

Mount Nansen Site Data Report: Surface Water and Meteorological Monitoring 2012 /13

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EXECUTIVE SUMMARY

Assessment and Abandoned Mines (AAM) retained EDI Environmental Dynamics Inc. (EDI) to conduct surface water and meteorological monitoring in watersheds at the Mount Nansen Site from April 2012 through March 2013. This report is an annual data report describing surface water (quantity and quality) and meteorological data collected from April 2012 through February 2013.

Meteorological data is collected via a meteorological station installed and maintained by Northern Avcom; EDI downloads this data from an internet site and compiles the raw data; EDI is not responsible for maintenance of the station instrumentation. During the open water season (May to September), the monitoring sites were visited bi-weekly for hydrology and surface water quality, save for the Brown-McDade pit lake where surface water quality was sampled monthly. Monitoring sites were visited monthly between October 2012 and February 2013. As of February 2013, the hydrometric and surface water quality monitoring networks covered five watersheds and included 20 hydrometric stations and 26 water quality sampling sites.

Meteorological data was downloaded from the internet site set up by Northern Avcom on a monthly basis, and compiled in a database provided to AAM. The data collected on a daily basis includes minimum and maximum air temperature, minimum and maximum humidity, and snow depth. The data collected on an hourly basis includes radiative fluxes, wind speed and direction, rainfall, snow depth, air temperature, humidity, ground surface temperature, and barometric pressure (data collection of barometric pressure began August 30, 2012). The snow depth sensor readings were offset through the 2011/12 season; this concern was addressed through sensor calibration on August 30, 2012.

During the open water season between April 2012 and September 2012, 14 of the 20 hydrometric stations were instrumented with continuous water level loggers (non-vented pressure transducers) installed in stilling wells with staff gauges; four of these level loggers were winterized and left in place over the winter. Discharge data were collected using a variety of hydrometric measurement methods and instrumentation including continuous water level loggers, the velocity-area mid-section method, salt tracers, a v-notch weir and volumetric measurements. In general, the measurement methods used at each station were consistent from trip to trip, however occasionally changes to channel conditions required alternative methods from the list previously noted (i.e., ice conditions). The velocity-area method was most suitable on Victoria Creek and Back Creek whereas volumetric, weir and salt tracers were found to be the most effective means of measurement for all other stations due to smaller channel sizes. Continuous water level loggers collected data during the peak discharge (spring freshet); however, field monitoring coincided with the rising and falling limbs of the flood hydrograph therefore peak discharge was not validated for the highest flows in 2012. Discharge and stage measurements were obtained at all stations (including the un-instrumented hydrometric stations) throughout the winter if appropriate channel conditions for measurement existed or until the channels were frozen to the substrate. Winter discharge measurements provided estimates of streamflow recession to baseflow levels for all channels that continued to convey water under the ice; however these measurements are considered less accurate than open water measurements.



Surface water quality monitoring included both *in-situ* measurements and the collection of water samples for laboratory analysis. Surface water quality sampling was conducted at all stations throughout the winter if appropriate channel conditions for measurement existed or until the channels were frozen to the substrate. Water quality on site is generally pH neutral and hardness is quite high; this has positive implications for the toxicity of total metals concentrations on site as many metals are less bioavailable in hard water, as is reflected by the CCME Aquatic Life (AL) guidelines, many of which are hardness dependent. All watercourses and the Brown-McDade pit lake are low nutrient, oligotrophic systems. Cyanide continues to be present on site, most notably in the Dome Creek watershed. Metals including, but not restricted to arsenic, cadmium, copper, iron and zinc are commonly present on site in concentrations that exceed the CCME AL guidelines and in some cases the effluent discharge standards developed for the Mount Nansen Site



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STATEMENT OF LIMITATIONS

EDI Environmental Dynamics Inc. (EDI) prepared this report for the use of Yukon Government Assessment and Abandoned Mines. The material in it reflects the judgment of EDI staff in light of the information available to EDI at the time of report preparation. Any use which a Third Party makes of this report, or reliance on decisions based on it, is the responsibility of such Third Parties. EDI accepts no responsibility for Third Party decisions made based on the findings of this report.



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1 INTRODUCTION

Assessment and Abandoned Mines (AAM) has retained EDI Environmental Dynamics Inc. (EDI) to conduct regular sampling of the surface water quality and hydrology, and to compile data from the meteorological station (the station itself is maintained by Northern Avcom). The surface water and meteorological monitoring data for the 2012/13 program are summarized in this annual data report; all data collected between April 2012 and February 2013 is included here.

Prior to the 2012/13 surface water and meteorological monitoring program, hydrometric, water quality and snow sampling were conducted in 2011/12 with a similar network of stations. In 2012/13 some additions were made to the monitoring network to address changes to surface water routing and/or accommodate additional project requirements. Hydrometric monitoring has been conducted on site during the open water season (May through September) since 2009; however winter monitoring (October through April) began in 2011. Water quality sampling has been conducted on site since 1999; though the number of sites included in the program has increased over the years.

