WOLVERINE MINE

MONITORING AND SURVEILLANCE PLAN

2014 ANNUAL REPORT

Prepared for:
Yukon Energy, Mines and Resources

Prepared by:
Yukon Zinc Corporation
Vancouver, British Columbia

March 31, 2015

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1 Introduction

This report summarizes the results of monitoring and surveillance conducted as per Monitoring and Surveillance Plan V2011-03 for 2014. This report is submitted as part of the requirements of Quartz Mining Licence (QML) 0006. As per Section 10.5, *on or before March 31st of each year... the Licensee must submit a written report covering the period of January 1st to December 31st of the prior year which includes... a summary of the programs undertaken for environmental monitoring and surveillance as outlined in the Monitoring and Surveillance Plan.*

Monitoring results reported herein include:

- Surface water including water quality sampling and hydrology;
- Groundwater including water quality sampling, water levels and water table (piezometers);
- Weather including temperature, precipitation, snowpack, and evaporation;
- Tailings storage facility monitoring;
- Engineering inspections for physical stability;
- Reclamation program effectiveness and Bio-pass system design monitoring;
- Geochemical testwork; and
- Underground mine monitoring.

2 Surface Water Monitoring

The surface water monitoring program for the Wolverine Mine includes the monitoring of hydrology and water quality at 20 locations at the Wolverine Mine site (including tailings storage facility), and in the Wolverine Lake, Go Creek and Money Creek watersheds. Water quality results are compared to the historic (1995-2008) baseline average and 95th percentile values provided in the Lorax Environmental *Baseline Characterization Summary Report* provided in Appendix A of *Monitoring and Surveillance Plan V2011-03* (*Baseline Report*).

2.1 Surface Water Quality Monitoring

Surface water quality for the purposes of baseline monitoring (as per *A Licence QZ04-065* (Yukon Water Board, 2007)) was taken at the locations and dates summarized in Table 2-1. A total of 194 sample sets were analyzed for physical parameters, TSS, dissolved and total metals (by ICP-MS) and mercury (by CVAS), as well as cyanide and dissolved organic carbon for select sampling sites (W16, W31, W85 & T1 – W1, W9, L1, W82, and W12 are DOC only), and total organic carbon (T1).

Table 2-1: Surface Water Monitoring Sites and Dates Sampled - 2014

Sampling Site	January	February	March	April	May	June	July	August	September	October	November	December
L1	11-Jan	8-Feb	10-Mar	2-Apr	A	21-Jun	26-Jul	22-Aug	13-Sep	A	A	20-Dec
W1	A	A	A	A	A	21-Jun	26-Jul	22-Aug	13-Sep	A	A	A
W8	11-Jan	8-Feb	D	A	26-May	21-Jun	26-Jul	B	13-Sep	A	A	D
W9	A	D	D	A	26-May	21-Jun	26-Jul	22-Aug	13-Sep	A	A	A
W12	8-Jan	10-Feb	D	D	A	1-Jun	1-Jul	4-Aug	1-Sep	A	1-Nov	21-Dec
W14	8-Jan	10-Feb	11-Mar	8-Apr	A	1-Jun	1-Jul	4-Aug	1-Sep	A	1-Nov	🟦 21-Dec
W15	🟦 15-Jan	19-Feb	29-Mar	5-Apr	24-May	29-Jun	8-Jul	8-Aug	23-Sep	6-Oct	8-Nov	10-Dec
W16	13-Jan	25-Feb	29-Mar	5-Apr	24-May	20-Jun	🟦 16-Jul	8-Aug	5-Sep	12-Oct	8-Nov	8-Dec
W21	10-Jan	3-Feb	🟦 7-Mar	6-Apr	6-May	🟦 28-Jun	21-Jul	20-Aug	12-Sep	19-Oct	21-Nov	19-Dec
W22	10-Jan	3-Feb	7-Mar	A	6-May	28-Jun	21-Jul	🟦 20-Aug	12-Sep	19-Oct	21-Nov	D
W31	D	D	D	D	11-May	20-Jun	2-Jul	13-Aug	2-Sep	🟦 22-Oct	17-Nov	D
W40	10-Jan	3-Feb	D	A	6-May	🟦 28-Jun	21-Jul	20-Aug	12-Sep	19-Oct	21-Nov	19-Dec
W71	10-Jan	🟦 5-Feb	D	6-Apr	6-May	18-Jun	2-Jul	12-Aug	12-Sep	19-Oct	21-Nov	3-Dec
W72	10-Jan	5-Feb	4-Mar	6-Apr	6-May	18-Jun	🟦 2-Jul	12-Aug	12-Sep	19-Oct	🟦 21-Nov	3-Dec
W73	10-Jan	5-Feb	4-Mar	6-Apr	6-May	18-Jun	2-Jul	12-Aug	7-Sep	19-Oct	21-Nov	3-Dec
W80	7-Jan	10-Feb	11-Mar	8-Apr	A	1-Jun	1-Jul	4-Aug	1-Sep	A	1-Nov	21-Dec
W81	12-Jan	19-Feb	30-Mar	🟦 9-Apr	24-May	29-Jun	8-Jul	8-Aug	🟦 22-Sep	6-Oct	9-Nov	10-Dec
W82	14-Jan	D	D	10-Apr	🟦 20-May	20-Jun	16-Jul	E	25-Sep	7-Oct	9-Nov	10-Dec
W85	12-Jan	11-Feb	29-Mar	5-Apr	24-May	20-Jun	16-Jul	E	🟦 25-Sep	12-Oct	8-Nov	10-Dec
T1	14-Jan	5-Feb	5-Mar	14-Apr	10-May	7-Jun	6-Jul	1-Aug	2-Sep	12-Oct	17-Nov	8-Dec

A = Site not sampled due to lack of safe access
B = Site modified due to wildlife interaction (eg. Beaver dam flooding)
D = Site dry (i.e., all water tied up in storage) or frozen through to ground
E = Transportation equipment under repair/Sampling equipment under repair
🟦 QAQC Sample Taken

Laboratory results for the samples taken in 2014 are compared to baseline average and 95th percentiles provided in *Appendix A* of the *Baseline Report*. Appendix A herein provides graphical representations of the water quality results for all baseline monitoring sites for the following parameters:

- Conductivity
- Hardness
- Total Alkalinity
- pH
- Total Suspended Solids (TSS)
- Turbidity
- Fluoride
- Sulphate
- Ammonia
- Nitrate
- Nitrite
- Total Aluminum
- Total Arsenic
- Total Cadmium
- Total Chromium
- Total Copper
- Total Iron
- Total Lead
- Total Mercury
- Total Molybdenum
- Total Nickel
- Total Selenium
- Total Silver
- Total Zinc

Red symbols in the graphs and in the figures below indicate the result was below the analytical detection limit, and is shown as being equal to the detection limit.

The majority of physical parameters and major anions (conductivity, hardness, pH, DOC, and sulphate) for all sites were within the average provided in the *Baseline Report*, and were generally below the 95th percentile value. High ammonia concentrations in 2010 and early 2011 were due to errors with analytical equipment, and do not necessarily reflect actual values.

Nitrate and nitrite concentrations were much higher than normal in samples taken since September 2011, due to interferences with the analytical equipment, caused by exceedances of the standard hold times. The interferences also resulted in laboratory detection limits that were an order of magnitude greater than the limits used previously (i.e., 0.2 mg/L vs. 0.002 mg/L).

The results for total metals were also within the average baseline range. The majority of results were less than the average values, and almost all were less than the 95th percentile values. ~80% of results for silver and ~99% of the mercury results were below the reportable detection limit hence these parameters were not graphed, nor are provided in Appendix A.

Noticeable exceptions for the period include:

- At stations T1, W85, and W15 nitrate and nitrite showed seasonal variability, increasing during spring and summer months and decreasing during winter months. Stations W22, W31, W71, W72, W73, W80 and W81 demonstrated increasing variability specifically during 2012, and then a reduction in concentration in 2013 and 2014.
- Station T1 showed elevated levels of sulphate, nitrite and metals concentrations such as arsenic, molybdenum, and selenium since 2012. However, sulphate and selenium appear to have stabilized throughout 2014.
- Stations W9, W16, W81, and W82 show increasing sulphate concentrations over time since 2010. However, W81 showed stability in sulphate concentrations after 2013.
- Station W81 shows increasing concentration levels of cadmium since 2012.
- Increased selenium concentrations spiked around July 2012 at stations, W15, W16, W72, W80, and W81. The majority of these stations recorded decreasing concentrations after

2012. However, W16 has shown a slight increasing trend in concentration throughout 2014.

2.1.1 Wolverine Lake

Surface water quality results for Wolverine Lake (stations W1 and L1) were mostly below the average baseline concentrations for the parameters outlined above (see graphs in Appendix A). Concentrations remained in a similar range throughout the year, as demonstrated by the lead concentrations shown in Figure 2-1. Samples were not consistently taken at station W1 between November 2013 and May 2014, due to a lack of safe access as a result of changing weather conditions and transportation equipment failure. 2014 metal and nutrient concentrations were comparable to 2009-2013 concentrations.

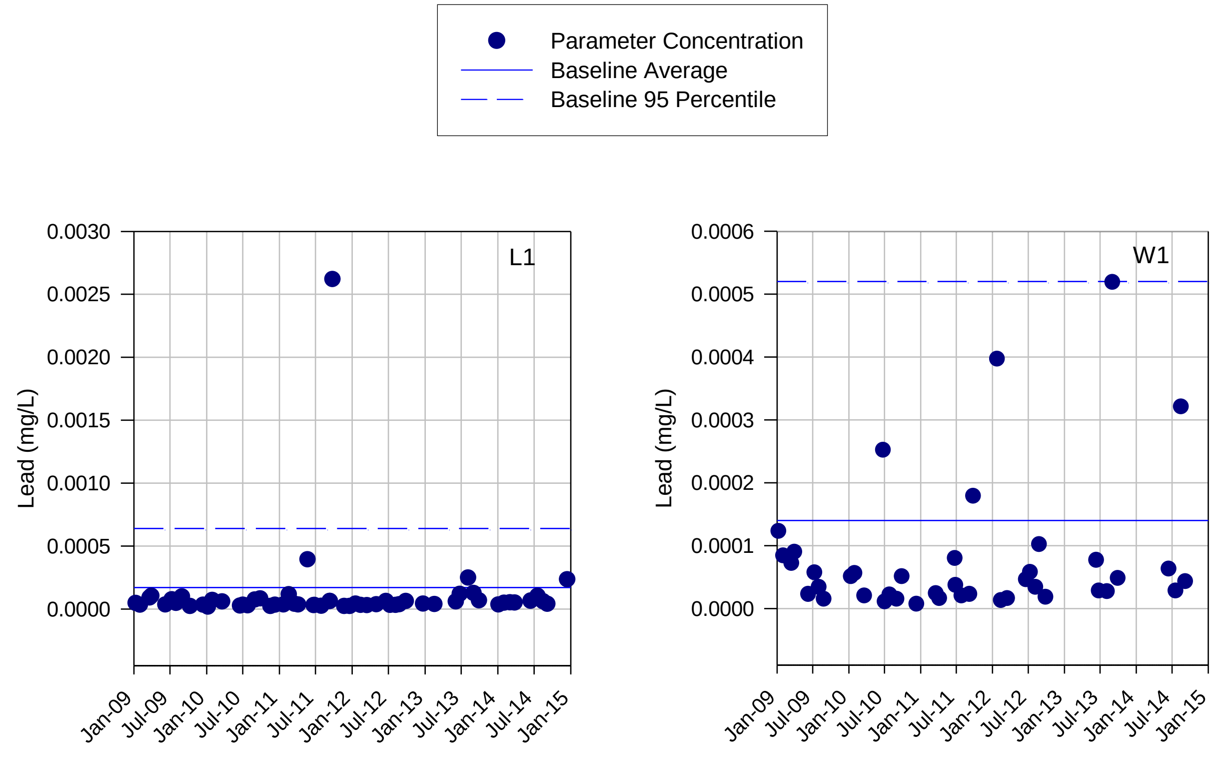


Figure 2-1: Lead in Wolverine Lake Stations, January 2009 – December 2014

2.1.2 Wolverine Creek

Surface water quality results for W8 at the outflow of Campbell Creek into Little Wolverine Lake, and stations W9 and W82 in Wolverine Creek, were also generally within the range of the average and 95th percentile values. Samples were not taken consistently at station W8 and W9 between January and May 2014, due to a lack of safe access as a result of changing weather conditions and transportation equipment failure. In addition, station W9 is typically not sampled during these months, due to the water at that site being frozen through. 2014 metal and nutrient concentrations were comparable to 2009-2013 concentrations.

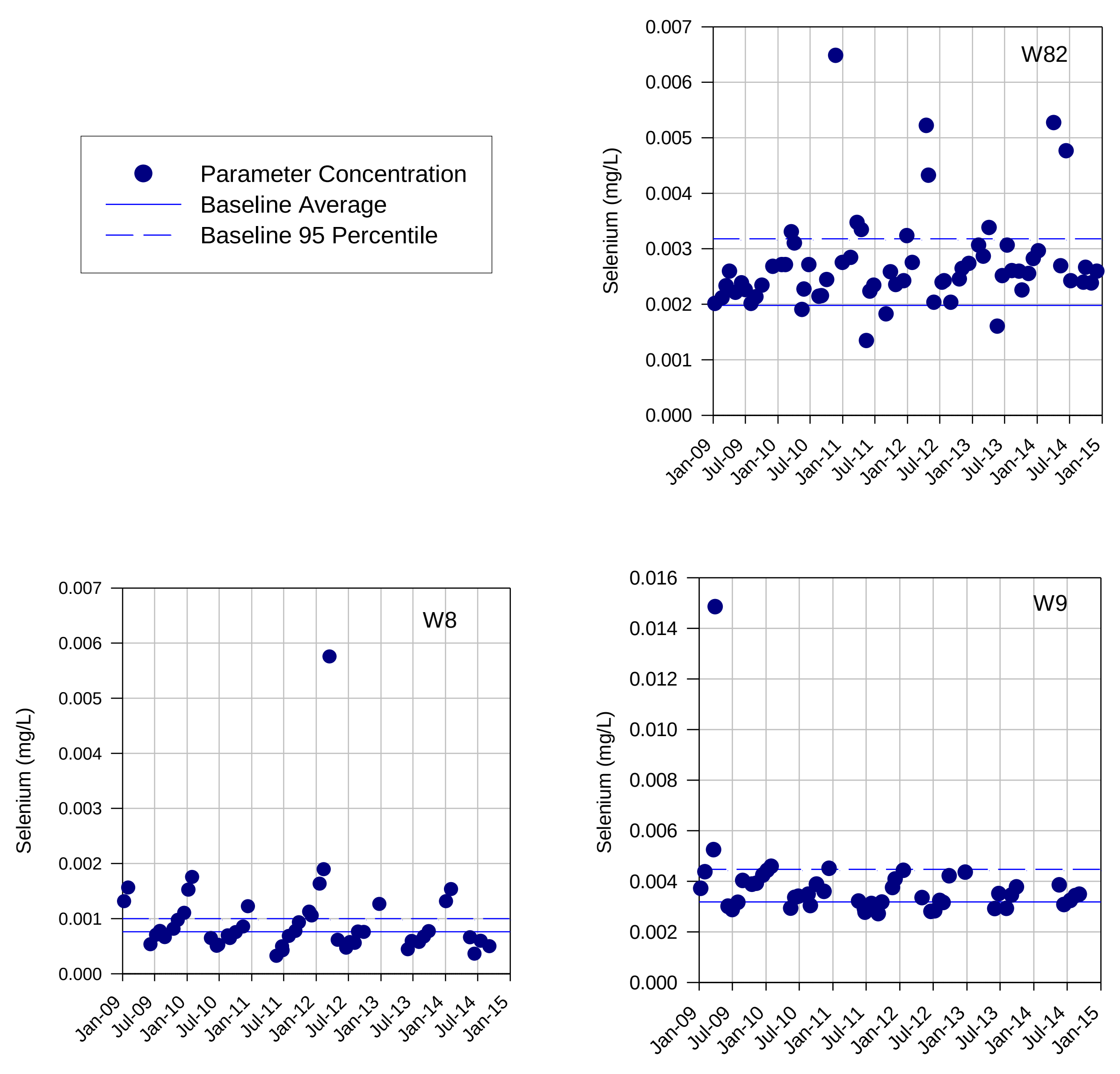


Figure 2-2: Selenium in Wolverine Creek Area Stations, January 2009 – December 2014

2.1.3 Upper Go Creek Watershed

Surface water quality results for the Upper Go Creek watershed (stations W31, W15, W16 and W81) were also generally near or below the range of the average baseline concentrations and 95th percentile values, comparable to 2009-2013 concentrations. Station W31 was not sampled between January and April, and December 2014, as the water at that site had frozen through. Metal concentrations were higher in May and June than the rest of the year, as shown in the copper concentrations presented in Figure 2-3, similar to previous years.

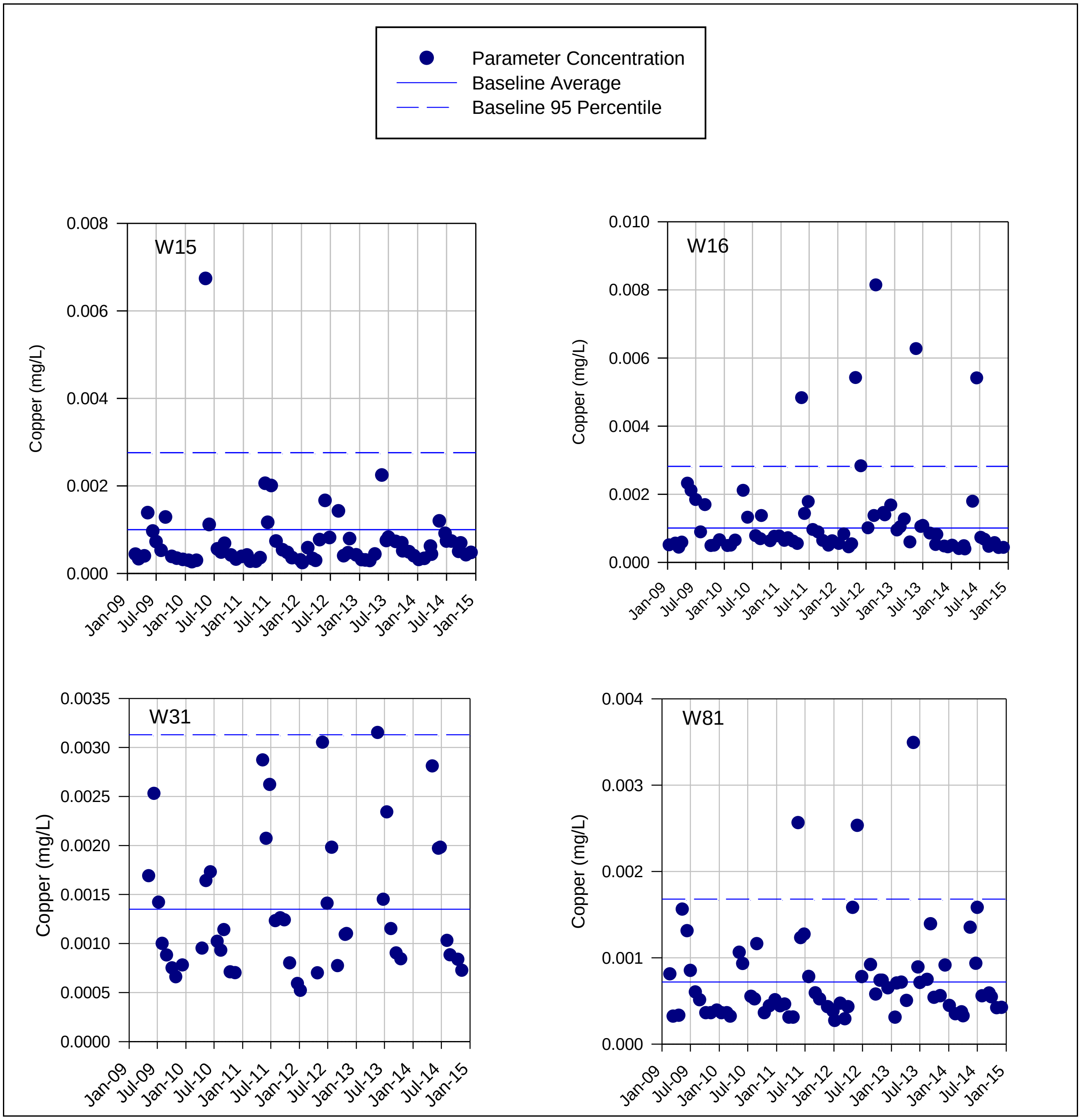


Figure 2-3: Copper in Upper Go Creek Stations, January 2009 – December 2014

2.1.4 Tailings Facility

Tailings facility monitoring (station T1) commenced in July 2010 to examine the chemistry of the tailings supernatant. Also, as mentioned above, a monitoring point (W85) was added in 2011 to represent the future location of effluent discharge from the tailings water treatment plant. The results of sampling at stations T1 and W85 are presented in Figure 2-4 for nickel. As these stations were not included in the *Baseline Report*, there are no average values or 95th percentile values against which to compare the data. Monitoring prior to discharge will represent baseline water quality against which water chemistry during discharge can be compared.

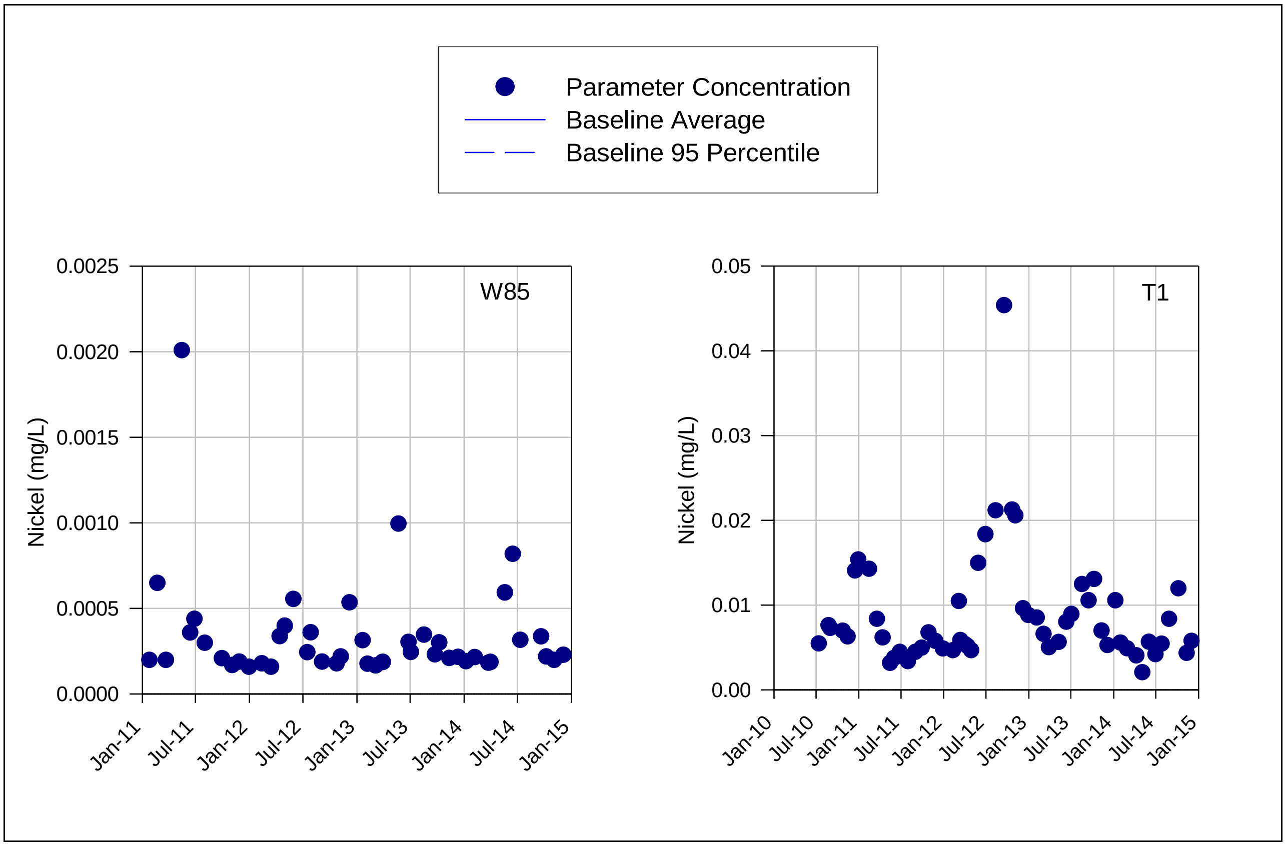


Figure 2-4: Nickel at stations W85 and T1, January 2011 - December 2014 and July 2010 - December 2014, respectively

2.1.5 Lower Go Creek Watershed

Surface water quality results for the Lower Go Creek watershed (stations W80 and W12) indicated metal and nutrient concentrations similar to those in 2009-2013, and concentrations in 2014 were all below the average baseline concentration, as shown for zinc concentrations presented in Figure 2-5.

