Environment

Yukon Government,
Assessment and Abandoned Mines Branch

Mt. Nansen Surface Water Quality Baseline Characterization

Prepared by:

AECOM
2251 2nd Avenue 867 633 6474 tel
Whitehorse, YT, Canada Y1A 5W1 867 633 6321 fax
www.aecom.com

Project Number:

60119144-112359

Date:

November 2009

Statement of Qualifications and Limitations

The attached Report (the “Report”) has been prepared by AECOM Canada Ltd. (“Consultant”) for the benefit of the client (“Client”) in accordance with the agreement between Consultant and Client, including the scope of work detailed therein (the “Agreement”).

The information, data, recommendations and conclusions contained in the Report:

- are subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the “Limitations”)
- represent Consultant’s professional judgement in light of the Limitations and industry standards for the preparation of similar reports
- may be based on information provided to Consultant which has not been independently verified
- have not been updated since the date of issuance of the Report and their accuracy is limited to the time period and circumstances in which they were collected, processed, made or issued
- must be read as a whole and sections thereof should not be read out of such context
- were prepared for the specific purposes described in the Report and the Agreement
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time

Unless expressly stated to the contrary in the Report or the Agreement, Consultant:

- shall not be responsible for any events or circumstances that may have occurred since the date on which the Report was prepared or for any inaccuracies contained in information that was provided to Consultant
- agrees that the Report represents its professional judgement as described above for the specific purpose described in the Report and the Agreement, but Consultant makes no other representations with respect to the Report or any part thereof
- in the case of subsurface, environmental or geotechnical conditions, is not responsible for variability in such conditions geographically or over time

The Report is to be treated as confidential and may not be used or relied upon by third parties, except:

- as agreed by Consultant and Client
- as required by law
- for use by governmental reviewing agencies

Any use of this Report is subject to this Statement of Qualifications and Limitations. Any damages arising from improper use of the Report or parts thereof shall be borne by the party making such use.

This Statement of Qualifications and Limitations is attached to and forms part of the Report.

November 30, 2009

Frank Patch
Senior Project Manager
Assessment and Abandon Mines Branch
Department of Energy Mines and Resources
Yukon Government
4114 4th Ave, Room 2C
Whitehorse, Yukon Y1A 1H9

Dear Mr. Patch

Project No: **60119144 - 112359**

Regarding: **Mt.** Nansen Surface Water Quality Baseline Characterization

Sincerely,
AECOM Canada Ltd.

Kai Woloshyn, B.Sc.
Environmental Scientist
Kai.Woloshynl@aecom.com

XX:xx
Encl.
cc:

Distribution List

# of Hard Copies	PDF Required	Association / Company Name

Revision Log

Revision #	Revised By	Date	Issue / Revision Description

AECOM Signatures

Report Prepared By:

May Quach, M.Env.Sc.
Aquatic Ecologist

Report Reviewed By:

Kai Woloshyn, B.Sc.
Environmental Scientist

Table of Contents

List of Figures

List of Tables

Appendices

1. Introduction

This report is a summary of the available surface water quality data collected to date for the closure assessment of the Mount Nansen Mine (Mt. Nansen). Surface water quality sampling at the mine site began in 1999 by the Department of Indian and Northern Affairs (DIAND). The Yukon Government took over the sampling program in 2003, and in 2005 contracted this work to EDI Environmental Dynamics (EDI). EDI is currently continuing this sampling effort on a bi-weekly basis.

Inspection of the water quality data showed a marked difference in detection limits prior to and after December 2007. This was due partly to laboratory methods that were specific to standards required during the time of sampling and partly to the switching of laboratories throughout the years. Detection limits for total metals prior to December 2007 were high enough that inclusion of this data in data analysis for this memo would have resulted in many false exceedances of guidelines. Since December 2007, samples have all been sent to Bodycote Testing Group, and total and dissolved metals are now analyzed such that detection limits are suitable to allow comparison with all applicable water quality guidelines.

Although bi-weekly sampling is currently ongoing, October 15, 2009 was chosen as the cut-off date for the purposes of this memo. As of this date, between one and two years of data are available for all sites.

1.1 Scope of Work

The Mt. Nansen Water Quality Baseline Characterization consists of the following:

- Compilation of water quality data;
- Review of mine impacts on water bodies and water quality trends;
- Basic statistical analysis of the water quality data; and
- Preparation of this report.

1.2 CCME Guidelines and Water License Standards

The historical water quality data for the Mt. Nansen Water Quality Baseline Characterization has been compared to two sets of water quality guidelines and standards: The Canadian Council of Ministers for the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life (CCME 2008) and the Effluent Quality Standards (EQS) from Water licence QZ94-004 issued by Yukon Territory Water Board to B.Y.G. Natural Resources Inc. for the Mt. Nansen mine site on February 13, 1996. Table 1 summarizes the CCME and EQS for physical and metal parameters for the Mt. Nansen project.

Table 1. Water Quality Guidelines and Standards

Parameter	Units	CCME	EQS
pH	pH units	6.5 – 9.0	6.0 – 8.5
TDS	mg/L	-	50
Ammonia-N	mg/L	0.832 at pH=8.0 and temperature=10°C	-
Nitrate-N	mg/L	2.9	-
Nitrite-N	mg/L	0.06	-
Cyanide-Total	mg/L	-	0.3
Cyanate	mg/L	0.5	-
CN-WAD	mg/L	-	0.1
Total Aluminum	mg/L	0.005 at pH <6.5	-

Parameter	Units	CCME	EQS
		0.1 at pH ≥6.5	
Total Antimony	mg/L	-	0.15
Total Arsenic	mg/L	0.005	-
Dissolved Arsenic	mg/L	-	0.15
Total Barium	mg/L	-	1
Total Cadmium	mg/L	$= 10^{\{0.86[\log(\text{hardness})]-3.2\}}$	0.02
Total Chromium	mg/L	0.0089	0.04
Total Copper	mg/L	0.002 at hardness 0-120 mg/L 0.003 at hardness 120-180 mg/L 0.004 at hardness >180 mg/L	0.2
Total Iron	mg/L	0.3	1.0
Total Lead	mg/L	0.001 at hardness 0-60 mg/L 0.002 at hardness 60-120 mg/L 0.004 at hardness 120-180 mg/L 0.007 at hardness >180 mg/L	0.1
Total Manganese	mg/L	-	0.5
Total Mercury	mg/L	0.000026	0.005
Total Molybdenum	mg/L	0.073	-
Total Nickel	mg/L	0.025 at hardness 0-60 mg/L 0.065 at hardness 60-120 mg/L 0.110 at hardness 120-180 mg/L 0.150 at hardness >180 mg/L	0.3
Total Selenium	mg/L	0.001	-
Total Silver	mg/L	0.0001	0.10
Total Thallium	mg/L	0.0008	-
Total Zinc	mg/L	0.03	0.30
Toxicity (LC50)	%	-	100

2. Study Methods

2.1 Study Area

The water quality study area is shown on Figure 1. The primary drainage is Dome Creek, which flows from above the mill site, past the tailings facilities into Victoria Creek. Pony Creek drains a small portion of the mine site north of the Brown-McDade Pit and eventually flows into Back Creek, a tributary to Victoria Creek. Victoria Creek is a tributary stream to the Nisling River, a medium-sized river in the White River drainage basin.

The study area focuses on the Dome Creek, Pony Creek, Back Creek and Victoria Creek watersheds. This includes areas potentially impacted by the mill, waste rock piles, tailings pond, seepage discharge, and the Brown-McDade pit. The fourteen surface water quality monitoring sites in the study area are separated into four distinct groups: reference, loading source, mine impacted and receiving environment as shown in Table 2.

As Dome Creek, Pony Creek and Victoria Creek have all been identified as being part of the receiving environment, each of these waterbodies have their own corresponding reference site(s) and receiving environment site.[1] The reference sites consist of Dry Creek Reference Site, Victoria Creek Reference Site, Upper Victoria, DX, and Pony U/S. The mine impacted area consists of two sites on Dome Creek, D1 and Upper Dome. The loading sources

[1] *In this study, "receiving environment" is defined as "any land, water, sediment, bog, swamp or muskeg containing receptors" (BC MOE). As Dome Creek, Pony Creek, Back Creek and Victoria Creek all contain either fish or fish habitat or aquatic insects that are consumed by fish; they are all considered part of the receiving environment. For further details, please refer to Appendix D.*

consist of the tailings pond, seepage discharge, and the Brown-McDade pit. The receiving environment consists of one site each in Victoria Creek, Dome Creek, Pony Creek and Back Creek.

Table 2. Surface Water Quality Monitoring Sites

	Site ID	Description	UTM Coordinates	
			Easting	Northing
Reference	VCR	Victoria Creek Reference Site	391595	6881330
	DCR	Dry Creek Reference Site	388111	6880251
	Upper Vic	Victoria Creek, north of confluence with Back Creek	391715	6880997
	DX	Dome Creek, upstream of Mill Site	387688	6881191
	Pony U/S	Pony Creek, upstream of Pit and waste rock pile	388598	6882030
Mine Impacted	D1	Dome Creek, upstream of Tailings Pond	388137	6881032
	Upper Dome	Dome Creek, downstream of Tailings Pond	389805	6880562
Receiving Environments	Vic @ Rd	Victoria Creek, north of Mine Access Road	392405	6878859
	Dome @ Rd	Dome Creek at Mine Access Road	391115	6880466
	Pony D/S	Pony Creek, Downstream of Pit	389015	6881723
	Back	Back Creek, near confluence with Victoria Creek	391619	6881068
Loading Sources	Tailings	Tailings Pond Site	389377	6880723
	Seep	Seepage Discharge Site	389618	6880577
	Pit	Brown-McDade Pit Site	388813	6881552

2.2 Data Analysis

The minimum, median, maximum, and upper and lower quartile concentrations of selected water quality parameters were calculated for each site. A parameter was selected for data analysis if it exceeded either or both of CCME guidelines and EQS as specified in Section 1.2.

The median, rather than the arithmetic mean, was assumed to be the best estimate of the central tendency of the data because many water quality variables tend not to be normally distributed. To calculate statistics, values below detection limits were replaced with half the detection limit.

The selected water quality parameters were compared to CCME guidelines and EQS, and exceedances were identified.

Figure 1. Mt Nansen Surface Water Sampling Locations

3. Baseline Characterization

The surface water quality data of sites in the Mt. Nansen project area from 2007 to 2009 is presented in Appendix A and Appendix B shows statistical analysis of the data presented in Appendix A, including the minimum, median, maximum, and upper and lower quartile values for selected water quality parameters.

Data in Appendix A shows all surface water quality data as reported by Bodycote Testing Group. Exceedances presented in the tables and charts below are based on these reported values. Statistical data, as shown in Appendix B, was generated from the data set in Appendix A, but data below the detection limits were set to half the detection limit in order to include as many data points as possible.

Water quality parameters that exceed CCME and EQS are shown in Tables 3 and 4, respectively. These tables provide a quick snapshot of whether or not water quality parameters exceed guidelines and standards. The corresponding figures referenced in this section (Appendix C) show the number of exceedances of total samples and are presented as percentages. Baseline characterization is organized by watercourse so that differences between the types of sites can be easier to distinguish.