The 2012/13 surface water monitoring program was designed to achieve the following:

- Continue monitoring at existing surface hydrometric and water quality stations to extend and enhance the year-round baseline dataset;
- Establish additional monitoring stations where gaps in the surface hydrology or water quality understanding of the site were determined through discussions with AAM;
- Address site specific problems encountered at the monitoring stations using solutions developed in discussion with AAM; and
- Produce quality-controlled databases containing all hydrometric, water quality and raw meteorological data collected at the Mount Nansen Site under this program.

1.1 PROJECT LOCATION

The Mount Nansen Site is located approximately 45 km east of Carmacks, in the Yukon Territory (Figure 1). The site is part of the Klondike Plateau eco-region characterized by warm summers and very cold winters. On a regional scale the site is part of the extensive discontinuous permafrost zone (50 to 90% coverage). The Klondike Plateau is part of the Beringia region where the last glaciations occurred approximately 3 million years ago. As a result, bedrock in the site area is highly weathered and fractured (Smith et al. 2004), which has implications for surface/groundwater interactions.

The Mount Nansen Site lies within the Nisling River drainage basin. The Nisling River flows into the Donjek River, a tributary of the White River which in turn flows into the Yukon River upstream of Dawson City (Figure 1). The Mount Nansen Site is located within the Pony Creek and Dome Creek watersheds (Figure 2). Surface water monitoring was conducted in five watercourses in the immediate project area; Pony



Creek, Dome Creek, Back Creek, Minnesota Creek and Victoria Creek (Figure 2). The meteorological station is located in the upper Dome Creek watershed (Figure 2).

The Pony Creek watershed (drainage area of 1.7 km²) is located on the north side of the site and flows into Back Creek. There are a number of sites along the length of the channel where flow follows sub-surface pathways and re-surfaces downstream. Channel dissection and infiltration to ground also appears to occur in the fan area upstream of the Back Creek confluence (Figure 2). Pony Creek empties into Back Creek near the southeast corner of the mine site via a poorly defined channel. The Pony Creek channel was affected by the construction of an access road with a culvert (Back Creek watershed access road) and the deposition of waste rock piles into the stream during active mining and trenching in the upper watershed. The trenching activity resulted in earth berms changing the course of the channel and caused pooling in some areas. Several placer claims are still active in the upper watershed and evidence of recent excavation activity was observed in 2012.

Back Creek is a small watercourse with a total drainage area of 10.4 km². It originates north of the Mount Nansen Site (Figure 2) where it flows southeast to the eastern edge of the mine site and into Victoria Creek just upstream of the pump house (artesian well water source). The middle and upper areas of the Back Creek watershed have active placer mining operations that use water from the creek for processing and may influence the streamflow regime. While there are sedimentation ponds associated with this placer activity, turbidity in the creek is often very high during the summer when the operation is active.

Dome Creek is the main watershed that overlaps with the Mount Nansen Site footprint; the channel joins Victoria Creek approximately 8.4 km upstream of the confluence with the Nisling River (Figure 1). The Dome Creek watershed has a total drainage area of 4.78 km². The upper portion of the watershed lies upstream of the mill site (Figure 2), the middle portion of the watershed contains the tailings pond where the channel is constrained to a diversion channel around the north side of the tailings pond. The lower portion of the Dome Creek watershed receives flow from both the diversion channel and the seepage pond outflow (water pumped from the seepage pond) and is thus influenced by pumping rates. Lower Dome Creek is also intersected by the Mount Nansen Road where streamflow is routed through a culvert. The accumulation of large amounts of snow and aufeis (overflow ice) throughout the Dome Creek Valley is an indication that groundwater discharge continues, despite the watercourse typically freezing to the substrate through the winter season. At the road crossing this accumulation of aufeis often leads to ice blockage in the culvert and build-up on the road. The melt of the aufeis typically leads to high flows in mid to late June.

The Minnesota Creek watershed is located east of Victoria Creek and the Mount Nansen Site. While the 12.7 square kilometre watershed does not overlap with the site, Minnesota Creek discharges to Victoria Creek upstream of the Mount Nansen Road crossing and contributes to streamflow and water quality measured at the hydrometric station/water quality sites on Victoria Creek near the road.

