE AB SILVER CK	7/23/1998	0.000	0.042	12.0
492697	PARK MEADOW DRAIN CK FROM GOLF COURSE AB SILVER CK	8/27/1998			3.0
492697	PARK MEADOW DRAIN CK FROM GOLF COURSE AB SILVER CK	10/1/1998			2.5
492697	PARK MEADOW DRAIN CK FROM GOLF COURSE AB SILVER CK	10/29/1998	0.000	0.000	2.0
492697	PARK MEADOW DRAIN CK FROM GOLF COURSE AB SILVER CK	12/17/1998			2.4
492697	PARK MEADOW DRAIN CK FROM GOLF COURSE AB SILVER CK	1/21/1999	0.000	0.000	12.0
492697	PARK MEADOW DRAIN CK FROM GOLF COURSE AB SILVER CK	2/18/1999	0.000	0.120	0.4
492697	PARK MEADOW DRAIN CK FROM GOLF COURSE AB SILVER CK	3/26/1999			3.1

492697	PARK MEADOW DRAIN CK FROM GOLF COURSE AB SILVER CK	4/14/1999	0.000	0.046	2.5
492697	PARK MEADOW DRAIN CK FROM GOLF COURSE AB SILVER CK	4/29/1999	**0.001**	0.210	8.0
492697	PARK MEADOW DRAIN CK FROM GOLF COURSE AB SILVER CK	5/14/1999	0.000	0.050	10.0
492697	PARK MEADOW DRAIN CK FROM GOLF COURSE AB SILVER CK	6/3/1999			16.0
492697	PARK MEADOW DRAIN CK FROM GOLF COURSE AB SILVER CK	6/17/1999	0.000	0.031	6.0

Appendix B

Seasonality and Statistical Analysis of Uncertainty

Seasonality and Statistical Analysis of Uncertainty

Variability and Uncertainty

As discussed in the body of this report, the issue of statistical reliability of data analysis was addressed by clustering the individual data points in Bi-Monthly (seasonal) time periods. This allowed for analysis of seasonal patterns. On the average there are 5.5 data points per period for Cadmium and 5.6 data points per period for Zinc. These numbers provide reasonable statistical validity for the conclusions presented. Table 1 shows average statistical parameters for the two constituents.

Table 1: Average Statistical Parameters

Constituent	Coefficient of Variation	Coeff. of Variation of the Means
Cadmium	118%	50%
Zinc	82%	35%

The coefficients of variation above indicate that typical data points for cadmium and zinc are, on average, within 118% and 82%, respectively, of the mean value. However, there exists significant uncertainty as to the accuracy of the estimated means for these clusters. The coefficient of variation of the means represent how tightly clustered the mean values are (between stations) relative to the mean value.

Seasonality

The annual pattern of normalized zinc concentrations is shown in Figure 1. As indicated by the graphical representation of the normalized data, this annual pattern is consistent throughout the reaches of Silver Creek between Wanship and Park City. Concentrations increase sharply between the September-October period and the November-December period, even though flows do not yet show significant upswing. So it is not necessarily a feature of flow-induced scouring.

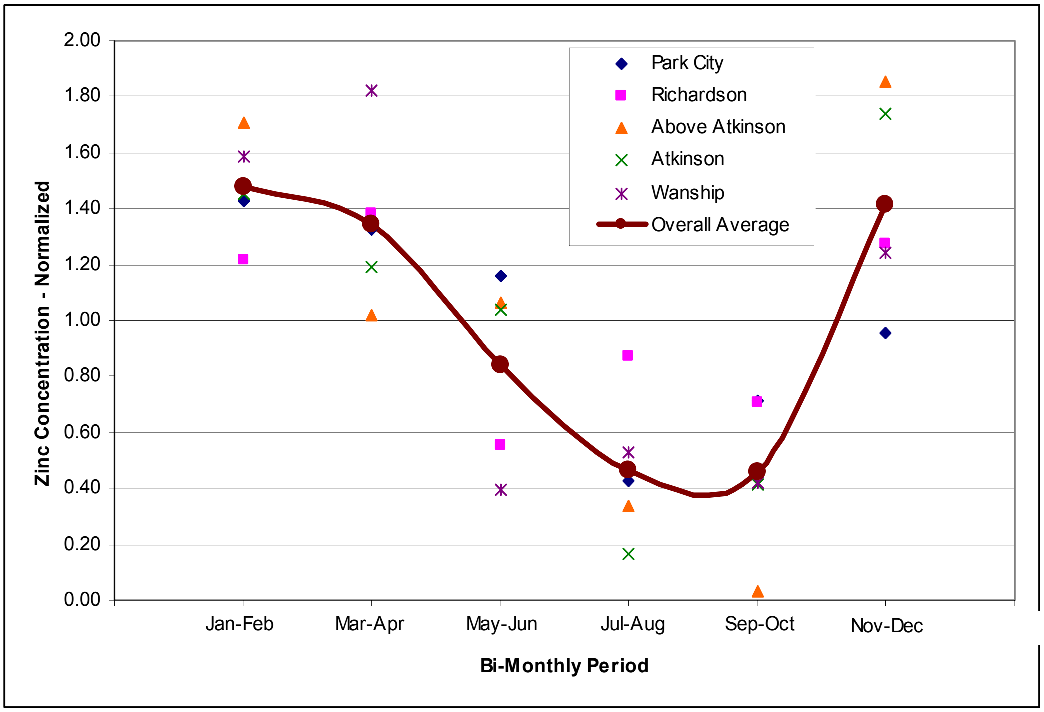

Figure 1: Annual Patterns of Zinc Concentrations

The annual pattern of normalized flows is shown in Figure 2. This pattern is characteristic of watersheds that are heavily influenced by snowmelt runoff. Note the peak flow period is May-June when concentrations have begun to decline.

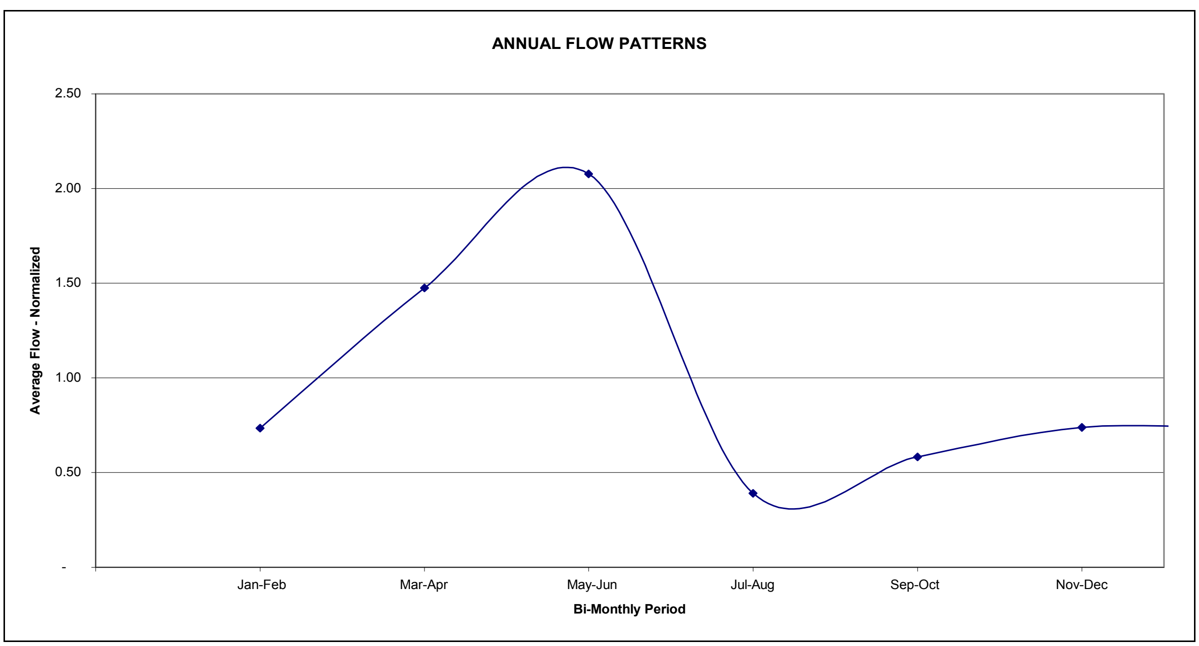

Figure 2: Annual Flow Patterns

Plotting Average Zinc Concentrations vs. Average Flow results in an Hysteresis Curve as shown in Figure 3. This plot shows values normalized by mean concentrations and flows. The mean values correspond to 1.0 on each axis. Values above or below 1.0 indicate values that are above or below the mean value. Early in the Winter season concentrations increase dramatically, even though flows have not yet begun to see the influence of significant snowmelt runoff. There are some possible explanations for this phenomenon, including the flushing of solubilized zinc from near-surface deposits at the onset of winter precipitation. However, the data are insufficient to verify this or other mechanisms.