Table 3. Water Quality Parameters Exceeding CCME Guidelines, Mt. Nansen, 2007-2009

	Reference Sites					Receiving				Mine Impacted		Loading Sources		
Parameter	DCR	VCR	Upper Vic	DX	Pony U/S	Vic @ Rd	Dome @ Rd	Pony D/S	Back	D1	Upper Dome	Tailings	Seep	Pit
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ammonia-N	-	-	-	-	-	-	●	-	-	-	●	●	●	-
Nitrate-N	-	-	-	-	-	-	-	-	-	-	-	●	●	●
Nitrite-N	-	●	●	●	●	-	●	●	-	●	●	●	●	●
Cyanate	-	-	●	-	-	-	●	-	-	-	●	●	●	NS
Al	-	●	●	●	●	●	●	●	●	●	●	●	●	●
As	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Cd	-	●	●	●	●	●	●	●	●	●	●	●	●	●
Cr	-	-	-	●	-	-	●	-	●	●	●	-	●	-
Cu	-	●	●	●	●	●	●	●	●	●	●	●	●	●
Fe	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Pb	-	●	●	●	-	●	●	●	●	●	●	●	●	●
Mo	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ni	-	-	-	-	-	-	-	-	●	-	-	-	-	-
Se	-	-	●	-	-	●	-	-	-	-	-	-	●	-
Ag	-	●	●	●	●	●	●	●	●	●	●	●	●	●
Tl	-	-	-	-	-	-	-	-	●	-	-	-	-	-
Zn	-	●	●	●	-	●	●	●	●	●	●	●	●	●

"●" indicates parameter exceeded CCME; "-*"indicates parameter did not exceeded CCME guidelines;. NS = Not sampled.*

Table 4. Water Quality Parameters Exceeding Effluent Quality Standards, 2007-2009

	Reference Sites					Receiving Environments				Mine Impacted		Loading Sources		
Parameter	DCR	VCR	Upper Vic	DX	Pony U/S	Vic @ Rd	Dome @ Rd	Pony D/S	Back	D1	Upper Dome	Tailings	Seep	Pit
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Cyanide-T	-	-	-	-	-	-	-	-	-	-	-	-	NS	NS
CN-WAD	-	-	-	-	-	-	-	-	-	-	●	●	●	NS
Sb	-	-	-	-	-	-	-	-	-	-	-	●	-	-
Ba	-	-	-	-	-	-	-	-	●	-	-	-	-	-
Cd	-	-	-	-	-	-	-	-	-	-	-	-	-	●
Cr	-	-	-	-	-	-	●	-	●	-	-	-	●	-
Cu	-	-	-	-	-	-	-	-	-	-	-	-	●	-
Fe	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Pb	-	-	-	-	-	-	-	-	●	-	-	●	-	-
Mn	-	-	-	●	●	-	●	●	●	●	●	●	●	●
Ni	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ag	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn	-	-	-	-	-	-	-	●	●	●	-	●	-	●
D-As	-	-	-	-	-	-	-	-	-	-	-	●	-	-

"●" indicates parameter exceeded CCME; "-*"indicates parameter did not exceeded CCME guidelines;. NS = Not sampled.*

3.1 Dome Creek

There are four sampling locations on Dome Creek: two near the mill, DX and D1, and two downstream of the tailings pond, Upper Dome and Dome @ Rd. DX is the furthest upstream site on Dome Creek. It is upstream of all mining activities and should represent reference water quality in Dome Creek. D1 is located immediately downstream of the mill site and is intended to determine effects from the mill. Upper Dome is located downstream of the tailings pond and the seepage pond. Dome Creek is diverted around the tailings facilities and this site is located approximately 25 m downstream of this diversion. Dome @ Rd is located on Dome Creek where it intersects the mine access road and is intended to qualify the water quality of Dome Creek as it flows into Victoria Creek. Dome @ Rd is also considered the receiving environment site for Dome Creek.

3.1.1 Reference Site - DX

DX is considered the reference site on Dome Creek as it is upstream of all mining activities. The water quality at DX is characterized by a circum neutral pH (median: 7.44), very hard (median: 247 mg/L) and not sensitive to additions of acidic water (median alkalinity: 86 mg/L $CaCO_3$). DX exceeds the CCME guidelines for nitrite and the following nine total metals: aluminum, arsenic, cadmium, chromium, copper, iron, lead, silver and zinc. Aluminum exceeded CCME guidelines in approximately 71% (n=21) of total samples while arsenic, iron, and cadmium exceeded CCME guidelines in approximately 50% of total samples (n=21). EQS were exceeded at DX for TDS, iron and manganese and TDS most frequently exceeded EQS at over 80% of total samples (n=21).

3.1.2 Mine Impacted Sites – D1 and Upper Dome Creek

As D1 and Upper Dome are located just downstream of mill and tailings pond, they are considered to be part of the mine impacted area. The same set of parameters that exceeded CCME guidelines for D1 exceeded CCME guidelines for DX (although the magnitude of exceedance differs as shown in Section 4, Figure 7). CCME guidelines

for arsenic, cadmium and zinc were exceeded in 100% of total samples (n=20) for D1. D1's median total zinc concentration (0.509 mg/L) exceeds EQS for 70% of samples (n=20). D1 is elevated in dissolved arsenic, total cadmium, total manganese, total zinc, TDS and sulphate in comparison to the DX reference station.

In the Upper Dome site, ammonia-N and cyanate exceeded CCME guidelines, along with the same set of parameters that exceeded CCME guidelines for DX and D1. Arsenic and iron exceeded CCME guidelines in 100% of total samples (n=27) while EQS was exceeded for TDS, iron and manganese for 100% of total samples (n=25, n=27, n=27, respectively). The Upper Dome site is elevated in dissolved arsenic, total manganese, TDS, ammonia, sulphate, nitrate, WAD cyanide and cyanate in comparison to the DX reference station.

3.1.3 Receiving Environment – Dome Creek at Road

Dome @ Rd is considered the receiving environment site in Dome Creek as it is furthest downstream from the mine site. The CCME guidelines that were exceeded at Dome @ Rd were the same as the reference station DX with the addition of ammonia and cyanate. Total arsenic and total iron exceeded CCME guidelines in 100% of the total samples (n=25) and TDS, total iron and total manganese also exceeded EQS in 100% of the total samples (n=23, n=25, n=25, respectively). Generally, all water quality parameters at the Dome at road station are elevated in comparison to the DX reference station.

3.2 Pony Creek

Pony Creek is a small tributary of Back Creek with ephemeral flows typically in the range of 1-15 L/s. There are two sampling locations in Pony Creek: Pony U/S and Pony D/S. Previously, waste rock was deposited in Pony Creek during mining activities from the Pony Creek adit. Pony U/S station is located upstream of the historical waste rock pile to characterize the background water quality of Pony Creek and Pony D/S is located downstream of the historical waste rock pile to determine the effect of the waste rock pile on Pony Creek.

3.2.1 Reference Site – Pony U/S

Pony U/S is considered the reference site and as shown in Table 3, exceeds CCME guidelines for nitrite and the following six total metals: aluminum, arsenic, cadmium, copper, iron and CCME guidelines were exceeded in approximately 48% of total samples iron (n=23), as shown in Figure C4. As shown in Table 3 and Figure C4, EQS were exceeded for TDS, total iron, and total manganese. TDS exceeded EQS the most frequently at over 95% (n=22). The Pony U/S site median water quality is characterized as having a circumneutral pH, hard and not sensitive to addition of acid.

3.2.2 Receiving Environment Site – Pony D/S

Pony D/S is considered the receiving environment site and as shown in Table 3, both Pony U/S and Pony D/S had a similar set of parameters that exceeded CCME guidelines with the additions of total lead and total zinc exceeding CCME for Pony D/S. The percent exceedance for CCME guidelines in Pony D/S were all over 50% (except nitrite and silver) with cadmium, copper and zinc exceeding CCME guidelines 100% (n=23). Pony D/s exceeded EQS for TDS at over 95% of total samples (n=23). The Pony D/S station contains elevated concentrations of total cadmium, total copper, total lead and total zinc in comparison to Pony U/S station.

3.3 Back Creek

This water quality site is located on Back Creek, just above the confluence with Victoria Creek. Back Creek is downstream of historical and active placer mining activities and reflects effects from these activities. CCME guidelines for the protection of freshwater aquatic life were exceeded for the following eleven total metals: aluminum, arsenic, cadmium, chromium, copper, iron, lead, nickel, silver, thallium and zinc. Concentrations of cadmium and iron exceeded CCME guidelines in 100% of total measurements (n=22), with median concentrations of 0.00015 mg/L and 1.24 mg/L, respectively. "●" indicates parameter exceeded CCME; "-*"indicates parameter did not exceeded CCME guidelines;. NS = Not sampled.*

Table 4 shows that EQS were exceeded for TDS and the following eight total metals: barium, chromium, iron, lead, manganese, and zinc. As shown in Appendix C (Figure C5) the percent exceedance of TDS was nearly 90% of total measurements (n=21). Percent exceedance was also over 50% for total manganese and total iron (n=22).

3.4 Victoria Creek

3.4.1 Reference Sites – VCR (Victoria Creek Reference) and Upper Victoria Creek

There are two reference sites on Victoria Creek: Upper Vic, located immediately upstream of the confluence with Back Creek, and VCR, located 500 m further upstream. VCR was added to the sampling program in October 2007 as it was suspected that Upper Vic was receiving backwater effects from Back Creek.

The water quality parameters that exceeded CCME guidelines for the protection of freshwater aquatic life were the same between VCR and Upper Vic, except for the addition of cyanate in Upper Vic. Exceedances included nitrite and eight total metals: aluminum, arsenic, cadmium, copper, iron, lead, silver and zinc, as shown in Table 3. The number of exceedances was highest for aluminum, iron, copper and lead at 20% (n=15) in VCR and highest for cadmium at approximately 46% (n=43), as shown in Appendix C (Figure C1). Table 4 shows that EQS were exceeded for total dissolved solids (TDS) and total iron in both VCR and Upper Vic. Exceedance of TDS was 80% of total measurements (n=15) for VCR and over 90% of total measurements (n=31) for Upper Vic as shown in Appendix C (Figure C1).

3.4.2 Receiving Environment Site – Victoria Creek at Road

The receiving environment site for Victoria Creek is represented by the sampling location Vic @ Rd. This site is located on Victoria Creek downstream of the mine site at the mine access road. Since this site is downstream of inputs from Dome Creek and Back Creek, water quality at this site should represent impacts from past mining activities. CCME guidelines for the protection of freshwater aquatic life were exceeded for all parameters listed in Table 3 with the exception of pH, nitrate, nitrite, cyanate and the following four total metals: chromium, molybdenum, nickel, and thallium. As shown in Appendix C (Figure C1), percent exceedance was highest for total cadmium at almost 50% of total measurements (n=33), with a median concentration of 0.00003 mg/L, and lowest for arsenic, zinc, selenium and cyanate at under 10% (n=33). "●" indicates parameter exceeded CCME; "-*"indicates parameter did not exceeded CCME guidelines;. NS = Not sampled.*

Table 4 shows that EQS were exceeded for TDS and total iron. As shown in Figure C2 approximately 90% of TDS measurements (n=26) exceeded the EQS. Exceedance of total iron standards were approximately 10% (n=33). The Victoria Creek at Road site contains elevated concentrations of sulphate, dissolved arsenic and total selenium in comparison to the Victoria Creek reference sites.

3.5 Dry Creek – DCR (Dry Creek Reference)

Dry Creek is located over a ridge to the west of the Mt. Nansen mine site and drains away from the mine. DCR was added to the sampling program in October 2007 and has been sampled six times to date.