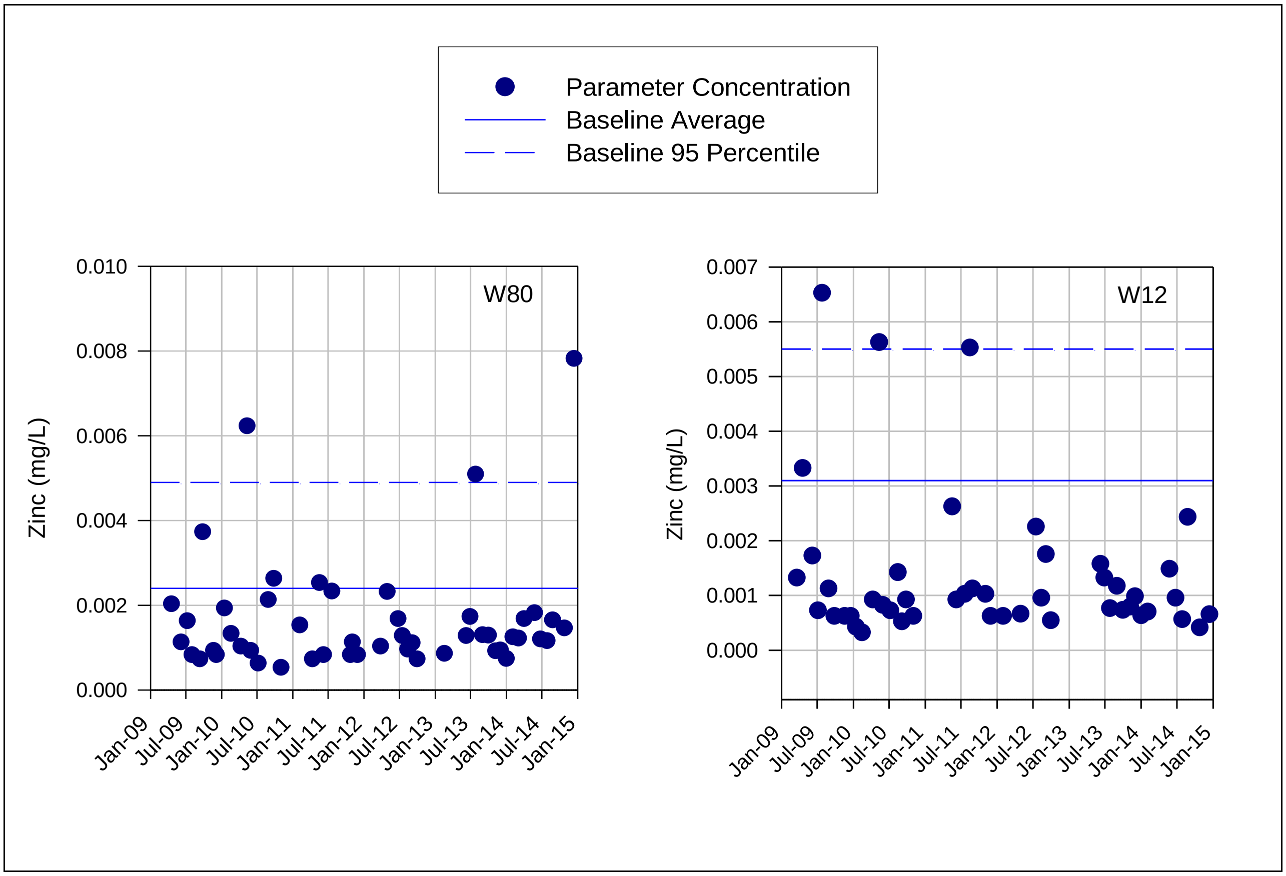


Figure 2-5: Zinc in Lower Go Creek Stations, January 2009 – December 2014

2.1.6 Money Creek Watershed

Surface water quality results for the Money Creek watershed (stations W14, W22 and W40) were also generally similar during 2014, and concentrations were generally below the average baseline concentrations for metal and nutrient parameters. Stations W40 and W14 show consistent peaks in metal concentrations during the months of May and June, associated with high TSS concentrations and increased turbidity, as shown in Figure 2-6 for cadmium.

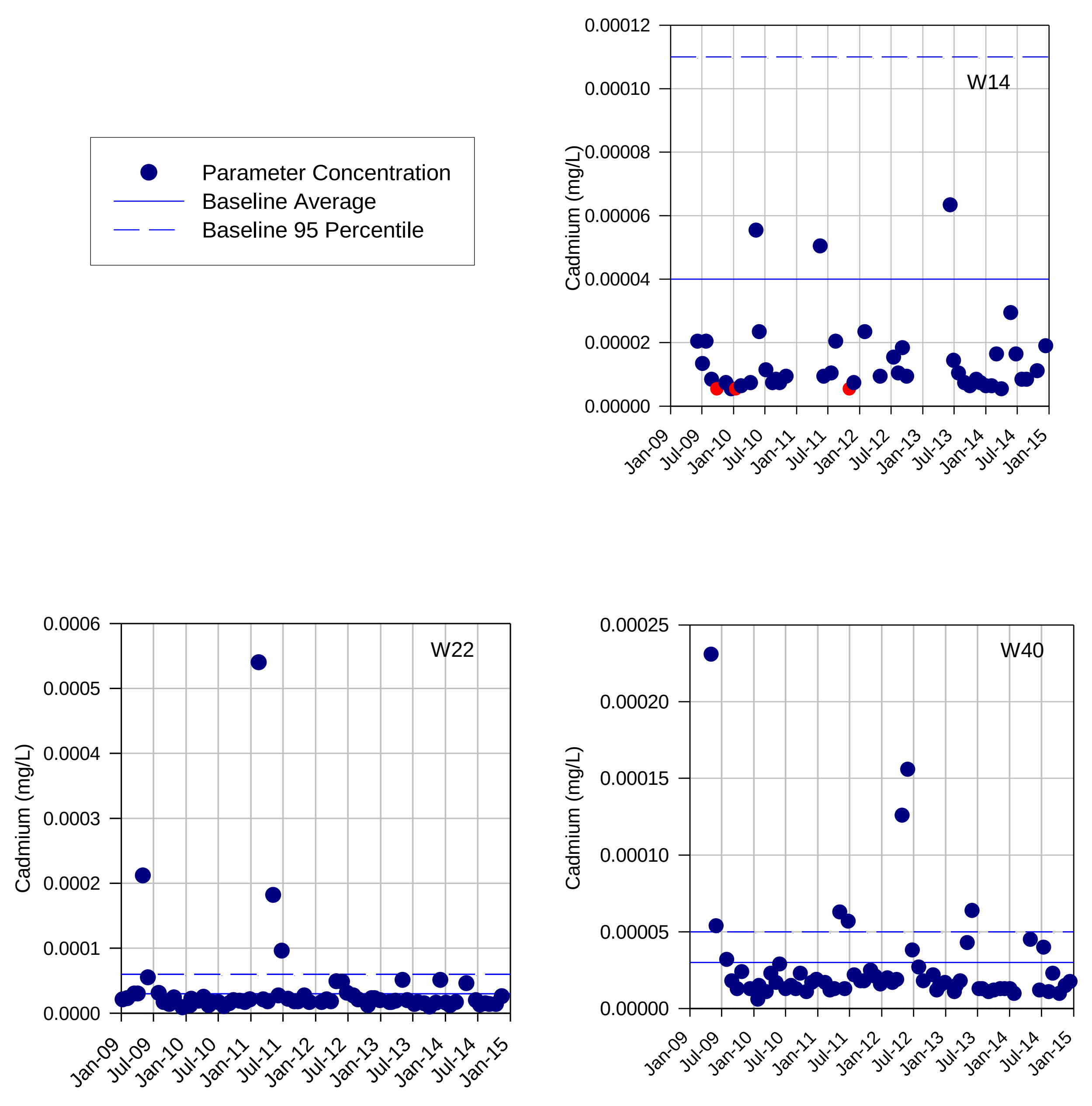


Figure 2-6: Cadmium in Money Creek Stations, Jan 2009 – December 2014

2.1.7 Mine Access Route

Surface water quality results for the Mine Access Route (stations W71, W72 and W73) were also generally the same throughout 2014 for all sites (as seen Figure 2-7 for aluminum). As a whole, concentrations were below the average baseline concentrations for metal and nutrient parameters. There was an increase in the metal concentrations in May and/or June, associated with higher than normal TSS concentrations.

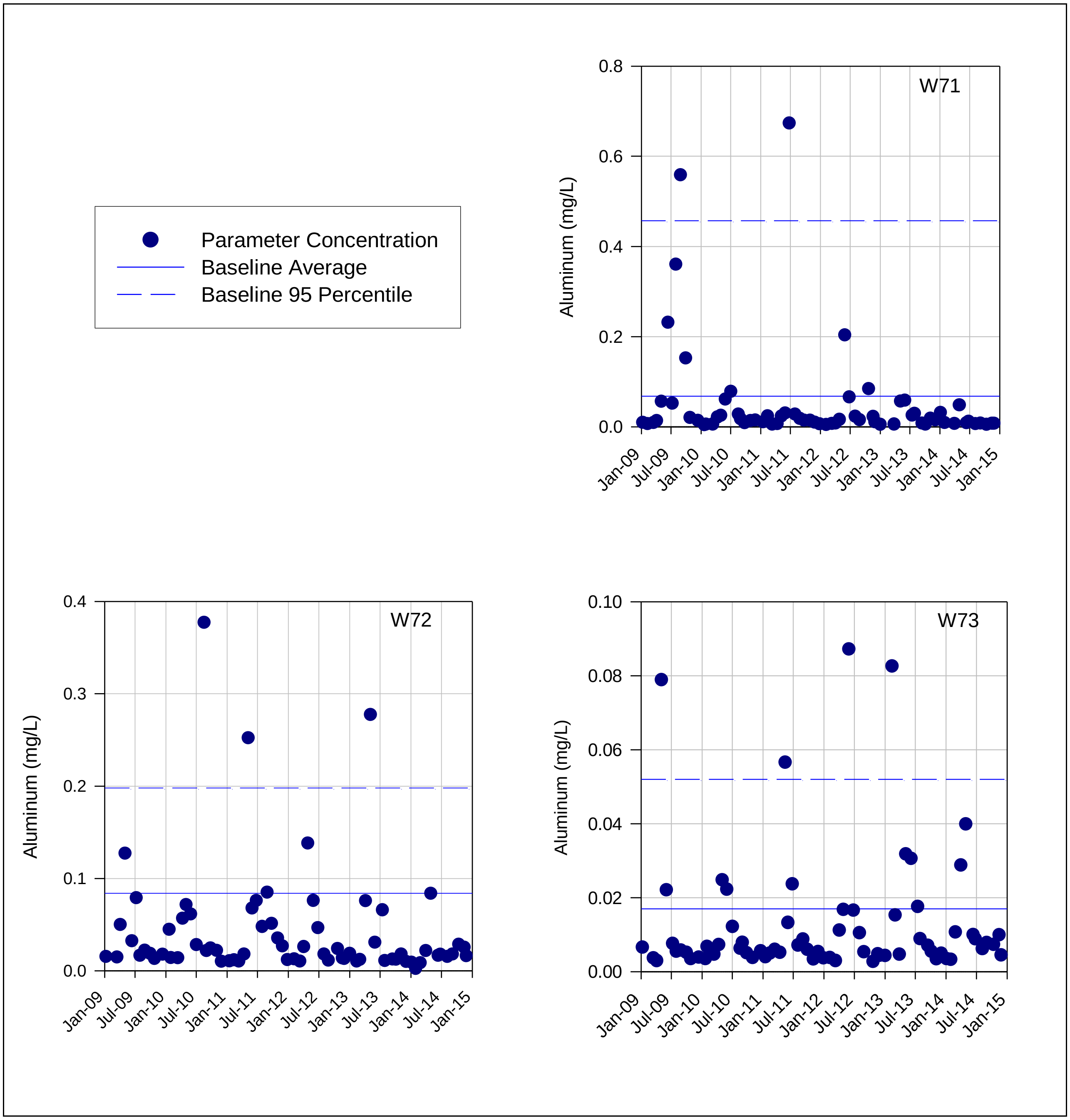


Figure 2-7: Aluminum for Stations Adjacent to the Mine Access Road, Jan 2009 – December 2014

2.2 Hydrology Results

Manual flow monitoring is required at stations W8, W15, W16, W31, W81 and W85, and continuous flow monitoring is required at stations W9, W12, W21, W22, W80 and W82, as outlined in *Type A Water Use Licence QZ04-065*. Manual flow monitoring is taken at all hydrology stations for the purposes of establishing a stage-storage curve from which the stage-discharge curve is calibrated. A power trend line is fit to the stage-storage curve to provide a calibration equation with which to convert downloaded water level (m) data to water flow (m^3). The results of the manual flow monitoring conducted from January to December 2014 are provided in

Table 2-2. The stage-storage curves and monthly average stage-discharge curves are presented below for continuous flow water monitoring stations W9, W12, W21, W22, W80, and W82.

Table 2-2: Manual flow monitoring results, January - December 2014

Sampling Site	W8	W9	W12	W15	W16	W21	W22	W31	W80	W81	W82	W85
January	*Note 1*	*Note 3*	*Note 2*	0.021	0.106	*Note 3*	*Note 2*	*Note 1*	*Note 2*	*Note 3*	*Note 1*	0.018
February	*Note 1*	*Note 3*	*Note 2*	*Note 1*	0.048	*Note 3*	*Note 2*	*Note 1*	*Note 2*	*Note 1*	*Note 1*	*Note 1*
March	*Note 1*	*Note 3*	*Note 1*	*Note 1*	0.087	*Note 3*	*Note 2*	*Note 1*	*Note 2*	0.071	*Note 1*	0.023
April	*Note 2*	*Note 3*	*Note 1*	0.004	0.014	*Note 3*	*Note 2*	*Note 1*	*Note 2*	0.037	0.004	0.015
May	0.150	0.011	*Note 2*	0.389	0.475	*Note 3*	*Note 2*	*Note 1*	*Note 2*	0.583	0.037	0.294
June	0.596	0.018	1.331	0.347	0.498	4.619	2.324	0.177	2.209	0.686	0.012	0.462
July	*Note 2*	0.008	0.930	0.289	0.200	1.905	6.934	0.044	1.152	0.635	0.021	0.117
August	*Note 2*	*Note 3*	0.236	0.082	0.094	1.829	5.424	0.014	0.617	0.255	*Note 3*	*Note 3*
September	*Note 3*	0.006	*Note 3*	*Note 3*	*Note 3*	*Note 3*	*Note 3*	*Note 3*	*Note 3*	*Note 3*	*Note 3*	*Note 3*
October	*Note 2*	*Note 2*	*Note 2*	*Note 3*	*Note 3*	*Note 3*	*Note 3*	*Note 3*	*Note 2*	*Note 3*	*Note 3*	*Note 3*
November	*Note 2*	*Note 2*	*Note 2*	0.071	0.089	*Note 2*	*Note 2*	0.022	*Note 2*	0.173	0.003	0.089
December	*Note 1*	*Note 2*	*Note 1*	*Note 1*	0.074	*Note 1*	*Note 1*	*Note 1*	*Note 3*	0.178	*Note 1*	*Note 1*

Note 1: Not enough flow to take accurate measurements or ice through to bottom of channel

Note 2: No safe access to sampling site

Note 3: Equipment malfunction

2.2.1 W9 Continuous Flow Monitoring Results

The stage-discharge curve for W9 is comprised of two curves: one July 2010 – October 2013 (Figure 2-8), and one following May 2014 (Figure 2-9), and the monthly average hydrograph in Figure 2-10. The stage-discharge curve has been updated following the installation of a Parshall flume at station W9 in July 2010, which resulted in a far more consistent stream channel, and more accurate manual and digital hydrology measurements. Readings from the data logger were obscured by ice pressure effects during the winter months of 2007, 2008 and 2009. The November 2009 through March 2010 average stream discharges were 0.034 m^3/s; however, as this was due to ice pressure effects, the value prior to the logger freezing in October was taken to be representative of winter flows. This is shown in Figure 2-10 as an average value of 0.01 m^3/s. The data logger installed at W9 was found to be damaged in March 2010 and was repaired in July, represented by a gap in the data during that time. Data collected showing ice pressure effects in winter 2011 and spring 2012 (i.e., data points < 0) were calibrated to be zero during monthly average stream discharge calculations. However, despite recalibration in July, monthly values appeared to be inconsistent with previous years, and hence, have been omitted from the record. Calibration and re-installation of the logger occurred on June 9th, 2013 and post-installation monitoring shows little variation in stream discharge over time. As a result, this logger was removed and sent away for assessment and repair. It was re-installed on May 26th and is logging successfully. The logger could not be safely accessed in the later winter months of 2014, hence was not downloaded.

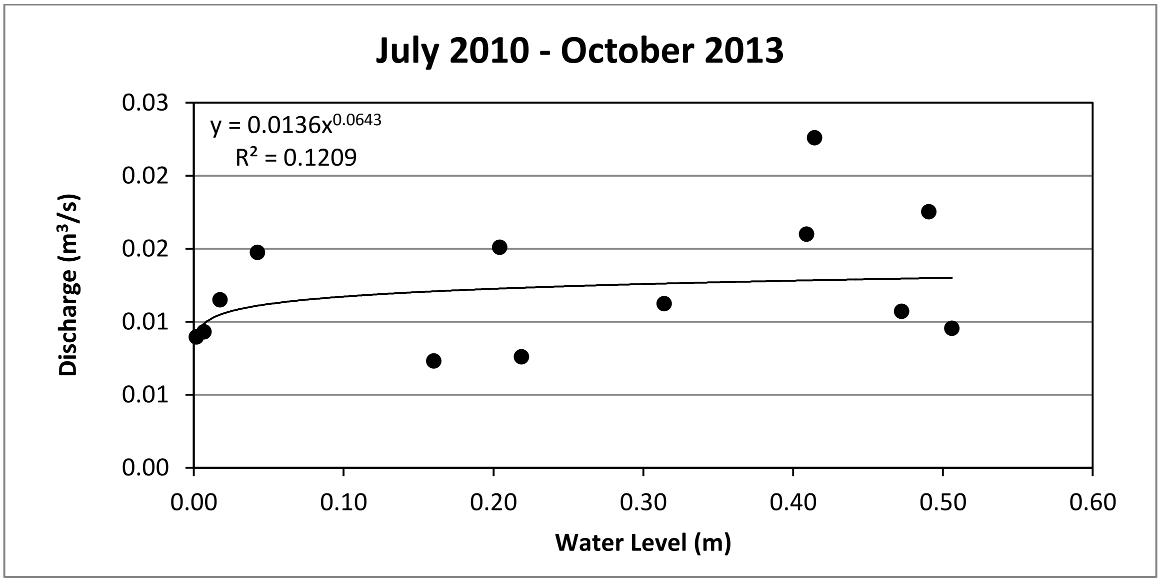


Figure 2-8 W9 Stage-Discharge Curve July 2010 - October 2013

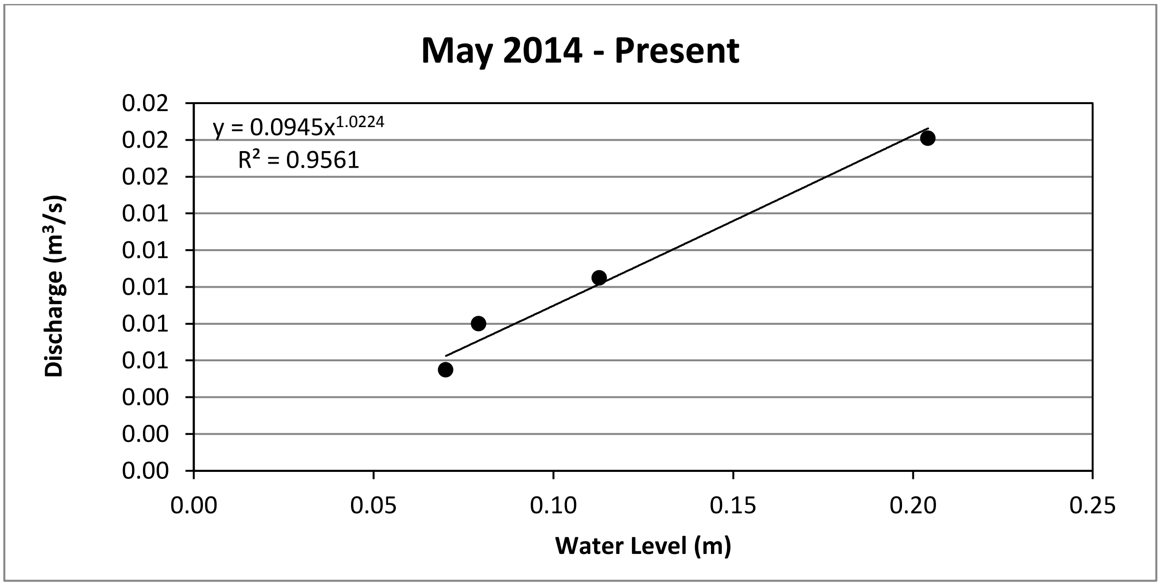


Figure 2-9: W9 Stage-Discharge Curve May 2014 - present

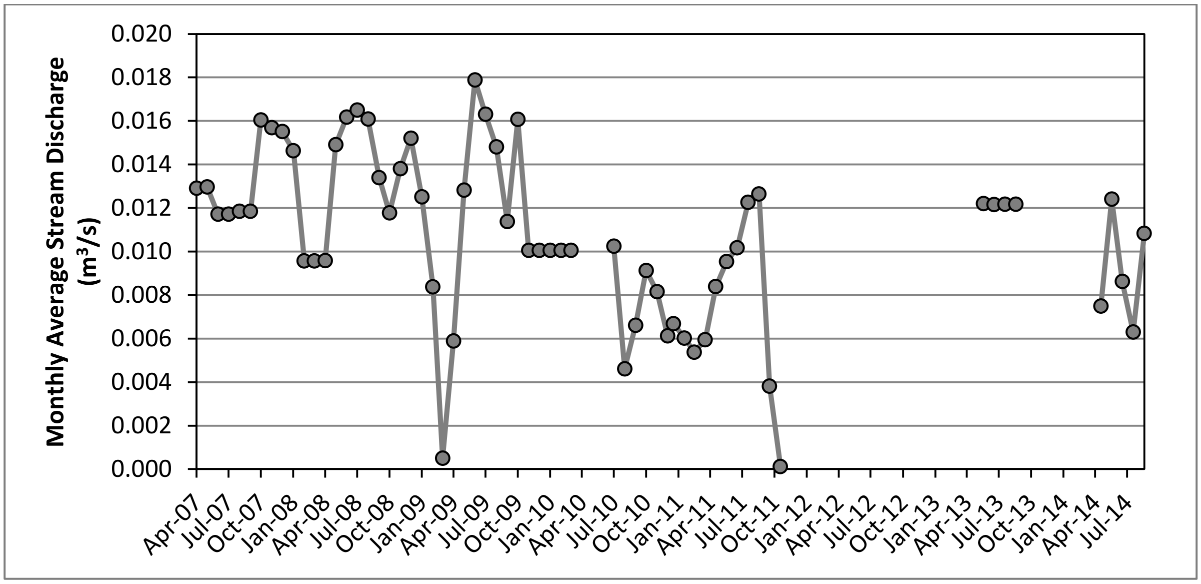


Figure 2-10: W9 Monthly Average Hydrograph, April 2007 – December 2014

2.2.2 W12 Continuous Flow Monitoring Results

The stage-discharge curve for station W12 is provided in Figure 2-11 and the average monthly hydrograph for W12 from May 2009 through December 2014 is presented in Figure 2-12 Data collected prior to May 2009 is omitted due to inconsistencies; and February to early April 2010 averages were adjusted to be 0.078 m^3/s (i.e., the average February/March 2010 discharge) due to evident ice pressure effects, as this value was expected to be more representative of actual flows; and January to April 2011 values were adjusted to a zero value. After an attempt was made to re-calibrate the W12 data logger in August of 2012 (due to a zero indication throughout the summer), it still presented inaccurate measurements. Therefore, the logger was removed and sent in for repair/replacement. It was re-installed on June 13th, 2013. The sudden drop in flow indicated during April 2014 is due to ice pressure effects.