Victoria Creek is the largest watercourse on the Mount Nansen site (Figure 2) draining a total area of 112.0 square kilometres into the Nisling River. Back Creek, Dome Creek and Minnesota Creek all contribute to Victoria Creek in the vicinity of the site. The Mount Nansen Road crosses Victoria Creek approximately 6.4 km upstream of the confluence with the Nisling River. In the summer of 2012, high suspended sediment



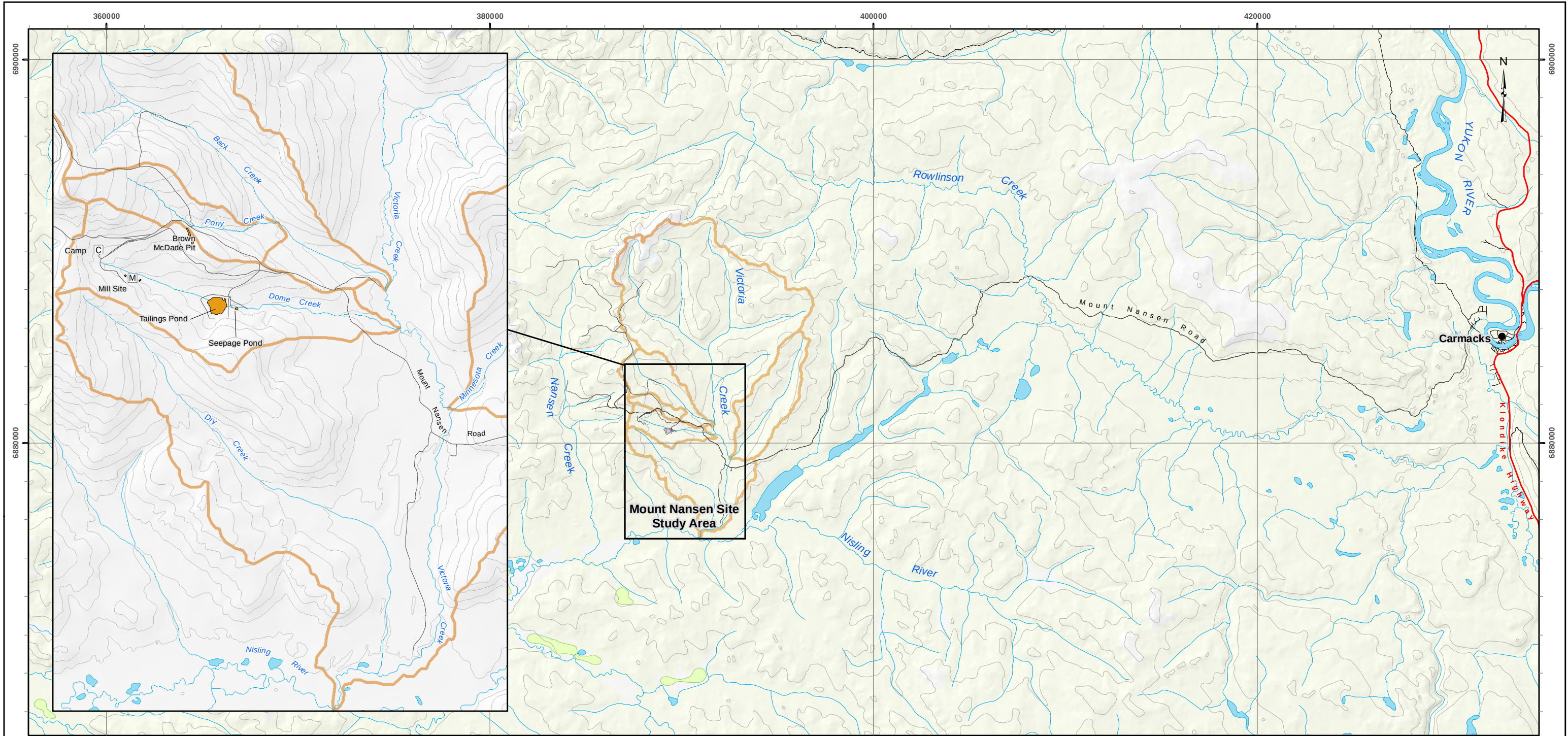
loads were observed in the channel indicating that placer activity may have been active upstream of the Victoria Creek station established as a baseline water quality reference site.

Further details on each of the hydrometric and water quality stations within these watersheds are found in the 2012/13 monitoring network description (Section 2.1).

1.2 PROJECT LOCATION CLIMATE

The climate of the Mount Nansen Site is characterized by long, cold winters and short warm summers (Smith, Meikle and Roots 2004). The area receives most of its precipitation from June to August during convective rain showers and summer thunderstorms (Smith, Meikle and Roots 2004). In general, mean monthly temperatures during the summer are colder on average compared to Carmacks, while winter temperatures are warmer on average. Temperature inversions frequently develop during the winter, where cold air remains in the valley bottoms (e.g., lower Victoria Creek) and milder temperatures are found at higher elevations (e.g., upper Dome Creek). A similar relationship exists between the Mount Nansen Site and Carmacks, based on air temperature data collected from the Carmacks CS meteorological station maintained by Environment Canada (station number 2100301).

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Regional Overview Map of Mount Nansen Site Area

Legend

- Secondary Road
- Highway
- Topographic Contour
- Watercourse
- Waterbody
- Wetland Area
- Drainage Areas (Local)

1:50,000 and 1:250,000 Topographic Spatial Data courtesy of Her Majesty the Queen in Right of Canada, Department of Natural Resources. All Rights Reserved.