Dry Creek exceeded CCME guidelines for total arsenic and total iron. CCME guidelines were exceeded in approximately 67% of total iron samples (n=6). Dry creek exceeded EQS for total iron in approximately 83% of samples (n=6) as shown in Figure C2. The Dry Creek reference site had the fewest amount of exceedances in comparison to the other reference stations.

3.6 Loading Sources – Tailings Pond, Seepage Pond, Brown-McDade Pit

3.6.1 Tailings Pond

The tailings pond holds an estimated volume of 300,000m^3 of Brown-McDade tailings. The tailings also contain residual mill process chemicals including copper sulphate, lime and cyanide. Water is diverted around the tailings impoundment and only receives local precipitation in the tailings pond. Water is pumped and discharged directly into Dome Creek for about 4-6 weeks of the year. Maintaining a low volume of water in the tailings pond is currently necessary for dam stability reasons as well as reducing the dam seepage.

Total concentrations of most metals and nutrients exceed the CCME guidelines for the protection of freshwater aquatic life. This includes all the parameters listed in Table 2 with the exception of pH, chromium, molybdenum, nickel, and thallium. Generally, these same parameters are below guidelines concentrations throughout the mine site as well. As shown in Appendix C (Figure C6) the following total metals exceed CCME guidelines in 100% of samples: arsenic, cadmium, copper, lead and silver (n=22), with median concentrations of 0.1295 mg/L, 0.00338 mg/L, 0.0710 mg/L, 0.034 mg/L and 0.00048 mg/L, respectively. Total zinc and total iron exceed CCME guidelines in over 90% of total measurements (n=22).

As shown in Table 4 and Figure C6, EQS were exceeded in the tailings pond, including TDS, CN-WAD, total antimony, total iron, total lead, total manganese, total zinc, and dissolved arsenic. Percent exceedance EQS was 100% for TDS (n=20) and over 70% for manganese (n=22).

3.6.2 Seepage Pond

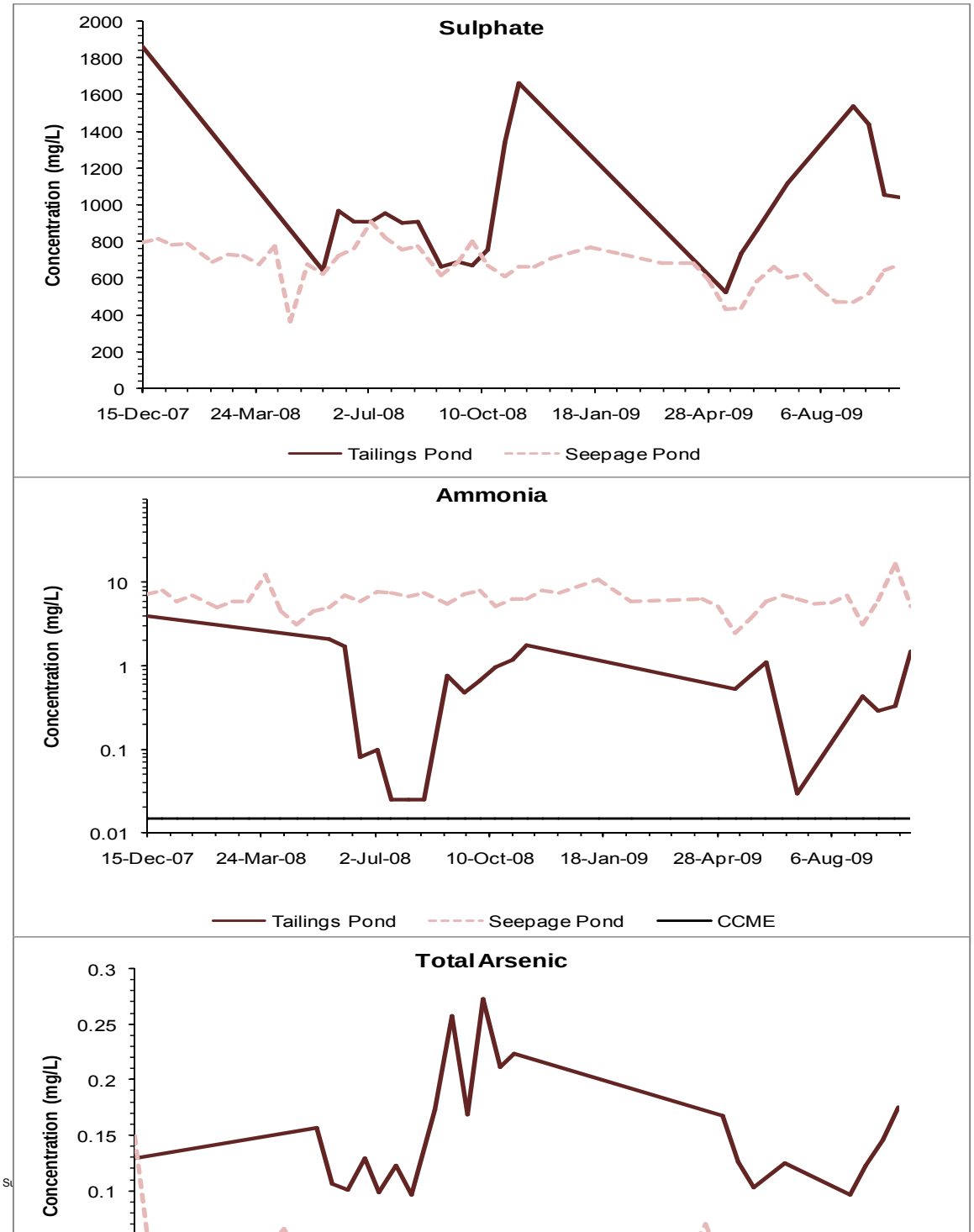
Seepage from the tailings pond is collected in the seepage pond and either pumped back to the tailings pond or discharged directly into Dome Creek. As expected, the water quality in the seepage is very similar to the tailings pond water. With the addition of chromium, the same set of parameters that exceeded CCME guidelines for the tailings pond exceeded CCME guidelines for the seepage pond (ammonia, nitrate, nitrite, cyanate, total aluminum, total arsenic, total cadmium, total copper, total iron, total lead, total selenium, total silver and total zinc). As shown

in Figure C7, ammonia, total arsenic, total cadmium, total copper and total iron exceeded CCME guidelines in 100% of samples (n=44), with median concentrations of 6.2 mg/L, 0.0358 mg/L, 0.00084 mg/L, 0.008 mg/L and 10.8 mg/L, respectively.

In the seepage pond EQS were exceeded for TDS, CN-WAD, total chromium, total copper, total iron and total manganese. TDS, total iron and total manganese exceeded EQS in 100% of samples (n=31, n=41 and n=42).

The seepage pond water quality has higher concentrations of ammonia cyanate, and WAD cyanide and lower concentrations of sulphate, total arsenic and total cadmium than the tailings pond water quality. Figure 2 shows the sulphate, ammonia and total arsenic concentrations in the Tailings Pond and Seepage Pond stations.

Figure 2. Sulphate, Ammonia and Total Arsenic in the Tailings Pond and Seepage Pond



3.6.3 Brown-McDade Pit

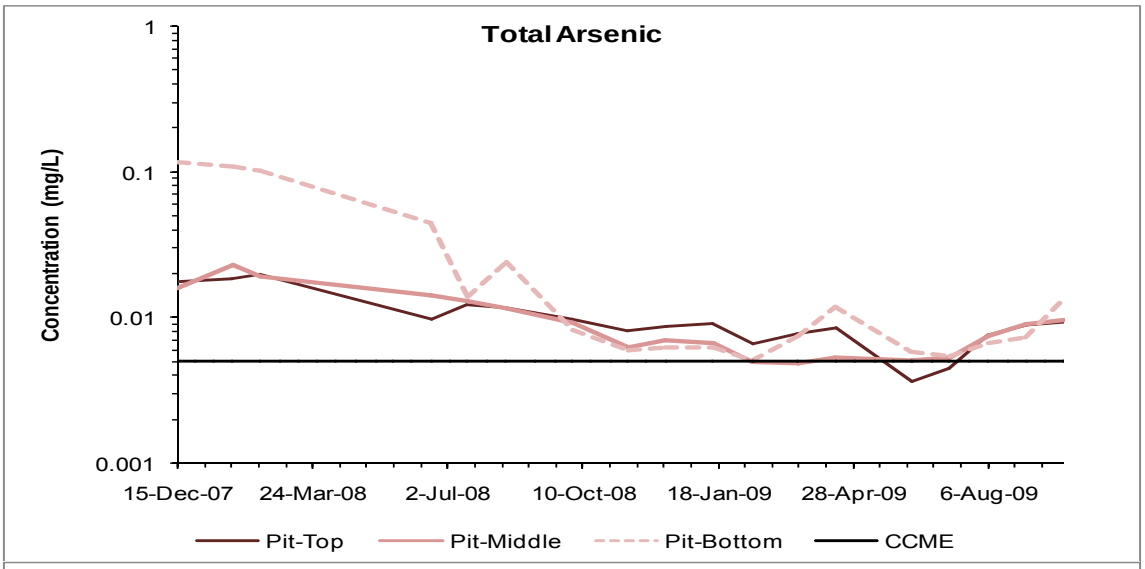
Water samples from the Brown-McDade Pit are collected from the surface, middle and bottom of the pit. Water quality data from the three points of collection were lumped into one dataset to characterize the pit water quality and are presented in Appendix A.

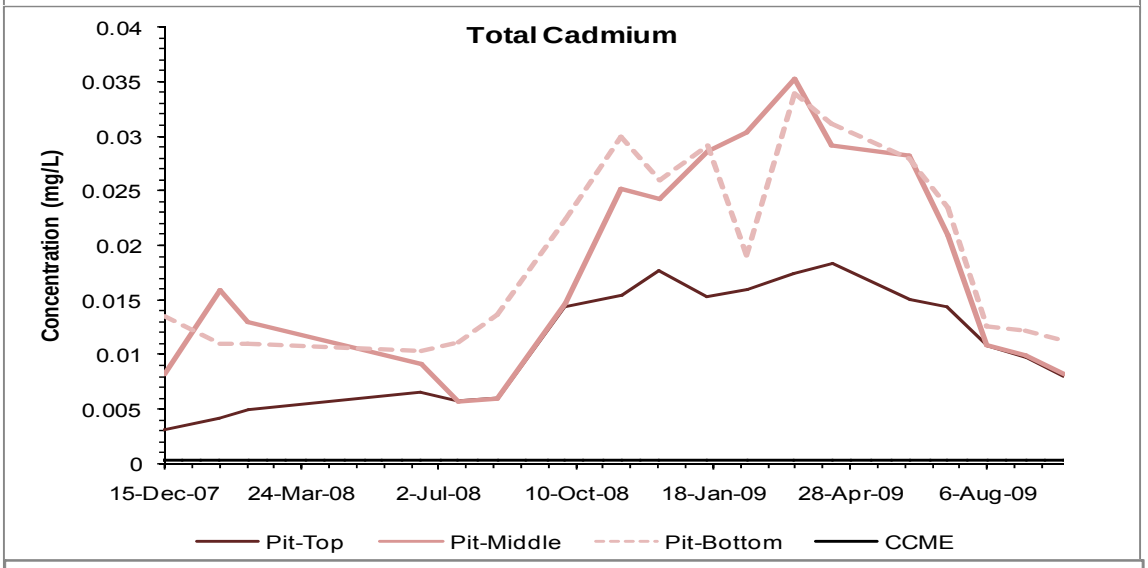
As shown in Table 3, the parameters that exceed CCME guidelines for the protection of freshwater aquatic life in the pit were nitrate, nitrite, and the following total metals: aluminum, arsenic, cadmium copper, iron, lead, silver and zinc. The parameters that exceeded CCME were the same as the parameters in the tailings pond, with the exception of ammonia, cyanate and total selenium. Total cadmium, total copper and total zinc exceeded the CCME guidelines in 100% of total measurements (n=54) with median concentrations of 0.0144mg/L, 0.028 mg/L and 1.485 mg/L, respectively. Total arsenic exceeded the CCME guidelines (0.005 mg/L) in approximately 90% of samples (n=54) with a median concentration of 0.0088 mg/L..