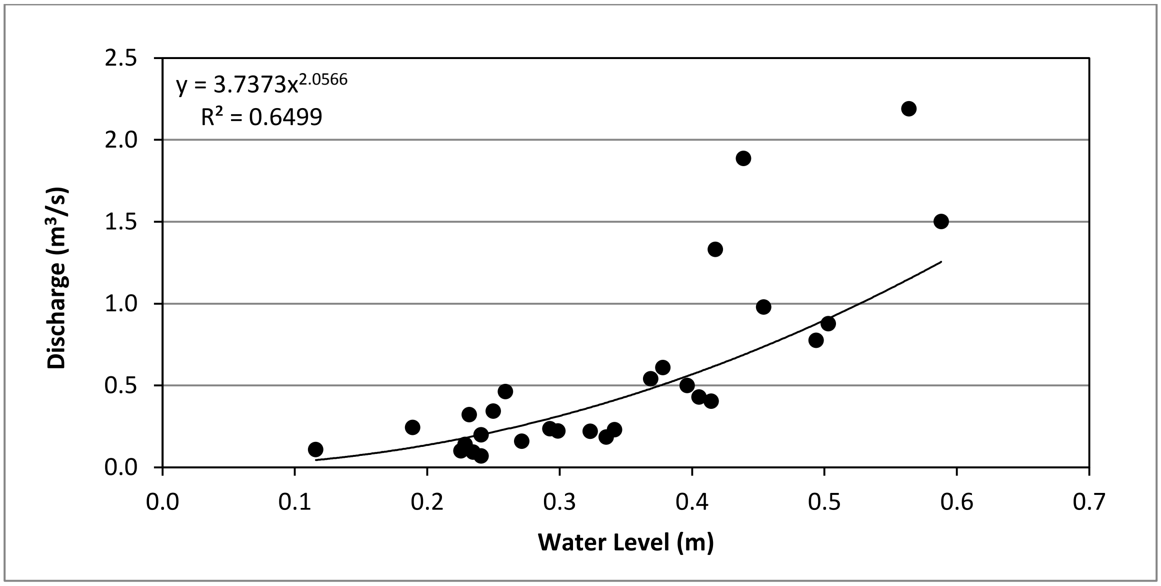


Figure 2-11: W12 Stage-Discharge Curve

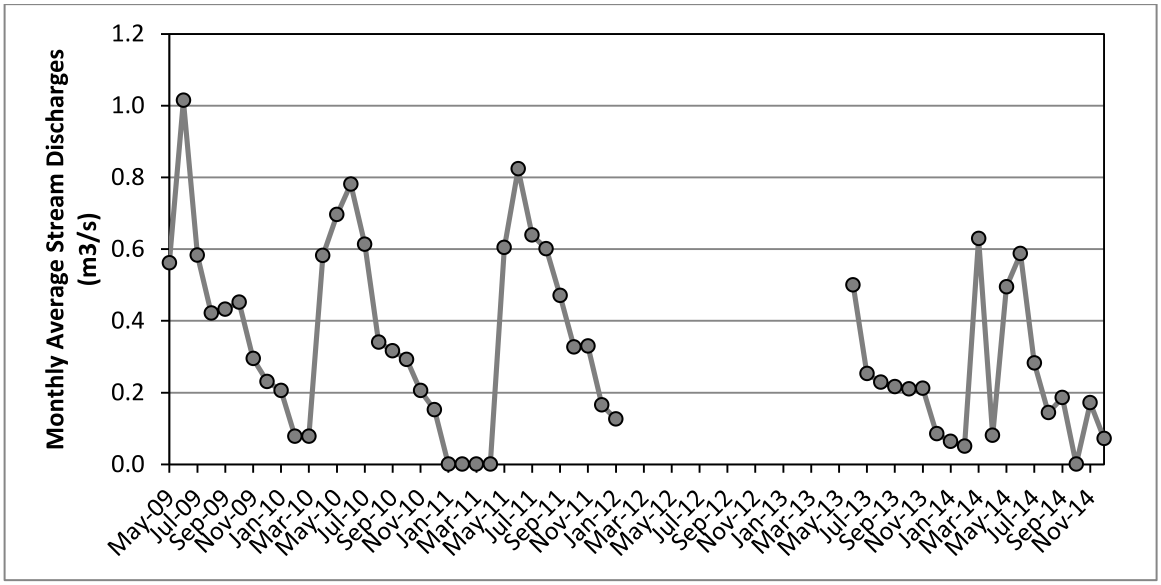


Figure 2-12: W12 Monthly Average Hydrograph, May 2009 – December 2014

2.2.3 W21 Continuous Flow Monitoring Results

The stage-discharge curve for W21 is provided in Figure 2-13 and the monthly average hydrograph for W21 from March 2007 through to December 2014 is presented in Figure 2-14. Ice pressure effects were observed in winter and early spring in 2007 through 2014 The higher flows in winter 2010/2011 are most likely due to ice pressure effects than to an actual increase in flow rate. The in-stream data logger was removed on August 28th and sent in for repair. It was recently re-installed on May 21st, and is logging successfully showing evidence of typical seasonal fluctuations for this site.

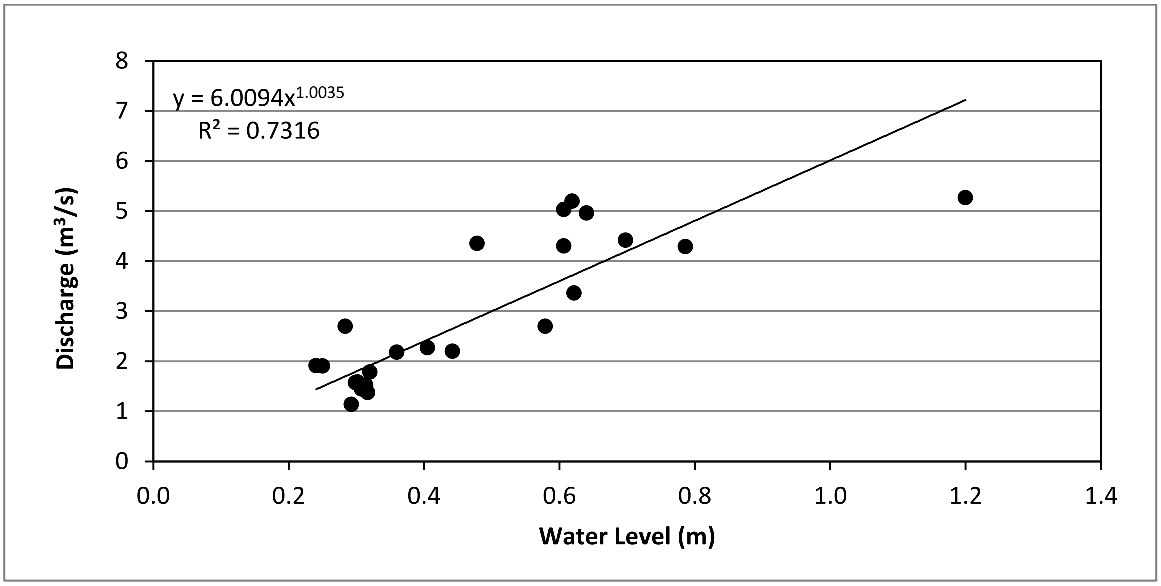


Figure 2-13: W21 Stage-Discharge Curve

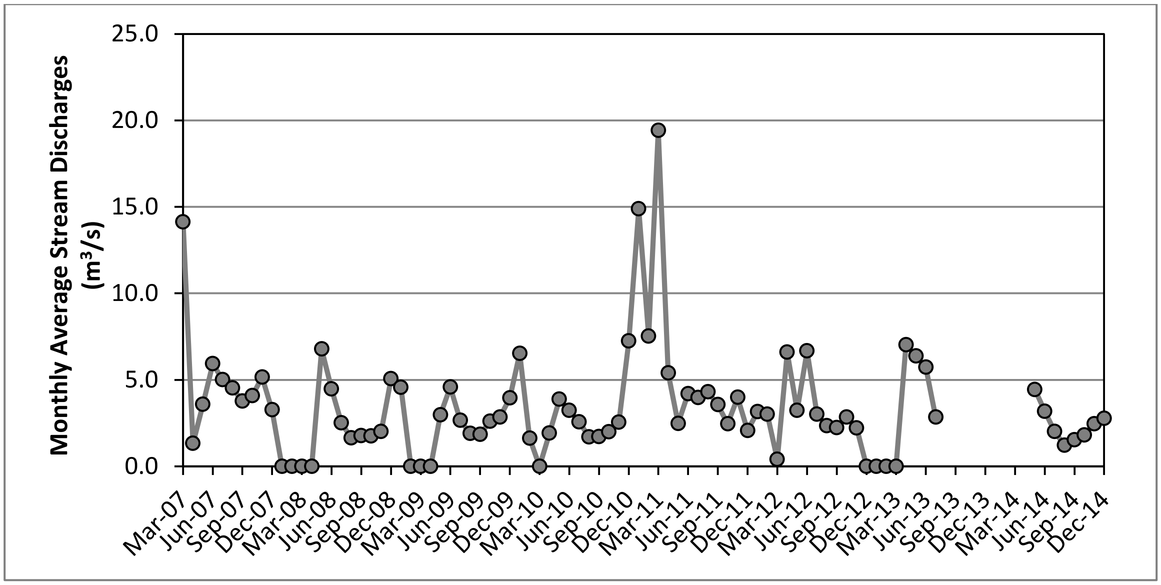


Figure 2-14: W21 Hydrograph, March 2007 – December 2014

2.2.4 W22 Continuous Flow Monitoring Results

The stage-discharge curve for station W22 is provided in Figure 2-15 and the continuous hydrograph for W22 from May 2008 through to December 2014 is presented in Figure 2-16. Ice pressure effects (normalized to zero values in Figure 2-16) are typically evident during the winter months. Although flows appear to be increasing from November 2009 through March 2010, and again in December 2010 and November 2012, 2013 and 2014 these increases are likely due to ice pressure effects, as flows are usually lowest during this time of the year. In August 2013, it was noticed that the logger had been dislodged by high flows. The staff gauge was used to re-position the logger and re-adjust values indicated by the logger.

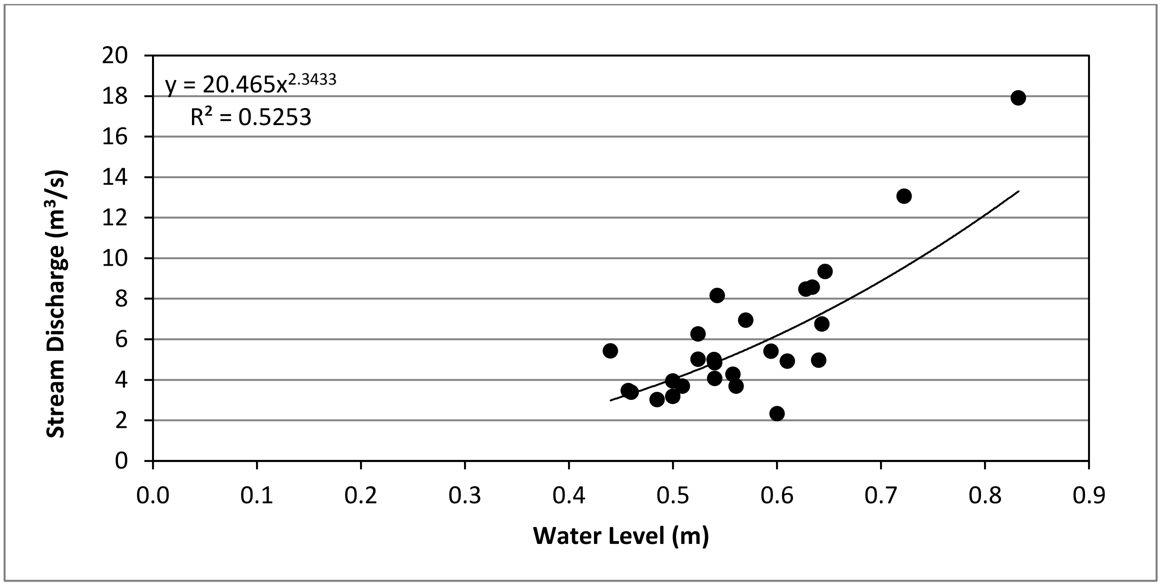


Figure 2-15: W22 Stage-Discharge Curve

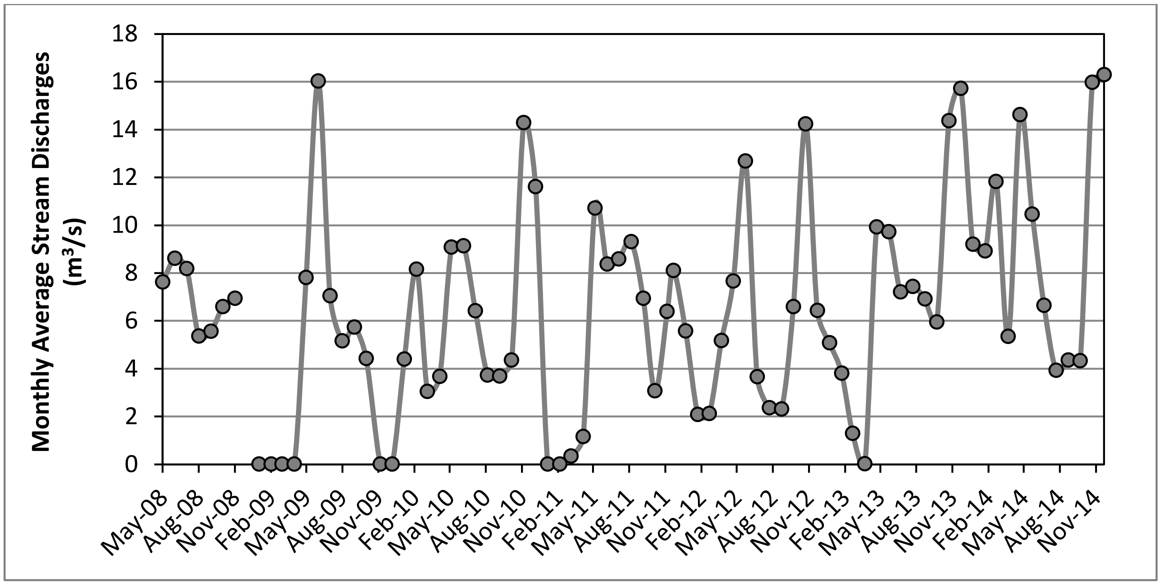


Figure 2-16: W22 Monthly Average Hydrograph, May 2008 – December 2014

2.2.5 W80 Continuous Flow Monitoring Results

Station W80 was sampled frequently in 2009 and consequently, the resulting stage-discharge is quite robust (Figure 2-17). The monthly average hydrograph for W80 from September 2006 through to December 2014 is presented in Figure 2-18. Due to ice pressure effects, when the data logger recorded negative values the values were adjusted to zero for the purposes of calculating monthly average discharges, as represented in Figure 2-18. Generally, low flows are evident at station W80 November through April, and high flows in June and October.

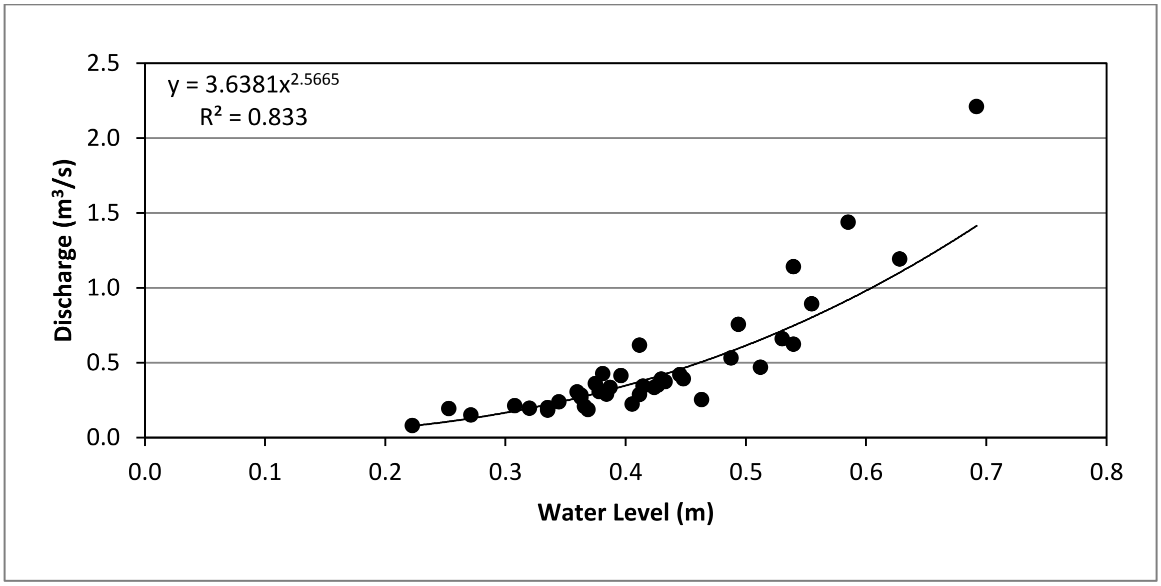


Figure 2-17: W80 Stage-Discharge Curve

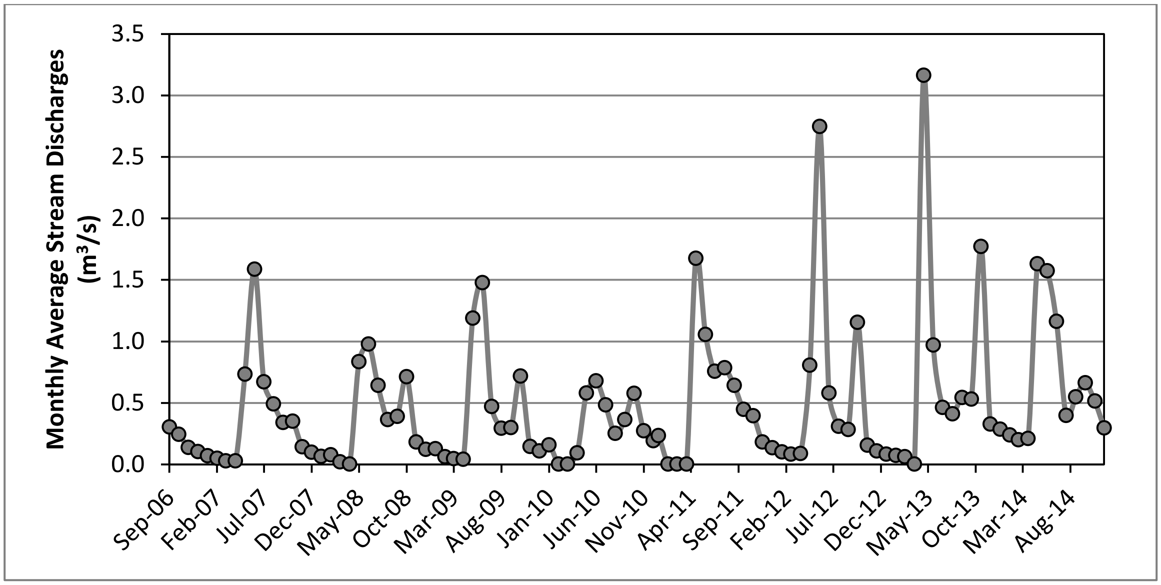


Figure 2-18: W80 Monthly Average Hydrograph, September 2006 – December 2014

2.2.6 W82 Continuous Flow Monitoring Results

The stage-storage curve for Station W82 is comprised of two curves: one prior to May 2009 (Figure 2-19), and one following May 2009 (Figure 2-20), as the logger was broken in April 2009, and replaced with a new logger in May. The average monthly discharges for W82 from November 2007 through December 2014 are presented in Figure 2-21. High flows were observed in spring 2008 – 2014 as expected. Ice pressure effects (negative values have been corrected to zero values in Figure 2-21) were evident in late winter months in 2009 – 2014.

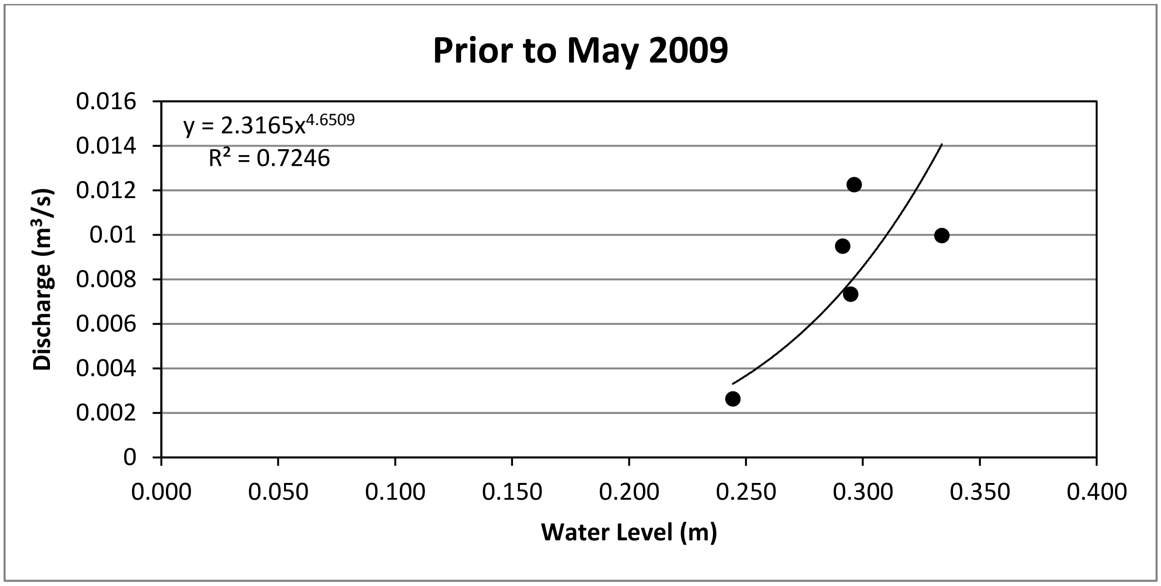


Figure 2-19: W82 Stage-Discharge Curve Prior to May 2009

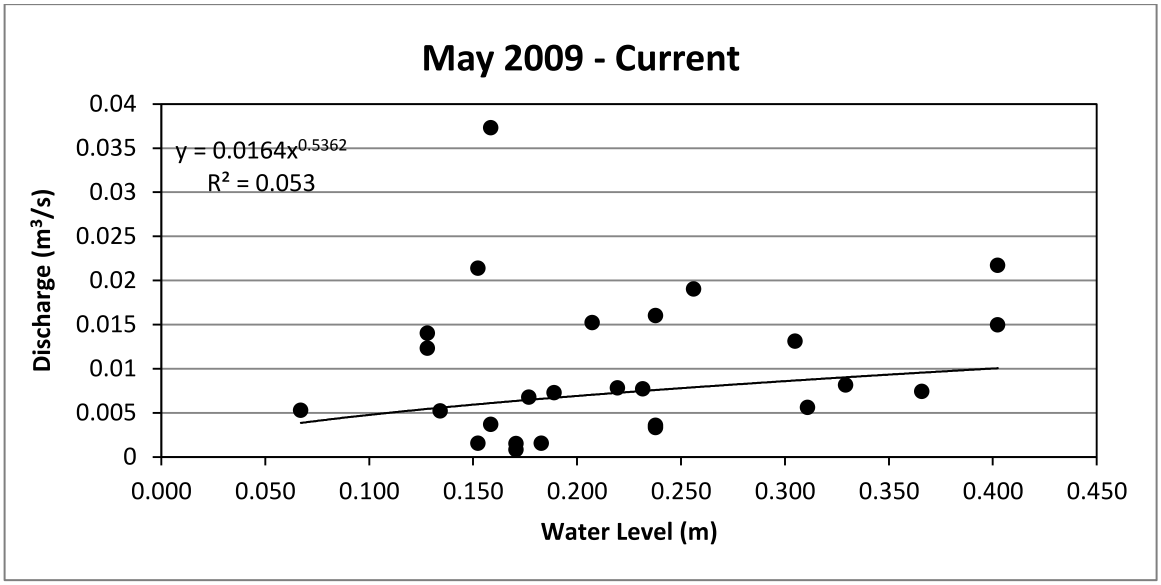


Figure 2-20: W82 Stage-Discharge Curve Following May 2009 - Current

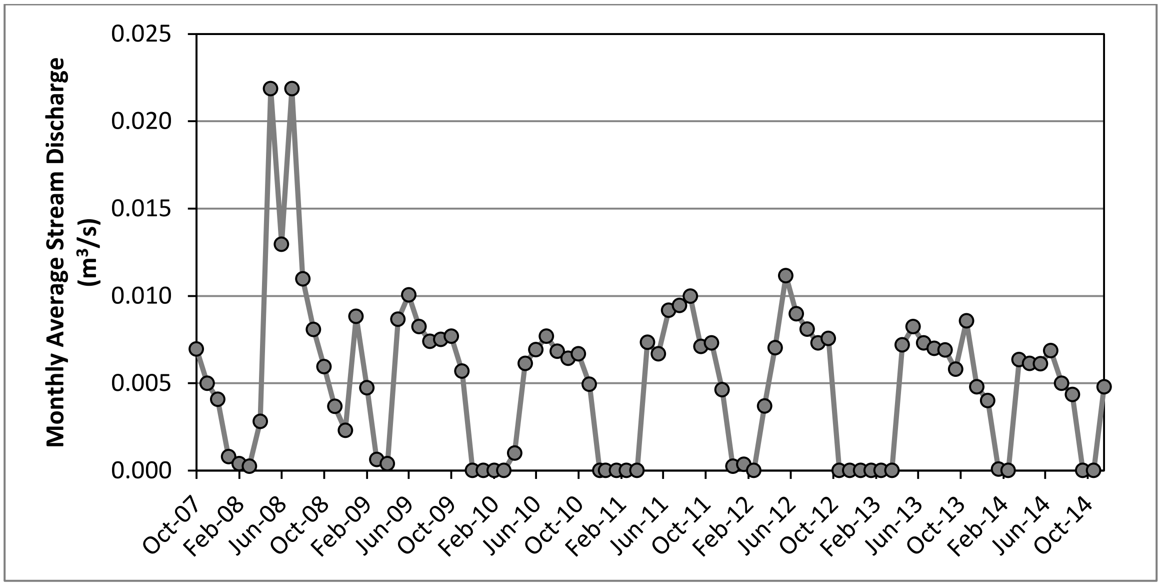


Figure 2-21: W82 Monthly Average Hydrograph, November 2007 – December 2014

3 Ground Water Monitoring Results

The groundwater monitoring program for the Wolverine Project includes the monitoring of water levels and water quality at 24 locations in the Wolverine Creek and Go Creek watersheds. Below are summarized the sampling dates, water quality results and water level and temperatures recorded by in-situ loggers.

3.1 Groundwater Sampling Program

The groundwater monitoring program for the Wolverine Mine includes the monitoring of water levels, temperature and water quality at 24 locations at the Wolverine Mine site in alluvial, shallow and deep bedrock in the Wolverine Lake and Go Creek watersheds. Groundwater quality samples for the purposes of ongoing operations monitoring (as per A Licence QZ04-065) were taken at the locations and dates summarized in Table 3-1. Gaps in the data in Table 3-1 represent times when the sample sites were frozen, and samples were not able to be taken. Well MW08-14 was discontinued in 2011 due to construction activities in the area of the well for the raising of the tailings storage dam.

