PHOTOGRAPHS

Cantung Site Photographs

Photo 1: Cantung mine site facing east from Vent Adit

Photo 2: Cantung mine site facing west from east valley slope. Open pit and Waste Rock Stockpile #3 visible in back of photo

Photo 3: Main portal entrance facing southwest

Photo 4: Underground workshop

Photo 5: Conveyor adit opening facing southwest

Photo 6: Convey adit interior

Photo 7: Open pit facing northeast. Localized ponding in base of pit

Photo 8: Waste Rock Stockpile #1 facing southwest from Ski Hill Borrow

Photo 9: Waste Rock Stockpile #3 facing southwest. Waste rock pushed over existing slope during operations to form pile

Photo 10: Flat River tailings facing northwest from Tailings Pond 4

Photo 11: Flat River tailings facing east.

Photo 12: Surface of Tailings Pond 1 and 2 facing northeast

Photo 13: Surface of Tailings Pond 3, 4 and 5 facing northeast

Photo 14: Tailings Ponds 3 and 4 facing south from Ski Hill Borrow

Photo 15: Townsite facing northwest from Tailings Pond 4. Water treatment plan in foreground

Photo 16: Minesite facing southeast. Mill in foreground of photo

Photo 17: Minesite facing southwest from Ski Hill Borrow

Photo 18: Warehouse and heavy duty shop facing northwest

Photo 19: Mill facing west from carpentry shop

Photo 20: Cantung airstrip facing southeast

Photo 21: Existing landfill facing northwest

Photo 21: Ski Hill Borrow facing northeast

APPENDIX A

WATER BALANCE MODEL DEVELOPMENT AND RESULTS

1.0 INTRODUCTION

A water balance was created in 2013 using the program GoldSim (EBA, 2013) to represent operational conditions at the Cantung Mine. The 2013 operational conditions water balance model was updated in 2020 to reflect existing care and maintenance conditions and future remediated site conditions. These changes included removing previous inputs, formulas, and junction points which captured chemical mixing, contaminate dilution, freshwater consumption, and townsite wastewater outflows characteristic of the active mine site. Further structural modifications were made to improve inflow location precision and channel volume estimates. Inflow and outflow nodes were added along the Flat River as well as at the entry and exit points of Drain A and Drain B, to allow for a better understanding of flow interactions and contributions of these conveyance systems. Two model scenarios were created, one future scenario that represents the remediated site layout and configuration, and one present day scenario of the mine's existing conditions prior to implementation of remediation activities. The models input parameters were calibrated against the upstream and downstream Water Survey Canada (WSC) gauging stations, namely 10EA002 and 10EA004, to ensure the model's overall mass balance was in keeping with the mass balance observed in historical flow data at these stations.

The updated model aims to capture the mine site's complete water balance on a yearly timestep. Climate and flow systems that have been integrated into the model include precipitation and runoff, infiltration, sublimation and evaporation, open channel inflows from the Flat River and its tributaries, along with shallow and deep groundwater contributions. For the purposes of this water balance, "deep groundwater" is defined as upper hillslope water that recharges intermediate or regional groundwater flow systems and is lost to the immediate water budget for the Flat River reach along the mine site. It is assumed that deep groundwater does not report to the Flat River along the mine reach. Outflows from mining infrastructure including Stinky Pond, the Polishing Pond, the main portal, and the conveyor adit were also incorporated into the water balance.

2.0 CLIMATE AND HYDROLOGY

2.1 Precipitation

As part of previous work, Tetra Tech undertook an analysis of historical and regional climate data obtained from the Meteorological Service of Canada (MSC) to determine the expected annual precipitation in the Flat River watershed. Three meteorological stations were used for this analysis including the discontinued station at the Cantung mine site and two others located within a 125 km wide radius. Table 2.1-1 provides information on the selected stations including the period of record and location.

Table 2.1-1: Summary of Regional MSC Climate Stations

Station Name	Station Number	Latitude (degrees)	Longitude (degrees)	Distance from Site	Elevation (m amsl)	Period of Record
Tungsten	2203922	61.95	-128.25	0 km	1,143	1967-1990
Tuchitua	2101135	60.93	-129.22	125 km SW	724	1967-2012
Hour Lake	2100FCG	61.18	-129.13	100 km SW	890	1982-2013
Rabbit Kettle	2203342	61.96	-127.21	55 km E	618	1995-2013

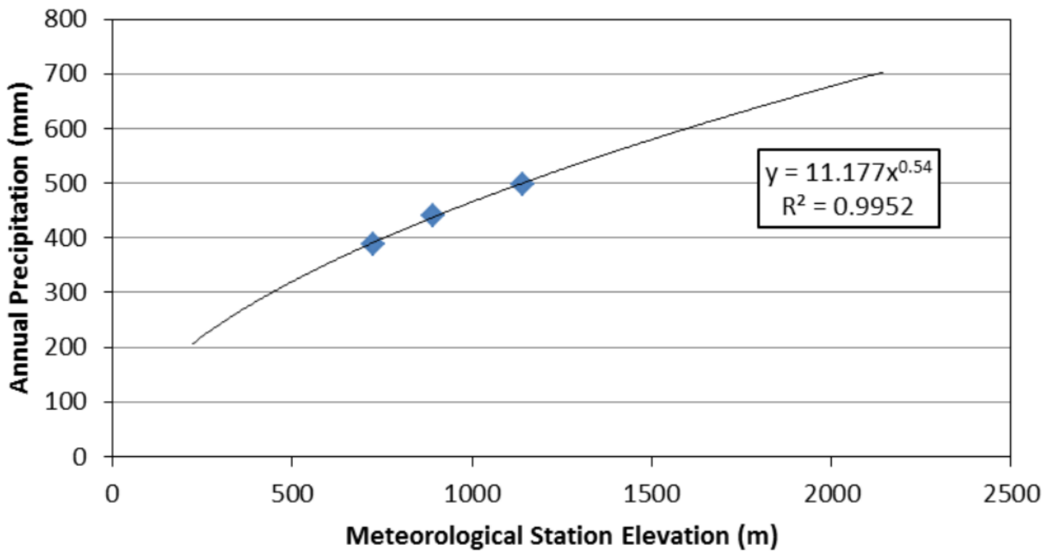
m amsl – meters above mean sea level

Climate data at the Cantung Mine Site was intermittently collected from 1966 to 1990 by the Tungsten 2203922 station. Climate data from this station was the predominant dataset used in determining the average annual precipitation at the mine site; however, in order to obtain a greater sample size, the years where no precipitation data existed for the Tungsten station were synthesized using two other regional stations namely Hour Lake and Tuchitua. The Rabbit Kettle station was not used due to its lower elevation and more limited period of record. The resulting data set consists of 36 years of annual precipitation values with an average annual precipitation of 645 mm/year.

To provide greater confidence, a second approach was applied to evaluate the mean annual precipitation at the mine site using ClimateWNA, Ver 4.72 (Wang, 2019). ClimateWNA is a program which generates high-resolution data in Western Canada for specific locations based on latitude and longitude. Using Climate WNA, the expected average annual precipitation was determined to be 660 mm for the Cantung site which is in good agreement with the regional analysis estimate of 645 mm (2.3% higher).

In addition to estimating the average precipitation expected at the mine site, it was also necessary to estimate the average precipitation expected over the Flat River watershed above the mine site. A common trend observed in meteorology is an increase in precipitation with an increase in elevation. In order to account for differences in elevation between the Tungsten Station, where precipitation data was recorded, and the average elevation of the Flat River watershed, where the Flat Rivers contributing flows originate, a relationship was developed by plotting mean annual precipitation against station elevation for 1989; a year in which all three regional meteorological stations recorded precipitation. Choosing a year in which all three stations recorded data allowed Tetra Tech to isolate the effect of elevation on precipitation as it could be assumed that each station otherwise experienced the same 1989 meteorological conditions. Figure 2.1-1 shows the plotting of Station Elevation vs. Annual Precipitation for the year 1989.

Figure 2.1-1: Annual Average Precipitation vs. Meteorological Station Elevation



The average elevation of the Flat River watershed upstream of the Site was estimated to be 1800 m amsl and the Tungsten Station elevation is noted to be 1143 m amsl. Applying these values into the equation derived in Figure 2.1-1 yields a multiplier of 1.28. This multiplier was then applied to the 36 years of precipitation data to compensate for the elevation difference between the location of the Tungsten meteorological station and the average Flat River watershed elevation. A frequency analysis was undertaken to determine the average annual condition, also referred to as the 2-year return period event, using HYFRAN using the 36 years of elevation compensated annual precipitation data. Results can be found in Table 2.1-2. This elevation compensated precipitation data is subsequently used in calculating the runoff coefficient.

Table 2.1-2: Elevation Compensated Annual Precipitation for Flat River Watershed

Return Period	Annual Precipitation (mm)
2-Year Average	828

2.2 Evaporation

Evaporation analysis was conducted by Tetra Tech as part of the “Combined Water Management Plan and Erosion and Sediment Control Plan” report, submitted to North American Tungsten Corp. in December 2011 (EBA, 2011). As part of this study hourly data was obtained from seven Meteorological Service of Canada stations within approximately 250 km of Cantung Mine. The names and locations of these stations is summarized in Table 2.2-1 below.

Table 2.2-1: Regional Meteorological Stations Used in Evaporation Estimates

Station Name	Latitude	Longitude	Elevation (masl)	Period of Record
Fort Liard Airport, NWT	60° 14.4'	123° 28.2'	215.8	1973 to 2009
Fort Nelson Airport, BC	58° 50.4'	122° 36.0'	381.9	1953 to 2009
Fort Simpson, NWT	61° 52.2'	121° 21.0'	131.7	1953 to 1963
Fort Simpson Airport, NWT	61° 45.6'	121° 14.4'	169.2	1963 to 2009
Smith River Airport, BC	59° 54.0'	126° 25.8'	673.0	1953 to 1969
Watson Lake Airport, YT	60° 7.2'	128° 49.2'	687.4	1953 to 2009
Wrigley Airport, NWT	63° 12.6'	123° 26.4'	149	1957 to 1978/1987 to 2009
Yohin, NWT	61° 14.4'	123° 44.4'	204.0	1973 to 2009

The hourly meteorological data available from these stations was used to generate hourly evaporation estimates using a bulk aerodynamic formulation (Friehe and Schmitt, 1976) based on wind speed, air temperature and relative humidity. These hourly results where then combined into monthly and yearly values for each year that data was available. Mean total annual evaporation was estimated based on two periods: from the beginning of the period of record until 1990, and from 1991 until 2008. Table 2.2-2 below shows the results of these two periods for both monthly and yearly values.

Table 2.2-2: Mean Evaporation Rates

Mean Monthly Evaporation Rates (mm) (pre-1991)												
Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEAR
Fort Simpson	2	3	6	20	46	56	56	43	24	9	3	2	275
Smith River	2	4	8	21	44	56	57	45	23	12	4	2	285
Watson Lake	2	3	10	27	52	70	70	53	29	17	3	2	344
Wrigley	2	3	7	28	65	91	87	66	34	10	3	2	407
Fort Liard	3	8	20	37	66	64	52	40	39	14	4	5	340
Fort Nelson	2	3	9	26	48	53	49	39	22	12	3	2	269
Yohin	3	3	3	4	5	15	27	25	14	7	4	3	114
Mean Monthly Evaporation Rates (mm) (1991 to 2008)												
Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEAR
Fort Simpson	2	2	6	21	48	58	50	41	22	7	2	2	262
Watson Lake	1	2	10	20	44	56	49	43	23	11	2	1	266
Wrigley	1	2	5	17	49	75	62	42	19	5	2	2	280
Fort Liard	5	8	20	40	77	74	67	57	42	22	7	6	430
Fort Nelson	2	3	12	29	52	55	48	37	24	11	3	2	279
Yohin	4	4	5	15	25	29	28	23	15	9	5	4	165

Averaging the results shown in Table 2.2-2 for the two periods of pre 1991 and 1991 to 2008 yields 291 mm and 280 mm of evaporation respectively.

Previous to Tetra Tech 2011 report, evaporation analysis and modelling had been conducted by Aur Resources Inc. using WREVAP, a program developed by Environment Canada's National Hydrological Research Institute which uses meteorological inputs comprising of humidity, air temperature and sunshine duration. Aur Resources modelling results estimated an annual average evaporation of 255 mm at the Cantung Mine site. These results are somewhat lower than the estimates derived by Tetra Tech (EBA) with the bulk aerodynamic method.

Overall, Tetra Tech's 2011 study concluded that annual evaporation rates at the Cantung Mine Site likely ranged between 255 mm and 291 mm. For the purpose of establishing a single annual value for use in our water balance update, Tetra Tech has chosen to average these two extreme values. As such an annual average evaporation of 273 mm is assumed.

2.3 Hydrology

Historically two Water Survey of Canada (WSC) hydrometric stations were installed on the Flat River near the Cantung site and data from these stations provides some understanding of the range of flows that can be expected at the site. However due their limited period of record, additional data points were needed to provide more confidence to these results. As such data from these stations was augmented with a regional analysis method. As part of this method, WSC hydrometric stations within the vicinity of the Cantung Mine Site were reviewed to find gauged watercourses with similar watershed characteristics and sufficient data for a meaningful statistical regional analysis. The selection of comparable watersheds was limited to regions of similar climate, topography, and watershed size. Table 2.3-1 below outlines the characteristics of considered WSC hydrometric stations.

Table 2.3-1: WSC Stations Comparison Summary

Station ID	Station Name	Distance from Site	Number of Years with Flow Data	Watershed Area (km^2)
10EA002	Flat River at Cantung Camp	~1 km NW	14	127
10EA003	Flat River near the mouth	155 km E	39	8,560
10EA004	Flat River at Tungsten Airstrip	~1 km SE	4	171
10EB002	Mac Creek near the mouth	40 km NW	15	216
10EB003	Lened Creek above Little Nahanni River	50 km NW	10	34
10AD002	Hyland River at Kilometre 108.5 Nahanni Range Road	55 km S	17	2,150

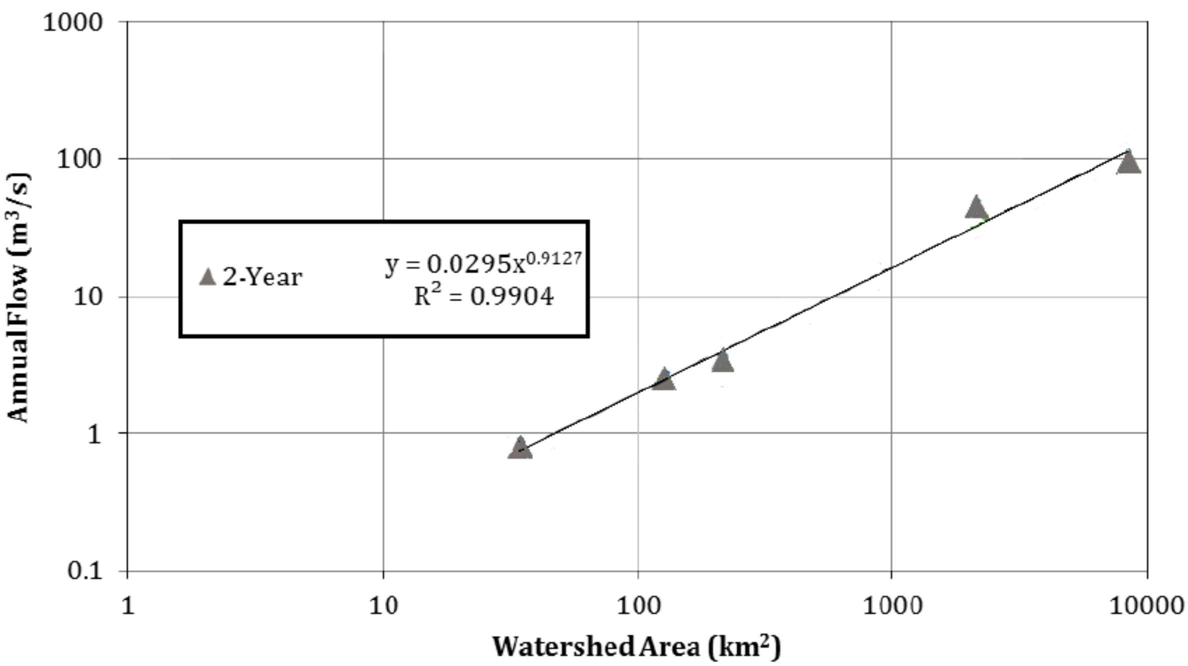
Of the six identified WSC stations outlined in Table 2.3-1, data from the Flat River Station 10EA004 was not included in the analysis due to the short period of record (4 years). The remaining five WSC stations outlined in Table 2.3-1 with ten or more years of available annual flow data were used in a frequency analysis to evaluate average annual flows which are defined as the 2-year return period event. Annual Flows for the 2-year return period were calculated using HYFRAN and are summarized in Table 2.3-2. Results summarized in Table 2.3-2 are based on a Log-Pearson Type 3 distribution which was found to give a good fit to the data.

Table 2.3-2: Annual Average Discharge Frequency Analysis for Selected Regional Stations

Return Period	Regional Stations				
	10EA002	10EA003	10EB002	10EB003	10AD002
Watershed Area (km^2)	127	8,560	216	34.3	2,150
2 – year (Average Annual Flow) (m^3/s)	2.44	96.5	3.34	0.779	44.4

The data for each of the WSC stations was plotted to a log-log chart of the 2-year return period flow vs. watershed area. This plot was then fitted with a power trendline to determine expected annual flows for a given watershed area. Figure 2.3-1 shows the plotted data.

Figure 2.3-1: Annual Flow vs. Watershed Area



Based on this data analysis and the resulting equation, Tetra Tech estimated the Flat River flow upstream of Sardine Creek (127 km^2) to be 2.45 m^3/s. As such it is noted that the regional analysis method served to confirm the flow estimates that would have been predicted based on Station 10EA002 alone. (2.44 m^3/s vs. 2.45m^3/s). Table 2.3-3 lists the finalized results and parameters.

Table 2.3-3: Flat River at 10EA002 Annual Flow and Runoff Frequency Analysis

Return Period	Flat River Annual Flow (m^3/s)	Flat River Annual Runoff Depth (mm)
2-Year (Average Annual Flow)	2.45	610.0

2.4 Runoff Coefficient

A runoff coefficient is defined as the total runoff volume which reports to the receiving watercourse divided by the corresponding precipitation volume. Included in the runoff component of the model is direct runoff (e.g. overland flow) and shallow groundwater flow that represents baseflow of the receiving surface water body. Shallow groundwater flow and baseflow can be used interchangeably. A catchment with a smaller runoff coefficient exhibits greater losses (i.e. evapotranspiration, sublimation, deep groundwater percolation) than a watershed with a larger runoff coefficient. The runoff coefficient accounts for all inputs and outflows from a water balance including precipitation, evaporation, sublimation, evapotranspiration as well as shallow, intermediate and regional groundwater flows.

For the Flat River watershed, an average runoff coefficient was calculated by taking the annual flow measured by the WSC hydrometric station 10EA002 (Flat River at Cantung Camp) and comparing to elevation compensated precipitation data collected at the Tungsten MSC station for years where both precipitation and flows were measured. The resulting coefficients for each year were then averaged to obtain a mean annual runoff coefficient of 0.74 for the Flat River watershed.

A runoff coefficient value of 0.74 was determined to be representative of the tailings ponds (TPs) under remediated conditions, but a lower runoff factor of 0.60 (TP1/2) and 0.55 (TP3/4/5) was used to represent the tailing ponds under existing conditions. These lower existing condition runoff coefficients were determined based on the results of seepage and infiltration modeling completed for the TPs. Simulations of the TPs were completed assuming no cover for TP-3, TP-4, and TP-5 and a cover over TP1/2. A soil cover was placed over the tailings material in TP1/2 so this is representative of current care and maintenance conditions. TP-3, TP-4, and TP-5 remain uncovered currently, which is why these TPs have a lower runoff coefficient.

The infiltration and seepage modeling was completed for the TPs using hydraulic conductivity values for the tailings material developed from the 2018 test pitting field program. The 2018 data evaluation showed that there are approximately three orders of magnitude in the range of hydraulic conductivity values for the cover material placed on TP1/2. The highest hydraulic conductivity value (2.00e-2 cm/sec) is consistent with material such as a sand, which would not significantly limit infiltration into the facility. The lowest value for the cover (2.79e-5 cm/sec) is more consistent with the expected hydraulic conductivity of cover material. The tailings material in TP1/2 showed a more consistent range of particle sizes between samples, resulting in a range of values over one order of magnitude (~5e-5 cm/sec). The TP-3, TP-4, and TP-5 material appears to be more heterogeneous with hydraulic conductivity values over a range of three orders of magnitude (9e-6 cm/sec to 2e-3 cm/sec). The results of this modeling found that approximately 65% of the water runs off the closed facility (TP1/2) and 52% runs off of the open facilities (TP-3, TP-4, and TP-5). Simulations of potential remediation cover designs found that the expected infiltration could be reduced, and the runoff increased to approximately 70%.

3.0 MODEL DEVELOPMENT AND INPUTS

3.1 Model Parameters

Hydrological inputs from the 2013 water balance, including runoff coefficients, annual precipitation amounts and evaporation rates as described above were reviewed to confirm accuracy and appropriateness for both the existing care and maintenance conditions and future remediated site conditions. Non-climatic modelling parameters and their derivation is described below.

Figure A-1 attached shows the model inputs and outputs and flow schematic for the site. The figure shows the remediated site condition.

3.1.1 Catchment Area Delineation

To improve watershed area and outflow location estimates, natural catchments were further defined, and additional outflow nodes were added. Catchment boundaries are shown on Figure A-2. The additional nodes and catchments served to more finitely route flows into the Flat River. Work undertaken to complete this was as follows:

- The 2013 catchment delineations in AutoCAD were overlaid with the most recent orthographic photos.
- Delineation accuracy for natural catchments outside the mine site was improved. These discerned areas were added to the newly defined catchment elements in the model.
- The Tailing Pond catchment areas were redefined based on the most recent mine planimetry drawings and Tailing Pond footprints.
- Accuracy of natural catchment routing allocation between Sardine Creek, Drain A and Drain B was improved.

Table 3.1-1 provides the catchment areas measured for each of the mine’s tailings facilities.

Table 3.1-1: Catchment Areas

Catchment Type	Name	Catchment Area (km^2)
Natural Catchment Upstream of Mine Site Area	Upstream Catchment Area	127
Tailings Ponds in Mine Site Area	TP1/TP2	0.041
	TP3	0.082
	TP4	0.069
	TP5	0.052
	Polishing Pond	0.0054
	Stinky Pond	0.0048
Natural Catchments in Mine Site Area	Sub-catchment No. 1	2.27
	Sub-catchment No. 2	5.85
	Sub-catchment No. 3	0.66
	Sub-catchment No. 4	0.69
	Sub-catchment No. 5	0.69
	Sub-catchment No. 6	2.31
	Sub-catchment No. 7	0.40
	Sub-catchment No. 8	1.47
	Sub-catchment No. 9	25.71
	Sub-catchment No. 10	1.22
	Sub-catchment No. 11	0.10
	Sub-catchment No. 12	0.44
Total Catchment Area Downstream of Mine Site Area		**170**

*Tetra Tech's measured watershed area varies from WSC Station 10EA004 - Flat River at Tungsten Airstrip watershed area (171 km^2) by approx. 1.5 km^2. As WSC's methodology and assumptions are unknown, Tetra Tech has used the watershed area measured internally in our water balance calculations.

3.1.2 Groundwater Parameters

The modeling incorporated the groundwater analysis detailed in Section 8.2 of main report. Results from this updated study of regional hydrogeology were reviewed and integrated in a way which enabled the proper allocation and routing of groundwater flows estimates from three zones identified in Section 8.2.

In differentiating between precipitation that runs off at surface level and that which infiltrates into the ground and returns to the Flat River as shallow groundwater, Tetra Tech refers to these flow paths as "Surface Flow" and "Base Flow" respectively. The Surface Flow to Base Flow breakdown, estimated to be 80% and 20%, respectively in the 2013 EBA Water Balance, was recalculated to be closer to 70% and 30% given the results present in Section 8.2 of main report. This 70% and 30% breakdown was used to estimate the runoff fraction from Tailing Ponds 1-5 in the existing conditions model. For the remediated site condition scenario, the previously calculated 80% and 20% breakdown was used to replicate the improved water shedding qualities expected from the decommissioned Tailings Ponds. The proportion of surface water and base flow for the waste rock piles was assumed to be 50% and 50% due to the coarse material size of these piles.

3.1.3 Conveyor Adit and Main Portal Flows

For purposes of this semi-quantitative water balance, Tetra Tech made some simplifying assumptions about the source of the Conveyor Adit and Main Portal Flows. Based on observations that the Conveyor Adit flows were less responsive to precipitation and seasonal freshet changes, had different water chemistry and behaved differently during mine flooding when compared to the Main Portal, Tetra Tech inferred that water discharging from the Conveyor Adit was derived from deep mine workings and deeper groundwater tables, physically isolated from near-surface hydraulic changes such as storms and freshet events. The Main Portal's flows conversely are observed to be highly affected by surface storm conditions and thus it's flows were assumed to have originated from shallow groundwater tables. In order to quantify the average long-term flows from the Conveyor Adit and Main Portal, Tetra Tech performed data reduction and analysis on the available historical flow recordings from monitoring stations S4-13 and S4-42. This resulted in projected long-term flows of 392 m^3/d for the Conveyor Adit and 138 m^3/d for Main Portal. These flows were entered into the model with Conveyor Adit Flows routed as surface flow to Drain A and Main Portal flows routed as surface flow to Sardine Creek.

3.1.4 Stinky Pond and Polishing Pond

As there are no ongoing mine related inflows or outflows, the water balance calculations for both Stinky Pond and the Polishing Pond were simplified to represent the acting natural processes while the mine is in care and maintenance. As such, on a yearly timestep, only direct precipitation and evaporation over each pond area were considered.

3.1.5 Summary of Input Parameters

Table 3.1-2 summarizes input parameters included in the annual water balance.

Table 3.1-2: Water Balance Climate and Hydrology Parameter Summary

Parameter/Input	Description	Existing Care and Maintenance Conditions Model Parameters	Remediated Site Model Parameters
Precipitation	Mean annual precipitation applied to evaluate surface runoff and direct precipitation to tailings ponds.	Average = 645 mm/yr	
Evaporation	Surface Water Evaporation (EBA 2011)	Average = 273 mm/yr	
Runoff Coefficient	Fraction of precipitation that is observed as total flow reporting to Flat River.	TP1/2 = 0.60 TP3/4/5 = 0.55 Waste Rock Piles = 0.50 All other Areas = 0.74	All Areas = 0.74
Total Runoff	Surface runoff based on precipitation, runoff coefficient and sub-catchment area.	See Precipitation and Runoff Coefficient	
Surface Water Flow	Portion of total flow observed as surface water	Surface Flow = 0.70 Total Runoff	Surface Flow = 0.80 Total Runoff
Baseflow (Shallow Groundwater Flow)	Portion of total flow observed as baseflow or shallow groundwater flow.	Baseflow = 0.30 Total Runoff	Baseflow = 0.20 Total Runoff

4.0 EXISTING CONDITIONS MODEL RESULTS

4.1 Tailings Ponds

To better understand the mine's water balance under present day conditions, Tetra Tech developed a model scenario which reflects the present-day runoff conditions on Tailings Ponds 1-5. Tables 4.1-1 to 4.1-3 summarize the results of this "existing conditions" model. Table 4.1-1 shows individual tailings pond outflows stemming from direct runoff and ditch inflow. In this table, "Surface Water Flow" is defined as open channel outflows from each tailings pond to the Flat River. "Ground Water Flow" is defined as subsurface flow which does not percolate into the deep bedrock aquifer and remains within the water balance (flows through shallow overburden aquifer), eventually received by the Flat River. Total Flow is the combined sum of these two metrics flowing into the Flat River. Table 4.1-3 identifies flows in drainage channels local to the mine site which convey direct runoff and decommissioned mine outflows through the mine into the Flat River. Table 4.1-3 highlights total flow through the Flat River before it reaches the mine site, downstream of the mine site as well as the total contributing inflow as it moves through the mine. All flow values are in cubic metres of water per day.

The quantities shown are those that Tetra Tech expects would move through the system on average throughout the year. As described in the preceding sections, due to seasonal variability, these numbers are not necessarily representative of daily flows at any one time but are the averages expected when observing a full year's cycle.

Table 4.1-1: Modelled Yearly Catchment Runoff – Existing Conditions

Catchment Type	Name	Surface Water Flow (m^3/d)	Shallow Groundwater Flow (m^3/d)	Total Flow (m^3/d)
Natural Catchment	Catchment Upstream of Mine Site Area	209,582	-	209,582
Tailings Ponds in Mine Site Area	TP1/TP2	30.4	13.0	43.4
	TP3	55.8	23.9	79.6
	TP4	46.9	20.1	67.0
	TP5	35.4	15.2	50.5
	Polishing Pond	899.4	2.9	902.3
	Stinky Pond	3.40	1.46	4.86
Natural Catchments in Mine Site Area	Sub-catchment No. 1	2787.6	178.8	2966.4
	Sub-catchment No. 2	7183.8	460.9	7644.6
	Sub-catchment No. 3	805.6	51.7	857.2
	Sub-catchment No. 4	847.3	54.4	901.7
	Sub-catchment No. 5	841.2	54.0	895.1
	Sub-catchment No. 6	2833.0	181.7	3014.7
	Sub-catchment No. 7	487.5	31.3	518.8
	Sub-catchment No. 8	1805.2	115.8	1921.0
	Sub-catchment No. 9	31571.8	2025.4	33597.2
	Sub-catchment No. 10	1473.6	94.5	1568.1
	Sub-catchment No. 11	103.8	6.7	110.4
	Sub-catchment No. 12	534.2	34.3	568.4
Total Flows Downstream of Mine Site Area				264,322*

*Model Derived Output. Quantities in table are intended to provide broad understanding of the relative contributions of each catchment and mine facility. Totals do not add up exactly due to the cross interactions between model features that are complex beyond the scope of this table.

Table 4.1-2: Modelled Drainage Channel Yearly Flows – Existing Conditions

Watercourse	Total Flow (m^3/d)
Sardine Creek	726.1
Drain A	866.4
Drain B	569.3

Table 4.1-3: Modelled Flat River Yearly Flows – Existing Conditions

Location	Flat River Flow (m^3/d)	Basis of Result
Flow Above Mine Site	209,582	Measured data from historical average yearly flows at WSC Station 10EA002 - Flat River at Cantung Camp
Flow Below Mine Site	264,322	Model output calibrated with historical average yearly flows at WSC Station 10EA004 - Flat River at Tungsten Airstrip
Flow Add Through Mine Site	54,740*	Calculated from the Existing Conditions Water Balance Model that was calibrated against WSC stations upstream and downstream from the mine site area.

4.2 Waste Rock Stockpiles

An analysis was undertaken to estimate the amount of surface water which might come in contact with the two primary waste rock stockpiles on a yearly basis. The waste rock pile catchment areas cover only a small subsection of the Catchments 4, 5 and 6 of the water balance model. It was impractical and unnecessary for the purposes of the water balance to discretize the waste rock piles out from the larger catchment areas. However, the runoff and groundwater contributions from these smaller areas was needed for use in the water quality modeling presented in Section 13.0 of the CSM, so they were analyzed outside of the water balance model. The approach taken for this analysis was as follows:

- The two waste rock stockpiles were modelled for current care and maintenance conditions, but this applies also to remediated conditions. The waste rock stockpiles are not planned to be capped and covered in such a way that would significantly impact flows, so the remediated conditions will be similar to the current care and maintenance site conditions.
- The waste rock stockpile areas were delineated based on present day best estimates of each pile's footprint.
- Upstream catchment areas were defined based on topographic survey information.
- Runoff volumes were calculated both for direct precipitation onto the waste rock stockpiles themselves and for flow through from the upstream catchments areas.
- Precipitation quantities and catchment runoff coefficients established as part of the water balance model update were used in generating runoff estimates. A direct runoff coefficient of 0.50 was used in establishing runoff from direct precipitation onto the waste rock stockpiles.

It is noted that the Upstream Catchment Flow through result assumes that no berm and/or ditch has been constructed around the waste rock stockpiles. Without a ditch or berm diversion structure protecting the waste rock stockpiles, it is reasonable to assume that water falling on the upstream catchment area will sheet flow through the waste rock pile areas. However, if a diversion feature was implemented, it could potentially eliminate and or reduce discharge originating from this contact method.

Footprint areas for the waste rock stockpiles and their associated upstream catchment areas are presented in Table 4.2-1 below.

Table 4.2-1: Waste Rock Stockpiles – Footprint Area and Catchment Area

Stockpile #	Feature	Area (km^2)
Waste Rock Stockpile #1	Pile Footprint Area	0.022
	Upstream Catchment Area	0.099
	Total:	**0.121**
Waste Rock Stockpile #2	Pile Footprint Area	0.010
	Upstream Catchment Area	0.096
	Total:	**0.106**

Results of this analysis are presented in Table 4.2-2 below.

Table 4.2-2: Waste Rock Discharge Results – Existing Conditions

Stockpile #	Method of Contact	Discharge (m^3/d)
Waste Rock Stockpile #1	Direct Runoff	19.8
	Upstream Catchment Flow Through	129.9
	Total:	**149.7**
Waste Rock Stockpile #2	Direct Runoff	8.6
	Upstream Catchment Flow Through	125.5
	Total:	**134.1**

5.0 REMEDIATED SITE MODEL RESULTS

Tables 5.1, 5.2, and 5.3 summarize the results of the finalized remediated site conditions model. Table 5.1 shows individual tailings pond outflows stemming from direct runoff and ditch inflow. In this table, “Surface Water Flow” is defined open channel outflows from each tailings pond to the Flat River. “Ground Water Flow” is defined as subsurface flow which does not percolate into the deep bedrock aquifer and remains within the water balance (flows through shallow overburden aquifer), eventually received by the Flat River. Total Flow is the combined sum of these two metrics flowing into the Flat River. Table 5.2 identifies flows in drainage channels local to the mine site which convey direct runoff and decommissioned mine outflows through the mine into the Flat River. Table 5.3 highlights total flow through the Flat River before it reaches the mine site, downstream of the mine site as well as the total contributing inflow as it moves through the mine. All flow values are in cubic metres of water per day.

The quantities shown are those that Tetra Tech expects would move through the system on average throughout the year. As described in the preceding sections, due to seasonal variability, these numbers are not necessarily representative of daily flows at any one time but are the averages expected when observing a full year’s cycle.

Table 5.1: Modelled Yearly Catchment Runoff – Remediated Site Conditions

Catchment Type	Name	Surface Water Flow (m³/d)	Shallow Groundwater Flow (m³/d)	Total Flow (m³/d)
Natural Catchment	Catchment Upstream of Mine Site Area	209,582	-	209,582
Tailings Ponds in Mine Site Area	TP1/TP2	42.9	10.7	53.6
	TP3	85.7	21.4	107.1
	TP4	72.1	18.0	90.1
	TP5	54.4	13.6	68.0
	Polishing Pond	907.5	1.9	909.4
	Stinky Pond	3.89	0.97	4.86
Natural Catchments in Mine Site Area	Sub-catchment No. 1	2787.6	178.8	2966.4
	Sub-catchment No. 2	7183.8	460.9	7644.6
	Sub-catchment No. 3	805.6	51.7	857.2
	Sub-catchment No. 4	847.3	54.4	901.7
	Sub-catchment No. 5	841.2	54.0	895.1
	Sub-catchment No. 6	2833.0	181.7	3014.7
	Sub-catchment No. 7	487.5	31.3	518.8
	Sub-catchment No. 8	1805.2	115.8	1921.0
	Sub-catchment No. 9	31571.8	2025.4	33597.2
	Sub-catchment No. 10	1473.6	94.5	1568.1
	Sub-catchment No. 11	103.8	6.7	110.4
	Sub-catchment No. 12	534.2	34.3	568.4
Total Flows Downstream of Mine Site Area				264,420*

*Model Derived Output. Quantities in table are intended to provide broad understanding of the relative contributions of each catchment and mine facility. Totals do not add up exactly due to the cross interactions between model features that are complex beyond the scope of this table.

Table 5.2: Modelled Drainage Channel Yearly Flows – Remediated Site Conditions

Watercourse	Total Flow (m³/d)
Sardine Creek	726.1
Drain A	866.4
Drain B	636.2

Table 5.3: Modelled Flat River Yearly Flows – Remediated Site Conditions

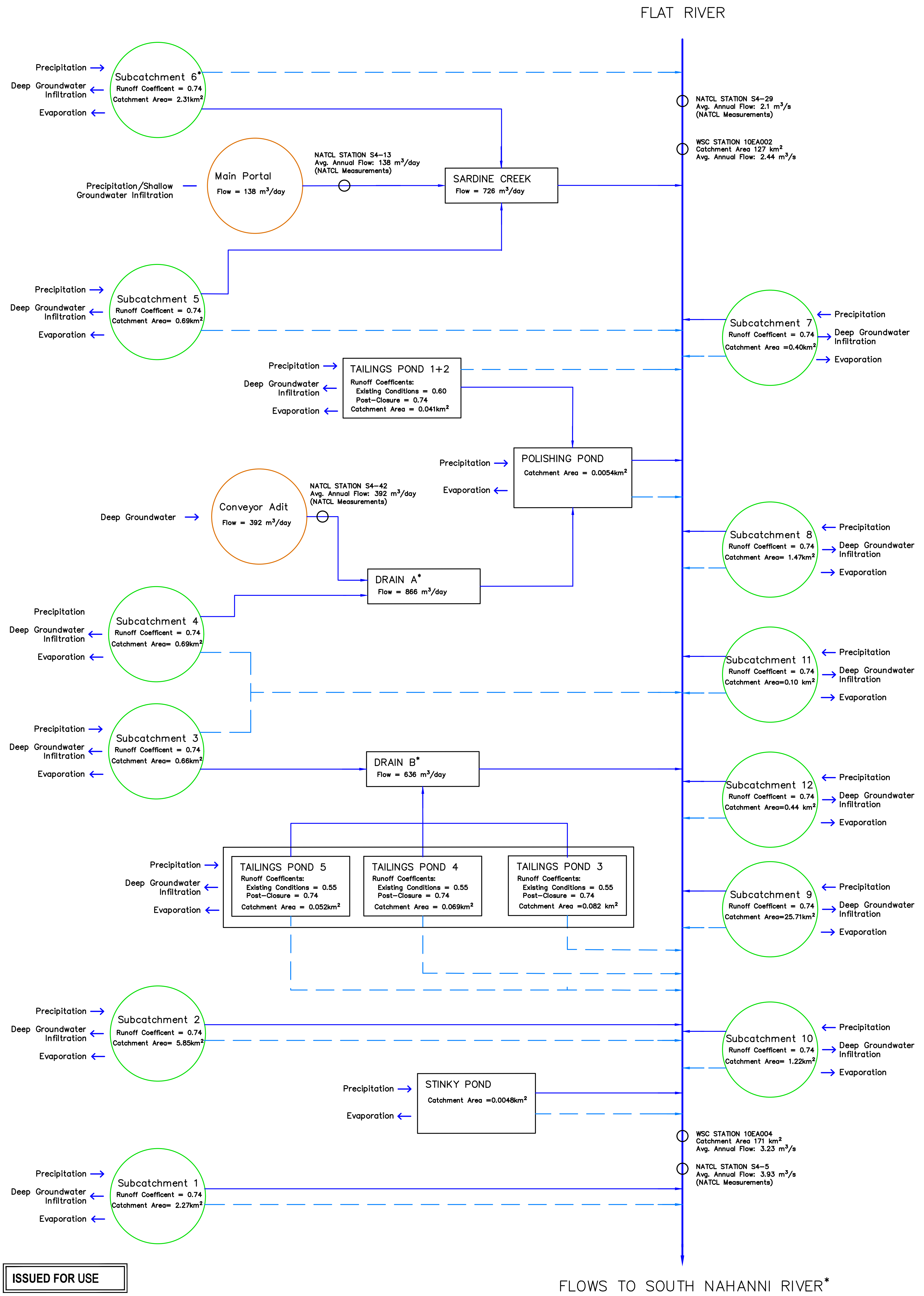
Location	Flat River Flow (m³/d)	Basis of Result
Flow Above Mine Site	209,582	Measure data from historical average yearly flows at WSC Station 10EA002 - Flat River at Cantung Camp
Flow Below Mine Site	264,420	Model output calibrated with historical average yearly flows at WSC Station 10EA004 - Flat River at Tungsten Airstrip
Flow Add Through Mine Site	54,838	Calculated based on the Remediated Site Conditions Water Balance Model

REFERENCES

EBA, 2013. Combined Water Management Plan and Erosion and Sediment Control Plan, Cantung Mine Site. Report No. V13201456 prepared by EBA, A Tetra Tech Company for North American Tungsten Corporation Ltd., December 2013.

Friehe, C.A. and K.F. Schmitt. 1976. Parameterization of air-sea interface fluxes of sensible heat and moisture by the bulk aerodynamic formulas, J. Phys. Oceanography. 76:801-805.

Wang et al. "ClimateWNA.". 2019. *ClimateNA_Map*, edited by Centre for Forest Conservation Genetics, University of British Columbia, 2019, www.climatewna.com/.



ISSUED FOR USE

LEGEND

Surface Water Flow

Shallow Groundwater Flow (Baseflow)

NOTES

1. Geographic locations for Subcatchment and their numbering system can be found in Figure 8-1.
2. The segments Drain A and Drain B are drainage channels which convey surface runoff through the mine site and into the Flat River.
3. South Nahanni River is 150 Km downstream from Cantung Mine Site

CLIENT

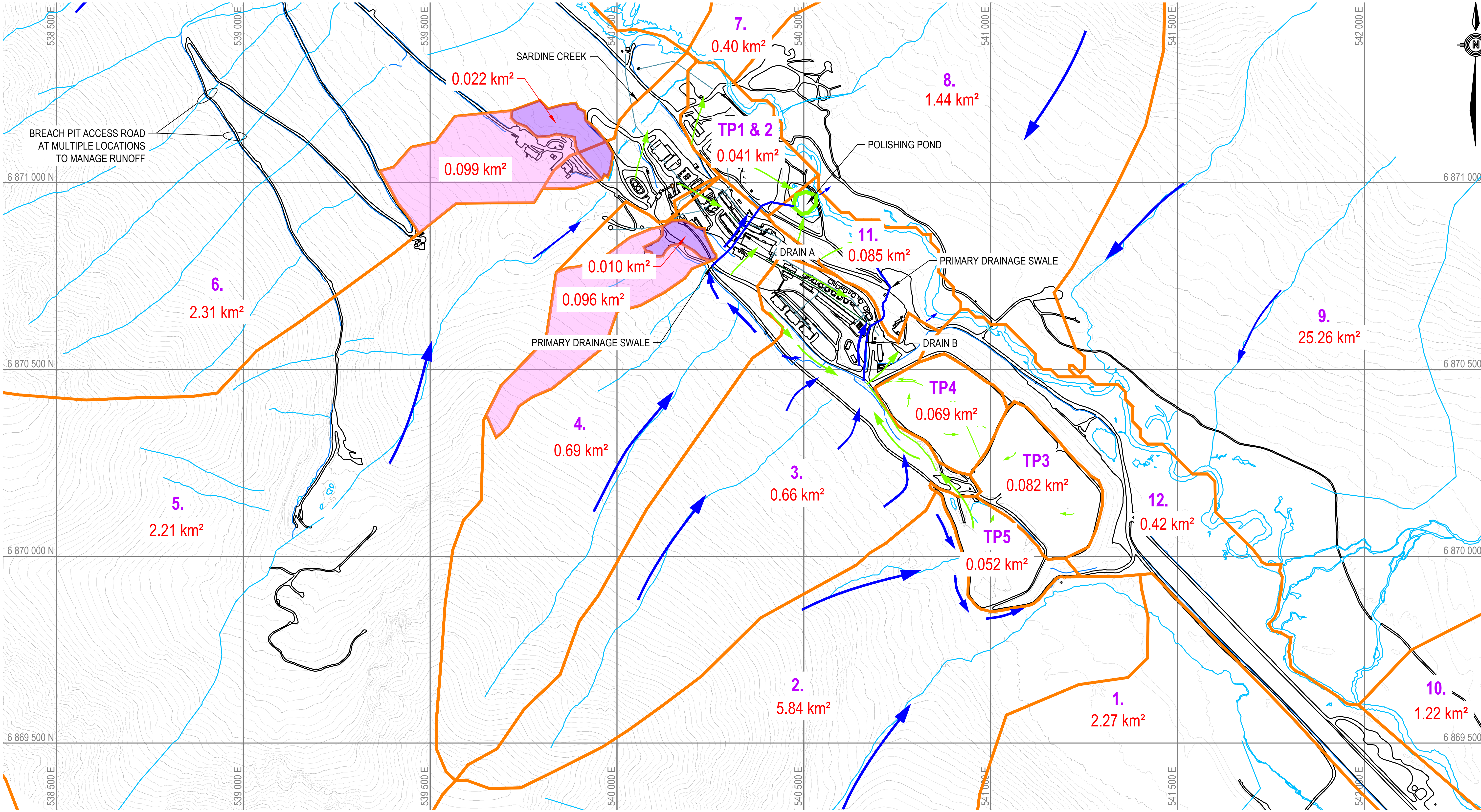
TETRA TECH

CANTUNG MINE

SITE WATER BALANCE SCHEMATIC

PROJECT NO.	DWN	CKD	REV
ENW.WENW03039-05	JAW	GC	B
OFFICE	DATE		
VANC	April 2021		

Figure A-1



LEGEND:

- CATCHMENT BOUNDARY
- NON-CONTACT SURFACE WATER FLOW
- CONTACT SURFACE WATER FLOW
- CHANNELS
- WASTE ROCK PILES
- CATCHMENT AREAS FOR WASTE ROCK PILES

0 500m

Scale: 1:10,000 @ 11"x17"

NOTES:

1. HORIZONTAL DATUM/PROJECTION: UTM ZONE 9N, NAD83 (CSRS) (2010) - METERS
2. CONTOUR INTERVAL 10 m

STATUS
ISSUED FOR REVIEW

CLIENT

NORTH AMERICAN TUNGSTEN CORPORATION LTD

TETRA TECH

CONCEPTUAL SITE MODEL
CANTUNG MINE, NT

CATCHMENT BOUNDARIES

PROJECT NO.	DWN	CKD	REV
ENW.WENW03039-03	EL/EP	GDK	A

OFFICE	DATE
EDMONTON	MARCH 2021

FIGURE A-2

APPENDIX B

GROUNDWATER QUALITY DATA AND TIME-SERIES TREND PLOTS

Appendix B1: Groundwater Chemistry Summary Statistics for Background Stations

				S4-27-17				S4-27-18				17BMW-01				Mine Background Water
				n=28, August 2009 to October 2018				n=8, September 2014 to August 2016, July 2018				n=2, October 2017, July 2018				n=1, September 2017
	Units	Background Value[1]	Federal Interim Guideline[2]	Min	Max	Median	95th Percentile	Min	Max	Median	95th Percentile	Min	Max	Median	95th Percentile	Single Sample
Alkalinity, as $CaCO_3$ (total)[3]	mg/L	89	-	179	229	198	183	84	109	93	86	106	107	107	107	133
Ammonia	mg/L	0.05	-	0.005	0.06	0.01	0.051	<0.01	0.05	<0.01	0.043	<0.01	<0.01	<0.01	<0.01	-
Chloride	mg/L	0.7	120	0.26	0.73	0.33	0.70	0.05	0.13	0.10	0.12	0.3	0.39	0.35	0.39	28
Fluoride	mg/L	0.39	0.12	0.05	0.10	0.07	0.09	0.05	0.09	0.07	0.09	**0.2**	**0.2**	**0.2**	**0.2**	**0.42**
Hardness	mg/L	292	-	196	225	212	225	155	252	195	242	188	307	248	301	176
Total Nitrogen	mg/L	5.6	-	0.2	0.6	0.4	0.58	0.05	9	0.3	6.2	0.26	0.26	0.26	0.26	-
Nitrate, as N	mg/L	0.29	13	0.005	0.32	0.25	0.30	0.07	0.16	0.14	0.16	0.14	0.23	0.18	0.22	0.20
Nitrite, as N	mg/L	0.01	-	0.001	0.015	<0.005	0.009	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Phosphate	mg/L	80	-	2	80	9.1	80	-	-	-	-	-	-	-	-	-
Silica	mg/L	7.3	-	4.4	5.7	5.3	5.5	5.4	7.4	5.8	7.3	-	-	-	-	-
Sodium	mg/L	3.1	-	1.02	1.9	1.3	1.6	0.6	3.8	1.1	3.3	1.0	1.7	1.3	1.6	10.7
Sulphate	mg/L	182	100	15	29	21	28	75	**143**	**107**	**141**	99	**189**	**144**	**185**	74
Electrical Conductivity	uS/cm	543	-	364	419	393	414	310	456	394	447	383	559	471	550	499
pH[3]	pH	7.2	6.5 - 9	7.6	8.5	7.9	7.6	7.2	7.9	7.8	7.2	7.3	7.5	7.4	7.3	7.6
TDS	mg/L	358	-	173	250	210	236	200	293	240	288	192	380	286	371	122
TOC	mg/L	16	-	0.61	9	1	2.38	0.9	22.8	1.3	16.38	-	-	-	-	-
TSS	mg/L	196	-	1	24	1	16	16	216	89.5	206	-	-	-	-	-
Dissolved Metals (filtered)																
Aluminium	mg/L	0.04	0.005 or 0.1[4]	<0.002	0.053	0.002	0.0080	0.002	0.046	0.005	0.031	0.002	0.008	0.005	0.008	0.041
Antimony	mg/L	0.001	-	0.0001	0.001	0.0001	0.001	-	-	-	-	<0.0002	0.0002	0.0002	0.0002	<0.0002
Arsenic	mg/L	0.00088	0.005	<0.0001	0.001	0.00020	0.00079	0.0002	0.0007	0.0006	0.00066	0.0003	0.0006	0.00045	0.00059	0.0009
Barium	mg/L	0.082	-	0.05	0.0937	0.0749	0.08959	-	-	-	-	0.0047	0.0158	0.01025	0.01525	0.0014
Beryllium	mg/L	0.0008	-	<0.00001	0.001	<0.00001	0.0008	<0.00001	0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Bismuth	mg/L	0.0005	-	0.0005	0.0005	0.0005	0.0005	-	-	-	-					
Boron	mg/L	0.047	-	0.006	0.015	0.01	0.014	0.001	0.043	0.003	0.028	0.003	0.008	0.006	0.008	0.05
Cadmium	mg/L	0.000047	0.000017	0.00001	**0.00007**	**0.00002**	**0.00005**	0.000005	**0.00002**	0.00001	0.000016	<0.00001	**0.00003**	**0.000018**	**0.000029**	<0.00001
Calcium	mg/L	84	-	55	60	57	60	-	-	-	-	59	88	73	86	46.6
Chromium (III+VI)	mg/L	0.001	0.0089	<0.0005	0.0014	<0.0005	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	0.0007	-	<0.00005	0.001	<0.00005	0.00071	<0.00005	0.00015	<0.00005	0.00011	0.00015	0.00051	0.00033	0.00049	<0.00005
Copper	mg/L	0.002	0.002 - 0.004[5]	0.0001	**0.008**	0.0005	0.002	0.0005	0.0011	0.0006	0.001	0.0009	0.0011	0.001	0.001	0.0009
Iron	mg/L	0.22	0.3	<0.01	**0.61**	0.03	0.23	<0.01	0.16	0.01	0.14	0.028	0.071	0.050	0.069	<0.01
Lithium	mg/L	0.082	-	0.0073	0.012	0.008	0.012	-	-	-	-	-	-	-	-	0.086
Magnesium	mg/L	18	-	17	19	18	19	-	-	-	-	10	15	13	15	15
Manganese	mg/L	0.12	-	0.0002	0.009	0.001	0.006	0.0005	0.05	0.0005	0.031	0.05	0.14	0.09	0.13	<0.001
Mercury	mg/L	0.000021	0.000026	0.000003	0.000025	<0.00001	0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-
Molybdenum	mg/L	0.0077	-	0.0004	0.003	0.0007	0.0023	0.0017	0.011	0.002	0.0073	0.0012	0.0082	0.005	0.008	0.00127
Nickel	mg/L	0.0021	0.025 - 0.15[5]	0.0001	0.003	0.0003	0.002	<0.0002	0.0005	<0.0002	0.00042	0.0006	0.0017	0.0012	0.002	0.0005
Phosphorus	mg/L	0.23	-	0.00005	0.3	<0.05	0.23	0.00005	<0.05	<0.05	<0.05	-	-	-	-	-
Lead	mg/L	0.00066	0.001 - 0.007[5]	0.00001	0.001	0.00004	0.0007	<0.00005	0.00017	<0.00005	0.00013	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005

Appendix B1: Groundwater Chemistry Summary Statistics for Background Stations

				S4-27-17				S4-27-18				17BMW-01				Mine Background Water
				n=28, August 2009 to October 2018				n=8, September 2014 to August 2016, July 2018				n=2, October 2017, July 2018				n=1, September 2017
	Units	Background Value[1]	Federal Interim Guideline[2]	Min	Max	Median	95th Percentile	Min	Max	Median	95th Percentile	Min	Max	Median	95th Percentile	Single Sample
Selenium	mg/L	0.0011	0.001	<0.0005	**0.001**	0.0005	**0.001**	<0.0005	**0.0013**	<0.0005	**0.0011**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Silicon	mg/L	2.6	-	2.3	2.6	2.4	2.6	-	-	-	-	-	-	-	-	-
Silver	mg/L	0.000072	-	0.00001	0.0001	<0.00002	0.00007	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Strontium	mg/L	0.12	-	0.0393	0.055	0.04485	0.05059	0.0823	0.128	0.113	0.128	-	-	-	-	-
Thallium	mg/L	0.000093	-	0.000002	0.0001	0.000005	0.0001	0.000005	0.00004	0.00001	0.000032	<0.00001	0.00002	0.00002	0.00002	<0.00001
Tin	mg/L	0.000090	-	<0.0001	<0.0001	<0.0001	<0.0001	-	-	-	-	0.00009	0.00009	0.00009	0.00009	-
Titanium	mg/L	0.0091	-	0.001	0.01	0.01	0.01	-	-	-	-	0.0008	0.0011	0.0010	0.0011	0.0007
Tungsten	mg/L	0.0069	-	0.00048	0.01	0.008	0.0072	0.0004	0.0064	0.0007	0.0045	0.00037	0.00037	0.00037	0.00037	-
Uranium	mg/L	0.0071	0.015	0.001	0.002	0.0017	0.0019	0.0021	0.0055	0.0028	0.0046	0.00207	0.0026	0.0023	0.0025	0.0075
Vanadium	mg/L	0.001	-	0.0001	0.001	<0.0005	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Zinc	mg/L	0.0066	0.03	0.001	0.007	0.0015	0.0037	0.001	0.005	0.002	0.0042	0.002	0.004	0.003	0.004	0.007

Notes:

1. Background value calculated by taking 95th percentile value of 95th percentile values of background stations per BC MOE (1996) and CCME (2003).
2. Federal Contaminated Sites Action Plan (FCSAP) Guidance Document on Federal Interim Groundwater Quality Guidelines (FIGWQG) for Federal Contaminated Sites Tier 2 Guidelines for Residential / Parkland Land Use - coarse- and fine-grained soils.
3. For alkalinity and pH, the 5th percentile value is shown; shaded cells identify values that are lower than background or guideline values.
4. Guideline is dependent upon the pH value. Value for pH greater than 6.5 shown. Value of 0.005 for pH less than 6.5
5. Guideline is based on the hardness value.

mg/L - milligrams per litre.

Shaded - Concentration above summary background value

Bold Red - Concentration above FIGWQG for both Residential/Parkland and Agricultural Land Use.

Bold, Red, Shaded - Concentration above both summary background and FIGWQG guideline values

Blank - No guideline available

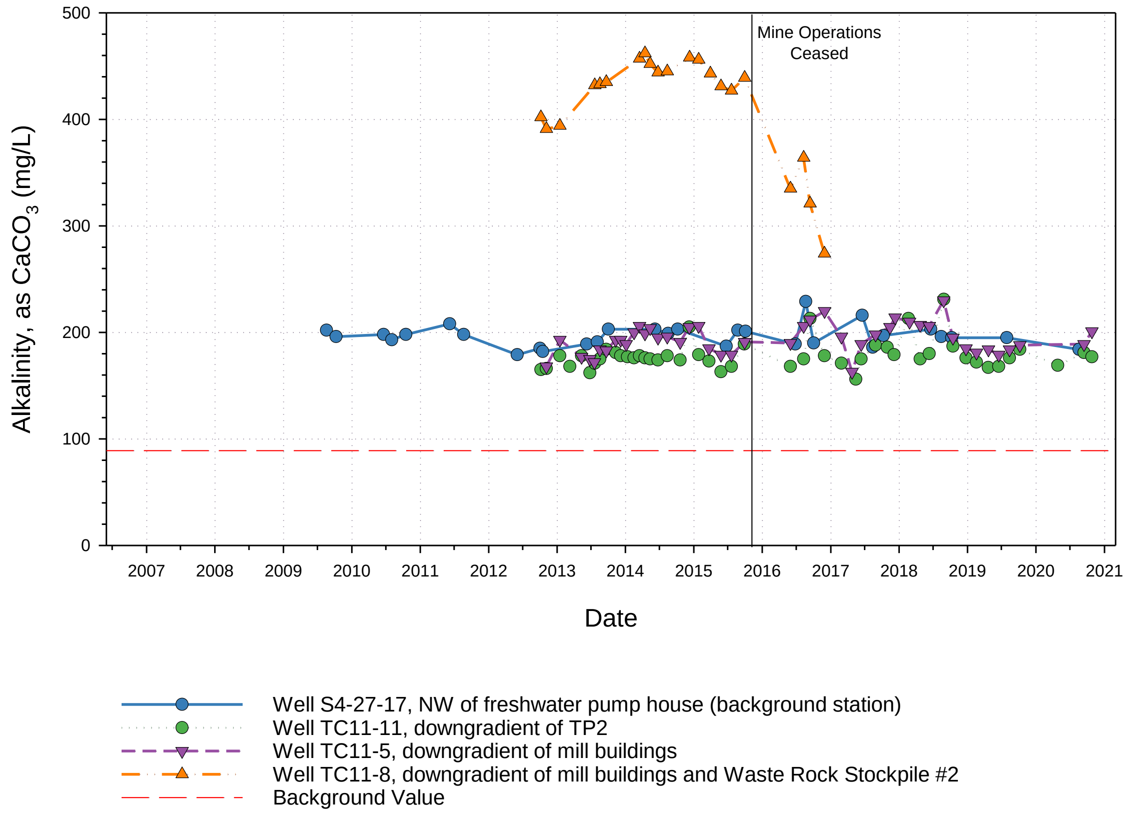
Appendix B2: Groundwater Chemistry Summary Statistics for Potentially Mine Affected Stations

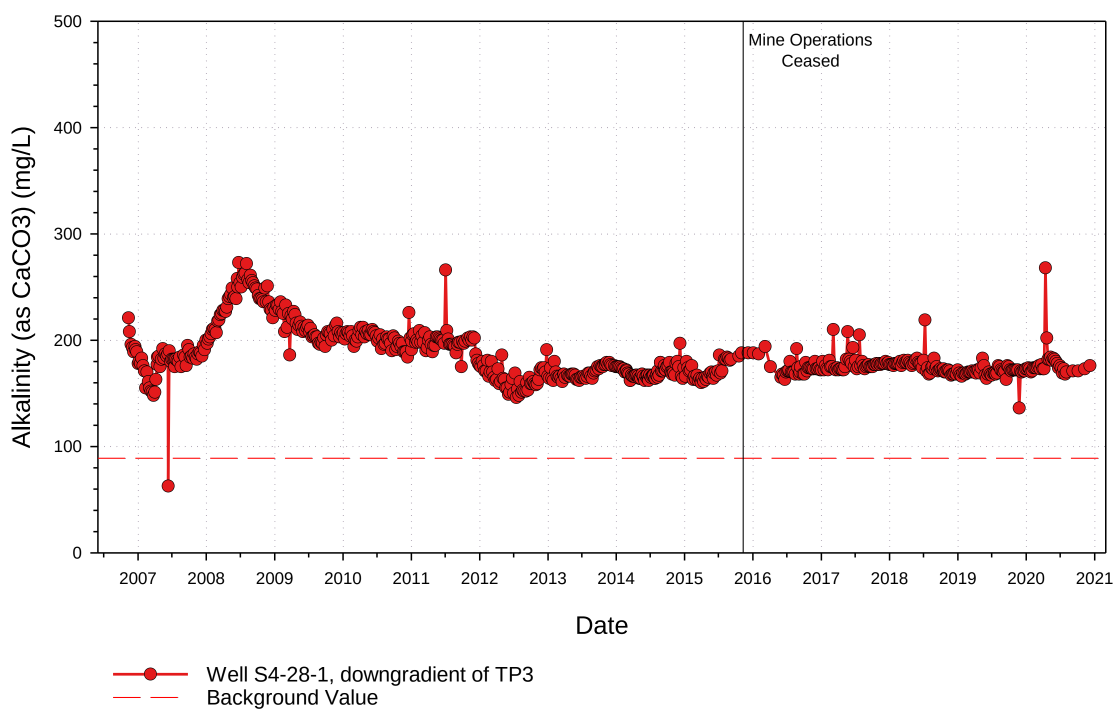
				Well S4-28-1, downgradient of TP3					Well TC11-11 downgradient of TP2					Well TC11-5 downgradient of mill buildings					Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2				
				n=458, November 2006 to December 2020					n=40 October 2012 to October 2020					n=39 November 2012 to October 2020					n=17 October 2012 to November 2016				
Parameter	Unit	Background Value[1]	Federal Interim Guideline[2]	Min	Max	Mean	Median	95th Percentile	Min	Max	Mean	Median	95th Percentile	Min	Max	Mean	Median	95th Percentile	Min	Max	Mean	Median	95th Percentile
Inorganics																							
Alkalinity (total as $CaCO_3$)[3]	mg/L	89	-	63	273	184	176	155	156	231	178	176	164	163	230	193	193	169	274	462	414	433	321
Ammonia	mg/L	0.05	-	-	-	-	-	-	0.04	0.07	0.06	0.06	0.07	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.03	0.03	0.04
Chloride	mg/L	0.7	120	1	27.3	18.9	19.7	26.2	1.1	3.8	2.2	2.3	3.4	0.5	2.5	1.3	1.2	2.1	2.1	25.6	17.6	18.4	24.2
Fluoride	mg/L	0.39	0.12	**0.14**	**2**	**1.04**	**1.05**	**1.2**	0.06	**0.22**	**0.12**	**0.12**	**0.15**	0.02	**0.12**	0.09	0.09	**0.12**	0.09	**0.77**	**0.49**	**0.48**	**0.71**
Hardness	mg/L	292	-	110	580	324.0	310.5	503	336	422	375.4	372	412	317	417	352.8	347	389	778	1,450	890.7	875	975
Nitrate, as N	mg/L	0.29	13	0.005	1.93	0.026	0.005	0.113	0.401	2.42	1.337	1.39	2.352	0.124	0.809	0.399	0.387	0.574	0.005	0.216	0.047	0.005	0.172
Nitrite, as N	mg/L	0.01	-	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	-	-	-	-	-
Phosphate	mg/L	80	-	2	508	23	2	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	mg/L	3.1	-	0.05	157	122.7	125	147	3.6	5.5	4.5	4.5	5.1	1.9	3.0	2.3	2.2	2.7	20.1	44.2	30.7	31.3	39.0
Sulphate	mg/L	182	100	37.4	**649**	**393.4**	**369**	**601.4**	**183**	**244**	**205.8**	**206**	**221.6**	**138**	**224**	**164.7**	**159**	**202.7**	**379**	**837**	**506.8**	**470**	**702**
Electrical Conductivity	uS/cm	543	-	1,370	1,380	1,374	1,373	1,380	613	846	706	702	760	571	767	650	646	721	1,400	1,910	1,515	1,490	1,700
pH[3]	pH	7.2	6.5 - 9	6.9	8.6	7.9	7.9	7.6	7.5	8.2	7.8	7.8	7.6	7.3	8.2	7.7	7.7	7.4	7.3	7.9	7.6	7.6	7.4
TDS		358	-	468	1,080	691	675	905	440	520	483	485	519	345	478	413	393	478	1,120	1,170	1,140	1,130	1,166
TOC		16	-	-	-	-	-	-	2.1	3.4	2.8	2.8	3.3	2.3	2.3	2.3	2.3	2.3	2.1	3.6	2.9	2.9	3.5
TSS		196	-	2	3	2	2	3	700	3,690	1,893	898	3,644	413	967	615	466	917	964	2,140	1,435	1,200	2,046
Dissolved Metals (filtered)																							
Aluminium	mg/L	0.04	0.005 or 0.1[4]	0.0001	0.098	0.004	0.002	0.009	0.002	**1.94**	0.050	0.002	0.04	0.002	**0.308**	0.016	0.002	0.022	0.002	0.055	0.007	0.002	0.02
Antimony	mg/L	0.001	-	0.0001	0.001	0.0003	0.0002	0.001	0.00006	0.0006	0.0002	0.0002	0.0002	0.00005	0.0003	0.0002	0.0002	0.0002	0.00005	0.0002	0.0002	0.0002	0.0002
Arsenic	mg/L	0.00088	0.005	0.0001	0.0017	0.0003	0.0003	0.001	0.0001	**0.0056**	0.0003	0.0002	0.0004	0.0001	0.0006	0.0003	0.0003	0.0005	0.0001	0.0015	0.0009	0.001	0.0013
Barium	mg/L	0.082	-	0.016	0.05	0.031	0.029	0.05	0.045	0.417	0.064	0.055	0.067	0.036	0.18	0.049	0.046	0.054	0.013	0.026	0.021	0.022	0.025
Beryllium	mg/L	0.0008	-	0.00001	0.0025	0.0005	0.00001	0.001	0.00001	0.0002	0.00001	0.00001	0.00001	0.00001	0.00002	0.00001	0.00001	0.00002	0.00001	0.00003	0.00002	0.00002	0.00003
Bismuth	mg/L	0.0005	-	0.0005	0.01	0.0013	0.001	0.0025	0.00005	0.0046	0.0002	0.00005	0.0001	0.00005	0.0005	0.00007	0.00005	0.0001	0.00005	0.0001	0.00005	0.00005	0.00006
Boron	mg/L	0.047	5	0.01	0.647	0.274	0.128	0.527	0.019	0.274	0.036	0.031	0.038	0.002	0.263	0.019	0.013	0.020	0.111	0.332	0.248	0.264	0.299
Cadmium	mg/L	0.000047	0.000017	0.00001	**0.00089**	**0.00008**	**0.00004**	**0.00013**	0.00001	**0.00052**	**0.00010**	**0.00006**	**0.00033**	**0.00002**	**0.00083**	**0.00009**	**0.00006**	**0.00015**	0.00001	**0.0003**	**0.00007**	**0.00003**	**0.00021**
Calcium	mg/L	84	-	31	180	92	93	134	98	147	112	110	126	95	134	106	104	119	203	399	239	227	290
Chromium (III+VI)	mg/L	0.001	0.0089	0.0005	0.006	0.0008	0.0005	0.001	0.0005	0.0039	0.0006	0.0005	0.0006	0.0005	0.0016	0.0005	0.0005	0.0007	0.0005	0.0019	0.000584	0.0005	0.0007
Cobalt	mg/L	0.0007	-	0.00005	0.0040	0.0023	0.0023	0.0033	0.00005	0.0029	0.0003	0.0002	0.0003	0.00005	0.0003	0.0001	0.0001	0.0002	0.0021	0.0278	0.0069	0.0053	0.0191
Copper	mg/L	0.002	0.002 - 0.004[5]	0.0001	**0.0099**	0.0007	0.0002	0.002	0.0002	**0.019**	0.0014	0.0004	0.0028	0.0002	**0.064**	0.0020	0.0004	0.0021	0.0002	0.0007	0.0003	0.0002	0.0006
Iron	mg/L	0.22	0.3	0.01	**3.3**	**0.31**	0.03	**0.82**	0.01	**3.89**	0.11	0.01	0.12	0.01	**0.39**	0.04	0.01	0.16	0.07	**3.02**	**1.65**	**1.87**	**2.65**
Lithium	mg/L	0.082	-	0.005	0.068	0.050	0.049	0.062	0.017	0.028	0.020	0.020	0.024	0.009	0.015	0.011	0.011	0.013	0.130	0.265	0.221	0.231	0.263
Magnesium	mg/L	18	-	8	32	22	22	28	22	27	24	23	26	19	27	22	22	25	64	110	75	74	88
Manganese	mg/L	0.12	-	0.001	2.000	0.995	0.940	1.498	0.001	0.152	0.007	0.001	0.011	0.001	0.125	0.046	0.037	0.098	0.025	0.479	0.266	0.265	0.474
Mercury	mg/L	0.000021	0.000026	0.000003	**0.00005**	0.000009	0.00001	0.000014	0.000003	0.000004	0.000003	0.000003	0.000003	0.000003	0.000003	0.000003	0.000003	0.000003	0.000003	0.000003	0.000003	0.000003	0.000003
Molybdenum	mg/L	0.0077	-	0.00005	0.0132	0.0080	0.0075	0.0122	0.00019	0.0006	0.0004	0.0004	0.0005	0.0003	0.0008	0.0004	0.0004	0.0006	0.0009	0.0021	0.0012	0.0011	0.0016
Nickel	mg/L	0.0021	0.025 - 0.15[5]	0.0002	0.0130	0.0072	0.0076	0.0099	0.0002	0.0078	0.0007	0.0004	0.0009	0.0003	0.0019	0.0008	0.0007	0.0013	0.0019	0.0098	0.0033	0.0026	0.0058
Phosphorus	mg/L	0.23	-	0.00005	0.30	0.13628	0.0003	0.30	0.00005	0.13	0.03269	0.05	0.056	0.00005	0.08	0.03184	0.05	0.074	0.00005	0.05	0.01846	0.00005	0.05
Lead	mg/L	0.00066	0.001 - 0.007[5]	0.00001	**0.0338**	0.00024	0.0001	0.001	0.00001	**0.0125**	0.00045	0.00005	0.00076	0.00001	**0.0618**	0.0015	0.00005	0.0002	0.00001	0.00062	0.00008	0.00005	0.0002
Selenium	mg/L	0.0011	0.001	0.0001	**0.005**	**0.0011**	0.0005	**0.002**	0.0005	**0.002**	**0.0012**	**0.0011**	**0.0016**	0.0002	0.0007	0.0005	0.0005	0.0005	0.0001	**0.0024**	0.0008	0.0005	**0.0013**
Silver	mg/L	0.000072	-	0.00001	0.00021	0.000024	0.00002	0.0001	0.00001	0.00002	0.00002	0.00002	0.00002	0.00001	0.00002	0.00002	0.00002	0.00002	0.00001	0.00002	0.00002	0.00002	0.00002
Strontium	mg/L	0.12	-	0.0001	0.203	0.101	0.097	0.153	0.099	0.149	0.125	0.124	0.142	0.107	0.203	0.131	0.131	0.147	0.448	0.759	0.540	0.538	0.652
Thallium	mg/L	0.000093	-	0.000002	0.0005	0.000136	0.00011	0.0002	0.000002	0.00005	0.000011	0.00001	0.00002	0.000002	0.0001	0.00002	0.00001	0.00004	0.000004	0.0001	0.00003	0.00001	0.000084
Tin	mg/L	0.00009	-	0.0001	0.00065	0.00021	0.0002	0.0005	0.00005	0.003	0.0001	0.00005	0.0003	0.00005	0.0147	0.0005	0.00005	0.00071	0.00005	0.00013	0.0001	0.00005	0.00011
Titanium	mg/L	0.0091	-	0.001	0.013	0.0094	0.01	0.01	0.0005	0.214	0.028	0.0007	0.196	0.0005	0.216	0.025	0.0008	0.177	0.001	0.418	0.048	0.002	0.383
Tungsten	mg/L	0.0069	-	0.2	50	3.9	2.86	10	0.6	20.1	2.2	1.4	5.1	0.01	27	1.6	0.4	2.9	1.5	15.4	3.8	3.0	6.7
Uranium	mg/L	0.0071	0.015	0.01	**18.8**	**10.58**	**10.4**	**15.1**	**2.26**	**3.53**	**2.78**	**2.78**	**3.25**	**1.64**	**2.6**	**2.03**	**2.03**	**2.45**	**9.45**	**24.5**	**12.5**	**11.2**	**19.46**
Vanadium	mg/L	0.001	-	0.0001	0.005	0.001	0.0005	0.002	0.0001	0.007	0.0006	0.0005	0.0005	0.0001	0.0005	0.0004	0.0005	0.0005	0.0001	0.0005	0.0004	0.0005	0.0005
Zinc	mg/L	0.0066	0.03	0.001	**0.034**	0.0065	0.004	0.013	0.001	**0.056**	0.0059	0.002	0.0146	0.001	**0.032**	0.005	0.003	0.017	0.002	0.013	0.0055	0.005	0.01