Digital Elevation Model provided by Geomatics - Yukon Government via online source (Corporate Spatial Warehouse) www.geomaticsyukon.ca.

Watercourse, drainage areas and Mount Nansen Road layers digitized / modified by EDI (2011) using orthophotos provided by Yukon Government, Energy, Mines and Resources (2011).

Project data displayed is site specific. Data collected by EDI Environmental Dynamics Inc. (2012) was obtained using Garmin GPS technology.

This document is not an official land survey and the spatial data presented is subject to change.

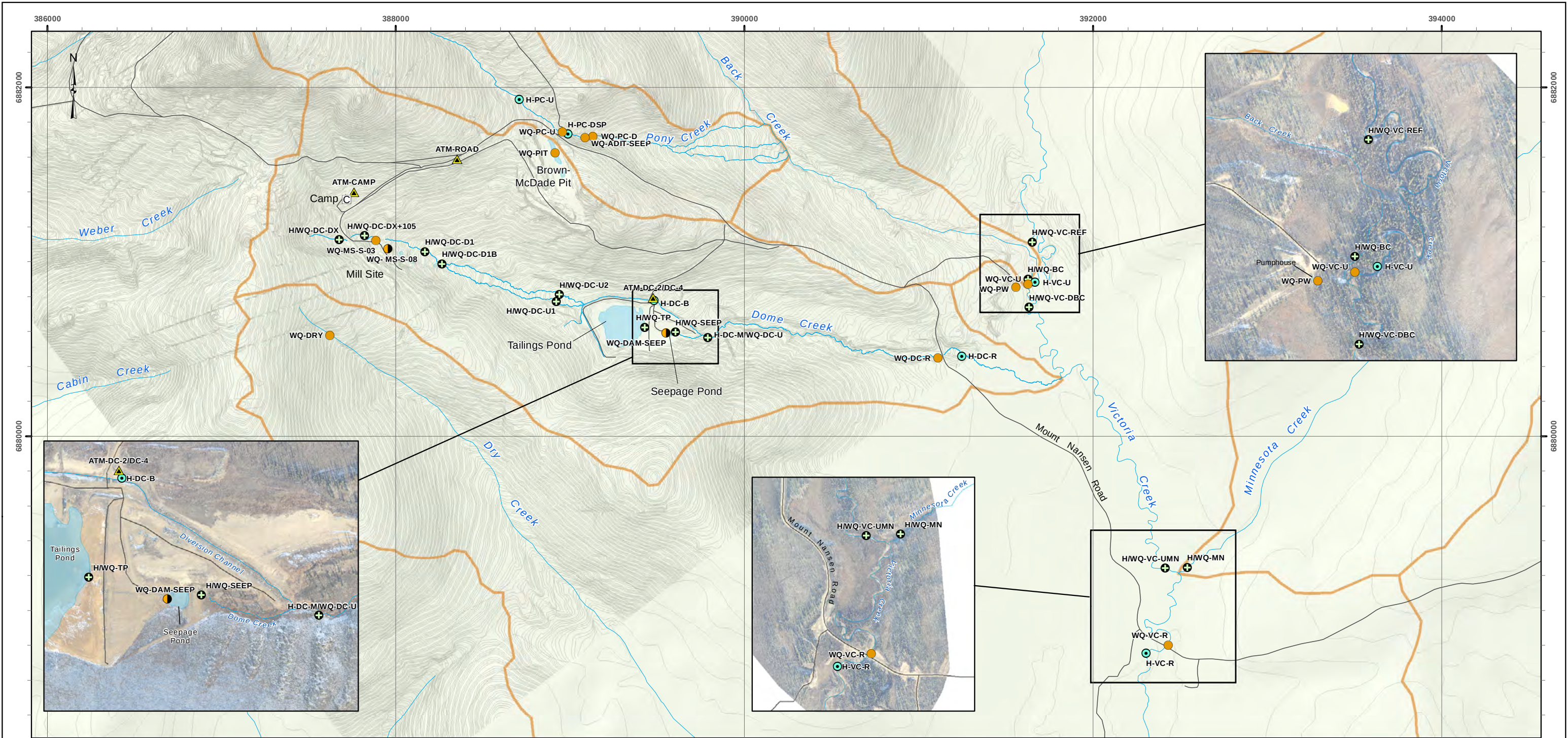


Map Scale = 1:200,000 (printed on 11 x 17)
Map Projection: North American Datum 1983 UTM Zone 8N

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Mount Nansen Site: Hydrometric and Water Quality Stations

Legend

- Atmospheric Station (label ex: ATM-DC-2)
- Hydrometric and Water Quality Station (label ex: H/WQ-VC-UMN)
- Hydrometric Station (label ex: H-VC-R)
- Water Quality Station (label ex: WQ-PC-U)
- Temporary Water Quality Site (label ex: WQ-MS-S-08)
- Unpaved Road/Access
- Contours (1 m where contours are shown in detail)
- Drainage Areas (Local)

1:50,000 and 1:250,000 Topographic Spatial Data provided by Geomatics - Yukon Government via online source (Corporate Spatial Warehouse) www.geomaticsyukon.ca.