Overall a total of 156 sample sets were analyzed for dissolved metals by ICP trace metals scan, nutrient parameters, major anions, total suspended solids and laboratory physical parameters. Water quality results are compared to the historic (1995-2008) baseline average and 95th percentile values provided in the Lorax Environmental *Baseline Characterization Summary Report* provided in Appendix A of *Monitoring and Surveillance Plan V2011-03* (*Baseline Report*).

Table 3-1: Groundwater Monitoring Sites and Dates Sampled - 2014

Sampling Site	January	February	March	April	May	June	July	August	September	October	November	December
MW05-1A	D	D	D	D	31-May	E	31-Jul	E	3-Sep	D	D	D
MW05-1B	D	D	D	D	D	E	31-Jul	E	3-Sep	D	D	D
MW05-2A	D	D	D	D	D	E	31-Jul	26-Aug	21-Sep	D	D	D
MW05-2B	D	D	D	D	D	27-Jun	31-Jul	26-Aug	21-Sep	D	D	D
MW05-3A	D	D	D	D	D	27-Jun	30-Jul	26-Aug	🟦 28-Sep	D	D	D
MW05-3B	D	D	D	D	D	27-Jun	30-Jul	26-Aug	28-Sep	21-Oct	D	D
MW05-4A	D	D	D	D	30-May	24-Jun	🟦 30-Jul	19-Aug	20-Sep	22-Oct	D	D
MW05-4B	D	D	D	D	30-May	24-Jun	30-Jul	🟦 19-Aug	20-Sep	22-Oct	D	D
MW05-5A	22-Jan	D	5-Mar	30-Apr	27-May	24-Jun	22-Jul	17-Aug	14-Sep	21-Oct	5-Nov	28-Dec
MW05-5B	22-Jan	D	5-Mar	D	27-May	24-Jun	29-Jul	17-Aug	14-Sep	21-Oct	5-Nov	28-Dec
MW05-6A	🟦 22-Jan	28-Feb	28-Mar	27-Apr	25-May	23-Jun	22-Jul	17-Aug	14-Sep	21-Oct	24-Nov	27-Dec
MW05-6B	22-Jan	28-Feb	D	D	25-May	23-Jun	22-Jul	17-Aug	14-Sep	21-Oct	🟦 24-Nov	27-Dec
MW05-7B	D	D	D	D	27-May	🟦 7-Jun	6-Jul	9-Aug	19-Sep	D	D	D
MW06-8S	26-Jan	D	D	30-Apr	27-May	25-Jun	29-Jul	16-Aug	D	26-Oct	D	2-Dec
MW06-8M	26-Jan	D	31-Mar	30-Apr	E	E	E	16-Aug	D	26-Oct	D	D
MW06-8D	25-Jan	D	28-Mar	🟦 27-Apr	27-May	🟦 25-Jun	29-Jul	16-Aug	20-Sep	26-Oct	D	1-Dec
MW06-9S	D	D	D	D	30-May	24-Jun	30-Jul	26-Aug	22-Sep	22-Oct	30-Nov	D
MW06-9M	D	D	D	D	30-May	24-Jun	30-Jul	26-Aug	22-Sep	D	D	D
MW06-10S	D	D	D	D	12-May	8-Jun	🟦 8-Jul	E	28-Sep	27-Oct	D	1-Dec
MW06-10M	D	D	D	D	E	8-Jun	8-Jul	E	28-Sep	27-Oct	D	1-Dec
MW06-10D	29-Jan	26-Feb	31-Mar	D	D	D	D	E	D	27-Oct	D	1-Dec
MW06-11S	D	D	D	D	D	27-Jun	29-Jul	26-Aug	28-Sep	🟦 24-Oct	D	D
MW06-12S	20-Jan	D	🟦 19-Mar	30-Apr	30-May	27-Jun	30-Jul	26-Aug	29-Sep	🟦 24-Oct	26-Nov	17-Dec
MW08-13	D	D	D	D	11-May	7-Jun	6-Jul	9-Aug	🟦 19-Sep	25-Oct	6-Nov	🟦 17-Dec

A = Site not sampled due to lack of safe access
D = Site dry (i.e., all water tied up in storage) or frozen through to ground
E = Transportation equipment under repair/Sampling equipment under repair
🟦 QAQC Sample Taken

3.2 Groundwater Quality Monitoring

Laboratory results for the groundwater samples taken in 2014 are compared to baseline average and 95th percentiles provided in *Appendix A* of the *Baseline Report*, except for stations MW06-8M and MW08-13, which were not installed until 2008, hence there was no baseline established for these sites. Appendix B herein provides graphical representations of the water quality results for all groundwater monitoring sites for the following parameters:

- Conductivity
- Hardness
- Total Alkalinity
- pH
- Total Suspended Solids (TSS)
- Turbidity
- Fluoride
- Sulphate
- Ammonia
- Nitrate
- Nitrite
- Dissolved Aluminum
- Dissolved Arsenic
- Dissolved Cadmium
- Dissolved Chromium
- Dissolved Copper
- Dissolved Iron
- Dissolved Lead
- Dissolved Mercury
- Dissolved Molybdenum
- Dissolved Nickel
- Dissolved Selenium
- Dissolved Silver
- Dissolved Zinc

Red symbols in the graphs and in the figures below indicate the result was below the analytical detection limit, and is shown as being equal to the detection limit. Also, for occasions when the average and 95th percentile are equal, only the blue line indicating the average is visible on the graphs.

The majority of physical parameters and major anions (conductivity, hardness, alkalinity, pH, TSS, turbidity, fluoride, sulphate, ammonia, nitrate and nitrite) for all sites were within the average provided in the *Baseline Report*, and were generally below the 95th percentile value. The 2010 ammonia concentrations were higher than the 95th percentile values and the 2009 and 2011 concentrations, due to a change in analysis methodology at the analyzing laboratory that was incorrectly detecting ammonia. This inconsistency was remedied for the 2011 sample analysis.

Nitrate and nitrite concentrations were much higher than normal in samples taken since September 2011, due to interferences with the analytical equipment. The interferences also resulted in laboratory detection limits that were an order of magnitude greater than the limits used previously (i.e., 0.2 mg/L vs. 0.002 mg/L).

The results for total metals were also generally within the average baseline range, and 2014 results were comparable to results achieved previously. The majority of results were less than the average values, and almost all were less than the 95th percentile values. ~96% of results for silver and 99% of the mercury results were below the reportable detection limits; hence these parameters were not graphed nor are provided in Appendix B.

Noticeable exceptions in the groundwater sample data include:

MW05-2A:
- Arsenic concentrations demonstrate a declining concentration levels during 2014.

MW05-3A:
- Majority of molybdenum concentrations were greater than the 95th percentile concentration for values in 2014. Station MW05-3A showed increasing concentration trends for arsenic, iron, molybdenum, and fluoride

since 2013. However, it also demonstrated decreasing concentrations during the same time period for cadmium, nickel, and zinc.

MW05-3B:	• Aluminum, selenium, and molybdenum concentrations decreased over the monitoring period. Whereas cadmium, zinc, nickel, and sulphate continue to demonstrate increasing trends. Majority of conductivity and alkalinity concentrations were greater than the 95th percentile concentration for all values in 2009-2014.
MW05-4B:	• Cadmium and zinc concentrations steadily increased from 2009 – 2012, but decreased during 2013 and 2014. During 2014 arsenic concentrations increased in comparison to previous years.
MW05-5A	• Aluminum concentrations began increasing in 2014.
MW05-6B:	• Majority of chromium concentrations were greater than the 95th percentile concentration for all values in 2009-2014.
MW05-7B	• Selenium and sulphate concentrations began to increase during 2014. While molybdenum continues to demonstrate declining concentrations since 2010.
MW06-8S:	• Zinc and nickel concentrations have increased since 2009, while iron has increased since 2012. However, aluminum showed a decline in concentration levels during 2014.
MW06-12S	• Arsenic concentrations have decreased since 2009.
MW08-13	• Molybdenum and fluoride concentrations have shown a decline in concentration since 2010. In 2014 increasing concentration trends were depicted by nickel, selenium and sulphate.
MW05-1A, MW05-2A/2B, MW05-3A, MW05-4B, MW06-9S, MW06-10M, MW06-12S	• Arsenic concentration changes during 2014 were seen increasing in MW05-3A and MW05-4B. While MW05-1A , MW05-2A/2B, MW06-9S, MW06-10M, and MW06-12S demonstrated declining concentration levels.
MW05-3A, MW05-4B, MW05-5A/5B, MW05-6A/6B, MW06-9M:	• Arsenic concentrations were greater than the 95th percentile concentration for the majority of 2011 – 2014. However, all samples taken from MW05-4B during 2014 fell below the 95th percentile.
MW05-1A, MW05-1B, MW05-3A, MW05-4A/4B, MW05-5B, MW05-6A/6B, MW06-8D:	• Ammonia concentrations were above the 95th percentile for the majority of points in 2010 - 2014. MW05-1B and MW06-12S demonstrated decreasing ammonia concentration since 2010. MW05-3A demonstrated increasing ammonia concentration since 2012.
MW05-3A, MW05-4A, MW06-8S, MW06-11S:	• Fluoride concentrations were above the 95th percentile for the majority of points in 2010 - 2014.
MW05-3B, MW05-4B, MW05-5B, and MW06-8S (only Zn & Ni):	• Cadmium, Nickel and Zinc concentrations were greater than the 95th percentile concentration for the majority of 2011 – 2014.
MW05-2B, MW05-3A, MW05-4B, MW06-6A, MW06-8D, MW06-8S,	• Iron concentrations were greater than the 95th percentile concentration for the majority of 2011 -

MW06-10S, MW06-11S, MW06-12S:	2014. MW05-3A was below the 95th percentile until 2014. MW06-8M, MW06-10D and MW06-10M have demonstrated declining concentrations since 2010. While MW05-2B, MW06-9S, MW06-11S demonstrate increasing concentrations.
MW05-2B, MW06-10M:	• Molybdenum concentrations have increased since 2012.
MW05-4A, MW05-7B, MW06-10S, MW06-11S:	• Majority of alkalinity concentrations were greater than the 95th percentile for 2009 - 2014.
MW05-4B, MW05-6A, MW06-8D, MW06-9S, MW06-10M, MW06-11S:	• Majority of turbidity concentrations were greater than the 95th percentile for 2009 – 2014.

The results of the groundwater quality are discussed in the below sections by well depth (i.e., alluvial, shallow bedrock or deep bedrock) and location (i.e., Go Creek and Wolverine Creek).

3.2.1 Wolverine Creek – Alluvial Groundwater Wells

Alluvial groundwater wells in the Wolverine Creek drainage include wells MW05-3B, MW05-4B and MW05-5B. Concentrations of cadmium, nickel and zinc in well 3B demonstrated increasing trends, as shown for cadmium in Figure 3-1. Well 4B similarly demonstrated increases in cadmium while all other graphed parameters did not demonstrate any noticeable trends, and were generally below the baseline average value.

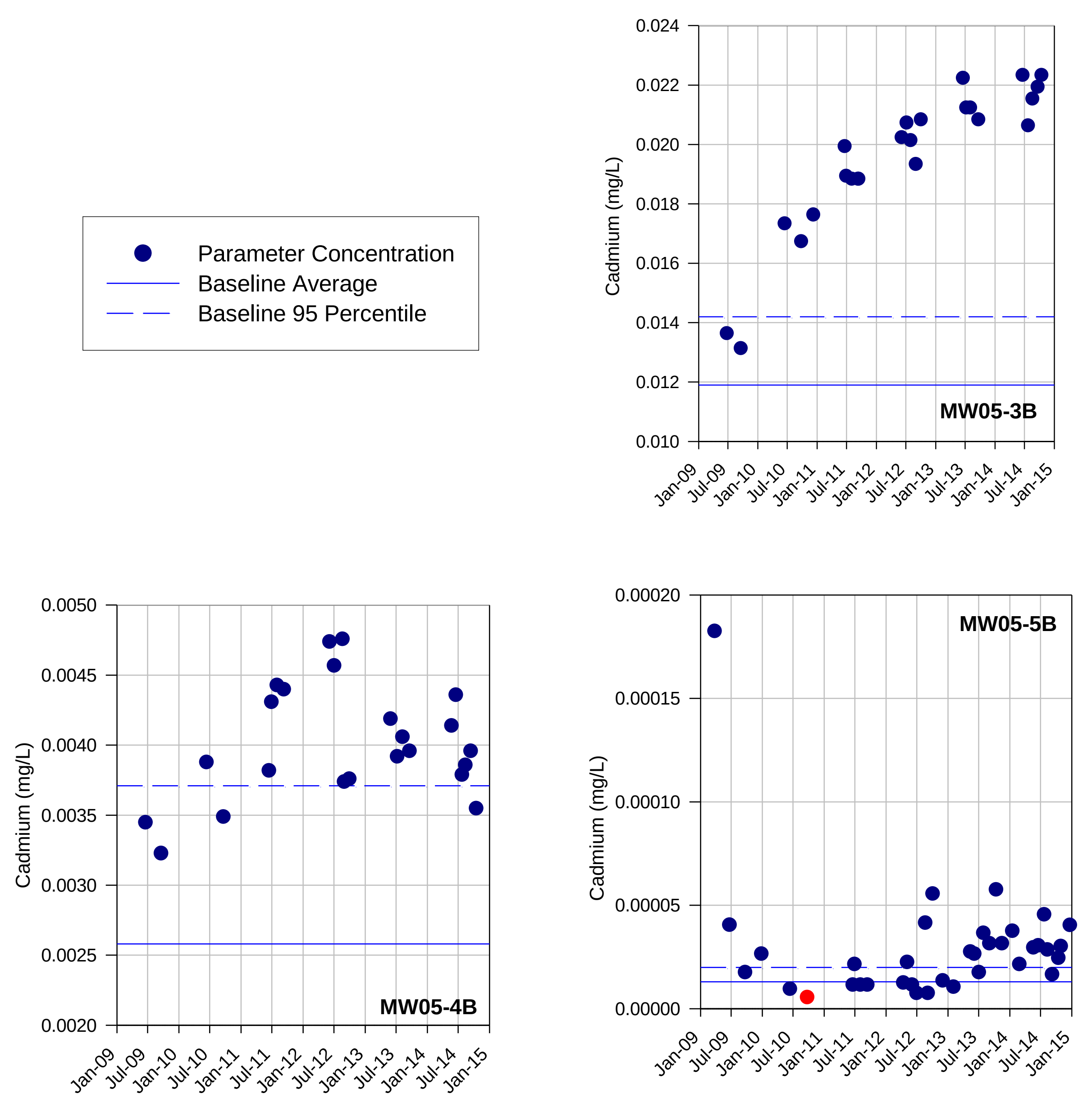
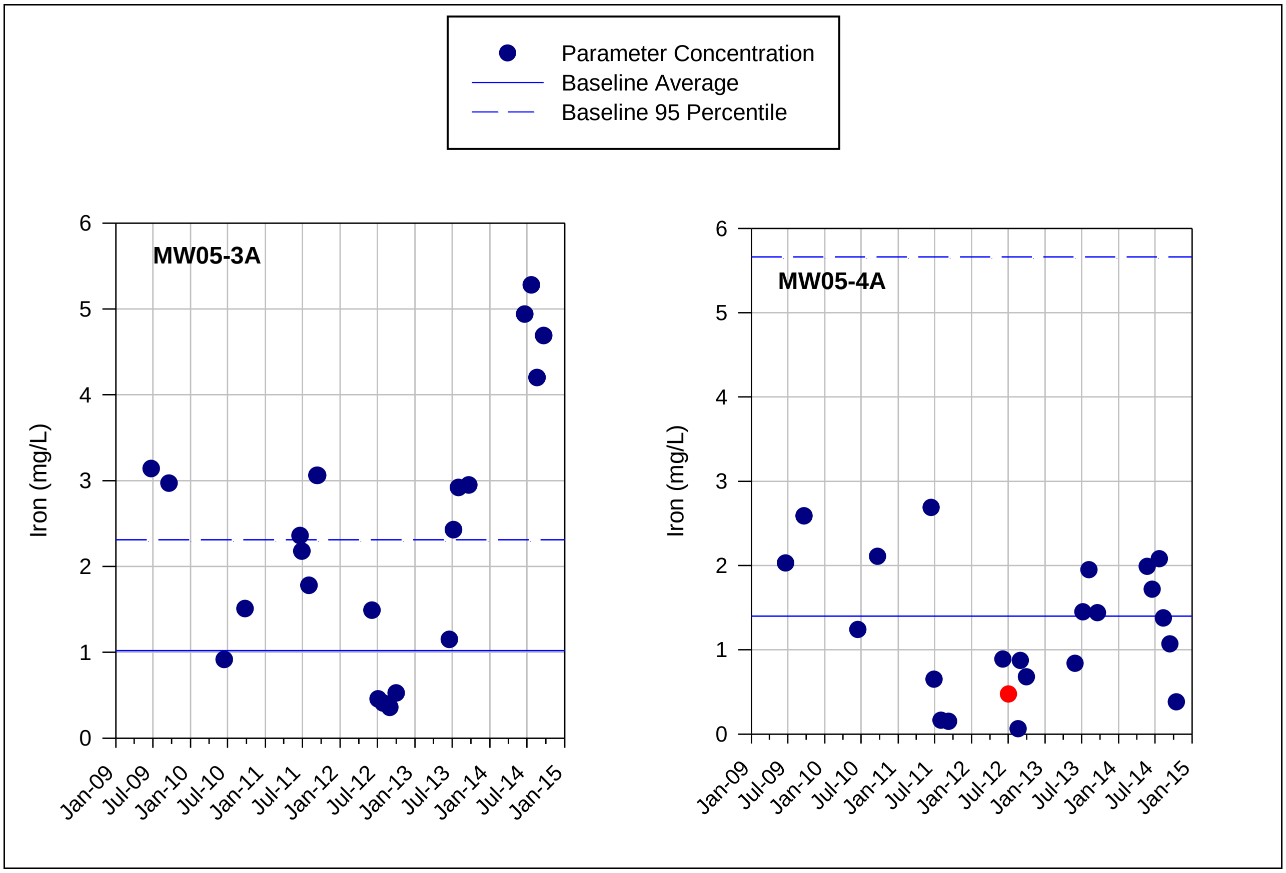
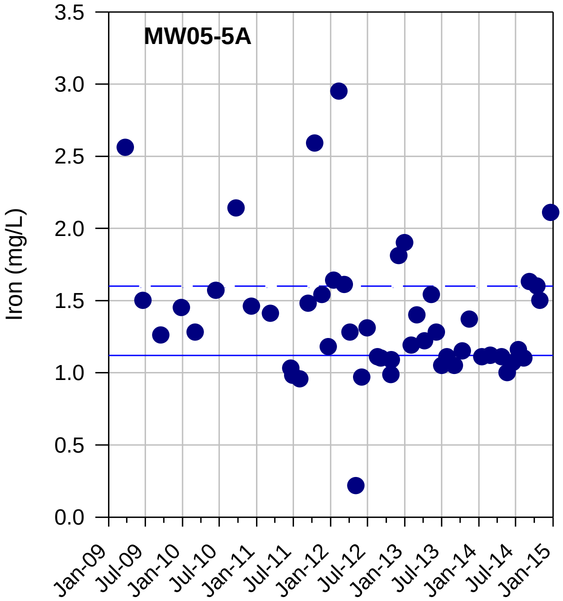


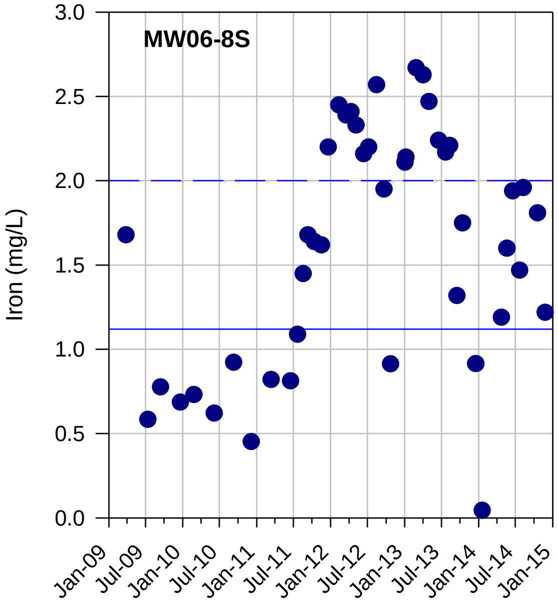
Figure 3-1: **Cadmium Concentrations in Wolverine Creek Alluvial Groundwater Stations, Jan 2009 – Dec 2014**

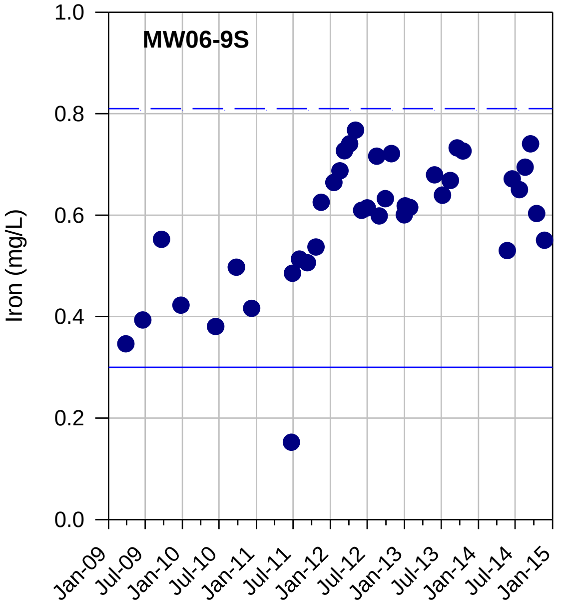
3.2.2 Wolverine Creek – Shallow Bedrock Groundwater Wells

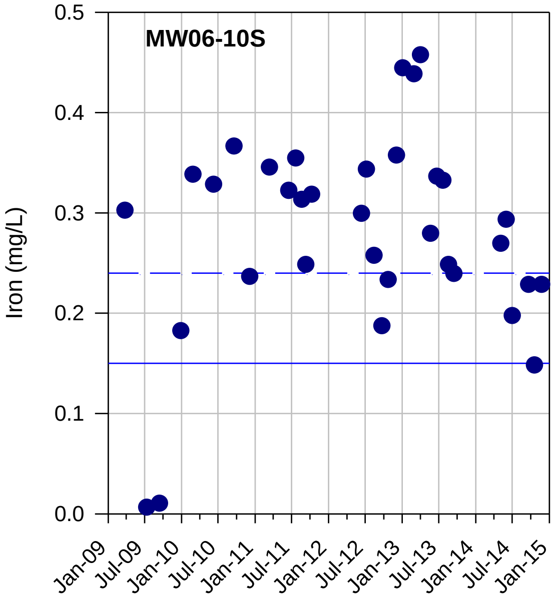
Shallow bedrock groundwater wells in the Wolverine Creek drainage include wells MW05-3A, MW05-4A, MW05-5A, MW06-8S, MW06-9S, MW06-10S, MW06-11S and MW06-12S. Generally the metal concentrations were less than the baseline average concentrations, although iron in wells 10S, 11S and 12S were generally above the 95th percentile, as shown in Figure 3-2. Well MW06-8S also demonstrated increasing trends in the concentrations of iron, nickel and zinc throughout 2009-2014, similarly to wells 3B and 4B, described above.