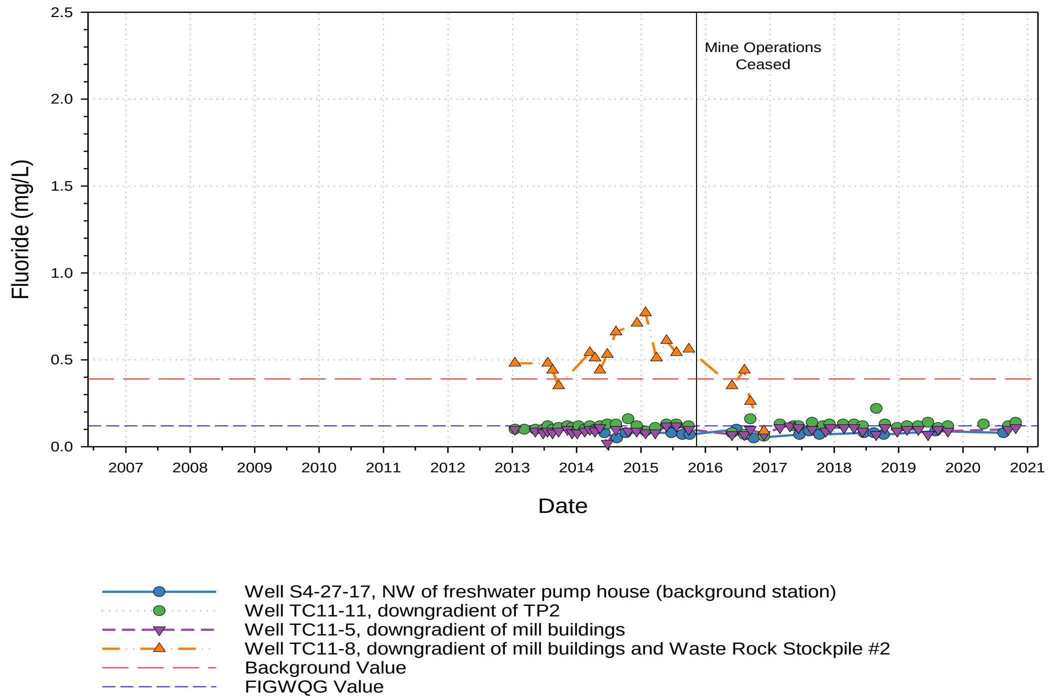
Notes:

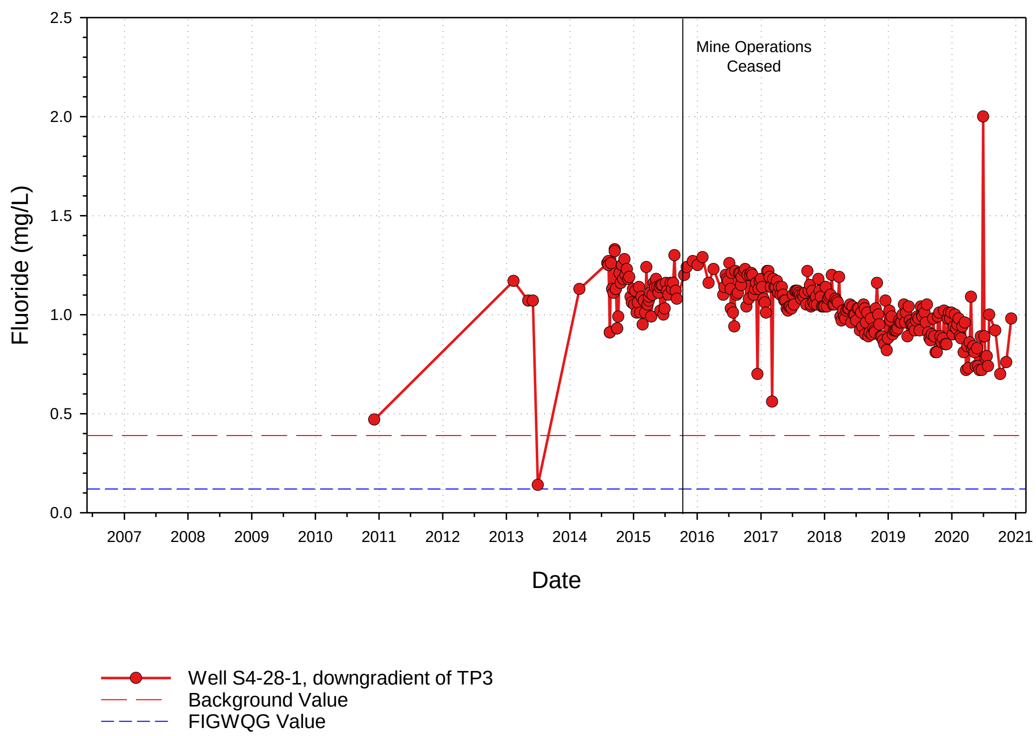
1. Background value calculated by taking 95th percentile value of 95th percentile values of background stations per BC MOE (1996) and CCME (2003).
2. Federal Contaminated Sites Action Plan (FCSAP) Guidance Document on Federal Interim Groundwater Quality Guidelines (FIGWQG) for Federal Contaminated Sites Tier 2 Guidelines for Residential / Parkland Land Use - coarse- and fine-grained soils.
3. For alkalinity and pH, the 5th percentile value is shown; shaded cells identify values that are lower than background or guideline values.
4. Guideline is dependent upon the pH value. Value for pH greater than 6.5 shown. Value of 0.005 for pH less than 6.5
5. Guideline is based on the Hardness value.

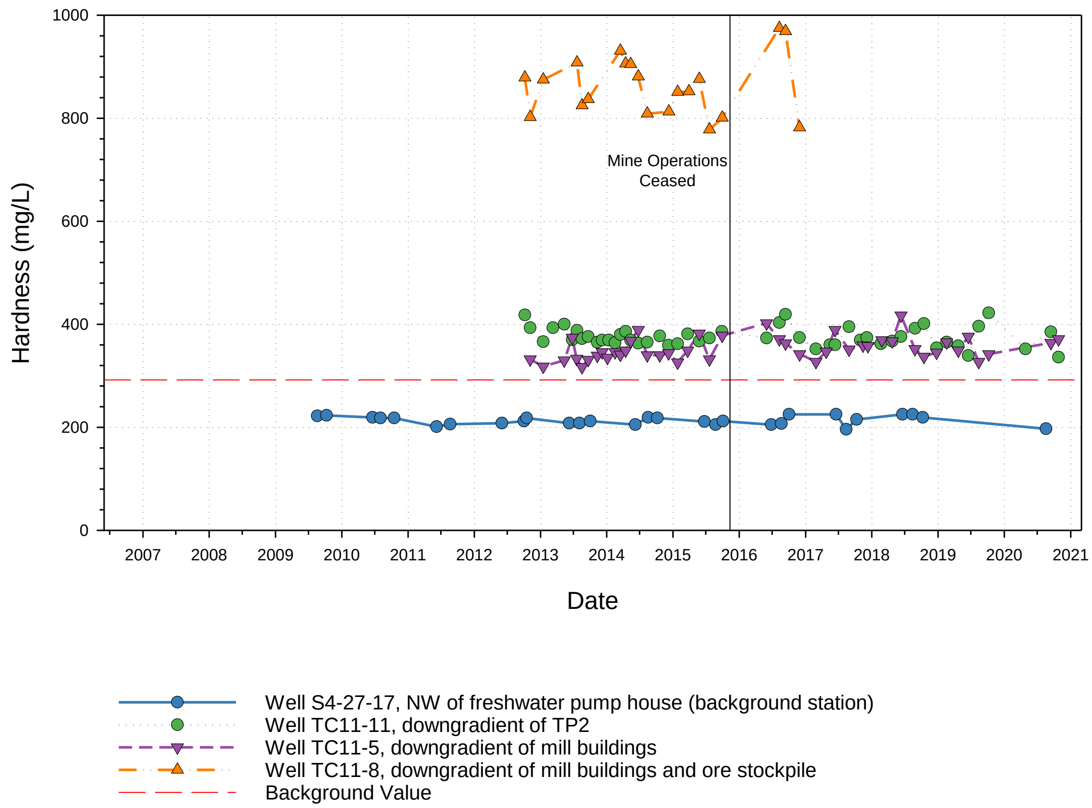
mg/L - milligrams per litre.
Shaded - Concentration above summary background value
Bold Red - Concentration above FIGWQG for both Residential/Parkland and Agricultural Land Use.
Bold, Red, Shaded - Concentration above both summary background and FIGWQG guideline values
Blank - No guideline available
Mine background water is from ESA, sampled on 2017-09-11, in table AEC UG-2

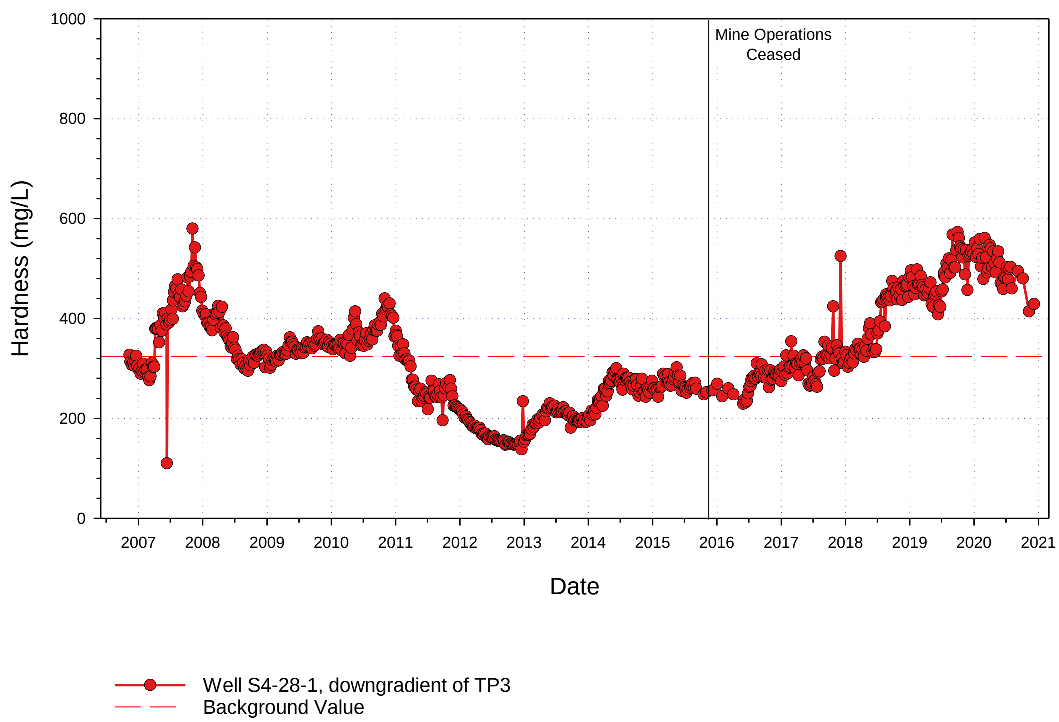

Alkalinity, as $CaCO_3$ (mg/L)
500
400
300
200
100
0
Mine Operations Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2
Background Value

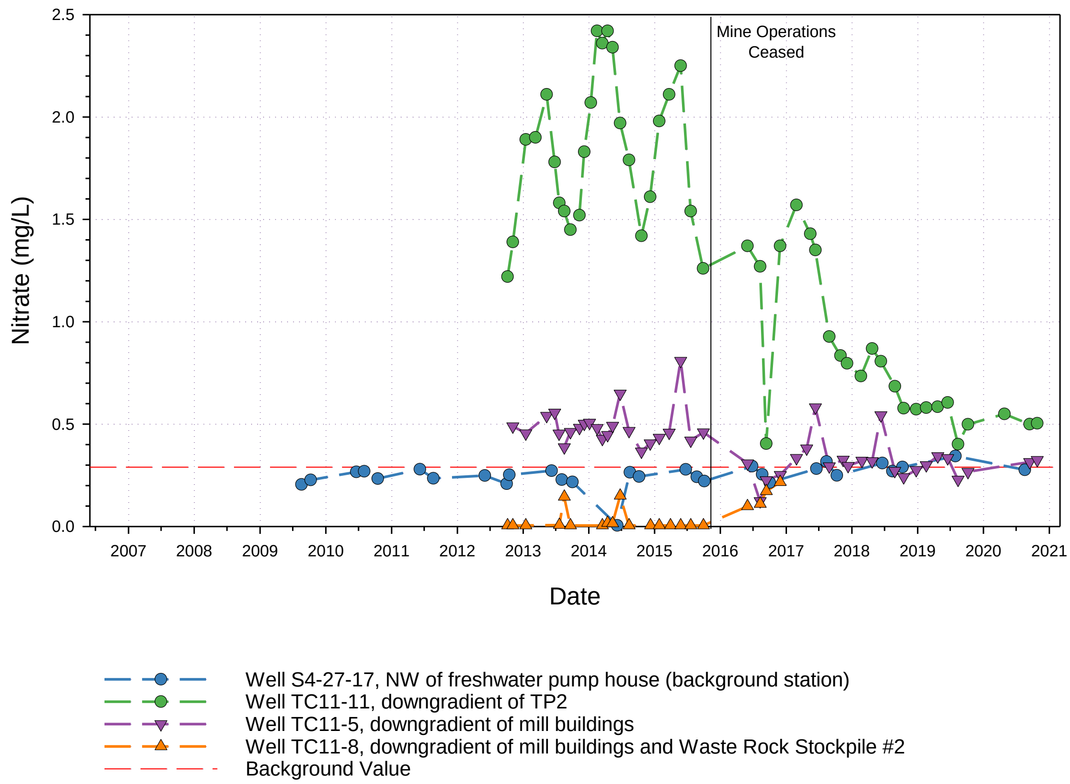

Alkalinity (as CaCO3) (mg/L)
500
400
300
200
100
0
Mine Operations Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-28-1, downgradient of TP3
Background Value

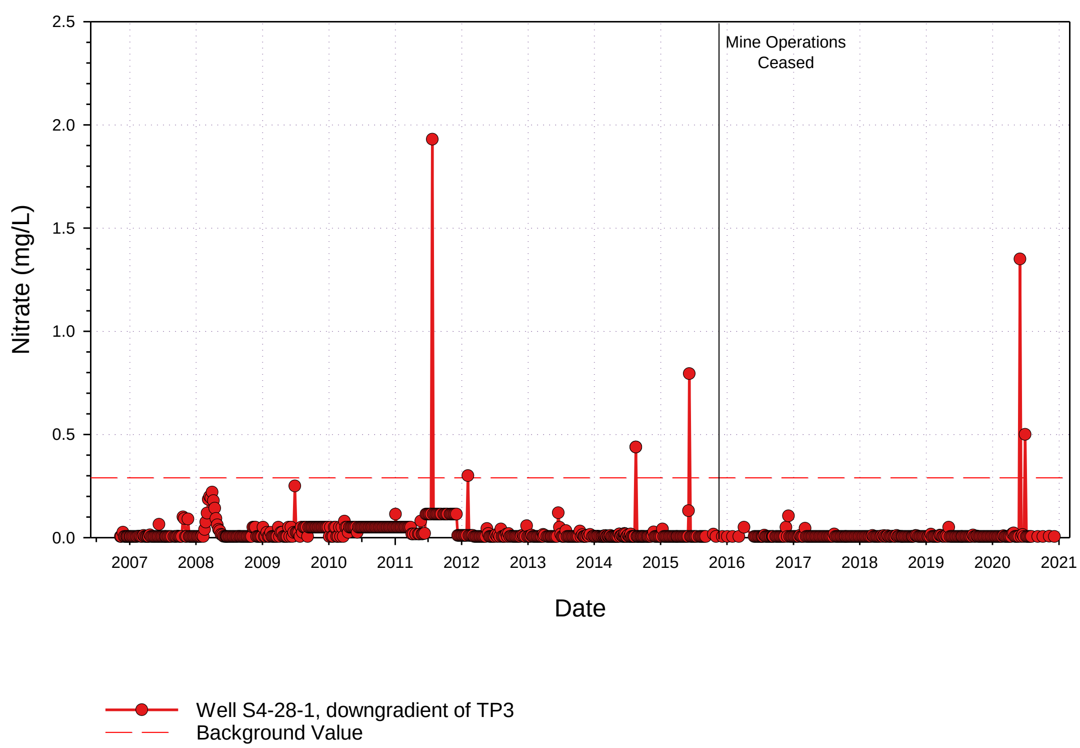

Fluoride (mg/L)
2.5
2.0
1.5
1.0
0.5
0.0
Mine Operations Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2
Background Value
FIGWQG Value

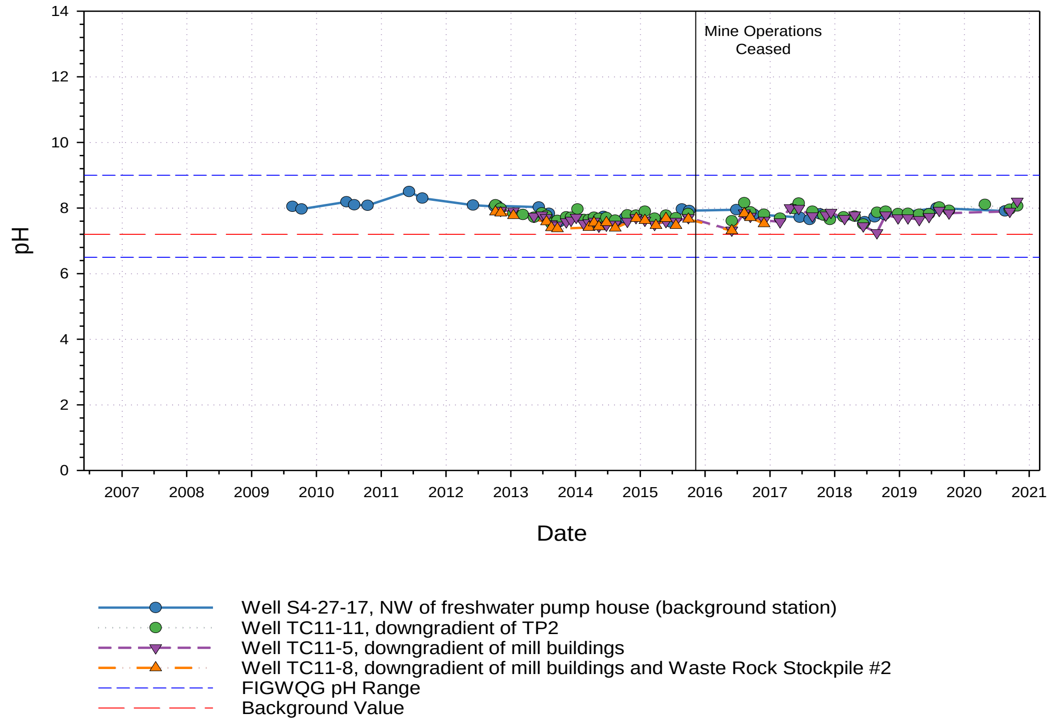

Fluoride (mg/L)
2.5
2.0
1.5
1.0
0.5
0.0
Mine Operations Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-28-1, downgradient of TP3
Background Value
FIGWQG Value

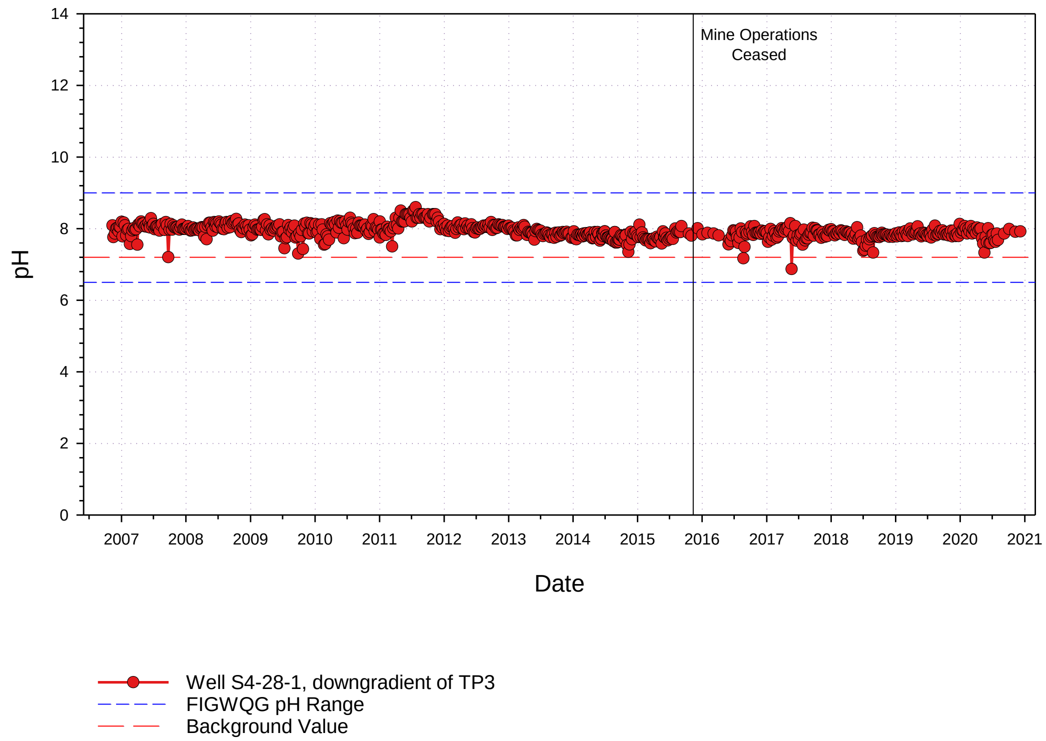

1000
800
600
400
200
0
Hardness (mg/L)
Mine Operations
Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and ore stockpile
Background Value

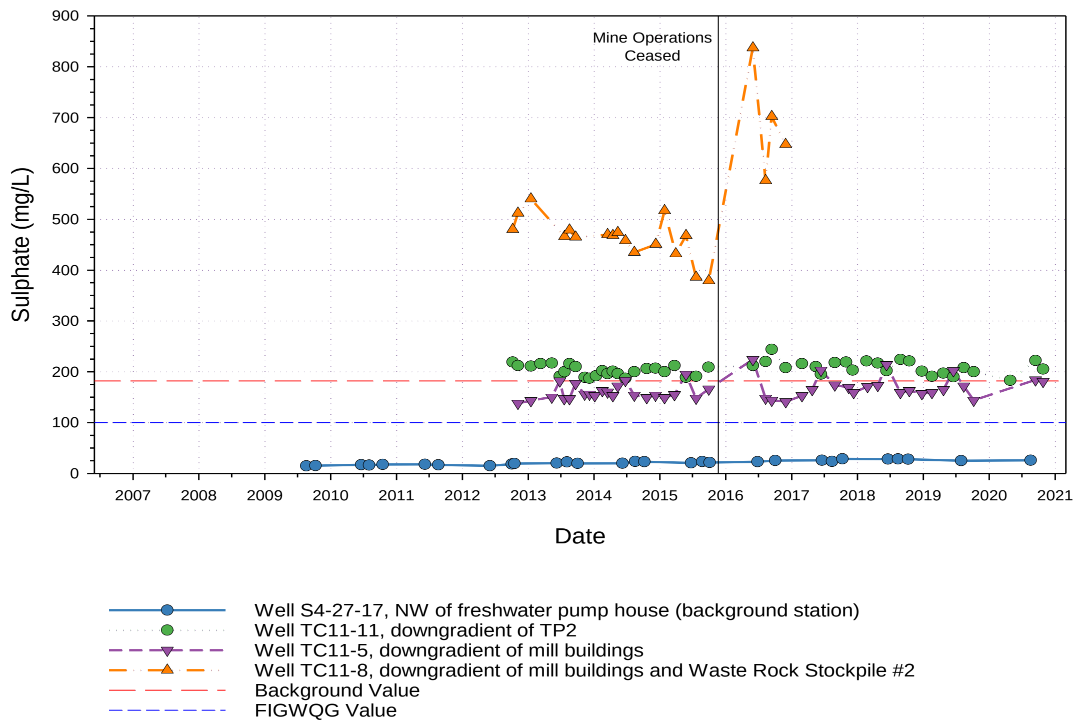

1000
800
600
400
200
0
Hardness (mg/L)
Mine Operations
Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-28-1, downgradient of TP3
Background Value

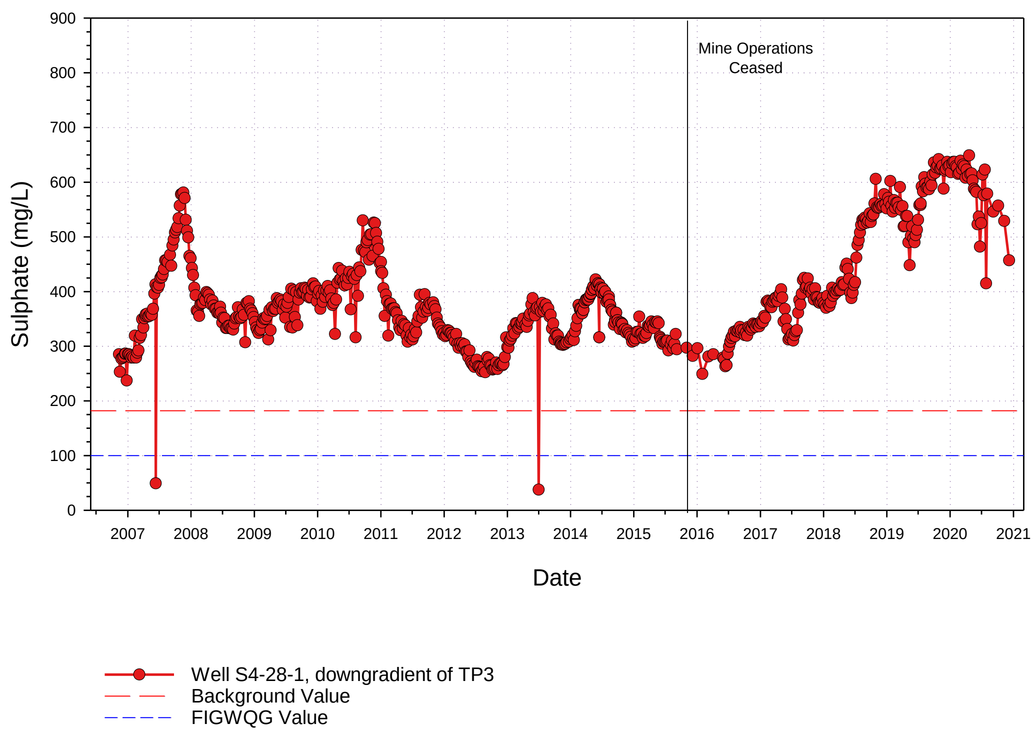

Nitrate (mg/L)
Date
Mine Operations Ceased
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2
Background Value

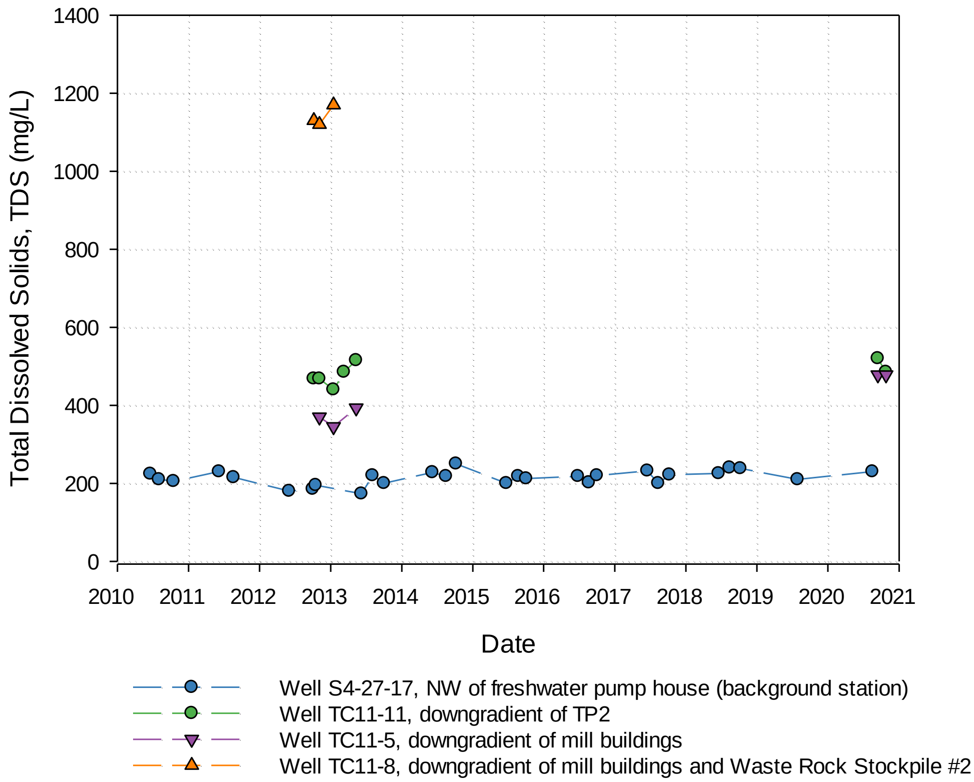

Nitrate (mg/L)
Date
Mine Operations Ceased
Well S4-28-1, downgradient of TP3
Background Value

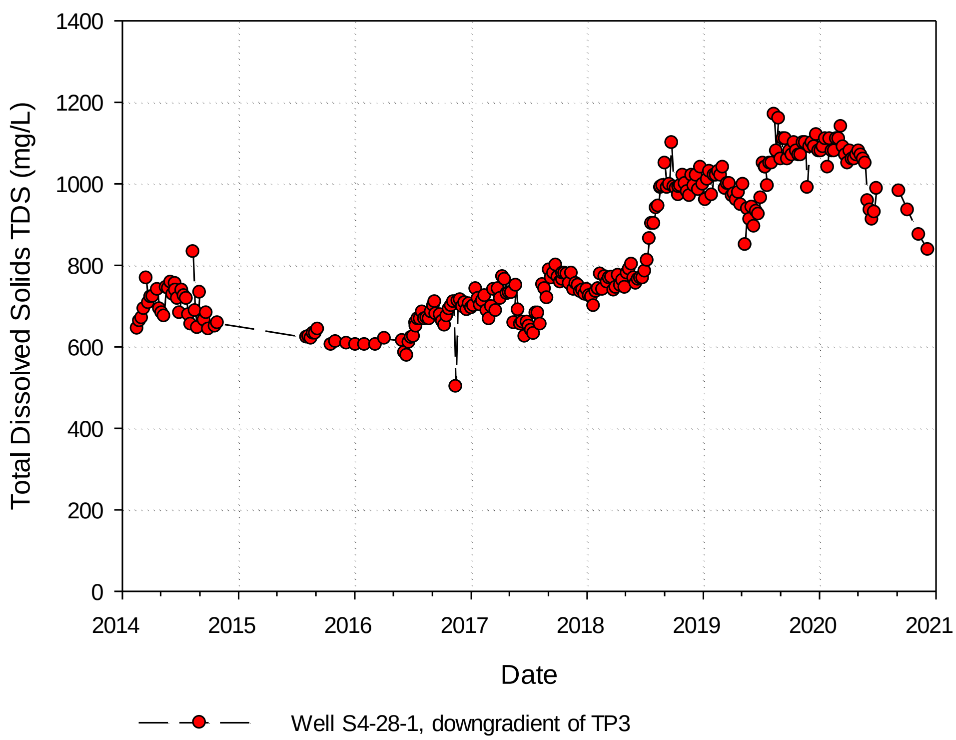

Mine Operations Ceased
pH
Date
0
2
4
6
8
10
12
14
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2
FIGWQG pH Range
Background Value

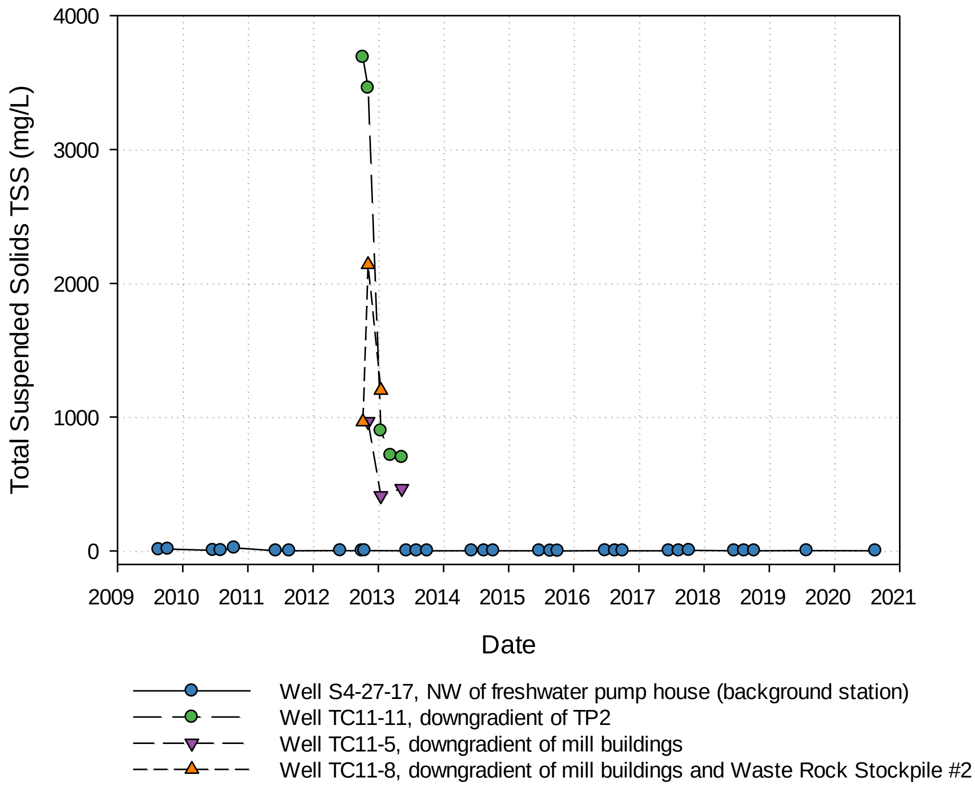

Mine Operations Ceased
pH
Date
0
2
4
6
8
10
12
14
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Well S4-28-1, downgradient of TP3
FIGWQG pH Range
Background Value

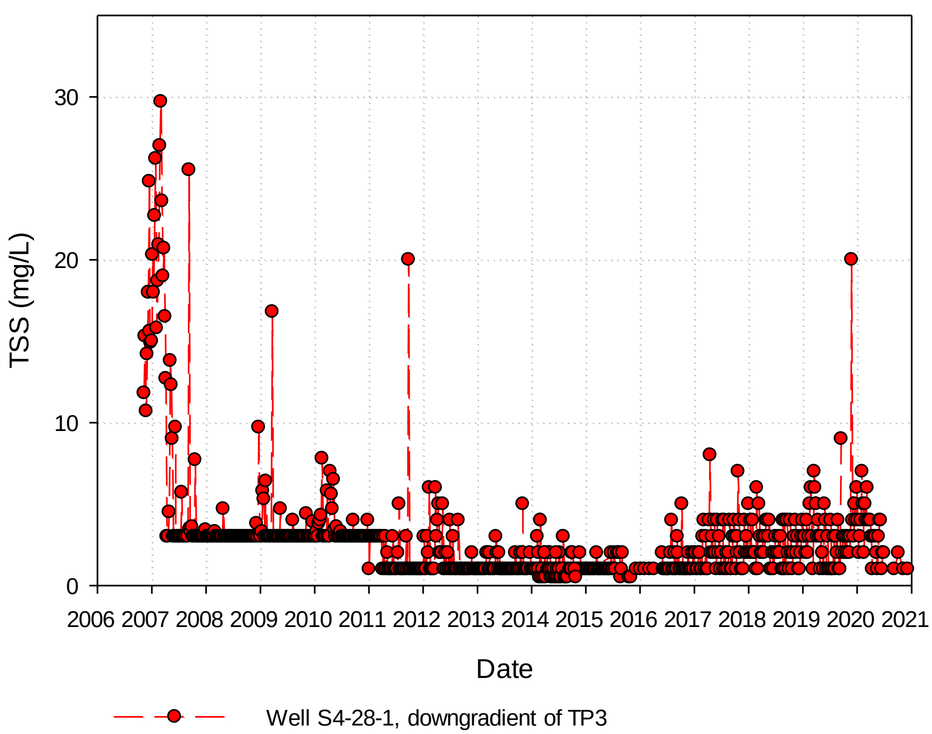

Sulphate (mg/L)
0
100
200
300
400
500
600
700
800
900
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Mine Operations
Ceased
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2
Background Value
FIGWQG Value

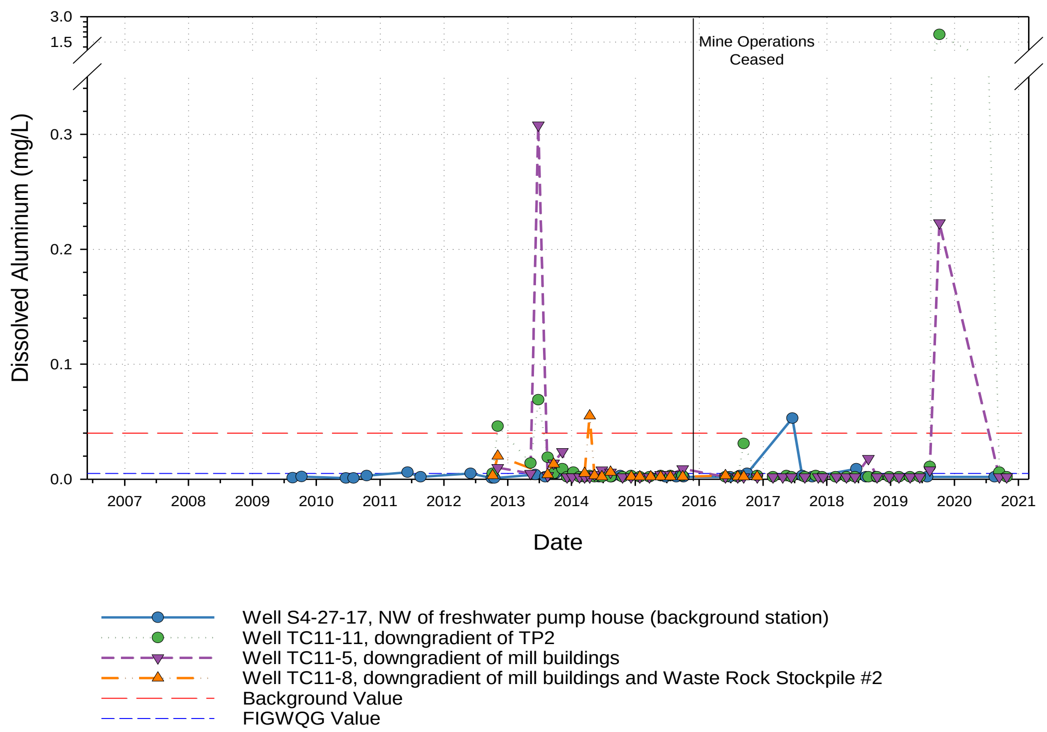

Sulphate (mg/L)
0
100
200
300
400
500
600
700
800
900
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Mine Operations
Ceased
Well S4-28-1, downgradient of TP3
Background Value
FIGWQG Value

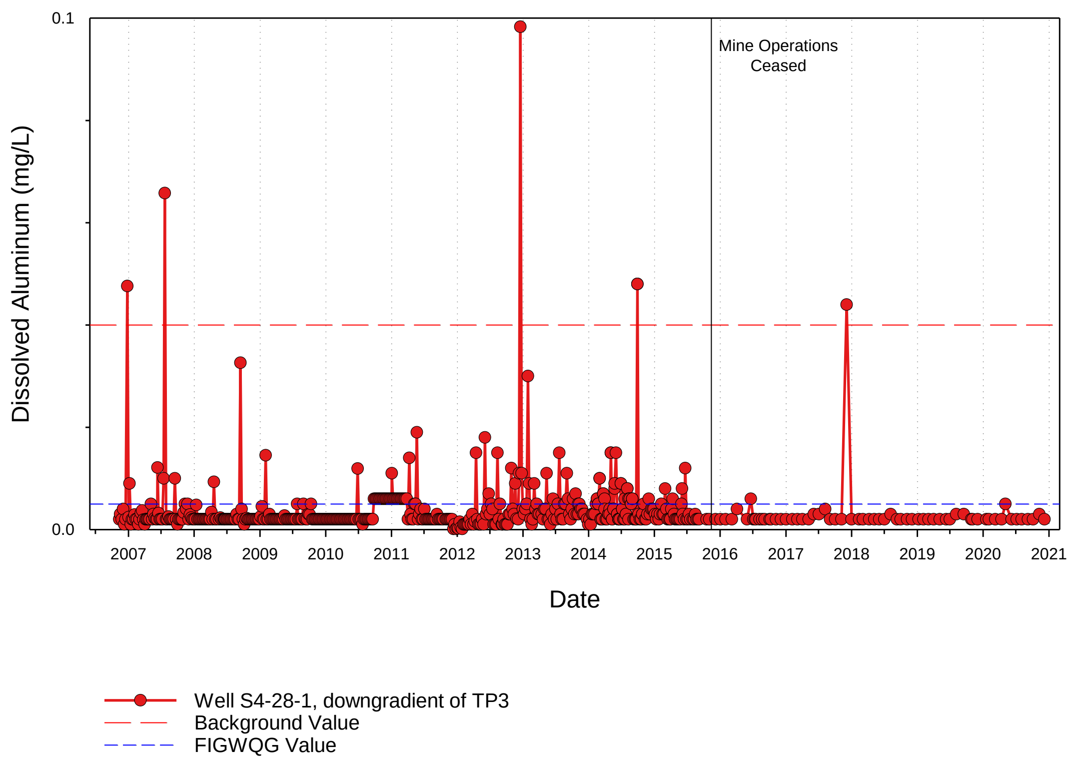

Total Dissolved Solids, TDS (mg/L)
0
200
400
600
800
1000
1200
1400
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2

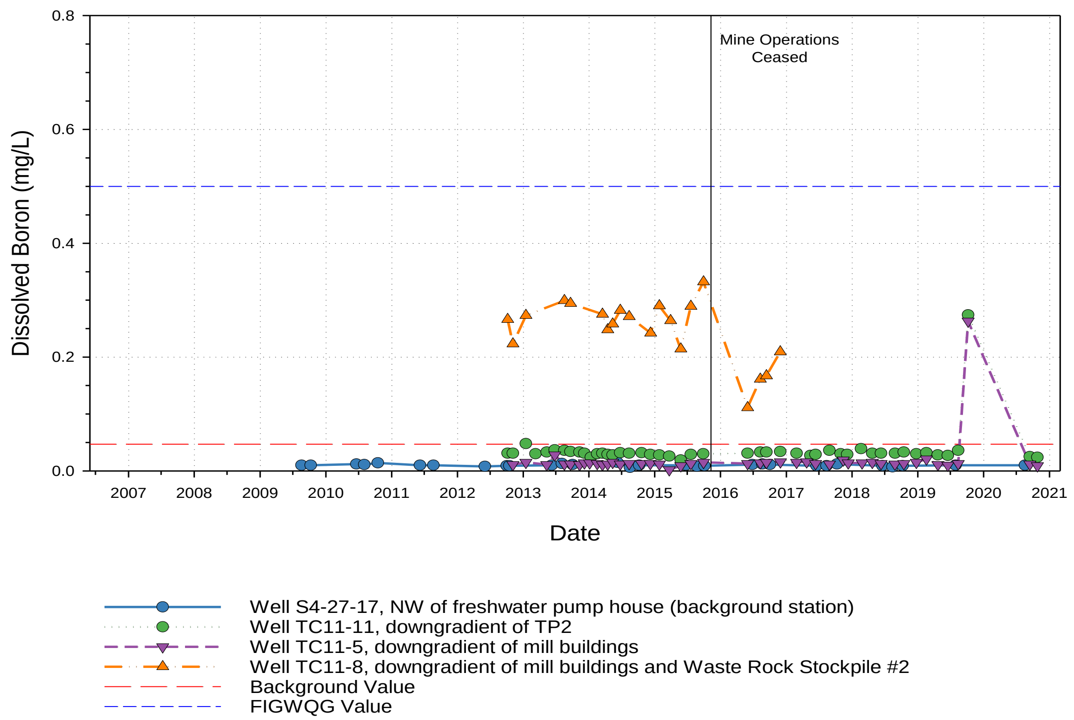

Total Dissolved Solids TDS (mg/L)
0
200
400
600
800
1000
1200
1400
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-28-1, downgradient of TP3

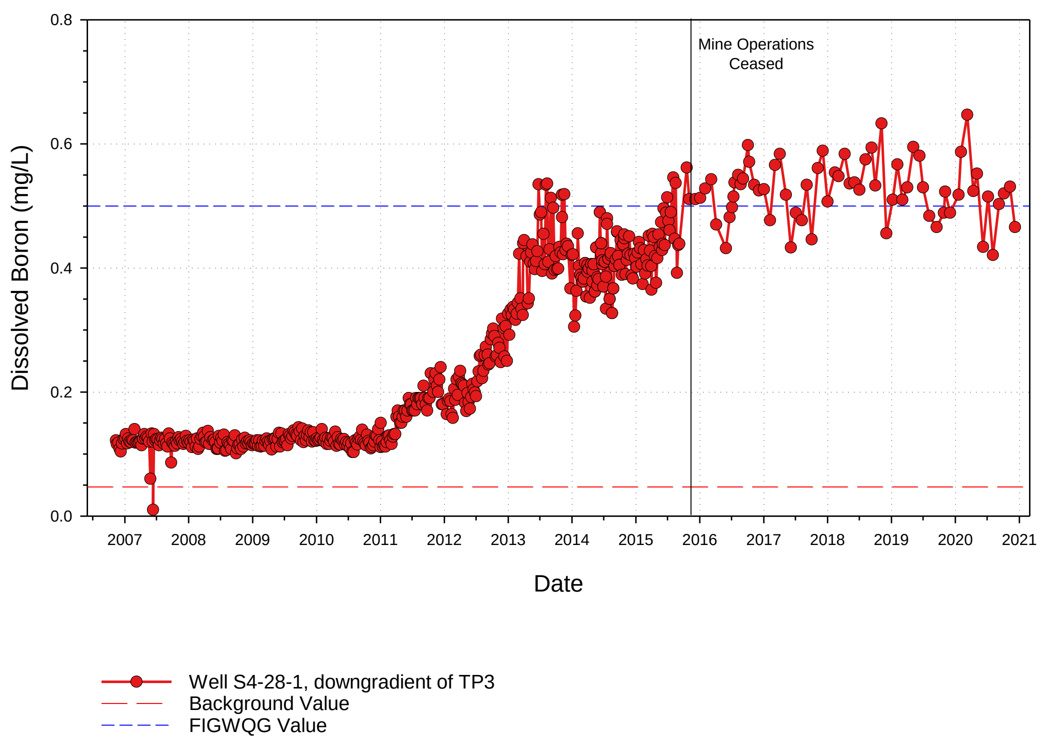

4000
3000
2000
1000
0
Total Suspended Solids TSS (mg/L)
2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2

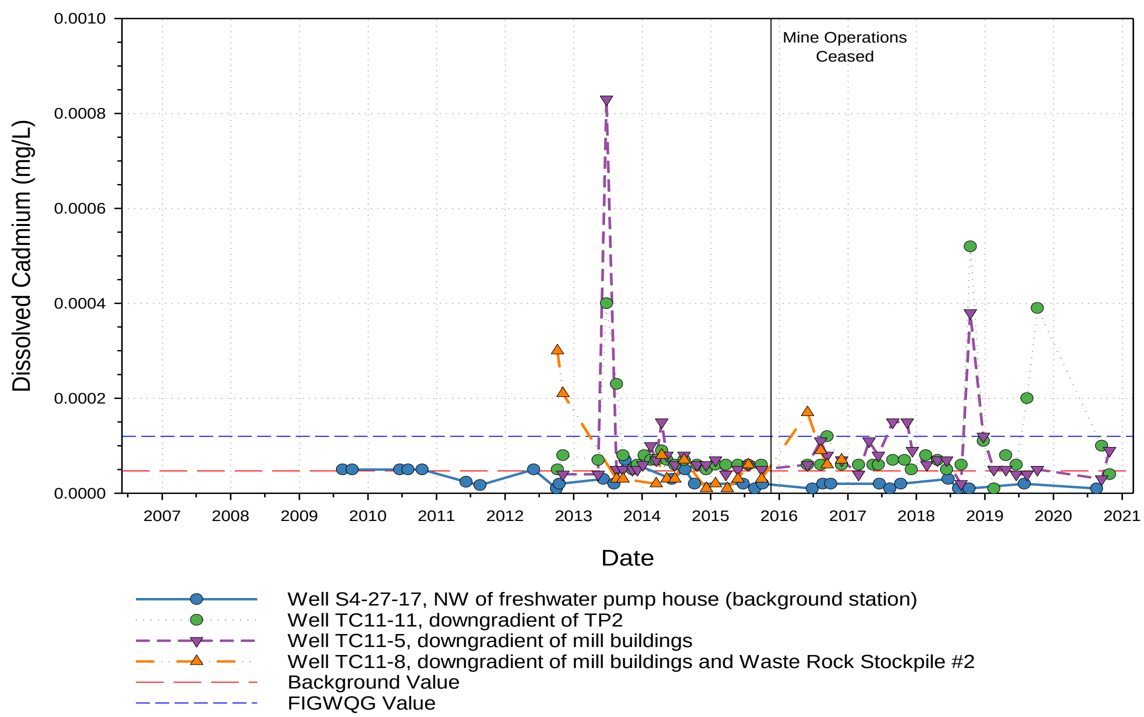

30
20
10
0
TSS (mg/L)
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Well S4-28-1, downgradient of TP3

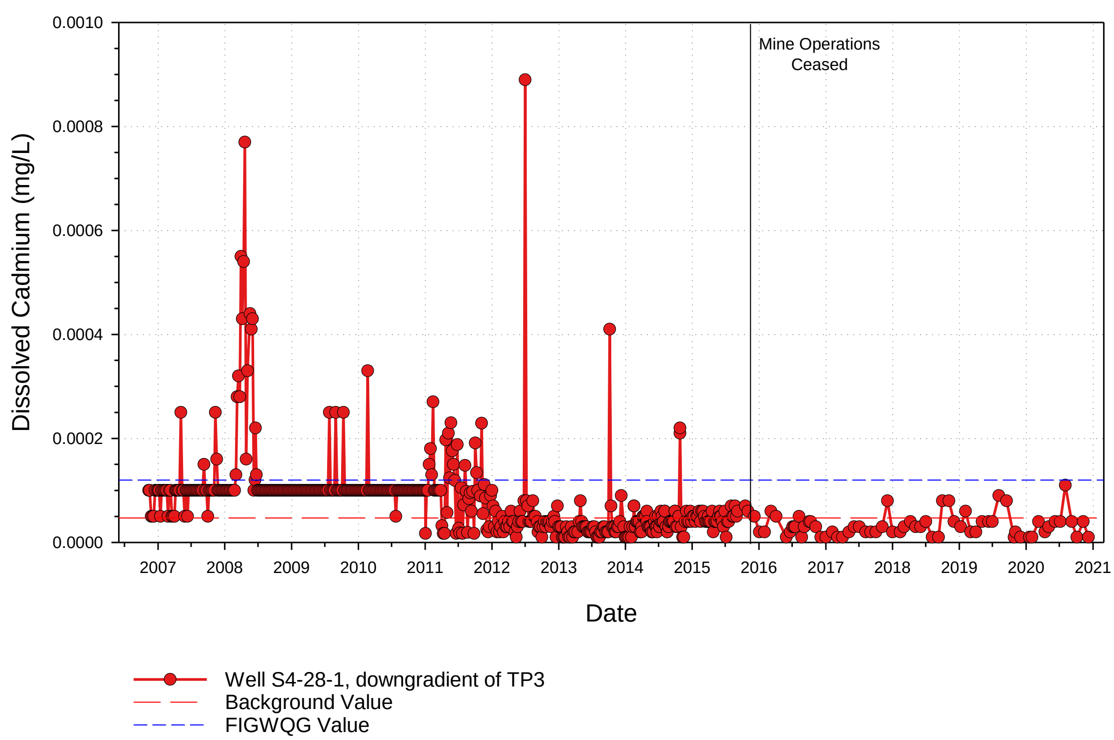

3.0
1.5
0.3
0.2
0.1
0.0
Dissolved Aluminum (mg/L)
Mine Operations Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2
Background Value
FIGWQG Value

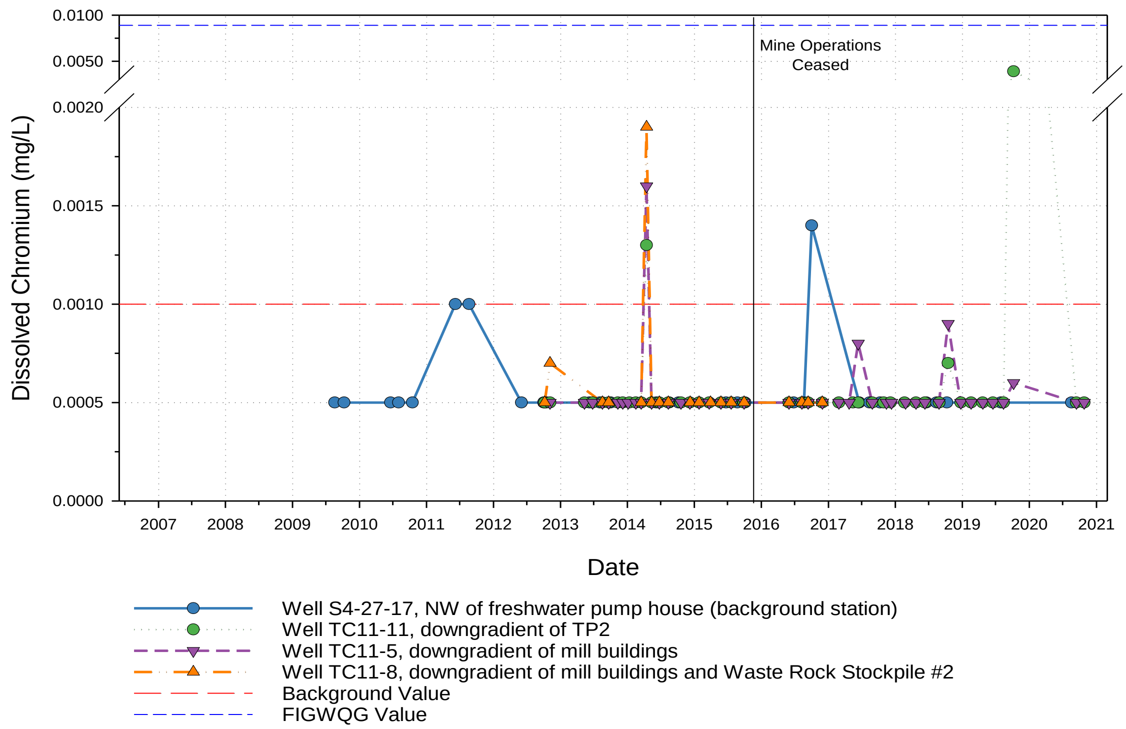

0.1
0.0
Dissolved Aluminum (mg/L)
Mine Operations Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-28-1, downgradient of TP3
Background Value
FIGWQG Value

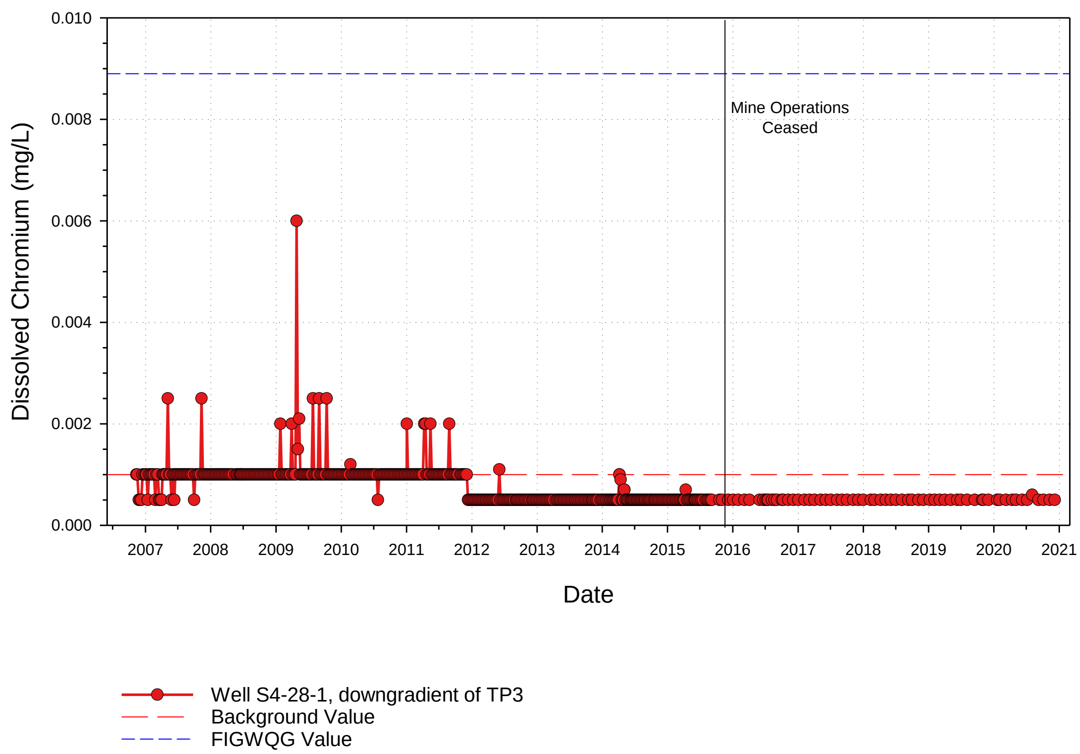

Dissolved Boron (mg/L)
0.8
0.6
0.4
0.2
0.0
Mine Operations Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2
Background Value
FIGWQG Value

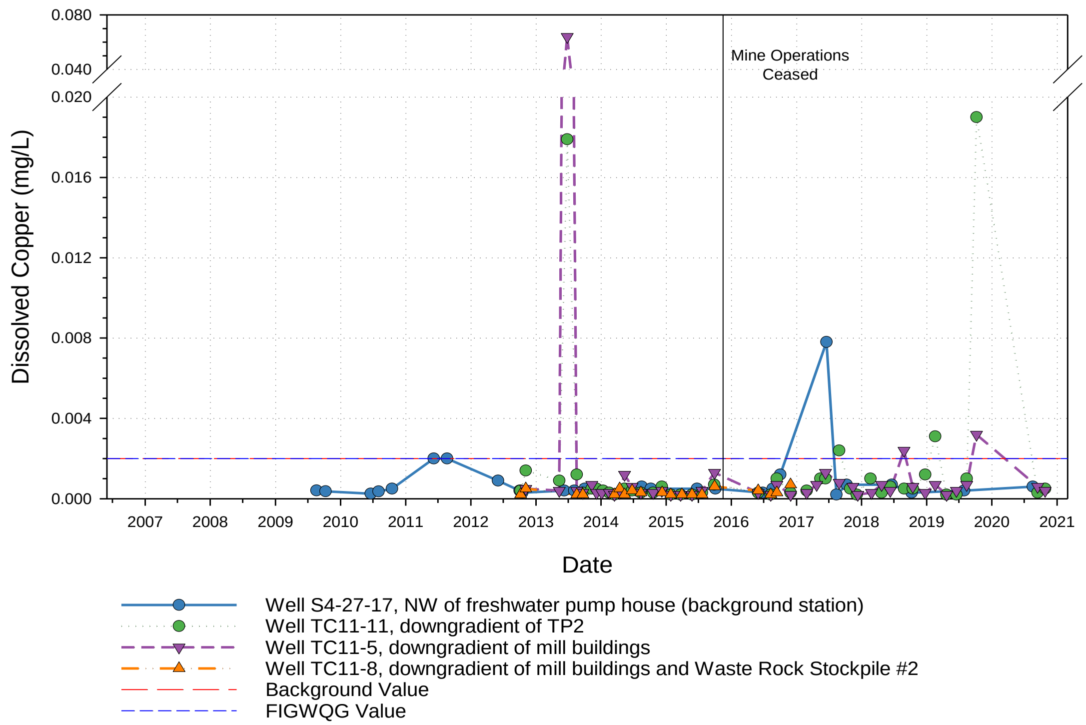

Dissolved Boron (mg/L)
0.8
0.6
0.4
0.2
0.0
Mine Operations Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-28-1, downgradient of TP3
Background Value
FIGWQG Value

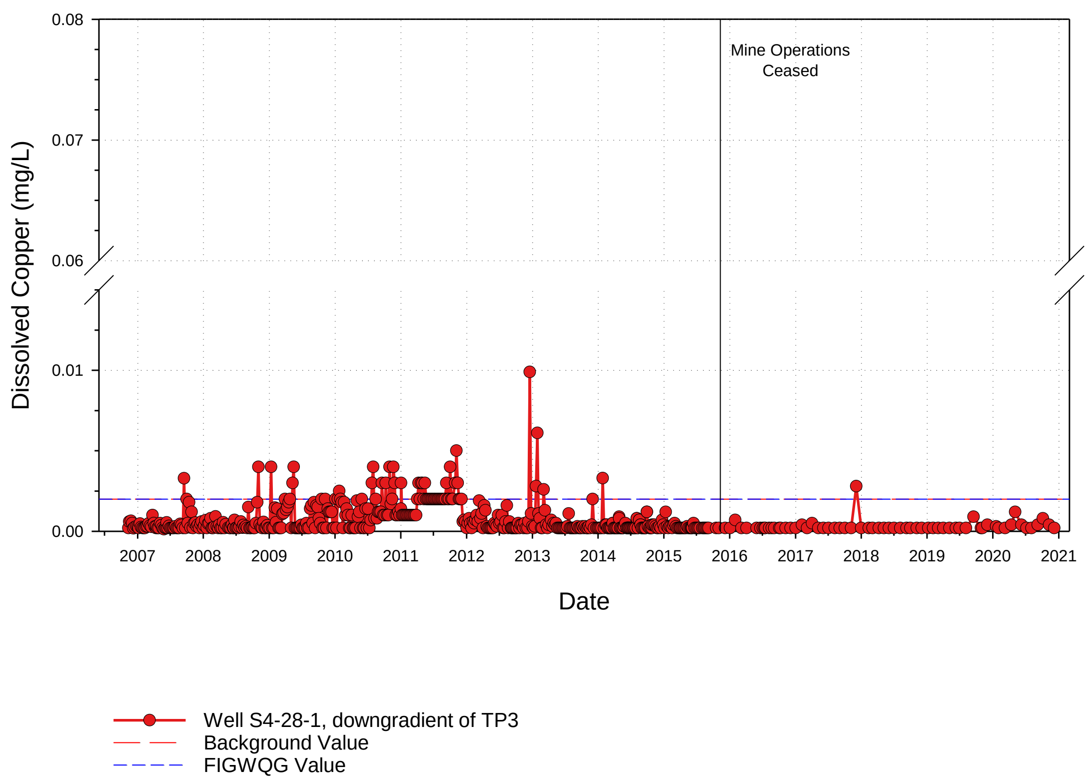

0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
Dissolved Cadmium (mg/L)
Mine Operations Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2
Background Value
FIGWQG Value