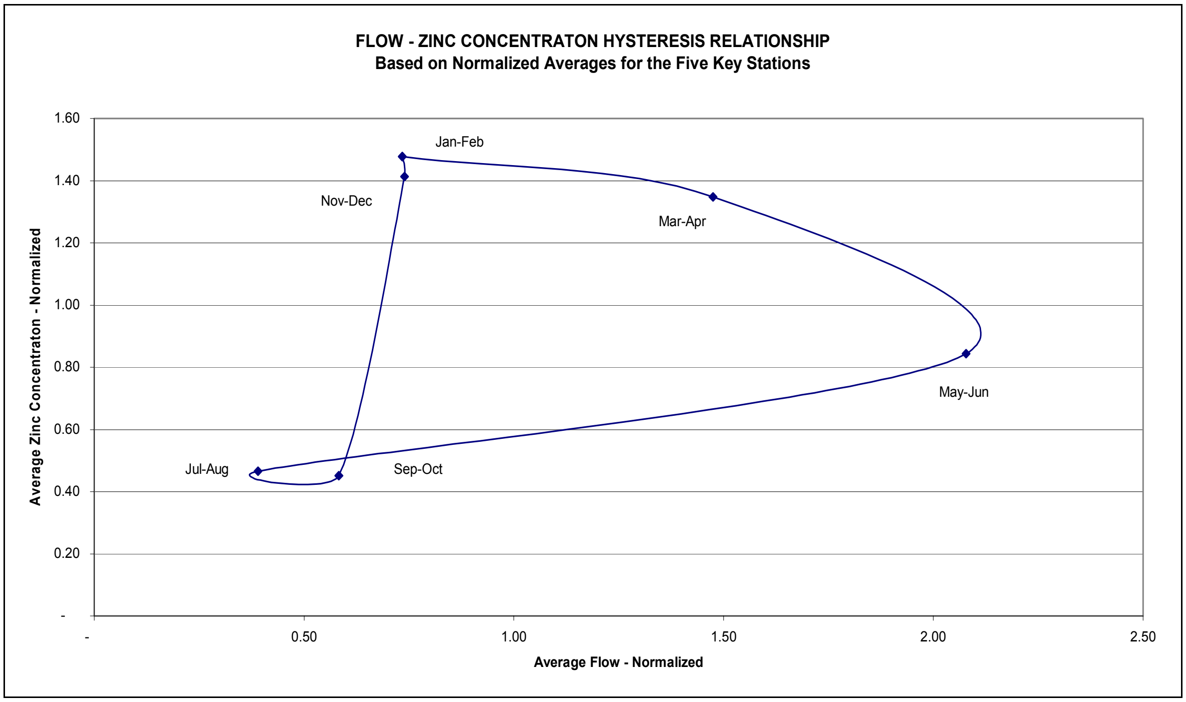

Figure 3: Flow - Zinc Concentration Hysteresis Relationship

The Annual Pattern of Zinc Loadings is more dramatic, as shown in Figure 4. The ratio of peak loadings in the Spring to minimum loadings in the Summer is about 8:1. This behavior could be incorporated in a comprehensive remediation strategy.

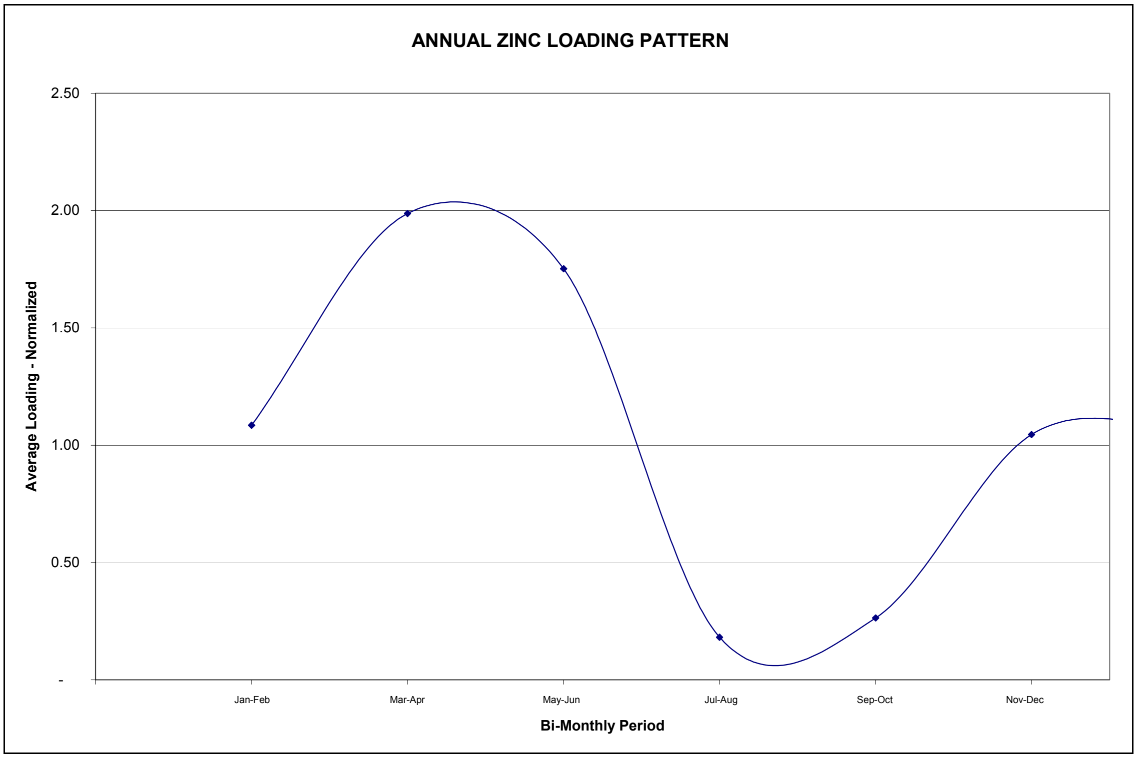

Figure 4: Annual Pattern of Zinc Loadings - based on Normalized Data

Hardness

Seasonal analysis of hardness data for each of the five key sampling locations indicates that there is significant variation by season at all stations except 492685 (Richardson Flat). Figure 5 shows a graphical representation of annual average hardness by station. Table 2 and Figure 6 depict the seasonal variation using the bimonthly approach applied to other water quality data in this report.

Table 2. Bi-monthly Hardness

Bi-monthly Season	Bi-monthly Hardness				
	Park City 492695	Rich. Flats 492685	Abv. Atkin. 492680	Below Atkin. 492674	Wanship 492675
Jan.-Feb.	526	517	777	491	396
Mar.- April	375	506	605	466	288
May-June	247	487	494	486	323
July-Aug.	376	498	622	384	409
Sept.-Oct.	300	533	540	447	375
Nov.-Dec.	325	529	683	548	406