MW05-5A
Iron (mg/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Jan-09
Jul-09
Jan-10
Jul-10
Jan-11
Jul-11
Jan-12
Jul-12
Jan-13
Jul-13
Jan-14
Jul-14
Jan-15


MW06-8S
Iron (mg/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Jan-09
Jul-09
Jan-10
Jul-10
Jan-11
Jul-11
Jan-12
Jul-12
Jan-13
Jul-13
Jan-14
Jul-14
Jan-15


MW06-9S
Iron (mg/L)
0.0
0.2
0.4
0.6
0.8
1.0
Jan-09
Jul-09
Jan-10
Jul-10
Jan-11
Jul-11
Jan-12
Jul-12
Jan-13
Jul-13
Jan-14
Jul-14
Jan-15


MW06-10S
Iron (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
Jan-09
Jul-09
Jan-10
Jul-10
Jan-11
Jul-11
Jan-12
Jul-12
Jan-13
Jul-13
Jan-14
Jul-14
Jan-15

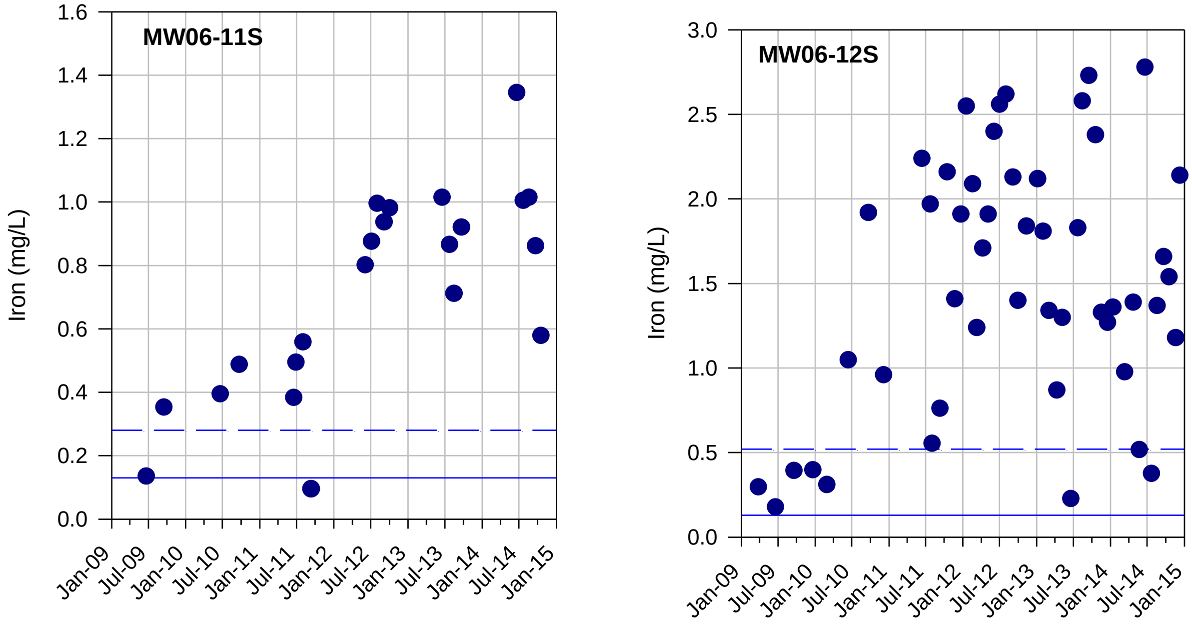
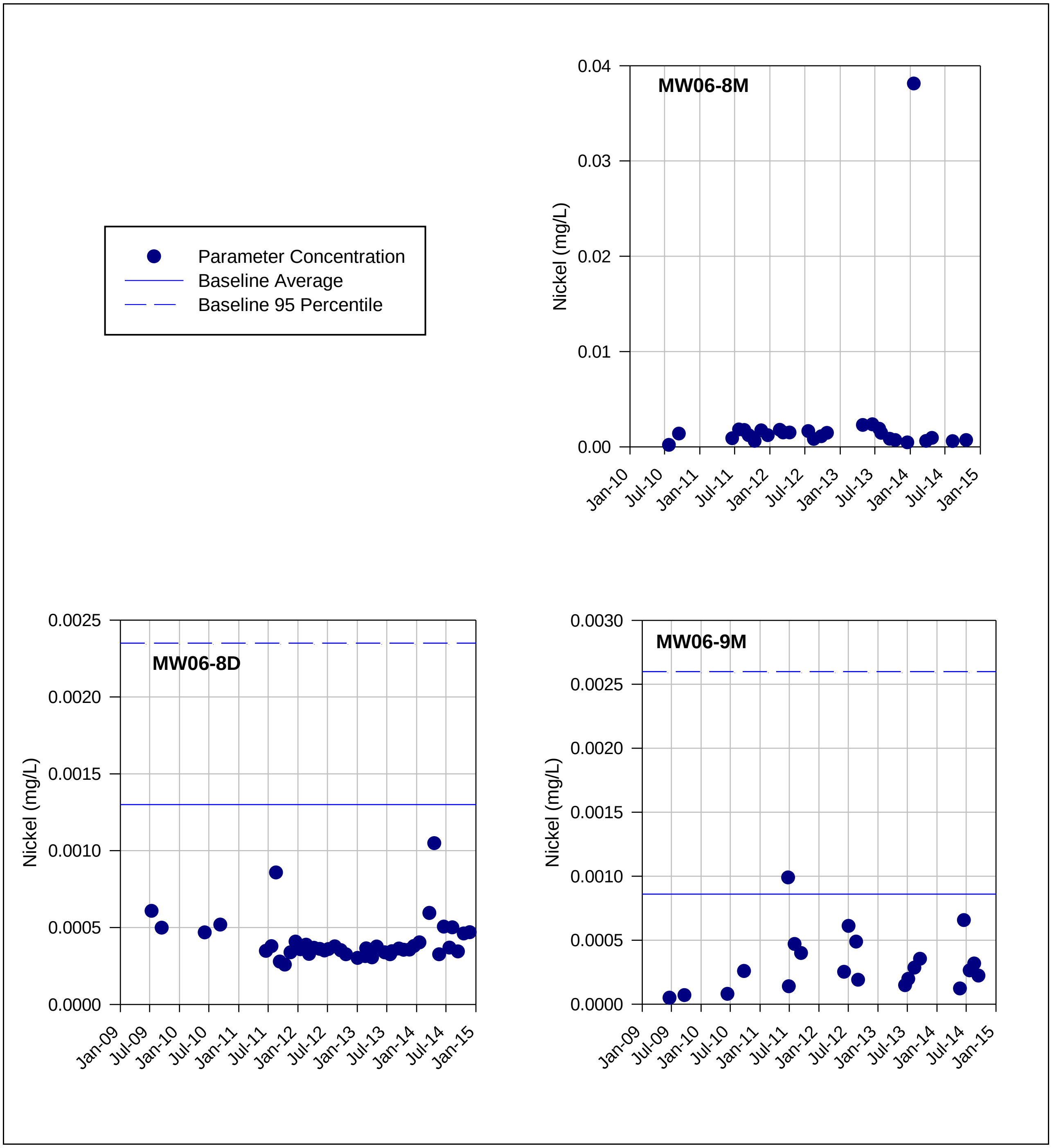


Figure 3-2: **Iron Concentrations in Wolverine Creek Shallow Bedrock Groundwater Stations, Jan 2009 – Dec 2014**

3.2.3 Wolverine Creek – Deep Bedrock Groundwater Wells

Deep bedrock groundwater wells in the Wolverine Creek drainage include wells MW06-8M, MW06-8D, MW06-9M, MW06-10M and MW06-10D. Monitoring well MW06-8M was improperly installed in 2006, hence had to be re-drilled in 2008. Consequently there is no baseline average or 95th percentile to compare with the 2009-2012 results. Overall the results at the deep bedrock wells are comparable to the average results, although some parameters are typically higher than the average (e.g., iron and arsenic) while the others are well below (i.e., nickel and selenium) as shown for nickel in Figure 3-3.



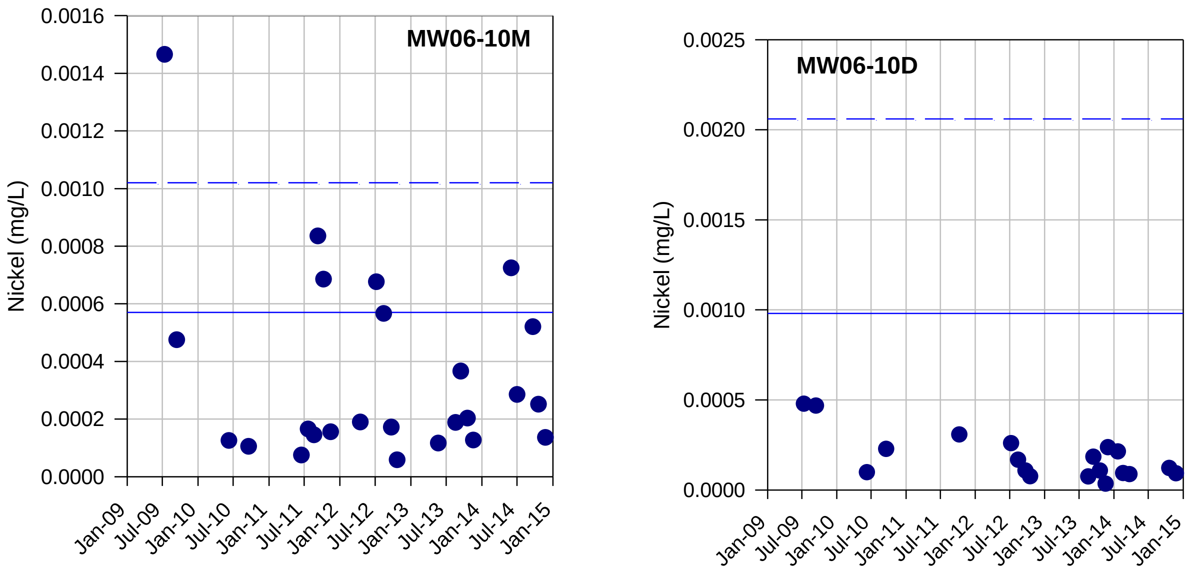
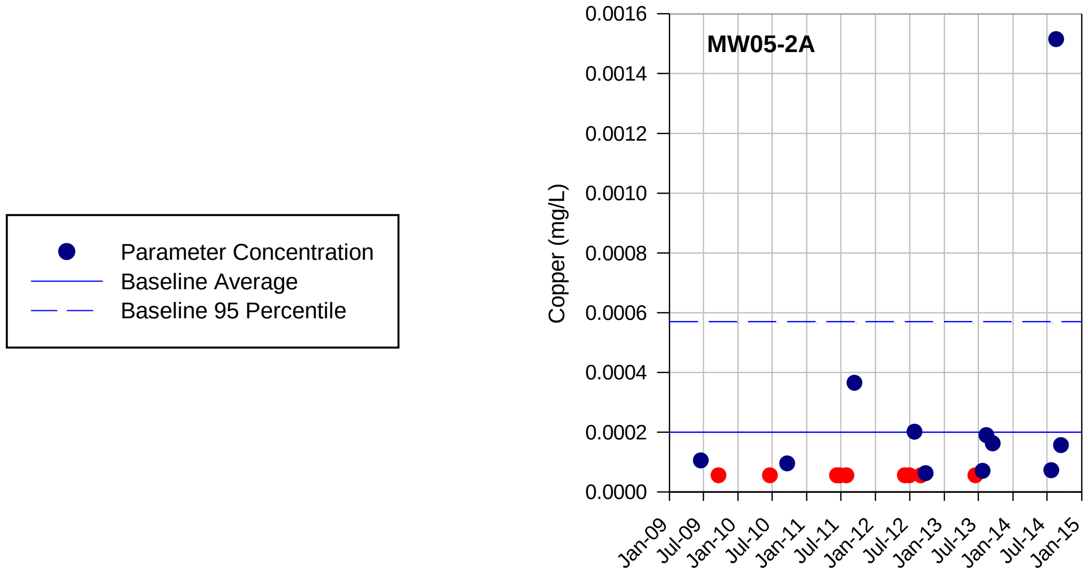


Figure 3-3: **Nickel Concentrations in Wolverine Creek Deep Bedrock Groundwater Stations, Jan 2009 – Dec 2014**

3.2.4 Tailings Storage Facility – Alluvial and Shallow Bedrock Groundwater Wells

There are four groundwater monitoring wells downslope of the tailings impoundment: MW05-2A (shallow bedrock), MW05-2B, MW05-7B and MW08-13 (alluvial) and one monitoring well upslope (MW08-14 – shallow bedrock). Monitoring wells 13 and 14 weren't installed until 2008; hence there is no baseline average or 95th percentile to compare with the 2009-2014 results. Monitoring well 14 was discontinued during late fall 2011 due to its proximity to the construction of the new waste rock pad, and was terminated during the construction of the Stage 2 tailings dam. Generally the results are similar to the baseline average results, as shown for copper in Figure 3-4. Chromium and selenium concentrations were frequently less than the reportable detection limit (Appendix B). There were no noticeable differences in metal concentrations from the groundwater wells upslope and downslope of the tailings storage facility.



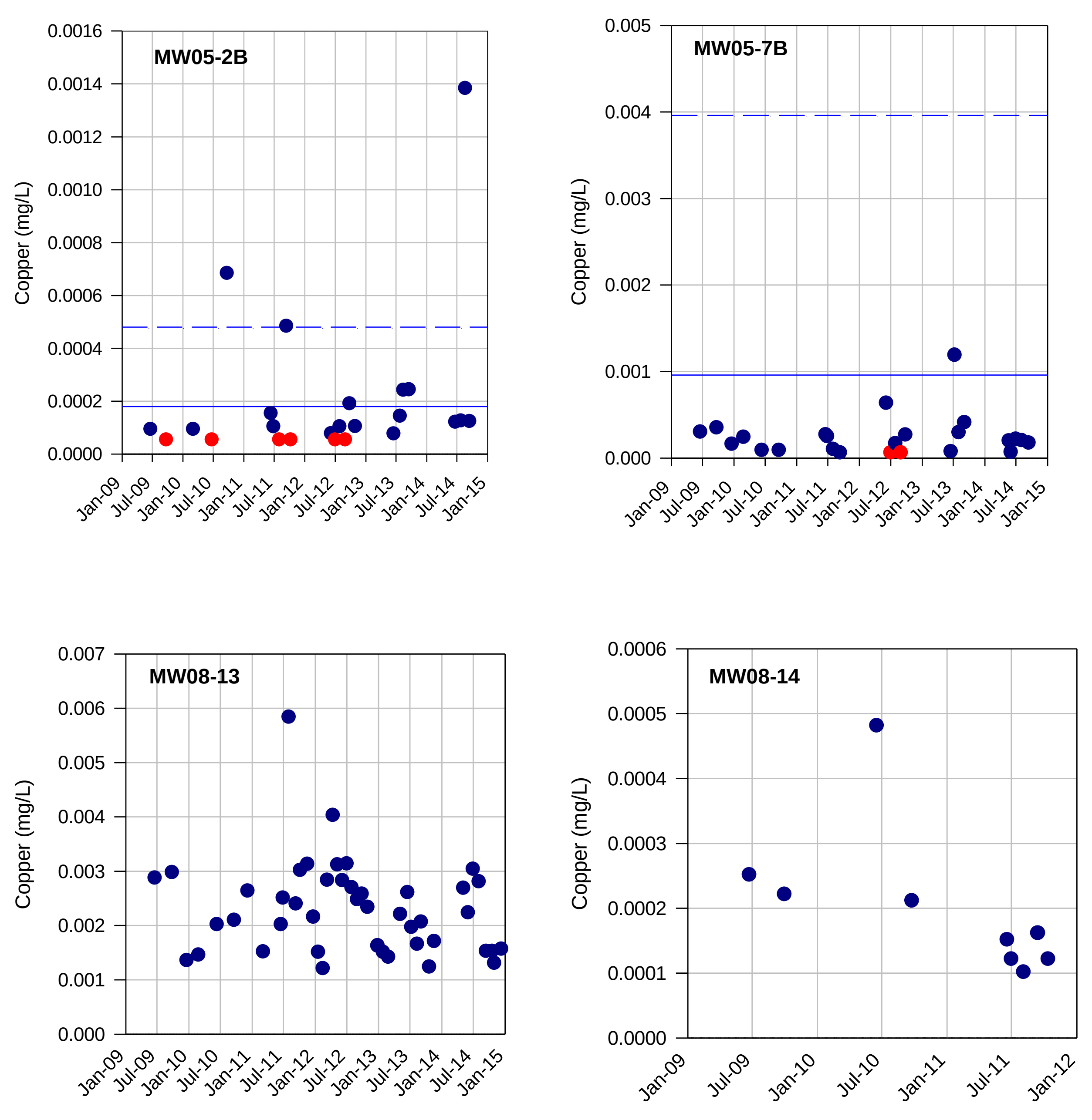
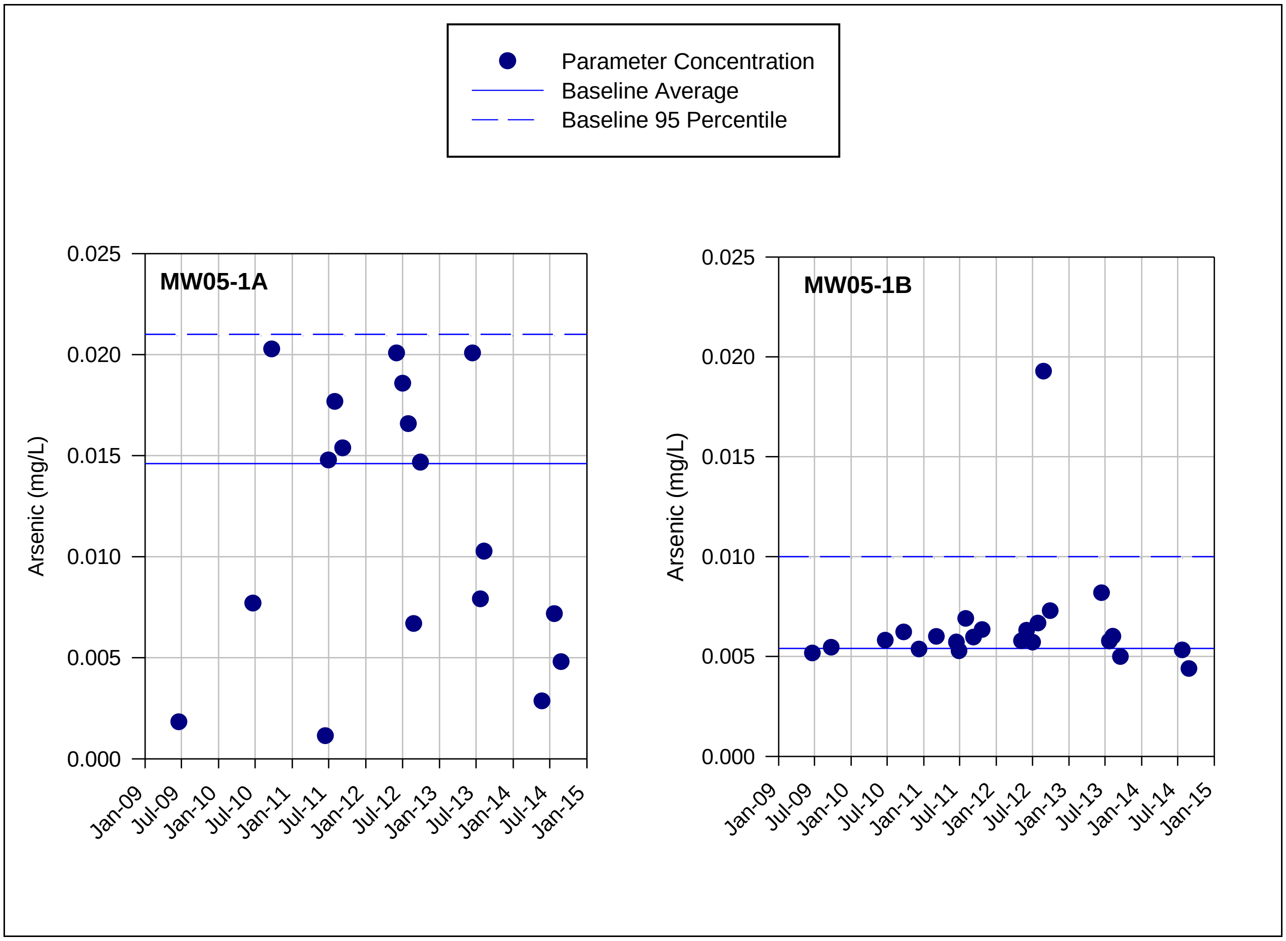


Figure 3-4: Copper Concentrations in Groundwater Stations near Tailings Storage Facility, Jan 2009 – Dec 2014

3.2.5 Go Creek – Shallow Bedrock and Alluvial Groundwater Wells

Concentrations in the groundwater from the shallow bedrock (MW05-1A and MW05-6A) and alluvial (MW05-1B and MW05-6B) groundwater wells in the Go Creek drainage demonstrated trends that were generally similar to baseline average concentrations. MW05-1B, MW05-6A, MW05-6B all had ammonia concentrations where the majority of points between 2009 – 2014 were higher than the baseline 95th percentile values. MW05-6A also had arsenic and iron concentrations in 2009 - 2014 there were almost all higher than the baseline 95th percentile values, as shown for arsenic in Figure 3-5.



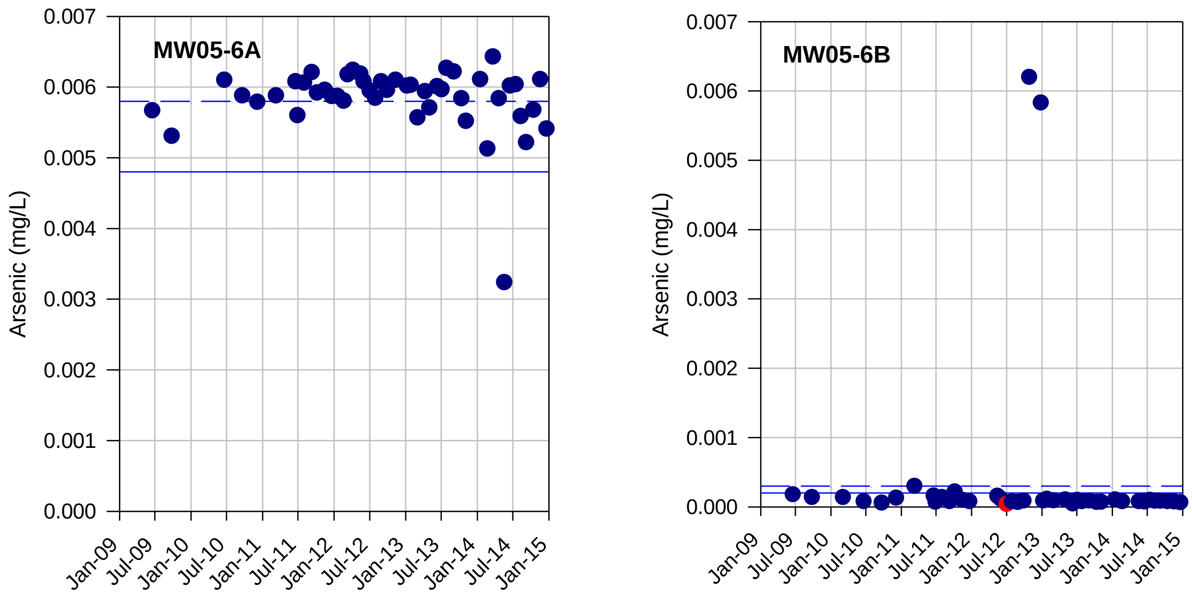
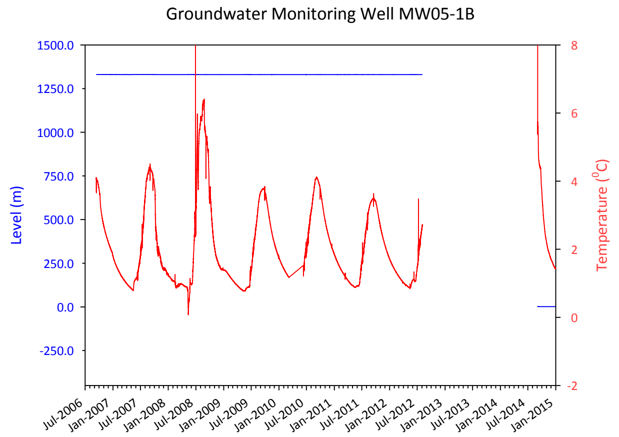


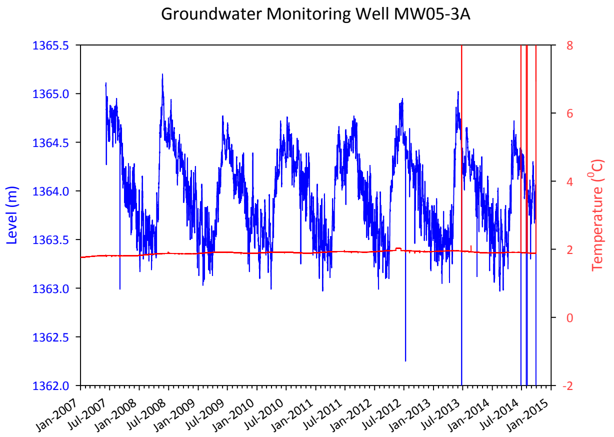
Figure 3-5: **Arsenic Concentrations in Go Creek Alluvial and Shallow Bedrock Groundwater Stations, Jan 2009 – Dec 2014**

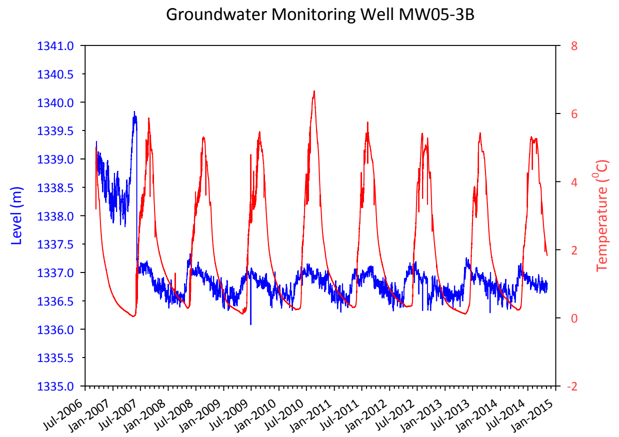
3.3 Groundwater Water Levels and Temperatures

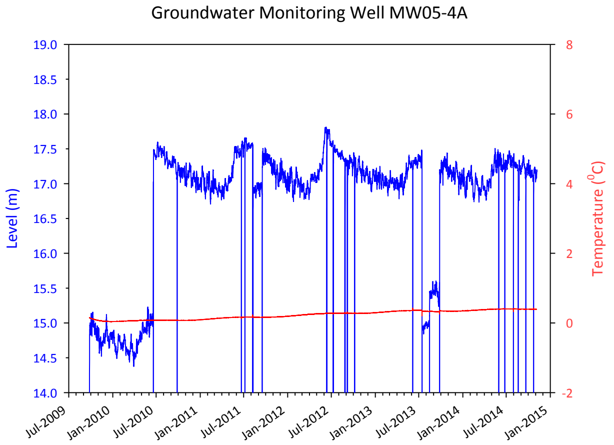
Figure 3-6 provides graphical representations of the water levels and water temperatures in the various groundwater wells. The majority of the wells commenced logging in September 2006; although wells MW05-4A and MW05-4B were decommissioned during construction in 2008, and replaced in the same location in 2009. These wells are not calibrated to reflect depth above sea level (asl), but are instead recording the depth of the water above the logger installation. Loggers are not installed in monitoring wells MW05-6A, MW05-6B, MW05-7B. The logger was removed from well MW08-14 in September 2011, as the well was decommissioned to allow for construction of the waste rock pad in 2011, and construction of the tailings dam raise in 2012; hence the data has not been presented below. There are also no loggers in wells MW05-2A, MW05-2B, MW05-1A and MW05-9M as they are artesian wells, and have a consistent water level of 0 m above ground level. Data for well MW06-9S is only presented up to the end of March 2012, as the logger data was inconsistent after March 27, 2012. This logger was removed for repair and recently re-installed. Loggers were also removed in late 2012 from wells MW05-1B, MW06-10M, and MW06-12S due to water damage. Loggers were replaced and re-installed in MW06-10M and MW06-12S, fall and spring 2013 respectively. While MW05-1B was installed in the fall of 2014.