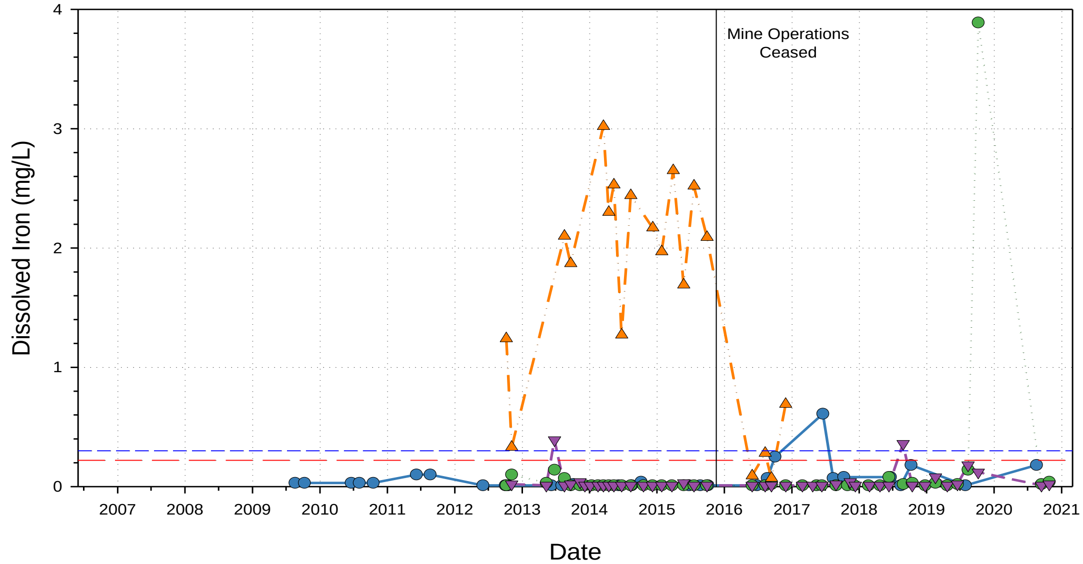

0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
Dissolved Cadmium (mg/L)
Mine Operations Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-28-1, downgradient of TP3
Background Value
FIGWQG Value


0.0100
0.0050
0.0020
0.0015
0.0010
0.0005
0.0000
Dissolved Chromium (mg/L)
Mine Operations
Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2
Background Value
FIGWQG Value

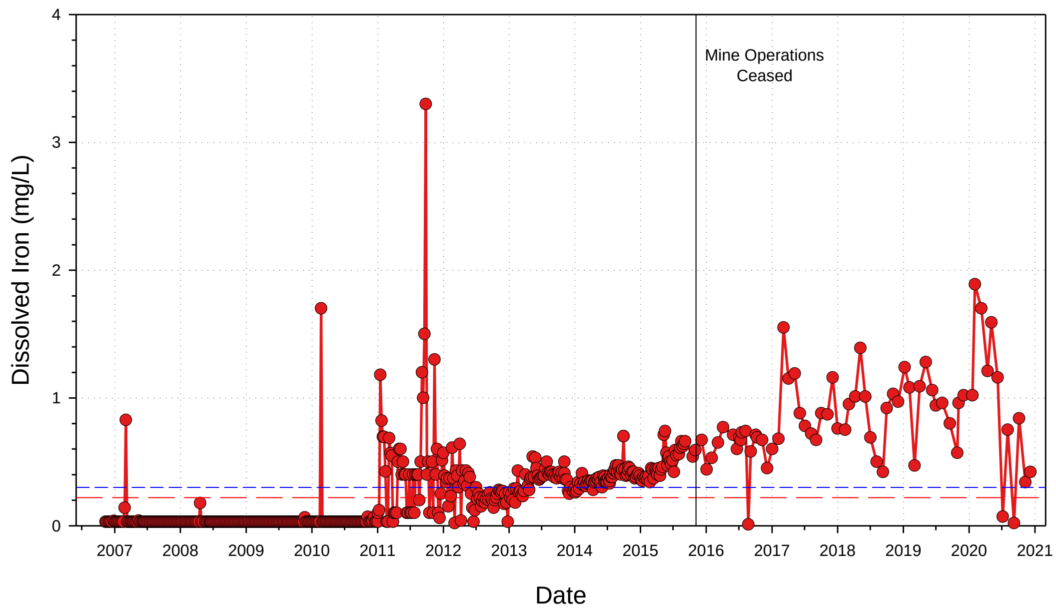

0.010
0.008
0.006
0.004
0.002
0.000
Dissolved Chromium (mg/L)
Mine Operations
Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-28-1, downgradient of TP3
Background Value
FIGWQG Value


Dissolved Copper (mg/L)
0.080
0.040
0.020
0.016
0.012
0.008
0.004
0.000
Mine Operations Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2
Background Value
FIGWQG Value

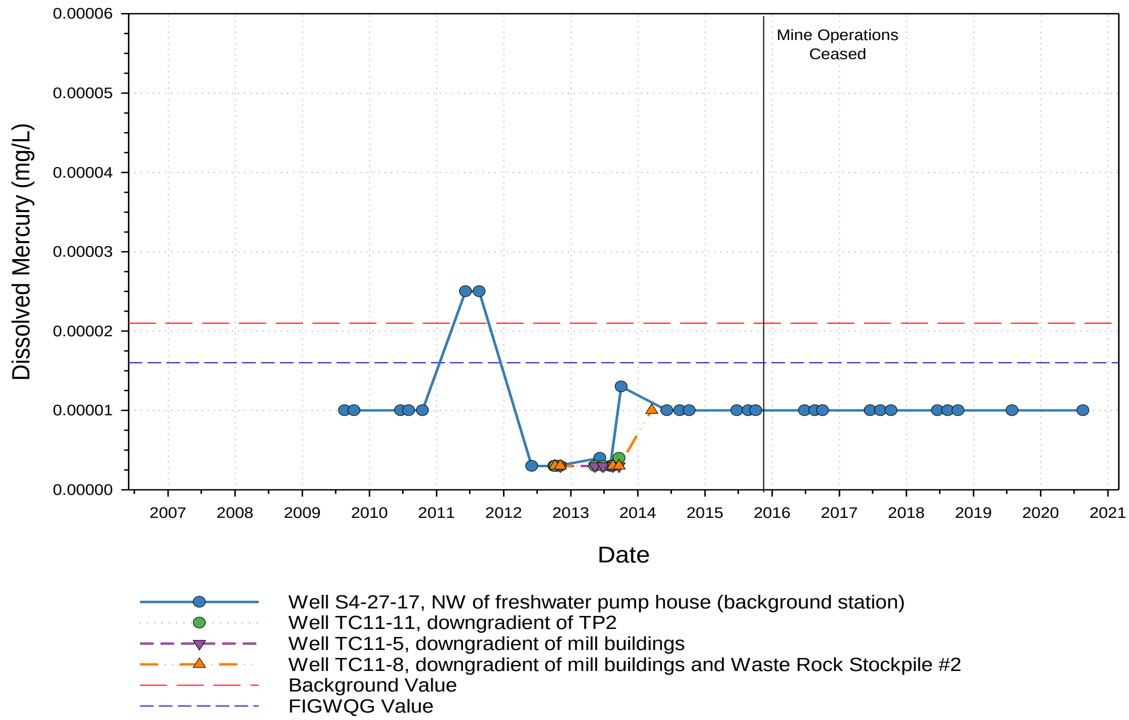

Dissolved Copper (mg/L)
0.08
0.07
0.06
0.01
0.00
Mine Operations Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-28-1, downgradient of TP3
Background Value
FIGWQG Value

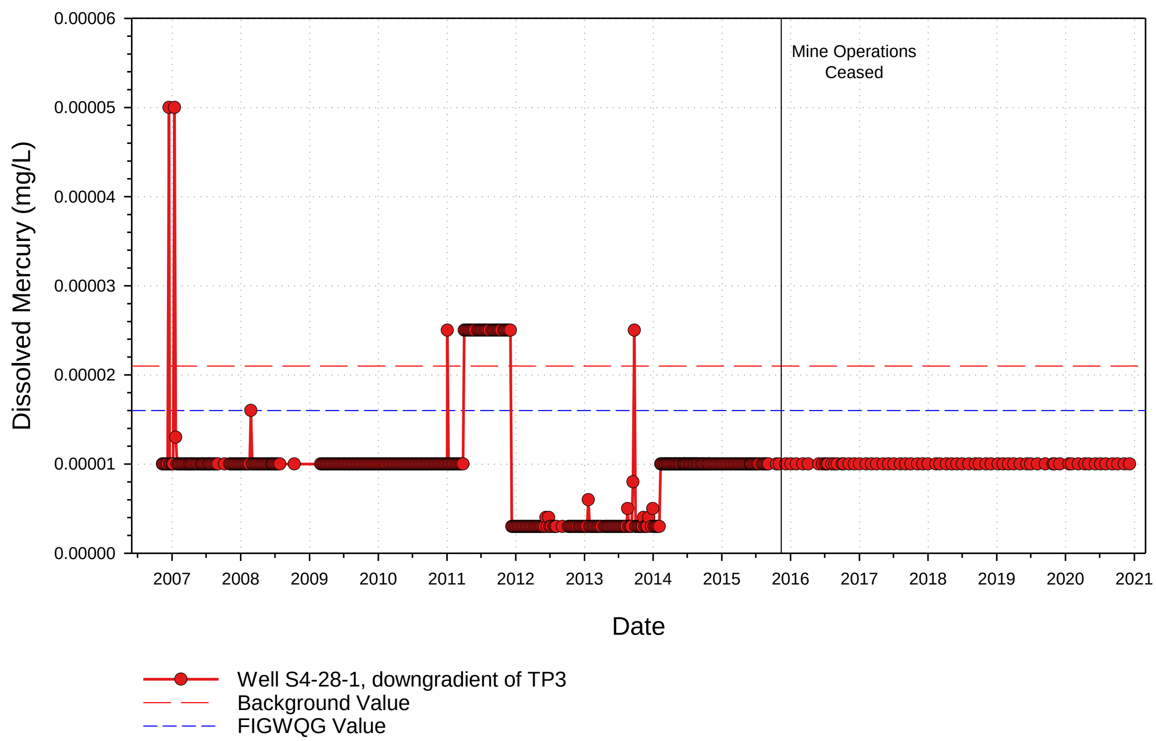


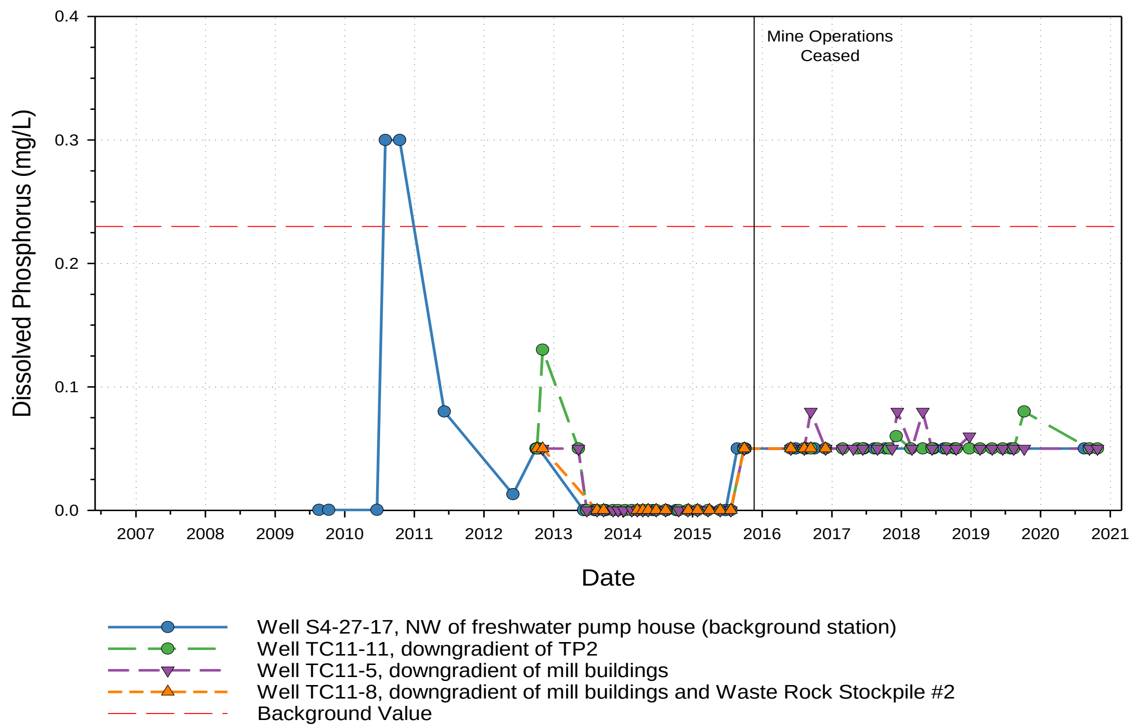
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2
Background Value
FIGWQG Value

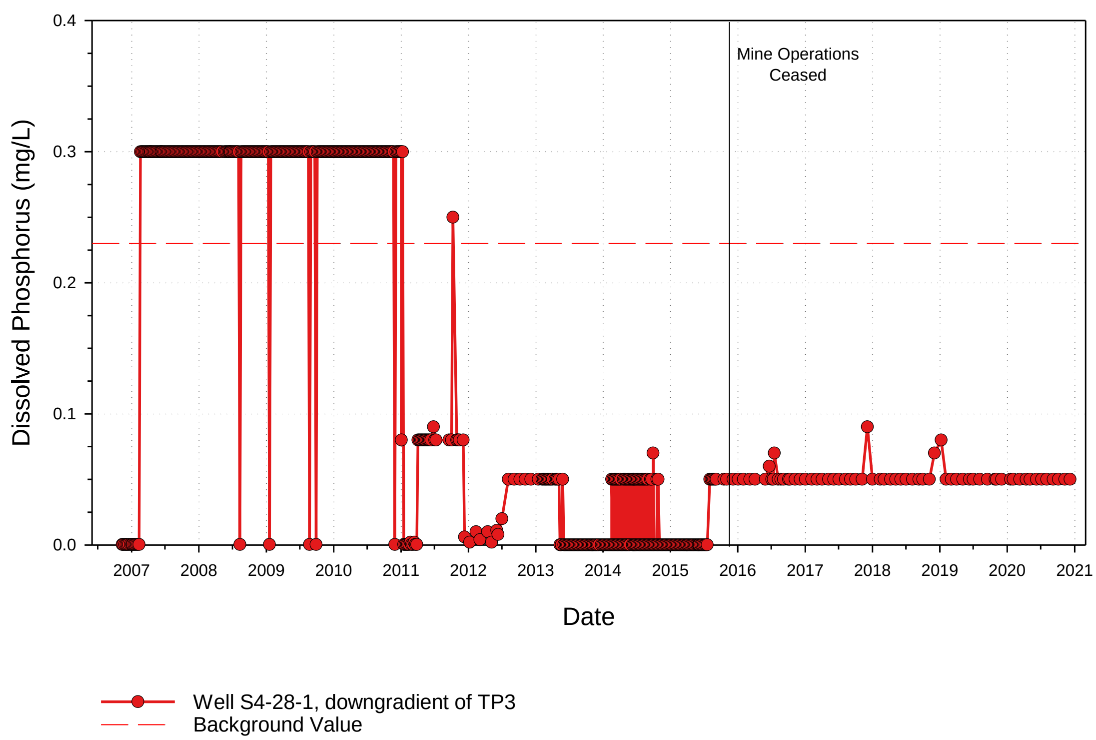


Well S4-28-1, downgradient of TP3
Background Value
FIGWQG Value


Dissolved Mercury (mg/L)
0.00006
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Mine Operations Ceased
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2
Background Value
FIGWQG Value


Dissolved Mercury (mg/L)
0.00006
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Mine Operations Ceased
Well S4-28-1, downgradient of TP3
Background Value
FIGWQG Value


0.4
0.3
0.2
0.1
0.0
Dissolved Phosphorus (mg/L)
Mine Operations Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2
Background Value


0.4
0.3
0.2
0.1
0.0
Dissolved Phosphorus (mg/L)
Mine Operations Ceased
2007
2008
2009
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2011
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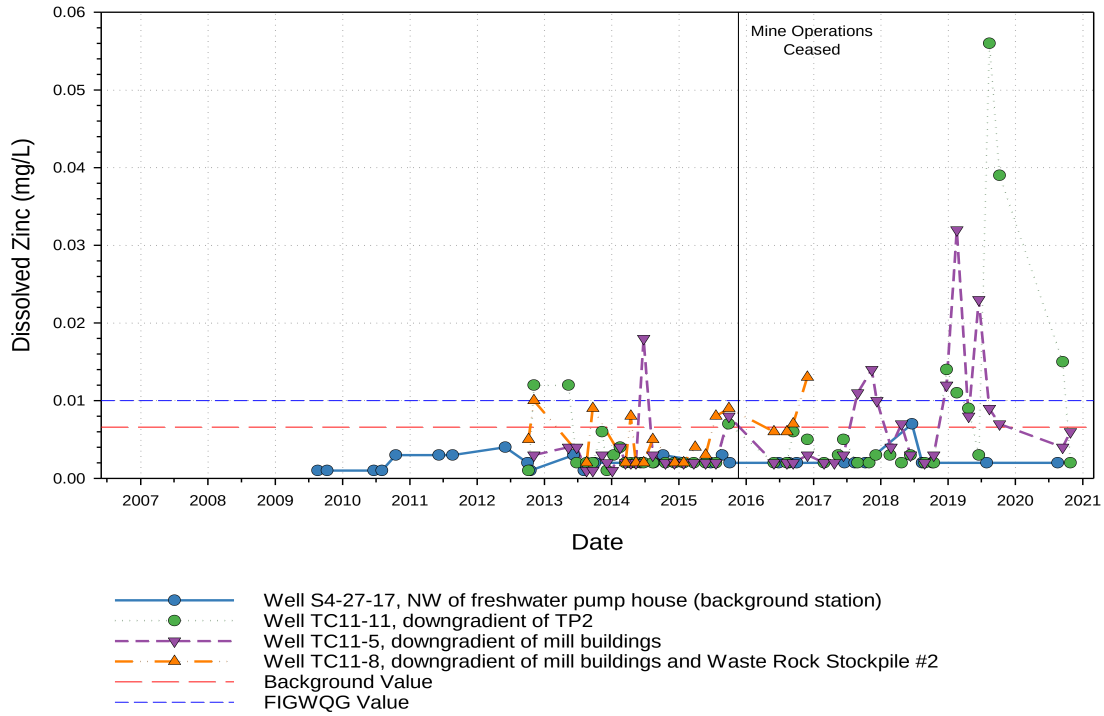
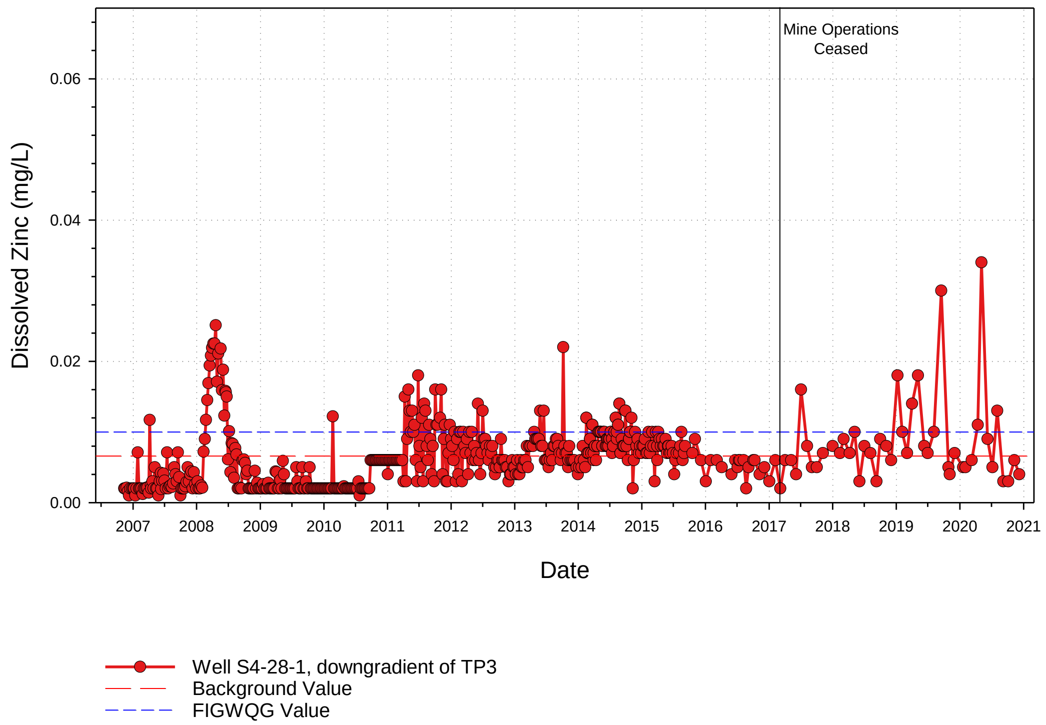
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-28-1, downgradient of TP3
Background Value


Dissolved Zinc (mg/L)
0.00
0.01
0.02
0.03
0.04
0.05
0.06
Mine Operations Ceased
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2
Background Value
FIGWQG Value


Dissolved Zinc (mg/L)
0.00
0.02
0.04
0.06
Mine Operations Ceased
2007
2008
2009
2010
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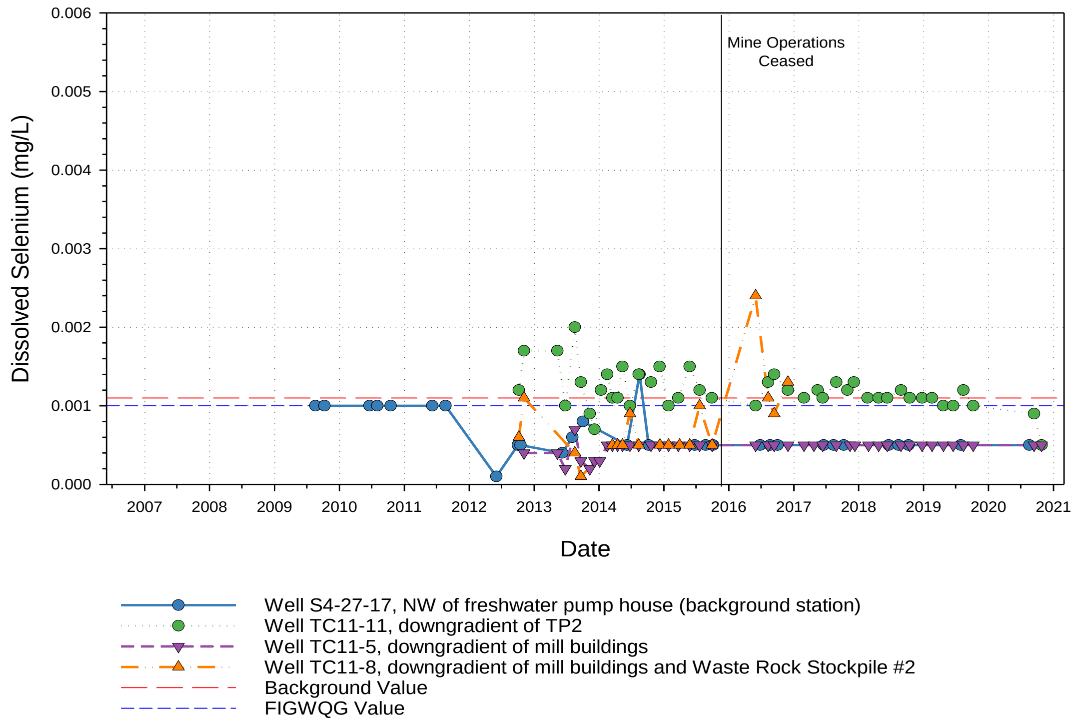
2019
2020
2021
Date
Well S4-28-1, downgradient of TP3
Background Value
FIGWQG Value


Dissolved Selenium (mg/L)
Date
Mine Operations Ceased
0.000
0.001
0.002
0.003
0.004
0.005
0.006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
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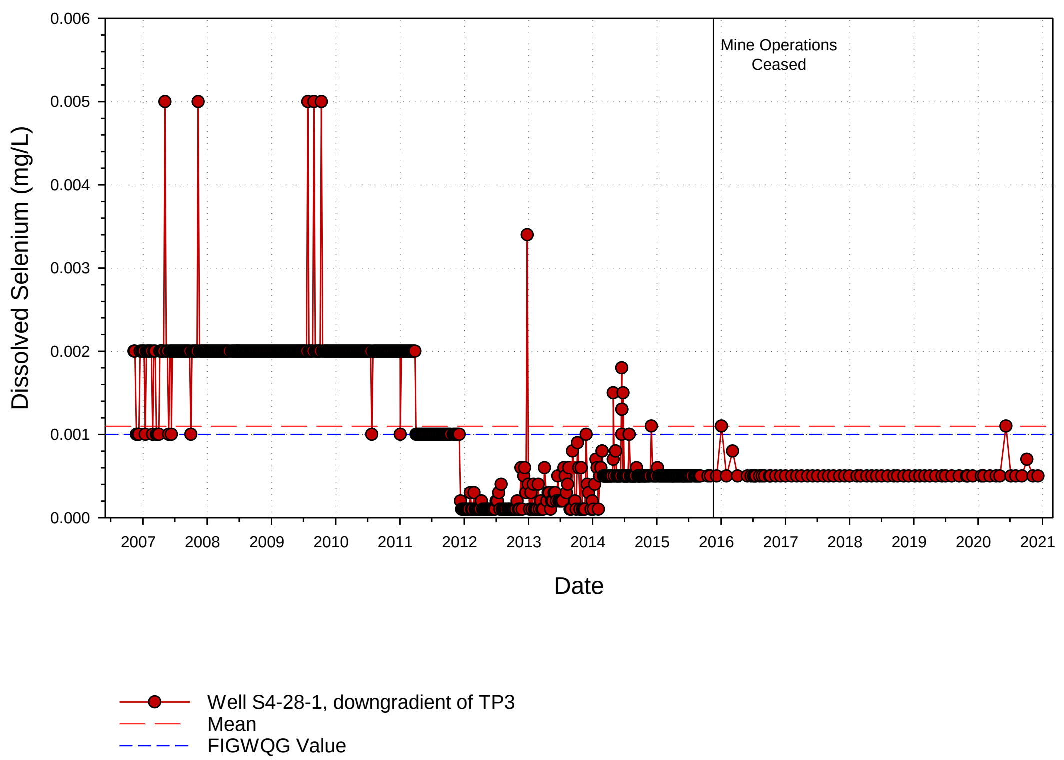
2019
2020
2021
Well S4-27-17, NW of freshwater pump house (background station)
Well TC11-11, downgradient of TP2
Well TC11-5, downgradient of mill buildings
Well TC11-8, downgradient of mill buildings and Waste Rock Stockpile #2
Background Value
FIGWQG Value


Dissolved Selenium (mg/L)
Date
Mine Operations Ceased
0.000
0.001
0.002
0.003
0.004
0.005
0.006
2007
2008
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2021
Well S4-28-1, downgradient of TP3
Mean
FIGWQG Value

APPENDIX C

UNDERGROUND DISCHARGE DATA AND TIME-SERIES TREND PLOTS

Appendix C, Table 1 - Summary of Median and 95th Percentile Values for Mine Discharge (DQC and Background Values)

		Background Groundwater Quality[1]	Flat River Background Upstream S4-29[2]	Discharge Quality Objectives (DQC)[3]	S4-13 (Main Portal)		S4-32 (Sardine Creek)		Percent Difference at Downstream		S4-42 (Conveyor Adit)		S5-2 (Polishing Pond)		Percent Difference at Downstream	
					Median	95th Percentile[0]	Median	95th Percentile[0]	Median	95th Percentile	Median	95th Percentile[0]	Median	95th Percentile[0]	Median	95th Percentile
Alkalinity (total) as CaCO3	mg/L	89	34	NG	134	125	76	61	-76%	-105%	125	113	118	94	-6%	-21%
Ammonia	mg/L	0.05	0.05	3.85	0.02	0.47	0.005	0.056	-300%	-739%	0.56	0.82	0.54	0.74	-4%	-11%
Chloride	mg/L	23.5	0.15	366	0.4	4.5	0.1	0.8	-245%	-493%	14.2	17.9	14.1	16.7	-1%	-7%
Electrical Conductivity	uS/cm	543	359	NG	394	753	413	499	5%	-51%	1355	1646	1340	1615	-1%	-2%
Fluoride	mg/L	0.39	0.08	2.98	0.2	1.1	0.1	0.2	-43%	-438%	3.8	4.8	3.7	4.9	-2%	2%
Hardness as CaCO3	mg/L	292	185	NG	197	348	199	245	1%	-42%	550	715	535	702	-3%	-2%
Nitrate (as N)	mg/L	0.29	0.11	8.9	0.27	0.74	0.24	0.42	-14%	-74%	0.41	1.49	0.35	0.75	-17%	-99%
Nitrite (as N)	mg/L	0.01	0.0068	0.18	0.0025	0.02	0.0025	0.0025	0%	-774%	0.0025	0.0172	0.0025	0.009	0%	-91%
pH (Lab)	pH	7.2	7.4	NG	8.0	7.6	7.8	7.4	-2%	-3%	8.0	7.7	8.0	7.6	0%	0%
Silica	µg/L	7300	5700	NG	7960	9325	2410	2410	-230%	-287%	-	-	17700	20400	-	-
Sodium	mg/L	9.6	2	NG	2	46	1	3	-67%	-1551%	87	109	82	105	-6%	-4%
Sulphate	mg/L	182	79	NG	72	253	122	164	41%	-54%	605	782	591	791	-2%	1%
TDS	mg/L	358	228	NG	242	504	275	339	12%	-49%	1035	1311	1020	1269	-1%	-3%
TOC	mg/L	16	1.04	NG	0.9	1.9	2.1	2.1	57%	10%	-	-	1.0	2.4	-	-
TSS	mg/L	8.6	8	7	1	7	1	36	0%	81%	8	27	2	7	-300%	-258%
Metals																
Aluminium	mg/L	NG	0.24	0.6	0.03	0.2208	0.031	0.38	3%	42%	0.039	0.28	0.025	0.15	-56%	-83%
Aluminium (filtered)	mg/L	0.04	NG	NG	0.003	0.0164	0.004	0.0078	25%	-110%	0.009	0.0284	0.005	0.022	-80%	-29%
Arsenic	mg/L	NG	0.0015	0.013	0.0003	0.0005	0.00115	0.00207	74%	76%	0.0009	0.00146	0.0006	0.00087	-50%	-68%
Arsenic (filtered)	mg/L	0.00088	NG	NG	0.0002	0.00035	0.00095	0.0012	79%	71%	0.0004	0.0007	0.0003	0.0005	-33%	-40%
Beryllium	mg/L	NG	0.0005	NG	0.000025	0.000025	0.000025	0.000025	0%	0%	0.0001	0.000492	0.000025	0.00025	-300%	-97%
Beryllium (filtered)	mg/L	0.0008	NG	NG	0.000005	0.000015	0.000005	0.000005	0%	-200%	0.00003	0.000118	0.00001	0.000067	-200%	-76%
Boron	mg/L	NG	0.01	4.6	0.018	0.89	0.0025	0.035	-620%	-2458%	1.62	2.072	1.51	1.9165	-7%	-8%
Boron (filtered)	mg/L	0.047	NG	NG	0.017	0.84	0.0045	0.027	-278%	-2980%	1.5	1.9	1.4	1.8	-7%	-4%
Cadmium	mg/L	NG	0.00006	0.0005	0.00003	7.4E-05	0.00002	9.6E-05	-50%	23%	0.00004	0.000152	0.00003	9.65E-05	-33%	-58%
Cadmium (filtered)	mg/L	0.000047	NG	NG	0.00003	0.000075	0.00001	0.000089	-200%	16%	0.00002	9.2E-05	0.00003	0.00007	33%	-31%
Calcium	mg/L	NG	52	NG	57.9	147.7	64.05	69.91	10%	-111%	152	158.6	161.5	220.4	6%	28%
Calcium (filtered)	mg/L	84	NG	NG	60	92	-	-	-	-	-	-	200	226	-	-
Chromium (III+VI)	mg/L	NG	0.001	0.002	0.00025	0.00035	0.00025	0.00132	0%	73%	0.00025	0.00066	0.00025	0.0005	0%	-32%
Chromium (III+VI) (filtered)	mg/L	0.001	NG	NG	0.00025	0.00025	0.00025	0.00025	0%	0%	0.00025	0.00025	0.00025	0.00025	0%	0%
Cobalt	mg/L	NG	0.001	0.0025	0.00021	0.00084	0.00005	0.000496	-320%	-69%	0.00046	0.000818	0.00041	0.0009555	-12%	14%
Cobalt (filtered)	mg/L	0.0007	NG	NG	0.00016	0.00061	0.000025	0.00007	-540%	-800%	0.00036	0.000846	0.00036	0.000717	0%	-18%
Copper	mg/L	NG	0.002	0.006	0.0014	0.0062	0.0013	0.036	-8%	83%	0.0013	0.01184	0.0013	0.007	0%	-60%
Copper (filtered)	mg/L	0.002	NG	NG	0.0008	0.00205	0.00035	0.0009	-129%	-128%	0.0003	0.0008	0.0004	0.002	25%	65%
Iron	mg/L	NG	0.37	3.3	0.09	0.672	0.095	0.7875	5%	15%	2.9	5.5	1.0	1.8	-191%	-198%
Iron (filtered)	mg/L	0.22	NG	NG	0.005	0.06	0.005	0.02	0%	-200%	0.01	0.5	0.005	0.24	-100%	-119%
Manganese	mg/L	NG	0.027	NG	0.014	0.463	0.003	0.0244	-367%	-1798%	0.557	1.082	0.5625	0.90495	1%	-20%
Manganese (filtered)	mg/L	0.12	NG	NG	0.014	0.4485	0.002	0.0166	-600%	-2602%	0.521	0.973	0.516	0.8595	-1%	-13%
Mercury	mg/L	NG	0.000025	0.000069	0.000005	0.0000075	0.000005	9.5E-06	0%	21%	0.000005	8E-06	0.000005	0.000005	0%	-60%
Mercury (filtered)	mg/L	0.000021	NG	NG	0.000005	0.000005	0.000005	0.000005	0%	0%	0.000005	0.000005	0.000005	0.000005	0%	0%
Lead	mg/L	NG	0.001	0.015	0.000025	0.000308	0.00006	0.000542	58%	43%	0.000025	0.000236	0.000025	0.0002865	0%	18%
Lead (filtered)	mg/L	0.00066	NG	NG	0.000025	0.000025	0.000025	0.000025	0%	0%	0.000025	0.000025	0.000025	4.25E-05	0%	41%
Molybdenum	mg/L	NG	0.0018	0.22	0.001	0.00204	0.0007	0.0008925	-43%	-129%	0.0029	0.0034	0.0028	0.003365	-4%	-1%
Molybdenum (filtered)	mg/L	0.0077	NG	NG	0.00093	0.00194	0.000625	0.000739	-49%	-163%	0.00268	0.003224	0.00261	0.003114	-3%	-4%
Nickel	mg/L	NG	0.0049	0.371	0.0008	0.00204	0.00025	0.00096	-220%	-113%	0.001	0.00192	0.0008	0.00193	-25%	1%
Nickel (filtered)	mg/L	0.0021	NG	NG	0.0007	0.0015	0.0001	0.000395	-600%	-280%	0.0008	0.00156	0.0007	0.001175	-14%	-33%
Phosphorus	mg/L	NG	0.05	NG	0.025	0.025	0.025	0.025	0%	0%	0.025	0.04	0.025	0.07	0%	42%
Phosphorus (filtered)	mg/L	0.23	NG	NG	0.025	0.06	0.025	0.025	0%	-140%	0.025	0.04	0.025	0.06	0%	33%
Selenium	mg/L	NG	0.0005	0.002	0.00025	0.0006	0.00025	0.00025	0%	-140%	0.00025	0.00052	0.00025	0.00083	0%	37%
Selenium (filtered)	mg/L	0.0011	NG	NG	0.00025	0.00055	0.00025	0.00025	0%	-120%	0.00025	0.00025	0.00025	0.00097	0%	74%
Silver	mg/L	NG	0.000053	0.0003	0.00001	0.00001	0.00004	0.00004	75%	75%	0.00001	0.00001	0.00001	0.00001	0%	0%
Silver (filtered)	mg/L	0.000072	NG	NG	0.00001	0.00001	0.00001	0.00001	0%	0%	0.00001	0.00001	0.00001	0.00001	0%	0%
Strontium	mg/L	NG	0.13	NG	0.125	0.7062	0.1025	0.18285	-22%	-286%	0.875	1.566	1.01	1.569	13%	0%
Strontium (filtered)	mg/L	0.12	NG	NG	0.121	0.667	0.0925	0.1588	-31%	-320%	0.84	1.41	0.961	1.345	13%	-5%
Thallium	mg/L	NG	0.0001	0.0024	0.00001	0.00003	0.00001	0.00001	0%	-200%	0.00001	0.00004	0.00001	0.00004	0%	0%
Thallium (filtered)	mg/L	0.000093	NG	NG	0.000005	0.00002	0.000005	0.000005	0%	-300%	0.000005	0.00002	0.00001	0.00004	50%	50%
Uranium	µg/L	NG	2.2	41	4.09	8.984	1.155	1.51	-254%	-495%	7.37	12.56	7.335	11.46	0%	-10%
Uranium (filtered)	µg/L	7.1	NG	NG	3.83	8.755	1.095	1.5135	-250%	-478%	7.54	12.22	7.44	10.44	-1%	-17%
Vanadium	mg/L	NG	0.005	NG	0.0005	0.0005	0.0005	0.0005	0%	0%	0.0005	0.0005	0.0005	0.0005	0%	0%
Vanadium (filtered)	mg/L	0.001	NG	NG	0.00025	0.00025	0.00025	0.00025	0%	0%	0.00025	0.00025	0.00025	0.00025	0%	0%
Tungsten	µg/L	NG	NG	NG	6.2	30.0	3.4	14.8	-82%	-103%	20.5	65.18	11.4	22.4	-80%	-191%
Tungsten (filtered)	µg/L	6.9	NG	NG	3.2	6.6	2.05	2.89	-56%	-128%	15	22.3	9	17.95	-67%	-24%
Zinc	mg/L	NG	0.008	0.075	0.006	0.0258	0.002	0.0107	-200%	-141%	0.008	0.054	0.008	0.043	0%	-26%
Zinc (filtered)	mg/L	0.0066	NG	NG	0.005	0.022	0.004	0.0195	-25%	-13%	0.004	0.0178	0.004	0.019	0%	6%

Median and 95th Percentile values for all samples collected since January 2016 to Present (post-mining)

Value of one half of detection limit used for calculation of median and 95th percentile values, where needed

Positive values indicate concentration is increasing downstream

Negative values indicate value is decreasing downstream

Values near zero are stable trend

[0] Alkalinity, pH, and H+ report 5th percentile values

1 As defined in the report. Calculated as the 95th percentile values of four background station locations.

[2] Background surface water quality at S4-29 in Flat River

BOLD Red- Concentration is greater than background groundwater concentration.

Double Underline - Concentration is greater than the background Flat River Water Quality

Shaded Cell - Concentration exceeds the Discharge Quality Criteria Value

Appendix C, Table 2 - Summary of Median and 95th Percentile Values for Mine Discharge (DQC and Background Values)

		CCME - AW (Freshwater)[1]	*Federal Interim Guideline - Res Park Coarse*[2]	S4-13 (Main Portal)		S4-32 (Sardine Creek)		Percent Difference at Downstream		S4-42 (Conveyor Adit)		S5-2 (Polishing Pond)		Percent Difference at Downstream	
				Median	95th Percentile[0]	Median	95th Percentile[0]	Median	95th Percentile	Median	95th Percentile[0]	Median	95th Percentile[0]	Median	95th Percentile
Alkalinity (total) as CaCO3	mg/L	*NG*	*NG*	134	125	76	61	-76%	-105%	125	113	118	94	-6%	-21%
Ammonia	mg/L	*NG*	*NG*	0.02	0.47	0.005	0.056	-300%	-739%	0.56	0.82	0.54	0.74	-4%	-11%
Chloride	mg/L	*120*	*120*	0.4	4.5	0.1	0.8	-245%	-493%	14.2	17.9	14.1	16.7	-1%	-7%
Electrical conductivity *(lab)	uS/cm	*NG*	*NG*	394	753	413	499	5%	-51%	1355	1646	1340	1615	-1%	-2%
Fluoride	mg/L	*0.12*	*0.12*	**0.2**	**1.1**	**0.1**	**0.2**	-43%	-438%	**3.8**	**4.8**	**3.7**	**4.9**	-2%	2%
Hardness as CaCO3	mg/L	*NG*	*NG*	197	348	199	245	1%	-42%	550	715	535	702	-3%	-2%
Nitrate (as N)	mg/L	*13*	*13*	0.27	0.74	0.24	0.42	-14%	-74%	0.41	1.49	0.35	0.75	-17%	-99%
Nitrite (as N)	mg/L	*0.06*	*0.06*	0.0025	0.02185	0.0025	0.0025	0%	-774%	0.0025	0.0172	0.0025	0.009	0%	-91%
pH (Lab)	pH	*6.5-9.0*	*6.5-9.0*	8.0	7.6	7.8	7.4	-2%	-3%	8.0	7.7	8.0	7.6	0%	0%
Silica	µg/L	*NG*	*NG*	7960	9325	2410	2410	-230%	-287%	-	-	17700	20400	-	-
Sodium	mg/L	*NG*	*NG*	2	46	1	3	-67%	-1551%	87	109	82	105	-6%	-4%
Sulphate	mg/L	*NG*	*100*	72	253	122	164	41%	-54%	605	782	591	791	-2%	1%
TDS	mg/L	*NG*	*NG*	242	504	275	339	12%	-49%	1035	1311	1020	1269	-1%	-3%
TOC	mg/L	*NG*	*NG*	0.9	1.9	2.1	2.1	57%	10%	-	-	1.0	2.4	-	-
TSS	mg/L	*NG*	*NG*	1	7	1	36	0%	81%	8	27	2	7	-300%	-258%
Metals															
Aluminium	mg/L	*0.1*[3]	*0.1*[3]	0.03	**0.2208**	0.031	**0.38**	3%	42%	0.039	**0.28**	0.025	**0.15**	-56%	-83%
Aluminium (filtered)	mg/L	*0.1*[3]	*0.1*[3]	0.003	0.0164	0.004	0.0078	25%	-110%	0.009	0.0284	0.005	0.022	-80%	-29%
Arsenic	mg/L	*0.005*	*0.005*	0.0003	0.0005	0.00115	0.00207	74%	76%	0.0009	0.00146	0.0006	0.00087	-50%	-68%
Arsenic (filtered)	mg/L	*0.005*	*0.005*	0.0002	0.00035	0.00095	0.0012	79%	71%	0.0004	0.0007	0.0003	0.0005	-33%	-40%
Beryllium	mg/L	*NG*	*0.0053*	0.000025	0.000025	0.000025	0.000025	0%	0%	0.0001	0.000492	0.000025	0.00025	-300%	-97%
Beryllium (filtered)	mg/L	*NG*	*0.0053*	0.000005	0.000015	0.000005	0.000005	0%	-200%	0.00003	0.000118	0.00001	0.000067	-200%	-76%
Boron	mg/L	*1.5*	*5*	0.018	0.89	0.0025	0.035	-620%	-2458%	**1.62**	**2.072**	**1.51**	**1.9165**	-7%	-8%
Boron (filtered)	mg/L	*1.5*	*5*	0.017	0.84	0.0045	0.027	-278%	-2980%	**1.5**	**1.9**	1.4	**1.8**	-7%	-4%
Cadmium	mg/L	*0.001*	*0.000017*	**0.00003**	**7.4E-05**	**0.00002**	**9.6E-05**	-50%	23%	**0.00004**	**0.000152**	**0.00003**	**9.65E-05**	-33%	-58%
Cadmium (filtered)	mg/L	*0.001*	*0.000017*	**0.00003**	**0.000075**	0.00001	**0.000089**	-200%	16%	**0.00002**	**9.2E-05**	**0.00003**	**0.00007**	33%	-31%
Calcium	mg/L	*NG*	*NG*	57.9	147.7	64.05	69.91	10%	-111%	152	158.6	161.5	220.4	6%	28%
Calcium (filtered)	mg/L	*NG*	*NG*	60	91.68	-	-	-	-	-	-	200	225.75	-	-
Chromium (III+VI)	mg/L	*0.001*	*0.0089*	0.00025	0.00035	0.00025	**0.00132**	0%	73%	0.00025	0.00066	0.00025	0.0005	0%	-32%
Chromium (III+VI) (filtered)	mg/L	*0.001*	*0.0089*	0.00025	0.00025	0.00025	0.00025	0%	0%	0.00025	0.00025	0.00025	0.00025	0%	0%
Cobalt	mg/L	*0.0025*	*NG*	0.00021	0.00084	0.00005	0.000496	-320%	-69%	0.00046	0.000818	0.00041	0.0009555	-12%	14%
Cobalt (filtered)	mg/L	*0.0025*	*NG*	0.00016	0.00061	0.000025	0.00007	-540%	-800%	0.00036	0.000846	0.00036	0.000717	0%	-18%
Copper	mg/L	*0.002*[4]	*0.002*[4]	0.0014	**0.0062**	0.0013	**0.036**	-8%	83%	0.0013	**0.01184**	0.0013	**0.007**	0%	-60%
Copper (filtered)	mg/L	*0.002*[4]	*0.002*[4]	0.0008	**0.00205**	0.00035	0.0009	-129%	-128%	0.0003	0.0008	0.0004	**0.002**	25%	65%
Iron	mg/L	*1*	*1*	0.09	0.672	0.095	0.7875	5%	15%	**2.9**	**5.5**	1.0	**1.8**	-191%	-198%
Iron (filtered)	mg/L	0.3	0.3	0.005	0.06	0.005	0.02	0%	-200%	0.01	**0.5**	0.005	0.24	-100%	-119%
Manganese	mg/L	*NG*	*NG*	0.014	0.463	0.003	0.0244	-367%	-1798%	0.557	1.082	0.5625	0.90495	1%	-20%
Manganese (filtered)	mg/L	*NG*	*NG*	0.014	0.4485	0.002	0.0166	-600%	-2602%	0.521	0.973	0.516	0.8595	-1%	-13%
Mercury	mg/L	*0.000026*	*0.000026*	0.000005	0.0000075	0.000005	9.5E-06	0%	21%	0.000005	8E-06	0.000005	0.000005	0%	-60%
Mercury (filtered)	mg/L	*0.000026*	*0.000026*	0.000005	0.000005	0.000005	0.000005	0%	0%	0.000005	0.000005	0.000005	0.000005	0%	0%
Lead	mg/L	*0.001*[4]	*0.001*[4]	0.000025	0.000308	0.00006	0.000542	58%	43%	0.000025	0.000236	0.000025	0.0002865	0%	18%
Lead (filtered)	mg/L	*0.001*[4]	*0.001*[4]	0.000025	0.000025	0.000025	0.000025	0%	0%	0.000025	0.000025	0.000025	4.25E-05	0%	41%
Molybdenum	mg/L	*0.073*	*0.073*	0.001	0.00204	0.0007	0.0008925	-43%	-129%	0.0029	0.0034	0.0028	0.003365	-4%	-1%
Molybdenum (filtered)	mg/L	*0.073*	*0.073*	0.00093	0.00194	0.000625	0.000739	-49%	-163%	0.00268	0.003224	0.00261	0.003114	-3%	-4%
Nickel	mg/L	*0.025*[4]	*0.025*[4]	0.0008	0.00204	0.00025	0.00096	-220%	-113%	0.001	0.00192	0.0008	0.00193	-25%	1%
Nickel (filtered)	mg/L	*0.025*[4]	*0.025*[4]	0.0007	0.0015	0.0001	0.000395	-600%	-280%	0.0008	0.00156	0.0007	0.001175	-14%	-33%
Phosphorus	mg/L	*0.004 - 0.010*[5]	*NG*	**0.025**	**0.025**	**0.025**	**0.025**	0%	0%	**0.025**	**0.04**	**0.025**	**0.07**	0%	42%
Phosphorus (filtered)	mg/L	*0.004 - 0.010*[5]	*NG*	**0.025**	**0.06**	**0.025**	**0.025**	0%	-140%	**0.025**	**0.04**	**0.025**	**0.06**	0%	33%
Selenium	mg/L	*0.001*	*0.001*	0.00025	0.0006	0.00025	0.00025	0%	-140%	0.00025	0.00052	0.00025	0.00083	0%	37%
Selenium (filtered)	mg/L	*0.001*	*0.001*	0.00025	0.00055	0.00025	0.00025	0%	-120%	0.00025	0.00025	0.00025	0.00097	0%	74%
Silver	mg/L	*0.00025*	*0.0001*	0.00001	0.00001	0.00004	0.00004	75%	75%	0.00001	0.00001	0.00001	0.00001	0%	0%
Silver (filtered)	mg/L	*0.00025*	*0.0001*	0.00001	0.00001	0.00001	0.00001	0%	0%	0.00001	0.00001	0.00001	0.00001	0%	0%
Strontium	mg/L	*NG*	*NG*	0.125	0.7062	0.1025	0.18285	-22%	-286%	0.875	1.566	1.01	1.569	13%	0%
Strontium (filtered)	mg/L	*NG*	*NG*	0.121	0.667	0.0925	0.1588	-31%	-320%	0.84	1.41	0.961	1.345	13%	-5%
Thallium	mg/L	*NG*	*NG*	0.00001	0.00003	0.00001	0.00001	0%	-200%	0.00001	0.00004	0.00001	0.00004	0%	0%
Thallium (filtered)	mg/L	*NG*	*NG*	0.000005	0.00002	0.000005	0.000005	0%	-300%	0.000005	0.00002	0.00001	0.00004	50%	50%
Uranium	µg/L	*15*	*15*	4.09	8.984	1.155	1.51	-254%	-495%	7.37	12.56	7.335	11.46	0%	-10%
Uranium (filtered)	µg/L	*15*	*15*	3.83	8.755	1.095	1.5135	-250%	-478%	7.54	12.22	7.44	10.44	-1%	-17%
Vanadium	mg/L	*NG*	*NG*	0.0005	0.0005	0.0005	0.0005	0%	0%	0.0005	0.0005	0.0005	0.0005	0%	0%
Vanadium (filtered)	mg/L	*NG*	*NG*	0.00025	0.00025	0.00025	0.00025	0%	0%	0.00025	0.00025	0.00025	0.00025	0%	0%
Tungsten	µg/L	*NG*	*NG*	6.2	30.0	3.4	14.8	-82%	-103%	20.5	65.18	11.4	22.4	-80%	-191%
Tungsten (filtered)	µg/L	*NG*	*NG*	3.2	6.6	2.05	2.89	-56%	-128%	15	22.3	9	17.95	-67%	-24%
Zinc	mg/L	*0.03*	*0.03*	0.006	0.0258	0.002	0.0107	-200%	-141%	0.008	**0.054**	0.008	**0.043**	0%	-26%
Zinc (filtered)	mg/L	*0.03*	*0.03*	0.005	0.022	0.004	0.0195	-25%	-13%	0.004	0.0178	0.004	0.019	0%	6%

Median and 95th Percentile values for all samples collected since January 2016 to Present (post-mining)

Value of one half of detection limit used for calculation of median and 95th percentile values, where needed

Positive values indicate concentration is increasing downstream

Negative values indicate value is decreasing downstream

Values near zero are stable trend

0. Alkalinity, pH, and H+ report 5th percentile values

1. Canadian Council of Ministers of the Environment (CCME) Environmental Quality Guidelines (CEQG), for the protection of freshwater aquatic life.

2. Federal Contaminated Sites Action Plan (FCSAP) Guidance Document on Federal Interim Groundwater Quality Guidelines (FIGWQG) for Federal Contaminated Sites Tier 1 and 2 Guidelines for Residential / Parkland Land Use - coarse- grained soils.

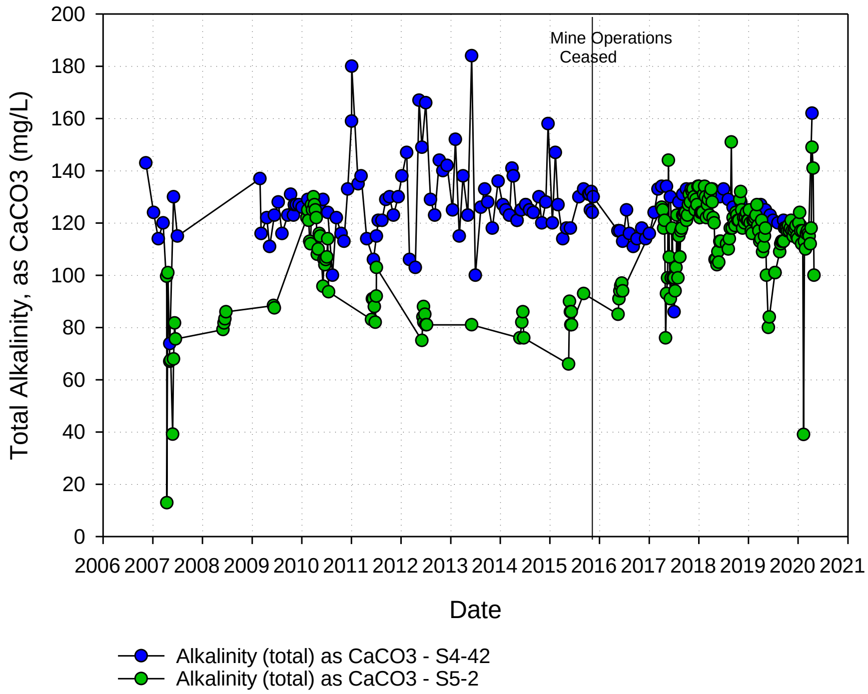
3. Guideline is dependent upon the pH value.

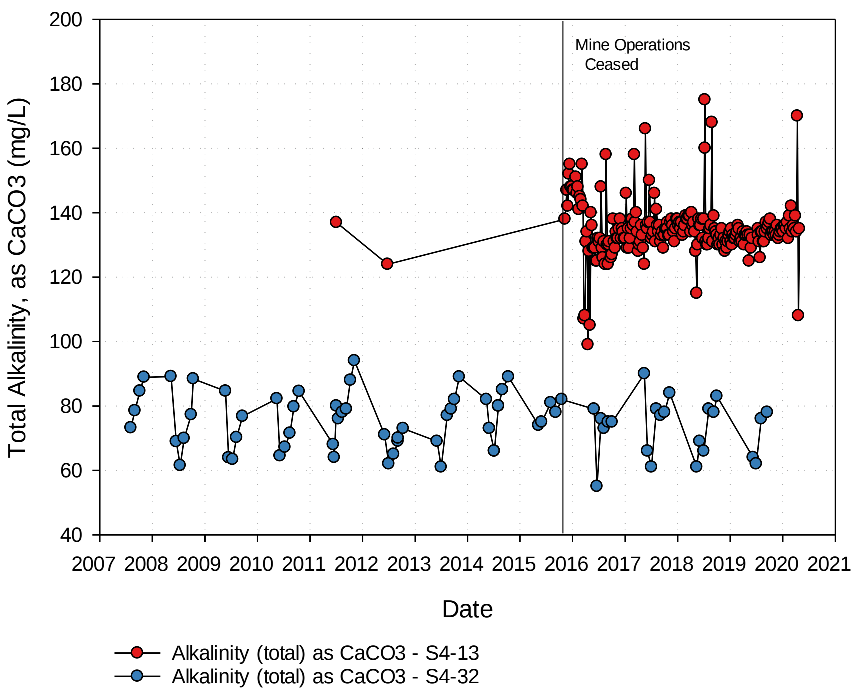
4. Guideline is based on the Hardness value.

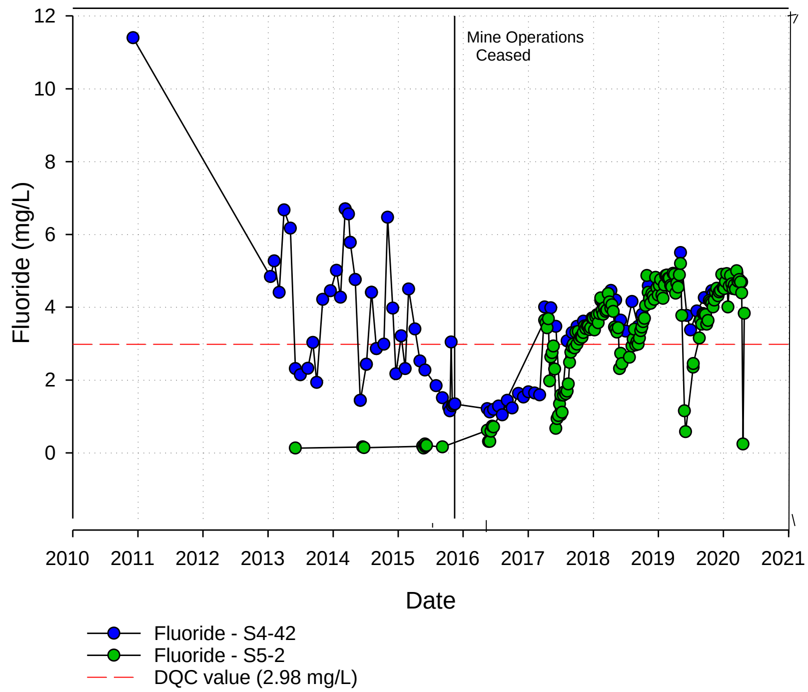
5. Guideline shown is based on the typical range of total phosphorous concentrations of a oligotrophic water body.