EQS were exceeded for TDS, total cadmium, total iron, total manganese and total zinc. These parameters are also the same parameters that exceeded EQS in Pony Creek. As shown in Figure C8, both TDS and zinc exceeded EQS in 100% of samples (n=42 and n=54, respectively).

The pit water quality is not homogenous between the three sample locations and contains discernible zones of water quality. Figure 4 and Figure 4 shows the pit water quality for total arsenic, total cadmium and total zinc and ammonia, sulphate nitrate, respectively. The top portion of the pit water has a with a more alkaline pH and contains elevated concentrations of nitrate in comparison to the bottom; where as the bottom portion of the pit water contains elevated concentrations of sulphate, ammonia, and the following total metals; cadmium, copper, iron, manganese and zinc.

Figure 3. Total Arsenic, Total Cadmium, and Total Zinc Concentrations in the Brown-McDade Pit





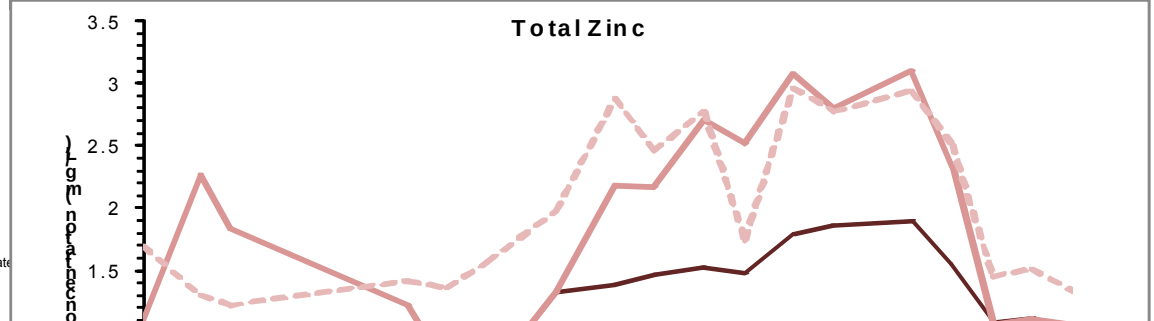
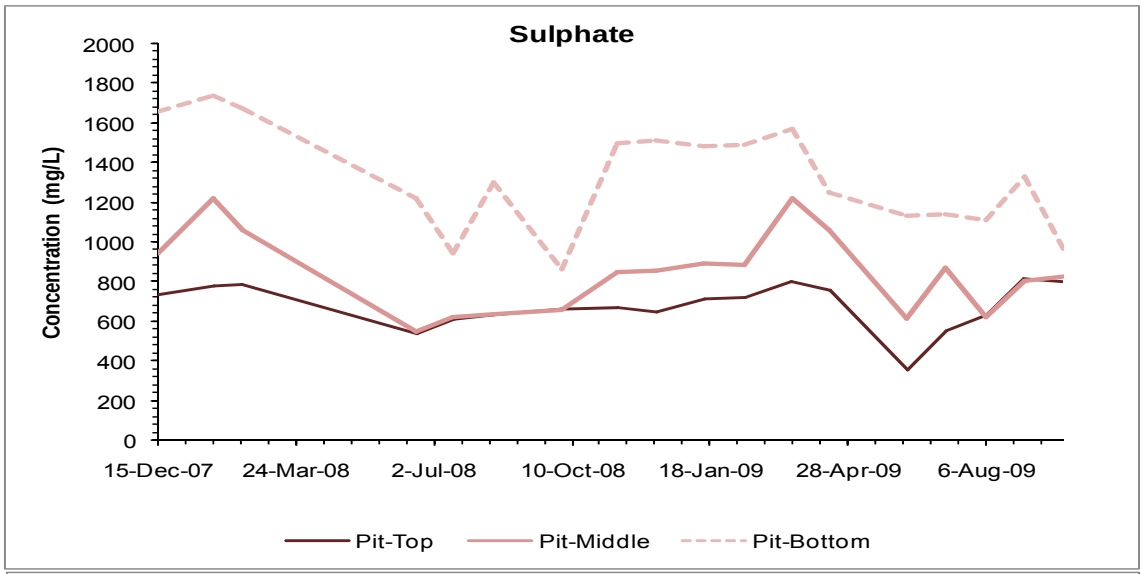
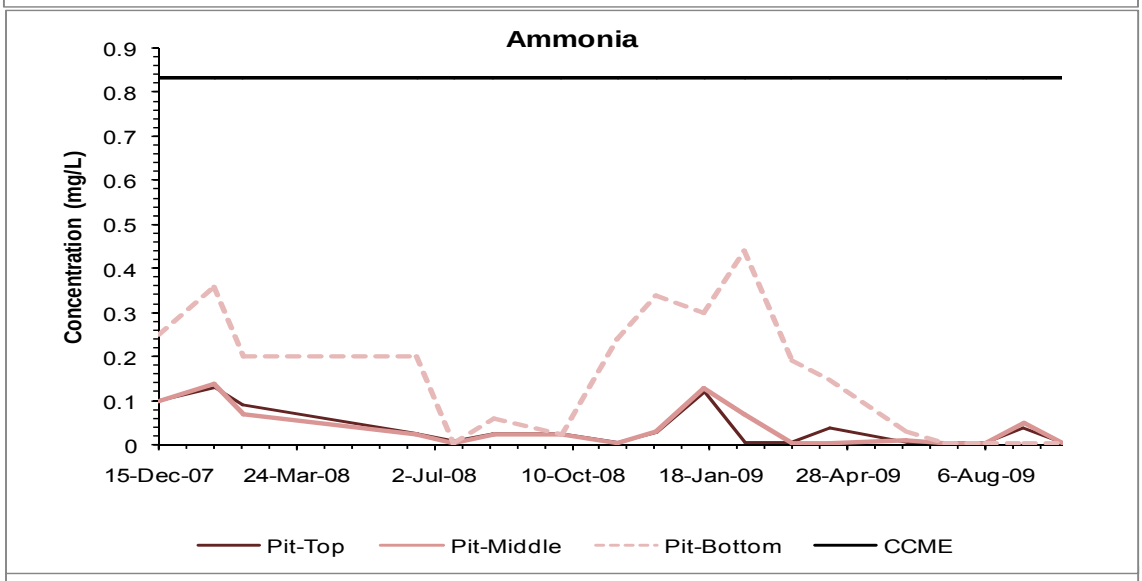
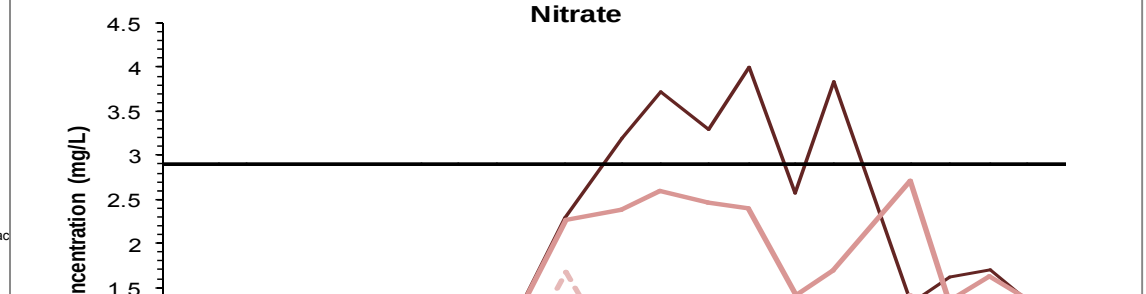


Figure 4. Sulphate, Ammonia, Nitrate Concentrations in the Brown-McDade Pit







3.7 Seasonal Variability in Total Suspended Solids Concentrations

The seasonal variability in total suspended solids concentrations (TSS) for the Mt. Nansen surface water quality data is shown in Figure 5 and

Figure 6 for Dome Creek and Victoria Creek, respectively. To identify a correlation between TSS and total metals concentrations, concentrations of total aluminum and total iron were compared with concentrations of TSS. Alumi S and tend to increa

Of the veen TSS and total r d.). Maximum conce nd iron. High TSS c Victoria Creek (**Erro** d total metals conce D/S and Back Creek