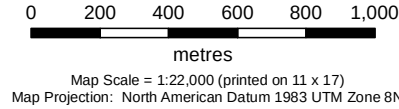
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Watercourse, drainage areas and Mount Nansen Road layers digitized / modified by EDI (2011) using orthophotos provided by Yukon Government, Energy, Mines and Resources (2011).

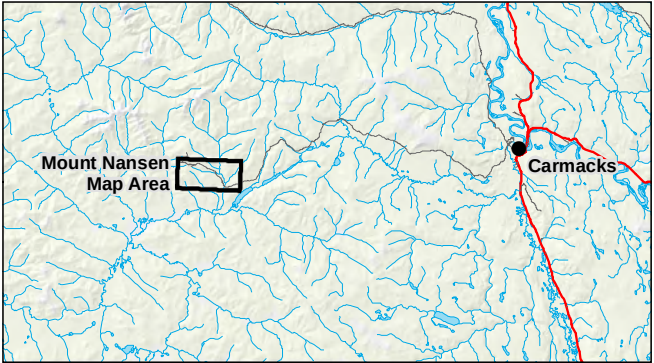
Contours (1 metre) were provided by Yukon Government Department of Energy, Mines and Resources (2012).

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2 METHODS

The 2012/13 surface water and meteorological monitoring network consists of several discrete components: meteorology, surface water hydrology, and surface water quality. The following sections describe in detail the various methods used for each of the disciplines. For the purpose of this report, all data from April 1, 2012 to February 12, 2013 will be summarized.

2.1 MONITORING NETWORK DESCRIPTION

There are a total of 20 hydrometric stations and 26 surface water quality sites (19 of these sites/stations are common to both disciplines) (Table 1; Figure 2) throughout the five key watersheds and Dry Creek, a reference watershed south of the site. In addition to these, there are three additional seeps that were identified during the 2012 open water season that AAM requested be sampled by EDI, either as a one-time water quality sample, or to be added to the regular water quality schedule. Two additional hydrometric stations were identified in 2012 and AAM requested that instantaneous measurements be collected and added to the regular hydrometric program. These sites are described in greater detail in the surface water hydrometric methods (Section 2.3) and surface water quality methods (Section 2.4).

Table 1. List of hydrometric stations and water quality sites at the Mount Nansen Site as of February 12, 2013.

Station/Site Name	Hydrology	Water Quality	Station/Site ID
Upper Pony Creek	X	X	H-PC-U/WQ-PC-U
Pony Creek Downstream of Pit	X	X	H-PC-DSP/WQ-PC-D
Dome Creek at DX	X	X	H-DC-DX/WQ-DC-DX
Dome Creek at DX+105	X	X	H-DC-DX+105/WQ-DC-DX+105
Dome Creek at D1	X	X	H-DC-D1/WQ-DC-D1
Dome Creek at D1b	X	X	H-DC-D1b/WQ-DC-D1b
Upper Dome Creek 1	X	X	H-DC-U1/WQ-DC-U1
Upper Dome Creek 2	X	X	H-DC-U2/WQ-DC-U2
Diversion Channel at Bridge	X		H-DC-B
Middle Dome Creek	X	X	H-DC-M/WQ-DC-U
Dome Creek at Road	X	X	H-DC-R/WQ-DC-R
Seepage Pond Outflow	X	X	H-SEEP/WQ-SEEP
Tailings Pond	X	X	H-TP/WQ-TP
Brown - McDade Pit		X	WQ-PIT-1,2,3



Station/Site Name	Hydrology	Water Quality	Station/Site ID
Mill Site Seep 03		X	WQ-MS-S-03
Mill Site Seep 08		X	WQ-MS-S-08
Adit Seep		X	WQ-ADIT-SEEP
Dam Seep		X	WQ-DAM-SEEP
Back Creek	X	X	H-BC/WQ-BC
Minnesota Creek	X	X	H-MN/WQ-MN
Victoria Creek Reference Site	X ¹	X	H-VC-REF/WQ-VC-REF
Upper Victoria Creek	X	X	H-VC-U/WQ-VC-U
Victoria Creek Downstream of Back Creek	X	X	H-VC-DBC/WQ-VC-DBC
Victoria Creek Upstream of Minnesota Creek	X	X	H-VC-UMN/WQ-VC-UMN
Victoria Creek at Road	X	X	H-VC-R/WQ-VC-R
Pump House Well		X	WQ-PW
Dry Creek Reference		X	WQ-DRY

¹ this site is meant to function as a reference site for surface water quality, not surface water hydrology.