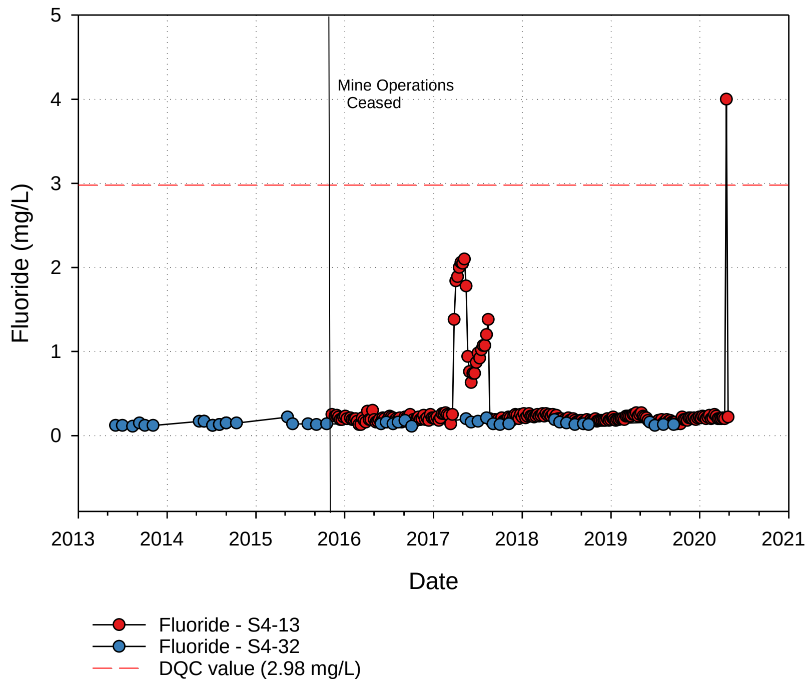
BOLD Black - Concentration exceeds the most stringent guideline

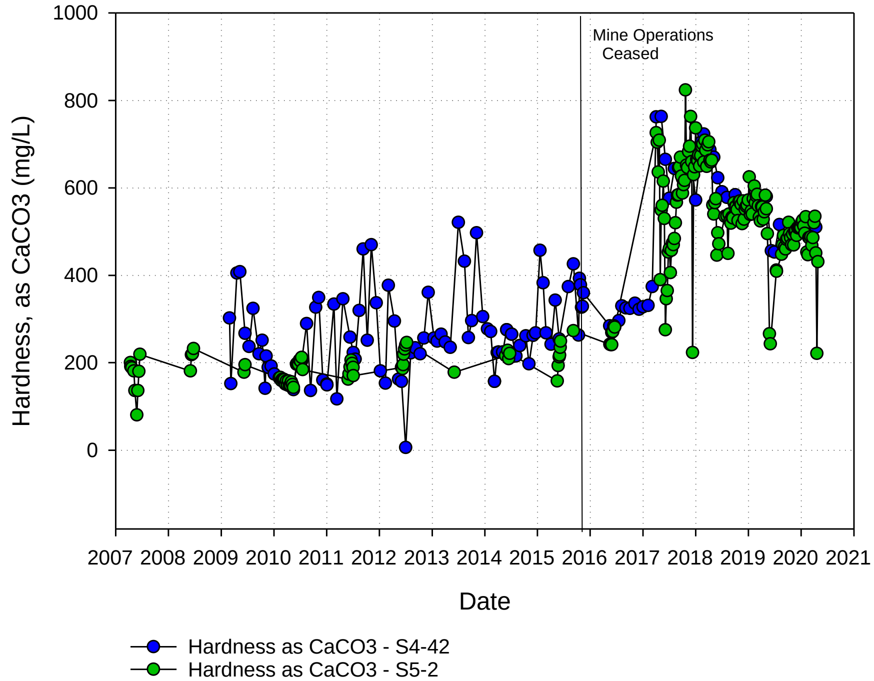
BOLD Black and Shaded - Concentration exceeds the most stringent guideline by an order of magnitude

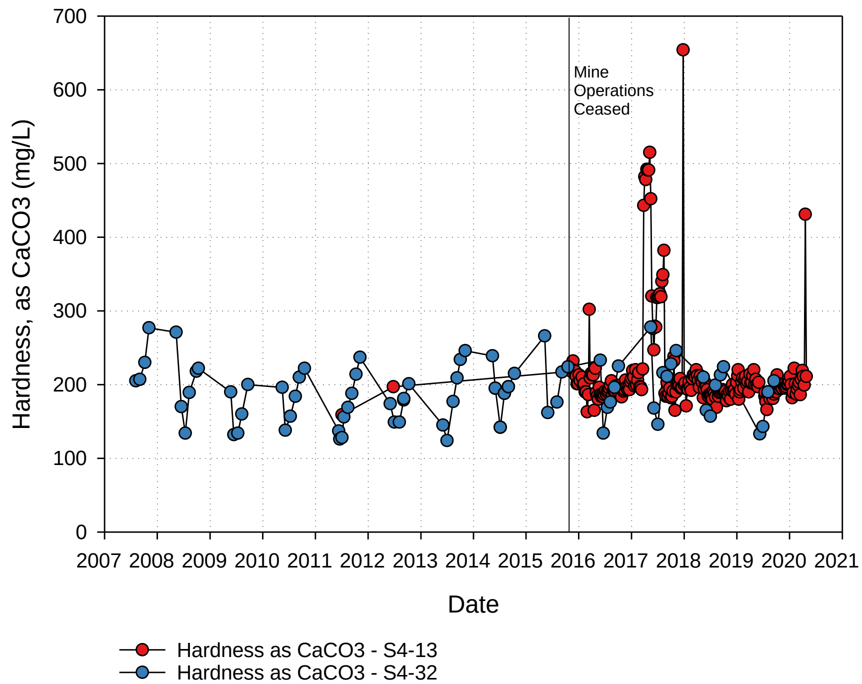

Total Alkalinity, as CaCO3 (mg/L)
0
20
40
60
80
100
120
140
160
180
200
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Mine Operations
Ceased
Alkalinity (total) as CaCO3 - S4-42
Alkalinity (total) as CaCO3 - S5-2

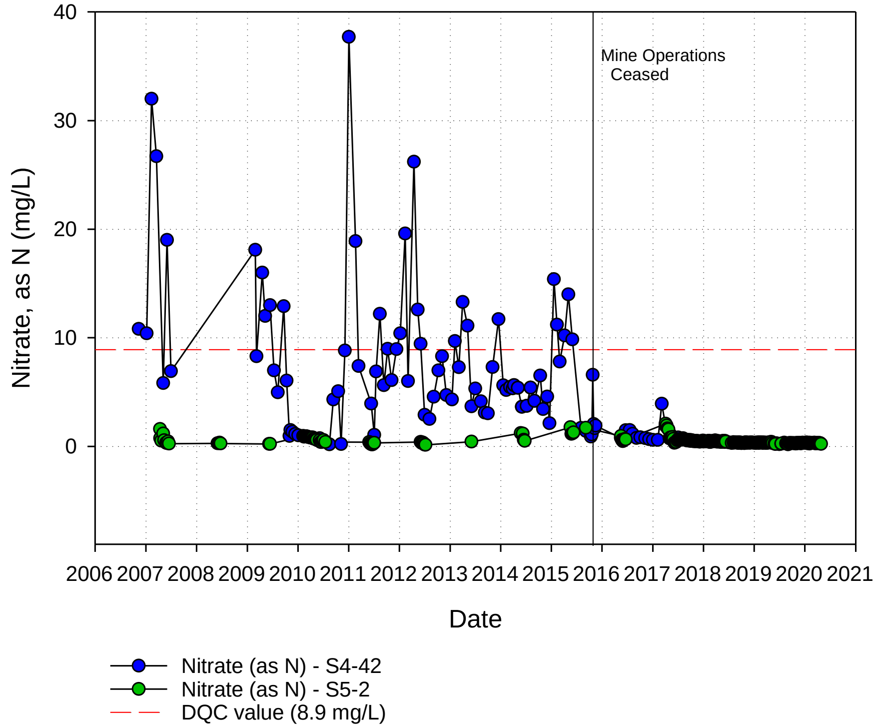

Total Alkalinity, as CaCO3 (mg/L)
40
60
80
100
120
140
160
180
200
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Mine Operations
Ceased
Alkalinity (total) as CaCO3 - S4-13
Alkalinity (total) as CaCO3 - S4-32

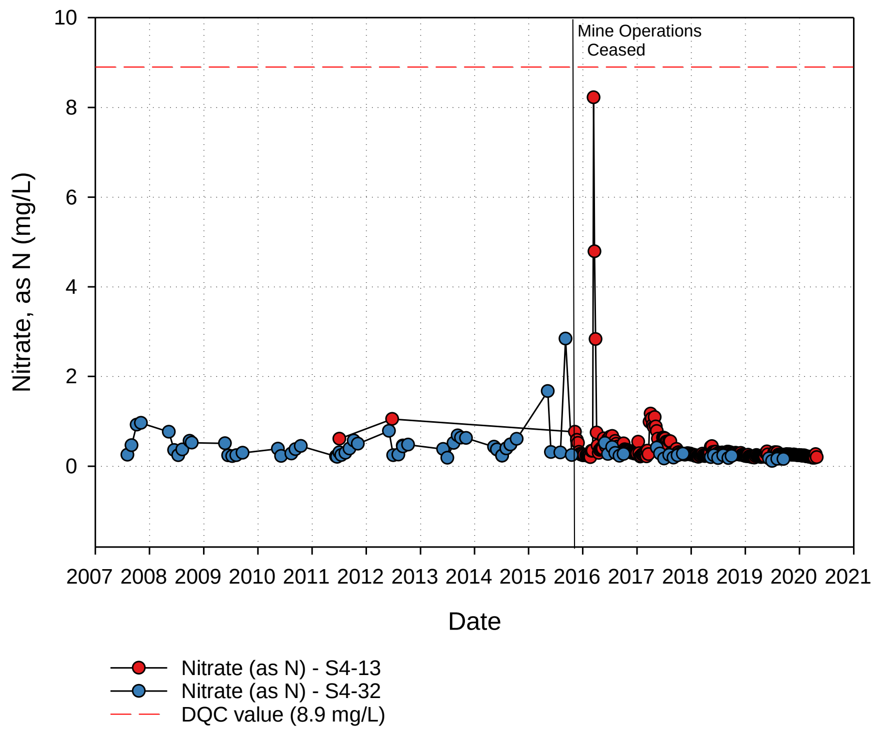

Fluoride (mg/L)
Date
Mine Operations Ceased
Fluoride - S4-42
Fluoride - S5-2
DQC value (2.98 mg/L)

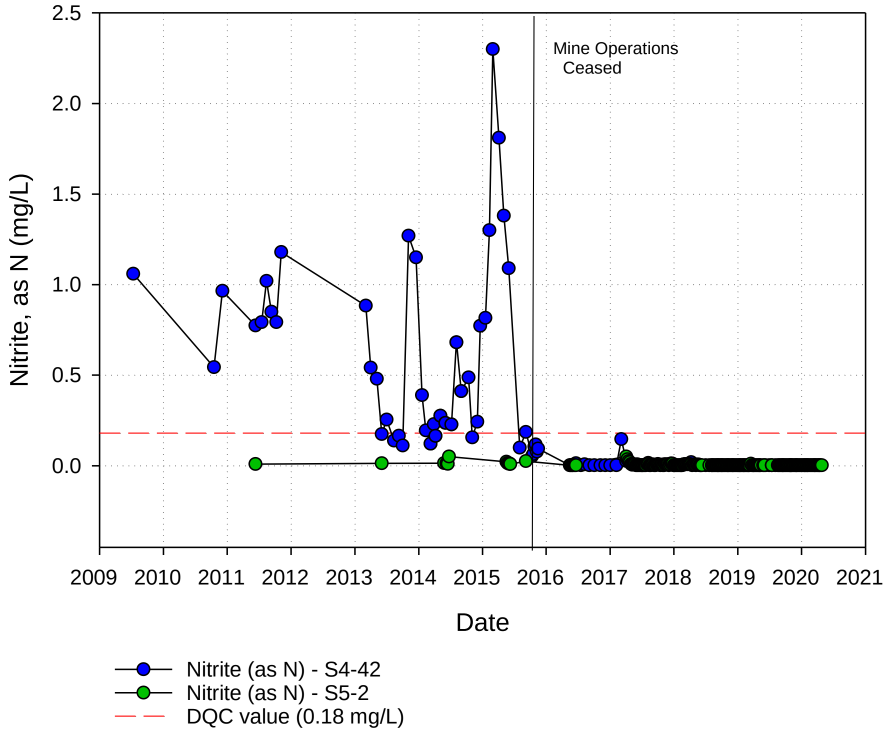

Fluoride (mg/L)
Date
Mine Operations Ceased
Fluoride - S4-13
Fluoride - S4-32
DQC value (2.98 mg/L)

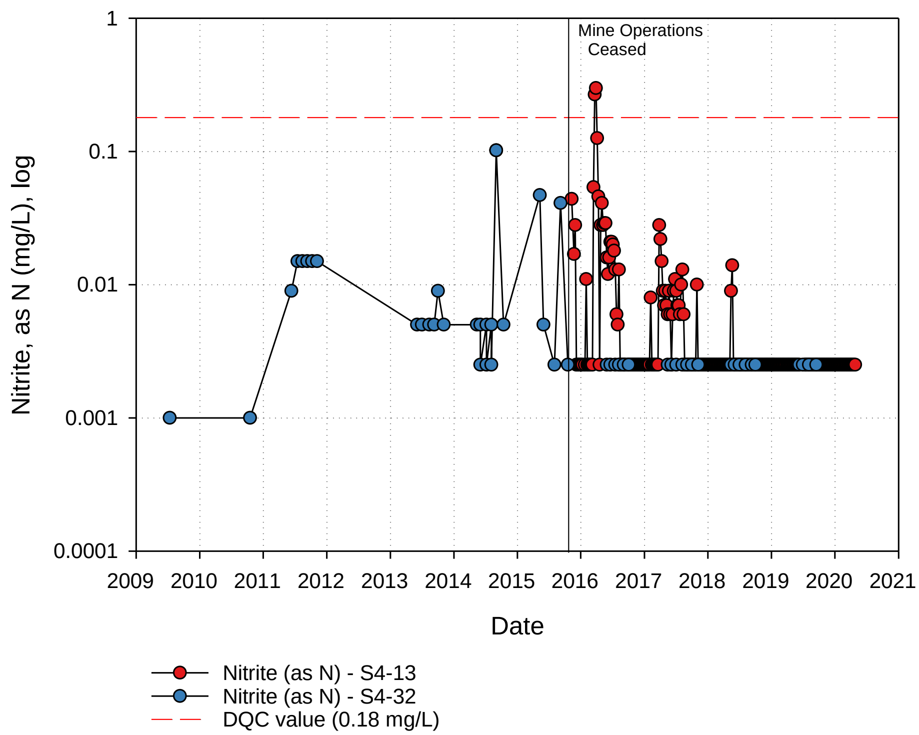

Hardness, as CaCO3 (mg/L)
1000
800
600
400
200
0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Mine Operations Ceased
Hardness as CaCO3 - S4-42
Hardness as CaCO3 - S5-2

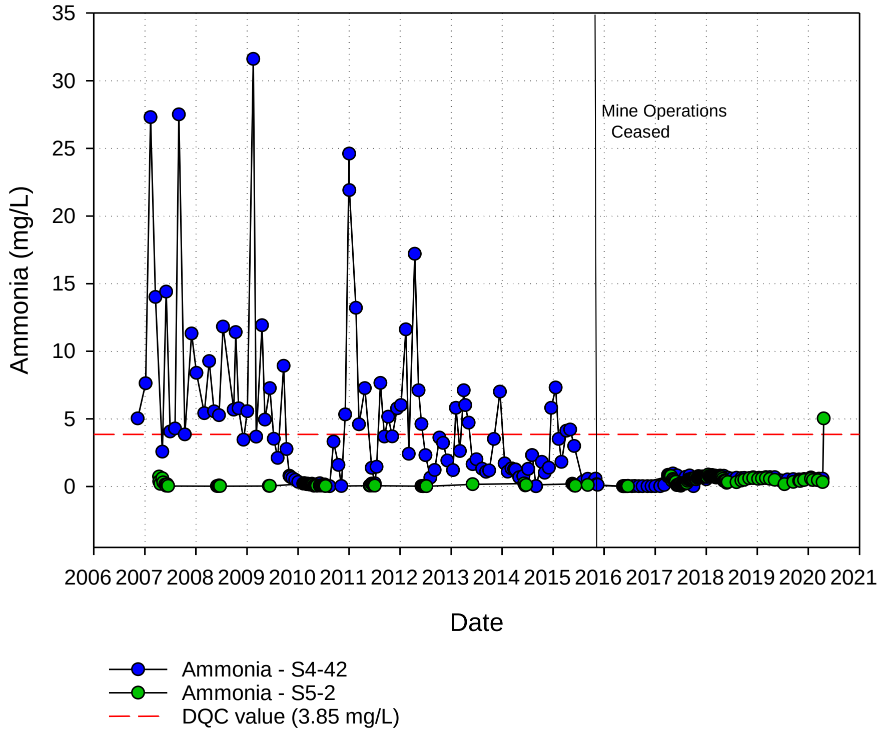

Hardness, as CaCO3 (mg/L)
700
600
500
400
300
200
100
0
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Mine Operations Ceased
Hardness as CaCO3 - S4-13
Hardness as CaCO3 - S4-32

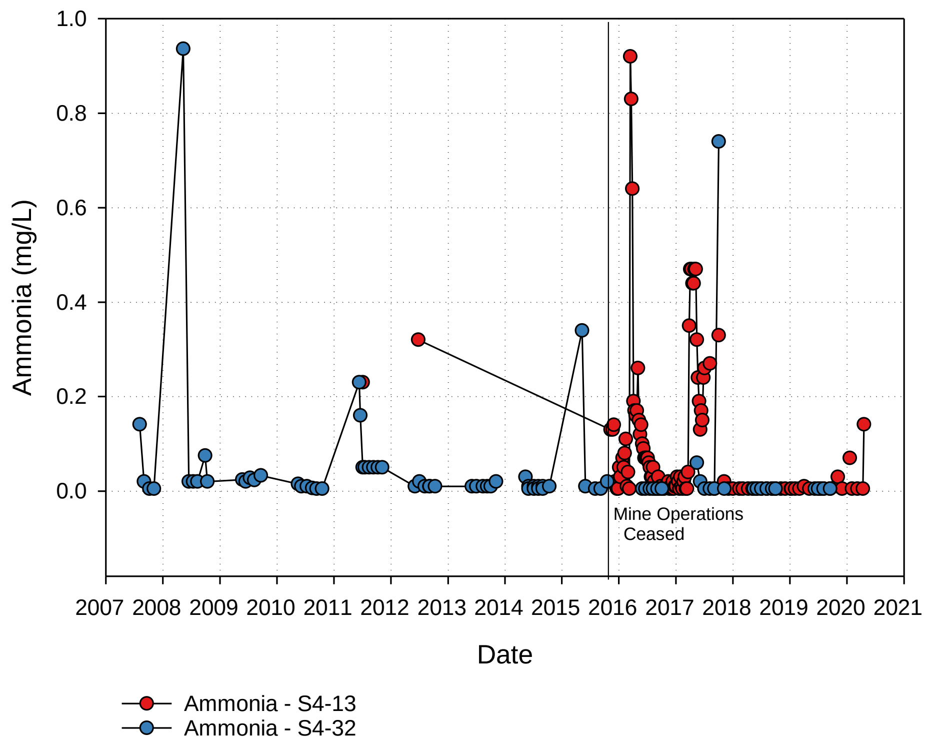

Mine Operations Ceased
Nitrate, as N (mg/L)
Date
Nitrate (as N) - S4-42
Nitrate (as N) - S5-2
DQC value (8.9 mg/L)

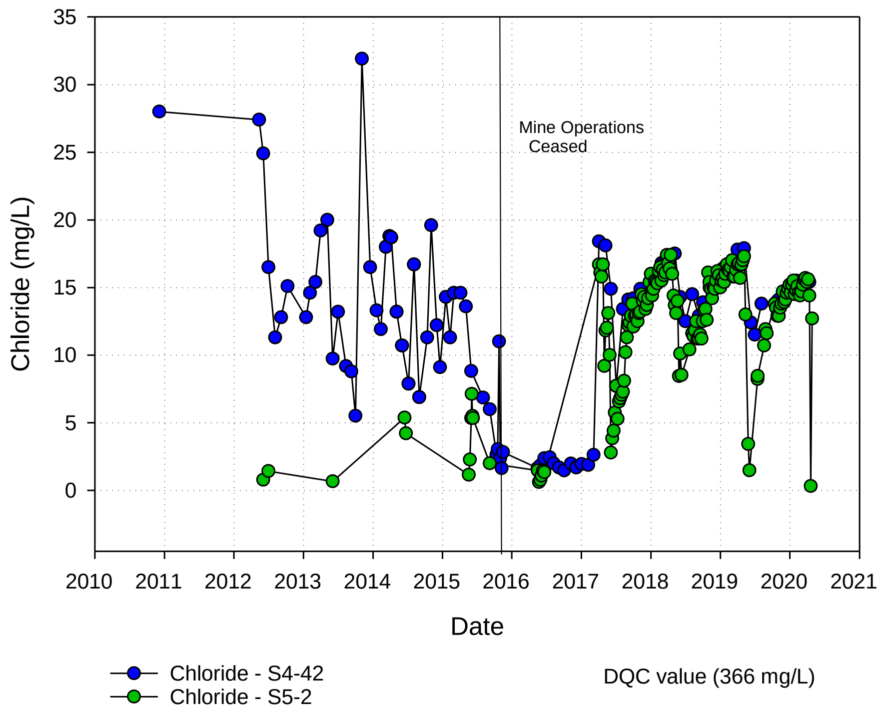

Mine Operations Ceased
Nitrate, as N (mg/L)
Date
Nitrate (as N) - S4-13
Nitrate (as N) - S4-32
DQC value (8.9 mg/L)

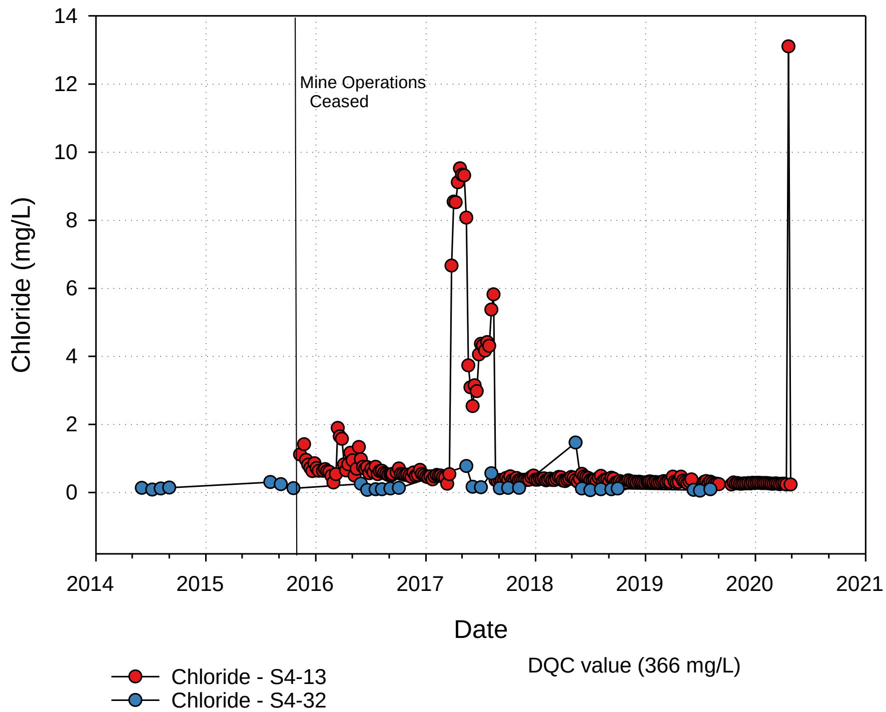

Mine Operations
Ceased
Nitrite, as N (mg/L)
2.5
2.0
1.5
1.0
0.5
0.0
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Nitrite (as N) - S4-42
Nitrite (as N) - S5-2
DQC value (0.18 mg/L)

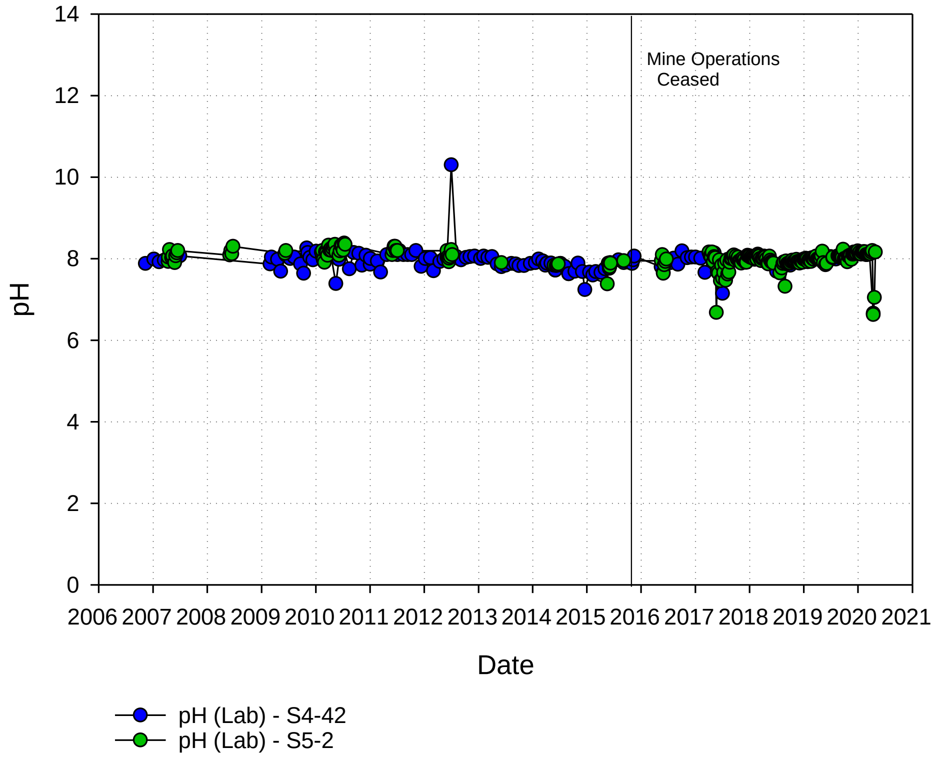

Mine Operations
Ceased
Nitrite, as N (mg/L), log
1
0.1
0.01
0.001
0.0001
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Nitrite (as N) - S4-13
Nitrite (as N) - S4-32
DQC value (0.18 mg/L)

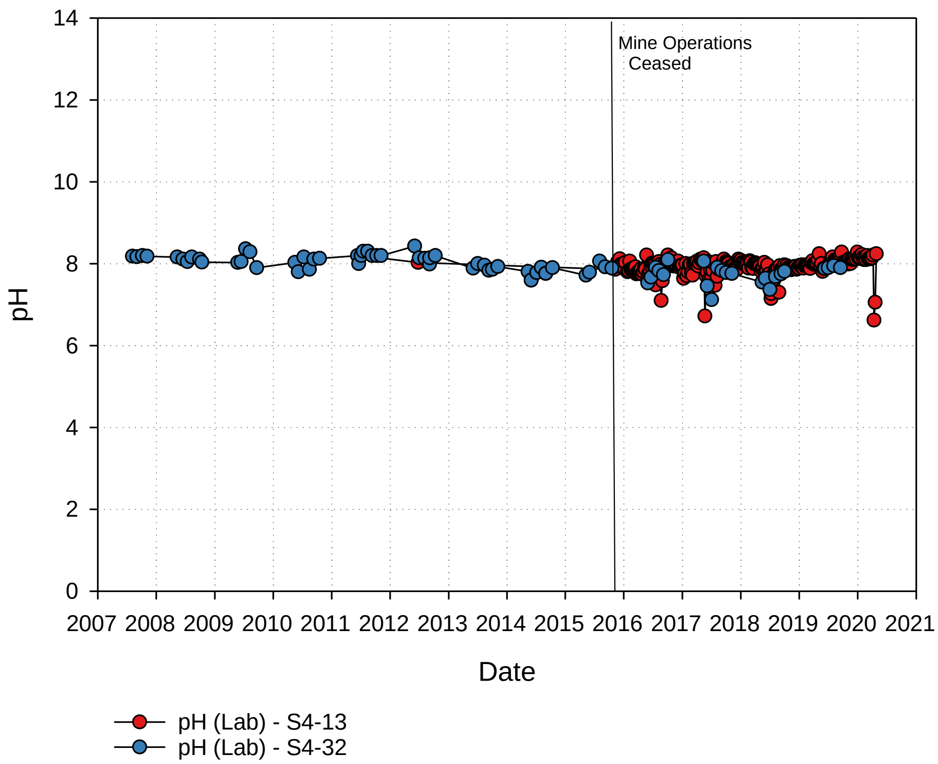

35
30
25
20
15
10
5
0
Ammonia (mg/L)
Mine Operations Ceased
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Ammonia - S4-42
Ammonia - S5-2
DQC value (3.85 mg/L)

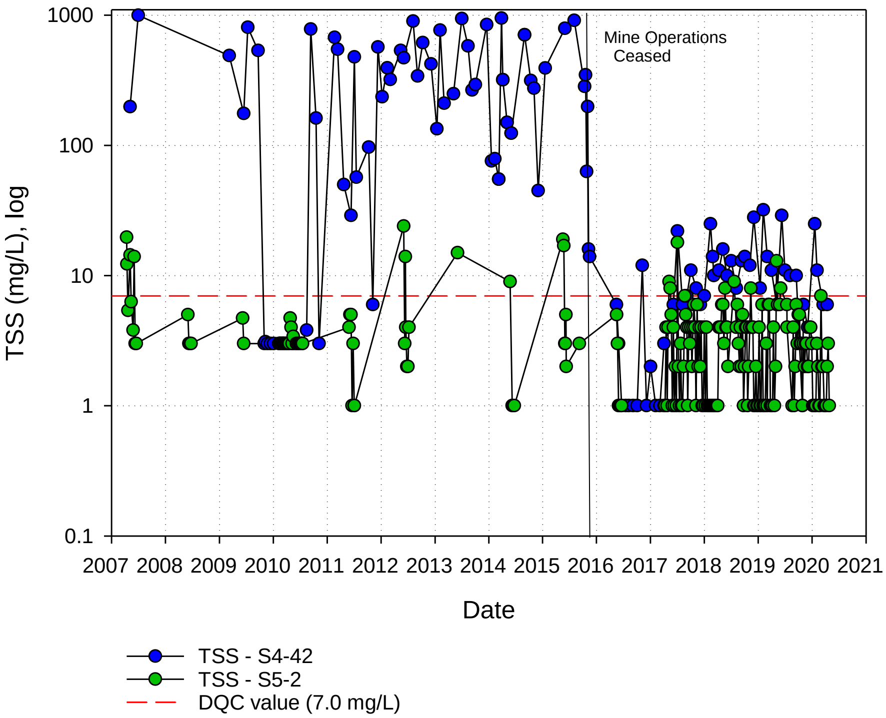

1.0
0.8
0.6
0.4
0.2
0.0
Ammonia (mg/L)
Mine Operations Ceased
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Ammonia - S4-13
Ammonia - S4-32

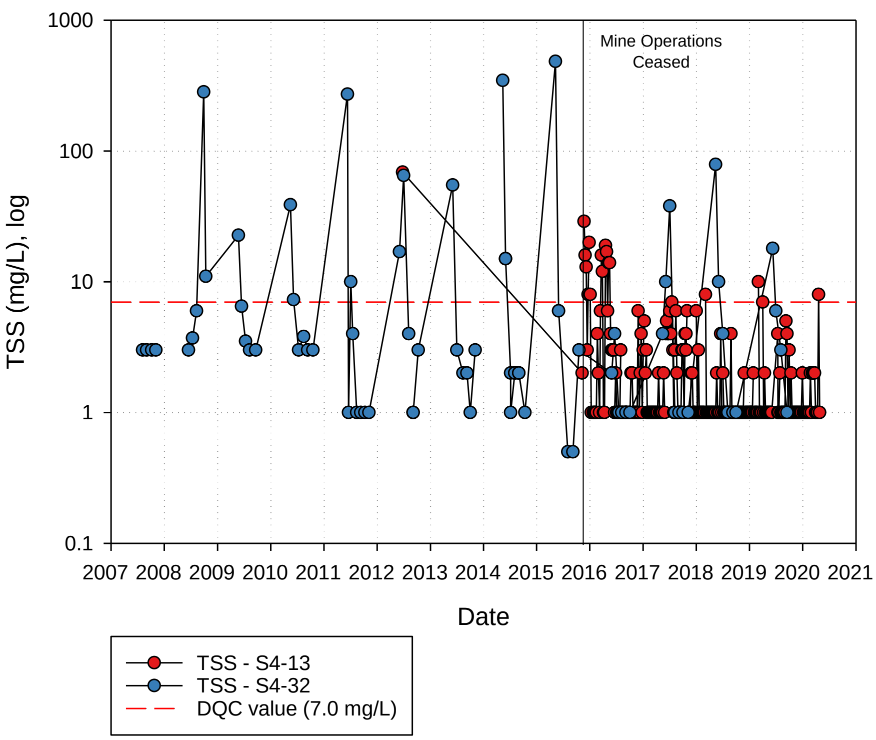

Chloride (mg/L)
35
30
25
20
15
10
5
0
Mine Operations
Ceased
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Chloride - S4-42
Chloride - S5-2
DQC value (366 mg/L)

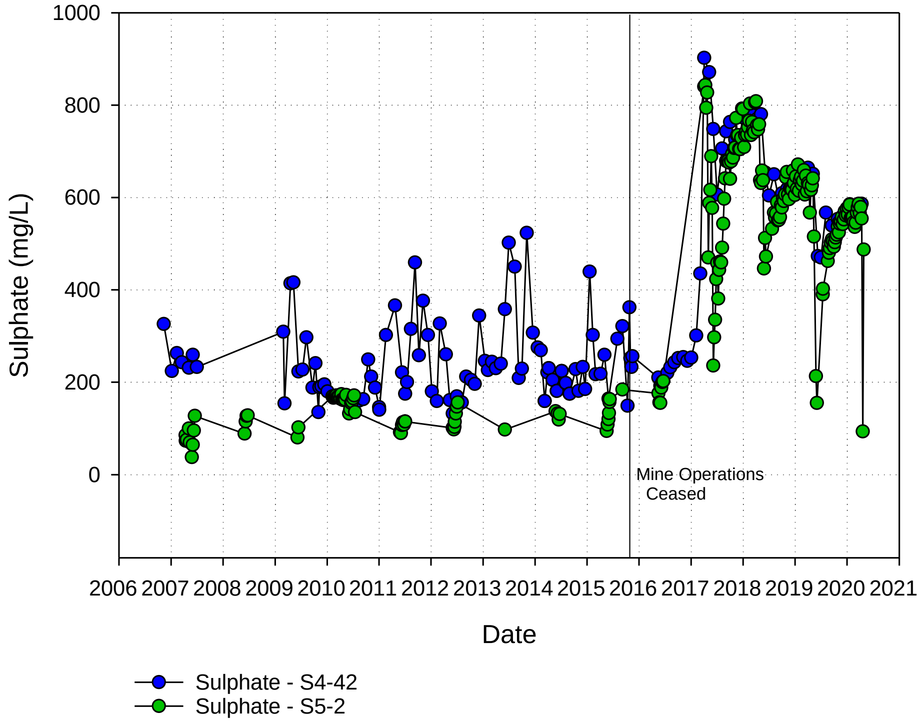

Chloride (mg/L)
14
12
10
8
6
4
2
0
Mine Operations
Ceased
2014
2015
2016
2017
2018
2019
2020
2021
Date
Chloride - S4-13
Chloride - S4-32
DQC value (366 mg/L)

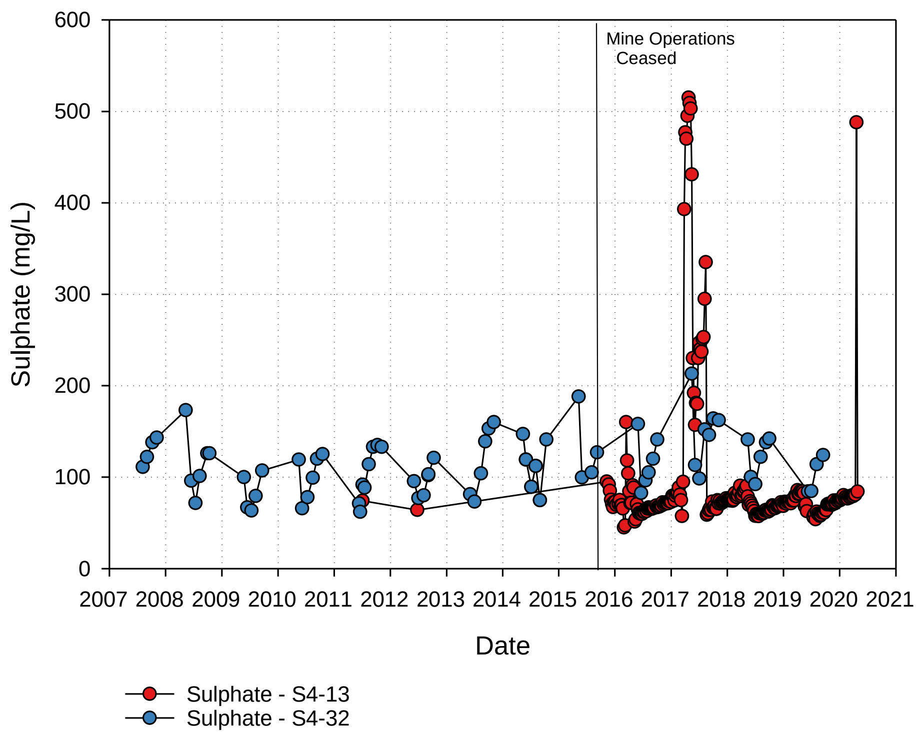

14
12
10
8
6
4
2
0
pH
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Mine Operations Ceased
pH (Lab) - S4-42
pH (Lab) - S5-2

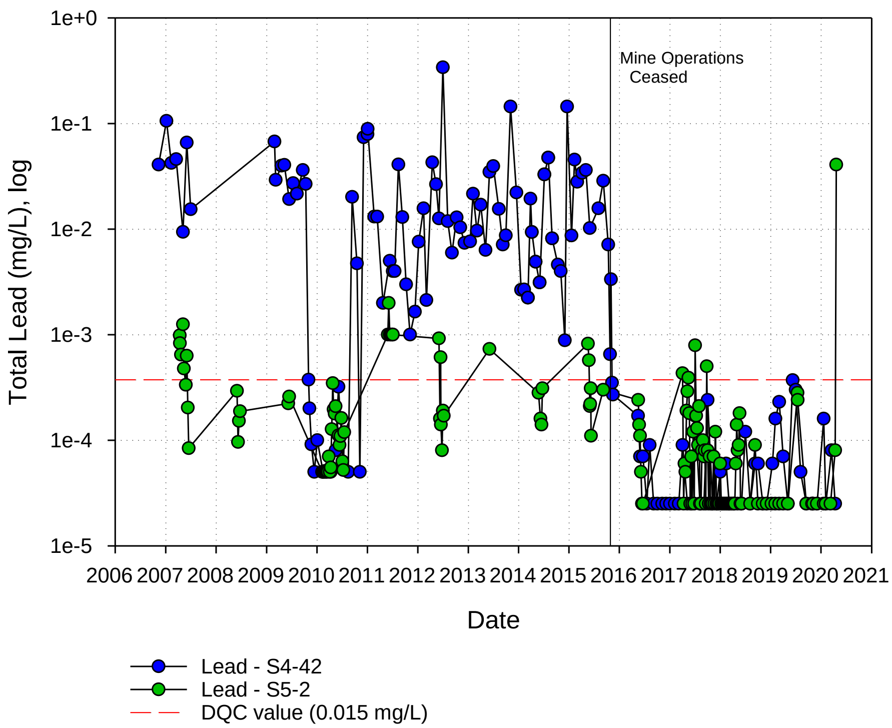

14
12
10
8
6
4
2
0
pH
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Mine Operations Ceased
pH (Lab) - S4-13
pH (Lab) - S4-32

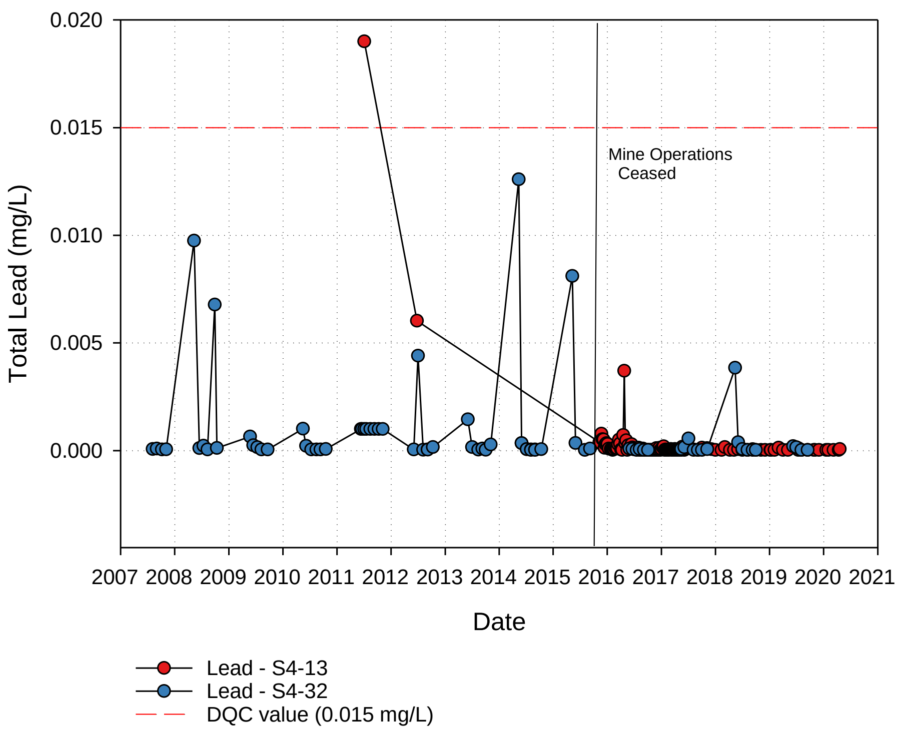

TSS (mg/L), log
1000
100
10
1
0.1
Mine Operations Ceased
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
TSS - S4-42
TSS - S5-2
DQC value (7.0 mg/L)

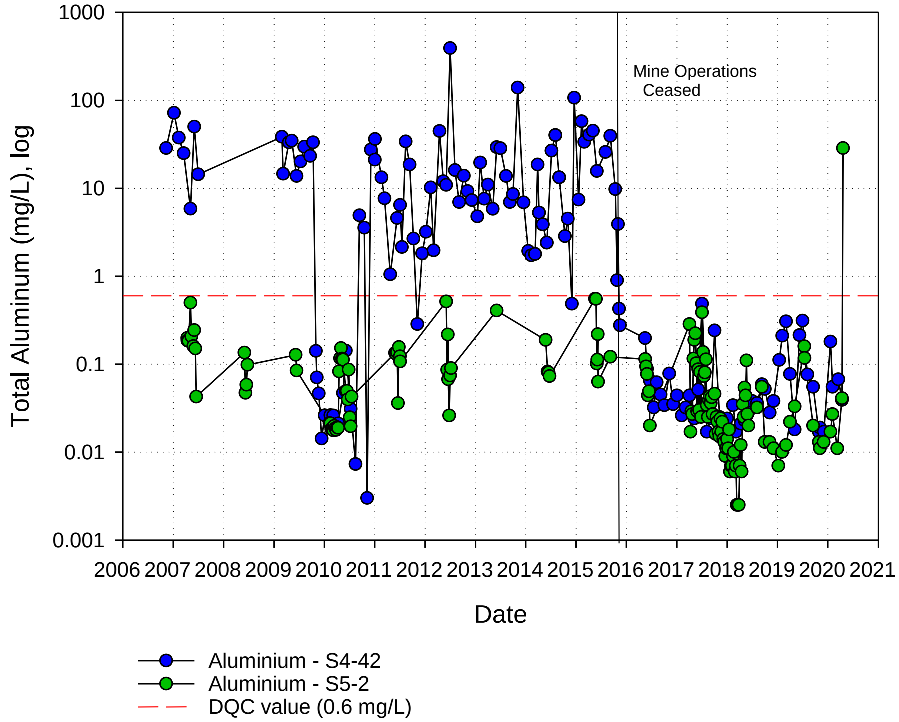

TSS (mg/L), log
1000
100
10
1
0.1
Mine Operations Ceased
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
TSS - S4-13
TSS - S4-32
DQC value (7.0 mg/L)

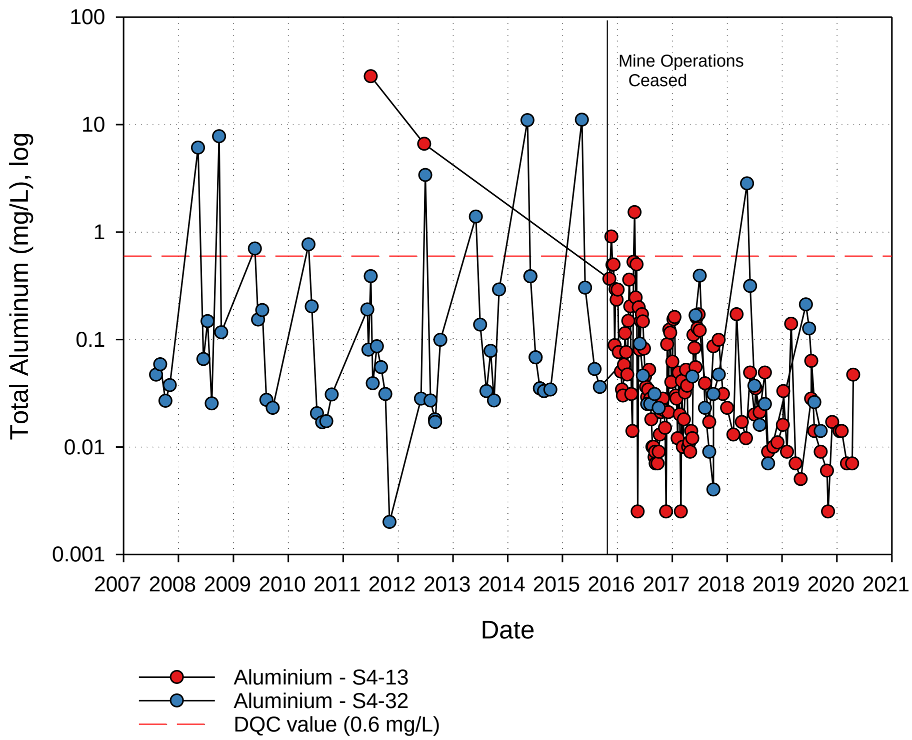

1000
800
600
400
200
0
Sulphate (mg/L)
Mine Operations
Ceased
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Sulphate - S4-42
Sulphate - S5-2

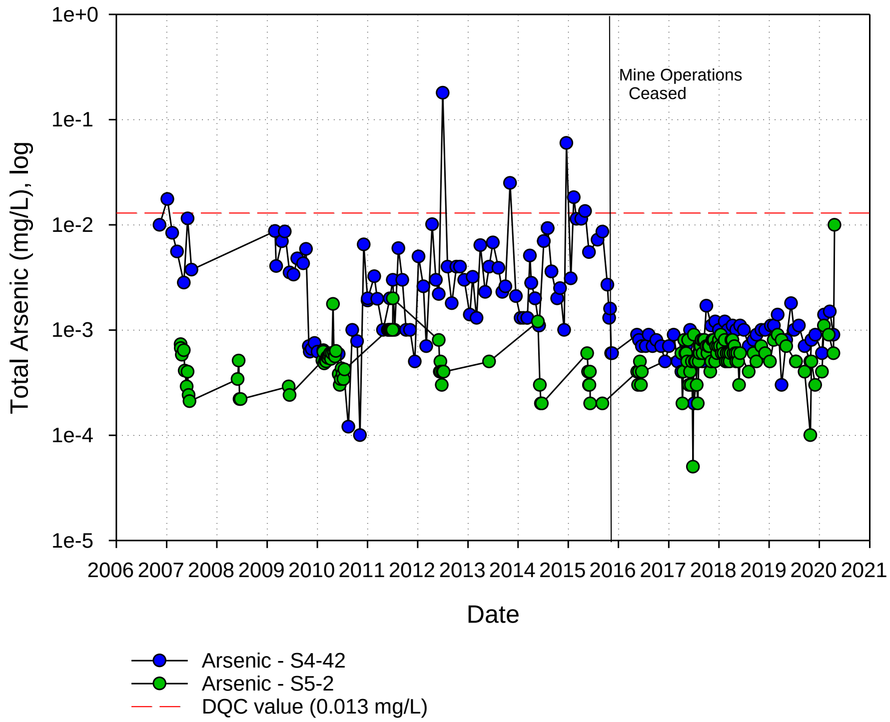

600
500
400
300
200
100
0
Sulphate (mg/L)
Mine Operations
Ceased
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Sulphate - S4-13
Sulphate - S4-32

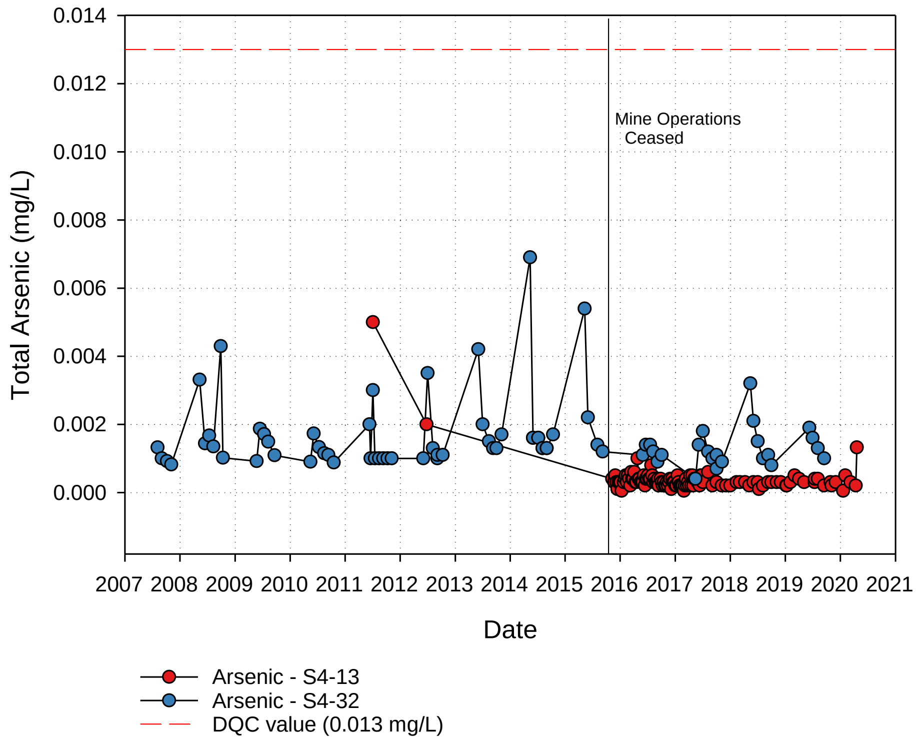

1e+0
1e-1
1e-2
1e-3
1e-4
1e-5
Total Lead (mg/L), log
Mine Operations
Ceased
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Lead - S4-42
Lead - S5-2
DQC value (0.015 mg/L)

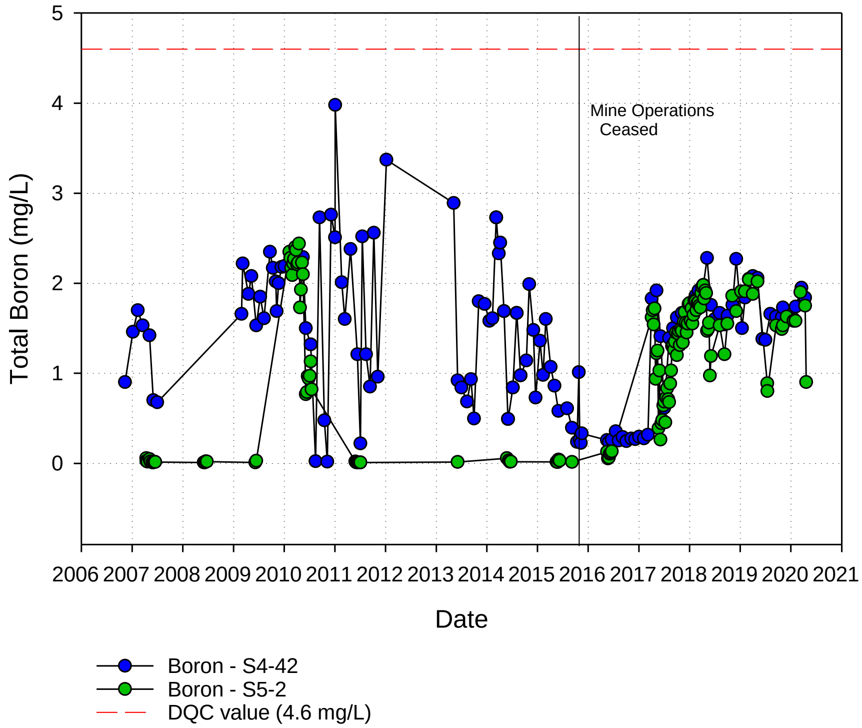

0.020
0.015
0.010
0.005
0.000
Total Lead (mg/L)
Mine Operations
Ceased
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Lead - S4-13
Lead - S4-32
DQC value (0.015 mg/L)

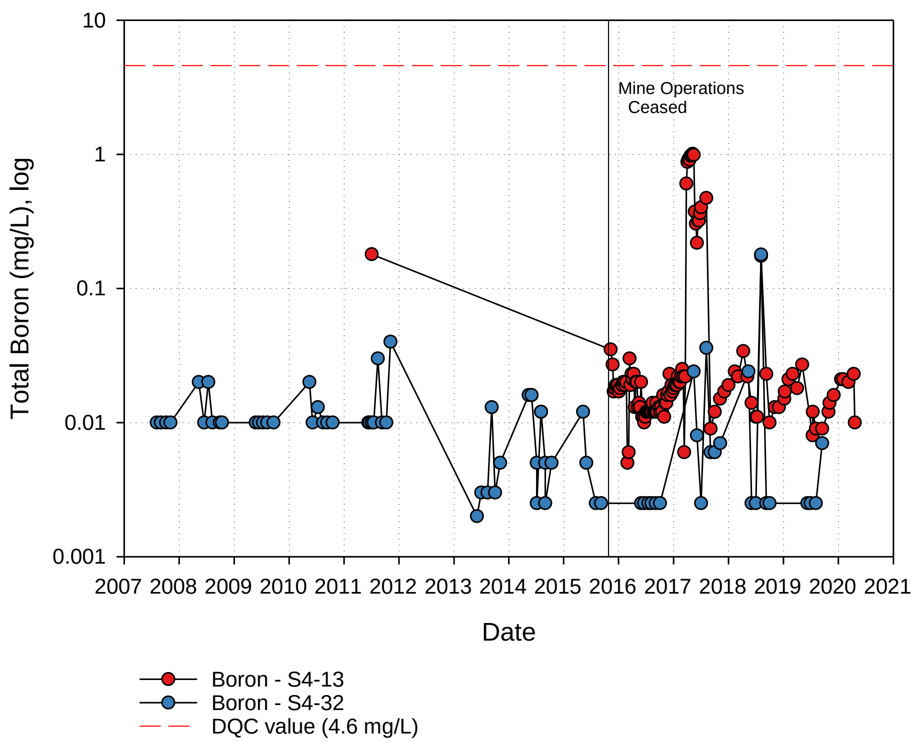

Total Aluminum (mg/L), log
1000
100
10
1
0.1
0.01
0.001
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Mine Operations Ceased
Aluminium - S4-42
Aluminium - S5-2
DQC value (0.6 mg/L)

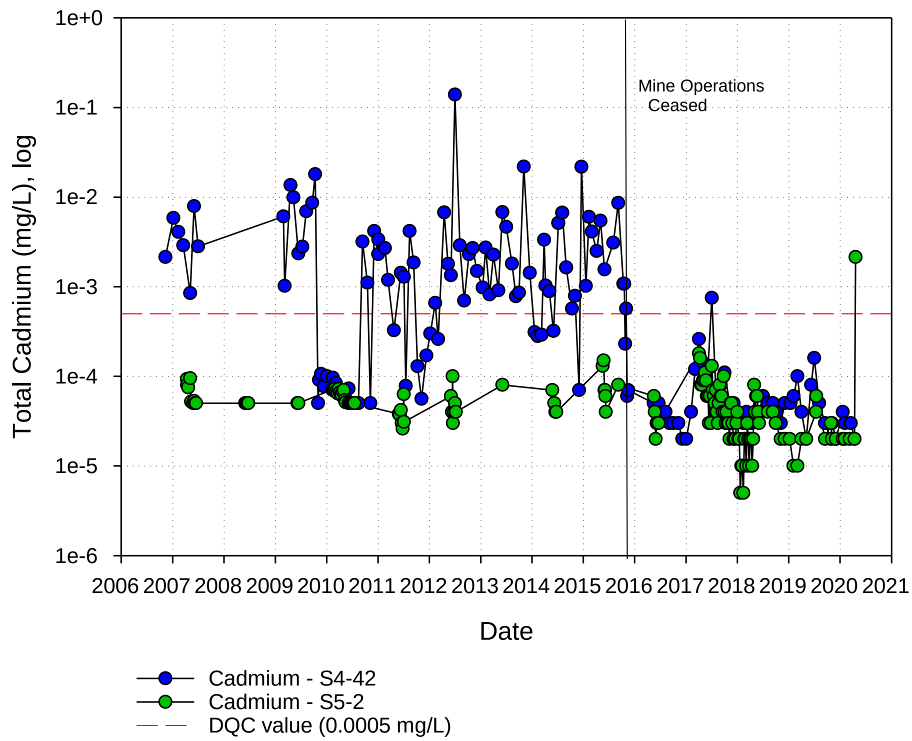

Total Aluminum (mg/L), log
100
10
1
0.1
0.01
0.001
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Mine Operations Ceased
Aluminium - S4-13
Aluminium - S4-32
DQC value (0.6 mg/L)

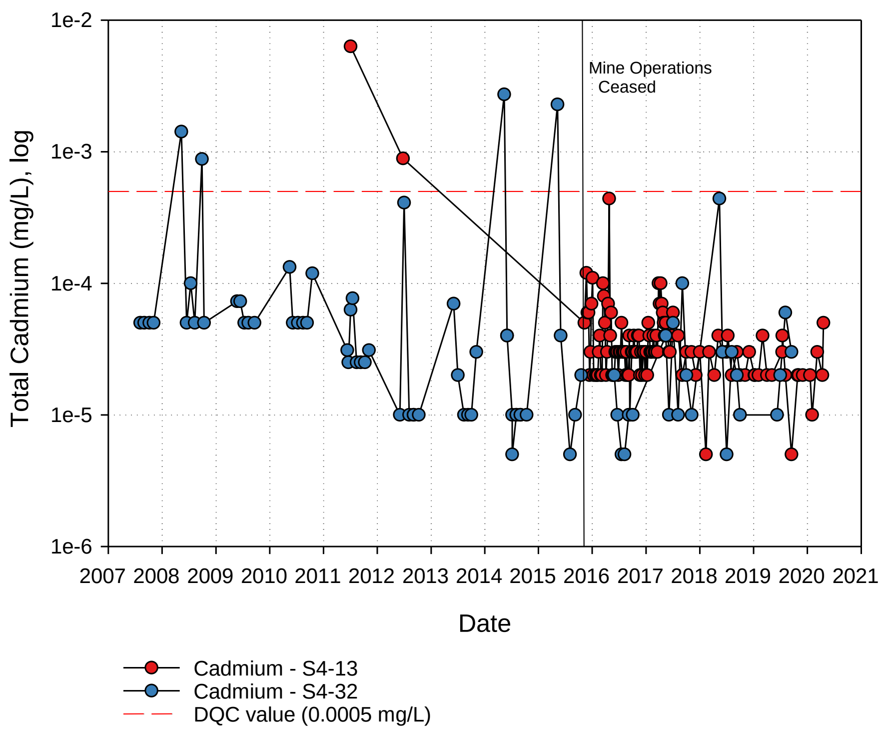

1e+0
1e-1
1e-2
1e-3
1e-4
1e-5
Total Arsenic (mg/L), log
Mine Operations Ceased
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Arsenic - S4-42
Arsenic - S5-2
DQC value (0.013 mg/L)

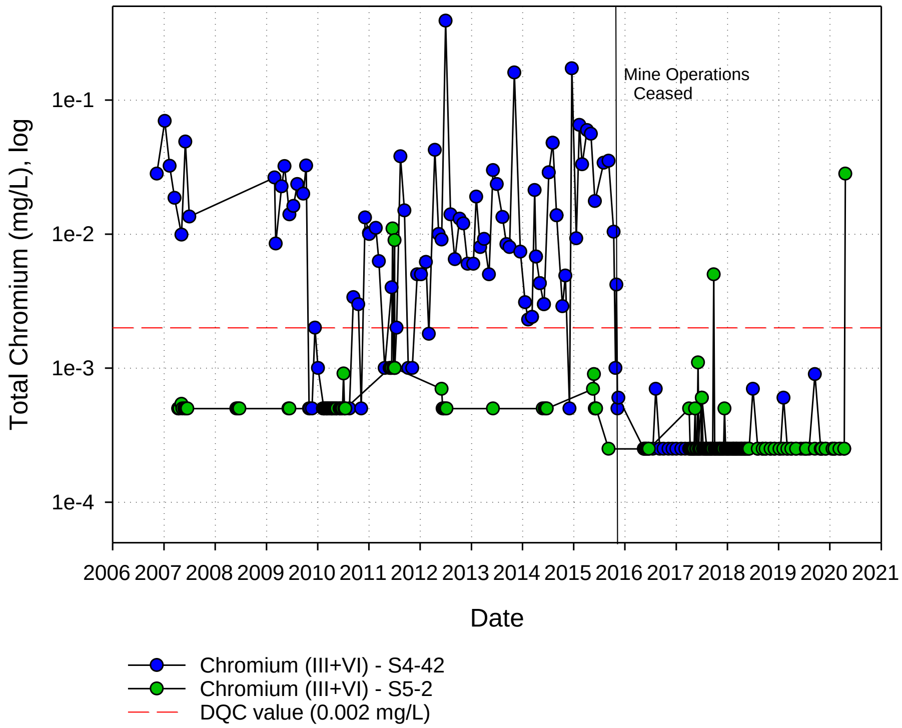

0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
Total Arsenic (mg/L)
Mine Operations Ceased
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Arsenic - S4-13
Arsenic - S4-32
DQC value (0.013 mg/L)

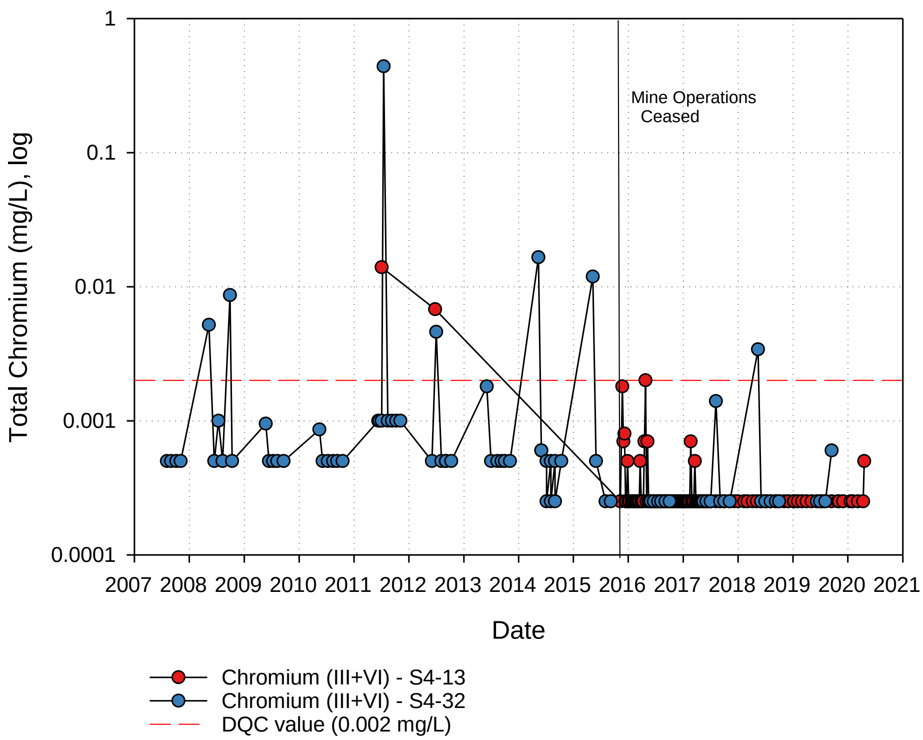

5
4
3
2
1
0
Total Boron (mg/L)
Mine Operations Ceased
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Boron - S4-42
Boron - S5-2
DQC value (4.6 mg/L)

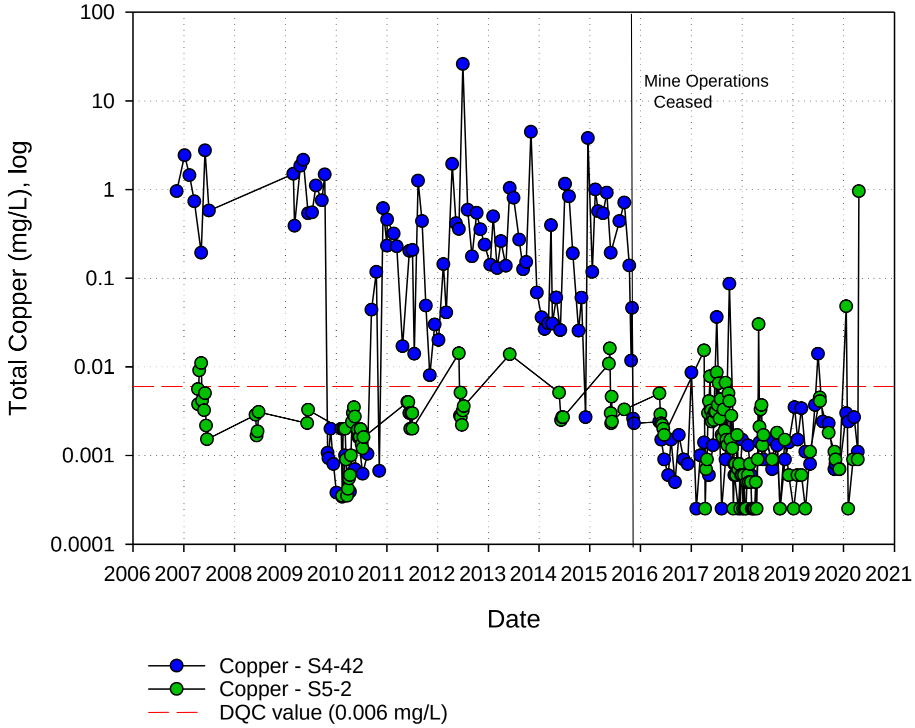

10
1
0.1
0.01
0.001
Total Boron (mg/L), log
Mine Operations Ceased
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Boron - S4-13
Boron - S4-32
DQC value (4.6 mg/L)

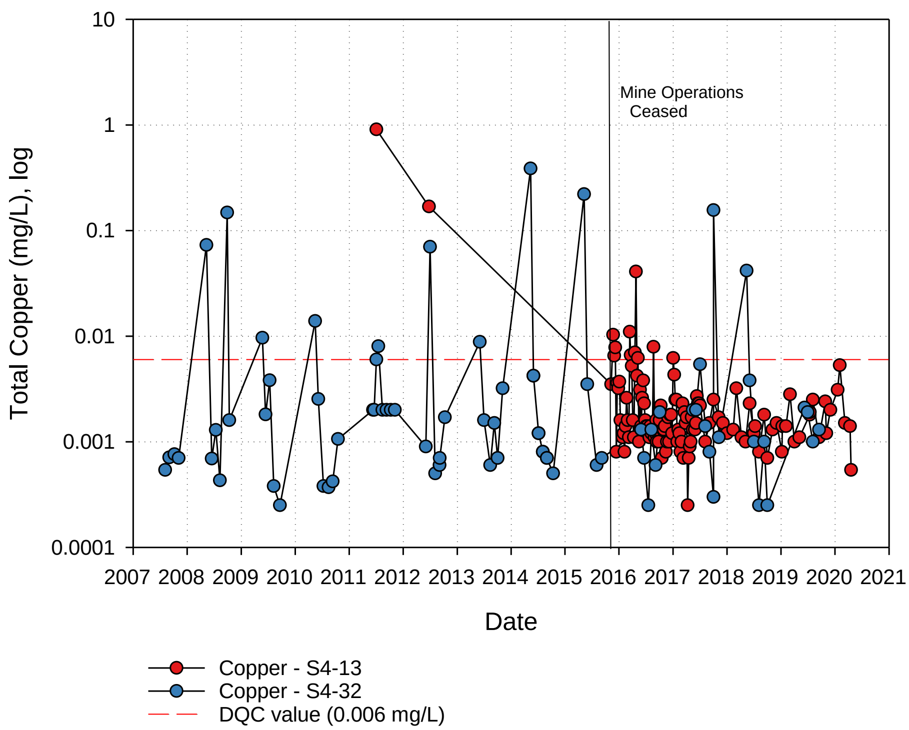

1e+0
1e-1
1e-2
1e-3
1e-4
1e-5
1e-6
Total Cadmium (mg/L), log
Mine Operations
Ceased
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Cadmium - S4-42
Cadmium - S5-2
DQC value (0.0005 mg/L)

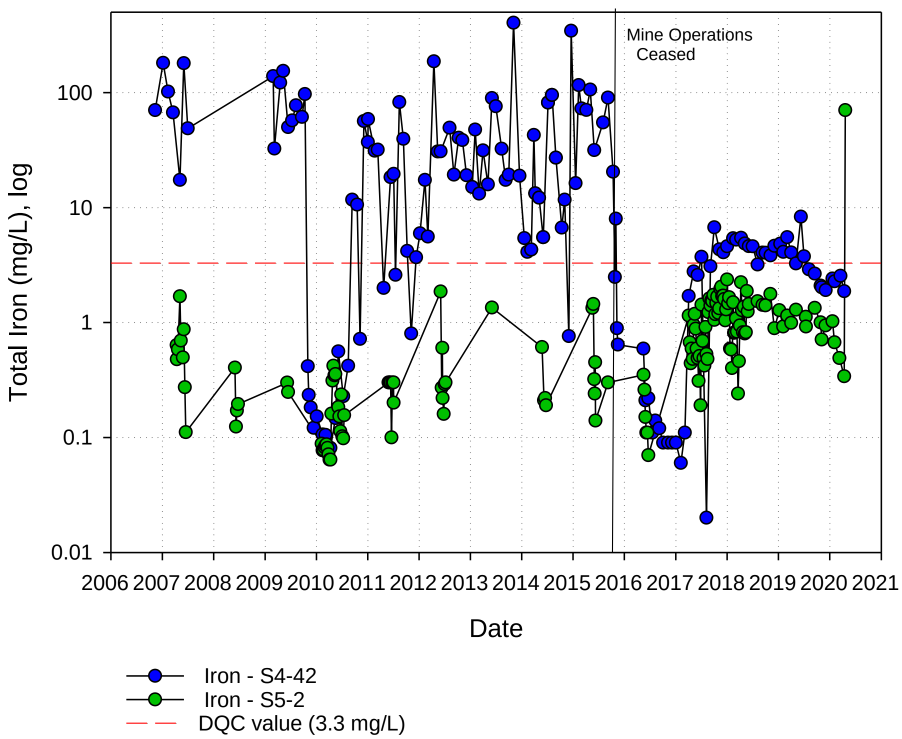

1e-2
1e-3
1e-4
1e-5
1e-6
Total Cadmium (mg/L), log
Mine Operations
Ceased
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Cadmium - S4-13
Cadmium - S4-32
DQC value (0.0005 mg/L)

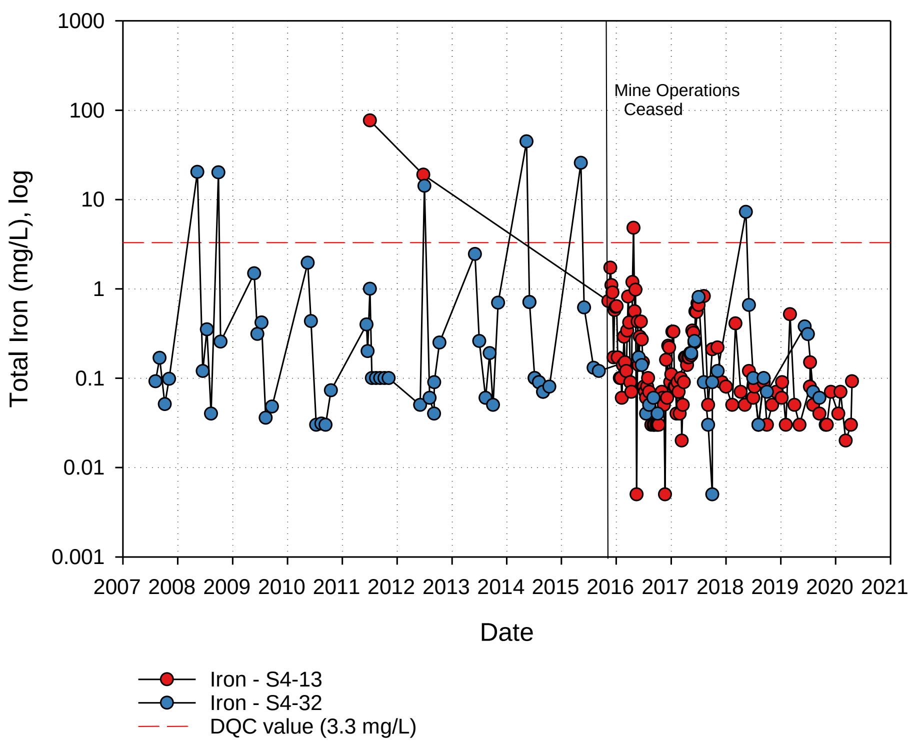

Mine Operations Ceased
1e-1
1e-2
1e-3
1e-4
Total Chromium (mg/L), log
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Chromium (III+VI) - S4-42
Chromium (III+VI) - S5-2
DQC value (0.002 mg/L)

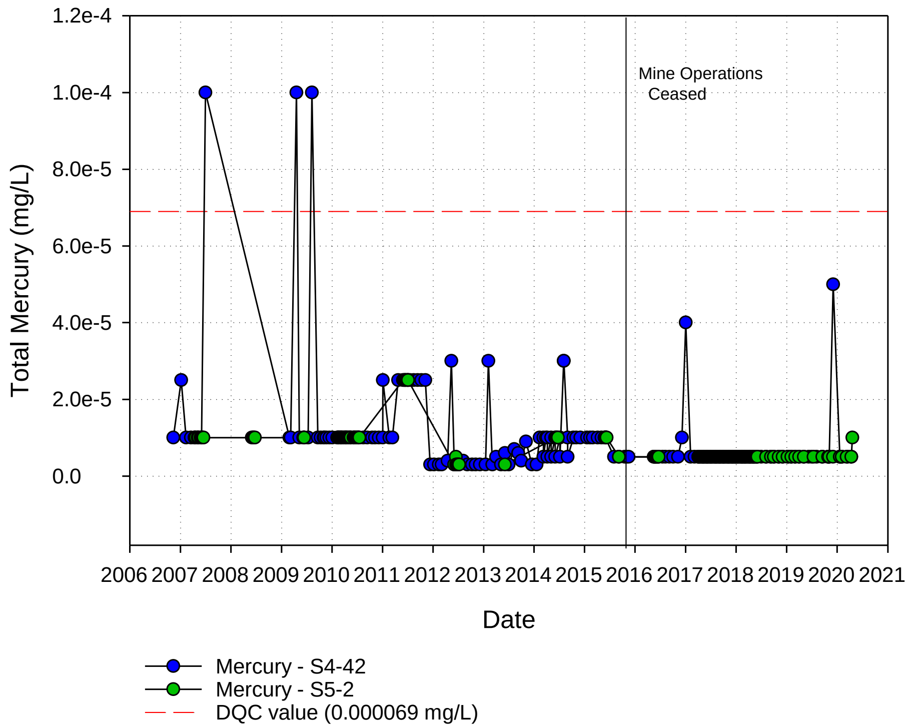

Mine Operations Ceased
1
0.1
0.01
0.001
0.0001
Total Chromium (mg/L), log
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Chromium (III+VI) - S4-13
Chromium (III+VI) - S4-32
DQC value (0.002 mg/L)