The D spring, but do exper ntrations at the Back ntration of TSS throug

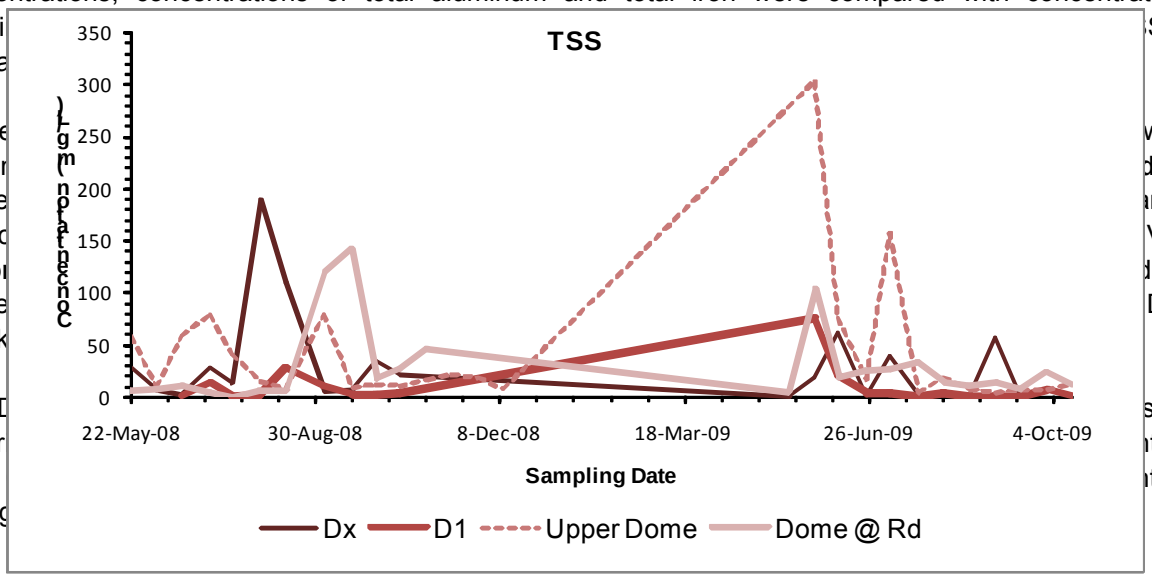
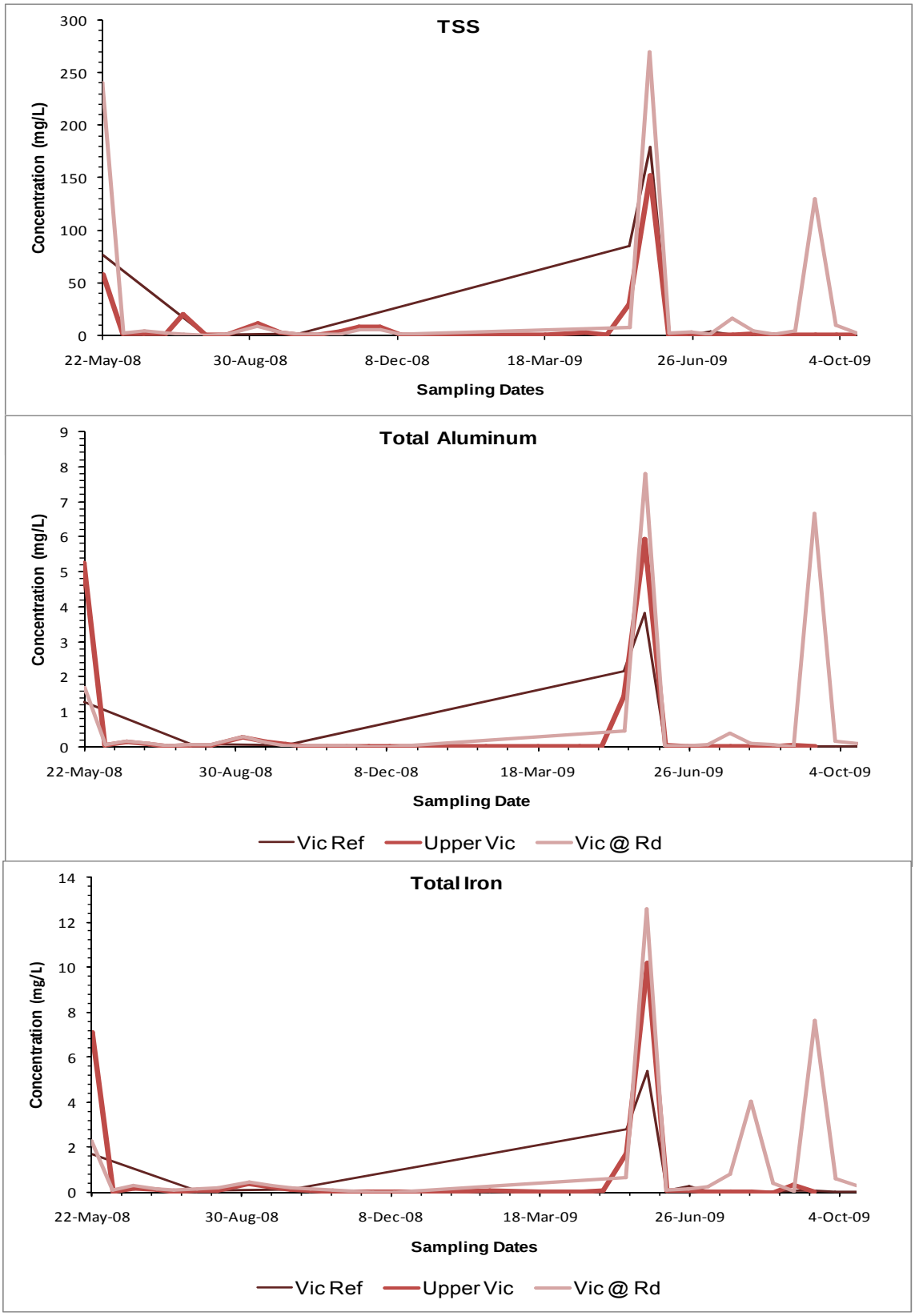


Figure 5. Concentrations of TSS, Total Aluminium and Total Iron in Dome Creek

Figure 6. Concentrations of TSS, Total Aluminum and Total Iron in Victoria Creek

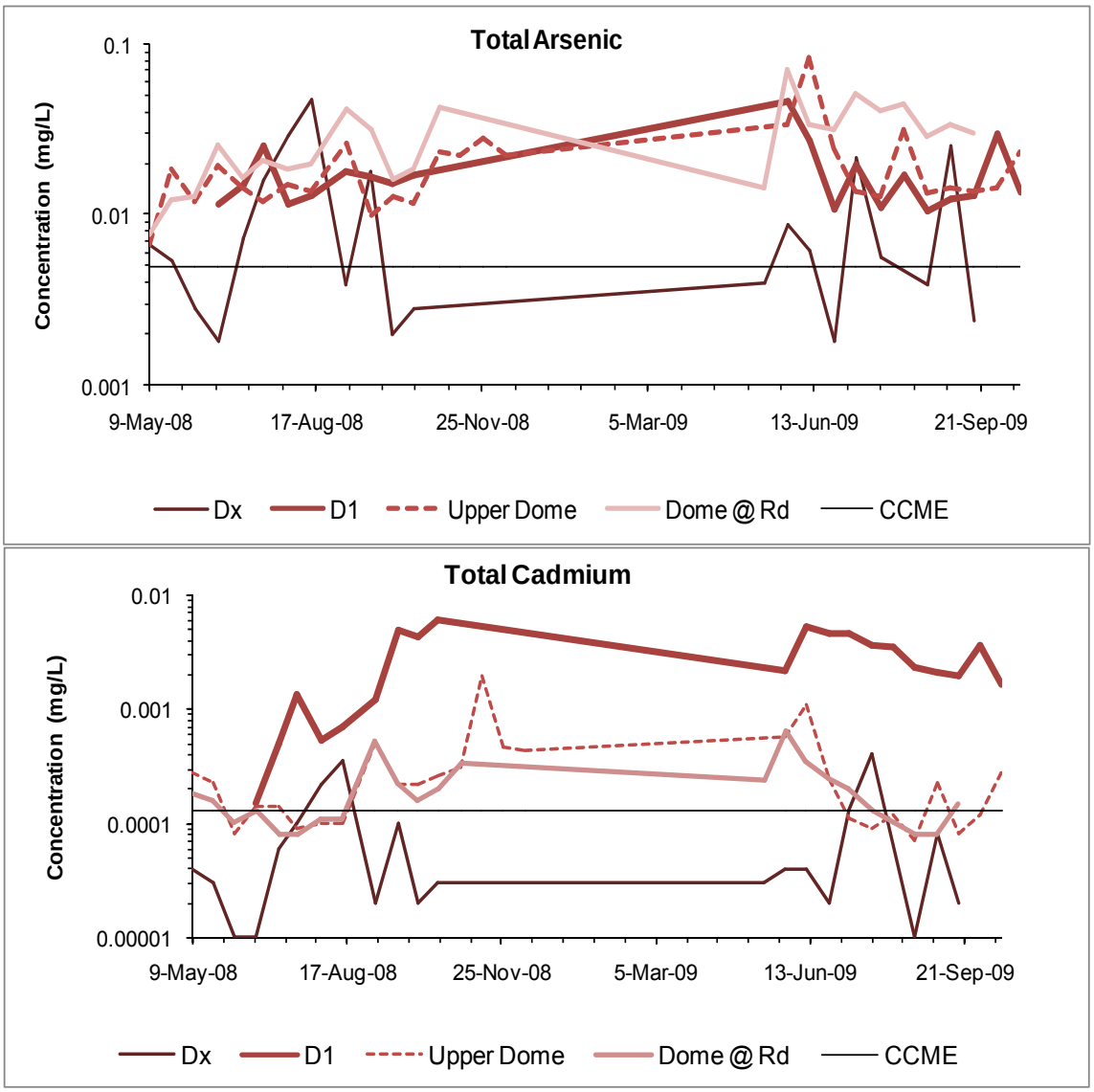


4. Mt. Nansen Mine Impacts on Surface Water Quality

4.1 Mine Impacts on Dome Creek

The water quality on Dome Creek can be influenced by the mill site, Brown-McDade Pit, waste rock piles, tailings pond or seepage discharge pond. It appears that the uppermost site on Dome Creek, DX, exhibits lower concentrations of total metals than the sites further downstream. Some metals, such as arsenic, steadily increase in concentration in a downstream trend, while other metals, such as cadmium, spike in concentration immediately downstream of the mill site (D1) and then gradually attenuate downstream by Dome @ Rd (Figure 7). Generally, mine impacts on Dome Creek is varied depending on inputs from the mill site, tailings pond or seepage pond.

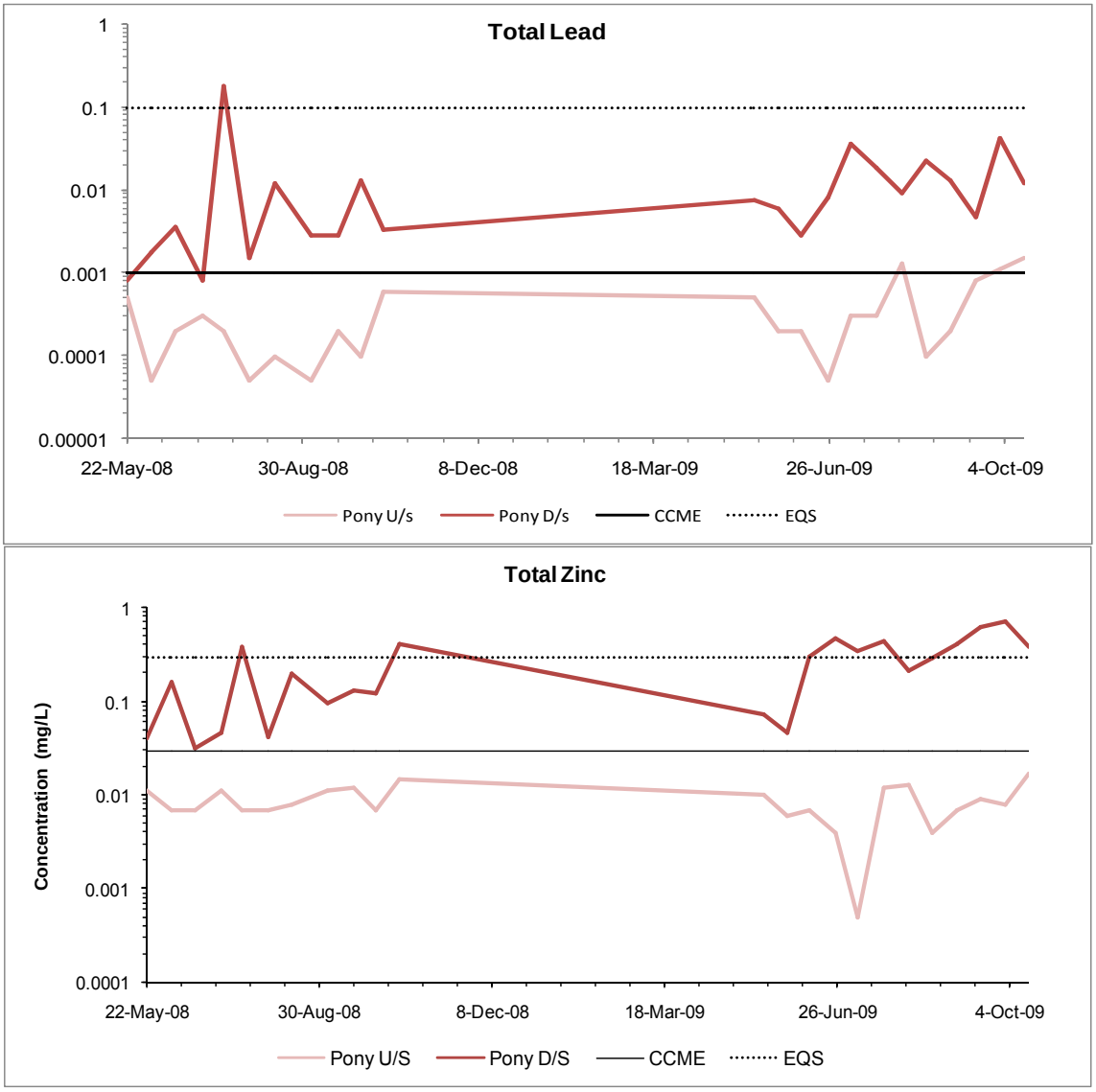
Figure 7. Concentrations of Total Arsenic and Total Cadmium in Dome Creek



4.2 Mine Impacts on Pony Creek

Generally, it appears that the water quality in Pony Creek is affected by Brown-McDade pit and/or the waste rock pile. As shown in Figure C4, there are more metals that exceeded CCME guidelines in Pony D/S than in Pony U/S. Concentrations of many metals are higher in the Pony D/S site compared to Pony U/S. A graphical example is shown in Figure 8Figure 8 with total lead and total zinc concentrations.