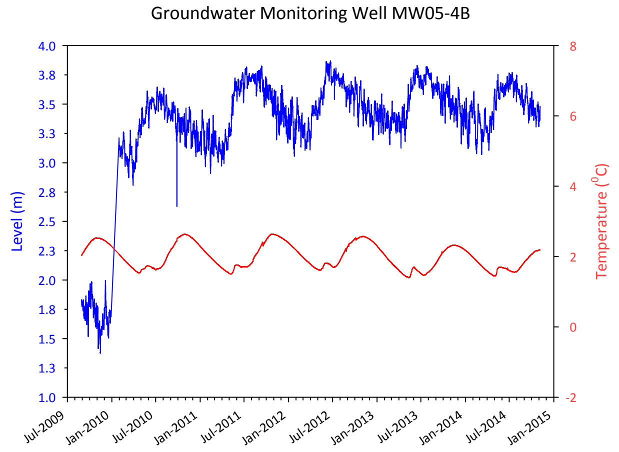
The short lived spike lines in the graphs correspond to sampling periods, when the water levels decrease drastically and the temperatures increase. In general, the water levels increase each year around May/June, and decrease to the lowest seasonal levels in March/April. The water temperatures are highest around July/August, and lowest around December/January. Annual water levels in the various monitoring wells have remained relatively constant over the monitoring period.

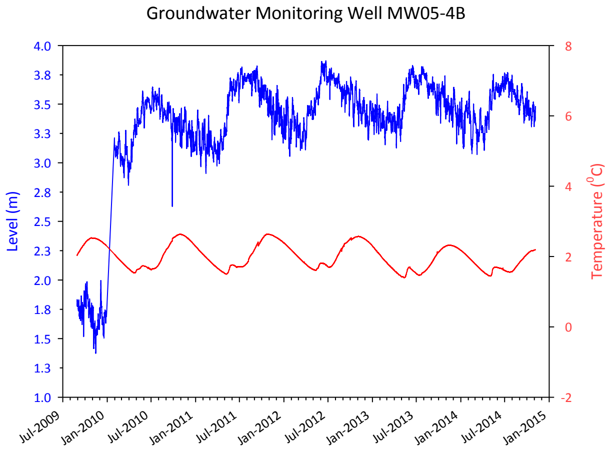

Groundwater Monitoring Well MW05-1B


Groundwater Monitoring Well MW05-3A

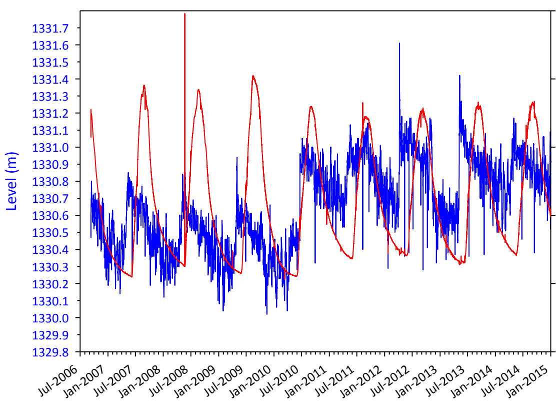

Groundwater Monitoring Well MW05-3B


Groundwater Monitoring Well MW05-4A

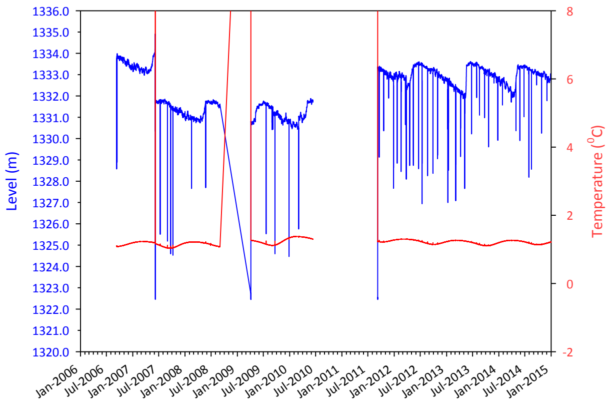

Groundwater Monitoring Well MW05-4B


Groundwater Monitoring Well MW05-4B

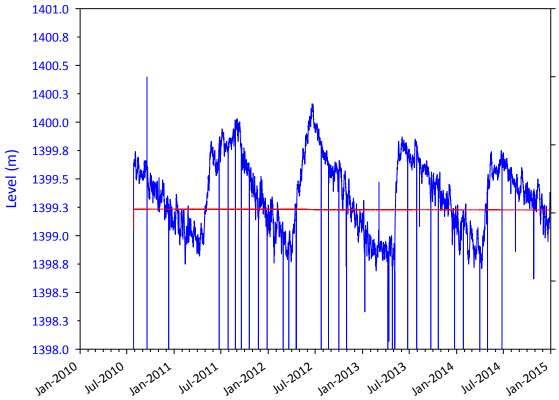
Groundwater Monitoring Well MW05-5B



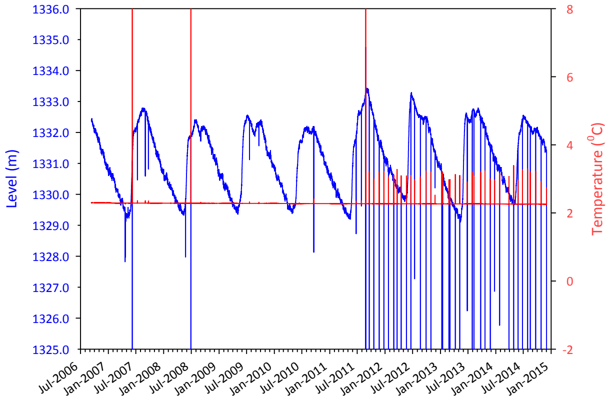
Groundwater Monitoring Well MW06-8S



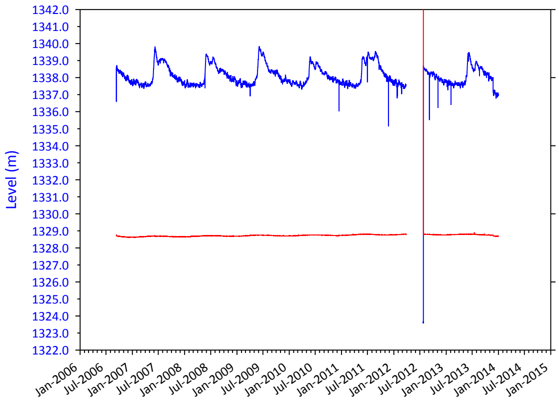
Groundwater Monitoring Well MW06-8M



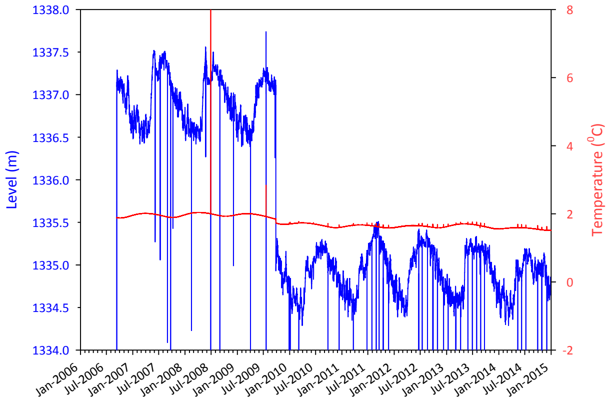
Groundwater Monitoring Well MW06-8D



Groundwater Monitoring Well MW06-9S



Groundwater Monitoring Well MW06-10S



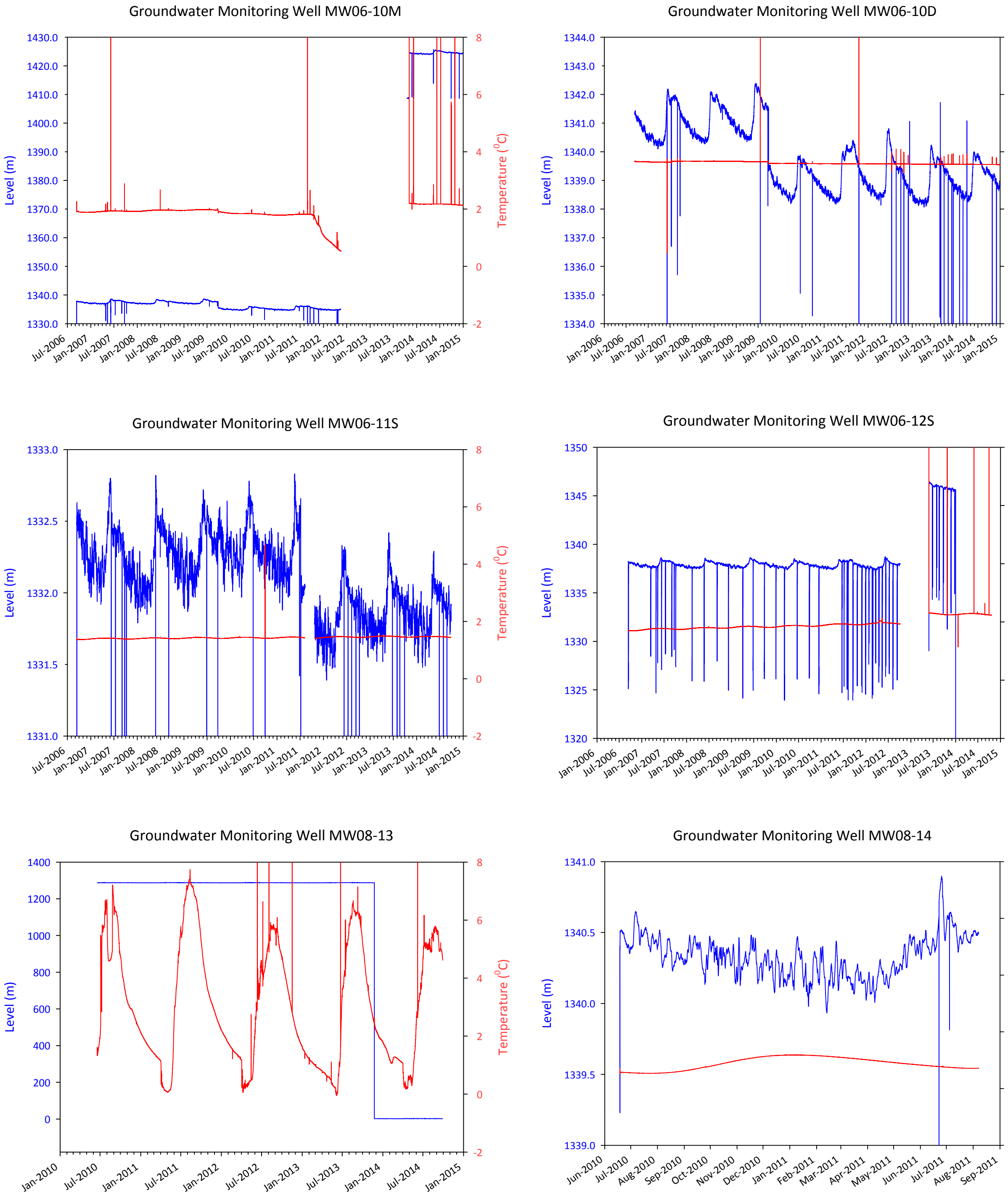


Figure 3-6: Groundwater Monitoring Wells Water Level and Temperature

3.4 Piezometer Monitoring

Four vibrating wire piezometers are installed at two locations (PZA and PZB) above the underground mine. The piezometers measure the water table above the mine and results reveal the effect of underground mining on the water table. Both locations have one shallow and one deep piezometer, and the results for 2005 to 2014 are provided in Figure 3-7. There is no precipitation data prior to the installation of the weather station in late 2007. Battery failure of the piezometers in 2009 resulted in gaps in the data. A malfunction was discovered with the PZA Deep sensor and data is corrupted after June 26th, 2014 which has resulted in a gap in the data. This is still currently under investigation and possible repair.

The average elevations for the annual monitoring periods are presented in Figure 3-8. The shallow PZA and PZB wells showed a slight decrease in average elevation between 2007-2013. However, the deep PZA and PZB wells showed a marked decrease from 2009 (i.e., 50 m lower), which may be attributed to an intersection of the mining operations with the well, as noted by the mining personnel. PZB Deep showed a steady decline from 2008 to 2013, down 53 m, markedly decreasing in 2009 and 2013 (18 m and 20 m respectively). PZA Deep shows the most significant decline of the four piezometers since 2008, down 110 m. The majority of this decline occurred during 2010 and 2011. During 2014 the data for all the wells, except for PZA Shallow, show a significant shift in water table readings and suggest potential damage or disruption to the equipment. The mine operations were heavily focussed in this area during 2014 and further investigation into the equipment and mining records will be conducted to determine fault. Water level increases are seen shortly after summer rain events, even in the deep well installations.

Overall the underground development (started in September 2009) seems to have had a significant overall effect on the lower (or deep) aquifers, with little to no effect on the upper (or shallow) aquifers.

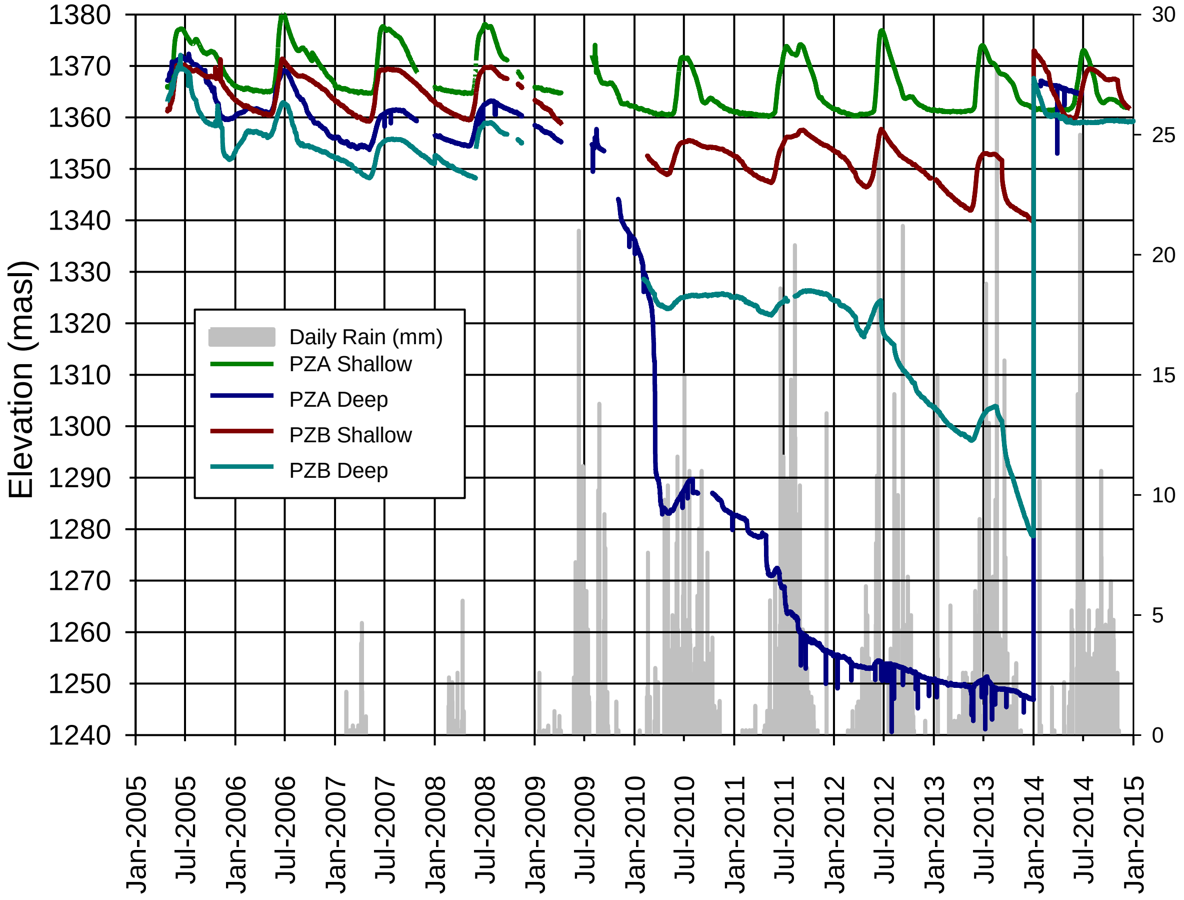


Figure 3-7 2005-2014 Pieziometric and 2007-2014 Precipitation Data

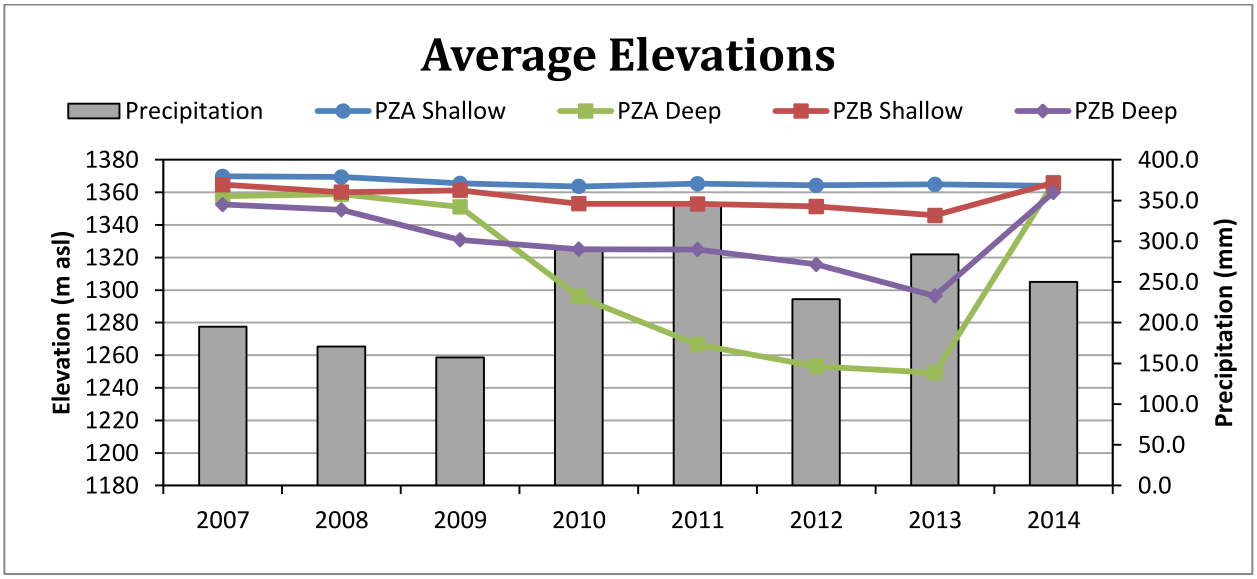


Figure 3-8: Average Pieziometric Elevation Data

4 Aquatic Life and Sediment

Monitoring requirements for stream periphyton, benthic invertebrates, water, and sediment quality are outlined in the *Environmental Effects Monitoring First Study Design*, provided in V2011-03 of the Monitoring and Surveillance Plan. Benthos and water quality were sampled in September 2011, and were conducted again in 2014.

Benthos, and water quality were all sampled in September 2014 at stations W12, W16 (exposure sites), W13 and W76 (reference sites). Results of these analyses were provided to Environment Canada in the *Metal Mining Effluent Regulations Environmental Effects Monitoring: Second Interpretive Report*, as required by the *Metal Mining Effluent Regulations* on December 5, 2014, provided in Appendix C. Appendices have been omitted from the *Second Interpretive Report*, but are available upon request.

The *First Interpretive Report* summarized the benthic community and water quality results, in addition to a detailed Site characterization. The *Second Interpretive Report* characterized and compared data collected to the details obtained in 2011, as presented in the following sections. The Tailings Facility has yet to discharge effluent; therefore, the 2011 and 2014 results should be viewed as detailed baseline analyses. The study design for the *Second Interpretive Report* followed very closely the approach used for the 2011 study, focussing on benthic invertebrates and ongoing site characterization presented in 2011.

4.1 Sediment Quality

Sediment quality samples were not collected during the study in September 2014; however, annual soil samples taken in two of the study locations (W12 and W16) in September 2013 were analyzed for total metals and the results are summarized in Table 4-1. They are compared to the average and 95th percentile values presented in the *Baseline Report*. Bold values indicate a parameter value was greater than the average baseline value for that parameter. In general, the values achieved in 2011 were within the bounds of the average and 95th values summarized in the *Baseline Report*, with the majority of parameters having values less than the average baseline value.

Table 4-1: 2013 Sediment Quality Results

Sample ID		**Station W12**					**Station W16**				
				A	**B**	**C**			**A**	**B**	**C**
Sample Date		**AVG**	**95th Percentile**	**11-Sep-13**	**11-Sep-13**	**11-Sep-13**	**AVG**	**95th Percentile**	**11-Sep-13**	**11-Sep-13**	**11-Sep-13**
Physical Properties											
Soluble (2:1) pH	pH Units	7.62	7.84	7.79	**7.85**	7.22	7.45	7.48	7.47	7.39	7.48
Total Metals by ICPMS											
Total Aluminum (Al)	mg/kg	10993	11750	9880	**11800**	11300	16367	17650	**17800**	16300	15000
Total Antimony (Sb)	mg/kg	0.29	0.33	0.25	0.29	0.33	0.14	0.17	0.12	0.12	**0.18**
Total Arsenic (As)	mg/kg	6.11	6.63	5.95	5.67	**6.7**	2.56	3.14	2.61	1.88	**3.2**
Total Barium (Ba)	mg/kg	148	167	116	**168**	161	85.2	113.4	72.1	65.4	**118**
Total Beryllium (Be)	mg/kg	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Total Bismuth (Bi)	mg/kg	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total Cadmium (Cd)	mg/kg	0.773	0.807	0.734	**0.811**	0.775	0.722	0.817	0.67	0.664	**0.833**
Total Calcium (Ca)	mg/kg	3343	3523	3040	**3530**	3460	5250	5454	5400	**5460**	4890
Total Chromium (Cr)	mg/kg	30.4	35.5	23.2	32.2	**35.9**	63.6	68.0	**68.6**	62.8	59.5
Total Cobalt (Co)	mg/kg	10.6	11.2	9.95	**11.3**	10.5	20.4	21.8	**22**	19.9	19.3
Total Copper (Cu)	mg/kg	23.7	25.8	20.9	24.3	**26**	27.5	30.5	26	25.6	**31**
Total Iron (Fe)	mg/kg	22367	23780	20500	**23900**	22700	29400	29890	**29900**	29800	28500
Total Lead (Pb)	mg/kg	9.42	12.58	**13.1**	7.3	7.86	2.37	2.55	2.26	2.28	**2.58**
Total Magnesium (Mg)	mg/kg	6717	7377	5660	**7410**	7080	14400	15170	14000	**15300**	13900
Total Manganese (Mn)	mg/kg	1260	1365	1230	**1380**	1170	976	1254	787	842	**1300**
Total Mercury (Hg)	mg/kg	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Total Molybdenum (Mo)	mg/kg	0.73	0.83	0.65	**0.84**	0.69	0.69	1.26	0.4	0.33	**1.35**
Total Nickel (Ni)	mg/kg	27.6	30.1	23.7	**30.2**	29	41.4	42.8	40.6	40.7	**43**
Total Phosphorus (P)	mg/kg	716	832	**845**	719	585	723	765	713	684	**771**
Total Potassium (K)	mg/kg	434	469	409	420	**474**	271	302	**305**	279	228
Total Selenium (Se)	mg/kg	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Total Silver (Ag)	mg/kg	0.064	0.080	0.05	0.061	**0.082**	0.05	0.05	0.05	0.05	0.05
Total Sodium (Na)	mg/kg	100	100	100	100	100	100	100	100	100	100
Total Strontium (Sr)	mg/kg	13.6	15.2	11.9	**15.4**	13.4	12.0	12.8	10.9	12.3	**12.9**
Total Thallium (Tl)	mg/kg	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Total Tin (Sn)	mg/kg	0.14	0.16	0.13	0.12	**0.16**	0.14	0.17	0.17	0.12	0.12
Total Titanium (Ti)	mg/kg	727	854	493	**857**	830	2123	2425	2110	**2460**	1800
Total Vanadium (V)	mg/kg	28.5	29.9	25.7	29.8	**29.9**	48.5	50.2	47.9	**50.5**	47
Total Zinc (Zn)	mg/kg	93.6	96.2	93	**96.6**	91.3	104.6	112.0	103	97.7	**113**
Total Zirconium (Zr)	mg/kg	1.88	2.39	1.54	**2.48**	1.62	1.37	1.70	1.38	1.7	1.01

4.2 Periphyton

Periphyton samples were not sampled in 2014 due to time restrictions and financial constraints. However, a sampling program can be completed in 2015, with comparisons made with 2011 data.