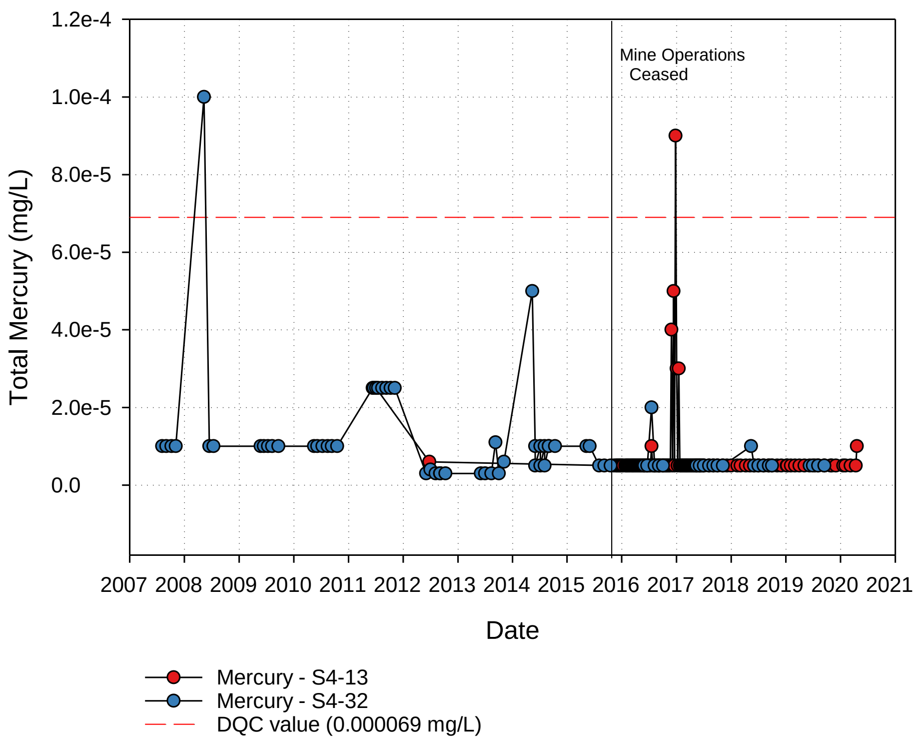

100
10
1
0.1
0.01
0.001
0.0001
Total Copper (mg/L), log
Mine Operations
Ceased
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Copper - S4-42
Copper - S5-2
DQC value (0.006 mg/L)

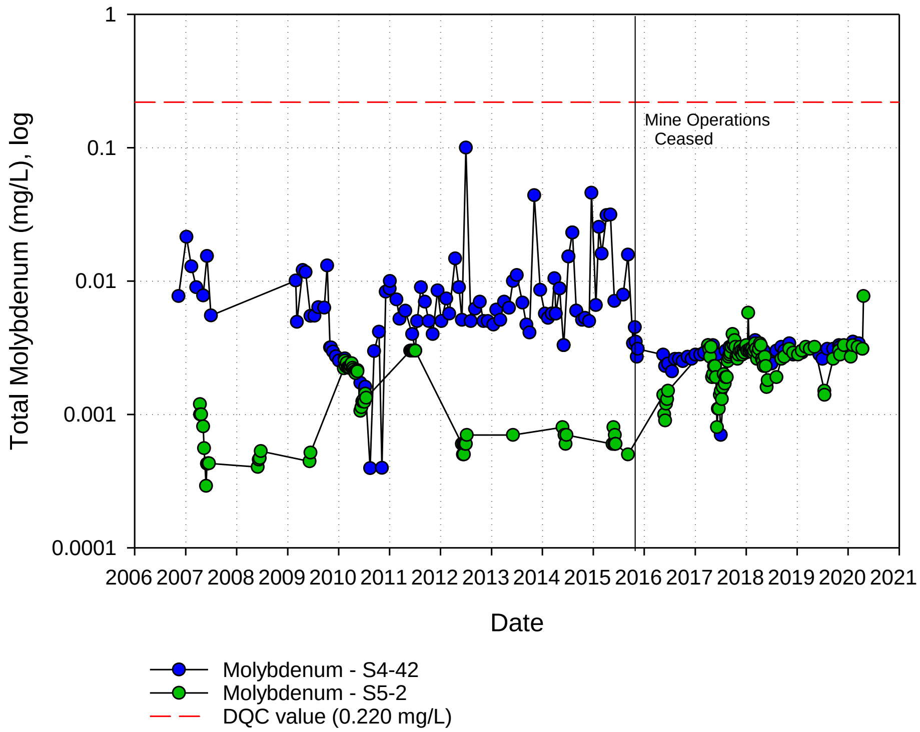

10
1
0.1
0.01
0.001
0.0001
Total Copper (mg/L), log
Mine Operations
Ceased
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Copper - S4-13
Copper - S4-32
DQC value (0.006 mg/L)

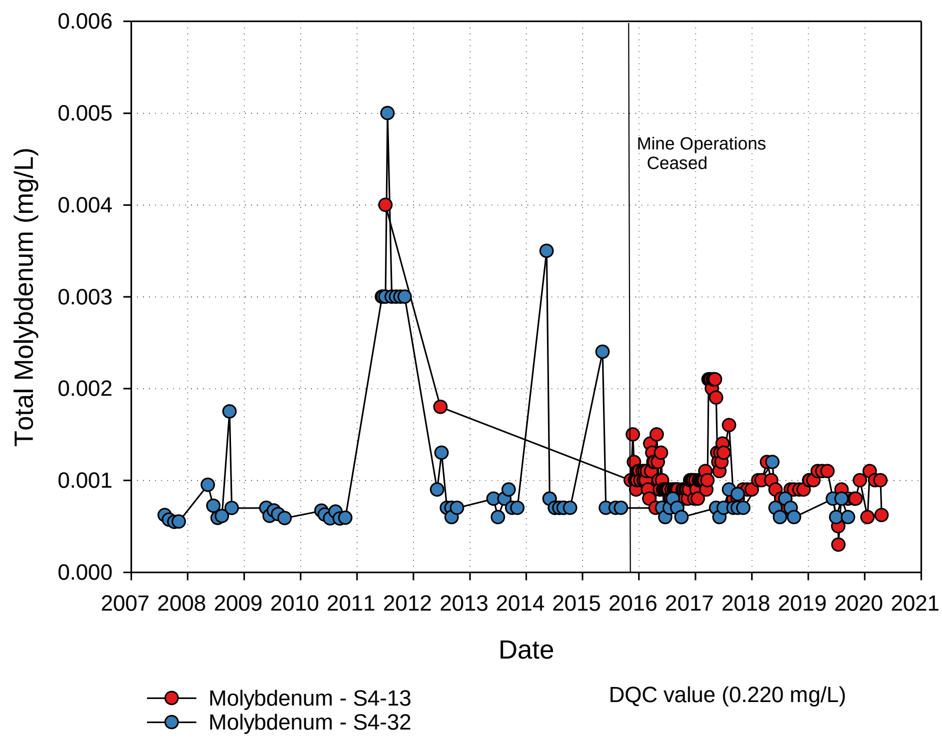

Mine Operations Ceased
Total Iron (mg/L), log
100
10
1
0.1
0.01
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Iron - S4-42
Iron - S5-2
DQC value (3.3 mg/L)

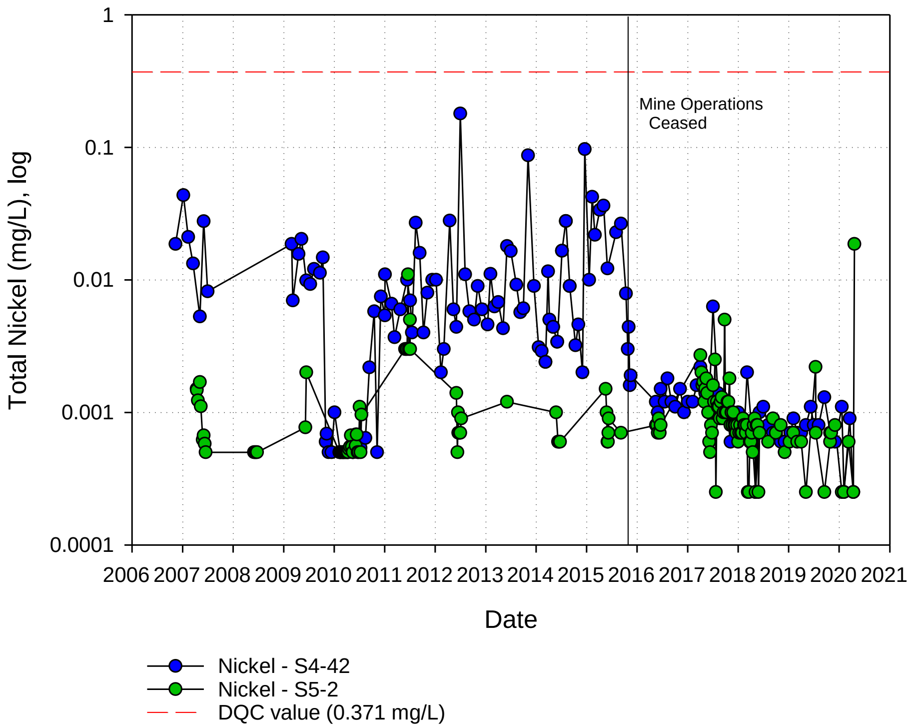

Mine Operations Ceased
Total Iron (mg/L), log
1000
100
10
1
0.1
0.01
0.001
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Iron - S4-13
Iron - S4-32
DQC value (3.3 mg/L)

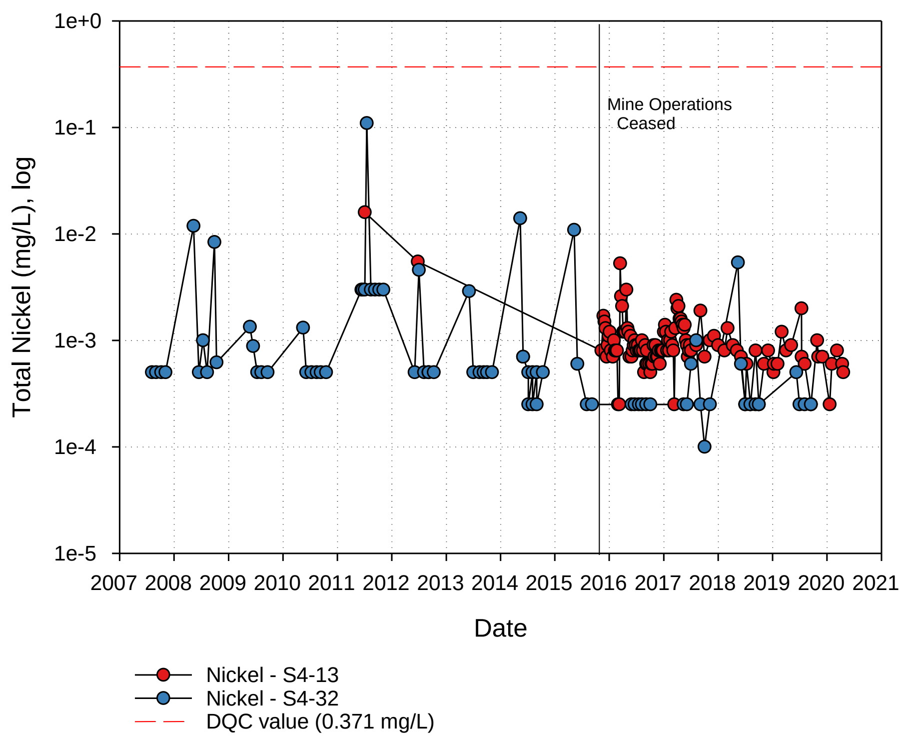

Total Mercury (mg/L)
1.2e-4
1.0e-4
8.0e-5
6.0e-5
4.0e-5
2.0e-5
0.0
Mine Operations Ceased
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Mercury - S4-42
Mercury - S5-2
DQC value (0.000069 mg/L)

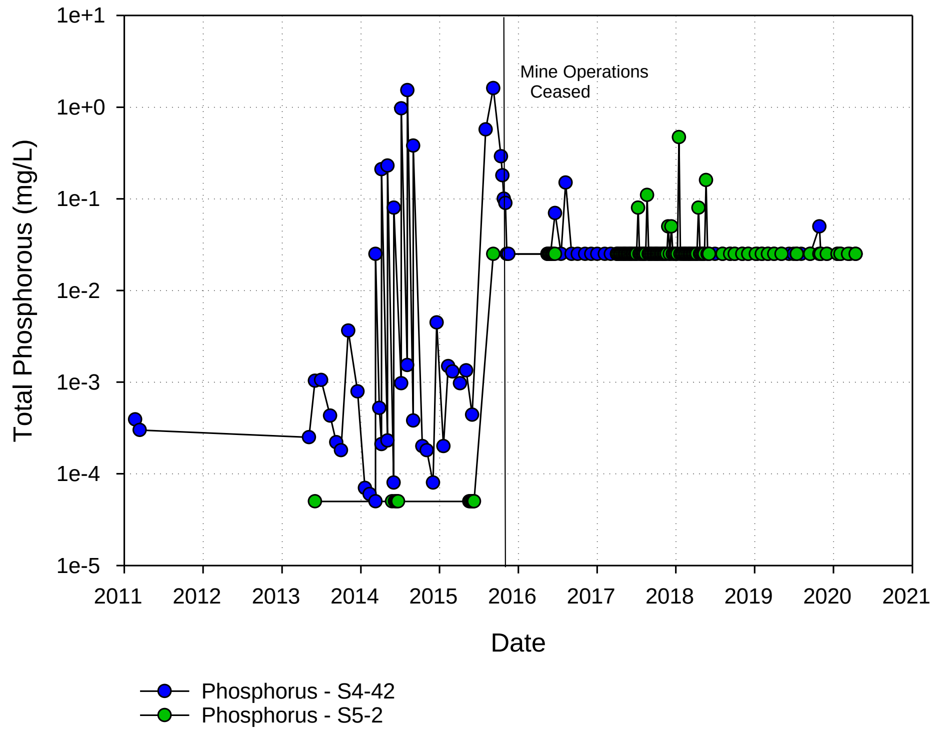

Total Mercury (mg/L)
1.2e-4
1.0e-4
8.0e-5
6.0e-5
4.0e-5
2.0e-5
0.0
Mine Operations Ceased
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Mercury - S4-13
Mercury - S4-32
DQC value (0.000069 mg/L)

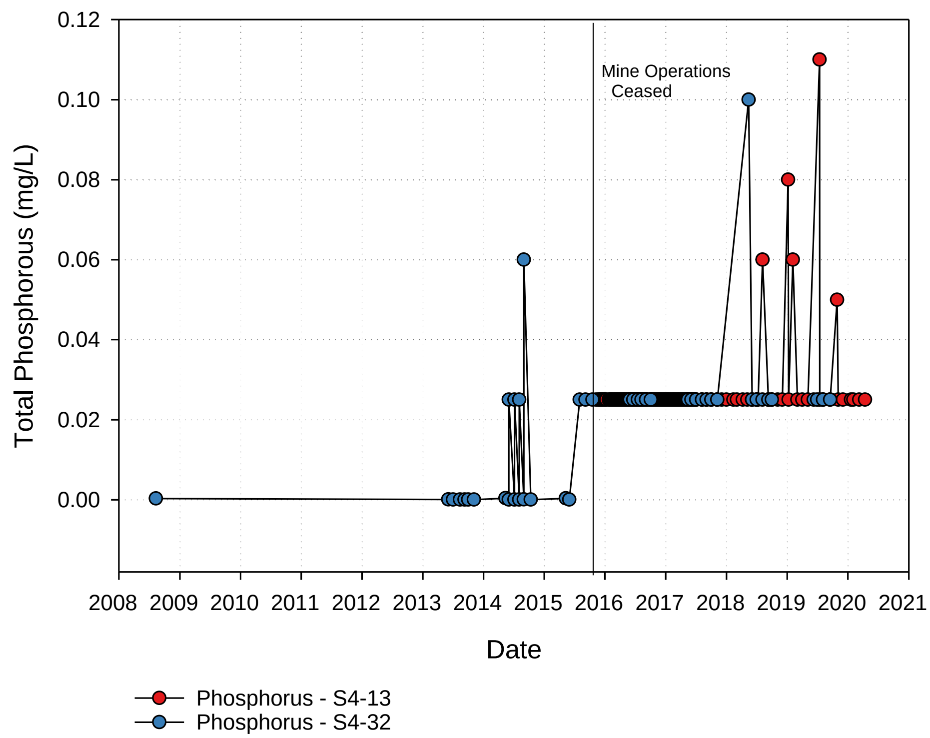

1
0.1
0.01
0.001
0.0001
Total Molybdenum (mg/L), log
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Mine Operations
Ceased
Molybdenum - S4-42
Molybdenum - S5-2
DQC value (0.220 mg/L)

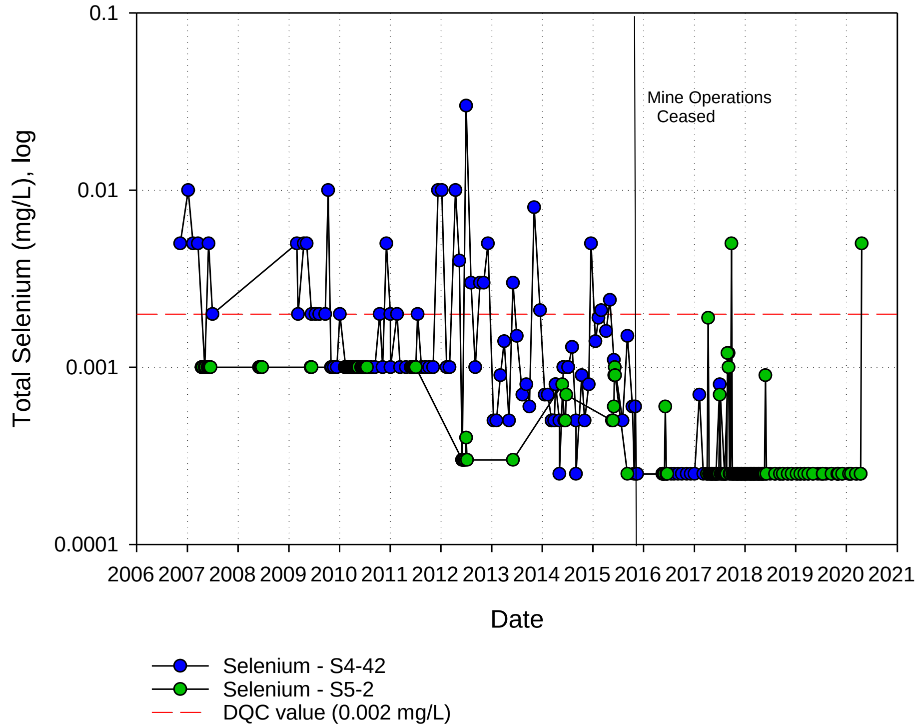

0.006
0.005
0.004
0.003
0.002
0.001
0.000
Total Molybdenum (mg/L)
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Mine Operations
Ceased
Molybdenum - S4-13
Molybdenum - S4-32
DQC value (0.220 mg/L)

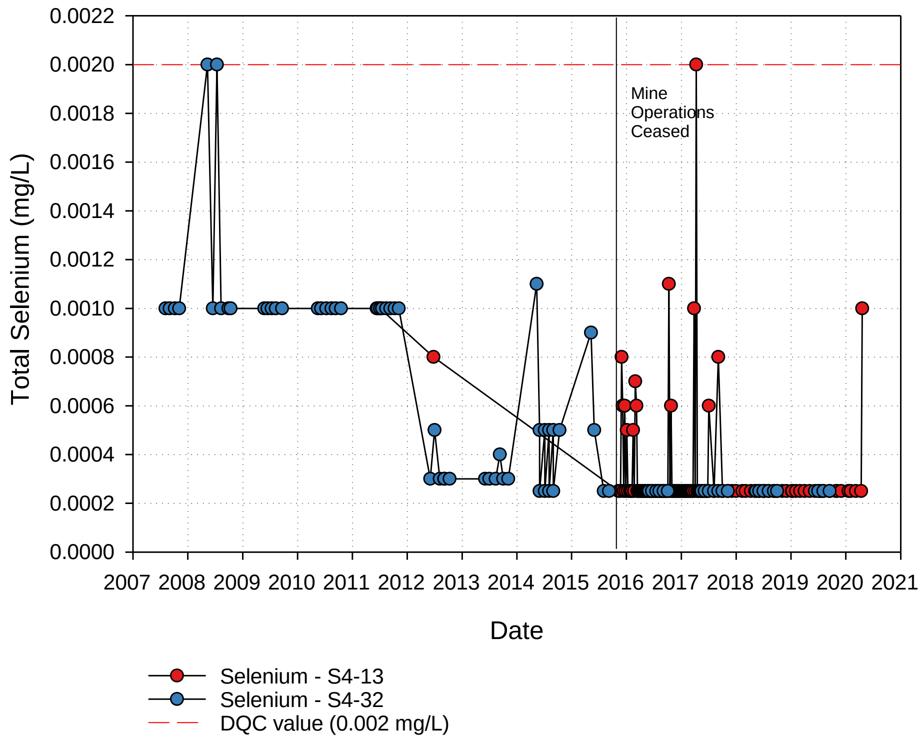

Total Nickel (mg/L), log
1
0.1
0.01
0.001
0.0001
Mine Operations Ceased
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Nickel - S4-42
Nickel - S5-2
DQC value (0.371 mg/L)

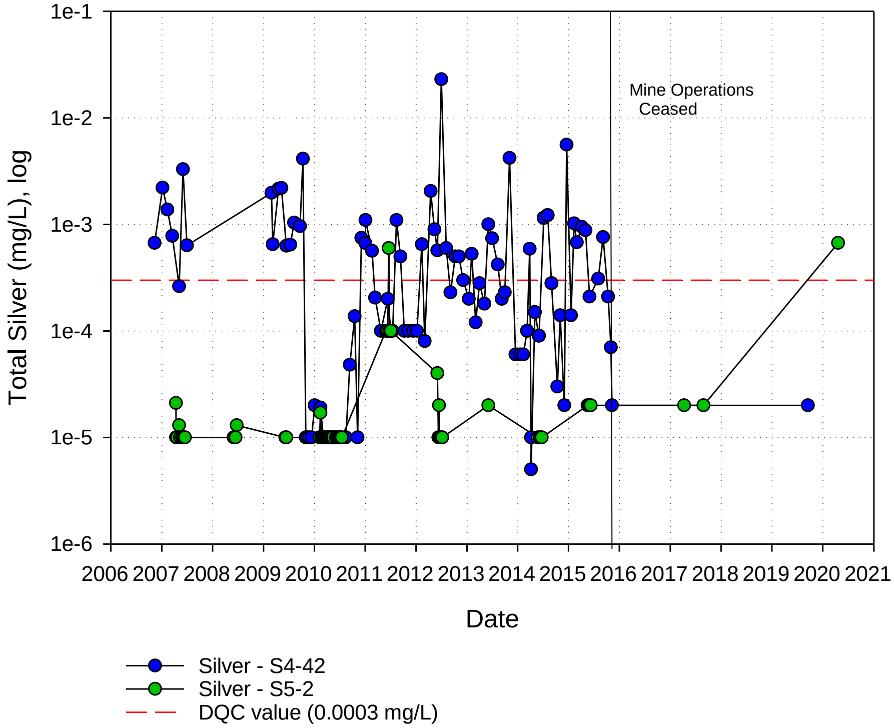

Total Nickel (mg/L), log
1e+0
1e-1
1e-2
1e-3
1e-4
1e-5
Mine Operations Ceased
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Nickel - S4-13
Nickel - S4-32
DQC value (0.371 mg/L)

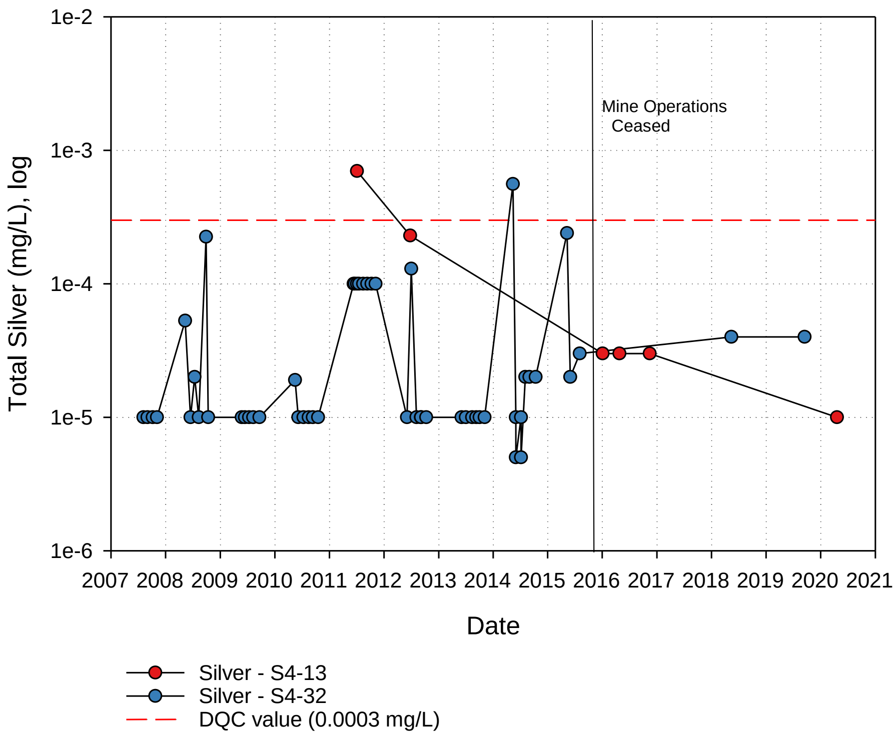

1e+1
1e+0
1e-1
1e-2
1e-3
1e-4
1e-5
Total Phosphorus (mg/L)
Mine Operations Ceased
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Phosphorus - S4-42
Phosphorus - S5-2

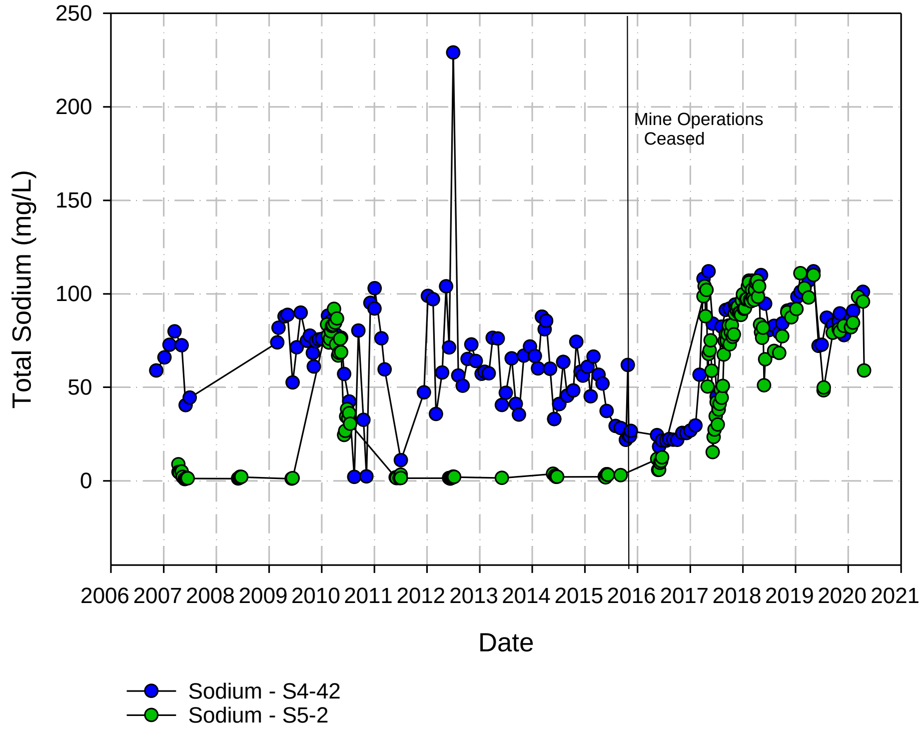

0.12
0.10
0.08
0.06
0.04
0.02
0.00
Total Phosphorous (mg/L)
Mine Operations Ceased
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Date
Phosphorus - S4-13
Phosphorus - S4-32

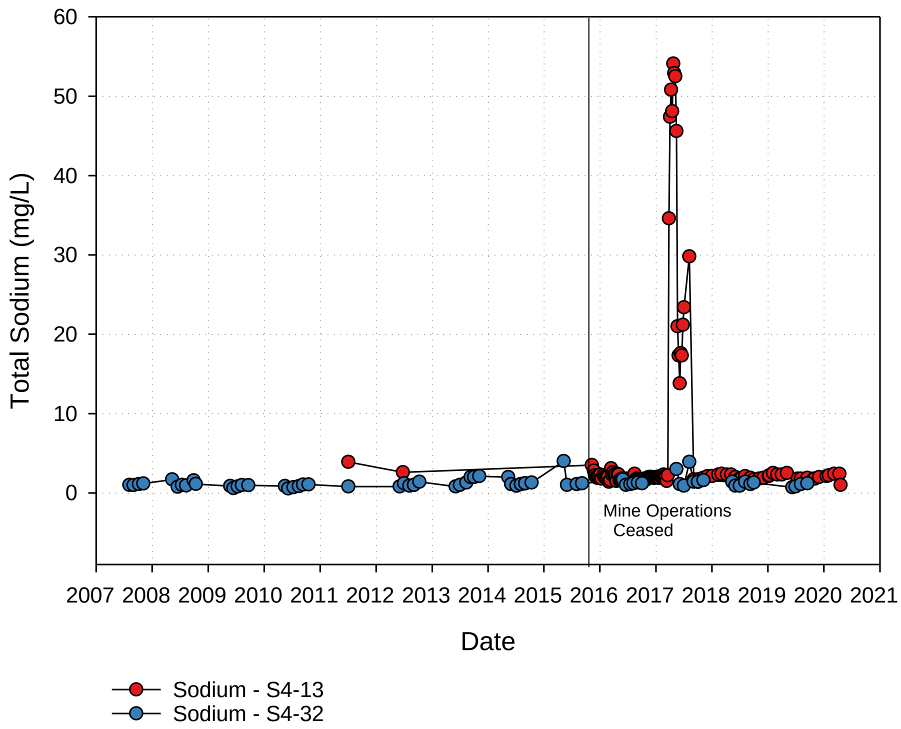

0.1
0.01
0.001
0.0001
Total Selenium (mg/L), log
Mine Operations
Ceased
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Selenium - S4-42
Selenium - S5-2
DQC value (0.002 mg/L)

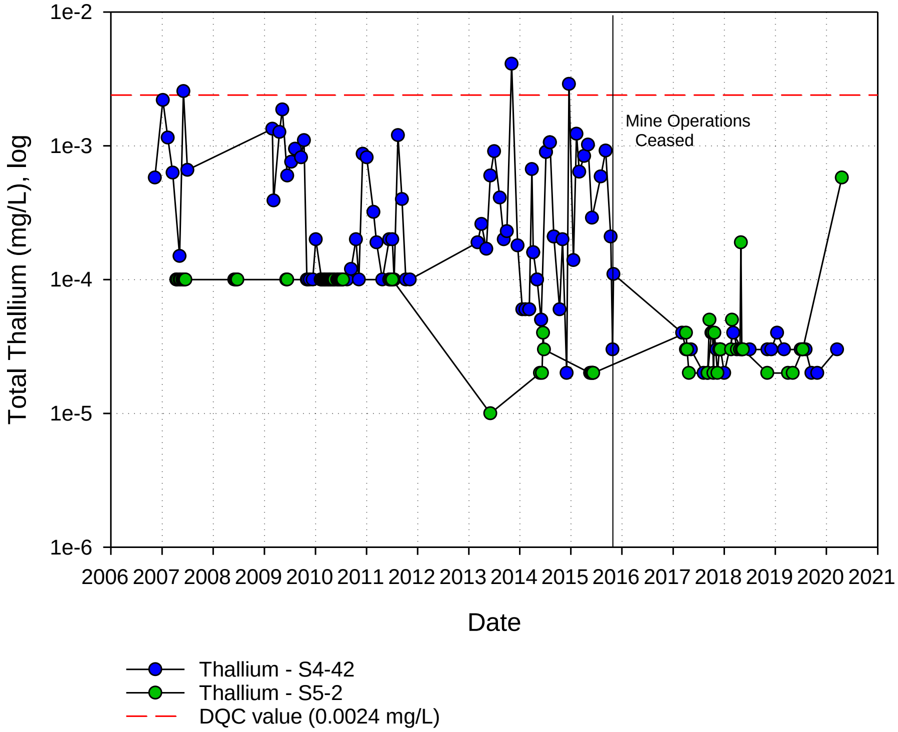

0.0022
0.0020
0.0018
0.0016
0.0014
0.0012
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
Total Selenium (mg/L)
Mine
Operations
Ceased
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Selenium - S4-13
Selenium - S4-32
DQC value (0.002 mg/L)

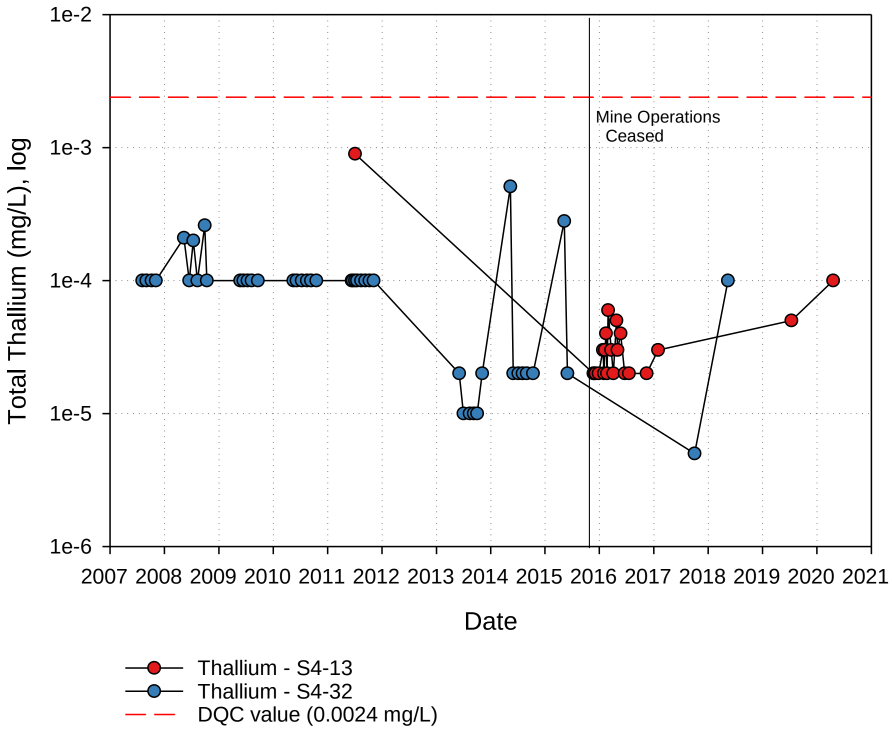

Total Silver (mg/L), log
1e-1
1e-2
1e-3
1e-4
1e-5
1e-6
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Mine Operations Ceased
Silver - S4-42
Silver - S5-2
DQC value (0.0003 mg/L)

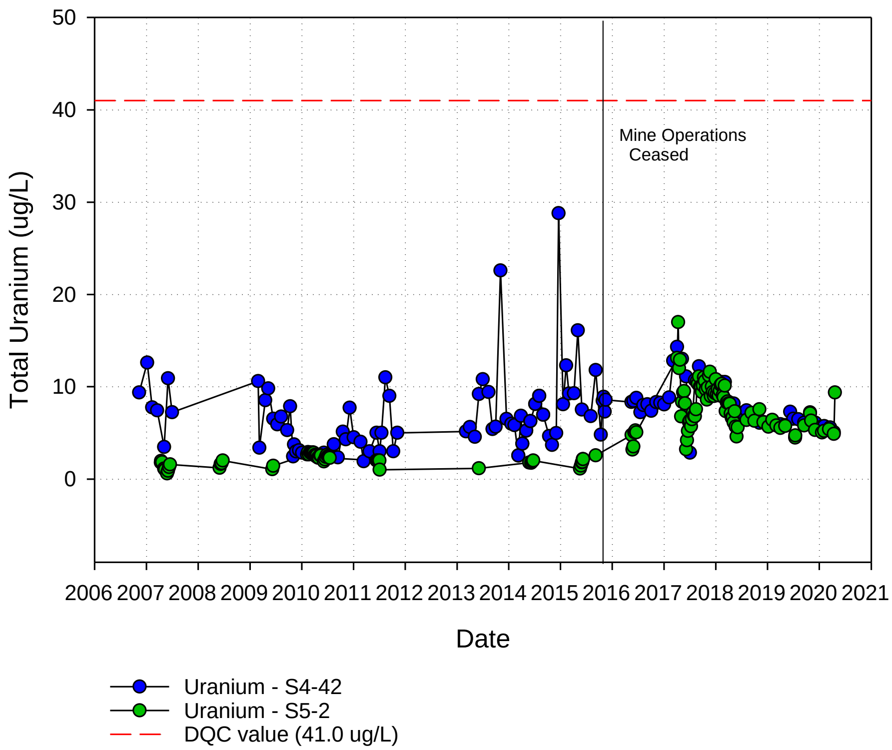

Total Silver (mg/L), log
1e-2
1e-3
1e-4
1e-5
1e-6
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Mine Operations Ceased
Silver - S4-13
Silver - S4-32
DQC value (0.0003 mg/L)

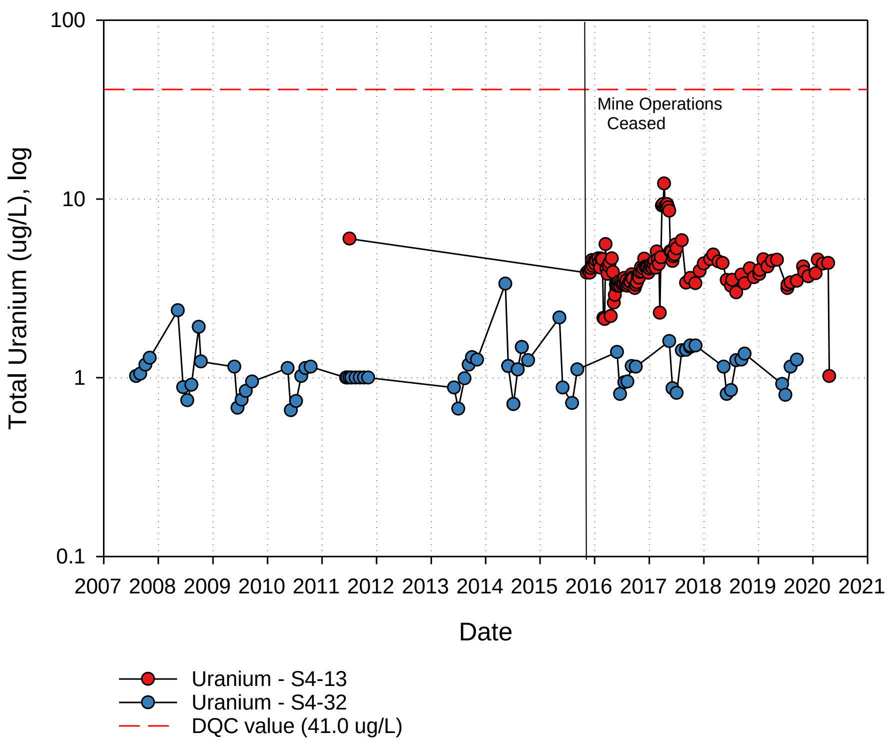

Total Sodium (mg/L)
250
200
150
100
50
0
Mine Operations Ceased
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Sodium - S4-42
Sodium - S5-2

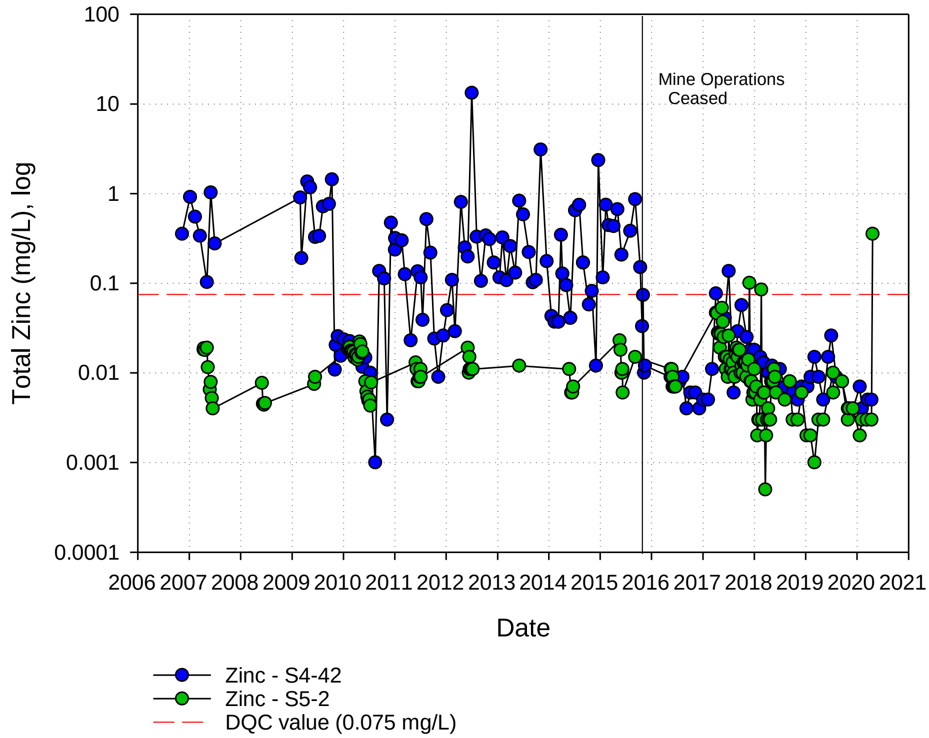

Total Sodium (mg/L)
60
50
40
30
20
10
0
Mine Operations Ceased
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Sodium - S4-13
Sodium - S4-32

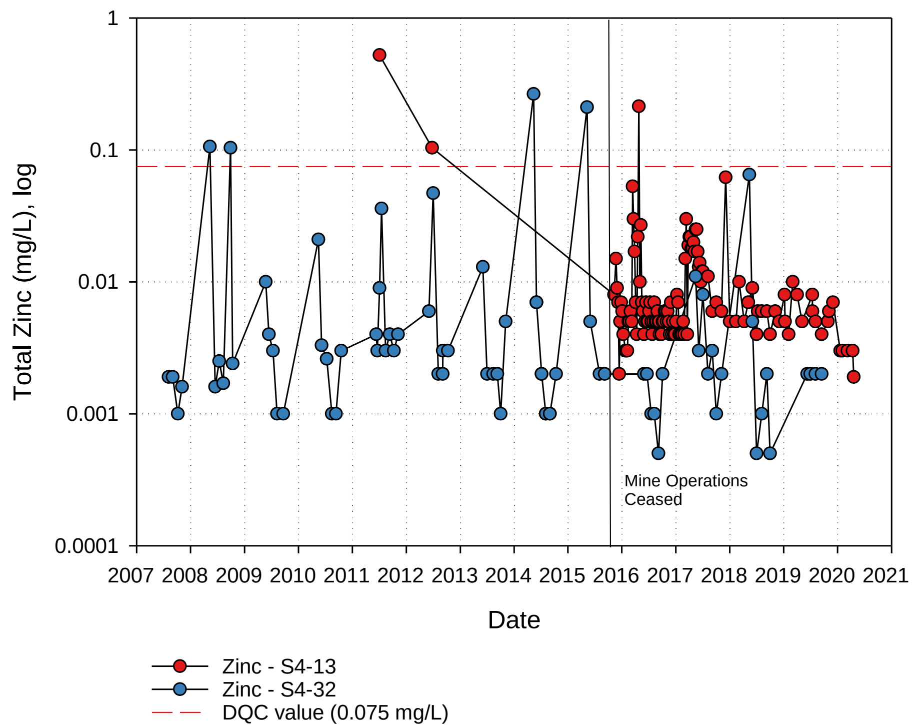

1e-2
1e-3
1e-4
1e-5
1e-6
Total Thallium (mg/L), log
Mine Operations
Ceased
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Thallium - S4-42
Thallium - S5-2
DQC value (0.0024 mg/L)


1e-2
1e-3
1e-4
1e-5
1e-6
Total Thallium (mg/L), log
Mine Operations
Ceased
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Thallium - S4-13
Thallium - S4-32
DQC value (0.0024 mg/L)


Total Uranium (ug/L)
50
40
30
20
10
0
Mine Operations Ceased
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Uranium - S4-42
Uranium - S5-2
DQC value (41.0 ug/L)


Total Uranium (ug/L), log
100
10
1
0.1
Mine Operations Ceased
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Uranium - S4-13
Uranium - S4-32
DQC value (41.0 ug/L)


Total Zinc (mg/L), log
100
10
1
0.1
0.01
0.001
0.0001
Mine Operations Ceased
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Zinc - S4-42
Zinc - S5-2
DQC value (0.075 mg/L)


Total Zinc (mg/L), log
1
0.1
0.01
0.001
0.0001
Mine Operations Ceased
2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021
Date
Zinc - S4-13
Zinc - S4-32
DQC value (0.075 mg/L)

APPENDIX D

FLAT RIVER SURFACE WATER QUALITY DATA AND TIME-SERIES TREND PLOTS

Appendix D, Table 1 - Surface Water Quality in Flat River, Comparisons of Median and 95th Percentile Concentrations at Downstream/Midstream Locations to Background

						S4-5					S4-33R				
						Within mine area					Downstream				
		CCME - AW (Freshwater) [1]	Environmental Quality Guidelines for Alberta Surface Waters [2]	*Flat River WQO* [3]	*Background WQ at S4-29* [4]	n=167, November 2006 to December 2020					n=196, April 2006 to December 2020				
	Units					Min	Max	Mean	Median	95th Percentile[10]	Min	Max	Mean	Median	95th Percentile[10]
Alkalinity, as CaCO3 (total)	mg/L	*-*	*Minimum 20*	*-*	34	27	151	94	109	38	27	149	92	106	38
Ammonia	mg/L	*0.021-231* [5]	*0.018-190* [5]	*1.27*	0.05	0.005	0.18	0.026	0.01	0.11	0.005	0.30	0.026	0.01	0.081
Hardness	mg/L	*-*	*-*	*-*	185	53	213	149	168	195	55	266	146	164	189
Chloride	mg/L	*120*	*120*	*120*	0.15	0.08	9.9	1.4	0.7	5.9	0.11	8.4	1.1	0.7	4.3
Fluoride	mg/L	*0.12*		*1.03*	0.08	0.04	0.49	0.16	0.16	0.28	0.06	0.44	0.18	0.18	0.29
Silica	mg/L	*-*	*-*	*-*	5.7	3.7	6.6	5.0	5.1	6.0	2.8	6.5	5.1	5.5	6.3
Kjeldahl Nitrogen Total	mg/L	*-*	*-*	*-*	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.94	0.11	<0.05	0.47
Nitrate, as N	mg/L	*13*	*3*	*3.0*	0.11	<0.005	0.28	0.089	0.092	0.16	<0.005	0.28	0.084	0.088	0.13
Nitrite, as N	mg/L	*0.06*	*0.02-0.20* [6]	*0.06*	0.0068	0.001	**0.25**	<0.005	<0.005	**0.09**	0.001	**0.19**	0.01	<0.005	0.032
Sodium, filtered	mg/L	*-*	*-*	*-*	2.0	0.8	21.6	6.1	4.9	16.9	0.9	34.4	6.3	5.1	16.3
Sulphate	mg/L	*-*	128-429 [8]	*-*	79	29	97	66	71	90	31	93	66	70	88
Electrical Conductivity	uS/cm	*-*	*-*	*-*	359	128	444	313.3	351.5	418	130	428	308	343	405
pH	pH	*6.5-9*	*6.5-9*	*6.5-9*	7.4	6.5	8.3	7.8	7.9	7.3	7.0	8.4	7.9	7.9	7.3
TDS	mg/L	*-*	*-*	*-*	228	74	310	187	205	265	75	288	186	198	256
TOC	mg/L	*-*	*-*	*-*	1.04	<0.5	1.4	0.70	0.61	1.27	<0.5	2.1	0.794	0.7	1.77
TSS	mg/L	*-*	*-*	*6*	8	0.5	**144**	5	3	**15**	0.5	**186**	5	3	**12**
Total Metals															
Aluminium	mg/L	*0.005 / 0.1* [7]	*0.05 / 0.1* [7]	*0.3*	0.24	0.003	**9.5**	0.14	0.03	**0.43**	0.00	**10.2**	0.14	0.02	**0.33**
Antimony	mg/L				<0.0001	<0.0001	0.003	<0.0001	<0.0001	<0.0001	<0.0001	0.001	<0.0001	<0.0001	<0.0001
Arsenic	mg/L	*0.005*	*0.005*	*0.005*	0.0015	0.0003	**0.025**	0.001	0.001	0.003	0.0002	**0.028**	0.0013	0.0009	0.002
Barium	mg/L	*-*	*-*	*-*	0.06	0.0223	0.07	0.050	0.0547	0.063	0.018	0.07	0.052	0.058	0.067
Beryllium	mg/L	*-*	*-*	*-*	0.0005	<0.00005	0.001	<0.00005	<0.00005	0.00052	<0.00005	0.001	0.0002	<0.00005	<0.00005
Bismuth	mg/L	*-*	*-*	*-*	<0.0005	<0.0005	0.0036	<0.0005	<0.0005	0.00071	<0.0005	0.01	0.0007	<0.0005	0.00081
Boron	mg/L	*1.5*	*1.5*	*1.5*	0.01	<0.005	0.15	0.033	0.024	0.10	<0.005	0.14	0.037	0.034	0.10
Cadmium	mg/L	*0.0001-0.0077* [8]	*0.00004-0.000037* [8]	*0.00021*	0.00006	<0.00001	0.00016	0.00003	0.00003	0.00005	<0.00001	**0.00024**	0.00003	0.000025	0.00005
Calcium	mg/L	*-*	*-*	*-*	52	17	61	44	49	57	19	75	43	48	55
Chromium (III+VI)	mg/L	*-*		*0.001*	0.001	<0.0005	**0.0049**	0.00050	<0.0005	0.001	<0.0005	**0.0047**	0.00053	<0.0005	0.001
Cobalt	mg/L	*-*	*0.0008-0.0018* [8]	*-*	0.001	<0.00005	**0.004**	0.00028	0.00016	**0.001**	0.00007	**0.0036**	0.00028	0.00014	**0.001**
Copper	mg/L	*0.002-0.004* [8]	*0.007*	*0.0042*	0.002	0.00022	**0.052**	0.0015	0.0008	0.0031	0.00021	**0.145**	0.0024	0.00081	0.0034
Iron	mg/L	*0.3*	*0.3*	*1.3*	0.37	0.18	**7.57**	0.44	0.33	0.87	0.10	**7.36**	0.37	0.27	0.72
Lithium	mg/L	*-*	*-*	*-*	0.0055	0.005	0.044	0.01	0.014	0.028	0.0058	0.055	0.02	0.024	0.039
Magnesium	mg/L	*-*	*-*	*-*	12.9	4.5	13.6	10.6	11.8	13.3	4.9	13.2	10.1	11.6	13.0
Manganese	mg/L	*-*	*-*	*-*	0.027	0.013	0.18	0.05	0.049	0.073	0.00878	0.18	0.038	0.040	0.058
Mercury	mg/L	*0.000026*	*0.000005*	*0.000026*	0.000025	0.000003	**0.0001**	0.00001	<0.00001	0.000025	0.000003	**0.00005**	0.000008	<0.00001	0.000023
Molybdenum	mg/L	*0.073*	*0.073*	*0.073*	0.0018	0.00005	0.0126	0.0014	0.0013	0.003	0.000301	0.0032	0.0014	0.0014	0.003
Nickel	mg/L	*0.025-0.150* [8]	*0.007-0.17* [8]	*0.125*	0.0049	0.0005	0.0076	0.0018	0.0016	0.0034	0.00051	0.00935	0.0019	0.0015	0.00372
Lead	mg/L	*0.001 - 0.007* [8]	*0.001-0.007* [8]	*0.005*	0.001	0.00001	**0.0054**	0.00020	<0.00005	0.001	0.00001	**0.0058**	0.0002	<0.00005	0.0009
Phosphorus	mg/L	*-*	*-*	*-*	0.05	0.00005	0.14	0.03	<0.05	0.1	0.00005	0.18	0.021	0.025	0.025
Potassium	mg/L	*-*	*-*	*-*	2	0.8	2.3	1.97	2	2	0.6	2	2.0	2	2
Selenium	mg/L	*0.001*	*0.002*	*0.001*	<0.001	<0.0005	**0.0014**	0.00061	<0.0005	0.001	<0.0005	0.0013	0.0006	<0.0005	0.001
Silicon	mg/L	*-*	*-*	*-*	2.6	1.6	3.6	2.4	2.5	2.9	1.3	3.2	2.6	2.7	3.1
Silver	mg/L	*0.00025*	*0.00025*	*-*	0.000053	0.000005	**0.00031**	0.000018	0.00001	0.0001	0.000005	0.0001	0.000015	0.00001	0.00004
Strontium	mg/L	*-*	*-*	*-*	0.13	0.0405	0.18	0.089	0.092	0.12	0.037	0.14	0.089	0.090	0.12
Thallium	mg/L	*0.0008*	*0.0008*	*0.0008*	0.0001	0.00001	0.00059	0.000057	0.00003	0.0001	0.00001	0.00034	0.00005	0.00002	0.0001
Tin	mg/L	*-*	*-*	*-*	0.00016	0.0001	0.0009	0.00012	0.0001	0.0001	0.0001	0.0005	0.00012	0.0001	0.00026
Titanium	mg/L	*-*	*-*	*-*	0.010	0.001	0.06	0.011	0.01	0.017	0.001	0.022	0.0098	0.01	0.015
Uranium	mg/L	*0.015*	*0.015*	*0.015*	0.0022	0.00041	0.0031	0.0016	0.0019	0.0024	0.00041	0.003	0.00176	0.0020	0.0028
Vanadium	mg/L	*-*	*-*	*-*	<0.001	<0.001	0.007	<0.001	<0.001	0.001	<0.001	0.005	0.00076	<0.001	0.001
Tungsten	mg/L	*-*	*-*	*-*	0.01	0.0006	0.122	0.00	0.0021	0.059	0.0008	0.10	0.0093	0.0024	0.050
Zinc	mg/L	*0.007* [9]	*0.03*	*0.03*	0.008	<0.001	**0.062**	0.00	0.003	0.007	<0.001	0.03	0.0033	0.003	0.007

Notes:

[1] Canadian Council of Ministers of the Environment (CCME) (Updated 2015). Canadian Water Quality Guidelines for the Protection of Aquatic Life (Freshwater)

[2] Alberta Environment and Parks (AEP). Environmental Quality Guidelines for Alberta Surface Waters. March 2018. Table 1 Surface water quality guidelines for the protection of freshwater aquatic life (PAL) - Guidelines only apply in the absence of CCME guideline.

[3] Flat River Water Quality Objectives. Mackenzie Valley Land and Water Board, 2012.

[4] Background water quality based on 95th percentile value from data from 2006 to Present at S4-29. Except pH and alkalinity which are 5th percentile values

[5] Guideline is dependant upon the pH value and temperature.

[6] Guideline is dependant upon the chloride concentration.

[7] Guideline is dependant upon the pH value.

[8] Guideline is based on the Hardness value.

[9] Guideline value based on hardness and DOC. Value for hardness of 50 mg/L and 0.5 mg/L DOC shown.

[10] For alkalinity and pH the 5th percentile value is shown, and cell highlights or shading are if the values are less than the background or guideline value.

mg/L - milligrams per litre.

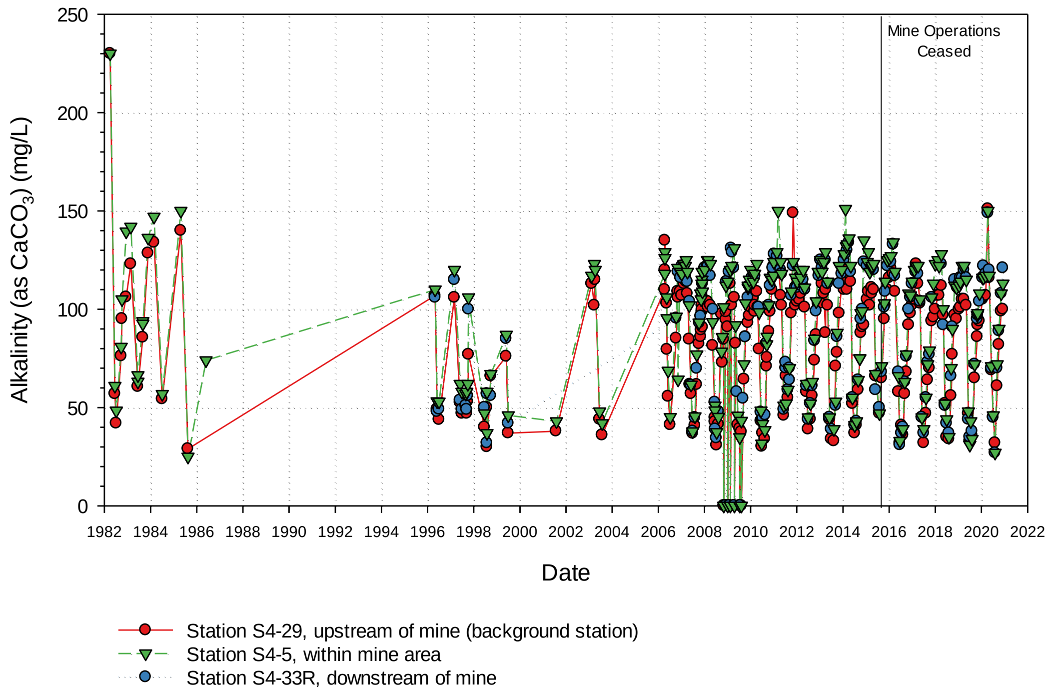
Shaded Cell - Median Concentration at Downstream or Midstream Station is above background.

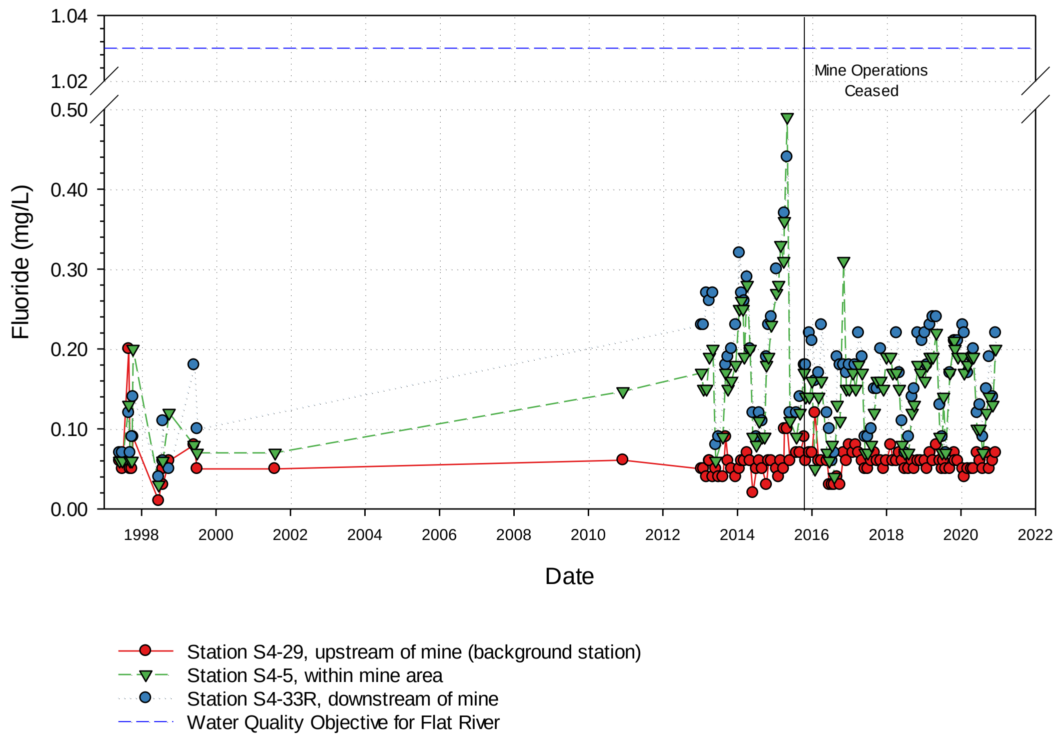
Red Bold - Concentration excceeds the Flat River Water Quality Objective, or lowest values of CCME or AEP value where a Flat River WQO does not exist.