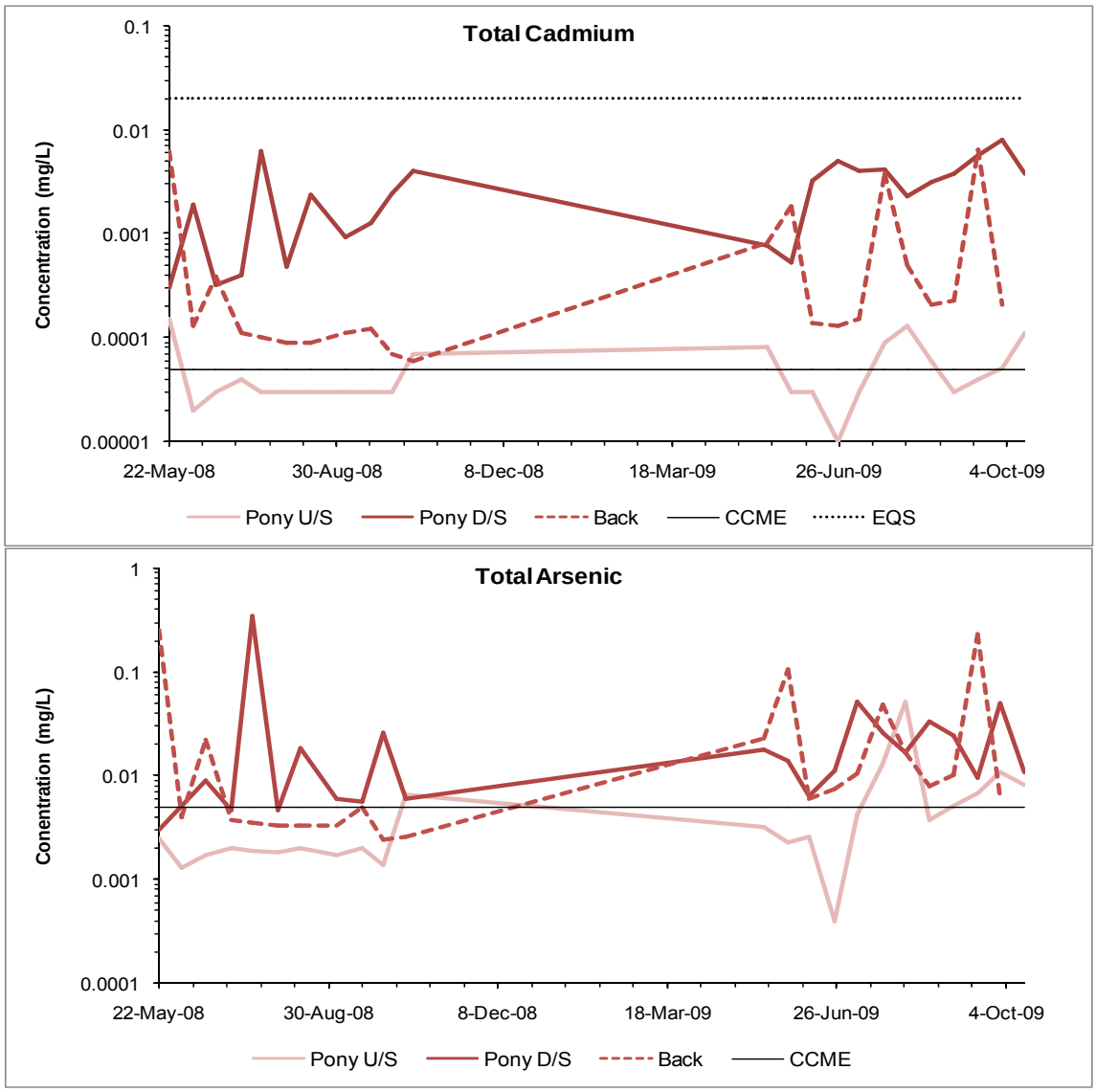
Figure 8. Concentration of Total Lead and Total Zinc in Pony Creek



4.3 Mine Impacts on Back Creek

The water quality in Back Creek does not appear to be strongly influenced by Pony Creek. As shown in Figure 10, total cadmium and total arsenic concentrations in Back Creek do not correlate with concentrations in Pony Creek. High concentrations in Pony Creek appear to attenuate by the time it reaches the Back Creek sampling site. The current placer mining activities on Back Creek and elevated concentrations of TSS are likely contributing to the poorer water quality in Back Creek. Any potential impacts from Pony Creek to Back Creek are overpowered by placer mining activities.

Figure 9. Concentrations of Total Cadmium and Total Arsenic in Back Creek



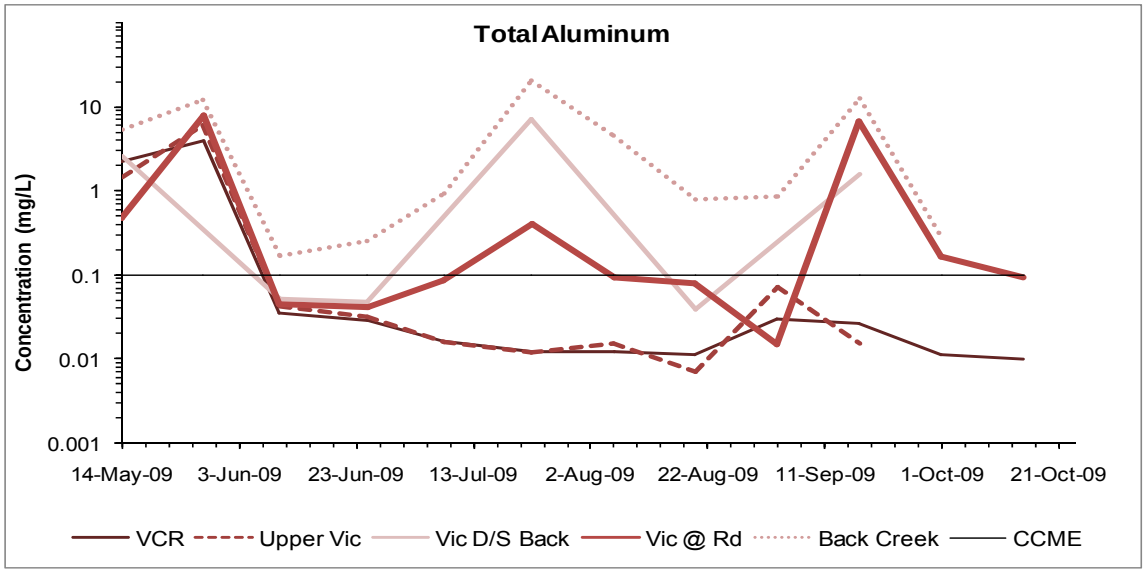
4.4 Mine Impacts on Victoria Creek

For the most part, concentrations of metals are similar between Victoria Creek reference stations VCR and Upper Vic, although there is evidence that the close vicinity of Upper Vic to Back Creek may have resulted in some backwater effects of Back Creek on the Upper Vic site. Figure 10 shows the concentrations of total aluminum and total cadmium in Victoria Creek and Back Creek. Although Pony Creek discharges into Back Creek, it appears that concentrations of some total metals in Back Creek are predominately affected by active placer mining operations on Back Creek. The high concentrations of TSS and metals associated with the active placer mine on Back Creek appear to be impacting Victoria Creek.

As there is strong evidence that Back Creek influences the water quality of Victoria Creek, the water quality downstream of Back Creek, but upstream of Dome Creek is considered the most representative of background water quality. This water quality was back-calculated from water quality concentrations and flows on the Upper Victoria Creek site and the Back Creek site and is shown in Appendix E. This background site is represented on Figure 10 and Figure 11 by “Vic D/S Back”.

Mine impacts to Victoria Creek from Dome Creek are evident through analysis of nitrate, sulphate and the dissolved phase of metals. Sulphate is a parameter that behaves conservatively through the environment and is commonly used to identify mine impacts. Elevated concentrations of sulphate at the Vic @ road site correspond to those in the Dome @ road site and are shown in Figure 11.

Figure 10. Concentrations of Total Aluminum and Cadmium in Victoria Creek and Back Creek



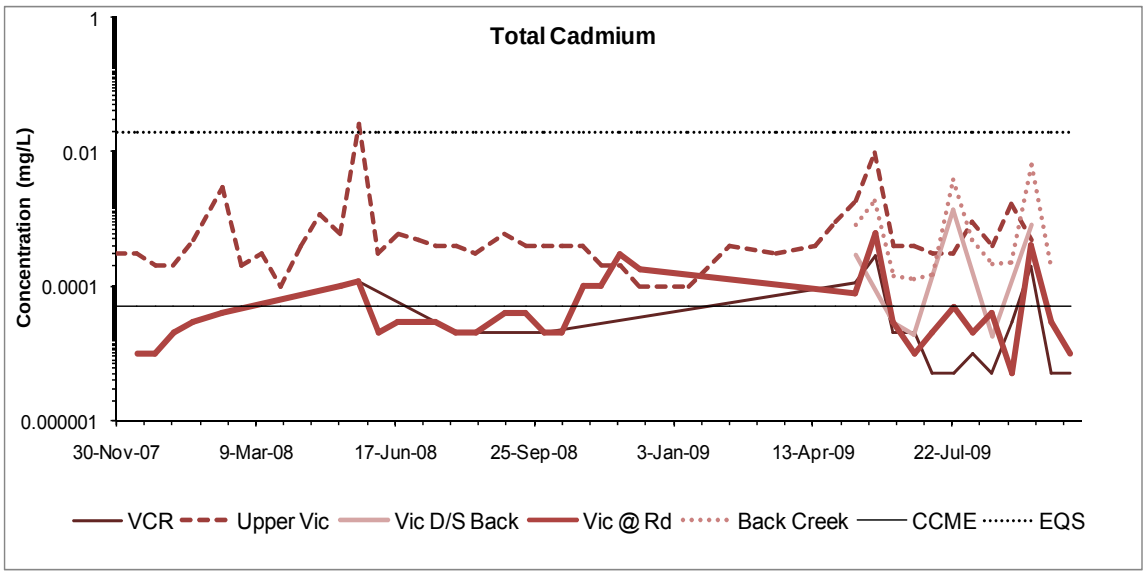
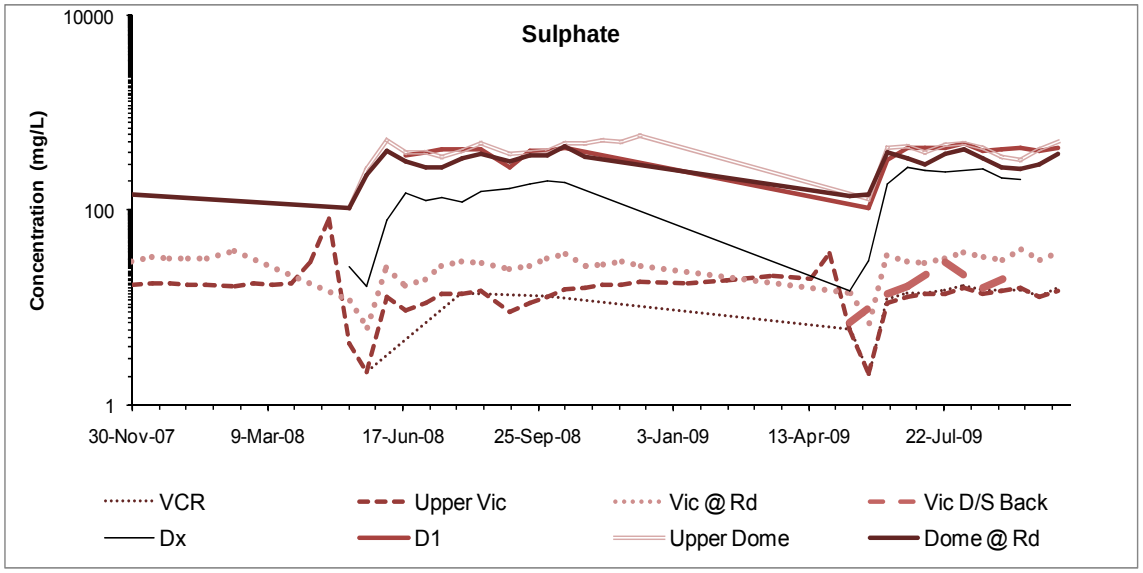