4.3 Benthic Invertebrates

The 2014 benthic invertebrate sampling program was carried out in September. Samples were analyzed by Cordillera Consulting, and the full analysis of the results were prepared by PGL Consulting, as per Environmnetal Effects Monitoring (EEM) under the Metal Mine Effluent Regulations (MMER). The 2nd Interpretive Report was submitted to Environment Canada on December 14, 2014, and is available in Appendix C.

4.4 Fish Study – Exploratory Work

In 2014 there were no discharges from the Tailings Facility; subsequently, a fish population study or fish tissue study are not required under the MMER at this time. The last detailed fisheries work was conducted at Wolverine Mine site in 2005, so it was decided that exploratory work would be conducted in September 2014 to better understand species composition and abundance in exposure and potential reference areas for future study designs.

Extensive sampling in the exposure area: Go Creek, yielded one bull trout in 2014, reaffirming results from 2005 that while Go Creek is technically fish-bearing it has an extremely low abundance. Pup Creek and Bunker Creek were found to have somewhat representative habitats to those of Go Creek and were used as reference sites. No fish were captured in Bunker Creek in 2014. In comparison, 16 bull trout were captured in Pup Creek (82-109 mm fork length). These results were reported in the 2nd Interpretive Report, available in Appendix C.

5 Weather Monitoring Program

Weather monitoring at the Wolverine Mine consists of weather data, collected from an on-site weather station, and snow pack measurements, and the 2014 results of this monitoring program are summarized below.

5.1 Weather Station Data

Weather station data is collected from a HOBO Weather Station installed at the south end of the airstrip. Data collected from the weather station includes:

- Temperature;
- Pressure;
- Precipitation;
- Radiation in and out;
- Wind speed and direction; and
- Relative humidity.

During 2014, the weather station located at the airstrip stopped logging due to maximum data storage capacity being reached as a result of technician error. This resulted in several small gaps in the data history. In order to accurately depict site conditions during these month data from a second

HOBO Weather Station, located above the Tailings Facility, was incorporated for these time periods. The last three years have shown only slightly different weather conditions. 2011 was a very wet year with 346 mm of rain, while 2014 recorded 250 mm more comparable to the last two years of 229 mm (2012) and 284 mm (2013). Precipitation data was not recorded in 2012 from June 16th – July 18th due to weather station malfunction. However, daily weather descriptions recorded throughout that time period indicate it only rained on 7 days. In 2014, average temperatures were below freezing late October through April. In addition to a milder winter, 2014 also experienced a mild summer in comparison to 2013. Annual evaporation was average at 304 mm, in comparison to the previous three years: 357 mm (2013), 249 mm (2012), and 321 mm (2011). Overall, as shown in Figure 5-1, temperature and precipitation have been fairly similar at the Wolverine Mine since consistent recording started in 2007.

The daily average temperatures are presented in Figure 5-1. The mean monthly temperature for 2014 was -2.5 °C. Mean monthly temperatures were below freezing from January through April and October through December, and above freezing May through September. The minimum recorded temperature was -31.3°C and the maximum recorded temperature was 22.9 °C.

The monthly precipitation as rain for 2014 is presented in Figure 5-1. The HOBO weather station does not record precipitation that falls as snow, consequently only precipitation as rain is provided in Figure 5-1. In 2014, June was the wettest month during the summer with 64 mm. The annual cumulative precipitation recorded as rain was 250 mm.

Evaporation figures were estimated from the Penmann Combination Equation, and the monthly and annual values are shown in Figure 5-2. The total evaporation in 2014 was 304 mm, with July (58 mm) having the highest evaporation within a month for 2014.

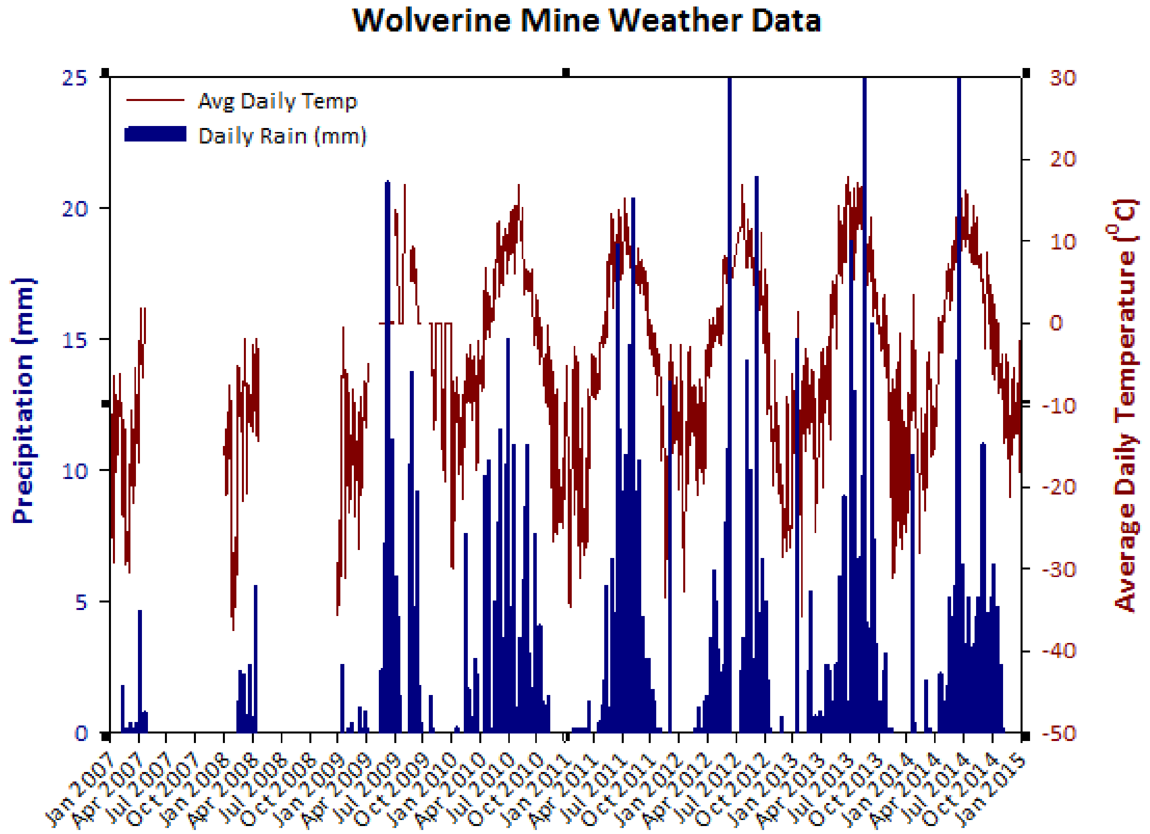


Figure 5-1: **Wolverine Mine Daily Precipitation and Average Daily Temperature 2007 - 2014**

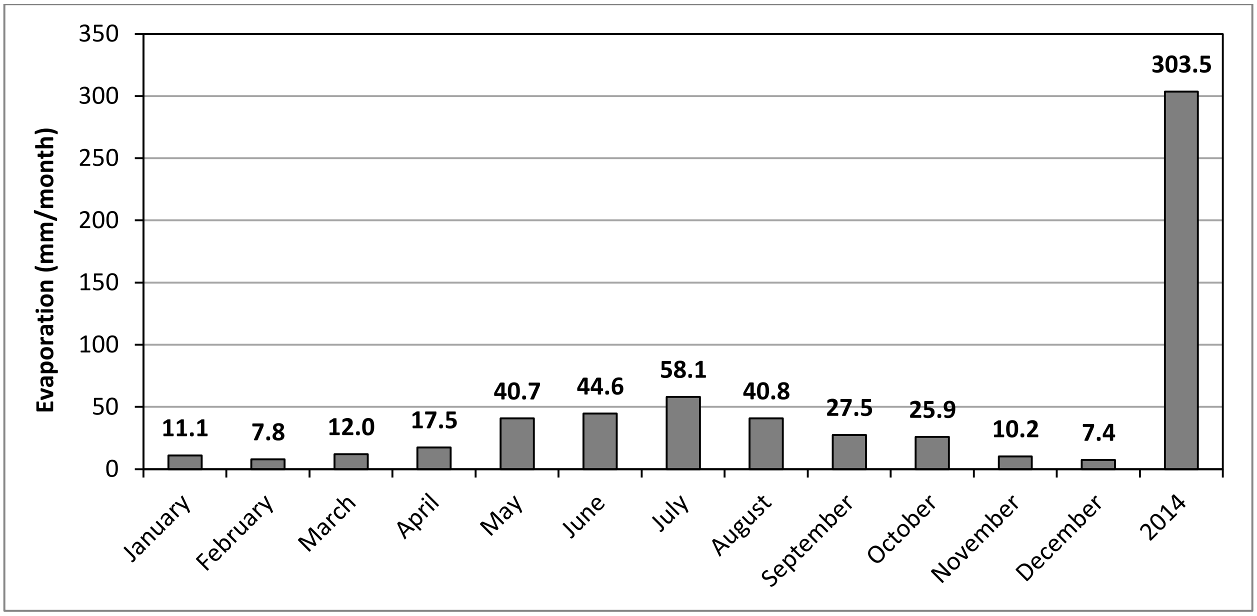


Figure 5-2: **2014 Monthly Evaporation**

5.2 Snow Water Equivalent

Snow pack measurements were conducted in March and April 2014 at two locations: above the powder magazine road and KM 25.5. Each site was measured once. The 2014 sample results indicate an average snow-water equivalent (SWE) of 229 mm with a density of 26%. To display the variability in snow-water equivalent for the site over the last five years, average snow-water equivalent and average density measured around the mine site for 2010-2014 are shown in Table 5-1.

Table 5-1 Average Snow-Water Equivalent and Average Density for Wolverine Mine 2010-2014

Year	Average SWE	Average Density	# of Surveys
2010	199	22	4
2011	205	23	7
2012	225	25	2
2013	279	29	6
2014	229	26	2

Table 5-2: Snow Pack Measurements – March and April 2014

Station:		Powder Mag Road		KM25.5			All Sites - Averages	
Sampling Date:		12-Mar-14		01-Apr-14				
		Total	Average	Total	Average		Total	Average
Snow Depth	(cm)	990.0	82.5	952.0	95.2		971	89
Core Length	(cm)	698.0	58.2	803.0	80.3		751	69
Core Length by Snow Depth	(%)	845.9	70.5	844.1	84.4		845	77
Weight Tube b/f sampling	(g)	22.3	2.0	20.2	2.0		21	2
Weight Tube & Core	(g)	24.8	2.3	22.8	2.3		24	2
SWE	(mm)	2440.0	203.3	2540.0	254.0		2490	229
Density	(%)	294.4	24.5	266.2	26.6		280	26

6 Tailings Storage Facility Monitoring

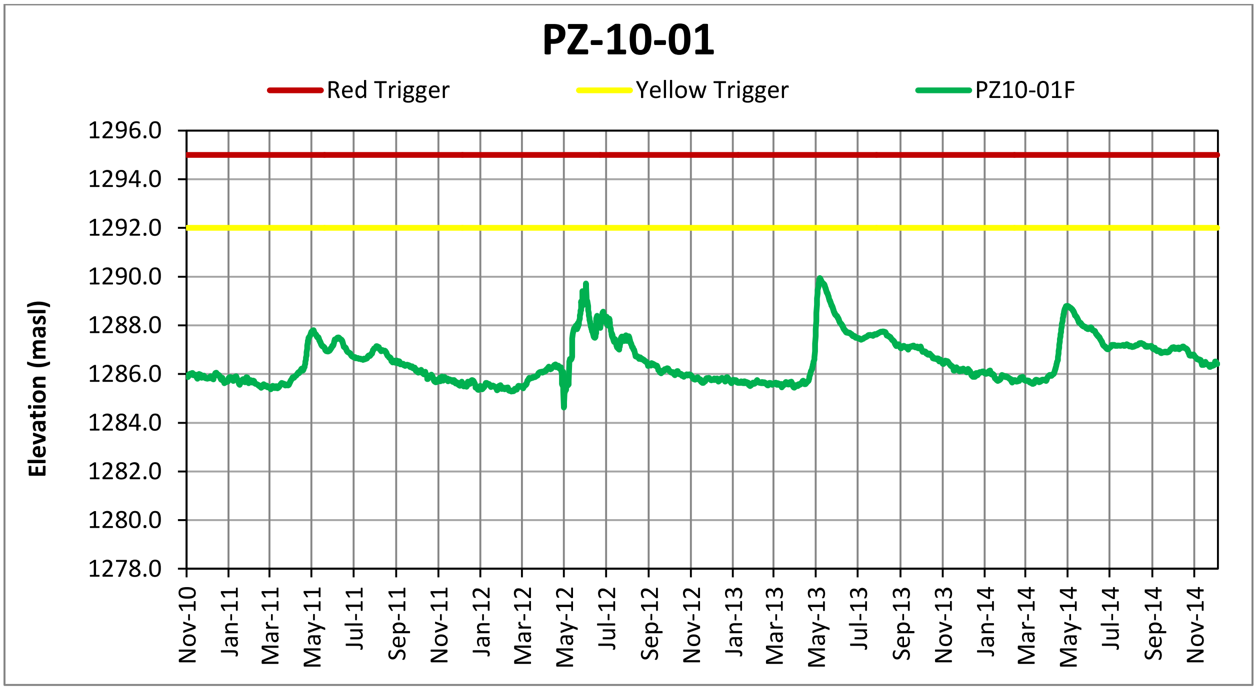
Monitoring of the tailings storage facility is carried out during operations according to the *Tailings Facility Operation, Maintenance and Surveillance Manual V2011-01* (approved August 12, 2010). Monitoring requirements for the tailings facility are summarized in Table 6-1. Routine inspections were carried out weekly and monthly to summarize the flows in and out of the facility. The forms are kept on-site for reference. On August 1st, 2014 a bathymetry of the pond was conducted to get a more accurate estimate tailings volume to water volume ratio. The bathymetry resulted in an estimated tailings volume of 489,600 m3 (up from a total of 371,778 m3 when measured on August 31st, 2013) translating to 407,300 m3 (up from 339,262 m3 when measured on August 31st, 2013) of water based on the total surveyed volume of 896,900 m3 (up from 711,040 m3 when measured on August 31st, 2013).

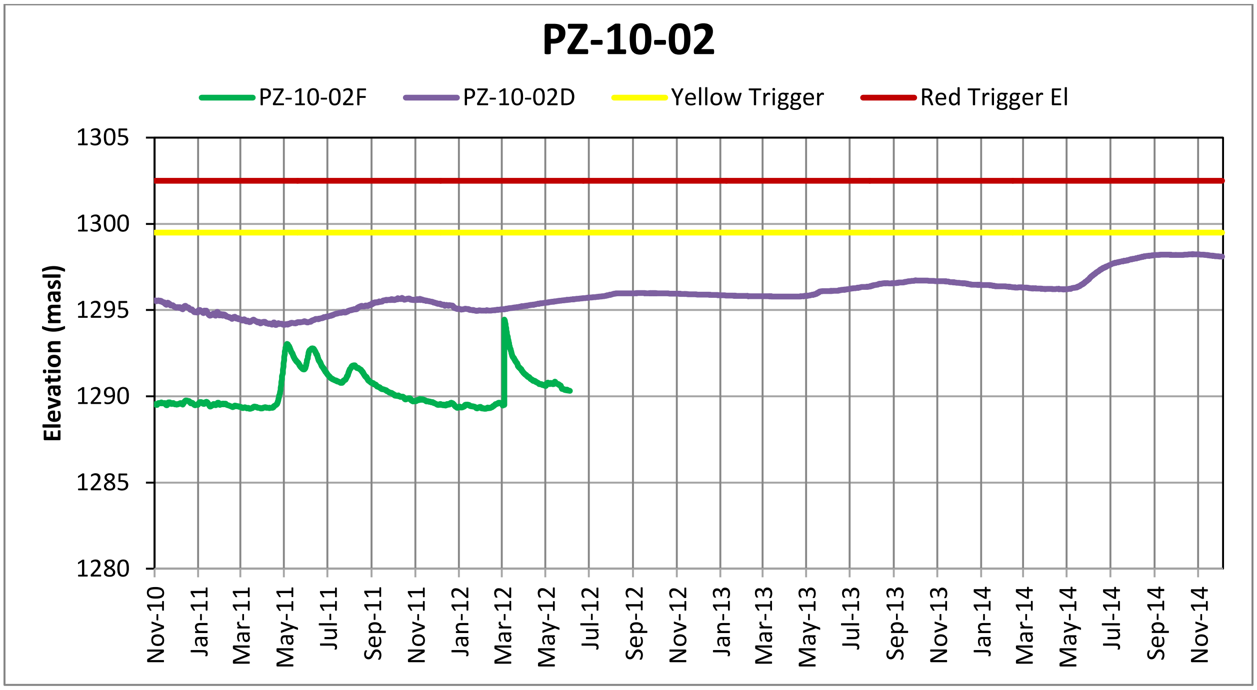
Instrumentation (e.g., piezometers and inclinometers casing) was installed in the dam in September 2010 and sensor locations were maintained during the completion of the Tailings Storage Facility Stage 2 Dam Raise tailings dam in September 2012. Piezometers at the tailings dam are downloaded monthly, and produce potentiometric measurements of the water in the dam and dam foundation. The results are compared to yellow and red triggers (provided by dam design engineers Klohn Crippen Berger) to ensure the water levels are not nearing elevations where they may cause issues in dam stability. The results of the 2014 downloads are provided in Figure 6-1. It was noted that piezometer PZ-10-03D hit the 'yellow-trigger' in August of 2012. However, this increase is atypical for that time in the year, and is thought to be associated with the tailings dam raise construction activities (e.g., extension of the piezometers to new elevation) being conducted during that period. This is substantiated by steady elevations throughout the remainder of 2012 and 2013 for this piezometer. Corrupted data was discovered for piezometer PZ-10-02F after July 2012. Further investigations into the cause of this malfunction indicate potential damage to the sensor during construction or failure; therefore, the logger was removed from use.

Inclinometers (IN10-01 and IN10-02) were monitored in June, July and September 2011 but monitoring was cancelled during 2012, due to the tailings dam construction project. Results indicate strong consistency between readings, which is important for the identification of potential movement in the dam. After the tailings construction was complete and the casing for the inclinometers extended, monitoring was re-established in May 2013. IN10-02 casing had been damaged too severely during construction and was decommissioned, while IN10-01 was still considered viable. Results for 2013 and early 2014, between 12m and 20m depths below the surface, continue to indicate a strong consistency between readings. However, some variability occurred in the data around the 8m and 12m depths. This is believed to be a result of damage to the casing during construction. Physical resistance was apparent at these two depths when inserting and removing the sensor when monitoring. This was further confirmed in April 2014 when the casing became no longer viable and was decommissioned to prevent sensor damage. During 2015, the placement of an accel array will allow for the re-establishment of monitoring at these locations.

Table 6-1 Surveillance Requirements for the Tailings Storage Facility

Surveillance	Frequency
Routine Inspection	
Dam and Liner	Min. Weekly
Diversion ditches	Min. Weekly
Seepage collection system	Min. Weekly
Spillways	Min. Weekly
Pipelines	Min. Weekly
Annual Inspection	Annually
Event Driven Inspection	Following unusual event
Comprehensive Review	Every 7 years & prior to decommissioning
Tailings Pond Monitoring	
Inflows, Outflows, Condition	Monthly
Topography	Annually
Bathymetry	Annually
Instrumentation	Monthly




PZ-10-02
PZ-10-02F
PZ-10-02D
Yellow Trigger
Red Trigger El
Elevation (masl)
1305
1300
1295
1290
1285
1280
Nov-10
Jan-11
Mar-11
May-11
Jul-11
Sep-11
Nov-11
Jan-12
Mar-12
May-12
Jul-12
Sep-12
Nov-12
Jan-13
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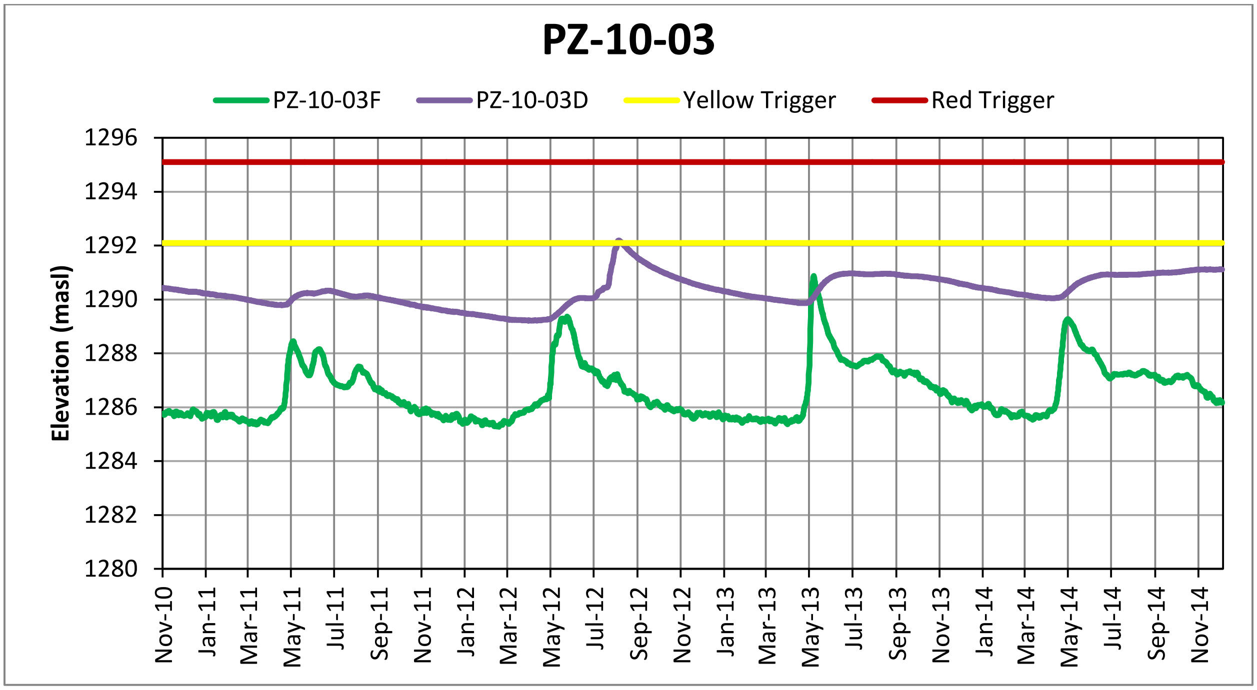
May-14
Jul-14
Sep-14
Nov-14


PZ-10-03
PZ-10-03F
PZ-10-03D
Yellow Trigger
Red Trigger
Elevation (masl)
1296
1294
1292
1290
1288
1286
1284
1282
1280
Nov-10
Jan-11
Mar-11
May-11
Jul-11
Sep-11
Nov-11
Jan-12
Mar-12
May-12
Jul-12
Sep-12
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May-14
Jul-14
Sep-14
Nov-14

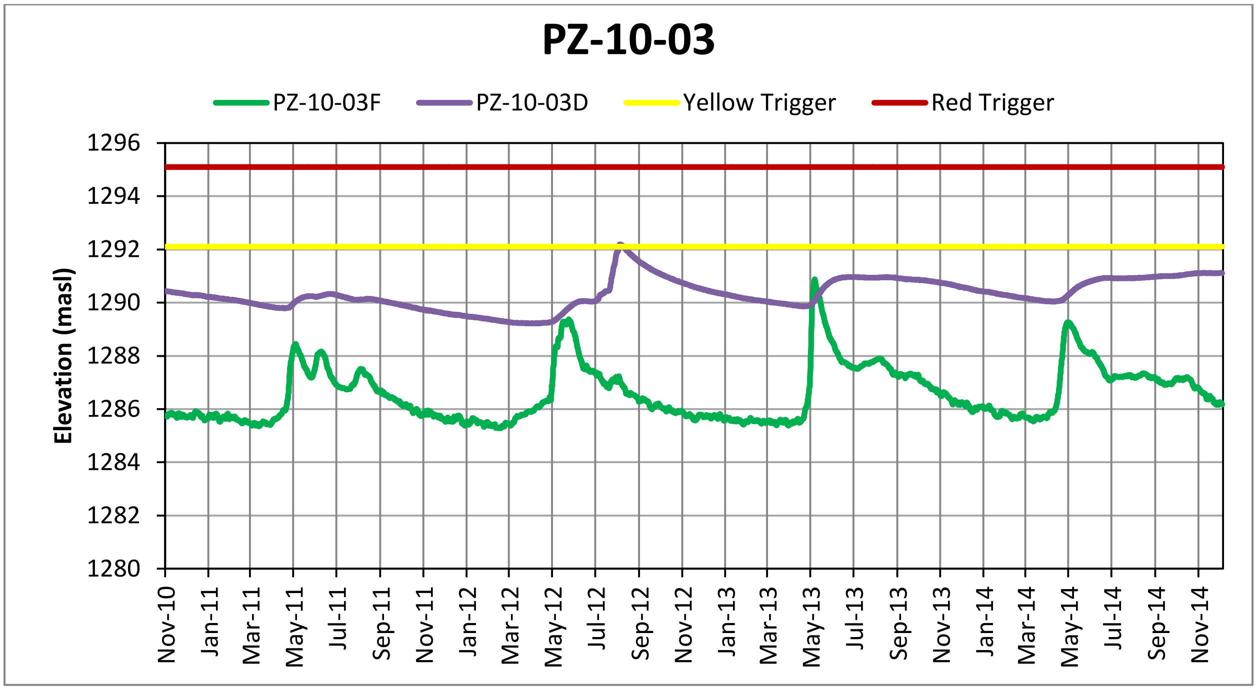


Figure 6-1: Tailings Facility 2014 Piezometer Results

7 Engineering Inspections

Three engineering inspections occurred in 2014 and subsequent reports were submitted to EMR. The inspections and respective reports are as follows:

- Woo Shin PEng. conducted an inspection of geotechnical aspects of the underground mine;
- EBA Engineering Consultants conducted an inspection of the structures at and around the industrial complex on July 24th & 25th, 2014; and
- Klohn Crippen Berger conducted a physical inspection of the Tailings Storage Facility.