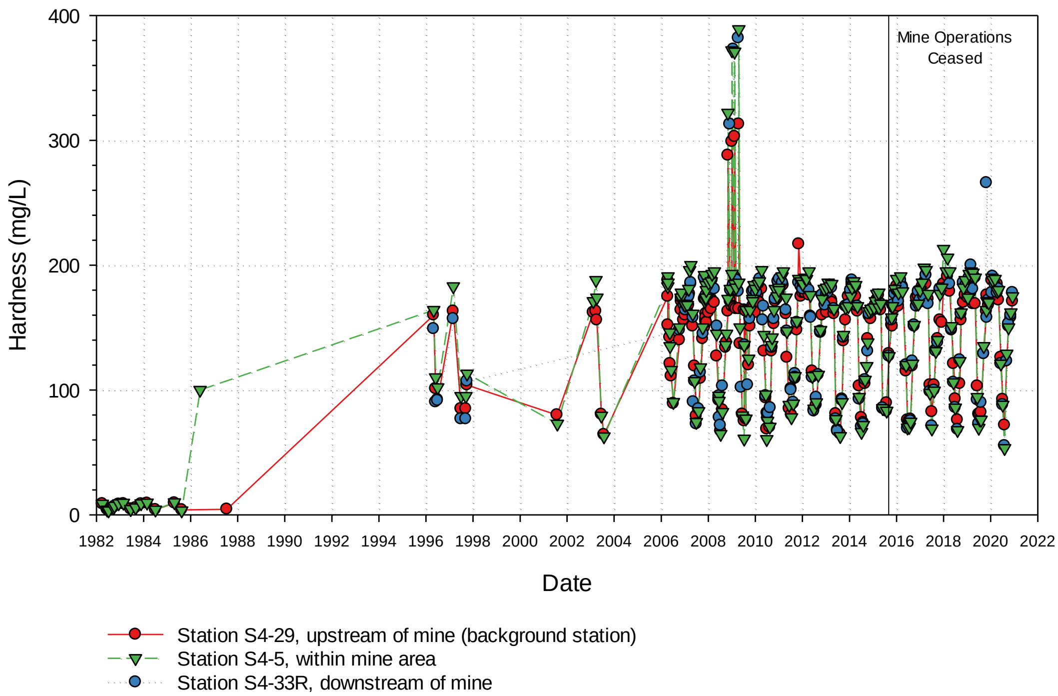
Appendix D, Table 2 - Flat River Station S4-29 background Water Quality Statistics

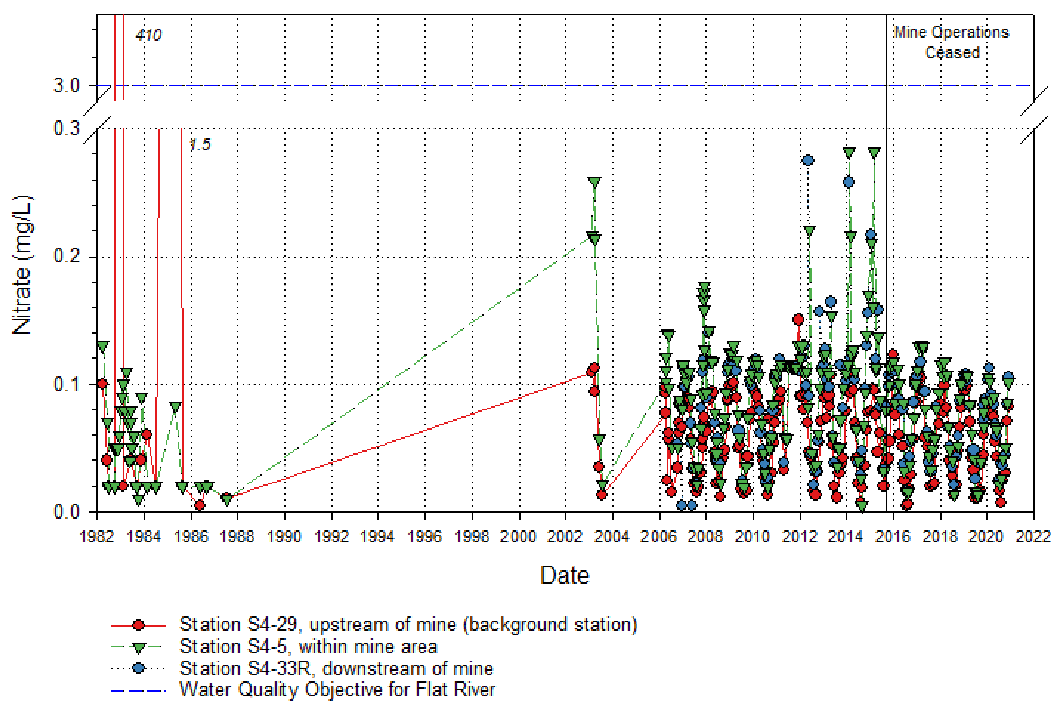
		S4-29				
		Upstream, background				
		n=199, April 2006 to December 2020				
	Units	Min	Max	Mean	Median	95th Percentile[1]
Alkalinity, as $CaCO_3$ (total)	mg/L	30.2	151	84	95	34
Ammonia	mg/L	0.005	0.28	0.02	0.01	0.05
Hardness	mg/L	65	217	143	159	185
Chloride	mg/L	<0.05	0.28	0.08	0.08	0.15
Fluoride	mg/L	0.01	0.12	0.06	0.06	0.08
Silica	mg/L	3.4	6.1	4.7	4.8	5.7
Kjeldahl Nitrogen Total	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrate, as N	mg/L	<0.005	0.15	0.06	0.07	0.11
Nitrite, as N	mg/L	0.001	0.015	<0.005	<0.005	0.0068
Sodium, filtered	mg/L	0.4	3.9	0.9	0.8	2.0
Sulphate	mg/L	35	85	60	61	79
Electrical Conductivity	uS/cm	140	390	281	305	359
pH	pH	6.5	8.3	7.8	7.8	7.4
TDS	mg/L	63	280	171	182	228
TOC	mg/L	<0.5	1.1	0.6	0.5	1.04
TSS	mg/L	0.5	21.8	2.9	2.5	8
Total Metals						
Aluminium	mg/L	0.0050	0.42	0.06	0.021	0.24
Antimony	mg/L	<0.0001	0.001	<0.0001	<0.0001	<0.0001
Arsenic	mg/L	0.0001	0.0085	0.00076	0.0006	0.0015
Barium	mg/L	0.0205	0.063	0.044	0.05	0.06
Beryllium	mg/L	<0.00005	0.001	<0.00005	<0.00005	0.0005
Bismuth	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Boron	mg/L	<0.005	0.25	0.0082	0.006	0.01
Cadmium	mg/L	0.000005	0.0004	0.00004	0.00003	0.00006
Calcium	mg/L	19	54	39	45	52
Chromium (III+VI)	mg/L	<0.0005	0.026	0.0006	<0.0005	0.001
Cobalt	mg/L	<0.00005	0.001	0.0002	0.0001	0.001
Copper	mg/L	0.0001	0.021	0.001	0.00058	0.002
Iron	mg/L	0.01	0.85	0.12	0.06	0.37
Lithium	mg/L	0.004	0.017	0.0053	0.005	0.0055
Magnesium	mg/L	5.3	13.4	10.2	11.0	12.9
Manganese	mg/L	0.001	0.063	0.010	0.0072	0.027
Mercury	mg/L	0.000003	0.0001	0.00001	<0.00001	0.000025
Molybdenum	mg/L	0.00005	0.003	0.001	0.001	0.0018
Nickel	mg/L	0.00084	0.01	0.0026	0.0023	0.0049
Lead	mg/L	0.00001	0.003	0.00018	<0.00005	0.001
Phosphorus	mg/L	0.00005	0.13	0.021	0.025	0.05
Potassium	mg/L	0.6	2	2	2	2
Selenium	mg/L	<0.0005	<0.001	0.0006	0.0006	<0.001
Silicon	mg/L	1.6	2.8	2.2	2.3	2.6
Silver	mg/L	0.000005	0.0007	0.00002	0.00001	0.000053
Strontium	mg/L	0.05	0.18	0.10	0.11	0.13
Thallium	mg/L	0.00001	0.0011	0.00006	0.00002	0.0001
Tin	mg/L	0.0001	0.0005	0.00011	0.0001	0.00016
Titanium	mg/L	0.001	0.017	0.010	0.01	0.01045
Uranium	mg/L	0.0003	0.0026	0.0014	0.0017	0.0022
Vanadium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Tungsten	mg/L	0.0001	0.052	0.003	0.0004	0.01
Zinc	mg/L	0.002	0.019	0.005	0.004	0.008

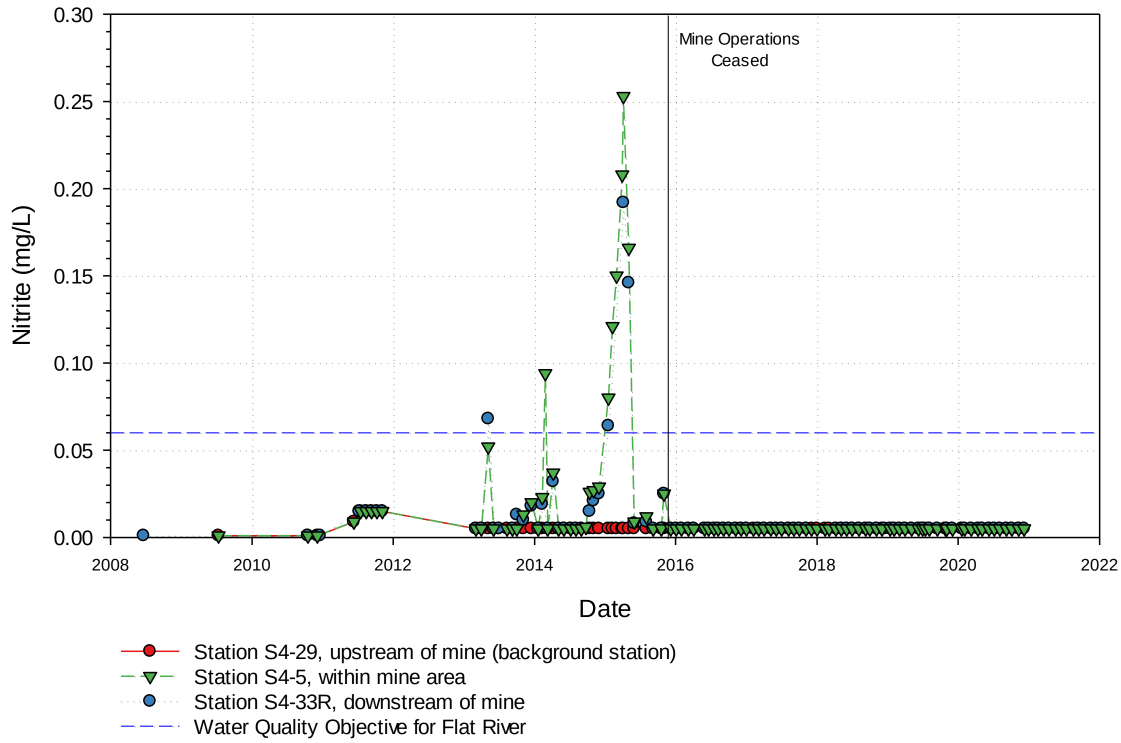
[1] 95th Percentile value is established as "background" for comparisons. Alkalinity and pH the 5th percentile value is shown

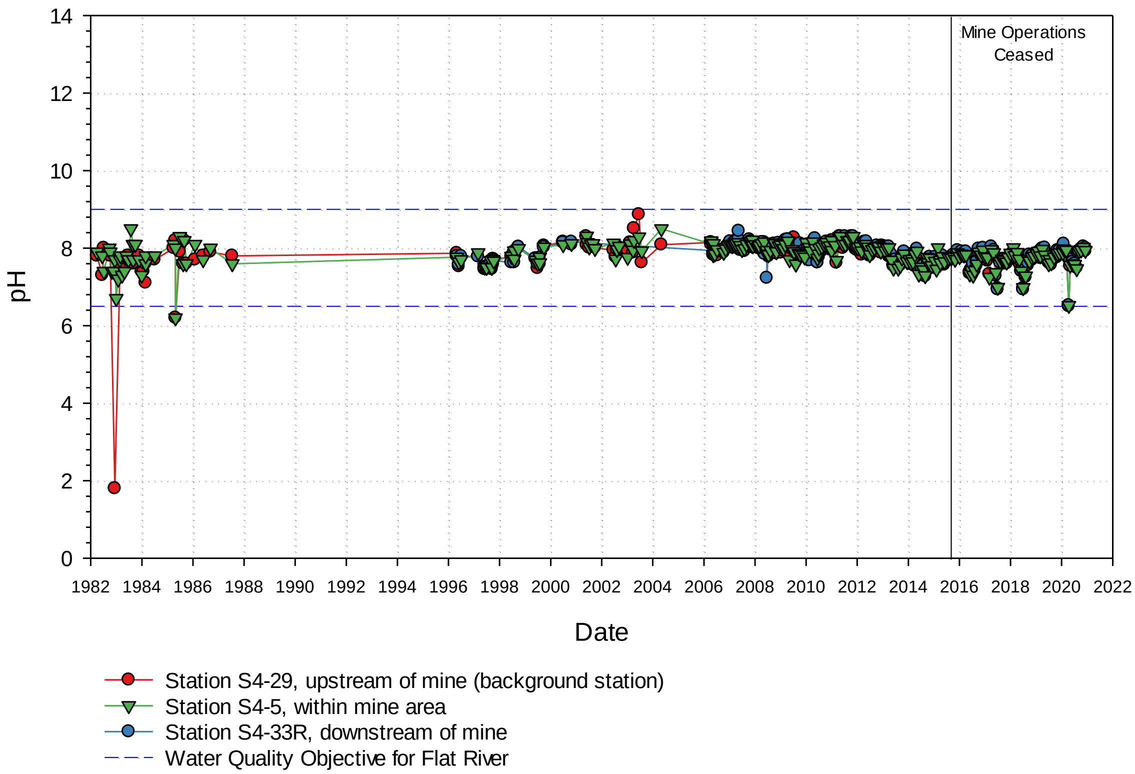

Alkalinity (as $CaCO_3$) (mg/L)
0
50
100
150
200
250
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Mine Operations Ceased
Date
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine

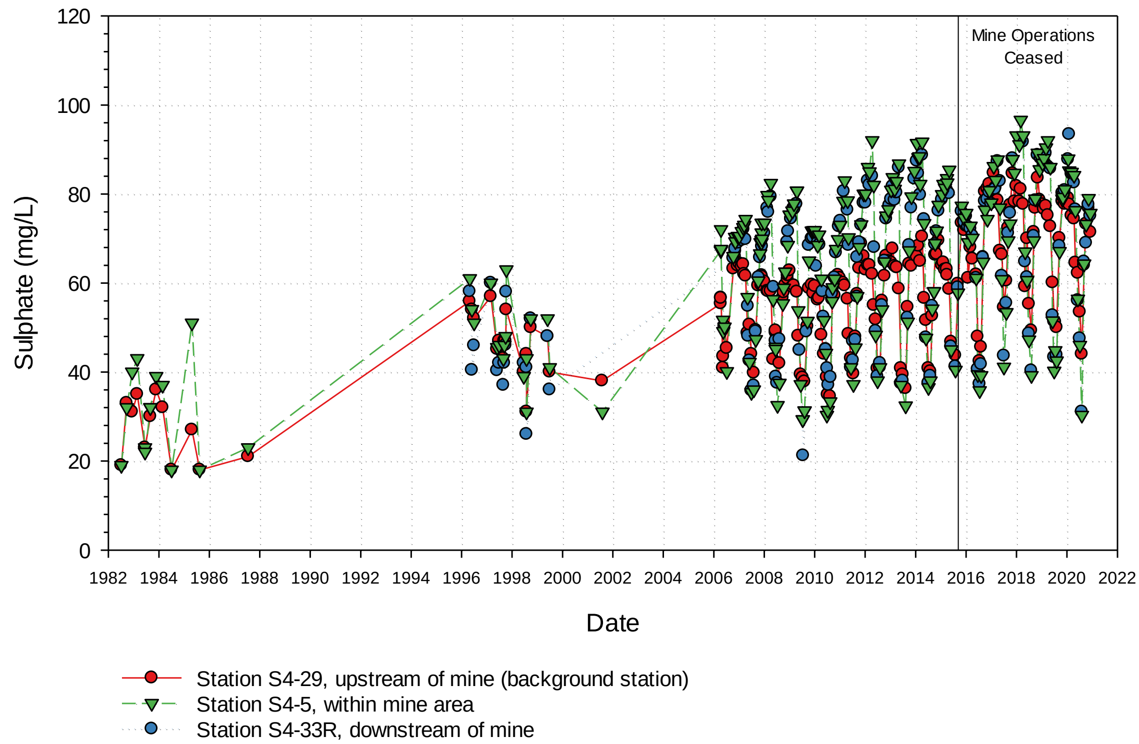

Fluoride (mg/L)
0.00
0.10
0.20
0.30
0.40
0.50
1.02
1.04
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Mine Operations Ceased
Date
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine
Water Quality Objective for Flat River

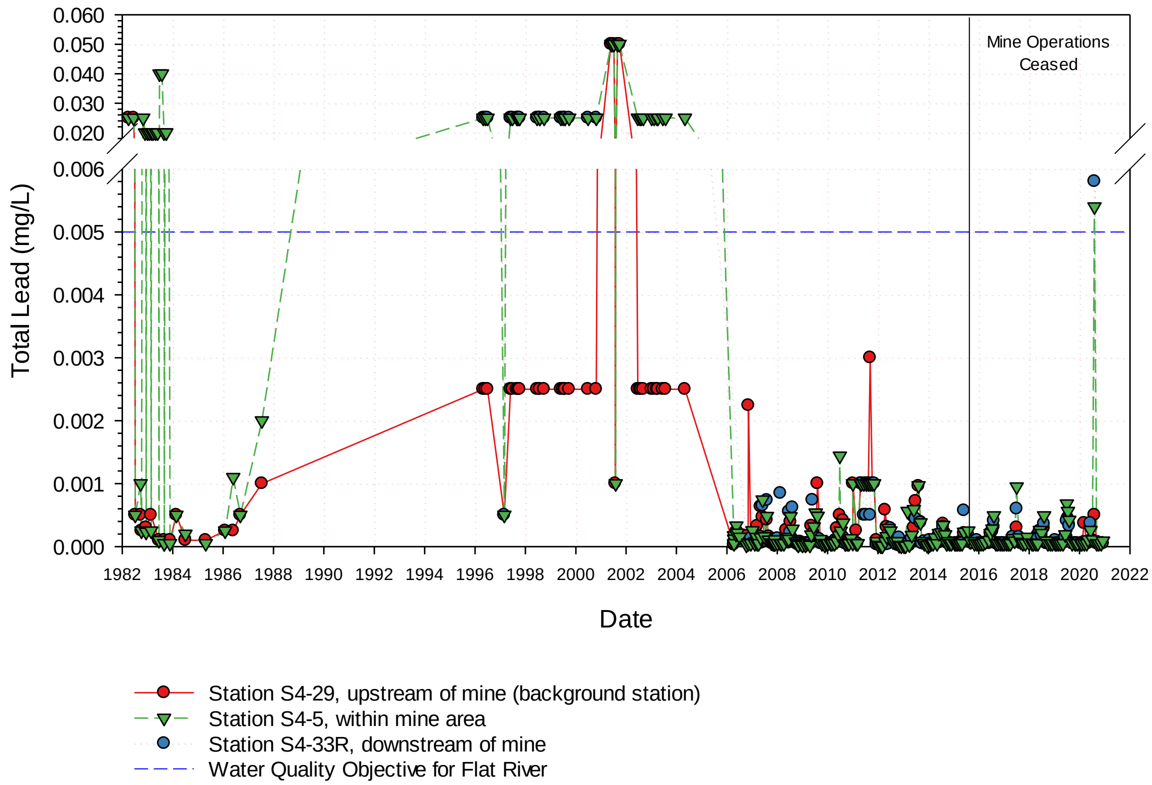

Mine Operations Ceased
Hardness (mg/L)
400
300
200
100
0
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Date
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine

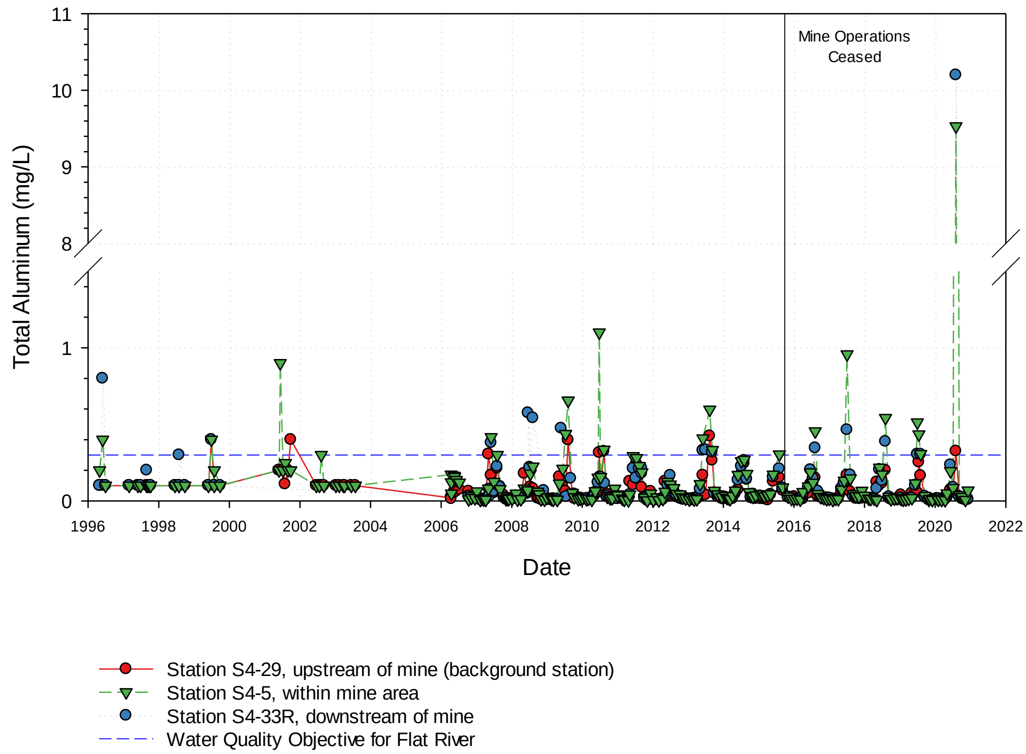

Mine Operations Ceased
410
1.5
Nitrate (mg/L)
3.0
0.3
0.2
0.1
0.0
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Date
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine
Water Quality Objective for Flat River

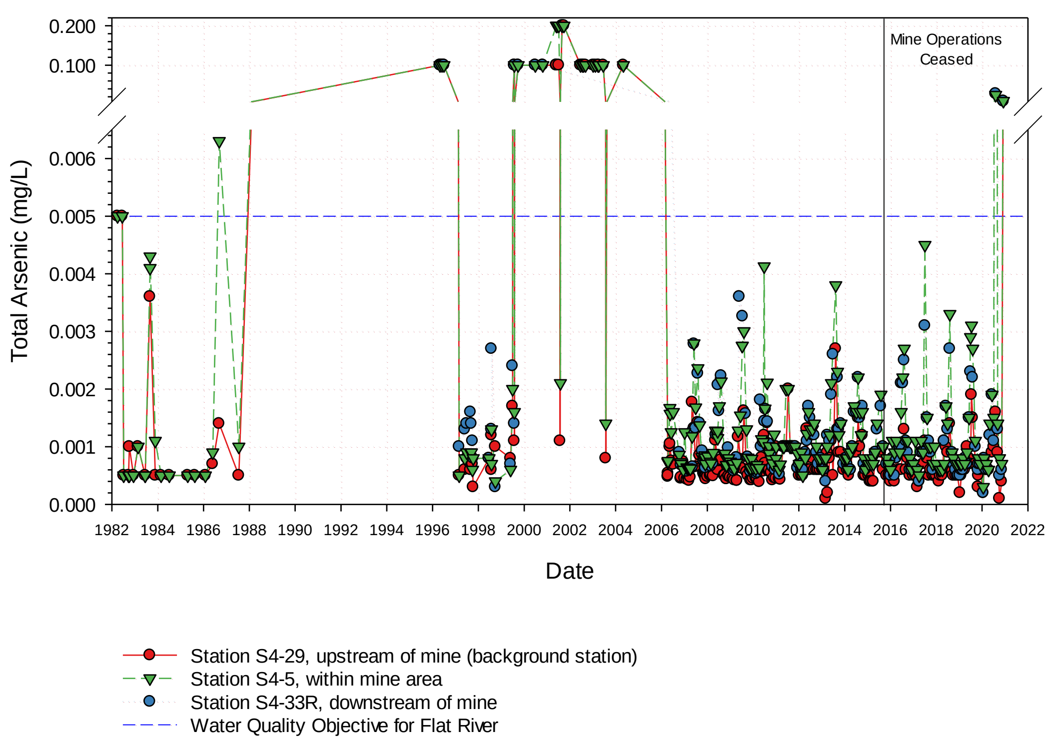

Mine Operations
Ceased
Nitrite (mg/L)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
2008
2010
2012
2014
2016
2018
2020
2022
Date
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine
Water Quality Objective for Flat River

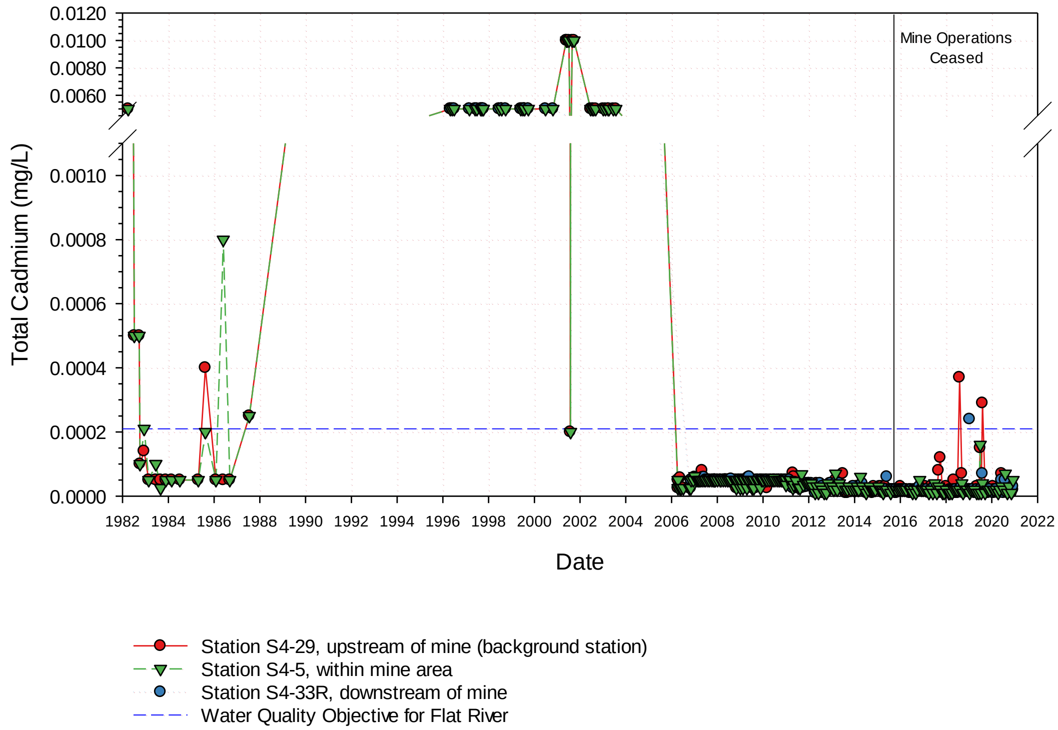

Mine Operations
Ceased
pH
14
12
10
8
6
4
2
0
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Date
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine
Water Quality Objective for Flat River

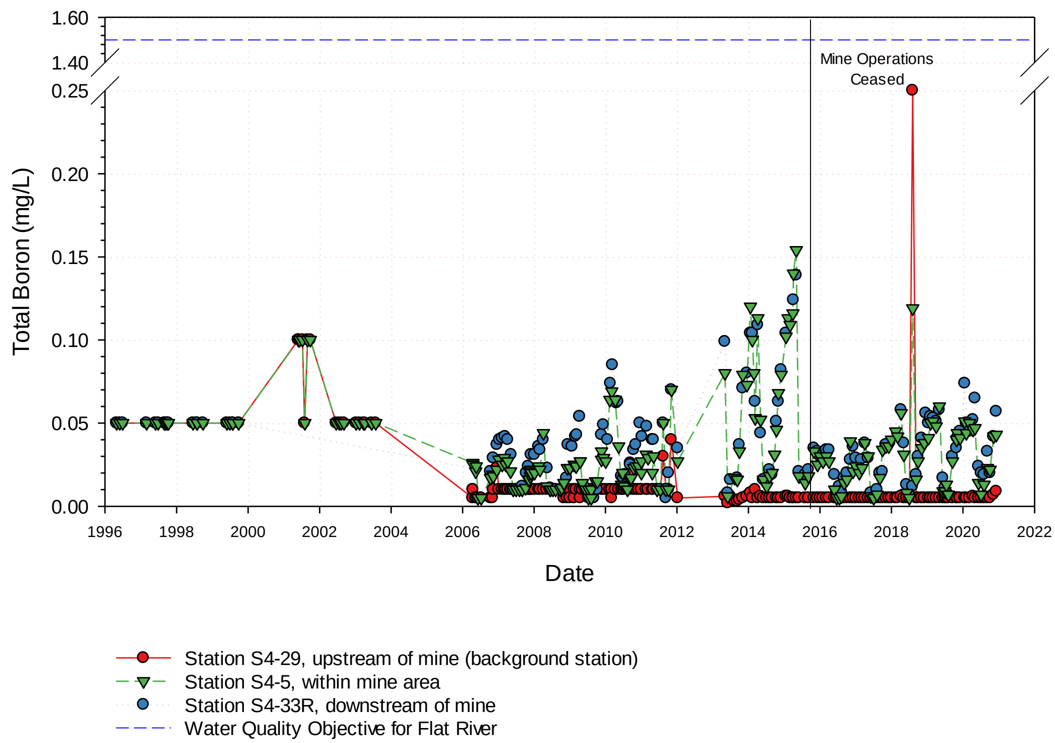

Mine Operations Ceased
Sulphate (mg/L)
0
20
40
60
80
100
120
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Date
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine

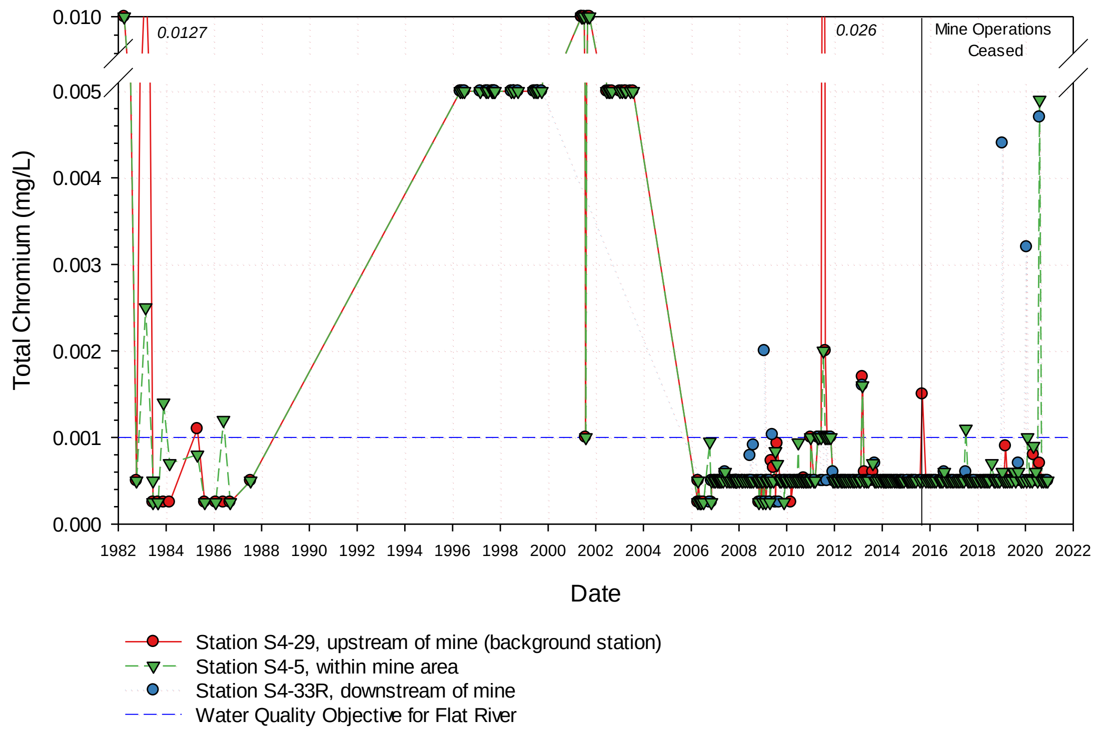

Mine Operations Ceased
Total Lead (mg/L)
0.000
0.001
0.002
0.003
0.004
0.005
0.006
0.020
0.030
0.040
0.050
0.060
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Date
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine
Water Quality Objective for Flat River

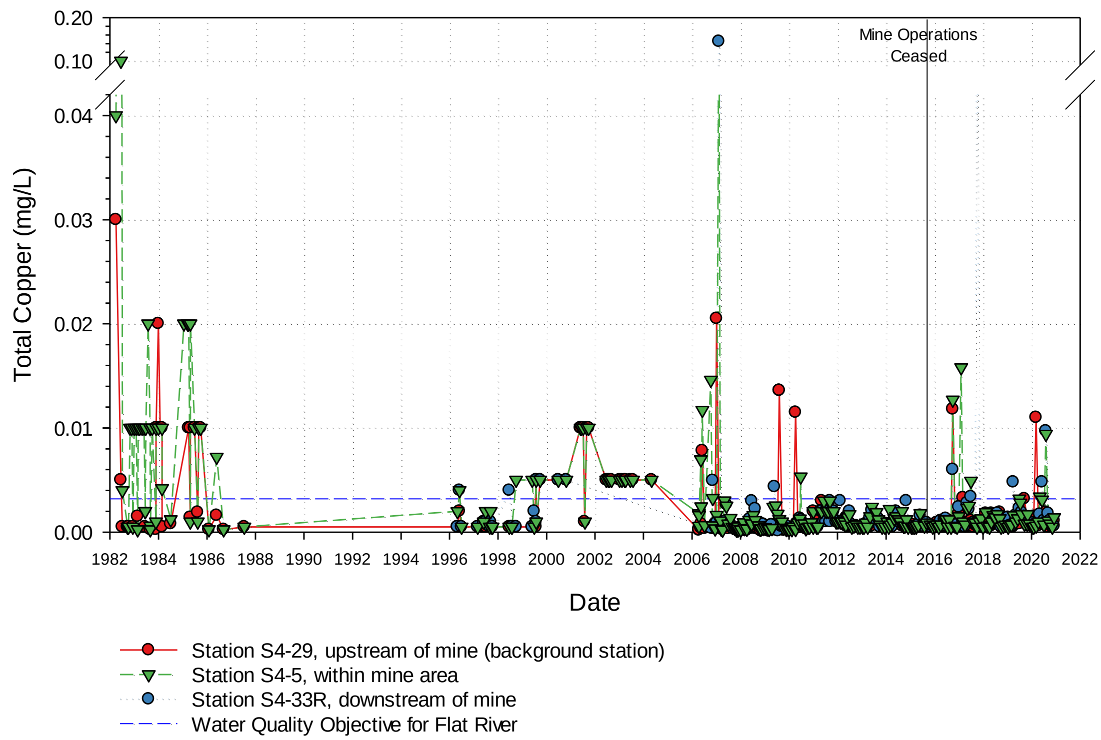

Total Aluminum (mg/L)
Date
Mine Operations Ceased
0
1
8
9
10
11
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine
Water Quality Objective for Flat River

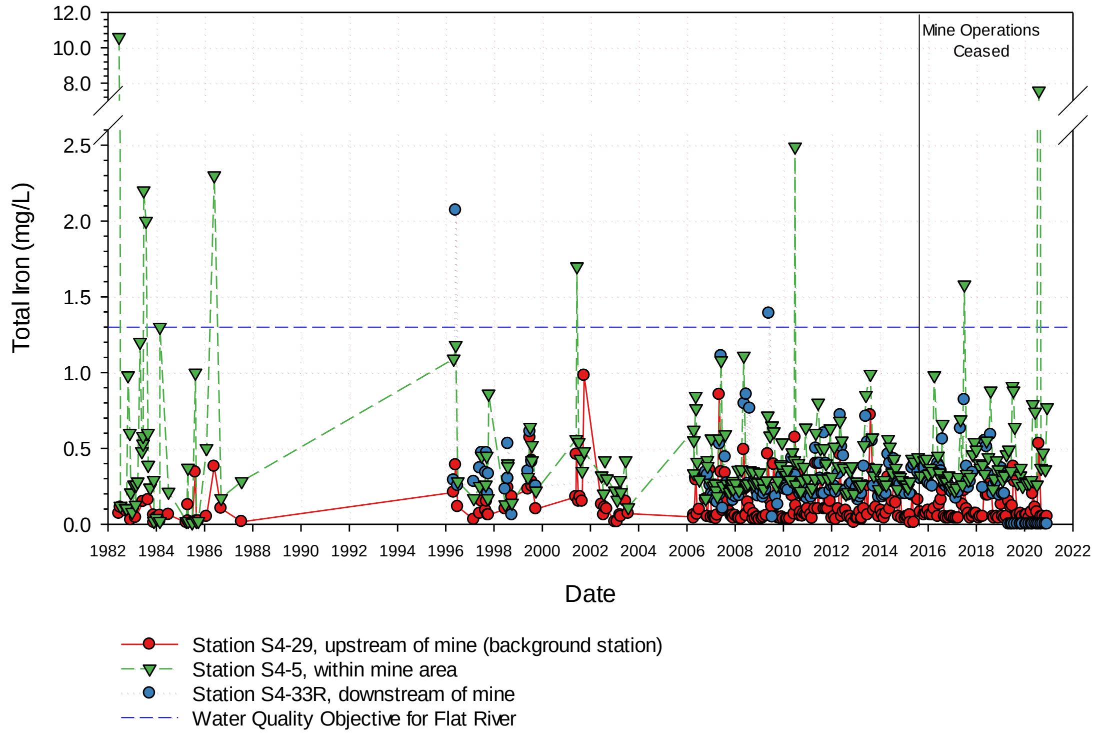

Total Arsenic (mg/L)
Date
Mine Operations Ceased
0.000
0.001
0.002
0.003
0.004
0.005
0.006
0.100
0.200
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine
Water Quality Objective for Flat River

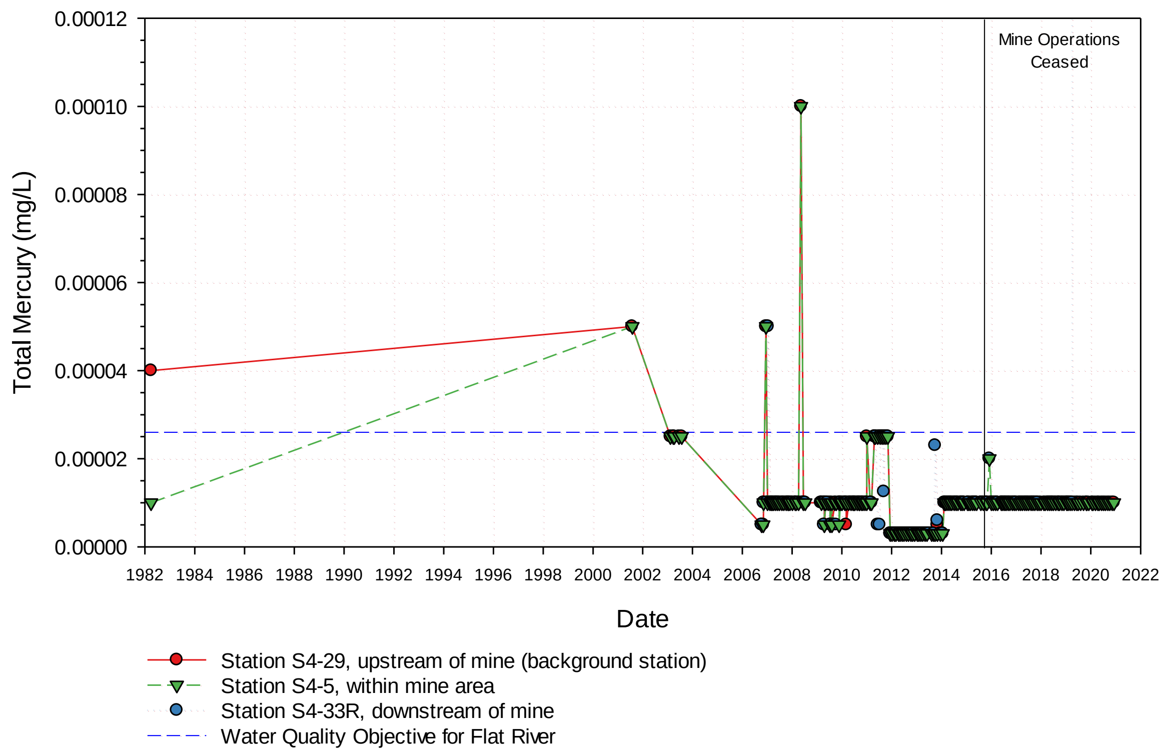

0.0120
0.0100
0.0080
0.0060
0.0010
0.0008
0.0006
0.0004
0.0002
0.0000
Total Cadmium (mg/L)
Mine Operations Ceased
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Date
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine
Water Quality Objective for Flat River

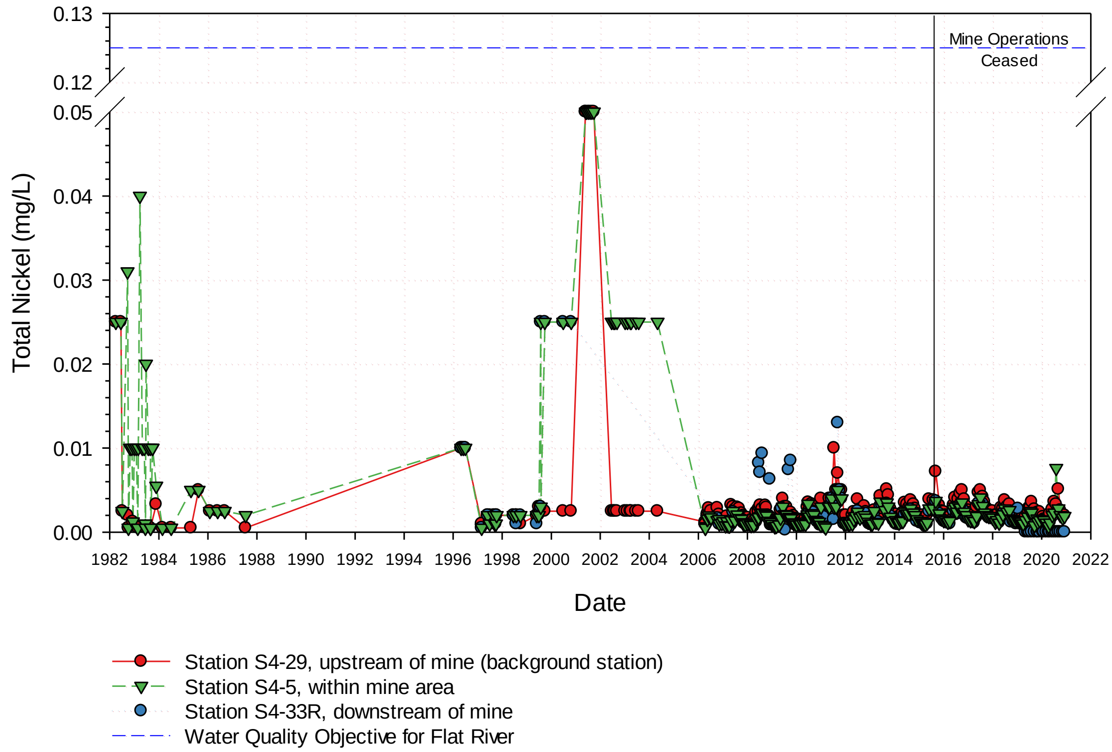

1.60
1.40
0.25
0.20
0.15
0.10
0.05
0.00
Total Boron (mg/L)
Mine Operations Ceased
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Date
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine
Water Quality Objective for Flat River

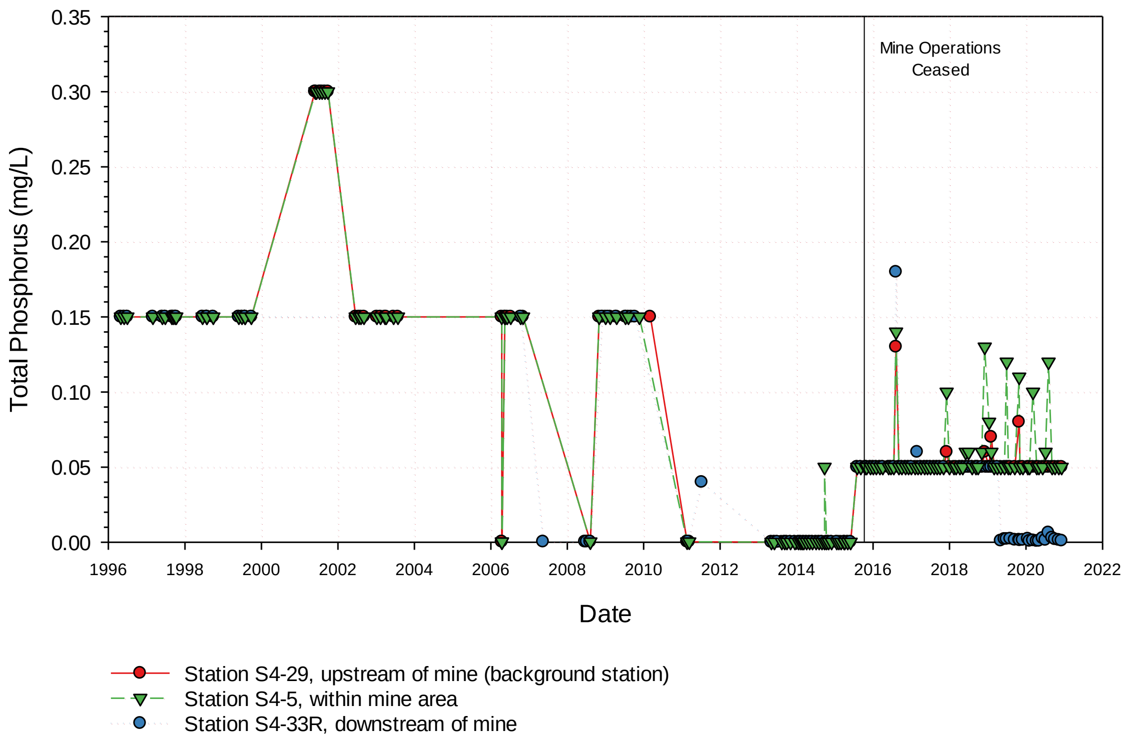

Total Chromium (mg/L)
Date
0.0127
0.026
Mine Operations Ceased
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine
Water Quality Objective for Flat River

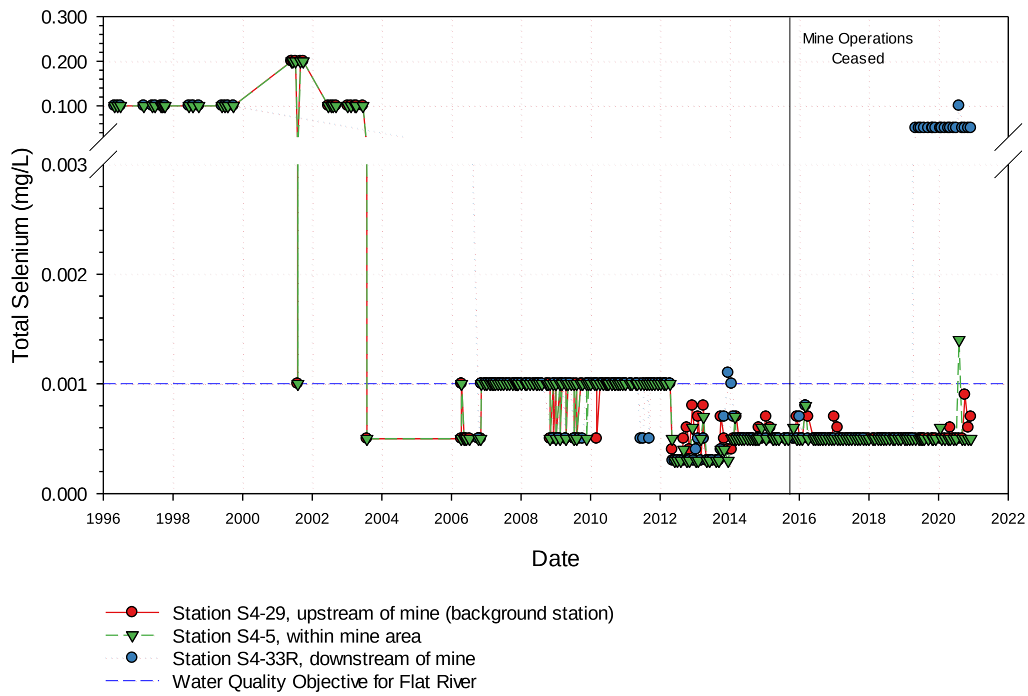

Total Copper (mg/L)
Date
Mine Operations Ceased
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine
Water Quality Objective for Flat River

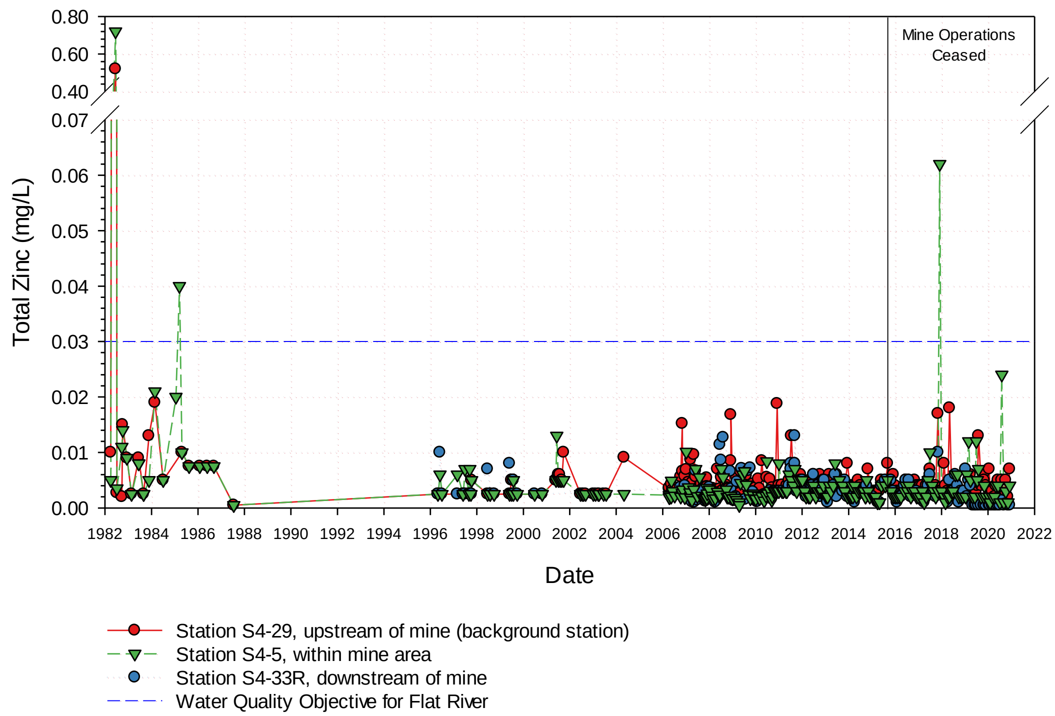

Total Iron (mg/L)
Date
Mine Operations Ceased
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine
Water Quality Objective for Flat River


Total Mercury (mg/L)
Date
Mine Operations Ceased
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine
Water Quality Objective for Flat River


Total Nickel (mg/L)
Date
Mine Operations Ceased
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine
Water Quality Objective for Flat River


Total Phosphorus (mg/L)
Date
Mine Operations Ceased
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine


0.300
0.200
0.100
0.003
0.002
0.001
0.000
Total Selenium (mg/L)
Mine Operations Ceased
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Date
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine
Water Quality Objective for Flat River

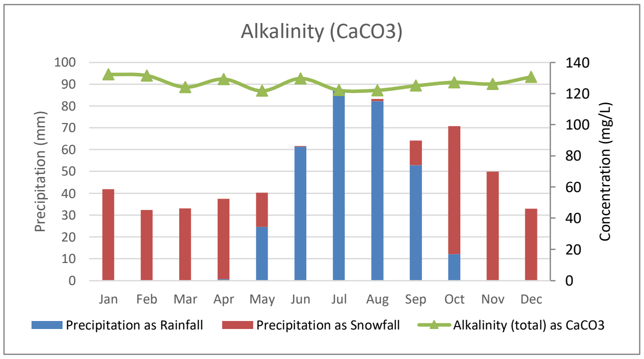

0.80
0.60
0.40
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Total Zinc (mg/L)
Mine Operations Ceased
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Date
Station S4-29, upstream of mine (background station)
Station S4-5, within mine area
Station S4-33R, downstream of mine
Water Quality Objective for Flat River

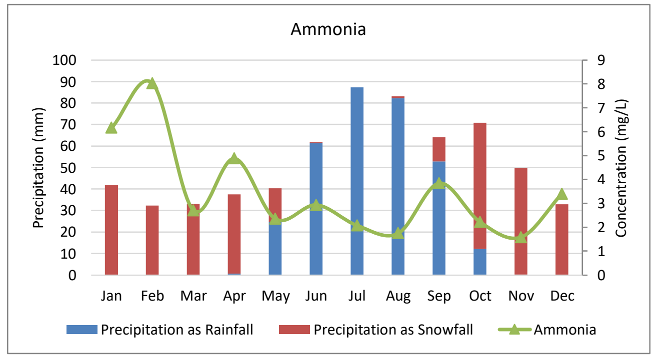
APPENDIX E

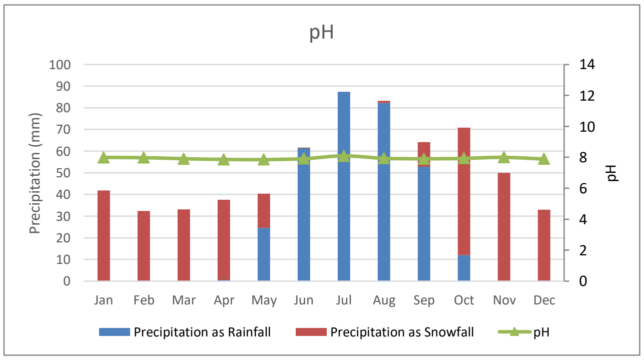
UNDERGROUND DISCHARGE CHEMISTRY VERSUS PRECIPITATION PLOTS

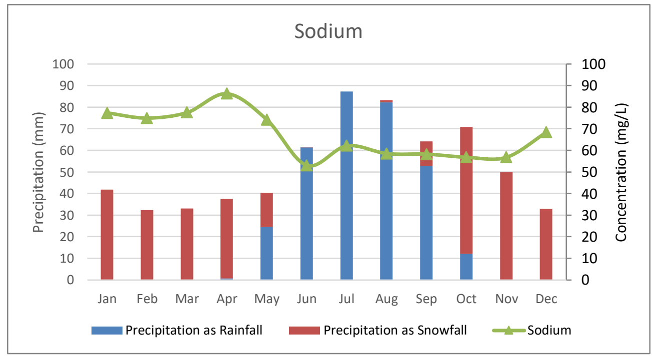
Appendix E1 – S4-42 All Data (November 2006 to April 2020)
Appendix E2 – S4-42 (November 2015 to April 2020)
Appendix E3 – S4-13 (November 2015 to April 2020)

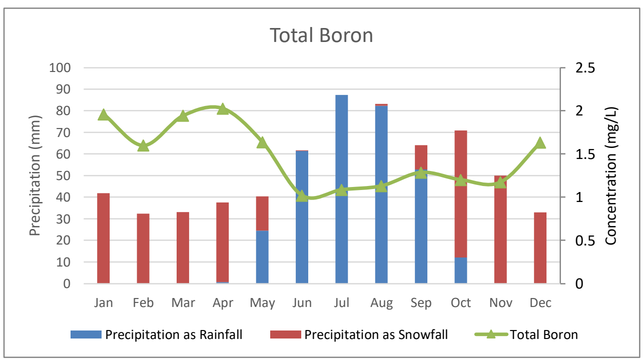
Appendix E1 – S4-42 All Data (November 2006 to April 2020)

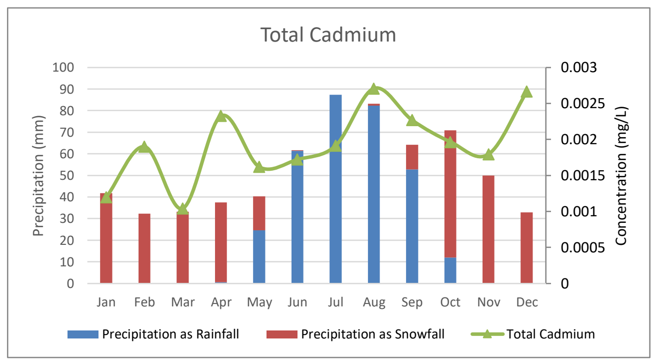

Alkalinity (CaCO3)
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Alkalinity (total) as CaCO3

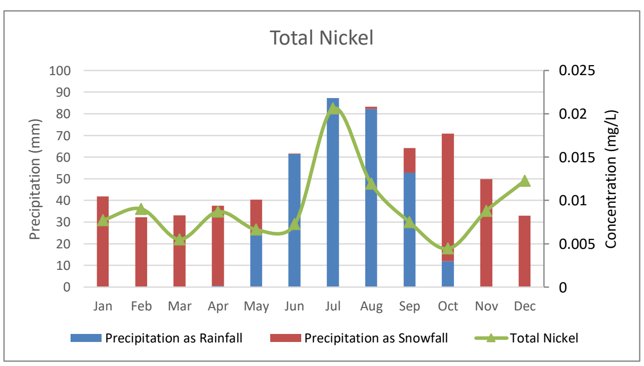

Ammonia
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Ammonia

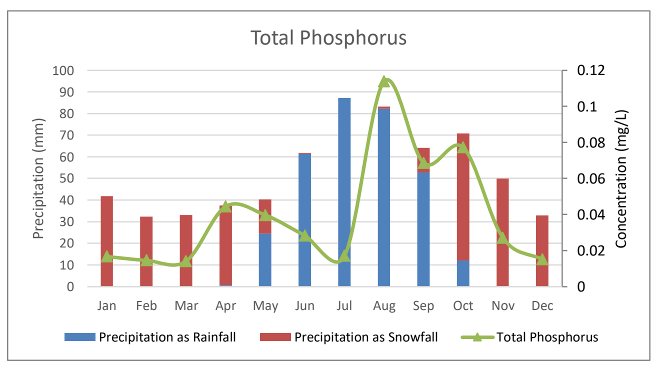

pH
Precipitation (mm)
pH
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
pH

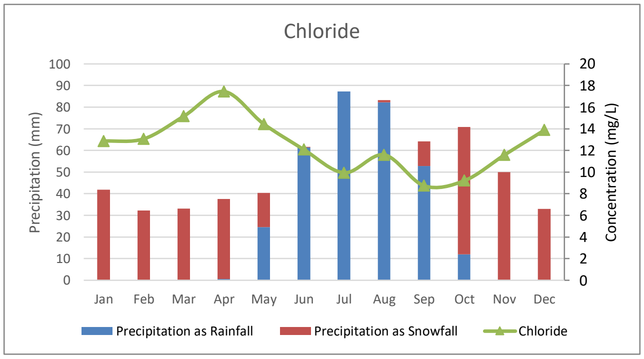

Sodium
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Sodium

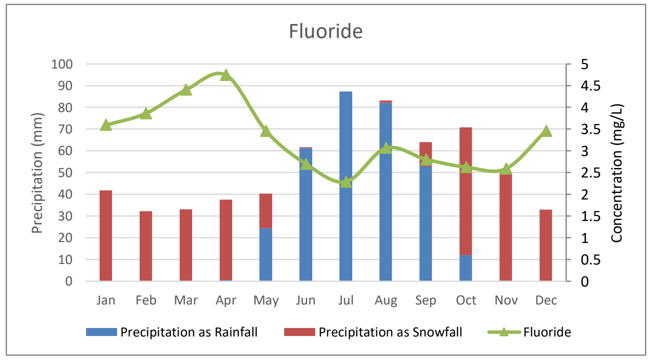

Total Boron
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Boron

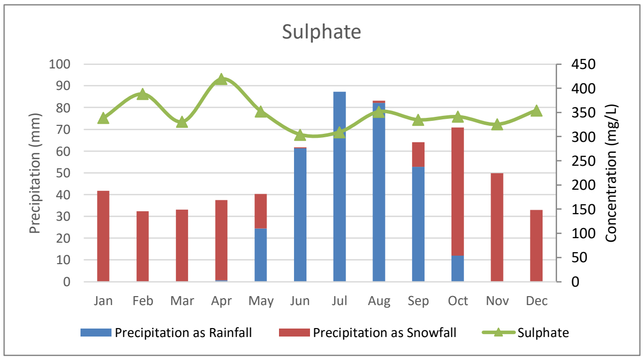

Total Cadmium
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Cadmium

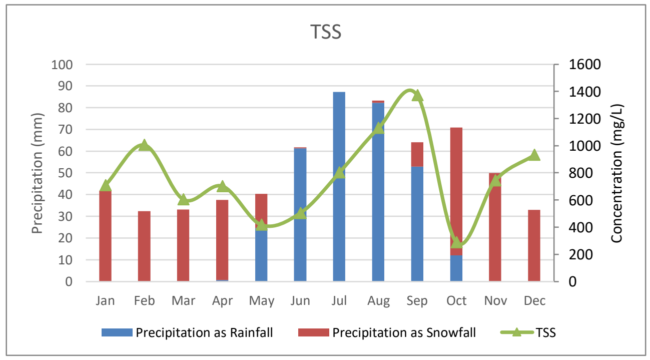

Total Nickel
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Nickel

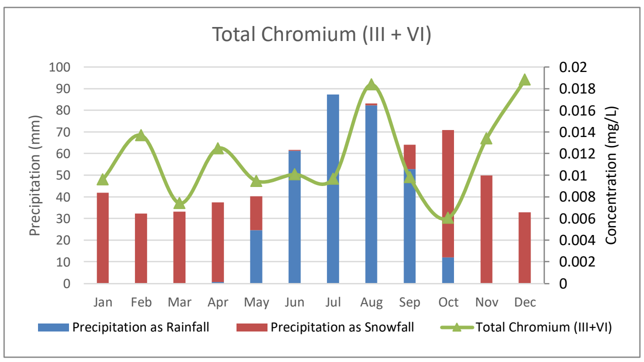

Total Phosphorus
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Phosphorus

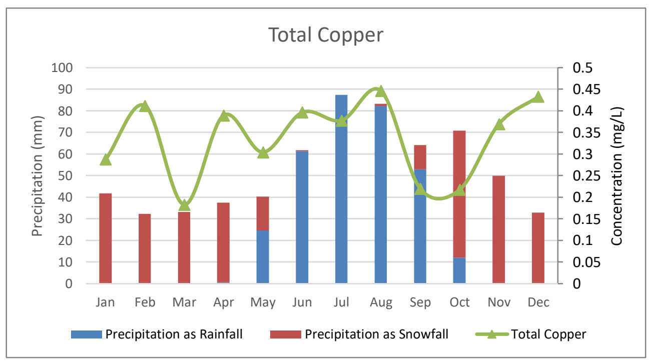

Chloride
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Chloride

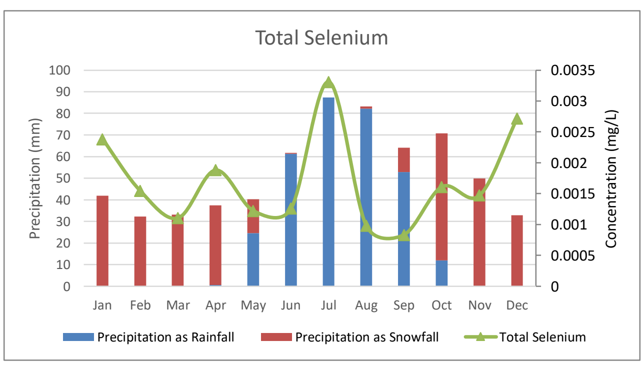

Fluoride
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Fluoride

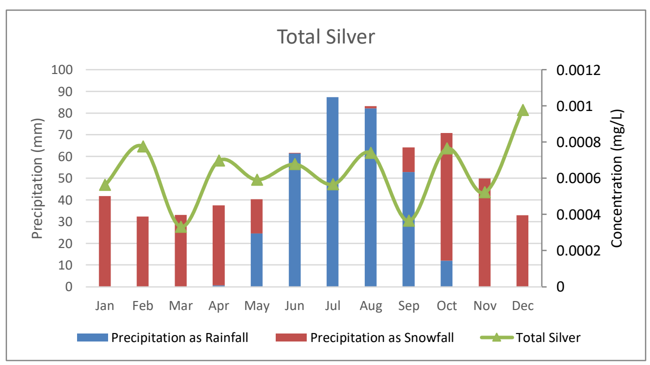

Sulphate
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Sulphate

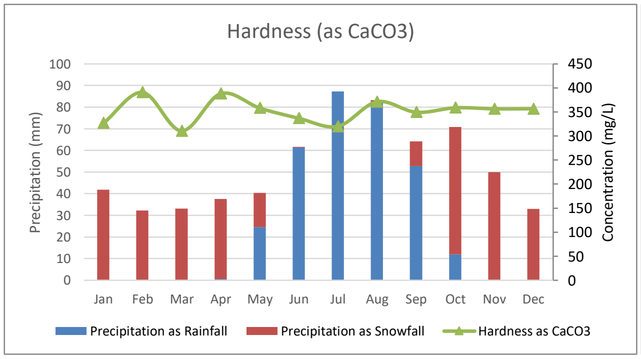

TSS
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
TSS

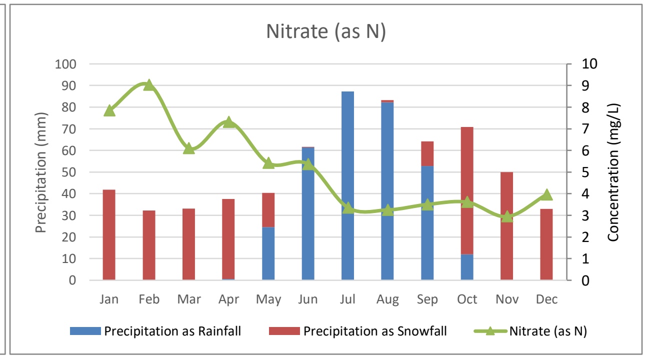

Total Chromium (III + VI)
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Chromium (III+VI)

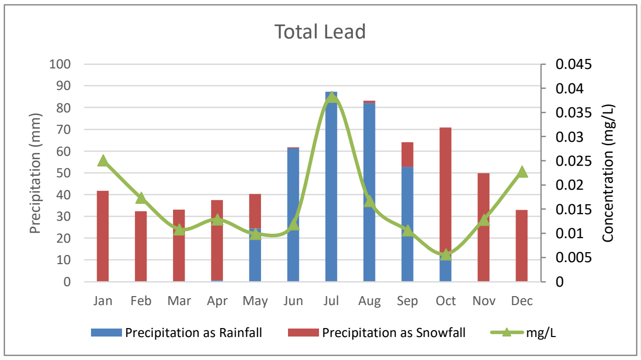

Total Copper
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Copper

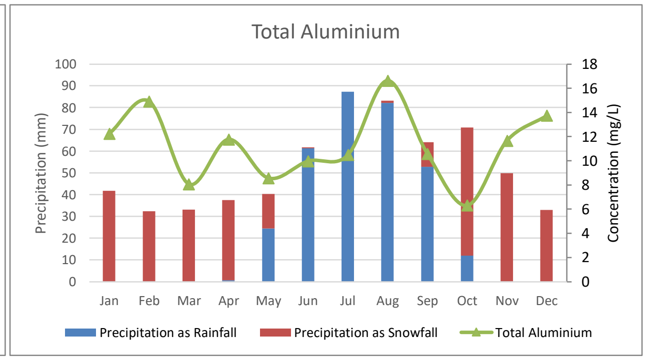

Total Selenium
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Selenium

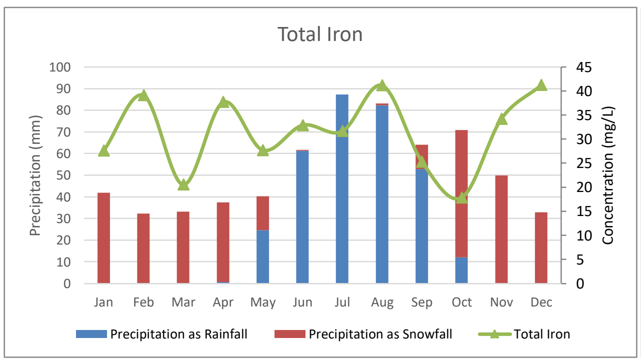

Total Silver
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Silver

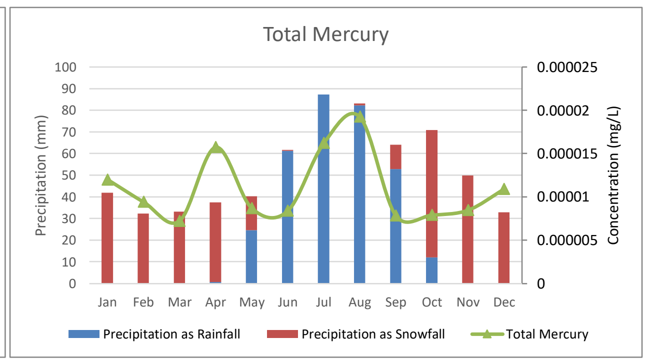

Hardness (as CaCO3)
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Hardness as CaCO3

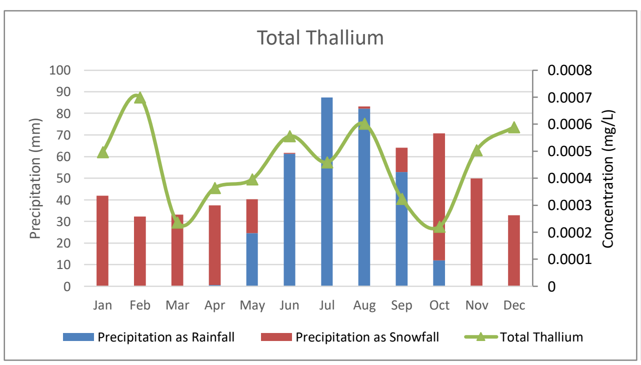

Nitrate (as N)
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Nitrate (as N)

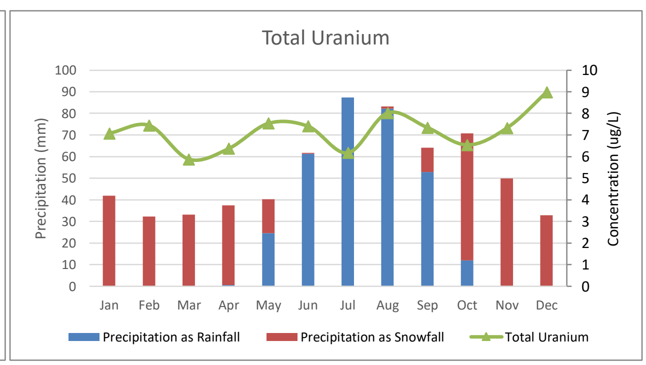

Total Lead
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
mg/L

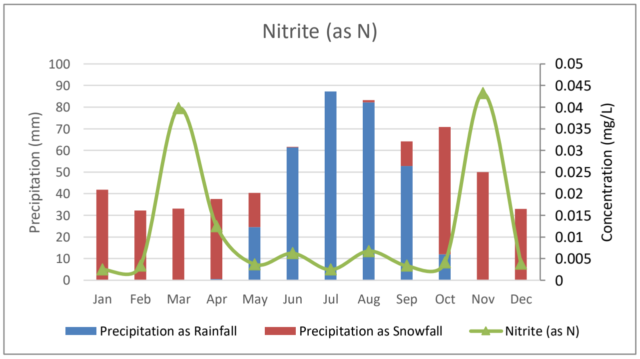

Total Aluminium
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Aluminium

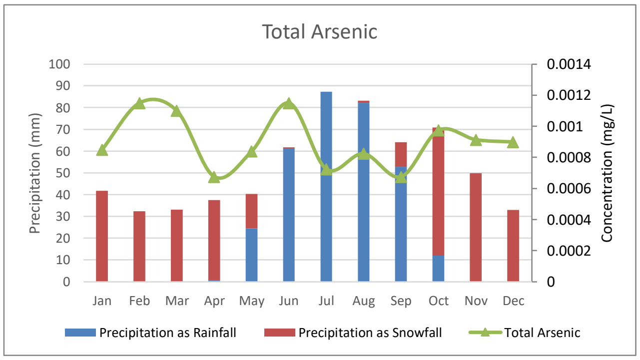

Total Iron
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Iron

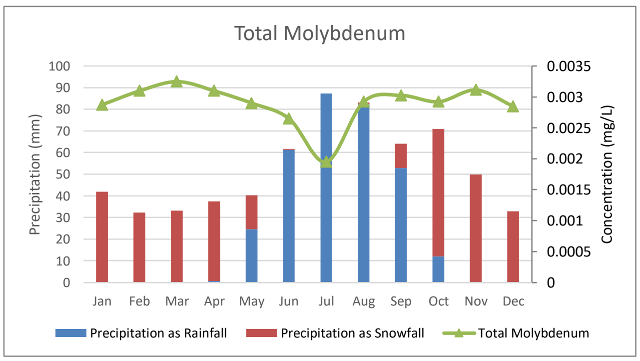

Total Mercury
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Mercury

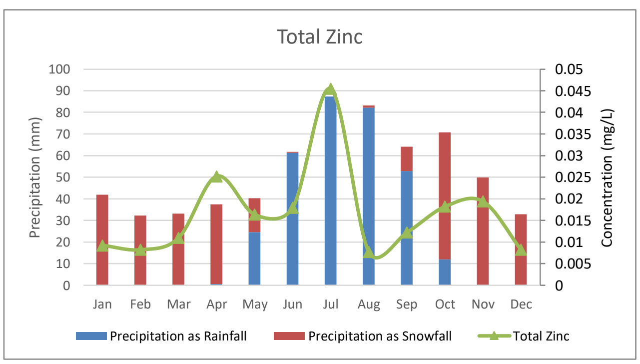

Total Thallium
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Thallium


Total Uranium
Precipitation (mm)
Concentration (ug/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Uranium