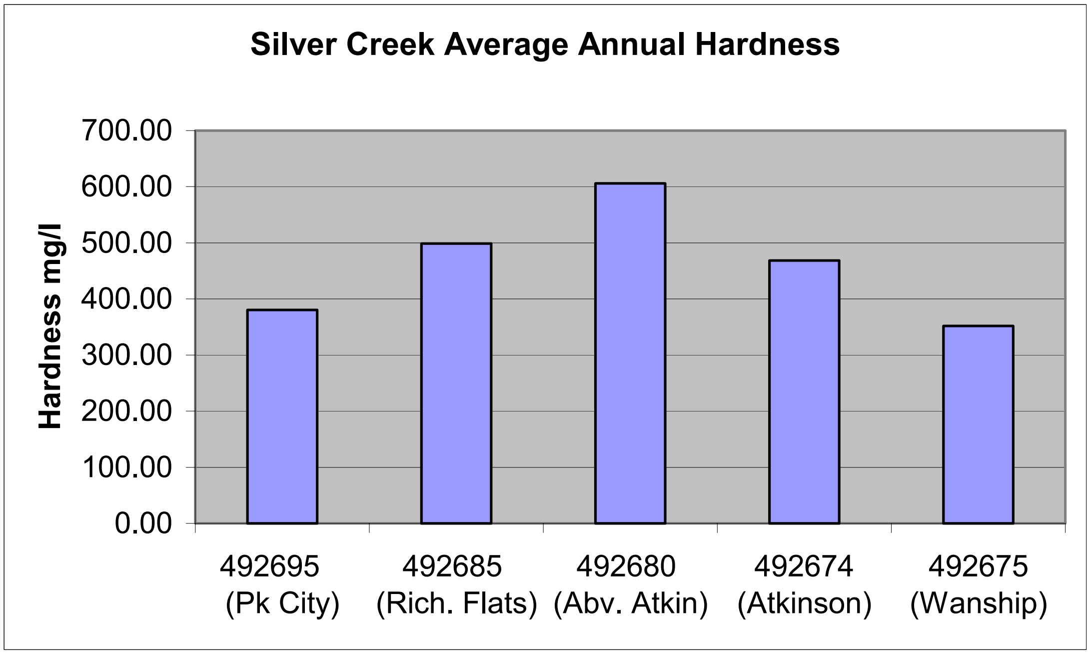

Figure 5: Average Hardness values

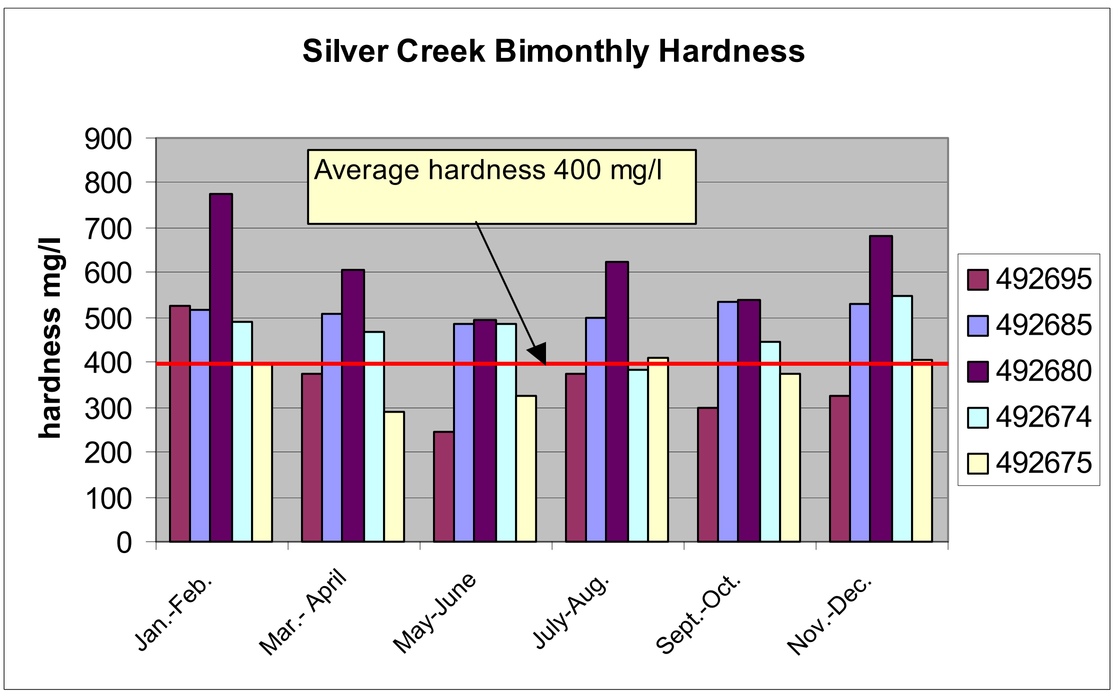

Figure 6: Bimonthly Hardness

Appendix C

Comments Received On Draft TMDL And Responsiveness Summary

March 25, 2004

Silver Creek Draft Total Maximum Daily Load Responsiveness Summary

The following responses address the major issues that were included in six comment letters and emails received on the Draft Silver Creek TMDL during the 30 day comment period that ended March 8, 2004. There were numerous additional comments that addressed editorial items and minor changes. These are not noted in this responsiveness summary but have been incorporated into the final TMDL.

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1. Several comments were received regarding the use of a maximum hardness value of 400 mg/l for calculating the water quality standard for zinc and cadmium. One comment suggested that since the average hardness for Silver Creek was 484 mg/l that a hardness value rounded up to 500 mg/l should be used instead of 400.

Response – The use of a maximum hardness of 400 mg/l for calculating hardness adjusted water quality standards for metals is in accordance with Utah's R317-2-14. Utah's use of this approach was specifically recommended by Region 8 EPA in a letter to the Division dated Dec. 20, 2001.

The National Recommended Water Quality Criteria: 2002 (EPA 822-R-02-047 Nov. 2002) specifically addresses this issue. A summary of the rationale for capping hardness at 400 mg/l from this guidance is as follows:

(a) few good data exist to define the relationship between hardness and toxicity at hardness levels above 400 mg/L (although the number of data and the strength of the relationship vary from metal to metal, almost all of the available data concerning the relationship between hardness and toxicity are at hardness levels in the range from 20 to 400 mg/L),

(b) in many waters with hardness above 400 mg/L, alkalinity and/or pH are lower than would be predicted based on the correlations that exist between hardness, alkalinity, and pH in lower hardness waters. This is significant because the relationship between hardness and toxicity is not due to hardness itself, but is wholly or partially due to constituents that are usually correlated with hardness, notably alkalinity and pH.

EPA recommends following one of two approaches; that a hardness of 400 be used or a Water Effect Ratio (WER) study be conducted to demonstrate the actual toxicity at the ambient hardness. Completion of a WER would require significant budget and time to complete in accordance with EPA's water effect ratio guidance. If any of the commenters would like to fund such a study, DWQ would be happy to undertake that approach and modify the TMDL in the future if results indicate it is appropriate.

The final TMDL will utilize the alternative of using a maximum of 400 mg/l as the hardness for calculating zinc and cadmium water quality standards with the exception of segments of the creek that show a seasonal hardness level below 400. Section 2.1 of the TMDL has been modified to provide the rationale behind using a maximum hardness of 400 in calculating the water quality standards applicable to the Silver Creek TMDL.

2. Two comments were received that requested added information and justification regarding why Silver Creek was actually impaired. The TMDL document needed to do a better job explaining the link between high zinc and cadmium levels and impairment to cold water fish and their food chain.

Response – Section 1.3 of the TMDL text has been modified to include a further explanation of the biology and chemistry regarding metals toxicity to aquatic organisms.

3. One comment expressed concern that the Silver Creek TMDL was considered a "high priority" TMDL and suggested it be classified as a "medium priority" TMDL.

Response - The priority designation of Utah TMDLs is a mechanism where UDWQ identifies what impaired water bodies will have TMDLs completed on over the following two year period. Silver Creek was designated "high priority" over two years ago when UDWQ committed to complete the Silver Creek TMDL by April 2004. UDWQ does not see any rationale nor compelling reason to modify this designation as the Silver Creek TMDL is complete and will be submitted to EPA in April 2004.

4. One comment requested that UDWQ provide a policy to support the recommendation in the TMDL that UPDES permit limits for the single point source in the watershed not be imposed until significant progress is made in cleaning up non-point sources of zinc and cadmium in the watershed.

Response - The TMDL is quite clear in establishing the clean up targets that need to be achieved before imposition of UPDES permit limits should take effect. UDWQ does not feel an added policy is needed for this matter.

5. Two comments indicated concern with the adequacy of the data set utilized to develop the TMDL. One comment expressed that the data set may not be adequate to set "strict water quality standards" and load allocations. The other comment focused on if the data was adequate to support selection of potential BMPs.

Response - The TMDL report does acknowledge in section 3.2 that there are some limitations to the data set. However, UDWQ supports the approach utilized in clustering the data by station into two month intervals. This allows for seasonal analysis at each of the five monitoring stations. In the aggregate, over 230 and 226 sample results for zinc and cadmium respectively have been incorporated into the analysis used to derive the TMDL allocations. This represents sample results over a 12 year period of record from 1990 through 2002. Further, completion of the TMDL was delayed for a year to allow monthly sampling to be conducted from July 2001 through June 2002 by UDWQ to augment the data set prior to completion of the TMDL.

The Margin of Safety utilized in the TMDL is an additional mechanism that is aimed directly at issues of uncertainty. UDWQ believes that the 25% explicit Margin of Safety utilized is appropriate to compensate for any uncertainty in the data set.