Figure 11. Concentrations of Sulphate in Victoria Creek and Dome Creek



5. Summary

Analysis of the Mt. Nansen mine site surface water quality data (December 2007 to October 2009) has revealed the following information:

- Parameters that had the most exceedances of CCME guidelines throughout the study area include: Nitrite-N and the following total metals: aluminum, arsenic, cadmium, copper, iron, lead and zinc;
- Parameters that had the most exceedances of EQS throughout the study area include: TDS and total iron;
- The tailings pond water quality exceeded CCME guidelines for total metals: arsenic, cadmium, copper, iron, lead, silver and zinc;
- Seepage pond water is similar to the water in the tailings pond except with higher concentrations of ammonia;
- The Brown-McDade pit exceeded of CCME and EQS for following total metals: aluminum, arsenic, cadmium, copper, iron, lead, manganese, silver, and zinc;
- Pony Creek, downstream of the Brown-McDade pit is more impacted than the upstream site, either from seepage from the Brown-McDade pit or from the waste rock in the creek;
- Dome Creek is being impacted from the Mt. Nansen mine and the Dome @ Road site contains elevated concentrations of sulphate, ammonia and total arsenic;
- Back Creek exceeded CCME guidelines for total cadmium and total iron in 100% of the samples;
- Impacts on Back Creek may be from either Pony Creek or from the active placer mining, although analysis indicates it may be more influenced by the placer mining;
- Vic @ Rd exceeded CCME guidelines for the following total metals: aluminum, arsenic, cadmium, copper, iron, lead and zinc, with total cadmium exceeding CCME and EQS the most;
- Impacts on Victoria Creek seem to be influenced both from Dome Creek and Back Creek, where inputs from Dome Creek likely originate from the Mt. Nansen mine and inputs from Back Creek are likely from the placer mining; and
- Seasonal variability was identified for the surface water quality results, indicating that data should be split into two data sets (turbid and clear water) for water quality modeling.

REFRENCES

McNeeley, R.N., V.P. Neimanis and L. Dwyer. 1979. Water Quality Sourcebook – A Guide to Water Quality Parameters. *Inland Waters Directorate, Water Quality Branch, Minister of Supply and Services Canada.*

Canadian Council of Ministers of the Environment. 2007. Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment, Winnipeg