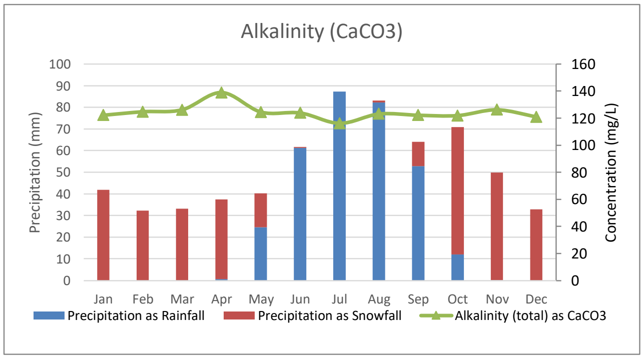

Nitrite (as N)
Precipitation (mm)
Concentration (mg/L)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Precipitation as Rainfall
Precipitation as Snowfall
Nitrite (as N)

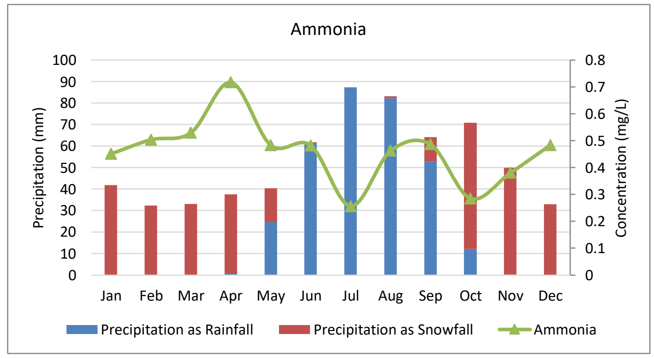

Total Arsenic
Precipitation (mm)
Concentration (mg/L)
Precipitation as Rainfall
Precipitation as Snowfall
Total Arsenic

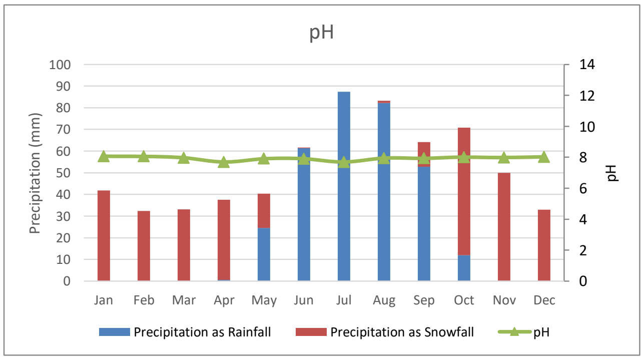

Total Molybdenum
Precipitation (mm)
Concentration (mg/L)
Precipitation as Rainfall
Precipitation as Snowfall
Total Molybdenum

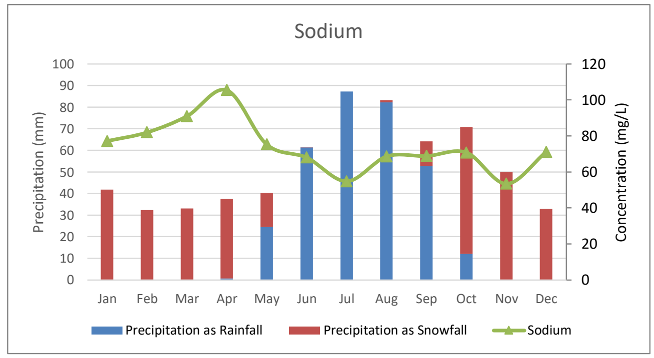

Total Zinc
Precipitation (mm)
Concentration (mg/L)
Precipitation as Rainfall
Precipitation as Snowfall
Total Zinc

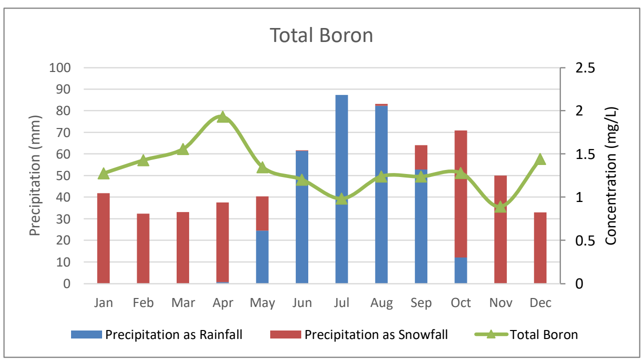
Appendix E2 – S4-42 (November 2015 to April 2020)

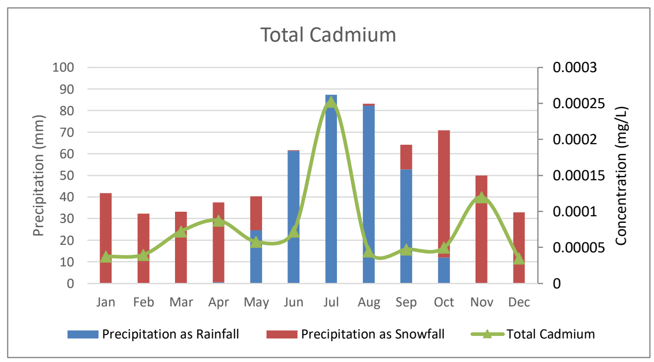

Alkalinity (CaCO3)
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Alkalinity (total) as CaCO3

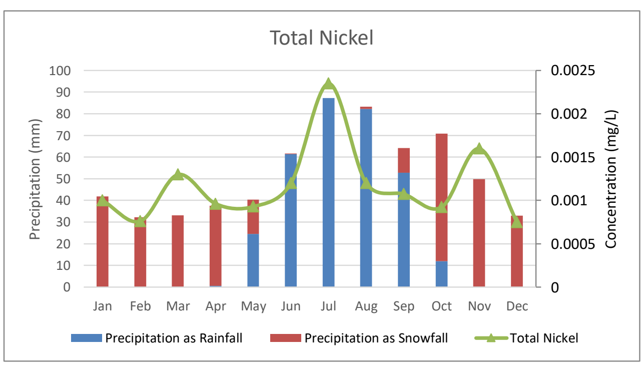

Ammonia
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Ammonia

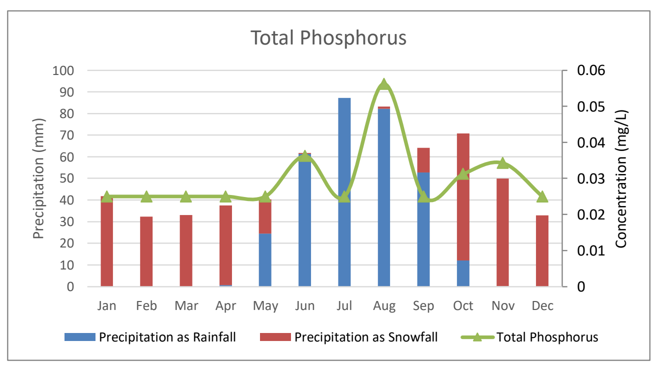

pH
Precipitation (mm)
pH
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
pH

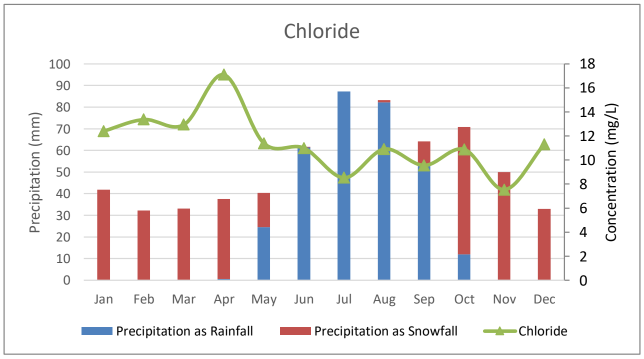

Sodium
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Sodium

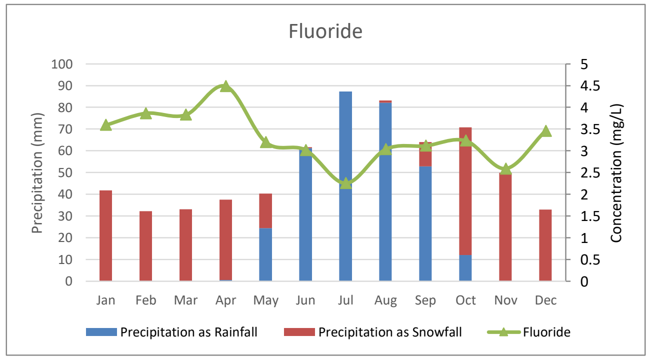

Total Boron
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Boron

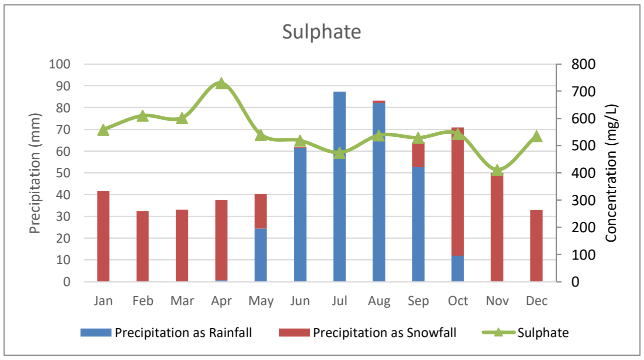

Total Cadmium
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Cadmium

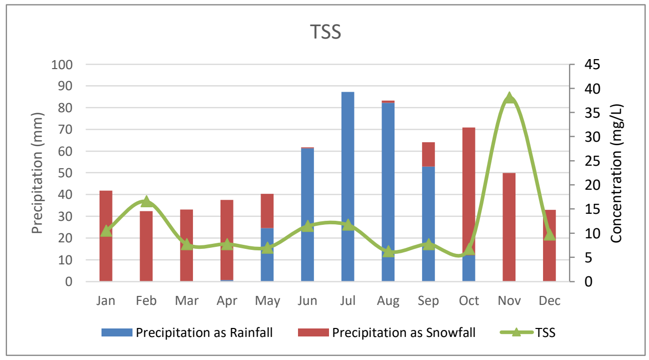

Total Nickel
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Nickel

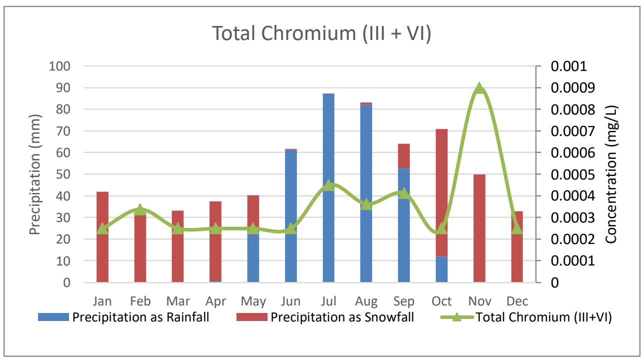

Total Phosphorus
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Phosphorus

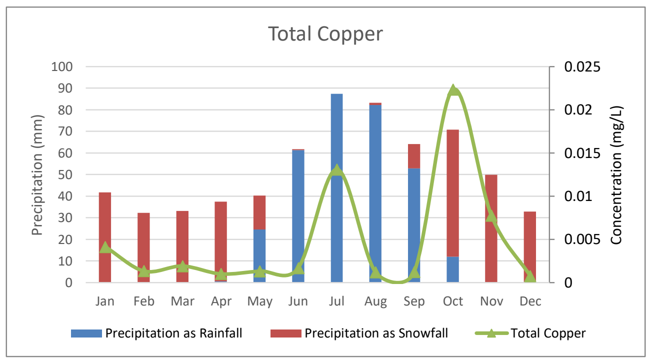

Chloride
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Chloride

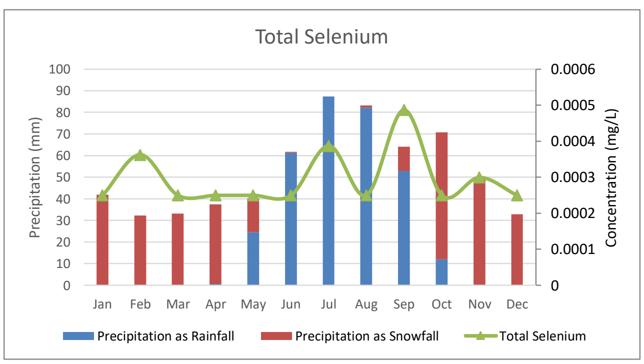

Fluoride
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Fluoride

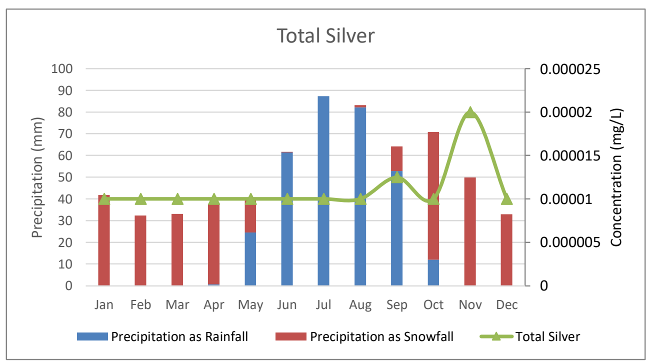

Sulphate
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Sulphate

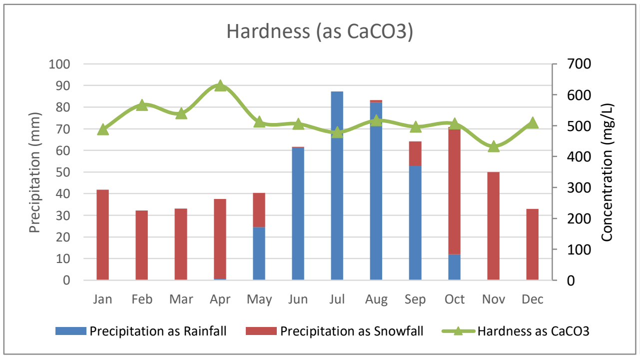

TSS
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
TSS

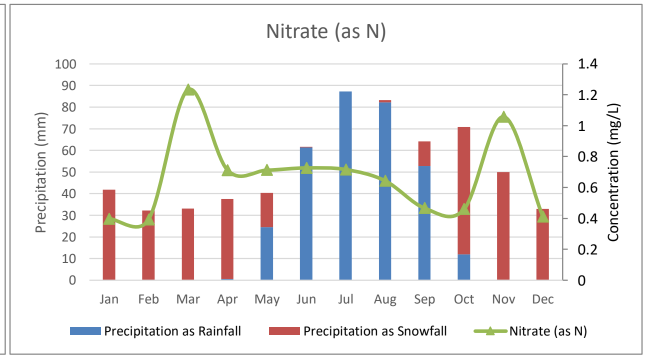

Total Chromium (III + VI)
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Chromium (III+VI)

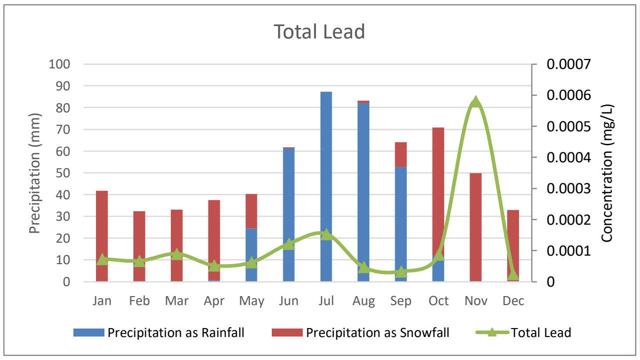

Total Copper
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Copper

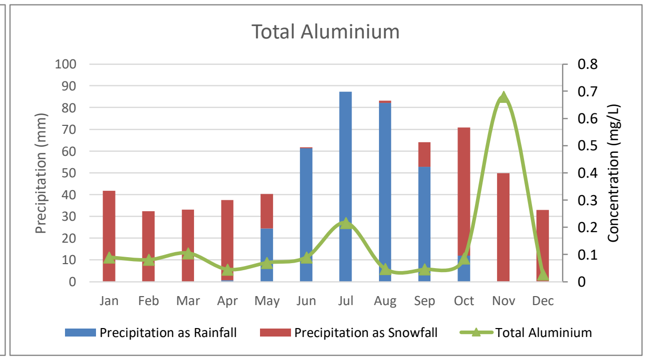

Total Selenium
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Selenium

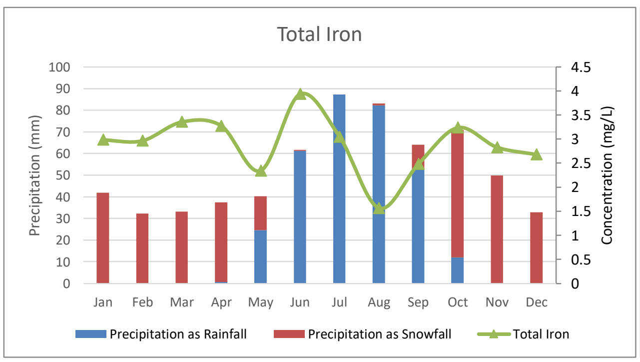

Total Silver
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Silver

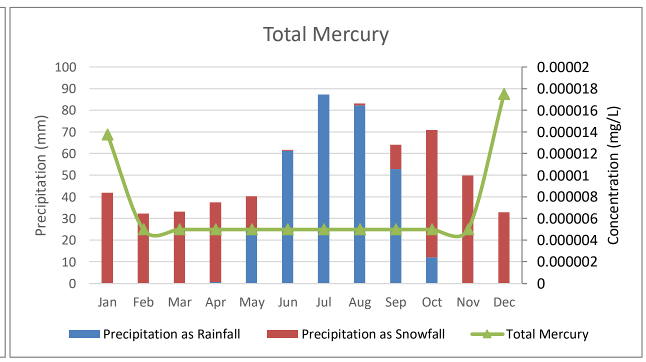

Hardness (as CaCO3)
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Hardness as CaCO3

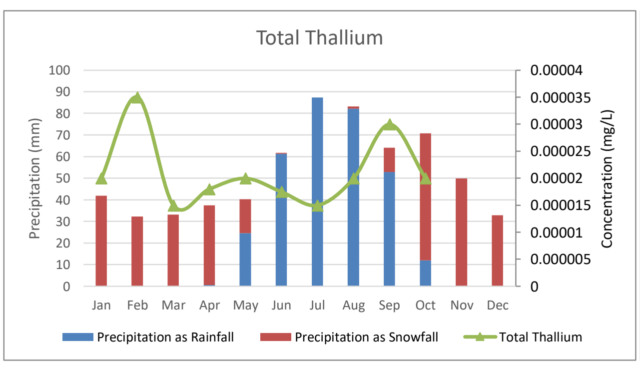

Nitrate (as N)
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Nitrate (as N)

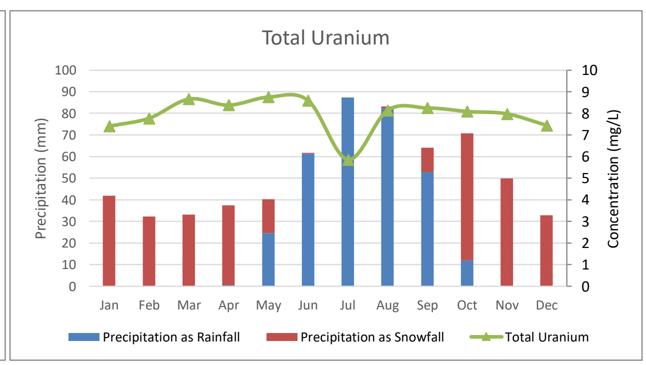

Total Lead
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Lead

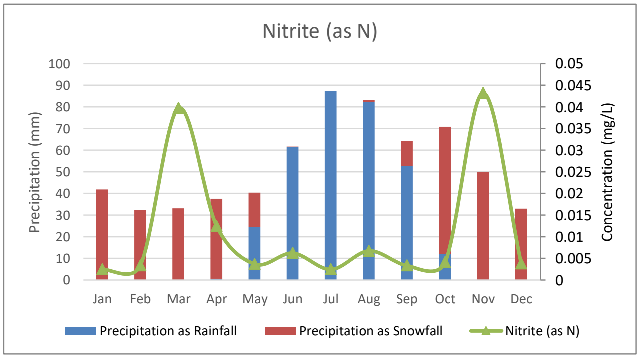

Total Aluminium
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Aluminium

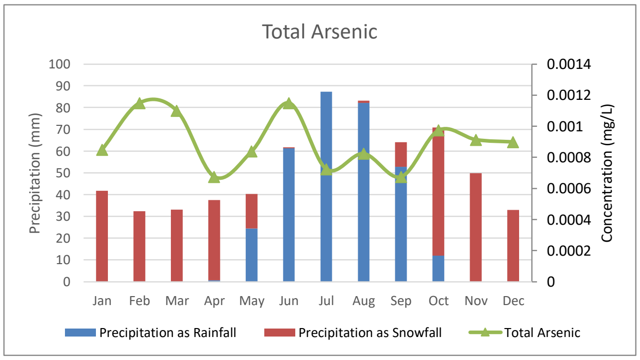

Total Iron
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Iron

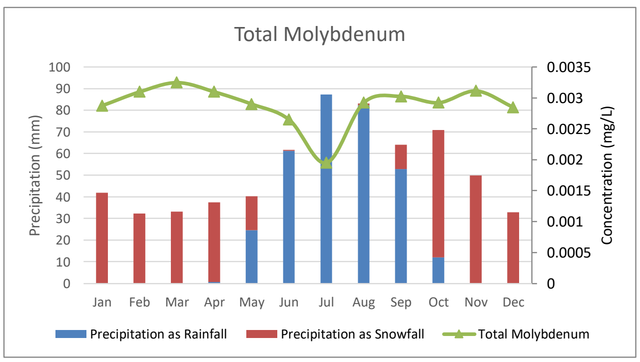

Total Mercury
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Mercury

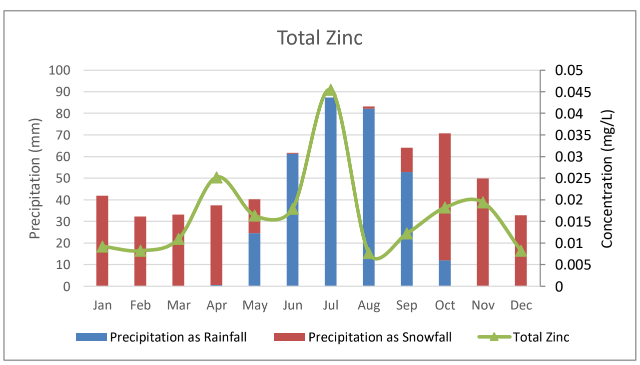

Total Thallium
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Thallium


Total Uranium
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Uranium

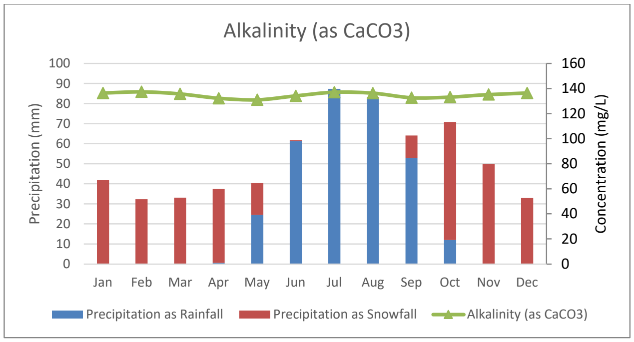

Nitrite (as N)
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Nitrite (as N)

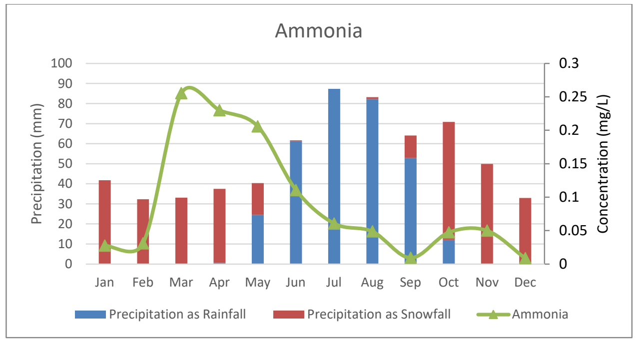

Total Arsenic
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Arsenic

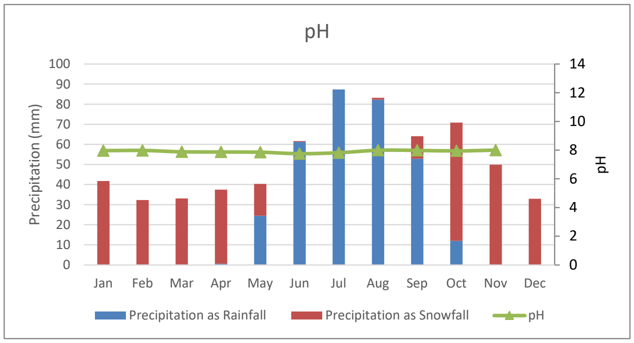

Total Molybdenum
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Molybdenum

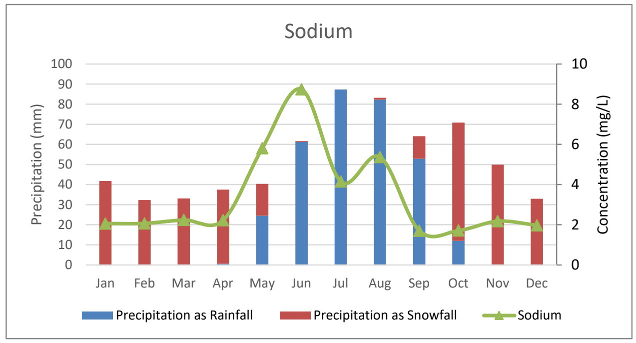

Total Zinc
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Zinc

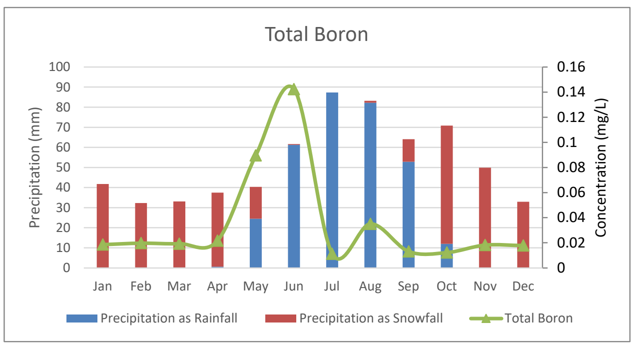
Appendix E3 – S4-13 (November 2015 to April 2020)

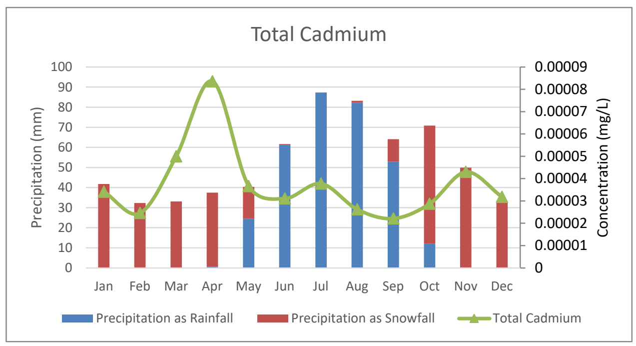

Alkalinity (as CaCO3)
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Alkalinity (as CaCO3)

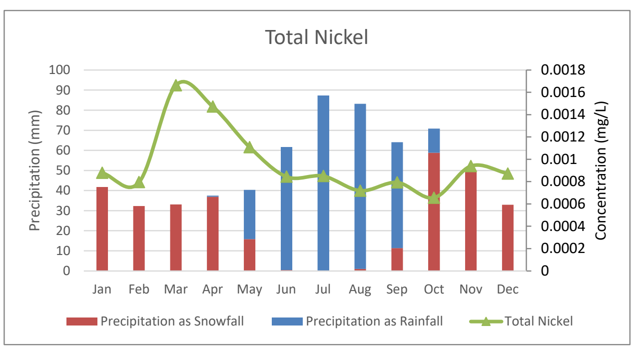

Ammonia
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Ammonia

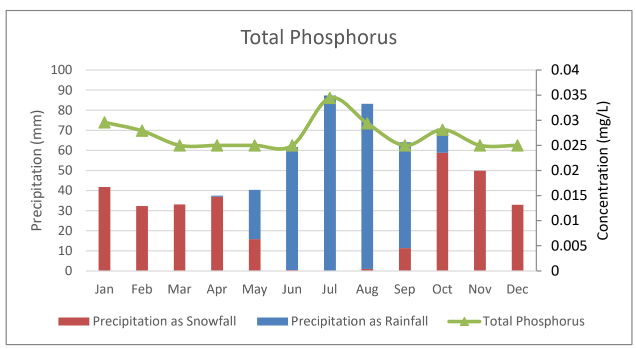

pH
Precipitation (mm)
pH
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
pH

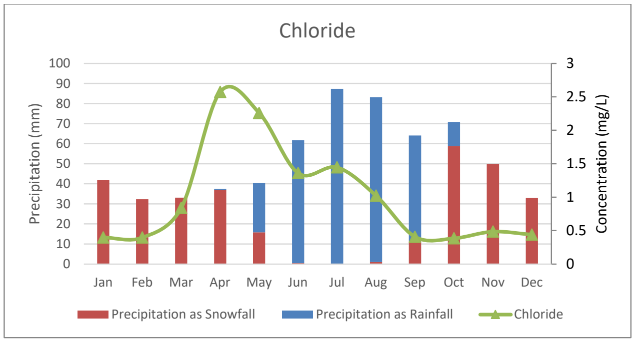

Sodium
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Sodium

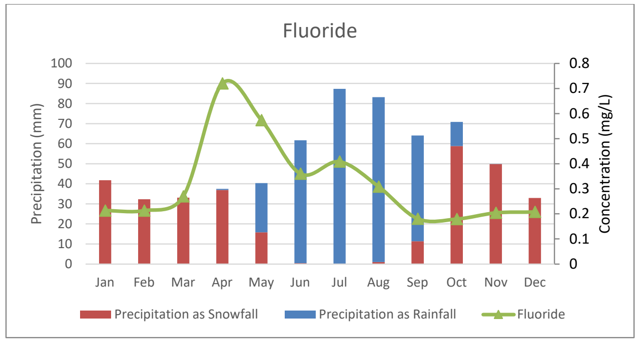

Total Boron
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Boron

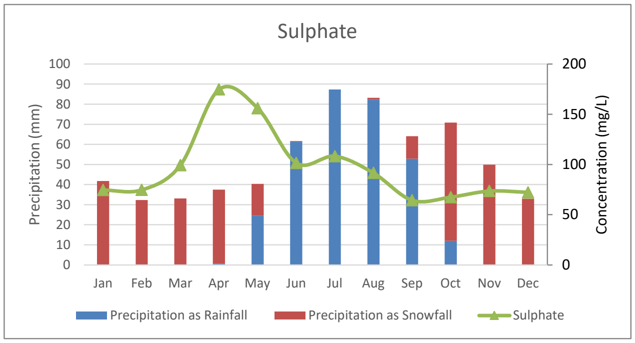

Total Cadmium
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Cadmium

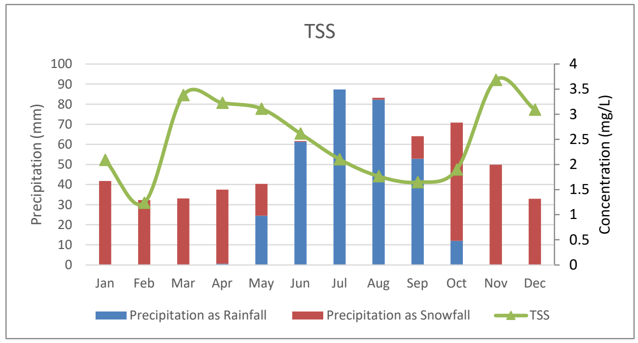

Total Nickel
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Snowfall
Precipitation as Rainfall
Total Nickel

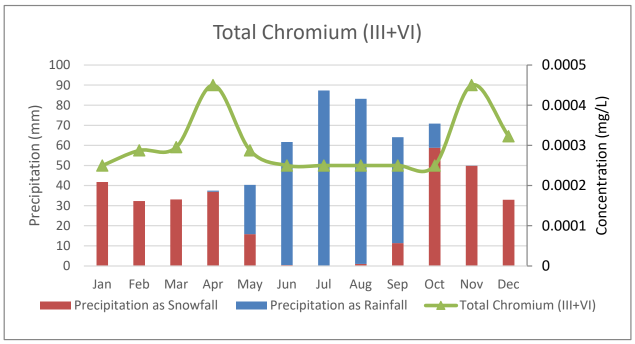

Total Phosphorus
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Snowfall
Precipitation as Rainfall
Total Phosphorus

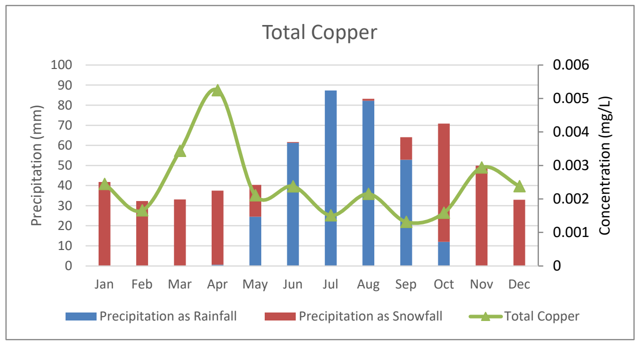

Chloride
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Snowfall
Precipitation as Rainfall
Chloride

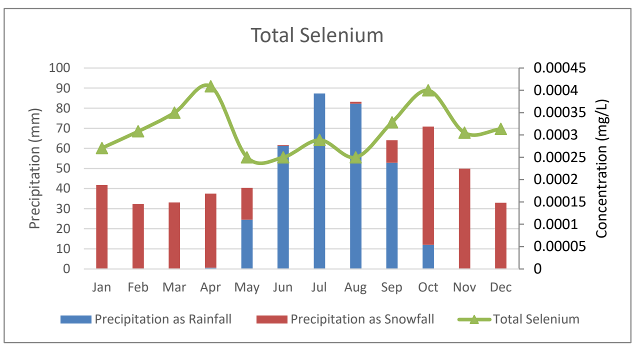

Fluoride
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Snowfall
Precipitation as Rainfall
Fluoride

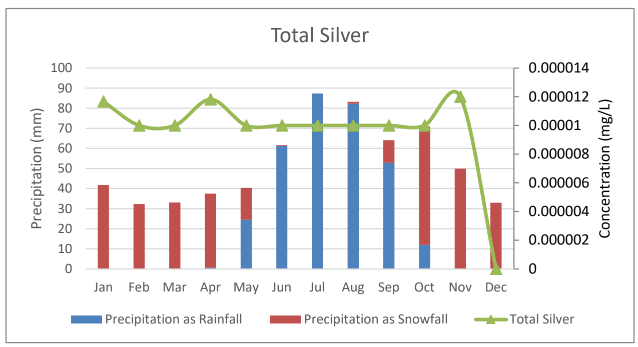

Sulphate
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Sulphate

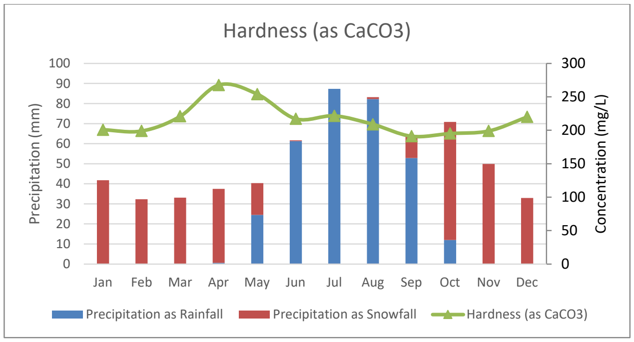

TSS
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
TSS

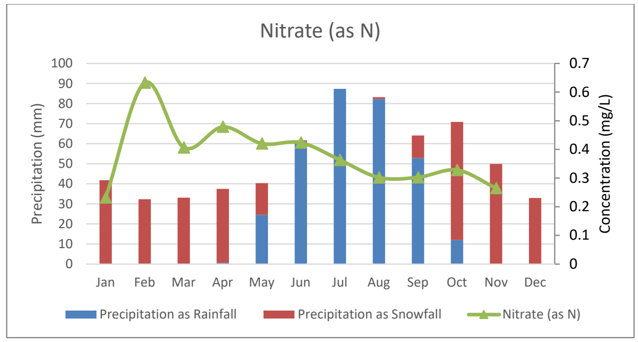

Total Chromium (III+VI)
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Snowfall
Precipitation as Rainfall
Total Chromium (III+VI)

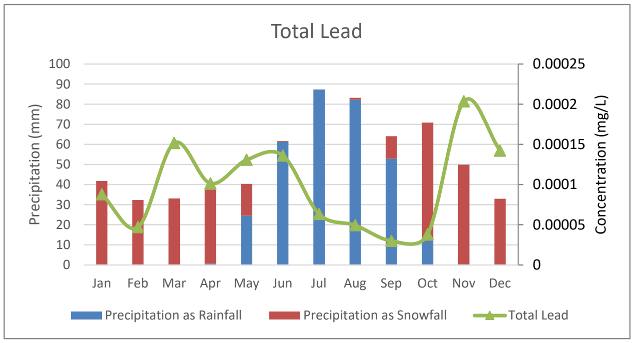

Total Copper
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Copper

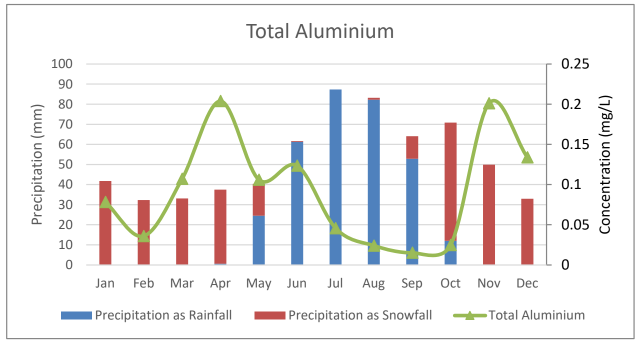

Total Selenium
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Selenium

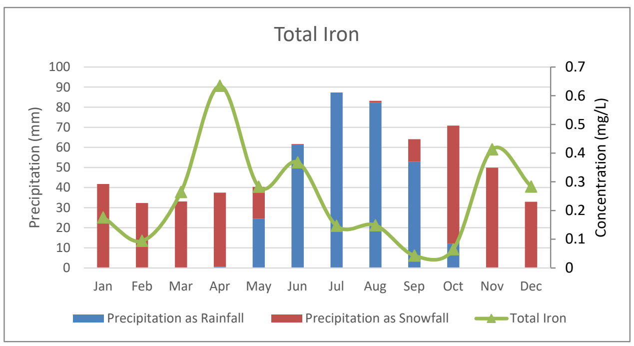

Total Silver
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Silver

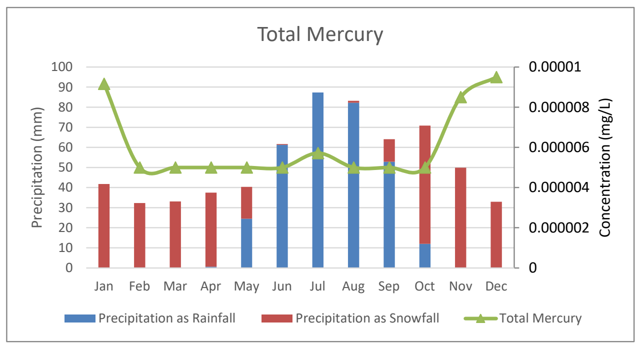

Hardness (as CaCO3)
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Hardness (as CaCO3)

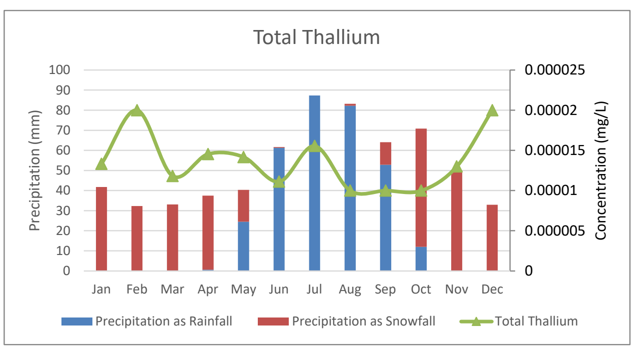

Nitrate (as N)
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Nitrate (as N)

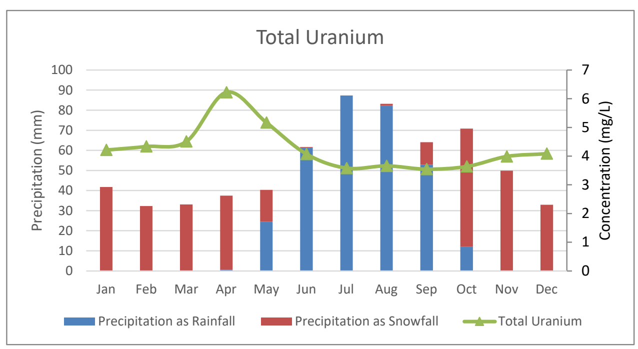

Total Lead
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Lead

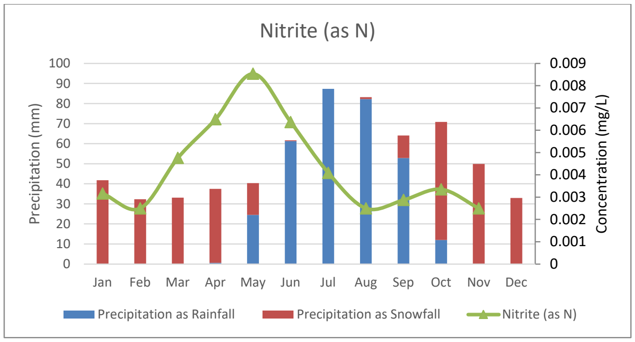

Total Aluminium
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Aluminium

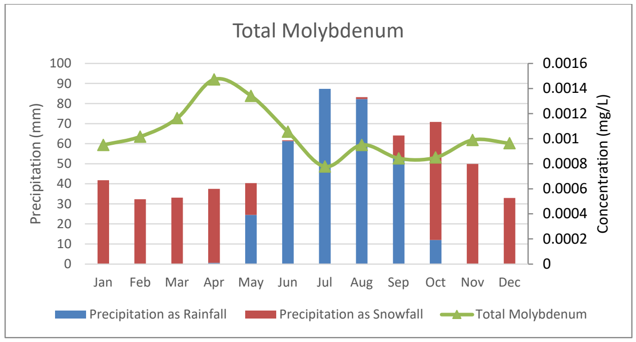

Total Iron
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Iron

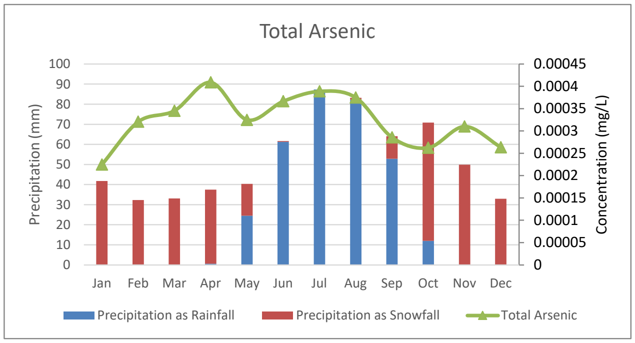

Total Mercury
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Mercury

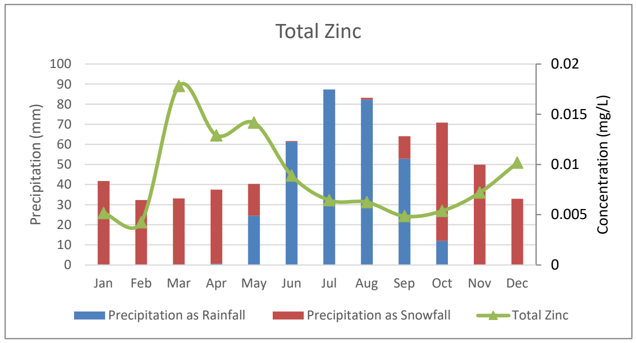

Total Thallium
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Thallium


Total Uranium
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Uranium


Nitrite (as N)
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Nitrite (as N)


Total Molybdenum
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Molybdenum


Total Arsenic
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Arsenic


Total Zinc
Precipitation (mm)
Concentration (mg/L)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Precipitation as Rainfall
Precipitation as Snowfall
Total Zinc

APPENDIX F

WATER QUALITY MODELLING REPORT

ISSUED FOR USE

Subject: Appendix F – Water Quality Modelling Report

1.0 WATER QUALITY MODELLING APPROACH

The water quality modeling focused on the primary areas of mining generated material, including Waste Rock Stockpiles #1 and #2, underground mine walls, tailings ponds, and Flat River Floodplain. The water quality modelling was completed to evaluate the impact of leachate from the facilities on surface water and groundwater quality. At this point, the modelling has been developed for evaluation of the impact from each facility independently, and therefore the results may not be directly comparable to overall site water quality which is influenced by multiple sources, including these facilities and other mine components.

Previous water quality modeling estimates were completed by pHase Geochemistry in 2017 (pHase, 2017), in combination with a site wide water balance model completed in GoldSim (O'Kane and pHase, 2017). For both modeling exercises, source terms were developed using the site data. The 2017 modeling relied on site observations from the TCAMP wells, the field barrel testing program, and monitoring sites within the sub-catchments. The 2020 modeling primarily relied on the field barrel program testing data.

The primary differences in the modeling completed in 2017 and that presented here are the mine phase being represented and the method of calculating the water quality. The 2017 modeling represented conditions of the site just after operations, while the 2020 model presents the current conditions of the site. The 2017 model included more sources than were considered in the current modeling because site had recently entered into the closure phase so areas of the site that are now not operation were then. The method used in the 2017 model linked the water quality calculations to the water balance model such that everything was combined to calculate site wide quality. The current modeling focused on the impacts from the individual facilities so each was modeled individually using a mass balance approach. The following describes the data used to support the modeling and the method used in the current estimates.

1.1 Source Terms Development

The accuracy and usefulness of a water quality model is dependent upon the quality of the data inputs, generally referred to as source terms. Source terms are estimates of the water quality that can be expected in the runoff or seepage from the various material types exposed in site facilities. Source terms are developed by combining the geochemical characterization data obtained from mine and rock tailings, including field barrel leachate data, with the expected proportions of material.

1.1.1 Data Source

Direct leaching data from the mine rock stockpiles, tailings ponds, and mine wall rocks is limited. There was a limited seep survey conducted in the vicinity for the waste rock stockpiles in 2014 and 2015. Field pH and conductivity values have also been collected during various sampling programs, but direct leachate has otherwise not been characterized at the mine site facilities. In the absence of this direct leachate data, the field barrel testing program was identified as the best source of information on leachate from the mined material over time. The field barrel testing program leachate analysis provides information on the material reactivity and leaching rates over time. The field barrel and static test data was used to determine source terms for each lithology or mine site material as described in the Geochemistry Summary Report (Tetra Tech, 2020a).

The source terms developed for use in the water quality modelling (Tetra Tech, 2020c) utilized the field barrel testing program and focused on a condition representative of long-term leaching concentrations from each lithology type and tailings source material. As of September 23, 2019, the majority of the field barrel parameters had not yet reached steady state values, and many parameters continue to fluctuate, therefore an estimation of long-term leaching concentrations was evaluated based on available data. The absence of steady-state conditions does not preclude the use of this data. It is the best available data to estimate future chemical loading from the primary mine rock and tailings areas. The application of various modelling conditions (described in more detail below) to bracket the range of expected conditions limits the uncertainty of non-steady state data.

The source terms for the waste rock and the underground wall rock were developed based on median and 95th percentile values of leachate data from the field barrel testing program between 2016-2020. The median and 95th percentile values are intended to provide a range of expected concentrations that could be leached from the mine site materials. The 95th percentile values, except for alkalinity and pH (H^+ analogue) which use the 5th percentile values, are intended to represent a potential upper limit for future leaching rates. The median values are intended to represent average long term conditions. For details of the source term development including data sources and limitations, consult the Geochemistry Summary Report (Tetra Tech, 2020a).

A number of parameters (e.g., antimony, barium, bismuth, calcium, lithium, magnesium, potassium, silicon, tin, and titanium) were only analyzed for during the initial years of operation from April 2010 to October 2011 (i.e., two seasons of sampling). In order to include these elements in the modelling, the median and 95th percentile values were calculated from the entire dataset available, rather than the 2016-2020 data set used for the other parameters. The parameters using the earlier data typically included 12 to 13 data points over the two years of sampling. The elemental concentrations observed in the early part of testing, may not be representative of the later stage leaching values but was evaluated to be a reasonable approximation and the best available data.

The tailings source terms are based on the barrel testing median and 95th percentile results, and these values were calculated over the entire period of record for the field barrels due to variability in the data.

1.1.2 Adjustments for Charge Balance

Summarizing median and 95th percentile statistics for the initial solutions does not typically result in a charge balanced solution, which can result in an imbalance of the solution components (e.g., a high acidity and low alkalinity, but a circum-neutral pH).The initial charge balances were between -50 to -100, because of a lack of multiple cations in the 2016-2019 dataset. Addition of the parameters from 2010-2011 improved the charge balance to a range of 0 to +20. Therefore, the initial solutions developed through mathematical calculation of median and 95th percentile values were run through the PHREEQC software (Parkhurst and Appelo, 2013) to allow for consideration of more realistic geochemical relationships among the elements, alkalinity, and pH.

PHREEQC (Parkhurst and Appelo, 2013), an industry standard software created by the U.S. Geological Survey (USGS) for predictive water quality modeling, is a flexible modeling platform that can be used to predict water chemistry across a wide range of modeling needs, from simple mass balance models to complex multiple geochemical equilibria and mixing reactions. In addition to a computer code PHREEQC, geochemical modeling requires a database of the thermodynamic and kinetic parameters. The database is a separate file to allow for additions, deletions, and updates to the information without impacting the model code. No database is fully comprehensive, so it is often necessary to make these changes (Zhu and Anderson, 2002). For this project, the WATEQ4F database (Ball and Nordstrom, 1991) was chosen. However, this database does not include all of the metals that are of concern to the project, so additional metals were added to the file. The information added was obtained from the PHREEQ database and the LLNL database published with the computer code (Parkhurst and Appelo, 2013). The combination of the three databases provides a broad range of parameters needed to model the metal leaching at the Site.

A charge balance of ±10% was targeted while maintaining lithologically representative solutions. Based on the lithology of the sample, initial solution anions or cations were adjusted within the range of observed values to achieve the desired charge balance range for use in PHREEQC. This was generally achieved with slight variations in calcium, magnesium, potassium and chloride adjustments, for example moving a value to the 90th percentile value, rather than the 95th percentile value.

The pH and the pe were allowed to be adjusted by the PHREEQC modeling software as part of its speciation of the solution. The pH was adjusted by the model based on the alkalinity of the solution and the pe value was adjusted based on the oxygen content of the solution. It was assumed that all initial solutions are at equilibrium with atmospheric concentrations of oxygen and carbon dioxide, resulting in pe values that are representative of oxygenated conditions. The pe value was initially the software's default value of +4 and adjusted to atmospheric conditions to values of about 12.5 for all solutions, except for the pyrrhotite skarn which is around 15 based on oxygen concentrations present.

1.1.3 Facility Specific Source Terms

The balanced lithologic specific solutions were then mixed using PHREEQC to develop the facility source terms. Base Case and Upper Case rock type proportions (Section 7.3.2 of CSM Report and Table 1-1 below) were used to develop lower and upper end member source terms for each of the three mine rock areas of interest. The resulting proportional mixing simulations are the proportional source terms designated for each of the areas considered in the water quality modelling.

Based on understanding that the field barrel data is not steady-state and may not be representative of the leachate conditions for the 100-year period, we have attempted to bracket the source term development with a range of rock proportions and median and 95th percentile values to bracket a range of conditions. The source term bracketing manages the uncertainty associated with non-steady state values and allows us to investigate the presence of high and low proportions of material generating acidic leachate.

Specifically, the pyrrhotite skarn leachate data is currently acidic and has elevated metals associated with acidic conditions. By adjusting the proportion of pyrrhotite skarn in the source term development, we have attempted to account for the fact some of the field barrels contain samples which were classified as PAG (argillite) or Uncertain (Swiss-Cheese limestone and calc-silicate skarn), but have not yet produced an acidic leachate, although they may be expected to do so during the proposed 100 year period of study. Increasing the proportion of pyrrhotite skarn allows for a future condition where a larger portion of the leachate is typical of the post-acidic and metalliferous leachate.

Table 1-1: Geochemical Equilibrium Modelling - Initial Solutions and Mixing Simulations

		Initial Solutions for each Representative Field Barrel, Median and 95th Percentile Values												Mixed Solutions for Base Case and Upper Case Rock Proportions and Median and 95th Percentile Values											
	Field Barrel	N/A	B4	B5	B6	B7	B8	N/A	B4	B5	B6	B7	B8	Waste Rock Stockpile #1				Waste Rock Stockpile #2				Underground Mine Walls in 10m Interval of Water Level (+-5m above and below)			
		Median Values						95th Percentile Values																	
Parameter	Units	Ore Limestone	Pyrrhotite Skarn	Swiss-Cheese Limestone	Argillite - Older/Younger	Calc-Silicate Skarn	Monzo-Granite	Ore Limestone	Pyrrhotite Skarn	Swiss-Cheese Limestone	Argillite - Older/Younger	Calc-Silicate Skarn	Monzo-Granite	Base Case, Median (WR1)	Upper Case, Median (WR1)	Base Case, 95th Percentile (WR1)	Upper Case, 95th Percentile (WR1)	Base Case, Median (WR2)	Upper Case, Median (WR2)	Base Case, 95th Percentile (WR2)	Upper Case, 95th Percentile (WR2)	Base Case, Median (UG)	Upper Case, Median (UG)	Base Case, 95th Percentile (UG)	Upper Case, 95th Percentile (UG)
pH	pH	8.13	5.55	8.18	8.33	8.28	8.32	7.87	5.78	7.90	8.13	8.00	8.09	6.43	5.85	6.06	5.65	6.03	5.56	5.71	5.74	6.57	6.03	6.17	5.70
pe	pe	12.5	15.1	12.4	12.3	12.3	12.3	12.7	14.8	12.7	12.5	12.6	12.5	14.2	14.8	14.5	14.9	14.6	15.1	14.9	14.8	14.0	14.6	14.4	14.9
Alkalinity, Total as $CaCO_3$	mg/L	85.2	1.1	92.7	131.1	117.2	127.4	46.9	1.1	75.1	87.0	65.3	75.1	95.7	61.3	54.8	34.9	71.2	10.8	38.5	3.6	104.3	79.9	56.7	42.6
Sulphate, SO_4	mg/L	247	2566	424	376	488	373	711	4828	554	628	915	493	628	1434	1145	2603	1030	2350	1988	4397	554	1125	961	1993
Nitrite, as N	mg/L	0.035	0.009	0.009	0.009	0.009	0.009	0.035	0.025	0.011	0.053	0.080	0.018	7.5E-14	7.2E-14	4.8E-13	5.3E-13	7.1E-14	6.9E-14	2.7E-13	3.2E-13	8.0E-14	7.9E-14	7.5E-13	8.0E-13
Nitrate, as N	mg/L	0.24	0.012	0.057	0.028	0.092	0.415	0.472	0.066	0.398	1.142	0.855	1.843	0.45	0.43	2.57	2.73	0.42	0.41	1.52	1.72	0.48	0.47	3.69	3.80
Ammonia, NH4	mg/L	0.05	0.10	0.06	0.09	0.08	0.05	0.06	0.37	0.08	0.14	0.15	1.54	-	-	-	-	-	-	-	-	-	-	-	-
Chloride, Cl	mg/L	0.62	0.15	0.38	0.19	0.19	0.24	0.79	0.25	0.84	0.52	0.36	0.53	0.33	0.21	0.58	0.44	0.32	0.17	0.49	0.29	0.30	0.22	0.57	0.47
Charge Balance	-	6.9	-3.2	0.4	-3.6	-3.5	-4.9	6.3	-8.4	2.7	-0.8	0.3	8.8	-2.0	-3.2	-1.5	-6.6	-2.2	-3.2	-4.8	-8.2	-2.5	-3.3	0.1	-5.3
Dissolved Metals																									
Aluminium	mg/L	0.5	2.5	0.01	0.005	0.006	0.003	0.1	3.9	0.08	0.01	0.11	0.01	0.4	1.2	0.5	1.9	0.9	2.3	1.2	3.5	0.3	0.9	0.4	1.4
Arsenic	mg/L	0.00043	0.00021	0.00005	0.00005	0.00005	0.00021	0.00053	0.00090	0.00021	0.00015	0.00015	0.00035	0.00020	0.00017	0.00039	0.00056	0.00022	0.00021	0.00050	0.00084	0.00019	0.00017	0.00037	0.00049
Boron	mg/L	0.011	0.041	0.018	0.007	0.013	0.012	0.029	0.060	0.027	0.016	0.023	0.020	0.015	0.026	0.028	0.040	0.021	0.038	0.036	0.057	0.014	0.022	0.025	0.034
Barium	mg/L	0.009	0.053	0.053	0.053	0.053	0.053	0.013	0.054	0.053	0.053	0.053	0.053	0.043	0.053	0.044	0.053	0.040	0.053	0.041	0.054	0.046	0.053	0.047	0.053
Calcium	mg/L	126	554	186	160	197	146	306	833	223	252	313	205	204	350	327	516	280	515	457	771	188	291	294	427
Cadmium	mg/L	0.00004	0.007	0.005	0.012	0.005	0.008	0.000	0.014	0.010	0.019	0.008	0.013	0.006	0.008	0.010	0.014	0.004	0.007	0.008	0.014	0.006	0.008	0.011	0.014
Cobalt	mg/L	0.001	0.030	0.000	0.0004	0.00006	0.0001	0.002	0.076	0.001	0.001	0.0002	0.0004	0.004	0.015	0.010	0.037	0.009	0.027	0.023	0.068	0.003	0.010	0.007	0.026
Copper	mg/L	0.003	0.006	0.002	0.002	0.003	0.004	0.006	0.062	0.006	0.003	0.007	0.007	0.003	0.004	0.012	0.033	0.004	0.005	0.023	0.056	0.003	0.004	0.011	0.025
Iron	mg/L	0.011	821	0.58	0.18	0.12	0.10	0.011	1466	15.6	0.99	0.83	0.27	99	394	178	706	246	739	441	1320	70	279	127	500
Potassium	mg/L	2.6	11.3	2.1	3.7	5.1	7.9	4.1	16.3	3.6	8.8	16.5	16.1	5.2	8.1	10.4	13.3	6.2	10.7	12.0	15.7	5.8	7.8	11.6	13.7
Lithium	mg/L	0.005	0.039	0.054	0.096	0.028	0.087	0.044	0.125	0.170	0.590	0.117	0.757	0.051	0.060	0.323	0.343	0.028	0.042	0.132	0.159	0.061	0.068	0.434	0.448
Magnesium	mg/L	3.6	94.9	3.8	6.1	9.4	8.3	14.9	246.7	13.2	11.0	45.8	19.9	16.7	48.9	46.7	126.5	33.0	86.0	93.9	223.7	14.1	36.9	38.5	95.0
Manganese	mg/L	0.09	7.38	0.01	0.03	0.01	0.01	0.55	14.33	0.19	0.10	0.05	0.10	0.9	3.6	1.9	6.9	2.2	6.6	4.5	12.9	0.7	2.5	1.4	5.0
Molybdenum	mg/L	0.00094	0.00010	0.00040	0.00037	0.00031	0.0016	0.0016	0.00032	0.00061	0.00064	0.00043	0.00254	0.00075	0.00052	0.00124	0.00091	0.00050	0.00019	0.00087	0.00044	0.00094	0.00078	0.0015	0.0013
Sodium	mg/L	0.84	2.27	4.38	1.28	0.48	4.62	3.19	3.65	6.52	1.84	0.88	4.80	2.40	2.96	3.61	4.05	1.53	2.49	2.88	3.85	2.93	3.33	3.89	4.20
Nickel	mg/L	0.0009	0.0053	0.0021	0.0038	0.0006	0.0004	0.0023	0.0188	0.0029	0.0059	0.0013	0.0007	0.0019	0.0035	0.0044	0.0105	0.0022	0.0049	0.0069	0.0171	0.0016	0.0028	0.0035	0.0078
Lead	mg/L	0.0049	0.0000027	0.0000027	0.0000027	0.0000027	0.0000027	0.0002132	0.0003648	0.0000027	0.0000027	0.0000027	0.0000153	0.0012	0.0000027	0.00010	0.00018	0.00147	0.0000027	0.00018	0.00033	0.00084	0.0000027	0.00007	0.00013
Selenium	mg/L	0.00096	0.00235	0.00027	0.00027	0.00061	0.00027	0.00181	0.01006	0.00072	0.00074	0.00139	0.00080	0.00072	0.0013	0.0022	0.0052	0.0012	0.0021	0.0041	0.0091	0.00059	0.00098	0.0018	0.0039
Strontium	mg/L	0.30	0.36	0.20	0.23	0.19	0.64	0.77	0.82	0.29	0.33	0.40	1.22	0.35	0.38	0.70	0.76	0.30	0.36	0.67	0.82	0.41	0.44	0.80	0.85
Uranium	mg/L	0.0006	0.0015	0.0007	0.0008	0.0023	0.0081	0.0021	0.0019	0.0012	0.0013	0.0045	0.0120	0.0027	0.0028	0.0043	0.0040	0.0018	0.0018	0.0032	0.0023	0.0039	0.0039	0.0060	0.0058
Tungsten	mg/L	0.015	0.00011	0.0036	0.0048	0.0037	0.0053	0.13	0.0006	0.0069	0.0108	0.0077	0.012	0.0065	0.0025	0.038	0.0056	0.0061	0.0005	0.043	0.0015	0.0061	0.0033	0.030	0.0073
Zinc	mg/L	0.003	1.11	0.50	0.93	0.44	0.48	0.79	2.04	0.66	1.65	0.79	0.73	0.51	0.85	1.04	1.48	0.52	1.05	1.16	1.90	0.51	0.76	0.98	1.29

The tailings material placed in the TPs is assumed to be more uniform due to the blending and extraction of the material during mineral processing. Therefore, the source terms representing the TPs did not require a mixing step like the mixed rock facilities. The median and 95th percentile concentrations from the field barrel tests were used directly to develop solutions for processing in PHREEQC. As with the lithologic specific solutions, the tailings solutions were balanced and speciated to eliminate any issues due to developing the solutions through mathematical methods. Initial solutions from field barrel leachate analysis are presented in Appendix G.

Details of the development of the source terms and the limitations of the data are presented in detail in Section 13 of the Geochemistry Summary Report (Tetra Tech, 2020c).

1.2 Water Quality Modelling Methodology

The water quality modeling was completed for the mine site features expected to have the most significant geochemical contributions to the site. The facilities included in the water quality modeling were:

- Waste Rock Stockpile #1
- Waste Rock Stockpile #2
- Underground Wall Rock
- Tailings Pile 1 and 2 (TP1, TP2)
- Tailings Piles 3, 4, and 5 (TP3, TP4, and TP5)

The water quality modeling uses a combination of the source terms developed as described above and the results of a water balance model. The source terms developed were used to develop water quality predictions for each of the primary areas of mining-generated materials that are potential contaminant source areas of the site. The water balance model is based on an evaluation of the exposed facility surfaces and contributing sources of water for the mine site, including direct precipitation and upgradient catchment flow, and provides the quantities of water that are expected to be contributed to surface water and groundwater from each facility. This provides a volume of water to which the chemical source term can be applied to develop a mixing model.

For each facility, the quantity of water expected to runoff of the facility or infiltrate through the facility and into the shallow groundwater system was calculated from the water balance model. The water balance and the expected flows associated with each facility are presented in Appendix A of the Conceptual Site Model Report. The volumetric flow (cubic meters per day [m^3/day]) from the water balance was multiplied by the facility specific source terms (milligrams per liter [mg/L]), which results in the expected mass loading from each facility (mg/day). Since the assumption that the source terms represent a long-term near steady state leaching condition is being relied upon, the mass balance models represent specific points in space (i.e., where facility seepage mixes with groundwater and where groundwater mixes with surface water) for the current and anticipated future conditions of these modelled areas under fully mixed conditions.

In order to understand how this facility specific loading would affect the groundwater quality, the loading was divided by the volumetric flow of the groundwater system below the site. Average groundwater flow below the site is 600 m^3/day was used to calculate the expected concentrations in the groundwater (mg/L) system directly below each facility. The groundwater system discharges to the ultimate receiving environment of the Flat River after transporting away from the facilities. Therefore, the calculated groundwater facility concentrations were mixed with a volume of water representative of the Flat River flows to calculated expected concentrations in the river due to the inputs from each facility. The low flow conditions in the Flat River were applied for conservatism. The low flow rate is 55,000 m^3/day. The average dilution of groundwater reaching the Flat River is approximately 99% based on the average flow rates.

The resulting water quality estimates for surface water and groundwater from each facility on site were compared to water quality data from around the site and receiving waters to verify the modelling results. Monitoring wells near the facilities, such as the TCAMP wells, and groundwater wells representing background concentrations (S4-27-17) were considered for comparison to the predicted groundwater concentration. Surface water monitoring locations in the site drainages and the Flat River, including upstream background concentration at S4-29, were considered for comparison to the calculated surface water concentrations. As noted above, the modelling has been developed to evaluate impact from each facility independently and therefore the results may not be directly comparable to overall site water quality. The Flat River water quality data represents all of the chemical loading from the entire site, so is not directly comparable to the water quality developed for each facility through this modelling.