Additional sampling will continue by UDWQ in accordance with the monitoring program outlined section 11.0 and should further bolster the data set for Silver Creek.

In regard to selection of the best BMPs to be utilized for implementing the TMDL, the selection of BMPs should proceed following completion of the TMDL during the implementation phase. UDWQ is quite open to supplemental monitoring that may be appropriate in order to select the best BMP for a given site should that need be apparent. UDWQ will work closely with sponsoring parties on each implementation project to assure that appropriate BMPs are supported.

6. One commenter wanted to make sure that the metals loading estimate provided for the Judge and Spiro tunnels in section 6.0 of the draft TMDL accurately reflected the actual flow and seasonality of flows from these two tunnels.

Response - UDWQ used actual flow and metals data provided by Park City Municipal Corp. in calculating the loads contributed by the Judge and Spiro tunnels. The flows from the Spiro tunnel that enter the Silver Creek drainage were obtained from Mount Aire East Flume data provided by Joel Congor, Park City Municipal Water Dept. on 12-3-03.

7. Two comments expressed concern with the water quality standard for cadmium that is used in the TMDL to establish the stream water quality endpoint or target of 0.00076 mg/l. One commenter questioned why the stream endpoint for the Silver Creek TMDL could be more stringent than the Primary Drinking Water Standard of 0.005 mg/l. Both commenters raised concern that the TMDL endpoint for cadmium was below current laboratory detection limits. One commenter noted that the drinking water best available treatment technology (BAT) can only treat drinking water to a .005 mg/l level.

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Response – TMDL allocations must result in meeting water quality standards. The cadmium endpoint selected for the Silver Creek TMDL is the Utah Water Quality Standard from R317-2-14 adjusted for hardness for class 3A beneficial uses (cold water species of game fish). This value is the same as the cadmium value provided in the EPA National Recommended Water Quality Criteria: 2002 (EPA 822-R-02-047 Nov. 2002).

Many of the metal water quality standards for aquatic beneficial uses are stricter than drinking water standards based on the fact that aquatic biota often have a greater sensitivity to metals than humans.

The issue of the standard for cadmium being below the laboratory detection limit is a legitimate concern. The laboratory capability to analyze metals is improving. By the time clean up activities are well under way in 5 years or more, detection limits may be below the water quality standard. If this is not the case then the generally accepted laboratory detection limit will have to be used as the measure of success for cadmium in this TMDL.

If after clean up actions are completed with all of the known source areas and water quality levels for cadmium in Silver Creek still do not achieve the respective water quality standards, it would be appropriate to undertake a formal Use Attainability Study to ascertain what the stream standard should be.

In regard to UPDES permit limits imposed as a result of the TMDL, the current approach used for water quality standards that are below laboratory detection limits is to set the permit limit at the detection limit. The details of this would be worked out with the permitee at the time the permit limits are developed.

8. One comment indicated that naturally occurring zinc concentrations as high as 74 ppm had been observed in soils in the Silver Creek drainage. The commenter wanted to know how the TMDL and the water quality standard for zinc have taken into account naturally occurring levels of zinc?

Response – Given that the Park City area supported metal mining activities for around a century, it is not surprising to find naturally occurring zinc values as high as 74 ppm have been observed in area soils. What impact these naturally occurring values would have on background water quality is, at this point in time, virtually impossible to estimate in light of the fact that 74 ppm pales in significance to some of the metals values of mining impacted areas in the watershed. As an example, in the meadow area between US-248 and I-80, the Innovative Assessment Analytical Results Report on Lower Silver Creek (DERR 2002) observed zinc concentrations in the 20,000 to 60,000 ppm level.

Accordingly, if clean up actions are completed with all of the known source areas and water quality levels for zinc and cadmium in Silver Creek still do not achieve the respective water quality standards, it would be appropriate to undertake a Use Attainability Study to ascertain what the stream standard should be.

9. One comment indicated that a more complete discussion of zinc and cadmium geochemistry should be included in the TMDL to include pH and hardness controls on the solubility of these two metals. The commenter requested that complete chemical analysis should be presented in the document for available samples.

Response – A full explanation of the geochemistry of zinc and cadmium relative to pH and hardness is beyond the scope of the TMDL. A brief addition to the text has been included in Section 4.5 to address this need in part. The complete data set is available to any party that requests it but will not be added to the TMDL document.

10. One comment expressed concern that the introduction to section 10 of the Draft TMDL indicated that actual clean up and remediation of the source areas for metals in Silver Creek would best be handled in the Superfund arena. The commenter indicated that this would be

contrary to the cooperative watershed approach that has been used in the Silver Creek watershed to date.

Response - UDWQ agrees that a cooperative watershed approach should continue to be utilized in clean up of Silver Creek. The text of the TMDL has been modified to better reflect that the approach utilized in Superfund clean ups that includes detailed investigation of the nature, extent and scope of pollution along with detailed analysis of the feasibility of clean up options is needed as the next step in this process. Most of the major source areas will need further study to determine the best approach to address the source areas for zinc and cadmium.

11. One comment was received that expressed concern about future development activities impacting contaminated areas identified in the watershed. The TMDL report makes the assumption that future development will avoid contaminated areas and not contribute additional zinc and cadmium loads to Silver Creek (sections 4.4 and 6.2).

Response – The current regulatory mechanisms that exist to prevent development activities from disturbing contaminated areas include the use of institutional controls via the Superfund program. In addition, because of liability under the Superfund program, real estate transactions go through a due diligence process to avoid any Superfund liability. UDWQ believes that this is sufficient to assume future development will not contribute additional zinc and cadmium loads to Silver Creek.

12. One comment requested a more detailed presentation of how the TMDL addressed the seasonal variation in hardness at some of the water quality monitoring stations. Additionally, the commenter pointed out that station 492695 showed seasonally lower hardness values for the months of September through December.

Response – Section 8.1 has been modified to include a more detailed description of how the seasonal hardness was addressed. This includes the seasonal hardness values at station 492695 for September through December.

13. One commenter recommended that a study be conducted to evaluate loadings of zinc and cadmium to Echo Reservoir and in reservoir sediments.

Response – This recommendation is a valid extension of the work included in the Silver Creek TMDL but outside the scope of this TMDL. When budget and manpower allows it UDWQ would consider such a study.

14. One comment pointed out that section 6.0 includes loading estimates for the single permitted point source in the watershed and two mining tunnels that contribute zinc and cadmium to Silver Creek, however, no estimate was provided for the load contributed by the Prospector Drain.

Response – The Prospector Drain outflow to Silver Creek is near the eastern end of Prospector Park, immediately upstream from the Silver Maple Claims area. There is some uncertainty as to the seasonal flows from the drain, however sufficient data exists to estimate the annual load attributable to that source. Since the annual load from Prospector Drain is significant and most likely larger than the total of the three sources identified currently in the TMDL, UDWQ feels it is appropriate to include load estimates for the Prospector Drain in the TMDL. Section 6.0 has been modified accordingly.

15. Concern was noted by one commenter about the reference to a 5 year implementation schedule and the uncertainty of obtaining the needed financial resources to effect clean up. Another commenter expressed concern that the TMDL did not provide stakeholders with information on the resources available to assist in clean up projects and that it is UDEQ's responsibility to provide and or assist in obtaining clean up grants.

Response – The scope and potential cost of implementing the clean up measures necessary to achieve the endpoints of the Silver Creek TMDL is quite daunting. UDWQ agrees that the five year estimate included in the TMDL is not realistic. The wording of Section 10.4 has been modified to reflect a more realistic time frame of 10 years.

UDWQ does not agree that the responsibility for obtaining financial resources to effect clean up rests solely with UDWQ. UDWQ very much appreciates the cooperation of all of the stakeholders involved in this process and is committed to supporting and assisting where possible the clean up efforts needed. UDWQ will continue to work cooperatively with stakeholders and other local, state, and federal agencies to address the various projects needed to remedy the water quality impairments that currently exist in Silver Creek.

16. One comment requested a change be made to section 8.3 regarding the time frame for implementing effluent limits for the Silver Creek Water Reclamation Facility. The current TMDL indicates that point source effluent limits should not be imposed until a 75% reduction in upstream non-point sources is achieved. The commenter requested that the 75% reduction be calculated in a different manner resulting in even more clean up being achieved before the point source effluent limits were imposed.

Response – UDWQ believes that the current calculation of clean up needed is accurate and adequate.

17. One commenter noted that the evaluation of load per distance depicted in section 4.4 and Table 9 results in a diminished importance being given to the stream reach between Richardson Flat and station 492680 (above Atkinson) when in fact this stream reach results in the overall largest load contribution of any.