2.2 METEOROLOGY

A new Campbell Scientific meteorological station (ATM-ROAD AAM) was established at the Mount Nansen Site on October 2011. The station is located adjacent to the Mount Nansen Road, east of the camp; (Figure 2). This new station replaced the HOBO Onset weather station that was located near the camp kitchen (ATM-CAMP AAM), which operated from 2009 to 2011. The ATM-ROAD AAM station is administered by Northern Avcom and data is accessible via an internet download. EDI is responsible for downloading and compiling these raw data; EDI does complete quality control/quality assurance review; however, plays no role in instrumentation maintenance or sensor calibration.

The ATM-ROAD AAM station records battery voltage, air temperature, ground temperature, humidity, rainfall, snow depth, net shortwave and long-wave radiation, total radiation, wind speed, and wind direction (Table 2). Barometric pressure (mbar) data collection at the station began on August 30, 2012.

Data from the Carmacks CS meteorological station, maintained by Environment Canada (Station Number 2100301), was downloaded for the April 2012 to February 2013 period for comparison to the Mount Nansen Site data. The Carmacks CS station is located at an elevation of 542.9 m and collects both air temperature and peak wind data (direction and velocity).



Table 2. Summary of weather data parameters collected at Mount Nansen Meteorological Station (ATM-ROAD AAM).

Meteorological Parameter	Units	Notes
Daily Collection		
Battery Voltage	Volts	Measured every 5 minutes. Daily minimum value is reported
Air Temperature Maximum	°C	Measured every 5 minutes. Daily maximum value is reported.
Air Temperature Minimum	°C	Measured every 5 minutes. Daily minimum value is reported.
Humidity Maximum	%	Measured every 5 minutes. Daily maximum value is reported.
Humidity Minimum	%	Measured every 5 minutes. Daily minimum value is reported.
Snow Depth	cm	Reports the depth of snow at the end of the day.
Hourly Collection		
Net Shortwave	W/m ²	Measured every 5 minutes. Hourly average is reported.
Net Longwave	W/m ²	Measured every 5 minutes. Hourly average is reported.
Net Total Radiation	W/m ²	Measured every 5 minutes. Hourly average is reported.
Wind Speed	m/s	Measured every 5 minutes. Hourly average is reported.
Wind Direction	degrees	Measured every 5 minutes. Hourly average is reported.
Precipitation	mm	Total precipitation recorded hourly.
Snow Depth	cm	Hourly sample recorded.
Air Temperature	°C	Measured every 5 minutes. Hourly average is reported.
Humidity	%	Measured every 5 minutes. Hourly average is reported.
Ground Temperature Surface	°C	Hourly sample recorded.
Barometric Pressure	mbar	Hourly sampling began August 30, 2012 at 15:00

2.3 SURFACE WATER HYDROLOGY

The 2012/13 hydrometric monitoring program closely follows that outlined by EDI (2012) in the *Mount Nansen Site Hydrologic Monitoring: 2011-2012* report including data management and data processing methodology. Hydrometric data presented in this report spans the monitoring period April 1, 2012 to February 12, 2013. In total, discharge and/or stage were measured at 20 different hydrometric stations either continuously with water level loggers, instantaneously during each site visit, or both. There were 14 combined continuous/instantaneous hydrometric stations and six instantaneous hydrometric stations (Table 2). Four stations recorded continuous water levels during the winter period with instantaneous discharge measurements collected during each visit.

Two of the 2012/13 instantaneous stations were added to the hydrometric monitoring network in the Dome Creek Valley during the monitoring period (Table 3). The first station was located in a moderately well-defined channel identified downstream of H-DC-D1 where substantial surface flow was observed in late June 2012. A hydrometric station was established at this location for instantaneous discharge



measurements and named H-DC-D1b (Figure 2). Surface flow at this location had not been observed previously. The second station was a manual water level monitoring station (staff gauge) installed by AAM in the tailings pond (H-TP). Detailed descriptions of these sites, H-DC-D1b and H-TP respectively, are found in Sections 3.2.2.4, 3.2.2.7 and Appendices B and D.

Methods employed for discharge measurement in 2012/13 included:

- the velocity-area mid-section method;
- volumetric measurements at perched outlets such as culverts and pipes;
- salt dilution gauging (brine salt slug injection); and
- v-notch weir measurements.

The velocity-area mid-section method is standardized by RISC (2009), however many of the channels at the site are inappropriate for using this method (i.e., too shallow or narrow). Alternative methods accepted by industry and regulators were employed at stations with channels, such as salt dilution gauging (e.g., Laberge Environmental Services 1999 and LWBC 2004). Field crews collected replicate measurements at hydrometric gauging sites where alternative measurement methods were used (e.g., two salt slug trials; five volumetric trials); resultant discharge values were averaged. Hydrometric leveling surveys were conducted during each visit at stations where continuous loggers were installed to monitor changes to the benchmark and staff gauge elevations related to periglacial processes and to document maintenance-related station offsets.