2.0 WATER QUALITY MODELLING RESULTS

2.1 Mine Rock Areas

The two primary waste rock stockpiles and the underground mine workings, with their associated discharge water, represent the dominant mine rock sources of chemical loading to both groundwater and surface water. The chemical loading concentrations resulting from the mine rock are less significant than from the tailings areas due to the presence of mixed sulphide-rich and carbonate-rich lithologies with variable ARD potential and due to the less reactive nature of the mine rock relative to the fine grained tailings materials. The volumes of the waste rock stockpiles are also smaller than the tailings areas and therefore represent smaller sources, and the flushing of underground mine walls is constrained to a small zone of water level fluctuation.

2.1.1 Waste Rock Stockpiles #1 and #2

Table 2-1 presents a summary of the groundwater and surface water mixing model results for leachate from the two waste rock stockpiles. The results show the effects of dilution and the elevated alkalinities in the background groundwater and surface water. The pH rises by about one pH unit when the mine rock leachate is mixed with groundwater, and another pH unit increase when mixed with Flat River surface water. The lowest pH after groundwater mixing (6.64) is associated with the Upper Case and 95th Percentile leachate from Waste Rock Stockpile #2, which is representative of a “worst-case” scenario for leachate. Subsequent mixing with the Flat River increases the pH to 8.3.

Alkalinity values also rise significantly due to the natural alkalinity in background water quality. Sulphate values drop but remain above the background groundwater quality of 182 mg/L, before being diluted further to values of less than 80 mg/L in the Flat River and within range of concentrations observed over time at the Flat River monitoring stations. Metal concentrations also report within range of observations in the Flat River water quality dataset. The exception is iron and aluminum, which remains elevated in the mixed solutions and supersaturated as observed in the source term leachate solutions.

Given the reduced remaining volume (65,000 m^3) in Waste Rock Stockpile #1 and the low volumes of leachate generated, the ARD impacts are anticipated to be of low concern from this stockpile. The water quality modelling indicates that ARD conditions are unlikely to develop in seepage from the mixed waste rock pile. The leachate from the stockpile has limited impact on the groundwater and surface water concentrations due to the volumes of flow, both in groundwater beneath the facility and further diluted in the Flat River receiving environment, and from the natural alkalinity in the background water quality.

The rock types present in Waste Rock Stockpile #2 indicate a greater potential for ARD impacts than from Waste Rock Stockpile #1 due to the prevalence of skarnified mine rock from near the ore zone. The leachate chemistry is slightly lower in pH and elevated in sulphate and some metals, however the water quality modeling again demonstrates the effects of significant dilution and alkalinity from the groundwater and surface water that the leachate mixes with. The water quality modelling considered an upper-case range that estimated a waste rock pile of 90% pyrrhotite skarn, in order to bracket an upper range of expected leachate conditions. Even under this upper bound condition, and a condition that is not representative of actual conditions, the leachate chemistry observations from the mass balance modelling do not predict downstream impacts to the receiving environment. There is relatively minor volume (15,000 m^3) of material in this area so the loading capacities are also reduced.

Table 2-1: Waste Rock Stockpile Mixing Simulations with Background Water Quality

Parameter	Units	Waste Rock Stockpile #1		Waste Rock Stockpile #2		Background Water Quality		Waste Rock Stockpile #1				Waste Rock Stockpile #2			
		Base Case, Median (WR1)	Upper Case, 95th Percentile (WR1)	Base Case, Median (WR2)	Upper Case, 95th Percentile (WR2)	Groundwater (S4-27-17, Median)	Surface Water (S4-29, Median)	Base Case, Median (WR1)		Upper Case, 95th Percentile (WR1)		Base Case, Median (WR2)		Upper Case, 95th Percentile (WR2)	
		Initial Source Term Leachate Chemistry						Source Term Mix with Groundwater	Impacted Groundwater Mix with Surface Water	Source Term Mix with Groundwater	Impacted Groundwater Mix with Surface Water	Source Term Mix with Groundwater	Impacted Groundwater Mix with Surface Water	Source Term Mix with Groundwater	Impacted Groundwater Mix with Surface Water
pH	pH	6.43	5.65	6.03	5.74	7.82	7.72	7.37	8.51	6.78	8.41	7.17	8.50	6.64	8.34
pe	pe	14.2	14.9	14.6	14.8	-		13.0	12.1	13.6	12.2	13.2	12.1	13.7	12.3
Alkalinity, Total as $CaCO_3$	mg/L	96	35	71	4	196	96	349	205	341	205	353	205	345	205
Sulphate, SO_4	mg/L	628	2603	1030	4397	25	70	111	75	390	78	145	75	545	80
Nitrite, as N	mg/L	7.5E-14	5.3E-13	7.1E-14	3.2E-13	2.8E-01	5.9E-02	5.2E-13	5.7E-14	7.7E-13	5.8E-14	5.7E-13	5.7E-14	7.3E-13	5.8E-14
Nitrate, as N	mg/L	0.45	2.73	0.42	1.72	0.0025	0.0025	1.14	0.35	1.47	0.35	1.16	0.35	1.31	0.35
Ammonia, NH4	mg/L	0	0	0	0	0.005	0.005	0	0	0	0	0	0	0	0
Chloride, Cl	mg/L	0.33	0.44	0.32	0.29	0.30	0.08	0.30	0.09	0.32	0.09	0.30	0.09	0.30	0.09
Charge Balance	-	-2.0	-6.6	-2.2	-8.2	-		-5.1	2.1	-6.6	2.0	-5.1	2.1	-7.7	1.9
Dissolved Metals															
Aluminium	mg/L	0.4	1.9	0.9	3.5	0.001	0.0	0.06	0.01	0.27	0.01	0.11	0.01	0.42	0.01
Arsenic	mg/L	0.00020	0.00056	0.00022	0.00084	0.00020	0.00040	0.00020	0.00042	0.00025	0.00042	0.00020	0.00042	0.00028	0.00042
Boron	mg/L	0.015	0.040	0.021	0.057	0.010	0.003	0.010	0.003	0.014	0.003	0.011	0.003	0.015	0.003
Barium	mg/L	0.043	0.053	0.040	0.054	-	-	0.006	0.000	0.008	0.000	0.005	0.000	0.006	0.000
Calcium	mg/L	204	516	280	771	-	42	65	45	109	46	71	45	129	46
Cadmium	mg/L	0.006	0.014	0.004	0.014	0.000020	0.00002	0.0008	0.00003	0.002	0.00004	0.0005	0.00003	0.0017	0.00004
Cobalt	mg/L	0.004	0.037	0.009	0.068	0.000025	0.00005	0.001	0.00006	0.005	0.00011	0.001	0.00006	0.008	0.00014
Copper	mg/L	0.003	0.033	0.004	0.056	0.001	0.0003	0.001	0.00033	0.005	0.00037	0.001	0.00033	0.007	0.00039
Iron	mg/L	99	706	246	1320	0.07	0.02	14	0.18	100	1.12	29	0.34	157	1.7
Potassium	mg/L	5.2	13.3	6.2	15.7	-	5	5.0	5.3	6.2	5.3	5.1	5.3	6.3	5.3
Lithium	mg/L	0.051	0.343	0.028	0.159	-	-	0.007	0.0001	0.049	0.001	0.003	0.00004	0.019	0.0002
Magnesium	mg/L	16.7	126.5	33.0	223.7	-	15	19.5	16.0	35.0	16.2	21.5	16.0	44.2	16.3
Manganese	mg/L	0.9	6.9	2.2	12.9	0.001	0.006	0.1	0.008	1.0	0.017	0.3	0.009	1.5	0.0
Molybdenum	mg/L	0.00075	0.00091	0.00050	0.00044	0.00069	0.00093	0.00069	0.00098	0.00072	0.00098	0.00066	0.00098	0.00065	0.00098
Sodium	mg/L	2.40	4.05	1.53	3.85	1.38	0.85	1.52	0.93	1.76	0.93	1.40	0.93	1.67	0.93
Nickel	mg/L	0.0019	0.0105	0.0022	0.0171	0.0002	0.0022	0.0004	0.0023	0.0017	0.0023	0.0004	0.0023	0.0022	0.0023
Lead	mg/L	0.0012	0.00018	0.00147	0.00033	0.000025	0.000025	0.00019	0.00005	0.00005	0.00005	0.00020	0.00005	0.00006	0.00005
Selenium	mg/L	0.00072	0.0052	0.0012	0.0091	0.00025	0.00025	0.0003	0.0005	0.0010	0.0005	0.0004	0.0005	0.0013	0.0005
Strontium	mg/L	0.35	0.76	0.30	0.82	0.05	0.11	0.09	0.12	0.15	0.12	0.08	0.12	0.14	0.12
Uranium	mg/L	0.0027	0.0040	0.0018	0.0023	0.0017	0.0017	0.0018	0.0018	0.0020	0.0018	0.0017	0.0018	0.0018	0.0018
Tungsten	mg/L	0.0065	0.0056	0.0061	0.0015	0.6	0.1	0.0014	0.0001	0.0013	0.0001	0.0013	0.0001	0.0007	0.0001
Zinc	mg/L	0.51	1.48	0.52	1.90	0.001	0.004	0.07	0.005	0.2	0.01	0.06	0.005	0.2	0.01

2.1.2 Underground Mine Discharge

For the underground mine discharge water quality modeling, only the zone of water level fluctuation for mine wall rock flushing, and the existing mine discharge chemistry were considered. The water recharging the mine workings from above is assumed to be the same as upgradient groundwater. The areas in the mine workings that are permanently flooded are also represented simply by current conditions and groundwater inflow. The mining impacts to water quality from the underground in the long term are associated with the portion of the wall rock that is in the zone of variable water level. It was assumed conservatively that a ten-meter zone of wall rock or 7% of the overall underground workings, could be susceptible to flushing. As the water level rises, it will wet new rock and flush salts that may have built up during the time the rock was not saturated and able to oxidize. As the water level falls, the area that was wet will be exposed to oxygen again, providing a suitable environment for oxidation reactions to build up salts that will flush when the area is re-wetted.

The surface area of the ten-meter zone of potential flushing is approximately 143,000 m^2, assuming open workings and no collapses. We assumed an active zone thickness of two meters into the wall rock, which is considered representative of the fractured blast impacted portion of the wall. The in-situ effective porosity of bedrock is less than 2%. Based on blast fracturing in the wall rocks, and professional experience, an estimated effective porosity of 5% was assumed for the underground mine wall rock within the zone of interest. The impacted volume of water from mine wall flushing is then 14,300 m^3 within the zone of potential flushing.

The average rise of the water level in the workings during mine flooding rate was about 0.26 m/day from late 2015 to spring 2017, when the mine was considered fully flooded. From this we can estimate that a ten meter fluctuation in the water level may take on the order of 40 days to occur, and that the contribution of flushing may be on the order of 360 m^3/day based on the volume of impacted water. Given that the underground mine water level has stabilized after mine flooding, we infer that aggregate groundwater inflow to the mine workings is equal to the sum of outflows from the Main Portal (S4-13) and Conveyor Adit (S4 42), which would range from 30 m^3/d to 1,700 m^3/d, with an average of 700 m^3/day.

A mixing model was completed using PHREEQC (Parkhurst and Appel, 2013) to mix equal proportions of the three source terms - the leachate from wall rock flushing within the ten meter water level fluctuation zone (as modelled and presented in Table 1-1), the baseline groundwater infiltrating into the mine as approximated from S4-27-17, and the median concentrations of current mine discharge chemistry as measured at S4-13 and S4-42. The mixing model provides an indication of resulting chemistry associated with fluctuations in the water level and leaching from the mine walls. The use of the potential ten meter zone of flushing and 33% contribution of this zone to the overall water mix is considered conservative. The Base Case, Median and Base Case, 95th percentile initial solutions for the ten meter wall rock section (Table 1-1) were considered. Table 2-2 presents a summary of the mixing models and the resulting output solutions. The resulting solutions are for discharge chemistry and are not mixed at downstream points. There is a high level of dilution downstream after the discharge daylights at the Flat River compared to underground mine discharge (Section 8.5 of CSM Report) so no impacts to the Flat River are expected from this source.

Chemical loading from the fluctuating water levels in the underground workings is lower than from the waste rock piles due to limited zone of flushing and surface area. The resulting solutions range in pH from 6.9 (using the Base Case 95th percentile mix) to 7.1 (using the Base Case median values). Sulphate values are elevated with respect to background concentrations in surface water, but in line with what is observed at S4-42 and the downstream discharge at the Polishing Pond. The DQC reference values are for total metals but can be applied for reference. A reminder that the DQC values only apply at the downstream stations and are conservatively applied for referenced at the discharge locations.

Dissolved iron remains oversaturated in solution and elevated in solution but is expected to precipitate. The cadmium and zinc values are elevated relative to the DQC values that are 0.0005 mg/L and 0.075 mg/L, respectively. The uranium concentration is marginally higher than DQC value in the S4-42 mixing simulation.

Table 2-2: Underground Discharge Water Quality Mixing Simulations

Parameter	Units	Underground Mine Walls in 10m Section Around Current Water Level (+/- 5m from 1204m)				Background Water Quality		Mine Discharge Median Values		Undergrouund Mine Walls Initial Source Term, mix with Background GW quality (S4-27-17) and underground mine discharge water quality at S4-42 or S4-13				Discharge Quality Objectives (DQC)[1]
		Base Case, Median (UG)	Upper Case, Median (UG)	Base Case, 95th Percentile (UG)	Upper Case, 95th Percentile (UG)	Ground Water (S4-27-17, Median)	Surface Water (S4-29, Median)	Mine Discharge Median at S4-42 (Conveyor Portal)	Mine Discharge Median at S4-13 (Main Portal)	Base Case, Median (UG)		Base Case, 95th Percentile (UG)		
		Initial Source Term Leachate Chemistry								At S4-42	At S4-13	At S4-42	At S4-13	
pH	pH	6.57	6.03	6.17	5.70	7.82	7.72	8.00	7.96	7.13	7.16	6.92	6.94	NG
pe	pe	14.0	14.6	14.4	14.9	-	-	-	-	13.3	13.3	13.4	13.5	NG
Alkalinity, Total as $CaCO_3$	mg/L	104	80	57	43	196	96	125	134	245	254	230	238	NG
Sulphate, SO_4	mg/L	554	1125	961	1993	25	70	605	72	395	217	531	353	NG
Nitrite, as N	mg/L	8.0E-14	7.9E-14	7.5E-13	8.0E-13	0.28	0.06	0.56	0.02	7.3E-13	3.0E-13	1.6E-12	7.5E-13	0.18
Nitrate, as N	mg/L	0.48	0.47	3.69	3.80	0.0025	0.0025	0.0025	0.0025	2.0	1.0	3.1	2.1	8.9
Ammonia, NH4	mg/L	-	-	-	-	0.005	0.005	0.41	0.27	-	-	-	-	3.85
Chloride, Cl	mg/L	0.30	0.22	0.57	0.47	0.30	0.08	14.2	0.4	4.9	0.3	5.0	0.4	366.0
Charge Balance	-	-2.5	-3.3	0.1	-5.3	-	-	-	-	-0.6	-2.2	0.3	-0.6	NG
Dissolved Metals														
Aluminium	mg/L	0.3	0.9	0.4	1.4	0.001	0.005	0.009	0.003	0.11	0.10	0.13	0.13	0.60
Arsenic	mg/L	0.00019	0.00017	0.00037	0.00049	0.0002	0.0004	0.0004	0.0002	0.0003	0.0002	0.0003	0.0003	0.0130
Boron	mg/L	0.014	0.022	0.025	0.034	0.010	0.003	1.5	0.02	0.51	0.01	0.52	0.02	4.60
Barium	mg/L	0.046	0.053	0.047	0.053	-	-	-	-	0.015	0.015	0.016	0.016	NG
Calcium	mg/L	188	291	294	427	-	42	152	60	128	97	163	132	NG
Cadmium	mg/L	0.006	0.008	0.011	0.014	0.000020	0.00002	0.00002	0.00003	0.002	0.002	0.004	0.004	0.001
Cobalt	mg/L	0.003	0.010	0.007	0.026	0.000025	0.00005	0.00036	0.00016	0.0011	0.0010	0.0025	0.0025	0.0025
Copper	mg/L	0.003	0.004	0.011	0.025	0.001	0.0003	0.0003	0.0008	0.001	0.002	0.004	0.004	0.006
Iron	mg/L	70	279	127	500	0.07	0.02	0.01	0.005	23	23	42	42	3
Potassium	mg/L	5.8	7.8	11.6	13.7	-	5	5	5	5	5	7	7	NG
Lithium	mg/L	0.061	0.068	0.434	0.448	-	-	-	-	0.020	0.020	0.145	0.145	NG
Magnesium	mg/L	14.1	36.9	38.5	95.0	-	15	60	15	31	16	40	24	NG
Manganese	mg/L	0.7	2.5	1.4	5.0	0.001	0.006	0.521	0.014	0.392	0.223	0.639	0.470	NG
Molybdenum	mg/L	0.00094	0.00078	0.00152	0.00129	0.00069	0.00093	0.00268	0.00093	0.00143	0.00085	0.00162	0.00104	0.22
Sodium	mg/L	2.9	3.3	3.9	4.2	1.4	0.9	85	2	30	2	30	2	NG
Nickel	mg/L	0.0016	0.0028	0.0035	0.0078	0.0002	0.0022	0.0008	0.0007	0.0009	0.0008	0.0015	0.0015	0.371
Lead	mg/L	0.0008	0.00000	0.00007	0.00013	0.000025	0.000025	0.000025	0.000025	0.000295	0.000295	0.000041	0.000041	0.015
Selenium	mg/L	0.00059	0.0010	0.0018	0.0039	0.00025	0.00025	0.00025	0.00025	0.00036	0.00036	0.00076	0.00076	0.002
Strontium	mg/L	0.41	0.44	0.80	0.85	0.05	0.11	0.84	0.12	0.43	0.19	0.56	0.32	NG
Uranium	mg/L	0.0039	0.0039	0.0060	0.0058	0.0017	0.0017	0.0075	0.0038	0.0044	0.0031	0.0051	0.0038	0.0041
Tungsten	mg/L	0.006	0.003	0.03	0.007	0.6	0.1	0.02	0.003	0.007	0.003	0.015	0.011	NG
Zinc	mg/L	0.51	0.76	0.98	1.29	0.001	0.004	0.004	0.005	0.17	0.17	0.33	0.33	0.08

[1] Discharge Quality Criteria (DQC), as defined in Phase III ESA Report and subject to board approval. Values are for total metals and apply only at stations S4-32 and S5-2, but are provided here as a reference point.
NG - No guideline value

2.1.3 Tailings Areas

The tailings overall represent that largest onsite source of chemical loading to both groundwater and surface water. The concentrations resulting from the TPs are estimated to be approximately an order of magnitude larger than that of the waste piles due to the reactive nature of the material and the large surface area of tailings in the TPs and floodplain area. The results of the tailings mass balance model are presented in Appendix G.

2.1.3.1 Tailings Ponds TP1 and TP2

A combined mass balance chemical calculation was completed for TP1 and TP2 which does not consider these two facilities separately. The field barrel test used to develop the source term for TP1 and TP2 is also a combined sample to represent the material of the combined TPs. The results of the TP1 and TP2 water quality mass balance model using the median value source terms suggest that the pH of the runoff and seepage will be circum-neutral and that concentrations of potential contaminants are generally low.

Sulphate (64 to 87 mg/L), calcium (10 to 13 mg/L), magnesium (11 to 14 mg/L), and silicon (81 to 145 mg/L) are the elements that are expected to leach at the highest concentrations from TP1 and TP2. These elements are indicative of primarily silicate weathering related to the till cover, with some sulphide oxidation and neutralization reactions associated with the tailings material. The mass balance model using the 95th percentile source term results in slightly elevated iron (0.4 mg/L), manganese (0.5 mg/L), and uranium (0.25 mg/L) concentrations in groundwater. The concentrations expected in the Flat River due to leaching from TP1 and TP2, under both the median and 95th percentile concentrations, are expected to be quite low and well below any surface water quality standard due to the greater than 95% dilution. The complete model results are presented in Appendix G.

Due to the high level of dilution in both the groundwater system and the Flat River compared to discharges from TP1 and TP2, it is not expected that these facilities on their own will result in adverse environmental conditions. In particular, the seepage contribution will be diluted by mixing with groundwater, which will be further diluted as the groundwater mixes with the significantly larger flows of the Flat River.

Comparison of the mass balance model concentrations with the TCAMP monitoring data suggests that the mass balance model is representative of the potential discharge from TP1 and TP2. The TCAMP locations directly beneath the center of TP1 (TC11-10) and TP2 (TC11-9) have concentrations that are the same order of magnitude as the mass balance model. The mass balance results using the upper end estimate of concentrations (95th percentile values from the barrel test) when added to the approximate background groundwater concentrations are similar to field observations. It appears that the mass balance calculations using the median values may underestimate the chemical loading to the environment from TP1 and TP2.

2.1.3.2 Tailings Ponds TP3, TP4, and TP5

A separate mass balance calculation was completed for each of the facilities TP3, TP4, and TP5. However, the field barrel testing program only includes a sample of the TP3 tailings material. Based on the geochemical characterization work, it was found that the material in TP3, TP4, and TP5 is similar, and thus the TP3 field barrel was used as the data source for all three TPs.

The mass balance model results for TP3, TP4, and TP5 are similar to the results of the TP1 and TP2 mass balance model, with elevated sulphate (40 to 70 mg/L), calcium (15 to 28 mg/L), magnesium (3 to 5 mg/L), and silicon (120 to 240 mg/L) expected in the leachate seeping into the groundwater system below the facility. TP3, TP4, and TP5 each have a larger surface area than TP1 and TP2, so the concentrations expected from these facilities is higher than those calculated for TP1 and TP2, but still generally low due to the expected level of dilution of the seepage by the groundwater system and runoff by the Flat River. There are no TCAMP monitoring locations directly below these facilities but based on the observations below TP1 and TP2 and other site monitoring wells, the mass balance model using the 95th percentile values from the field barrel testing is representative of current conditions at the site. The complete model results are presented in Appendix G of the Conceptual Site Model Report (Tetra Tech, 2020b).

2.1.3.3 Flat River Floodplain Tailings

The Floodplain Tailings have been generating ARD since their deposition and are expected to continue to contribute a significant chemical load to the environment compared to other areas of the Cantung site. The mass balance model of the Floodplain tailings shows that this area of mine waste has a higher contribution than both the TPs and the waste rock stockpiles. However, the relatively small area of the tailings and the high alkalinity of the Flat River has prevented this area from adversely impacting the water quality of the Flat River.

The results of the mass balance model using the median values from the field barrel testing appears to be an accurate representation of the long term chemical loading from this area of tailings. Concentrations of sulphate (2,400 to 11,850 mg/L), aluminum (40 to 115 mg/L), calcium (18 to 30 mg/L), copper (4 to 15 mg/L), iron (836 to 2,405 mg/L), magnesium (99 to 174 mg/L), manganese (2 to 6 mg/L), and tungsten (1.5 to 20 mg/L) are expected to be elevated in the groundwater directly below the tailings deposition. However, the relatively small area of the tailings and the high alkalinity of the Flat River has prevented this area from adversely impacting the water quality of the Flat River. The mass balance model confirms that the greater than 95% dilution of the groundwater by the Flat River flows reduces the concentrations by more than two orders of magnitude. The results of the mass balance model using the median values from the field barrel testing appears to be an accurate representation of the long-term chemical loading from this area of tailings. There is no direct monitoring data in the area of the Floodplain tailings, but comparison of the modeled Flat River concentrations and the surface water quality data are generally in good agreement. The complete model results are presented in Appendix G of the Conceptual Site Model Report (Tetra Tech, 2020b).

There is no direct monitoring data in the area of the Floodplain tailings, but comparison of the modeled Flat River concentrations and the surface water quality data are generally in good agreement.

3.0 LIMITATIONS OF REPORT

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REFERENCES

Ball, J.W. and Nordstrom, D.K., 1991. WATEQ4F – User's Manual with Revised Thermodynamic Database and Test Cases for Calculating Speciation of Major, Trace, and Redox Elements in Natural Water. USGS Open-File Report 90-129, 185 pp.

O'Kane and pHase, 2017. Updated Geochemical Load Balance and Risk Assessment, Cantung Mine, NWT.

pHase, 2017. Geochemical Source Terms for the Water & Load Balance, Cantung Mine, NWT.

Parkhurst, D.L. and C.A.J. Appelo, 2013, Description of input and examples for PHREEQC version 3 – A computer program for speciation, batch-reaction, one-dimensional transport, and inverse geochemical calculations. U.S. Geological Survey Techniques and Methods, Book 6, Chapter A43, 497 pp.

Tetra Tech. 2020a. Geochemistry and ARD/ML Summary Report, Issued for Use. December 24, 2020.

Tetra Tech 2020b. Conceptual Site Model Report, Issued for Review v3, March 5, 2021

Zhu, C. and G. Anderson, 2002, Environmental Applications of Geochemical Modeling. Cambridge University Press: Cambridge, United Kingdom.

APPENDIX G

TAILINGS AREAS MODELLING RESULTS

Field Barrel Leachate Data

Parameter	Unit	TP1/TP2 Base Case (Median)	TP1/TP2 Upper Case (95th Percentile)	TP3 (also used for TP4 and TP5) Base Case (Median)	TP3 (also used for TP4 and TP5) Upper Case (95th Percentile)	Floodplain Tailings Base Case (Median)	Floodplain Tailings Upper Case (95th Percentile)
pH (Lab)	pH_Units	7.78	7.62	7.61	5.87	2.36	2.04
Potassium	mg/L	1.02E+01	3.83E+01	1.19E+01	1.87E+01	1.04E+01	3.64E+01
Chloride	mg/L	-	-	4.40E-01	4.40E-01	8.33E-01	9.39E-01
Ammonia	mg/L	6.00E-02	7.80E-02	6.50E-02	3.55E-01	-	-
Nitrate (as N)	mg/L	4.00E-01	4.00E-01	4.00E-01	4.00E-01	6.96E-21	9.15E-21
Silica	µg/L	6.58E+03	6.58E+03	2.15E+04	2.16E+04	-	-
Sodium	mg/L	2.28E+01	3.27E+01	4.07E+00	8.67E+00	3.19E+01	6.08E+01
Sulphate	mg/L	2.93E+03	4.01E+03	1.62E+03	1.93E+03	2.84E+04	1.40E+05
Aluminium	mg/L	3.00E-03	1.85E-02	2.00E-03	2.73E-01	4.84E+02	1.36E+03
Antimony	mg/L	1.00E-03	1.00E-03	1.00E-03	1.00E-03	-	-
Arsenic	mg/L	5.00E-04	1.00E-03	5.00E-04	1.20E-03	1.04E-02	5.64E-02
Barium	mg/L	5.00E-02	5.00E-02	3.64E-02	5.00E-02	5.20E-02	6.46E-02
Beryllium	mg/L	3.00E-05	1.00E-03	1.00E-04	3.50E-03	-	-
Bismuth	mg/L	1.00E-02	1.00E-02	2.50E-03	9.00E-03	-	-
Boron	mg/L	6.40E-02	2.19E-01	3.60E-02	9.40E-02	1.04E-01	3.48E+01
Cadmium	mg/L	1.40E-04	6.80E-04	1.10E-04	6.48E-04	1.46E-02	1.09E-01
Calcium	mg/L	4.60E+02	6.12E+02	5.93E+02	6.95E+02	3.56E+02	2.08E+02
Chromium (III+VI)	mg/L	5.00E-04	5.00E-03	5.00E-04	5.00E-03	-	-
Cobalt	mg/L	3.51E-03	1.39E-02	2.50E-04	2.87E-03	1.27E+00	3.57E+00
Copper	mg/L	2.00E-03	3.96E-03	3.00E-03	3.58E-02	5.08E+01	1.76E+02
Iron	mg/L	1.20E-01	2.00E+01	6.50E-01	3.45E+01	9.90E+03	2.85E+04
Lead	mg/L	5.00E-05	1.00E-03	5.00E-05	1.00E-03	1.04E-03	1.17E-02
Lithium	mg/L	2.30E-01	3.05E-01	6.80E-02	1.45E-01	6.35E-01	8.57E-01
Magnesium	mg/L	5.18E+02	6.54E+02	1.23E+02	1.53E+02	1.17E+03	2.06E+03
Manganese	mg/L	1.03E+01	2.20E+01	2.99E+00	7.35E+00	2.80E+01	7.30E+01
Mercury	mg/L	1.00E-05	2.50E-05	1.00E-05	3.00E-04	-	-
Molybdenum	mg/L	2.70E-04	3.00E-03	5.00E-04	3.00E-03	3.09E-03	5.81E-03
Nickel	mg/L	6.80E-03	3.09E-02	5.00E-04	1.70E-02	3.33E-01	1.15E+00
Phosphorus	mg/L	2.50E-02	1.35E-01	2.50E-02	3.00E-01	6.87E-01	8.78E+00
Potassium	mg/L	9.70E+00	3.81E+01	1.14E+01	1.94E+01	1.04E+01	3.64E+01
Selenium	mg/L	1.00E-03	1.56E-03	1.00E-02	8.54E-02	4.01E-02	1.16E-01
Silicon	µg/L	3.73E+03	6.69E+03	4.71E+03	5.95E+03	-	-
Silver	mg/L	2.00E-05	1.00E-04	3.00E-05	1.20E-04	-	-
Strontium	mg/L	2.26E+00	3.21E+00	4.70E+00	1.02E+01	8.95E-01	1.41E+00
Thallium	mg/L	1.00E-05	1.00E-04	1.00E-05	3.60E-04	-	-
Tin	mg/L	1.00E-04	5.00E-04	1.00E-04	8.25E-04	-	-
Titanium	mg/L	5.50E-03	7.18E-02	1.00E-02	4.64E-02	-	-
Tungsten	µg/L	1.91E+00	1.38E+01	1.54E+00	1.72E+01	1.77E+01	2.35E+02
Uranium	µg/L	4.08E+00	1.15E+01	3.03E+00	9.22E+00	8.59E-02	1.89E-01
Vanadium	mg/L	5.00E-04	1.00E-03	5.00E-04	3.20E-03	-	-
Zinc	mg/L	2.60E-02	9.48E-02	1.30E-02	1.21E-01	2.06E+00	7.22E+00

TP1/TP2 Base Case

Parameter	Unit	Chemical Load to GW (mg/day)	Concentration in GW (mg/L)	Chemical Load to SW (mg/day)	Concentration in river (low flow) (mg/L)	Concentration in river (high flow) (mg/L)
pH (Lab)	pH_Units					
Potassium	mg/L	132,600	2.21E-01	310,080	5.64E-03	5.37E-12
Chloride	mg/L	-	-	-	-	-
Ammonia	mg/L	780	1.30E-03	1,824	3.32E-05	3.16E-14
Nitrate (as N)	mg/L	5,200	8.67E-03	12,160	2.21E-04	2.11E-13
Silica	µg/L	8.6E+07	1.43E+02	2.0E+08	3.64E+00	3.46E-09
Sodium	mg/L	295,750	4.93E-01	691,600	1.26E-02	1.20E-11
Sulphate	mg/L	3.8E+07	6.35E+01	8.9E+07	1.62E+00	1.54E-09
Aluminium	mg/L	39	6.50E-05	91	1.66E-06	1.58E-15
Antimony	mg/L	13	2.17E-05	30	5.53E-07	5.26E-16
Arsenic	mg/L	7	1.08E-05	15	2.76E-07	2.63E-16
Barium	mg/L	650	1.08E-03	1,520	2.76E-05	2.63E-14
Beryllium	mg/L	0.39	6.50E-07	0.91	1.66E-08	1.58E-17
Bismuth	mg/L	130	2.17E-04	304	5.53E-06	5.26E-15
Boron	mg/L	832	1.39E-03	1,946	3.54E-05	3.37E-14
Cadmium	mg/L	2	3.03E-06	4	7.74E-08	7.37E-17
Calcium	mg/L	5,973,500	9.96E+00	13,968,800	2.54E-01	2.42E-10
Chromium (III+VI)	mg/L	7	1.08E-05	15	2.76E-07	2.63E-16
Cobalt	mg/L	46	7.61E-05	107	1.94E-06	1.85E-15
Copper	mg/L	26	4.33E-05	61	1.11E-06	1.05E-15
Iron	mg/L	1,560	2.60E-03	3,648	6.63E-05	6.32E-14
Lead	mg/L	1	1.08E-06	2	2.76E-08	2.63E-17
Lithium	mg/L	2,990	4.98E-03	6,992	1.27E-04	1.21E-13
Magnesium	mg/L	6,734,000	1.12E+01	15,747,200	2.86E-01	2.73E-10
Manganese	mg/L	133,900	2.23E-01	313,120	5.69E-03	5.42E-12
Mercury	mg/L	0.13	2.17E-07	0.30	5.53E-09	5.26E-18
Molybdenum	mg/L	4	5.85E-06	8	1.49E-07	1.42E-16
Nickel	mg/L	88	1.47E-04	207	3.76E-06	3.58E-15
Phosphorus	mg/L	325	5.42E-04	760	1.38E-05	1.32E-14
Potassium	mg/L	126,100	2.10E-01	294,880	5.36E-03	5.11E-12
Selenium	mg/L	13	2.17E-05	30	5.53E-07	5.26E-16
Silicon	µg/L	48,425,000	8.07E+01	113,240,000	2.06E+00	1.96E-09
Silver	mg/L	0.3	4.33E-07	0.6	1.11E-08	1.05E-17
Strontium	mg/L	29,380	4.90E-02	68,704	1.25E-03	1.19E-12
Thallium	mg/L	0.1	2.17E-07	0.3	5.53E-09	5.26E-18
Tin	mg/L	1	2.17E-06	3	5.53E-08	5.26E-17
Titanium	mg/L	72	1.19E-04	167	3.04E-06	2.90E-15
Tungsten	µg/L	24,765	4.13E-02	57,912	1.05E-03	1.00E-12
Uranium	µg/L	53,040	8.84E-02	124,032	2.26E-03	2.15E-12
Vanadium	mg/L	7	1.08E-05	15	2.76E-07	2.63E-16
Zinc	mg/L	338	5.63E-04	790	1.44E-05	1.37E-14

TP1/TP2 Upper Case

Parameter	Unit	Chemical Load to GW (mg/day)	Concentration in GW (mg/L)	Chemical Load to SW (mg/day)	Concentration in river (low flow) (mg/L)	Concentration in river (high flow) (mg/L)
pH (Lab)	pH_Units					
Potassium	mg/L	497,640	8.29E-01	1,163,712	2.12E-02	2.02E-11
Chloride	mg/L	-	-	-	-	-
Ammonia	mg/L	1,014	1.69E-03	2,371	4.31E-05	4.11E-14
Nitrate (as N)	mg/L	5,200	8.67E-03	12,160	2.21E-04	2.11E-13
Silica	µg/L	8.6E+07	1.43E+02	2.0E+08	3.64E+00	3.46E-09
Sodium	mg/L	425,165	7.09E-01	994,232	1.81E-02	1.72E-11
Sulphate	mg/L	5.2E+07	8.69E+01	1.2E+08	2.22E+00	2.11E-09
Aluminium	mg/L	240	4.00E-04	561	1.02E-05	9.72E-15
Antimony	mg/L	13	2.17E-05	30	5.53E-07	5.26E-16
Arsenic	mg/L	13	2.17E-05	30	5.53E-07	5.26E-16
Barium	mg/L	650	1.08E-03	1,520	2.76E-05	2.63E-14
Beryllium	mg/L	13	2.17E-05	30	5.53E-07	5.26E-16
Bismuth	mg/L	130	2.17E-04	304	5.53E-06	5.26E-15
Boron	mg/L	2,847	4.75E-03	6,658	1.21E-04	1.15E-13
Cadmium	mg/L	9	1.47E-05	21	3.76E-07	3.58E-16
Calcium	mg/L	7,949,500	1.32E+01	18,589,600	3.38E-01	3.22E-10
Chromium (III+VI)	mg/L	65	1.08E-04	152	2.76E-06	2.63E-15
Cobalt	mg/L	181	3.01E-04	423	7.68E-06	7.32E-15
Copper	mg/L	51	8.58E-05	120	2.19E-06	2.08E-15
Iron	mg/L	260,195	4.34E-01	608,456	1.11E-02	1.05E-11
Lead	mg/L	13	2.17E-05	30	5.53E-07	5.26E-16
Lithium	mg/L	3,962	6.60E-03	9,264	1.68E-04	1.60E-13
Magnesium	mg/L	8,498,750	1.42E+01	19,874,000	3.61E-01	3.44E-10
Manganese	mg/L	285,870	4.76E-01	668,496	1.22E-02	1.16E-11
Mercury	mg/L	0.33	5.42E-07	0.76	1.38E-08	1.32E-17
Molybdenum	mg/L	39	6.50E-05	91	1.66E-06	1.58E-15
Nickel	mg/L	402	6.70E-04	939	1.71E-05	1.63E-14
Phosphorus	mg/L	1,755	2.93E-03	4,104	7.46E-05	7.11E-14
Potassium	mg/L	495,820	8.26E-01	1,159,456	2.11E-02	2.01E-11
Selenium	mg/L	20	3.38E-05	47	8.62E-07	8.21E-16
Silicon	µg/L	86,905,000	1.45E+02	203,224,000	3.69E+00	3.52E-09
Silver	mg/L	1	2.17E-06	3	5.53E-08	5.26E-17
Strontium	mg/L	41,717	6.95E-02	97,554	1.77E-03	1.69E-12
Thallium	mg/L	1.3	2.17E-06	3	5.53E-08	5.26E-17
Tin	mg/L	7	1.08E-05	15	2.76E-07	2.63E-16
Titanium	mg/L	933	1.55E-03	2,181	3.97E-05	3.78E-14
Tungsten	µg/L	179,400	2.99E-01	419,520	7.63E-03	7.26E-12
Uranium	µg/L	149,500	2.49E-01	349,600	6.36E-03	6.05E-12
Vanadium	mg/L	13	2.17E-05	30	5.53E-07	5.26E-16
Zinc	mg/L	1,232	2.05E-03	2,882	5.24E-05	4.99E-14

TP3 Base Case

Parameter	Unit	Chemical Load to GW (mg/day)	Concentration in GW (mg/L)	Chemical Load to SW (mg/day)	Concentration in river (low flow) (mg/L)	Concentration in river (high flow) (mg/L)
pH (Lab)	pH_Units					
Potassium	mg/L	284,410	4.74E-01	664,020	1.21E-02	1.15E-11
Chloride	mg/L	10,516	1.75E-02	24,552	4.46E-04	4.25E-13
Ammonia	mg/L	1,554	2.59E-03	3,627	6.59E-05	6.28E-14
Nitrate (as N)	mg/L	9,560	1.59E-02	22,320	4.06E-04	3.86E-13
Silica	µg/L	5.1E+08	8.56E+02	1.2E+09	2.18E+01	2.08E-08
Sodium	mg/L	97,273	1.62E-01	227,106	4.13E-03	3.93E-12
Sulphate	mg/L	3.9E+07	6.45E+01	9.0E+07	1.64E+00	1.57E-09
Aluminium	mg/L	48	7.97E-05	112	2.03E-06	1.93E-15
Antimony	mg/L	24	3.98E-05	56	1.01E-06	9.66E-16
Arsenic	mg/L	12	1.99E-05	28	5.07E-07	4.83E-16
Barium	mg/L	870	1.45E-03	2,031	3.69E-05	3.52E-14
Beryllium	mg/L	2	3.98E-06	6	1.01E-07	9.66E-17
Bismuth	mg/L	60	9.96E-05	140	2.54E-06	2.42E-15
Boron	mg/L	860	1.43E-03	2,009	3.65E-05	3.48E-14
Cadmium	mg/L	3	4.38E-06	6	1.12E-07	1.06E-16
Calcium	mg/L	14,172,700	2.36E+01	33,089,400	6.02E-01	5.73E-10
Chromium (III+VI)	mg/L	12	1.99E-05	28	5.07E-07	4.83E-16
Cobalt	mg/L	6	9.96E-06	14	2.54E-07	2.42E-16
Copper	mg/L	72	1.20E-04	167	3.04E-06	2.90E-15
Iron	mg/L	15,535	2.59E-02	36,270	6.59E-04	6.28E-13
Lead	mg/L	1	1.99E-06	3	5.07E-08	4.83E-17
Lithium	mg/L	1,625	2.71E-03	3,794	6.90E-05	6.57E-14
Magnesium	mg/L	2,939,700	4.90E+00	6,863,400	1.25E-01	1.19E-10
Manganese	mg/L	71,461	1.19E-01	166,842	3.03E-03	2.89E-12
Mercury	mg/L	0	3.98E-07	1	1.01E-08	9.66E-18
Molybdenum	mg/L	12	1.99E-05	28	5.07E-07	4.83E-16
Nickel	mg/L	12	1.99E-05	28	5.07E-07	4.83E-16
Phosphorus	mg/L	598	9.96E-04	1,395	2.54E-05	2.42E-14
Potassium	mg/L	272,460	4.54E-01	636,120	1.16E-02	1.10E-11
Selenium	mg/L	239	3.98E-04	558	1.01E-05	9.66E-15
Silicon	µg/L	112,569,000	1.88E+02	262,818,000	4.78E+00	4.55E-09
Silver	mg/L	1	1.20E-06	2	3.04E-08	2.90E-17
Strontium	mg/L	112,330	1.87E-01	262,260	4.77E-03	4.54E-12
Thallium	mg/L	0.2	3.98E-07	0.6	1.01E-08	9.66E-18
Tin	mg/L	2	3.98E-06	6	1.01E-07	9.66E-17
Titanium	mg/L	239	3.98E-04	558	1.01E-05	9.66E-15
Tungsten	µg/L	36,806	6.13E-02	85,932	1.56E-03	1.49E-12
Uranium	µg/L	72,298	1.20E-01	168,795	3.07E-03	2.92E-12
Vanadium	mg/L	12	1.99E-05	28	5.07E-07	4.83E-16
Zinc	mg/L	311	5.18E-04	725	1.32E-05	1.26E-14

TP3 Upper Case

Parameter	Unit	Chemical Load to GW (mg/day)	Concentration in GW (mg/L)	Chemical Load to SW (mg/day)	Concentration in river (low flow) (mg/L)	Concentration in river (high flow) (mg/L)
pH (Lab)	pH_Units					
Potassium	mg/L	447,886	7.46E-01	1,045,692	1.90E-02	1.81E-11
Chloride	mg/L	10,516	1.75E-02	24,552	4.46E-04	4.25E-13
Ammonia	mg/L	8,485	1.41E-02	19,809	3.60E-04	3.43E-13
Nitrate (as N)	mg/L	9,560	1.59E-02	22,320	4.06E-04	3.86E-13
Silica	µg/L	5.2E+08	8.60E+02	1.2E+09	2.19E+01	2.09E-08
Sodium	mg/L	207,094	3.45E-01	483,507	8.79E-03	8.37E-12
Sulphate	mg/L	4.6E+07	7.68E+01	1.1E+08	1.96E+00	1.86E-09
Aluminium	mg/L	6,520	1.09E-02	15,222	2.77E-04	2.64E-13
Antimony	mg/L	24	3.98E-05	56	1.01E-06	9.66E-16
Arsenic	mg/L	29	4.78E-05	67	1.22E-06	1.16E-15
Barium	mg/L	1,195	1.99E-03	2,790	5.07E-05	4.83E-14
Beryllium	mg/L	84	1.39E-04	195	3.55E-06	3.38E-15
Bismuth	mg/L	215	3.59E-04	502	9.13E-06	8.70E-15
Boron	mg/L	2,247	3.74E-03	5,245	9.54E-05	9.08E-14
Cadmium	mg/L	15	2.58E-05	36	6.57E-07	6.26E-16
Calcium	mg/L	16,618,865	2.77E+01	38,800,530	7.05E-01	6.72E-10
Chromium (III+VI)	mg/L	120	1.99E-04	279	5.07E-06	4.83E-15
Cobalt	mg/L	69	1.14E-04	160	2.91E-06	2.78E-15
Copper	mg/L	855	1.42E-03	1,995	3.63E-05	3.46E-14
Iron	mg/L	824,789	1.37E+00	1,925,658	3.50E-02	3.33E-11
Lead	mg/L	24	3.98E-05	56	1.01E-06	9.66E-16
Lithium	mg/L	3,457	5.76E-03	8,071	1.47E-04	1.40E-13
Magnesium	mg/L	3,656,700	6.09E+00	8,537,400	1.55E-01	1.48E-10
Manganese	mg/L	175,713	2.93E-01	410,242	7.46E-03	7.10E-12
Mercury	mg/L	7	1.20E-05	17	3.04E-07	2.90E-16
Molybdenum	mg/L	72	1.20E-04	167	3.04E-06	2.90E-15
Nickel	mg/L	406	6.77E-04	949	1.72E-05	1.64E-14
Phosphorus	mg/L	7,170	1.20E-02	16,740	3.04E-04	2.90E-13
Potassium	mg/L	464,138	7.74E-01	1,083,636	1.97E-02	1.88E-11
Selenium	mg/L	2,041	3.40E-03	4,764	8.66E-05	8.25E-14
Silicon	µg/L	142,240,850	2.37E+02	332,093,700	6.04E+00	5.75E-09
Silver	mg/L	3	4.78E-06	7	1.22E-07	1.16E-16
Strontium	mg/L	243,684	4.06E-01	568,937	1.03E-02	9.85E-12
Thallium	mg/L	9	1.43E-05	20	3.65E-07	3.48E-16
Tin	mg/L	20	3.29E-05	46	8.37E-07	7.97E-16
Titanium	mg/L	1,109	1.85E-03	2,589	4.71E-05	4.48E-14
Tungsten	µg/L	411,080	6.85E-01	959,760	1.75E-02	1.66E-11
Uranium	µg/L	220,262	3.67E-01	514,253	9.35E-03	8.90E-12
Vanadium	mg/L	76	1.27E-04	179	3.25E-06	3.09E-15
Zinc	mg/L	2,887	4.81E-03	6,741	1.23E-04	1.17E-13

TP4 Base Case

Parameter	Unit	Chemical Load to GW (mg/day)	Concentration in GW (mg/L)	Chemical Load to SW (mg/day)	Concentration in river (low flow) (mg/L)	Concentration in river (high flow) (mg/L)
pH (Lab)	pH_Units					
Potassium	mg/L	239,190	3.99E-01	558,110	1.01E-02	9.66E-12
Chloride	mg/L	8,844	1.47E-02	20,636	3.75E-04	3.57E-13
Ammonia	mg/L	1,307	2.18E-03	3,049	5.54E-05	5.28E-14
Nitrate (as N)	mg/L	8,040	1.34E-02	18,760	3.41E-04	3.25E-13
Silica	µg/L	4.3E+08	7.20E+02	1.0E+09	1.83E+01	1.75E-08
Sodium	mg/L	81,807	1.36E-01	190,883	3.47E-03	3.31E-12
Sulphate	mg/L	3.3E+07	5.43E+01	7.6E+07	1.38E+00	1.32E-09
Aluminium	mg/L	40	6.70E-05	94	1.71E-06	1.62E-15
Antimony	mg/L	20	3.35E-05	47	8.53E-07	8.12E-16
Arsenic	mg/L	10	1.68E-05	23	4.26E-07	4.06E-16
Barium	mg/L	732	1.22E-03	1,707	3.10E-05	2.96E-14
Beryllium	mg/L	2	3.35E-06	5	8.53E-08	8.12E-17
Bismuth	mg/L	50	8.38E-05	117	2.13E-06	2.03E-15
Boron	mg/L	724	1.21E-03	1,688	3.07E-05	2.92E-14
Cadmium	mg/L	2	3.69E-06	5	9.38E-08	8.93E-17
Calcium	mg/L	11,919,300	1.99E+01	27,811,700	5.06E-01	4.82E-10
Chromium (III+VI)	mg/L	10	1.68E-05	23	4.26E-07	4.06E-16
Cobalt	mg/L	5	8.38E-06	12	2.13E-07	2.03E-16
Copper	mg/L	60	1.01E-04	141	2.56E-06	2.44E-15
Iron	mg/L	13,065	2.18E-02	30,485	5.54E-04	5.28E-13
Lead	mg/L	1	1.68E-06	2	4.26E-08	4.06E-17
Lithium	mg/L	1,367	2.28E-03	3,189	5.80E-05	5.52E-14
Magnesium	mg/L	2,472,300	4.12E+00	5,768,700	1.05E-01	9.99E-11
Manganese	mg/L	60,099	1.00E-01	140,231	2.55E-03	2.43E-12
Mercury	mg/L	0.2	3.35E-07	0.5	8.53E-09	8.12E-18
Molybdenum	mg/L	10	1.68E-05	23	4.26E-07	4.06E-16
Nickel	mg/L	10	1.68E-05	23	4.26E-07	4.06E-16
Phosphorus	mg/L	503	8.38E-04	1,173	2.13E-05	2.03E-14
Potassium	mg/L	229,140	3.82E-01	534,660	9.72E-03	9.26E-12
Selenium	mg/L	201	3.35E-04	469	8.53E-06	8.12E-15
Silicon	µg/L	94,671,000	1.58E+02	220,899,000	4.02E+00	3.83E-09
Silver	mg/L	1	1.01E-06	1	2.56E-08	2.44E-17
Strontium	mg/L	94,470	1.57E-01	220,430	4.01E-03	3.82E-12
Thallium	mg/L	0.2	3.35E-07	0.5	8.53E-09	8.12E-18
Tin	mg/L	2	3.35E-06	5	8.53E-08	8.12E-17
Titanium	mg/L	201	3.35E-04	469	8.53E-06	8.12E-15
Tungsten	µg/L	30,954	5.16E-02	72,226	1.31E-03	1.25E-12
Uranium	µg/L	60,803	1.01E-01	141,873	2.58E-03	2.46E-12
Vanadium	mg/L	10	1.68E-05	23	4.26E-07	4.06E-16
Zinc	mg/L	261	4.36E-04	610	1.11E-05	1.06E-14

		TP4 Upper Case					TP5 Base Case				
		Chemical Load to GW	Concentration in GW	Chemical Load to SW	Concentration in river (low flow)	Concentration in river (high flow)	Chemical Load to GW	Concentration in GW	Chemical Load to SW	Concentration in river (low flow)	Concentration in river (high flow)
		mg/day	mg/L	mg/day	mg/L	mg/L	mg/day	mg/L	mg/day	mg/L	mg/L
pH (Lab)	pH_Units										
Potassium	mg/L	376,674	6.28E-01	878,906	1.60E-02	1.52E-11	180,880	3.01E-01	421,260	7.66E-03	7.29E-12
Chloride	mg/L	8,844	1.47E-02	20,636	3.75E-04	3.57E-13	6,688	1.11E-02	15,576	2.83E-04	2.70E-13
Ammonia	mg/L	7,136	1.19E-02	16,650	3.03E-04	2.88E-13	988	1.65E-03	2,301	4.18E-05	3.98E-14
Nitrate (as N)	mg/L	8,040	1.34E-02	18,760	3.41E-04	3.25E-13	6,080	1.01E-02	14,160	2.57E-04	2.45E-13
Silica	µg/L	4.3E+08	7.23E+02	1.0E+09	1.84E+01	1.75E-08	3.3E+08	5.45E+02	7.6E+08	1.38E+01	1.32E-08
Sodium	mg/L	174,167	2.90E-01	406,389	7.39E-03	7.04E-12	61,864	1.03E-01	144,078	2.62E-03	2.49E-12
Sulphate	mg/L	3.9E+07	6.46E+01	9.0E+07	1.64E+00	1.56E-09	2.5E+07	4.10E+01	5.7E+07	1.04E+00	9.93E-10
Aluminium	mg/L	5,483	9.14E-03	12,794	2.33E-04	2.22E-13	30	5.07E-05	71	1.29E-06	1.23E-15
Antimony	mg/L	20	3.35E-05	47	8.53E-07	8.12E-16	15	2.53E-05	35	6.44E-07	6.13E-16
Arsenic	mg/L	24	4.02E-05	56	1.02E-06	9.75E-16	8	1.27E-05	18	3.22E-07	3.06E-16
Barium	mg/L	1,005	1.68E-03	2,345	4.26E-05	4.06E-14	553	9.22E-04	1,289	2.34E-05	2.23E-14
Beryllium	mg/L	70	1.17E-04	164	2.98E-06	2.84E-15	2	2.53E-06	4	6.44E-08	6.13E-17
Bismuth	mg/L	181	3.02E-04	422	7.67E-06	7.31E-15	38	6.33E-05	89	1.61E-06	1.53E-15
Boron	mg/L	1,889	3.15E-03	4,409	8.02E-05	7.63E-14	547	9.12E-04	1,274	2.32E-05	2.21E-14
Cadmium	mg/L	13	2.17E-05	30	5.53E-07	5.26E-16	2	2.79E-06	4	7.08E-08	6.74E-17
Calcium	mg/L	13,976,535	2.33E+01	32,611,915	5.93E-01	5.65E-10	9,013,600	1.50E+01	20,992,200	3.82E-01	3.64E-10
Chromium (III+VI)	mg/L	101	1.68E-04	235	4.26E-06	4.06E-15	8	1.27E-05	18	3.22E-07	3.06E-16
Cobalt	mg/L	58	9.62E-05	135	2.45E-06	2.33E-15	4	6.33E-06	9	1.61E-07	1.53E-16
Copper	mg/L	719	1.20E-03	1,677	3.05E-05	2.90E-14	46	7.60E-05	106	1.93E-06	1.84E-15
Iron	mg/L	693,651	1.16E+00	1,618,519	2.94E-02	2.80E-11	9,880	1.65E-02	23,010	4.18E-04	3.98E-13
Lead	mg/L	20	3.35E-05	47	8.53E-07	8.12E-16	1	1.27E-06	2	3.22E-08	3.06E-17
Lithium	mg/L	2,907	4.85E-03	6,784	1.23E-04	1.17E-13	1,034	1.72E-03	2,407	4.38E-05	4.17E-14
Magnesium	mg/L	3,075,300	5.13E+00	7,175,700	1.30E-01	1.24E-10	1,869,600	3.12E+00	4,354,200	7.92E-02	7.54E-11
Manganese	mg/L	147,775	2.46E-01	344,809	6.27E-03	5.97E-12	45,448	7.57E-02	105,846	1.92E-03	1.83E-12
Mercury	mg/L	6	1.01E-05	14	2.56E-07	2.44E-16	0.2	2.53E-07	0.4	6.44E-09	6.13E-18
Molybdenum	mg/L	60	1.01E-04	141	2.56E-06	2.44E-15	8	1.27E-05	18	3.22E-07	3.06E-16
Nickel	mg/L	342	5.70E-04	797	1.45E-05	1.38E-14	8	1.27E-05	18	3.22E-07	3.06E-16
Phosphorus	mg/L	6,030	1.01E-02	14,070	2.56E-04	2.44E-13	380	6.33E-04	885	1.61E-05	1.53E-14
Potassium	mg/L	390,342	6.51E-01	910,798	1.66E-02	1.58E-11	173,280	2.89E-01	403,560	7.34E-03	6.99E-12
Selenium	mg/L	1,716	2.86E-03	4,004	7.28E-05	6.93E-14	152	2.53E-04	354	6.44E-06	6.13E-15
Silicon	µg/L	119,625,150	1.99E+02	279,125,350	5.08E+00	4.83E-09	71,592,000	1.19E+02	166,734,000	3.03E+00	2.89E-09
Silver	mg/L	2	4.02E-06	6	1.02E-07	9.75E-17	0.5	7.60E-07	1	1.93E-08	1.84E-17
Strontium	mg/L	204,940	3.42E-01	478,192	8.69E-03	8.28E-12	71,440	1.19E-01	166,380	3.03E-03	2.88E-12
Thallium	mg/L	7	1.21E-05	17	3.07E-07	2.92E-16	0.2	2.53E-07	0.4	6.44E-09	6.13E-18
Tin	mg/L	17	2.76E-05	39	7.04E-07	6.70E-16	2	2.53E-06	4	6.44E-08	6.13E-17
Titanium	mg/L	933	1.55E-03	2,176	3.96E-05	3.77E-14	152	2.53E-04	354	6.44E-06	6.13E-15
Tungsten	µg/L	345,720	5.76E-01	806,680	1.47E-02	1.40E-11	23,408	3.90E-02	54,516	9.91E-04	9.44E-13
Uranium	µg/L	185,242	3.09E-01	432,230	7.86E-03	7.48E-12	45,980	7.66E-02	107,085	1.95E-03	1.85E-12
Vanadium	mg/L	64	1.07E-04	150	2.73E-06	2.60E-15	8	1.27E-05	18	3.22E-07	3.06E-16
Zinc	mg/L	2,428	4.05E-03	5,666	1.03E-04	9.81E-14	198	3.29E-04	460	8.37E-06	7.97E-15

		TP5 Upper Case					Floodplain Tailings Base Case				
		Chemical Load to GW	Concentration in GW	Chemical Load to SW	Concentration in river (low flow)	Concentration in river (high flow)	Chemical Load to GW	Concentration in GW	Chemical Load to SW	Concentration in river (low flow)	Concentration in river (high flow)
		mg/day	mg/L	mg/day	mg/L	mg/L	mg/day	mg/L	mg/day	mg/L	mg/L
pH (Lab)	pH_Units										
Potassium	mg/L	284,848	4.75E-01	646,530	1.18E-02	1.12E-11	527,686	8.79E-01	1,232,307	2.24E-02	2.13E-11
Chloride	mg/L	6,688	1.11E-02	15,180	2.76E-04	2.63E-13	42,220	7.04E-02	98,598	1.79E-03	1.71E-12
Ammonia	mg/L	5,396	8.99E-03	12,248	2.23E-04	2.12E-13	-	-	-	-	-
Nitrate (as N)	mg/L	6,080	1.01E-02	13,800	2.51E-04	2.39E-13	3.5E-16	5.88E-22	8.2E-16	1.50E-23	1.43E-32
Silica	µg/L	3.3E+08	5.47E+02	7.4E+08	1.35E+01	1.29E-08	-	-	-	-	-
Sodium	mg/L	131,708	2.20E-01	298,943	5.44E-03	5.18E-12	1,614,947	2.69E+00	3,771,395	6.86E-02	6.53E-11
Sulphate	mg/L	2.9E+07	4.88E+01	6.6E+07	1.21E+00	1.15E-09	1.4E+09	2.40E+03	3.4E+09	6.11E+01	5.82E-08
Aluminium	mg/L	4,147	6.91E-03	9,412	1.71E-04	1.63E-13	24,540,828	4.09E+01	57,310,336	1.04E+00	9.92E-10
Antimony	mg/L	15	2.53E-05	35	6.27E-07	5.97E-16	-	-	-	-	-
Arsenic	mg/L	18	3.04E-05	41	7.53E-07	7.17E-16	528	8.80E-04	1,232	2.24E-05	2.13E-14
Barium	mg/L	760	1.27E-03	1,725	3.14E-05	2.99E-14	2,639	4.40E-03	6,162	1.12E-04	1.07E-13
Beryllium	mg/L	53	8.87E-05	121	2.20E-06	2.09E-15	-	-	-	-	-
Bismuth	mg/L	137	2.28E-04	311	5.65E-06	5.38E-15	-	-	-	-	-
Boron	mg/L	1,429	2.38E-03	3,243	5.90E-05	5.62E-14	5,288	8.81E-03	12,349	2.25E-04	2.14E-13
Cadmium	mg/L	10	1.64E-05	22	4.06E-07	3.87E-16	740	1.23E-03	1,727	3.14E-05	2.99E-14
Calcium	mg/L	10,569,320	1.76E+01	23,989,575	4.36E-01	4.15E-10	18,066,438	3.01E+01	42,190,656	7.67E-01	7.31E-10
Chromium (III+VI)	mg/L	76	1.27E-04	173	3.14E-06	2.99E-15	-	-	-	-	-
Cobalt	mg/L	44	7.28E-05	99	1.80E-06	1.72E-15	64,450	1.07E-01	150,510	2.74E-03	2.61E-12
Copper	mg/L	544	9.06E-04	1,234	2.24E-05	2.14E-14	2,575,459	4.29E+00	6,014,483	1.09E-01	1.04E-10
Iron	mg/L	524,552	8.74E-01	1,190,595	2.16E-02	2.06E-11	501,894,510	8.36E+02	1,172,077,120	2.13E+01	2.03E-08
Lead	mg/L	15	2.53E-05	35	6.27E-07	5.97E-16	53	8.80E-05	123	2.24E-06	2.13E-15
Lithium	mg/L	2,199	3.66E-03	4,990	9.07E-05	8.64E-14	32,202	5.37E-02	75,202	1.37E-03	1.30E-12
Magnesium	mg/L	2,325,600	3.88E+00	5,278,500	9.60E-02	9.14E-11	59,090,850	9.85E+01	137,995,200	2.51E+00	2.39E-09
Manganese	mg/L	111,750	1.86E-01	253,644	4.61E-03	4.39E-12	1,419,651	2.37E+00	3,315,318	6.03E-02	5.74E-11
Mercury	mg/L	5	7.60E-06	10	1.88E-07	1.79E-16	-	-	-	-	-
Molybdenum	mg/L	46	7.60E-05	104	1.88E-06	1.79E-15	157	2.61E-04	366	6.65E-06	6.34E-15
Nickel	mg/L	258	4.31E-04	587	1.07E-05	1.02E-14	16,883	2.81E-02	39,427	7.17E-04	6.83E-13
Phosphorus	mg/L	4,560	7.60E-03	10,350	1.88E-04	1.79E-13	34,831	5.81E-02	81,341	1.48E-03	1.41E-12
Potassium	mg/L	295,184	4.92E-01	669,990	1.22E-02	1.16E-11	527,680	8.79E-01	1,232,294	2.24E-02	2.13E-11
Selenium	mg/L	1,298	2.16E-03	2,946	5.36E-05	5.10E-14	2,035	3.39E-03	4,753	8.64E-05	8.23E-14
Silicon	µg/L	90,462,800	1.51E+02	205,326,750	3.73E+00	3.56E-09	-	-	-	-	-
Silver	mg/L	2	3.04E-06	4	7.53E-08	7.17E-17	-	-	-	-	-
Strontium	mg/L	154,979	2.58E-01	351,762	6.40E-03	6.09E-12	45,387	7.56E-02	105,992	1.93E-03	1.84E-12
Thallium	mg/L	5	9.12E-06	12	2.26E-07	2.15E-16	-	-	-	-	-
Tin	mg/L	13	2.09E-05	28	5.18E-07	4.93E-16	-	-	-	-	-
Titanium	mg/L	705	1.18E-03	1,601	2.91E-05	2.77E-14	-	-	-	-	-
Tungsten	µg/L	261,440	4.36E-01	593,400	1.08E-02	1.03E-11	897,165	1.50E+00	2,095,155	3.81E-02	3.63E-11
Uranium	µg/L	140,083	2.33E-01	317,952	5.78E-03	5.51E-12	4,354	7.26E-03	10,168	1.85E-04	1.76E-13
Vanadium	mg/L	49	8.11E-05	110	2.01E-06	1.91E-15	-	-	-	-	-
Zinc	mg/L	1,836	3.06E-03	4,168	7.58E-05	7.22E-14	104,528	1.74E-01	244,105	4.44E-03	4.23E-12

		Floodplain Tailings Upper Case				
		Chemical Load to GW	Concentration in GW	Chemical Load to SW	Concentration in river (low flow)	Concentration in river (high flow)
		mg/day	mg/L	mg/day	mg/L	mg/L
pH (Lab)	pH_Units					
Potassium	mg/L	1,845,227	3.08E+00	4,309,168	7.83E-02	7.46E-11
Chloride	mg/L	47,624	7.94E-02	111,217	2.02E-03	1.93E-12
Ammonia	mg/L	-	-	-	-	-
Nitrate (as N)	mg/L	4.6E-16	7.73E-22	1.1E-15	1.97E-23	1.88E-32
Silica	µg/L	-	-	-	-	-
Sodium	mg/L	3,083,675	5.14E+00	7,201,325	1.31E-01	1.25E-10
Sulphate	mg/L	7,109,661,000	1.18E+04	1.7E+10	3.02E+02	2.88E-07
Aluminium	mg/L	69,175,080	1.15E+02	161,544,960	2.94E+00	2.80E-09
Antimony	mg/L	-	-	-	-	-
Arsenic	mg/L	2,857	4.76E-03	6,673	1.21E-04	1.16E-13
Barium	mg/L	3,274	5.46E-03	7,646	1.39E-04	1.32E-13
Beryllium	mg/L	-	-	-	-	-
Bismuth	mg/L	-	-	-	-	-
Boron	mg/L	1,765,628	2.94E+00	4,123,280	7.50E-02	7.14E-11
Cadmium	mg/L	5,543	9.24E-03	12,943	2.35E-04	2.24E-13
Calcium	mg/L	10,547,628	1.76E+01	24,631,936	4.48E-01	4.27E-10
Chromium (III+VI)	mg/L	-	-	-	-	-
Cobalt	mg/L	181,151	3.02E-01	423,043	7.69E-03	7.33E-12
Copper	mg/L	8,929,284	1.49E+01	20,852,608	3.79E-01	3.61E-10
Iron	mg/L	1,443,023,400	2.41E+03	3,369,900,800	6.13E+01	5.84E-08
Lead	mg/L	595	9.92E-04	1,390	2.53E-05	2.41E-14
Lithium	mg/L	43,470	7.24E-02	101,515	1.85E-03	1.76E-12
Magnesium	mg/L	104,386,230	1.74E+02	243,773,760	4.43E+00	4.22E-09
Manganese	mg/L	3,702,773	6.17E+00	8,647,107	1.57E-01	1.50E-10
Mercury	mg/L	-	-	-	-	-
Molybdenum	mg/L	295	4.91E-04	688	1.25E-05	1.19E-14
Nickel	mg/L	58,320	9.72E-02	136,196	2.48E-03	2.36E-12
Phosphorus	mg/L	445,360	7.42E-01	1,040,052	1.89E-02	1.80E-11
Potassium	mg/L	1,845,690	3.08E+00	4,310,251	7.84E-02	7.46E-11
Selenium	mg/L	5,887	9.81E-03	13,749	2.50E-04	2.38E-13
Silicon	µg/L	-	-	-	-	-
Silver	mg/L	-	-	-	-	-
Strontium	mg/L	71,436	1.19E-01	166,826	3.03E-03	2.89E-12
Thallium	mg/L	-	-	-	-	-
Tin	mg/L	-	-	-	-	-
Titanium	mg/L	-	-	-	-	-
Tungsten	µg/L	11,912,487	1.99E+01	27,819,300	5.06E-01	4.82E-10
Uranium	µg/L	9,584	1.60E-02	22,382	4.07E-04	3.88E-13
Vanadium	mg/L	-	-	-	-	-
Zinc	mg/L	366,221	6.10E-01	855,239	1.55E-02	1.48E-11

APPENDIX H

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

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1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

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1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems, methods and standards employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historical environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional exploration and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

Construction activity can impact structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques, and construction sequence are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, and the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function. Where temporary or permanent drainage systems are installed within or around a structure, these systems must protect the structure from loss of ground due to mechanisms such as internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design details regarding the geotechnical aspects of such systems (e.g. bedding material, surrounding soil, soil cover, geotextile type) should be reviewed by the geotechnical engineer to confirm the performance of the system is consistent with the conditions used in the geotechnical design.

1.16 DESIGN PARAMETERS

Bearing capacities for Limit States or Allowable Stress Design, strength/stiffness properties and similar geotechnical design parameters quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition used in this report. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions considered in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

1.18 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

This document has been prepared based on the applicable codes, standards, guidelines or best practice as identified in the report. Some mandated codes, standards and guidelines (such as ASTM, AASHTO Bridge Design/Construction Codes, Canadian Highway Bridge Design Code, National/Provincial Building Codes) are routinely updated and corrections made. TETRA TECH cannot predict nor be held liable for any such future changes, amendments, errors or omissions in these documents that may have a bearing on the assessment, design or analyses included in this report.