Response - UDWQ agrees with the comment. The segment of the stream between Richardson and the above Atkinson station contributes approximately 5000 lbs. per year of zinc. The next largest contribution of 3000 lbs. per year is in the reach between the Park City monitoring station and Richardson Flat. The text in section 4.3 has been modified to address this comment.

18. One comment pointed out that the TMDL report needed to clarify if total, dissolved, or a mix of water quality results was used for the analysis of zinc and cadmium. If both total and dissolved values were used to derive the TMDL allocations for cadmium and zinc, then a discussion should be added to the document to clarify how this should be interpreted.

Response – A review of the data set shows that there were only 7 instances where total zinc or total cadmium were available. This is not a sufficient number of data points to use in this analysis. The analysis presented in the TMDL is based on dissolved values. The text in section 3.3 has been modified to reflect this.

19. Several comments indicated that the TMDL report needed to include a better explanation of science behind the impairment listing. Information should be included that demonstrates the biological implications to fish and their food chain when metals values exceed water quality standards.

Response – Text has been added to the TMDL report in Section 1.3 to provide this information.

TOTAL MAXIMUM DAILY LOAD FOR DISSOLVED ZINC AND CADMIUM IN SILVER CREEK, SUMMIT COUNTY, UTAH,

DRAFT Report: February 5, 2004

COMMENTS by

UTAH BLM
Salt Lake Field Office

Page #	Comment
3	**Significant Sources**: Note that the Floodplain tailings occur on the east side of the Silver Maple Claims site and this land, according to our Realty Specialist, belongs to Park City Municipal Corporation (Owner).
7 Fig 1	What do the numbers 695, 697, 685 and 680 represent?
7 Fig 1	There is a strange box-like polygon on highway U-248 in the figure. What is it?
8	How are the hydrologic data inconsistent and where are they limited in the watershed?
30	**Zinc,** para 3, “However, careful consideration must also be given to the sequence of clean up from an upstream to downstream order to insure that upstream sources do not contaminate areas downstream that have been addressed earlier.” I agree with this approach.
30	**Zinc**, 4.4, para 4, “Between Park City and Richardson, the incremental load amounts to about 3,000 pounds per year. Therefore, the focus of attention as far as remediation should be in the reach of Silver Creek between Park City and Atkinson.” Should this be between **Richardson** and Atkinson instead of between **Prospector** and Atkinson?
30	**Zinc**, 4.4, para 5, “It is expected that all future development activities will avoid contaminated areas and as a result it is expected that these areas will not contribute zinc or cadmium load to Silver Creek.” How can we protect cleaned up areas ? I don’t think it is a good assumption that future development activities will avoid these areas once they are cleaned up, do you? The Silver Maple Claims site is a perfect example. The site has been annexed by Park City. Future plans by the city for that area have never been fully discussed or clearly stated.

It may be useful to review from EPA’s website a description of the

NFRAP (No Further Remediation Action Planned) of the Silver Maple Claims site as of 11/8/2000:

"This site (Silver Maple Claims Site) is located on a 38 acre parcel of public land within the Silver Creek drainage area about one mile northeast of downtown Park City. The site is situated between two prominent land features known as the Prospectors Square Subdivision of Park City and Richardson Flats. The environmental impact report for the groundwater and surface water study concluded that the tailings in the Prospector Square area are affecting groundwater quality in the unconsolidated valley fill aquifer."

33 **Table 10: List of Known Sources**: A considerable amount of tailings materials occur below (east) of BLM's Silver Maple Claims site and is thought to be owned by Park City Municipal Corporation (conversation with Mike Nelson).

36 **Table 11: Source Information**: Silver Maple Claims- BLM→ add
1) BLM, Site Investigation (SI) 2003; 2) Wetland Functional Assessment, 2003 Dynamac, 3) Macro-invertebrate study, 2003, University of Utah,
4) Geoprobe coring, Dynamac, 2003.

36 **6.2, Future Sources**. "It **<u>is expected</u>** that all future development activities will avoid contaminated areas and, as a result, it is expected that these areas will not contribute zinc or cadmium load to Silver Creek."

I am not sure what this is saying for future development activities at Prospector Square and/or at the Silver Maple Claims area. Is there some regulatory enforcement "teeth" behind this expectation? Any activities that will increase the contaminant runoff to the PC pipe should be regulated for successful downstream efforts. Likewise any planned activities by others (ie. Park City, BLM has no plans for any development of the Silver Maple Claims site to date) should also be regulated.

40 **Silver Creek Water Reclamation Facility**: Where and what is this? Is this the same facility as the Snyderville W*astewater Treatment Plant*?
BLM still wonders if it is possible to hook the Prospector drain up to the Exit sting sewer system in which the fluids would effectively bypass the Silver Maple Claims Site to the wastewater treatment plant.

44 ***Temporary Erosion Control:*** How is <u>*downward water percolation*</u> dealt with in the Park City Contaminated Soils Ordinance? This downward percolation is of concern to BLM because we assume that downward water would percolate through the large tailings pile at Prospector Square and may source the Prospector Drain which is flowing onto BLM. This downward percolation of water I believe should be identified as a source of contamination and contribution to the Prospector Drain.

50	***Silver Maple Claims***: What are the recommended BMPs for the BLM's Silver Maple Claims site?
54	***Park City to Richardson Flat***: No where in the implementation measures efficiencies and costs do you address the Prospector Drain or its possible remedy.
54	***Park City to Richardson Flat***: BLM's Silver Maple Claims site has diminished in **size to 38.35 acres** since 26.61 acres were transferred to the Air Force north of the highway. Where did the 387,197 number of cubic yards of tailings come from for the Silver Maple Claims site?
55	**Implementation Schedule**: Change→ Draft EE/CA Spring/Summer 2004, Cleanup begins following Park City drain pipe resolution.
58	Tim Ingwell is key contact (Project Manager) not Mike Nelson.
59	**REFERENCES**: You might like to add the following relevant reference. Giddings, E.M., Hornberger, M.I. and Hadley, H.K., 2001, Trace-metal concentrations in sediment and water and health of aquatic macroinvertebrate communities of streams near Park City, USGS Water Resources Investigation Report 01-4213, 22p. I would be interested in getting a copy of the Brodie, et.al., 1993 paper on staged aerobic wetlands based acid drainage treatment systems design.

John, that is my review in a nutshell. The writing was clear. The figures where easy to read and interpret. Figure 5, the Silver Creek Hydrology Map, I thought should have been more legible. Maybe a smaller subset of maps that zero in on these areas would work better. The same comment applies to Figure 22- Silver Creek Contaminant Source Map. I would welcome a more detailed map from Prospector Square to Richardson Flat. Overall a nice Draft Report John.

From: "Briant A Kimball" <bkimball@usgs.gov>
To: <jwhitehead@utah.gov>
Date: 2/25/2004 9:48:49 AM
Subject: TMDL

John,

Let me make a few comments on the draft TMDL. You did a good job going through it the other day. It was short and sweet.

1. p. 19: I am very curious why the concentrations are lowest in July and August for Cd and Zn. This is not really an expected pattern. There would be a great percentage of base flow, and so I would expect concentrations to be higher. I know you have to work with 0.45-micrometer filtration, but I have to wonder if there are not some procedure artifacts in the dataset. I may take some ultrafiltrate samples when we work this spring to investigate that. The only physical or chemical explanation I can think of would be that the sources dry up and just stop contributing.
2. p. 22: Where our synoptic data are included the values are often high, as in figure 13. I would expect that because of the extreme dry conditions when we sampled.
3. p. 23: We had Cd data that are not included in Figures 14, 17 and 19. Any particular reason for leaving them out?
4. p. 30, first paragraph: This evaluation of load per distance is right, but seems to lessen the importance of the Meadow area as a source. The load from that area overall is much greater than the load that seems more important in this paragraph.
5. p. 34, figure 22: I don't thin you have the right location for the Prospector Square Ground Water Drain. It falls right on the stream.
6. p. 50, Prospector Square: the pipe is not upstream of Silver Maple but within Silver Maple, if the fence is right on the boundary.
7. p. 50: Flood plains tailings: You might want to say the "source of water" rather than the "source of hydrology."

I hope these make sense. None of them is real serious; just suggestions. I found that I agreed with most everything as I read through it.