Given the small channels sizes and low discharge magnitudes at many stations, the minimum reportable discharge is set to $0.001 \text{ m}^3/\text{s}$ or 1 L/s ; this resolution is lower than typical hydrometric reporting (e.g., Water Survey of Canada uses $\pm 0.01 \text{ m}^3/\text{s}$ for open water conditions). Field methods used can accommodate this resolution of discharge under ideal conditions, however measurement uncertainty for each method should be considered when interpreting results. Discharges calculated for several stations were less than $0.001 \text{ m}^3/\text{s}$ and reported as $0.000 \text{ m}^3/\text{s}$, below reportable confidence limits.

Two changes were made to the hydrometric measurement equipment to increase field measurement efficiency and accuracy in the 2012/13 program from the 2011/2012 program. The first was the use of a Sontek Acoustic Doppler Velocimeter (ADV) for all velocity-area discharge measurements. The ADV replaced the Swoffer current meter used in 2011. The ADV was advantageous to the hydrometric program because it has the ability to collect velocity measurements in two dimensions and thus compensate for measurement error associated with velocity angles. The ADV also provides a variety of quality control and assurance assessments in real-time, reducing field measurement error. The absence of moving parts on the acoustic sensor also decreases measurement error during winter conditions when moving parts tend to freeze. It should be understood that while the measurement equipment changed in 2012/13, there were no changes to the velocity-area mid-section method of measuring discharge.



The second equipment change involved upgrading and replacing the v-notch weir located at Upper Pony Creek following damage during winter 2011/12. The v-notch weir was re-designed to be more robust and was replaced on July 24, 2012 (Photo 1).



Photo 1. Upper Pony Creek (H-PC-U) v-notch weir; re-installed July 24, 2012.



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Table 3. Mount Nansen hydrometric network station information, for the period April 1, 2012 to February 13, 2012.

Hydrometric ID (HID) ¹	Hydrometric Station Name	Station Type (2012/13) ²	Location ³		Drainage Area (km ²)	Elevation ⁴ (m)
			Easting	Northing		
ATM-DC2	Barometric Logger at Diversion Channel	ATM	389476	6880792	-	1099
ATM-DC3	Barometric Logger at Diversion Channel - Temporary Backup Logger	ATM	389476	6880792	-	1099
ATM-DC4	Barometric Logger at Diversion Channel - Backup Logger	ATM	389476	6880792	-	1100
H-PC-U	Upper Pony Creek	C	388709	6881930	0.8	1227
H-PC-DSP	Pony Creek Downstream of Pit	C	388986	6881734	1.0	1191
H-DC-DX	Dome Creek at DX	I	387674	6881127	0.2	1215
H-DC-DX+105	Dome Creek at DX+105	I	387820	6881150	0.9	1204
H-DC-D1	Dome Creek at D1	I	388167	6881059	0.9	1171
H-DC-D1b	Dome Creek at D1b	I	388262	6881000	1.4	1156
H-DC-U1	Upper Dome Creek 1	C	388919	6880772	2.1	1115
H-DC-U2	Upper Dome Creek 2	C	388937	6880819	2.1	1102
H-DC-B	Diversion Channel at Bridge	C / I	389480	6880780	3.0	1095
H-DC-M	Middle Dome Creek	C/CW	389788	6880565	3.3	1065
H-TP	Tailings Pond	I	389427	6880625	-	1093
H-SEEP	Seepage Pond Outflow	I	389604	6880598	-	1072
H-DC-R	Dome Creek at Road	C	392540	6879249	4.5	1020
H-BC	Back Creek	C	391626	6880901	10.4	1021
H-MN	Minnesota Creek	C	392540	6879249	12.7	989
H-VC-REF	Victoria Creek Reference Site	C	391650	6881113	64.0	1036



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Hydrometric ID (HID) ¹	Hydrometric Station Name	Station Type (2012/13) ²	Location ³		Drainage Area (km ²)	Elevation ⁴ (m)
			Easting	Northing		
H-VC-U	Upper Victoria Creek	C/CW	391667	6880882	64.6	1019
H-VC-DBC	Victoria Creek Downstream of Back Creek	C/CW	391627	6880840	75.0	1017
H-VC-UMN	Victoria Creek Upstream of Minnesota Creek	C	392413	6879244	83.4	986
H-VC-R	Victoria Creek at Road	C/CW	392305	6878755	97.7	975

Notes:

¹ - HID = unique station identifier that corresponds with hydrometric database tables.

² - Station Type: ATM = atmospheric pressure monitoring; C = continuous water level monitoring with instantaneous discharge rating measurements; I = instantaneous discharge measurement; CW = continuous winter water level monitoring with instantaneous discharge rating measurements.

³ - NAD 83, UTM Zone 8.

⁴ - Elevations for hydrometric stations are estimates based on field data collected by handheld Garmin GPS units.



2.3.1 Velocity-Area Mid-Section

The velocity-area mid-section method was used to determine discharge at hydrometric stations where channel criteria met those outlined in standard guidance documents (RISC 2009; WSC 1999). Cross-section locations were established for each hydrometric station where this method was applied; these cross-sections were located in close proximity to continuous data logger installations.