Figure C1. Exceedance of CCME Guidelines and EQS in Victoria Creek

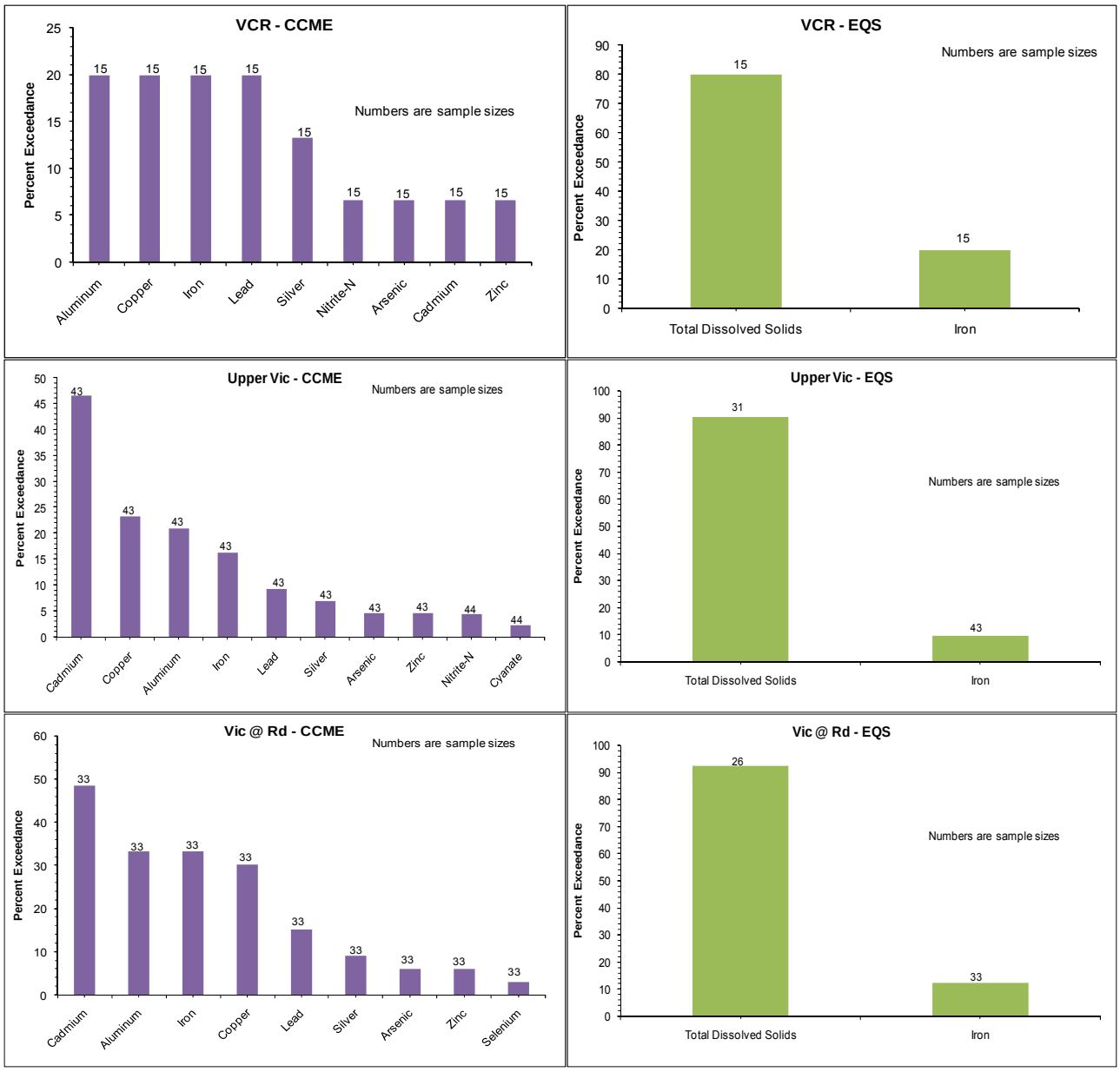


Figure C2. Exceedance of CCME Guidelines and EQS in Dry Creek

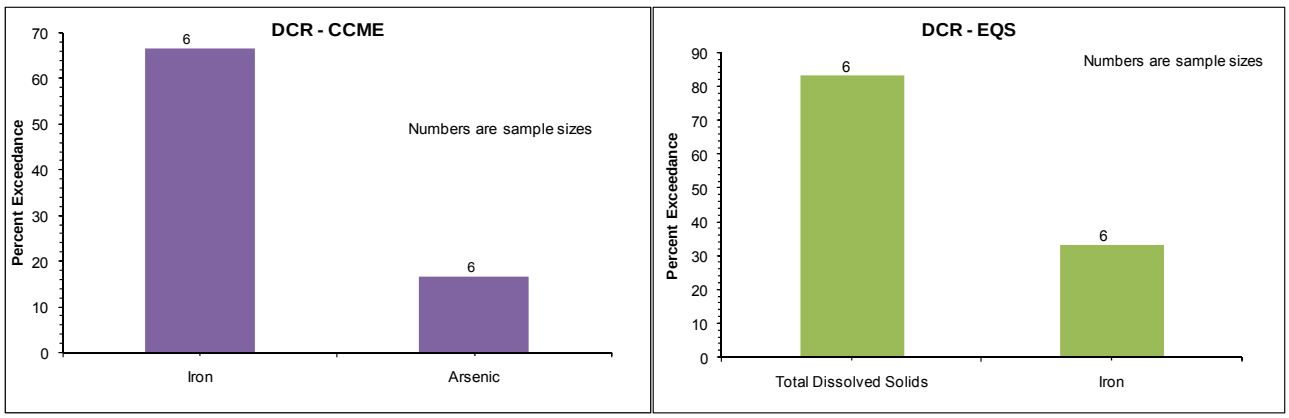


Figure C3. Exceedance of CCME Guidelines and EQS in Dome Creek

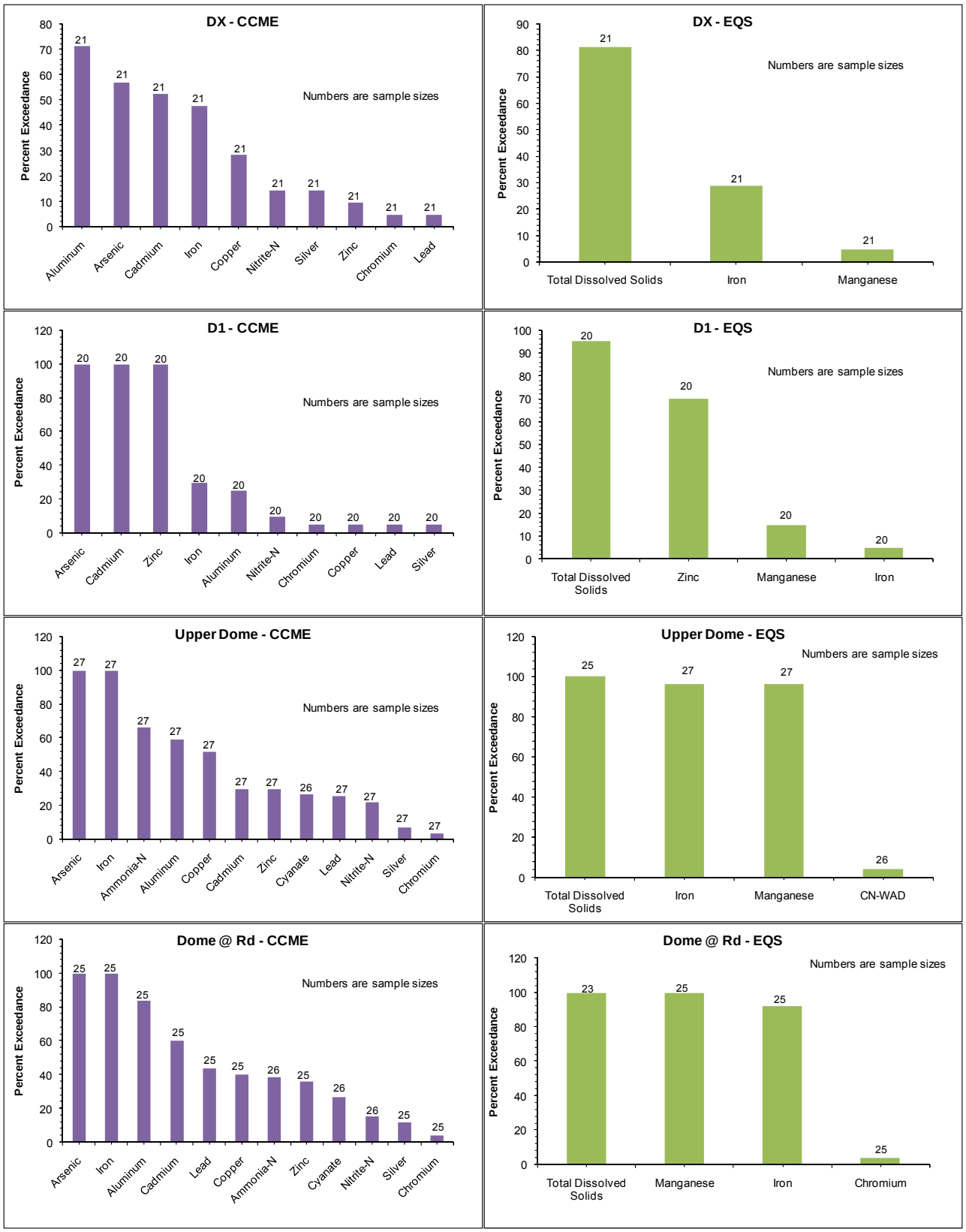


Figure C4. Exceedance of CCME Guidelines and EQS in Pony Creek

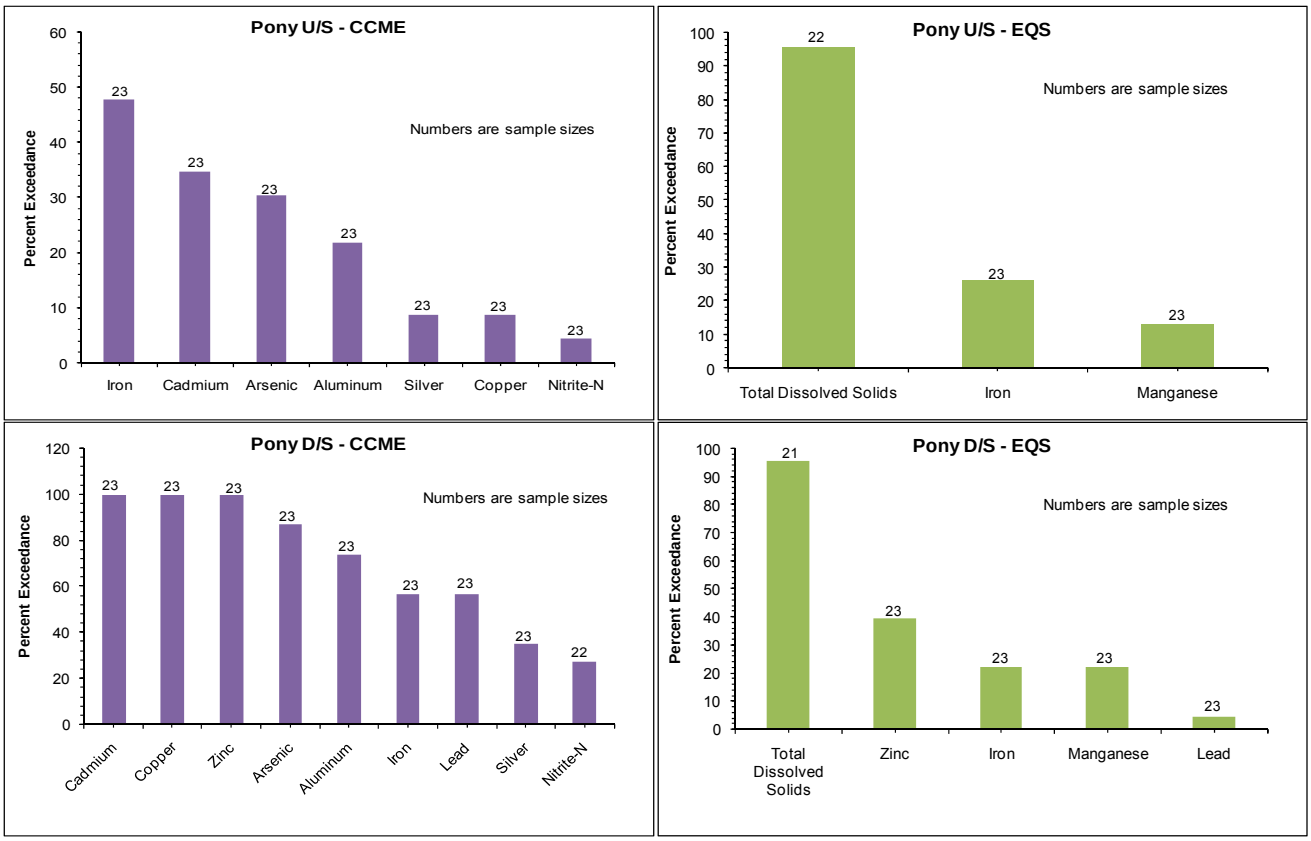


Figure C5. Exceedance of CCME Guidelines and EQS in Back Creek

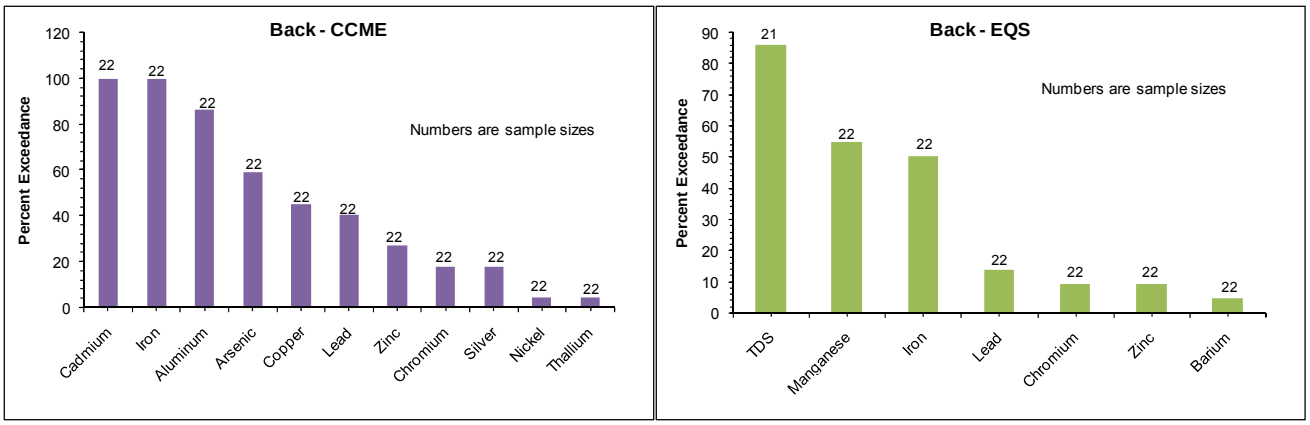


Figure C6. Exceedance of CCME Guidelines and EQS in the Tailings Pond

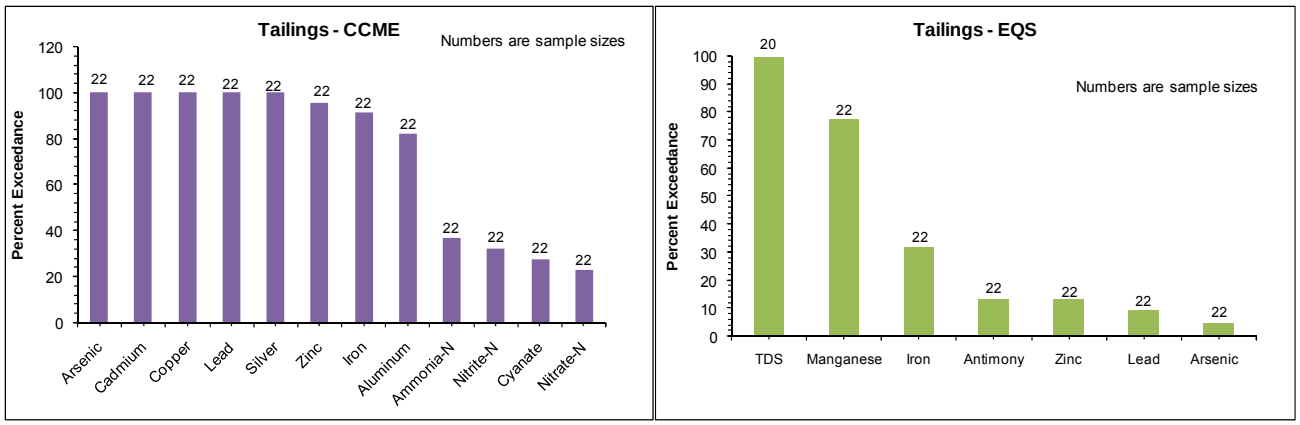


Figure C7. Exceedance of CCME Guidelines and EQS in the Seepage Pond

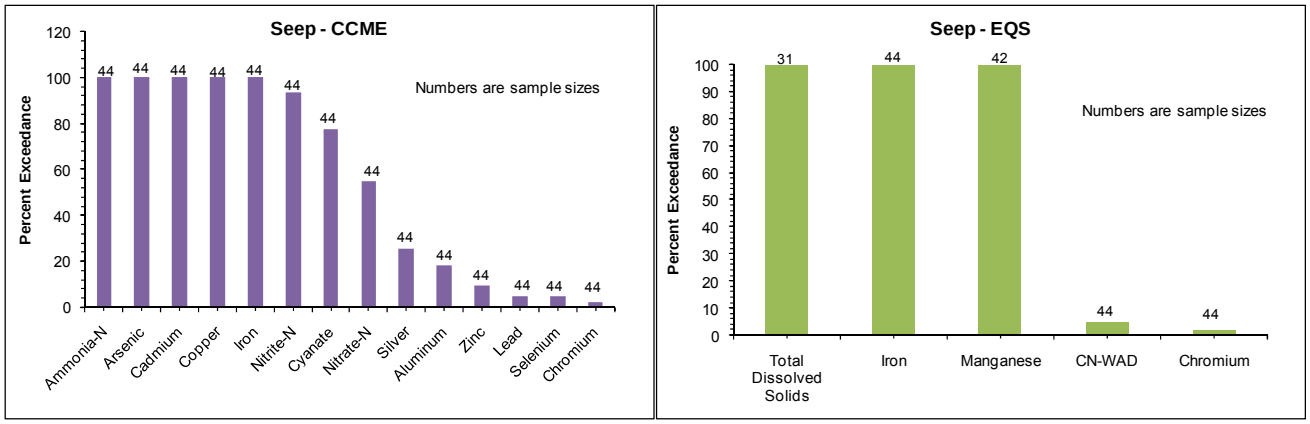


Figure C8. Exceedance of CCME Guidelines and EQS in Brown-McDade Pit