Briant A. Kimball
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Snyderville Basin Water Reclamation District
2800 Homestead Road • Park City, Utah 84098 • Phone 435-649-7993 • Fax 435-649-8040

February 16, 2004

RECEIVED
FEB 25 2004
DIVISION OF
WATER QUALITY

Mr. John Whitehead
Division of Water Quality
Department of Environmental Quality
288 North 1460 West
P.O. Box 144870
Salt Lake City, UT 84114-4870

Subject: Comments on Draft Silver Creek Total Maximum Daily Load (TMDL) Study, dated February 5, 2004

Dear Mr. Whitehead:

Thank you for providing the Snyderville Basin Water Reclamation District the opportunity to review the draft report for the Silver Creek TMDL. Listed below are our comments:

1. Section 2.0 addresses water quality standards but does not actually discuss how elevated levels of zinc and cadmium impair the stream. As an example, when cadmium levels exceed 0.00076 mg/l, are benthic populations negatively impacted? Additional information concerning the impact of these metals on the biota would add meaning to the section.

2. Contained within Table 7, page 28, the zinc loading from the Silver Creek Water Reclamation Facility (SCWRF) is shown to be 700 lbs. Actual loading is 588 lbs. believe you are aware of this correction.

3. Section 6.0 addresses known sources of contaminants. The District's SCWRF contributes 588 lbs/yr of Zn. The Judge and Spiro tunnels jointly contribute 400 lbs/yr of Zn. What is the loading from the Prospector drain pipe and how is this loading allocated?

4. Section 8.0 allocates zinc and cadmium loadings. Table 12, provides a waste load allocation for cadmium of 4.6 lbs/yr to the SCWRF. This loading is based on a cadmium concentration of 0.00076 mg/l. In reviewing the State of Utah's approved laboratory methods the lowest achievable concentration is 0.001 mg/l. Therefore, it is not possible to measure a concentration of 0.00076 mg/l using approved methods. Furthermore, when non-detectable laboratory results are reported, they are often reported as <0.001 mg/l. As is often the case, a concentration of <0.001 mg/l is assumed to be 0.001 mg/l. If the SCWRF is given

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an effluent concentration limit of 0.00076 mg/l, but the results are reported as <0.001 mg/l, it would give the appearance that the facility is in violation of an effluent limitation. An enforceable effluent limitation should not be set beyond the capability of the approved analytical laboratory methodology.

5. Section 10.2 addresses implementation measures by site including the SCWRF on page 51. The following highlighted words should be added to the end of the last sentence "...laboratory detection limit ***of 0.001 mg/l.***"

6. The implementation schedule (Section 10.4) assumes a five year cleanup period Where will the cleanup funding come from for those areas downstream of the Silver Maple property?

7. The last paragraph on page 42 discusses a zinc loading of 7,670 lbs that represents a 75% reduction of the current loading above Atkinson station. We would propose that the 75% be applied to the reduction needed above Atkinson of 11,768 lbs. Therefore, 75% of the goal or a reduction of 8,826 lbs would be reached before an effluent limitation is placed upon SBWRD.

Again, thank you for the opportunity to review the draft document.

Sincerely,

Michael D. Luers
General Manager

cc: Michael Boyle

PARK CITY
1884

March 3, 2004

Department of Community Development
Engineering • Building Inspection • Planning

Utah Division of Water Quality
288 North 1460 West
Salt Lake City, Utah 84114

Attention: John Whitehead, Project Manager

Subject: Comments for Draft Report Total Maximum Daily Load for Dissolved Zinc and Cadmium in Silver Creek, Summit County, Utah

Dear Mr. Whitehead:

Park City Municipal Corporation (PCMC) respectfully submits the attached comments to the Utah Department of Environmental Quality (UDEQ) on the proposed Silver Creek Total Maximum Daily Load (TMDLs) standards.

PCMC remains committed to improving water quality within the East Canyon and Silver Creek watershed by employing practical best management practices and proven technology for minimizing pollutant loading. This continues to be demonstrated by PCMC's approved Storm Water Management Plan and the accomplished storm water goals, water quality institutional controls, and a firm commitment to conservation programs directly related to minimizing non-point source pollution (NPS). Furthermore, PCMC Water Department has invested a substantial amount of financial resources committed to education and the new Judge Tunnel Plant, which will include treating the pollutant loads originating from the tunnel. It should also be noted, that City residents residing within the Soils Ordinance Boundary continue to cap and vegetate property impacted with mine tailing material. The progress of this capping effort emphasizes the City's dedication in isolating soils contaminated with heavy metals from coming in contact with surface water and thereby impairing the watershed.

In providing UDEQ with these comments, PCMC would like to emphasize that the TMDL for Silver Creek watershed should be achievable for those stakeholders contributing to that water body. It is PCMC's understanding that UDEQ has classified Silver Creek as a "Class 3 A – Cold Water Fishery" with the water quality standard targets being zinc at .39 mg/l and cadmium at .00076 mg/l. The City has divided these comments to address the proposed standards and address the conclusions documented in the draft dated February 5th, 2004. These comments are intended to provide UDEQ with additional insight in regards to PCMC position and concerns with the first draft.

PCMC appreciates having the opportunity to comment on the proposed standards and I thank you for your time and consideration. In the event you need to contact me, I can be reached at 435 615 5058 or email at jschoenbacher@parkcity.org.

Sincerely,

Jeff Schoenbacher
Environmental Coordinator

RECEIVED
MAR 08 2004
DIVISION OF
WATER QUALITY

CC: Tom Baklay
Ron Ivie

JTS

Park City Municipal Corporation • 445 Marsac Avenue • P.O. Box 1480 • Park City, Utah 84060-1480
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PARK CITY MUNICIPAL CORPORATION

COMMENTS ON PROPOSED SILVER CREEK TMDL

March 3, 2004

TABLE OF CONTENTS

Priority Ranking – Page 2.

PCMC believes the UDEQ "high priority" ranking for Silver Creek should be further justified in the draft document. Generally speaking TMDL high priority designations are for water bodies that pose a threat to aquatic life (usually endangered or threatened) as well as a danger to human health (i.e. impairment contributing to a violation of an MCL). The current zinc and cadmium load to Silver Creek although may pose a threat to aquatic life., it is PCMC's understanding that these concentrations do not pose a threat to human health. As a result, PCMC believes that the priority group should be reclassified as "medium", unless otherwise justified by UDEQ.

Allocation – Page 4.

PCMC questions the statement "These effluent limits will not be required until significant progress is made on the non-point source pollution problems in the Silver Creek Watershed." Although this is a comforting statement for those stakeholders having discharge permits or on the verge of obtaining a discharge permit. PCMC firmly believes that UDEQ should provide a specific policy directive to UDES permit writers, acknowledging that these standards will not be enforced within effluent limitation guidelines for newly issued permits. PCMC is quite aware of what these standards mean and how they are used by UDES discharge permit writers and unless otherwise specified by UDEQ. PCMC anticipates that future permits will be required to comply with these standards. If PCMC is in error with that assumption, the City would like UDEQ's policy that supports the statement that the effluent limits will not be required nor enforced by UDES permit writers issuing new permits.

Water Quality Targets and Endpoints – Page 12

PCMC recognized that the amount of zinc and cadmium a waterbody can receive without experiencing damage is affected by many variables, one of which is the hardness of the water. Therefore, the hardness value is used to calculate the water quality standard for the acceptable amount of these constituents based on either chronic or acute toxicity. PCMC further understands that the number derived, is the concentration limit necessary to protect aquatic life. However, UDEQ used a hardness value of 400 mg/l to calculate the theoretical maximum amount of zinc and cadmium that can be discharged to the receiving water without harming the aquatic organisms of Silver Creek. However, UDEQ admits that the actual average hardness value detected was 484 mg/l, but chose a stricter hardness criteria for calculating the zinc and cadmium chronic standard. PCMC does not believe UDEQ adequately justified in this section using 400 mg/l for calculating the chronic water quality standard. Although UDEQ may believe that calculating a "stricter" standard is a better approach, it is unfair for those that hold UDES permits and must comply with such a standards. PCMC believes that the hardness value should be rounded up from 484 mg/l to 500 mg/l rather than rounding down. PCMC request that chronic water quality standard be recalculated based on the actual hardness averages detected during the monitoring of Silver Creek. The explanation for rounding down the hardness measurement to a stricter standard is inadequate within this section. Researching the USEPA's "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and their Uses", PCMC does not find the approach of subjectively reducing the hardness value resulting in a stricter standard acceptable. Furthermore, the data does not support the use of 400 mg/l.