The results of these inspections and the actions taken to date by YZC are summarized in the *Wolverine Mine QML-0006 2014 Annual Report*.

8 Progressive Reclamation Effectiveness Monitoring Program

No progressive reclamation effectiveness monitoring has been conducted in 2014. The program was submitted as an addendum to the *Reclamation and Closure Plan V2013-05* and will begin implementation in the fall of 2015.

9 Biopass System

Bench scale test work for the bio-pass system was completed in 2010, with the data analysis completed in early 2012. The results were compiled into a Master's of Science Thesis for Royal Roads University, and is available at http://dspace.royalroads.ca/docs/bitstream/handle/10170/500/mioska_mary.pdf.

Based on this research, recommendations have been advanced to further the design of a semi-passive treatment system. In collaboration with Yukon College, a study plan was developed and implemented with Dr. Amelie Janin (Industrial Research Chair) during 2013 and 2014. Further details on the Biopass Pilot Testing program can be found in the updated *Reclamation and Closure Plan V2013-05*.

10 Geochemical Testwork

Geochemical testwork at the Wolverine Mine was limited to humidity cell testwork, during construction. There were no construction activities in 2014, and no geochemical characterization samples were taken. These humidity cells have since been decommissioned. Humidity cells OA and OD were decommissioned February 3, 2012 and in April 2012 a request was sent to the Yukon Government Department of Energy, Mines and Resources to for approval to shut down the remaining seven operating cells. Approval to shut down the cells was received on May 11, 2012, and the cells were shut down in June 2012. The report summarizing the final results for these last seven decommissioned cells is provided in Appendix D (AMEC report) and Appendix E (MEA Report).

11 Underground Mine Monitoring

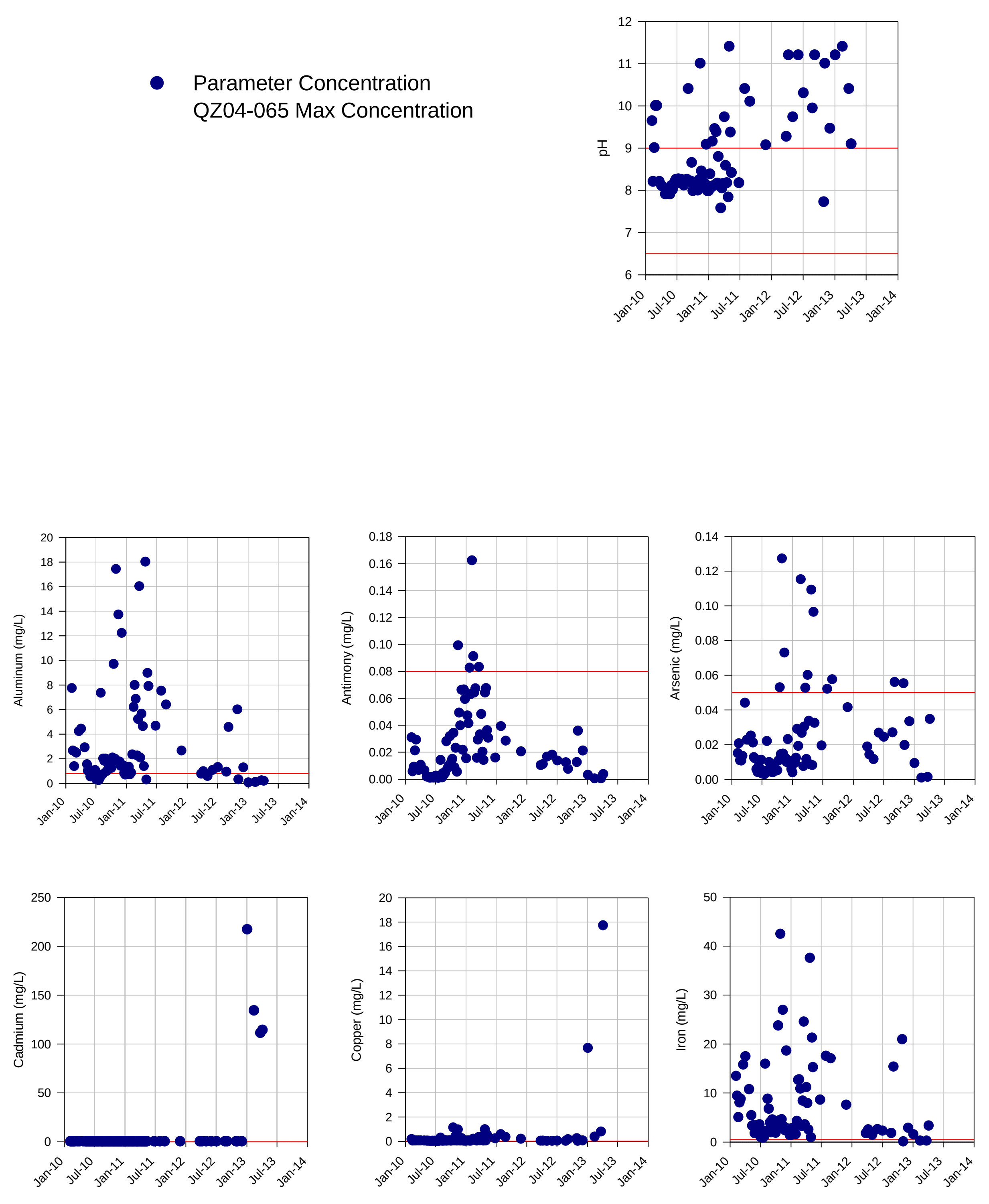
Underground mine monitoring in 2014 consisted of mostly water quality sampling and in-situ geochemical test pads. Paste and waste backfill placement underground continued in 2014. In total 138,120 cubic metre of underground space was filled with paste (95,253 cubic metre), cemented sand and waste in 2014. Establishment of wall wash stations were attempted in the underground in both 2013 and 2014 but due to the combination of high moisture content and poor ground conditions (shotcrete is on all walls), it was not achievable. The results of the water quality sampling and in-situ geochemical test pads are summarized below.

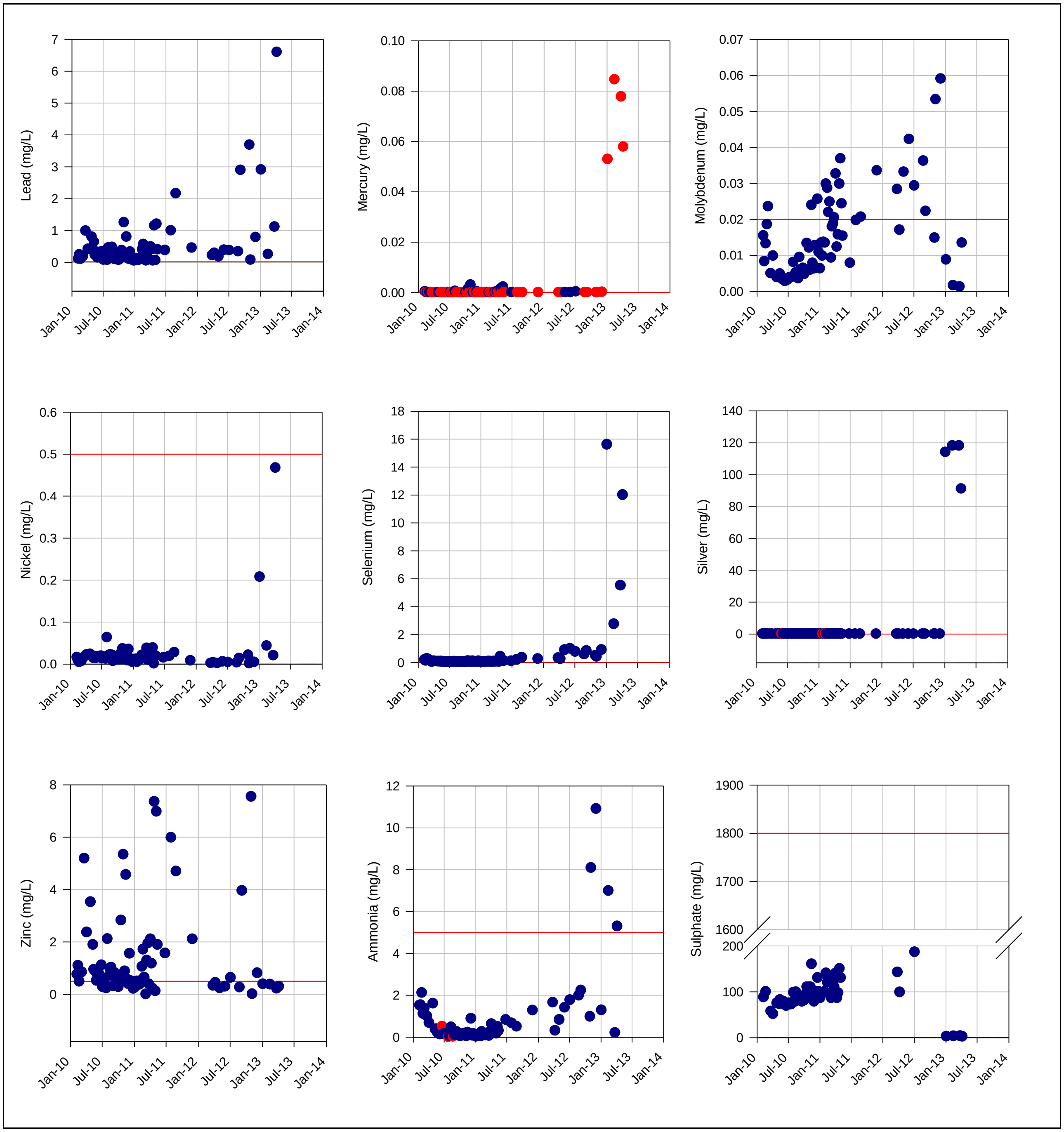
11.1 Underground Water Quality Sampling

Water quality samples were collected from the end of the pipeline that discharged underground effluent into settling Sump #2, until April 2013. Revisions in June 2011 to the operating phase of the *YZC Wolverine Mine Water Management and Treatment Plan* (December 2009), reflected the operational changes to the majority of water management and treatment infrastructure and mine waste infrastructure. Underground mine effluent is subsequently pumped to the tailings storage facility for storage, and monitored monthly with samples captured from the tailings storage facility (T1). As result, sampling for Underground Test Mine Discharge (UTMD) in Sump #2 was decommissioned.

The results are presented graphically below for parameters limited by Type A Water Use Licence QZ04-065 (Yukon Water Board, 2007), and are compared to the maximum allowable discharge concentrations, as outlined in Part C of Licence QZ04-065. Red symbols in the graphs represent concentrations that were less than the laboratory reportable detection limits, and were taken to be equal to the detection limit in the graphs. The full water quality results for the underground water quality is presented in the *Type B Water Use Licence QZ01-051 2011 Annual Report.*

Water quality in the underground effluent was typically higher than Type A Water Use Licence QZ04-065 discharge limits for total suspended solids, Al, Sb, As, Cd, Cu, Fe, Pb, Hg, Mo, Ag, Se, Zn as well as nitrite.


● Parameter Concentration
QZ04-065 Max Concentration
pH
Aluminum (mg/L)
Antimony (mg/L)
Arsenic (mg/L)
Cadmium (mg/L)
Copper (mg/L)
Iron (mg/L)
Jan-10
Jul-10
Jan-11
Jul-11
Jan-12
Jul-12
Jan-13
Jul-13
Jan-14


Lead (mg/L)
0
1
2
3
4
5
6
7
Mercury (mg/L)
0.00
0.02
0.04
0.06
0.08
0.10
Molybdenum (mg/L)
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
Nickel (mg/L)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
Selenium (mg/L)
0
2
4
6
8
10
12
14
16
18
Silver (mg/L)
0
20
40
60
80
100
120
140
Zinc (mg/L)
0
2
4
6
8
Ammonia (mg/L)
0
2
4
6
8
10
12
Sulphate (mg/L)
0
100
200
1600
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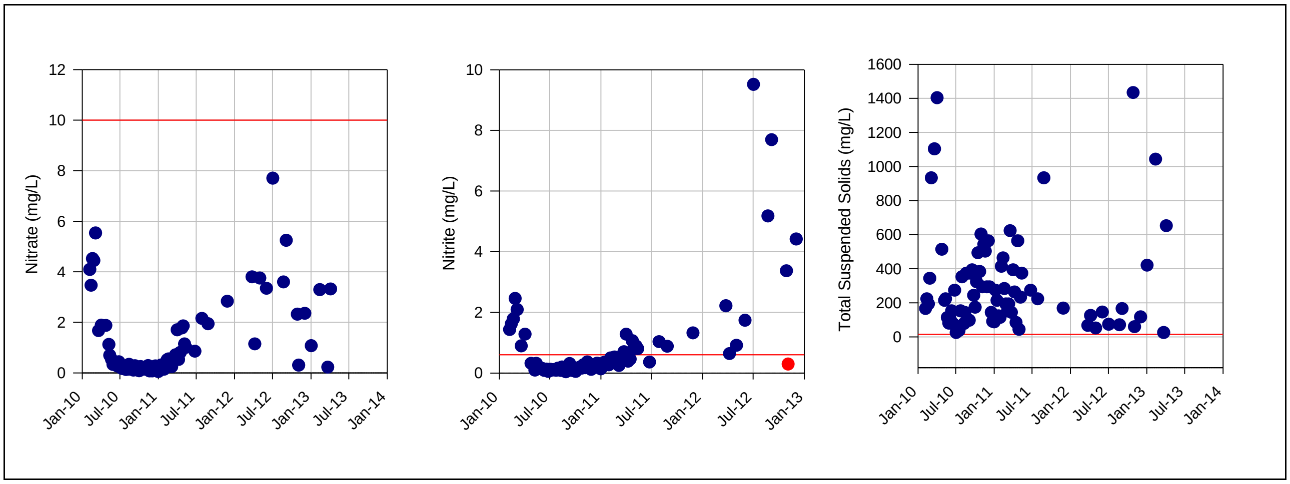
Jul-12
Jan-13
Jul-13
Jan-14



11.2 Paste Leachate Monitoring

Paste backfilling of the underground mine commenced in November 2011, and reached steady state in 2013. The composition and cement used for the paste backfill changed in 2014. As paste backfill continues to develop, paste leachate monitoring will begin in 2015.

11.3 Wash Stations

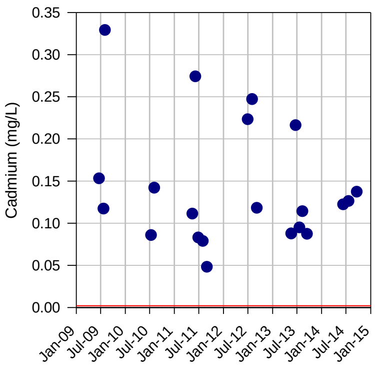
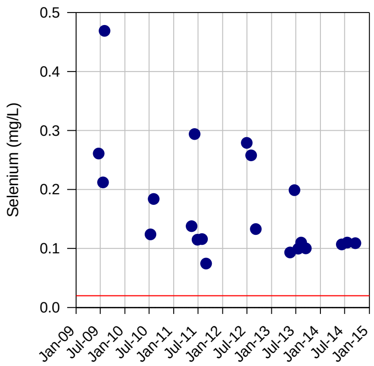
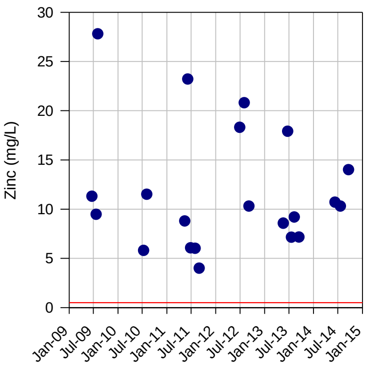
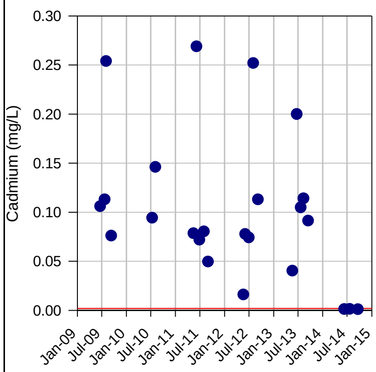
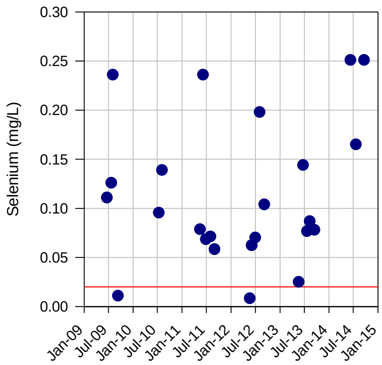
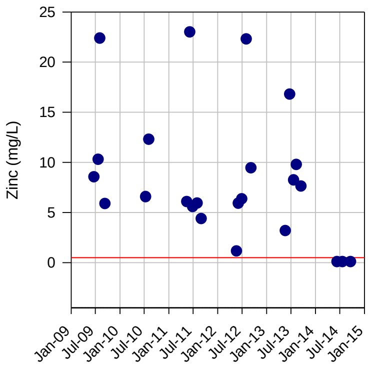
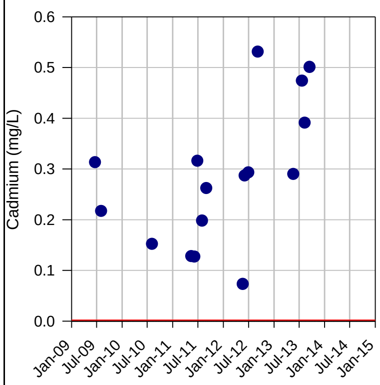
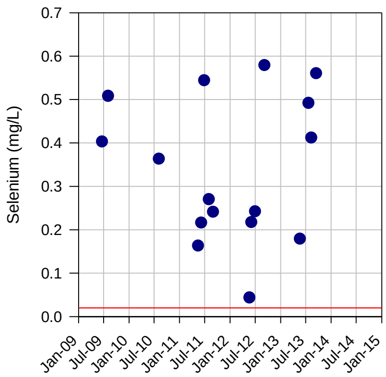
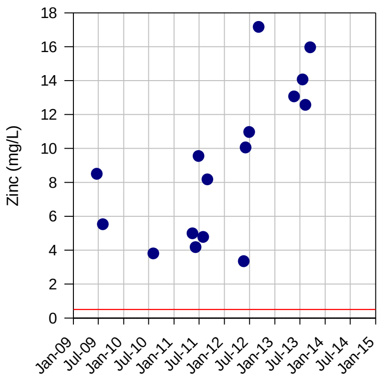
Wall washing techniques measure unit-area geochemical reaction rates and concentrations. Wall washing is to be performed quarterly on selected walls within the mine that represent dominant rock types and paste backfilled stopes. However, as described above, wall washing was not conducted in 2014 sue to the extremely poor ground conditions (shotecrete on all walls) and high moisture levels.

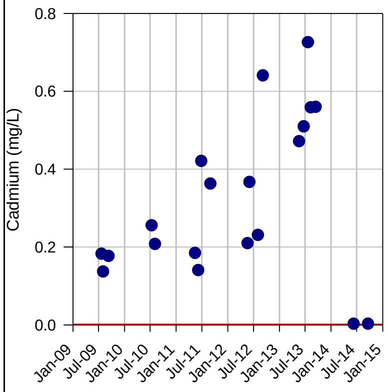
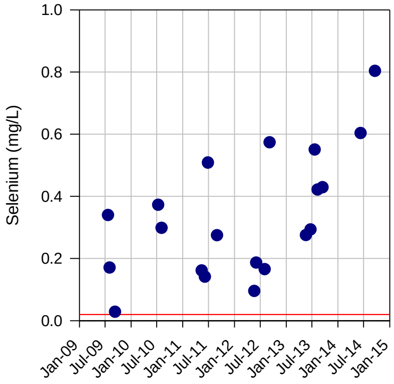
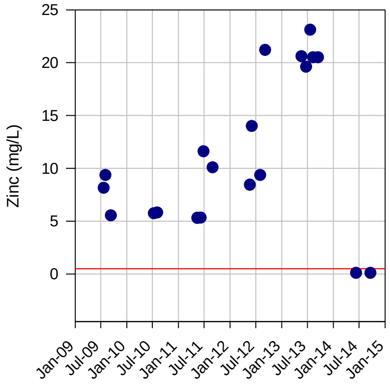
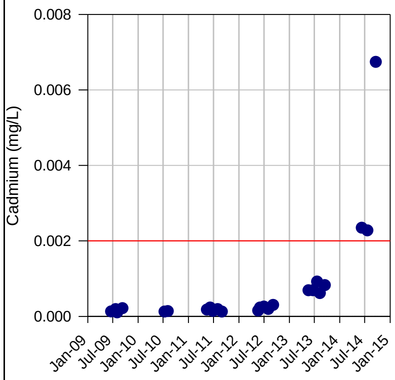
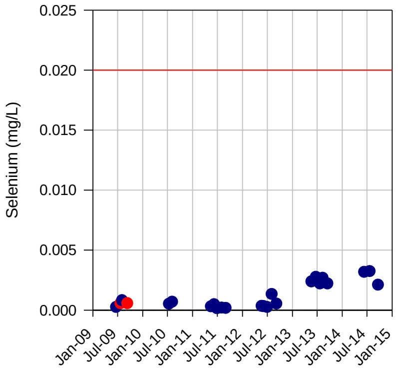
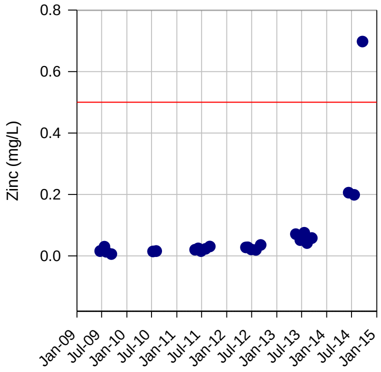
11.4 In-situ Geochemical Test Pads

The geochemical test pads (lysimeters) installed at the Wolverine Mine received precipitation from the environment and the leachate collects in 20L buckets placed below the pads. There are five pads constructed at the Wolverine Mine: two containing 100% ore (lysimeters A & B); two containing 50% ore and 50% waste rock (lysimeters C & D); and one control cell, which collects only rainwater (lysimeter E). Water quality samples were taken in 2014 and the results are summarized graphically below. Four addition test pads (two duplicate pads) are to be established in 2015 for the evaluation of tailings and paste backfill geochemistry.

The water chemistry in the runoff from the lysimeters with 100% ore and 50% ore and waste rock are typified by high metal concentrations, most notably for Cd, Cu, Fe, Pb, Se, and Zn, for which the concentrations are at least one order of magnitude greater than the concentrations in the runoff from the control cell. Cd, Se and Zn concentrations in the runoff from the ore containing cells are three orders of magnitude greater than the control cell, as shown in the figures below. The leachate selenium and zinc concentrations were greater in the cells with 50% ore and 50% waste compared to the cells containing 100% ore. Concentrations in Cd, Cu, Fe, and Zn appear to have significantly declined during 2014 from the ore containing cells, while these same concentrations increased in the control cell.

The figures below have the Type A Water Use Licence QZ04-065 discharge limit shown to allow comparison between cells. Red data points indicate that the result was below the reportable detection limit, and is shown as equal to the limit in the graph. The graphs for the other parameters limited by Licence QZ04-065 are provided in Appendix F, and the full water quality results are available upon request. Water quality in the lysimeters with ore were typically higher than Type A Water Use Licence QZ04-065 discharge limits for cadmium, lead, zinc, selenium, and copper.

Test Pad	**Cadmium**	**Selenium**	**Zinc**
A			
B			
C			

Test Pad	Cadmium	Selenium	Zinc
D			
E			

12 Summary

This report summarized the results of monitoring and surveillance conduced as per Monitoring and Surveillance Plan V2011-02 for the January – December 2014 period. The results indicate that there is no change in environmental performance of the undertaking evident during the monitoring period.

13 Works Cited

Metal Mining Effluent Regulations, SOR/2202-222 (2006).

Yukon Water Board. (2007, October 4). Type A Water Use Licence QZ04-065. Whitehorse, YT, Canada.

Appendix A: Surface Water Quality – Graphs

Appendix B: Groundwater Quality – Graphs

Appendix C: Metal Mining Effluent Regulations Environmental Effects Monitoring: Second Interpretive Report – PGL Report

Appendix D: Geochemical Testwork – AMEC Report

Appendix E: Geochemical Testwork – MEA Report

Appendix F: In-situ Geochemical Test Pads (Lysimeters) – Graph