Data Limitations – Page 15

UDEQ states in this section "As with many studies of this nature, there has been unsystematic sampling conducted throughout the watershed. The sampling included different time spans, non-uniform sampling within the time spans, and inconsistent flow measurements. Sometimes flow measurements were made concurrently with water quality sampling, and at other times no flow measurements were made."

PCMC understands that this has resulted in UDEQ clustering data for the individual data points. PCMC feels that UDEQ should further explain if this practice is acceptable and reflects a representative load allocation for each individual data point. The premise of establishing such strict water quality standards without a representative load allocations that take into consideration month to month flow fluctuations results in PCMC questioning the science behind the standard. PCMC believes that the Silver Creek TMDL Standard should be set with sound science that justifies the criteria. Based on the statements contained in this section, PCMC questions whether the UDEQ compiled data is representative for 12-month uniform sampling period that takes into consideration all variables. Data concerns were also stated in Section 5.2 Margin of Safety, which states. "As pointed out in this appendix, although the statistical analysis resulted in satisfactory results, there remain significant uncertainties in the estimates of representative concentrations and loadings based on the variability of the existing data." PCMC firmly believes that obtaining representative samples is of primary importance for an accurate description of the Silver Creek environment. If this has not been done in establishing the Silver Creek TMDL, PCMC request that additional representative data be obtained before finalizing a standard.

Sources – Page 33

PCMC attributes all of the "metals of concern" to have originated from mine tailings, generated from the historic silver mining era dating back to the 1800's. On page 33-second paragraph first sentence reads, "Most indications suggest that the metals of concern in this watershed are from historical mining activities in the Park City area". PCMC believes this sentence infers the small probability that the "metals of concern" originate from other activities within the City. As result, PCMC recommends that this sentence be rewritten stating that, "All indications suggest that the metals of concern... Section 1.3 Water Quality Impairment, Page 11; last paragraph also has the same sentence which PCMC requests to be revised.

Lastly, the draft mentions Judge and Spiro Tunnel contributing to the Silver Creek watershed and PCMC would like to clarify that the Judge overflow contributes to the watershed 100% of the time. However, Spiro only contributes 35% of the time to Silver with the remaining time being directed to McLeod Creek, which eventually enters East Canyon Creek. PCMC requests that this load be adjusted to factor in the percentage of time that the Spiro flow is actually released to Silver Creek watershed.

Best Management Practices – Page 44

The section titled "Temporary Erosion Control" refers to "Park City has a contaminated soil ordinance that requires that contaminated soils be addressed prior to construction." The correct title for the soils ordinance is Park City Landscaping and Maintenance of Soil Cover, which is found in Chapter 15 of Title 11 of the Park City Municipal Code. PCMC requests that the correct title be used throughout the TMDL document. This ordinance requires much more than what was described in this section, as it mandates the capping and vegetating of all lots containing elevated levels of lead. In addition, as written within the ordinance, the cap is to be maintained and any soils that are generated are to be strictly managed and disposed of depending on the characteristics. Also, this section failed to mention that PCMC has implemented a compliant Storm Water Management Plan, which details the City's requirements as they

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relate to construction BMP's that are specific conditions for the issuance of a Building Permit. The Building Department requires BMPs be identified on submitted building plans, mitigation plans, certification statement, as well as the City Engineer requiring utility contractors to identify storm water slope control practices.

Implementation Measures – Page 46

The bullet with the title "Ordinances" mentions Park City Landscaping and Maintenance of Soil Cover and the intent and then closes that paragraph with "Federal ordinances, i.e. Superfund designation would require full cleanup and stabilization of a site." PCMC believes that is it important that the TMDL authors realize Prospector is a line item in the 1986 SARA amendment, which precludes future listing of the site on the Superfund National Priority List. Therefore, if UDEQ wishes to use this language, PCMC would prefer that the 1986 SARA amendment fact be included. Table 14 also infers that the Superfund Program jurisdiction within Prospector.

Table 14: Best Management Practices – Description of Removal Efficiencies – Page 46

The second to the last row in Table 14 identifies "Park City Soil Ordinance" and within the description column states that certain areas are designated as "no or minimal disturbance". PCMC does not understand what the author was intending to convey as it does not coincide with any of the standards within the ordinance. Furthermore, this section states that contaminated soils are not allowed offsite. PCMC Landscaping and Maintenance of Soil Cover does allow soils impacted with mine tailings to be transported offsite to a permitted disposal facility. Also, developers are required to comply with PCMC mitigation plan requirements, which include construction storm water management BMP's.

Lastly, PCMC has reviewed the Georgia Stormwater Manual identified in the reference column and finds no mention of the City soil ordinance. As a result, PCMC would recommend UDEQ revise the reference section to Park City Municipal Code.

Implementation Measures by Site – Page 50

The narrative describing Prospector Square failed to mention that the area contains single-family housing structures. PCMC feels that this section should be updated to acknowledge that single-family units are a component to this area. This section also mentions the Prospector drain and states that it drains shallow ground water. PCMC continues to investigate where the drain line originates and the contributors. There have been no conclusions on where the line starts and the origin theories range from an installed drain line, to a vacated mine slurry line, to a line installed to convey residential basement sump water.

Within this section PCMC request that the correct title for the ordinance replace "Park City contaminated soil ordinance". PCMC also requests that the statement referring to "Contaminated soils can be "capped"…" be followed with the fact the lots are required to be vegetated and the cap maintained.

Regarding the recommendation of a treatment wetland for the Prospector Drain, as conveyed on February 23rd 2004 in a meeting with John Whitehead (UDEQ), Jim Christiansen (USEPA), and Tim Ingwell (BLM), PCMC will be pursuing a wetland bio-cell for treating the Prospector drain. Currently, PCMC is in the process of obtaining a wetland consultant and it is anticipated that a plan and design will be available for this wetland by early June 2004.

3

Implementation Measures Efficiencies and Costs – Page 52

PCMC believes the cost for topsoil at $3.50 sq/yd is grossly inaccurate in regards to the real cost for "screened" and "unscreened" topsoil. The going rate for "screened" topsoil for this area is $11.50 cu/yd and for "unscreened" $10.50 cu/yd. For a delivered product, this then comes to $14.50 to $15.50 cu/yd. PCMC realizes that the figure that was used was obtained from a UDOT Statewide Standard Average. However, PCMC believes the cost should be researched locally instead of using a Statewide Average that is not reflective of the Park City area costs. As a result, PCMC requests the BMP cost figures be recalculated using the local price for topsoil and not a Statewide Average. Topsoil is a fairly expensive local product that is mostly imported to the City limits from the Kamas Valley.

Implementation Schedule – Page 55

Although this section provided an implementation schedule, it failed to provide Silver Creek stakeholders an awareness of clean-up funding resources. PCMC believes that it is also UDEQ's responsibility to assist in providing and obtaining clean-up grants to offset the BMP costs. Therefore, PCMC requests this section be expanded to address potential cost share funding opportunities that stakeholders can seek for paying for the implementation of the recommend BMP's. PCMC firmly believes that UDEQ needs to take an active role as a partner in regards to providing funding assistance.

Cadmium Chronic Water Quality Standard 0.00076 mg/l

PCMC has previously mentioned in these comments that UDEQ needs to use the actual hardness averages rounded up (484 mg/l to 500 mg/l) instead of rounding down (400 mg/l), for calculating the zinc and cadmium chronic water quality standard.

PCMC does not believe UDEQ has adequately justified the cadmium chronic standard of 0.00076 mg/l. PCMC feels that there should be a full explanation of why the current cadmium concentration found in Silver Creek does not support the designated use of a 3A Cold Water Fishery. Furthermore, PCMC requests further clarification to why UDEQ has chosen a standard that is more stringent than the cadmium Primary Drinking Water Standard of .005 mg/l (R309-200-5). Is PCMC to assume that if Silver Creek were classified as Class 1C drinking water source that the standard would be more lenient? PCMC would also question whether this standard is more stringent than naturally occurring background levels. If this is the case, mixing zones are of no benefit, forcing those with UDES discharge permit holders to invest in costly treatment that produces little or no real change. PCMC strongly believes that ambient pollutant levels should not exceed the lowest levels technically and economically achievable. The current cadmium standard of 0.00076 mg/l is an unattainable goal and cannot even be measured with the present laboratory technology (0.005 mg/l Chem-Tech Ford Laboratory). In addition, referencing USEPA Consumer Fact Sheet for cadmium the following statement is made:

The MCL has also been set at 5 ppb because EPA believes, given present technology and resources, this is the lowest level to which water systems can reasonably be required to remove this contaminant if it occurs in drinking water.

Based on this information, if the present technology cannot treat down to 0.00076 mg/l, how are those with discharge permits within the Silver Creek watershed going to achieve the goal or monitor for it? Also, PCMC would ask what UDEQ would be using for a benchmark for success. If the cadmium concentrations are reduced and the waterbody still does not support the designated use of 3A in 2 years, will that be UDEQ's justification for reducing the standard even further? To reiterate, PCMC believes that the Silver Creek TMDL should not be set at a levels that exceeds the lowest levels technically and

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economically achievable. And unless a clear justification is made into how the current concentrations of cadmium are contributing to the impairment of Silver Creek, PCMC feels that this constituent should not be listed.

Zinc Chronic Water Quality Standard 0.39 mg/l

PCMC has previously mentioned in these comments that UDEQ needs to use the actual hardness averages rounded up (484 mg/l to 500 mg/l) instead of rounding down (400 mg/l), for calculating the zinc and cadmium chronic water quality standard.

PCMC feels that there should also be a full explanation of why the current zinc concentration found in Silver Creek does not support the designated use of a 3A Cold Water Fishery. PCMC would also like to recognize that naturally occurring zinc concentrations have been found as high as 74 ppm within this area, therefore the City would like an explanation of how this has been factored into the TMDL. PCMC feels that it is important to factor the naturally occurring levels into the TMDL and as result request UDEQ explain how that was factored into the standard.

Uolin W.

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FEB 27 2004
DIVISION OF WATER QUALITY

United States Department of the Interior
FISH AND WILDLIFE SERVICE
UTAH FIELD OFFICE
2369 WEST ORTON CIRCLE, SUITE 50
WEST VALLEY CITY, UTAH 84119

In Reply Refer To
FWS/R6
ES/UT
04-0508

February 25, 2004

Don Ostler
Department of Environmental Quality
Division of Water Quality
288 North 1460 West
Box 144870
Salt Lake City, UT 84114-4870

RE TMDL for Silver Creek, Summit County, Utah

Dear Mr. Ostler:

The U.S. Fish and Wildlife Service (Service) has reviewed the February 5, 2004 draft TMDL for Silver Creek, Summit County, Utah and is providing the following comments for your consideration.

The TMDL includes a new section on hardness (4.3). This section mentions that the TMDL target values (i.e., water quality standards) were adjusted for two stations (Park City and Wanship) for certain bimonthly periods because of lower hardness values. Since zinc and cadmium standards are hardness dependent, this is the correct approach. However, the specific hardness-derived water quality standards are not provided in the document. Related sections are 4.3, 8.1, 8.2 and Appendix B, but these do not provide the necessary information. The document should provide the hardness values used in the calculations and should provide the adjusted chronic water quality standards that were then used to determine the loading reductions. In addition, please re-evaluate the number of exceedances relative to these revised standards as it is possible that the number of exceedances has increased.

In Section 8.1, the document indicates that that average hardness at Park City and Wanship is lower than 400 mg/L for the bimonthly periods March-April and May-June. Figure 6 in Appendix B shows that hardness is also substantially lower for the Park City site during the bimonthly periods Sept-Oct and Nov-Dec. Therefore, it would be appropriate to apply lower water quality standards for zinc and cadmium here as well.

We encourage the UDWQ to evaluate the loadings of zinc and cadmium to Echo Reservoir. We recommend that sediment from the upper end of Echo Reservoir be analyzed for zinc, cadmium and other heavy metals to determine if loadings from Silver Creek have impacted the Reservoir.

1

We appreciate that many of our comments on the earlier draft were addressed or incorporated into the most recent copy of the TMDL. Overall, the Silver Creek TMDL looks great, and we congratulate UDWQ on a job well done. We appreciate the opportunity to comment on this TMDL. If further assistance is needed or you have any questions, please contact Nathan Darnall, at (801) 975-3330 extension 137.

Sincerely,

Henry R. Maddux
Utah Field Supervisor

cc: John Whitehead, Utah Department of Environmental Quality, Box 144870, Salt Lake City, Utah 84114-4870
Kathryn Hernandez, U.S. Environmental Protection Agency, Water Quality Unit, 999 18th Street, Suite 300, Denver, CO 80202-2466
Bill Bradwisch, UDWR

United Park City Mines Company

March 8, 2004

Mr. John Whitehead
Department of Environmental Quality
Division of Water Quality,
288 North 1460 West. P.O. Box 144870
Salt Lake City, Utah 84114-4870

RE: United Park City Mines Company Comments on Silver Creek TMDL.

Dear John:

United Park City Mines Company appreciates the opportunity to comment on the Draft Report of the Total Maximum Daily Load For Dissolved Zinc and Cadmium in Silver Creek, Summit County, Utah received via email on February 5, 2004. I hope you find that the comments contained in this letter to be constructive.

1 It appears unclear whether or not total or dissolved data (or both) was used in the calculation of average values for Zn and Cd. Table 7 references the use of dissolved data for calculation of average values for Zn and Cd. No other references to dissolved vs. total analysis are made. A review of both the total and dissolved data, if available, is warranted and can help in the understanding of the transport mechanisms for the metals. For the sake of consistency, the data used in the analysis should be clarified as to whether or not it was total or dissolved. If both were used, a discussion should be made as to how the use of both fractions may influence the results of the analysis.

2. I appears that there is not sufficient data to track loads through the system and evaluate the relationships between concentration, flow and loads moving through the system. The use of average concentrations and flows to calculate loads and make assessments about loading in various sections of Silver Creek appears to be simplified and defining remedial objectives based on this analysis may be premature. As an example it is noted in the study that Zn concentrations are highest in the fall and winter months (see Appendix B, Figure 1) while the flows have not increased

P.O. Box 1450, Park City, Utah 84060, (435) 649-8011, Fax (435) 649-8035

proportionally (see Appendix B, Figure 2). The reasons for this phenomenon have significant implications for the effectiveness of the various BMPs recommended. For instance, the concentration increases in the fall and winter could be that the system is dominated by shallow groundwater recharge impacted by the nearby tailings. Conversely the increases could be related to greater infiltration and stream recharge as evapo-transpiration drops off. The successful remediation associated with these two cases would involve very different approaches.

3. The TMDL analysis should discuss Zn and Cd geochemistry including the pH and hardness controls on solubility. Complete chemical analyzes, if available, should be presented in the document for the available samples.

4. The introduction to Section 10 states that: The detailed analysis of the clean up options and remedies along with determination of responsible parties is best handled in the Superfund arena. This comment seemingly is at odds with the cooperative watershed approach currently successfully used by the EPA for the upper watershed. The presentation of the clean up strategies and their estimated costs (>$100 M for lower Silver Creek) in this document seems to be moving away from a cooperative approach.

5. It is unclear as to the position in the report regarding the Richardson Flat proposed NPL site. On page 3, there is a table that describes Richardson Flat as a significant source. Yet on page 51 they state that Richardson's Flat is a minor contributor of contaminants to Silver Creek. United Park City Mines Company believes that the supporting data indicates that Richardson Flat is a minor contributor to the Zn and Cd loading into Silver Creek.

6. The average hardness in Silver Creek is 484. However a value of 400 is used in the analysis. The average zinc and cadmium concentrations are used in the analysis. An explanation of why the hardness value of 400 was used and not the average of 484 should be made available.

7. On page 49, a reference is made to "mine tailings". This term should be changed to "mine waste". It is technically correct.

8. Beginning on page 53, there is a reference that looks at placing topsoil back on remediated areas in square yards yet material is excavated in square yards. A change should be made to be consistent with excavation terminology or an explanation should

be given as to how material will be placed onto the site in square yards.

9. The construction costs portion of the report is not consistent. It is stated that an excavation cost per yard of $4/cu.yd will be used. Yet in some of the calculations, $3/cu.yd is used. The document should be consistent or a clear explanation should be made as to the reasoning behind changing the cost number.

10. As noted in the Draft TMDL Report: "*There is significant variability in the existing flow and chemical data set for this TMDL which lends uncertainty to the loading analysis. Additionally, there is uncertainty in the actual degree of success that implementation of the BMPs identified to address nonpoint sources will achieve.*" We agree with these statements and believe that the data set may be too incomplete to support the selection of potential BMPs and to prepare cost estimates for implementation of BMPs.

Again, United Park appreciates the opportunity to comment on the Draft TMDL for Silver Creek. If you would like to discuss these comments with me, please do not hesitate to call.

Sincerely,

Kerry C. Gee

United Park City Mines Company

Kerry C. Gee