Using the continuity relationship for discharge (Q),

$$Q = v \cdot A = b d v \quad [1]$$

Depth (d), velocity (v) and width (b) measurements were obtained for at least 20 panels across the metering cross-section. The cross-section panel width and depth were multiplied by the velocity and averaged over 40 seconds (RISC 2009) to obtain an instantaneous discharge measurement (q) for each panel. Panel discharges were subsequently summed to obtain total discharge. The discharge for the first and last panels was calculated using half the distance from the edge to the first and last mid-panel verticals.

The velocity-area discharge calculation is described by the following equations:

$$q_n = v_n d_n \frac{(b_{n+1} - b_{n-1})}{2} \quad [2]$$

$$Q = q_1 + q_2 + q_3 + q_4 + q_5 + \cdots q_n \quad [3]$$

Where SI units of m^3/s , m/s , and m are used for discharge, velocity and depth respectively.

The current meter used to obtain the velocity measurements¹ was a 2D, side looking, FlowTracker Handheld Acoustic Doppler Velocimeter (ADV) (Sontek/YSI Inc. 2009). The FlowTracker is used by both the Water Survey of Canada and the U.S. Geological Survey. The FlowTracker computer calculates discharge using the mid-section method and calculates the statistical discharge uncertainty based on methods developed by the U.S. Geological Survey (Cohn et al. 2006). This method of calculating uncertainty accounts for both the uncertainty associated with width, depth and accuracy of the FlowTracker calibration and the effects of channel variability on depth and velocity across the cross-section (Sontek 1999). Typically the statistical discharge uncertainty calculated by the FlowTracker at Mount Nansen was less than $\pm 5\%$; typically, $\pm 10\%$ is an acceptable uncertainty for the velocity-area mid-section method. The statistical uncertainty was applied for all velocity-area discharge measurements obtained with the ADV; discharge uncertainty was estimated to be $\pm 10\%$ for measurements collected with the Swoffer current meter.

¹ On April 17, 2012 a Swoffer current meter was used for one site (H-DC-B).



2.3.2 Salt Dilution Gauging

Salt dilution gauging was used at hydrometric stations where the channel conditions were not suitable for using a current meter. Typically this occurred when water depths were less than 0.05 m, channel widths were less than 3.0 m or during winter when ice was prohibitively thick for conducting velocity-area measurements beneath the ice.

There are three different methods of salt dilution gauging: constant rate injection (brine); slug injection (brine) and dry salt injection. Method selection depends on the magnitude of discharge to be measured, channel conditions and feasibility for remote sites as the required equipment varies for each method. All methods require the selection of an input (injection) site and a downstream electrical conductivity measurement site. The distance between these sites (mixing length) must be optimized for the minimum distance required for complete mixing of the fully dissolved salt tracer.

Specific channel conditions during open water and winter periods are required for successful salt dilution gauging. These criteria ensure that complete lateral and vertical mixing occurs in as short a distance as possible; minimal pools; no backwater areas; no braiding; little to no in-stream vegetation; and no losses or gains of water (Moore 2004; Laberge Environmental Services 1999).

Channel geomorphology and winter temperatures required some adaptations to the methodology presented in Moore (2004; 2005) therefore field protocols and subsequent calculations were based on those presented in Kite (1994) and Laberge Environmental Services (1999). Laberge Environmental Services (1999) describes practical, field tested and validated protocols for winter low flow measurements in the Yukon with a focus on streams with high background conductivities similar to the Mount Nansen region.

The gram conductivity of salt, the conductivity of 1 g NaCl in 1 m³ of solution at 25 °C, is non-linear at higher background conductivities (Laberge Environmental Services 1999). Background specific conductance at the hydrometric stations range from 28.7 µS/cm (H-MN) to 1,623 µS/cm (H-DC-D1b). The field protocol presented in Moore (2004; 2005) accounts for the non-linearity of the gram conductivity but requires additional field calibration tests for each visit and each gauging location. This method was not practical at extreme cold temperatures but was employed on several visits during the fall and winter of 2012/13 for comparative analytical purposes only.

The slug injection (brine) method was selected for use at the Mount Nansen Site hydrometric stations because this method was most feasible for the remote sites, channel conditions, discharges and the most efficient for the field monitoring program. In addition, the use of brine slugs allows for shorter mixing lengths to be used; ideal for channels at Mount Nansen. Measurement reaches were carefully selected to meet the measurement criteria and overlap with the physical location of continuous water level loggers. Salt injection sites were located upstream of constrictions (e.g., culverts) where possible to facilitate full mixing. A conductivity meter recorded specific conductance approximately 60 m downstream for the smaller creeks and approximately 90 m for Victoria Creek, depending on channel conditions.

The same measurement reach was used for each field visit unless changes to the channel conditions warranted minor adjustments to the input/output measurement locations. The slug injection method requires an electrical conductivity meter (YSI ProPlus or YSI 556 Multi-Meters with logging capabilities) to be set up at the downstream end of the measurement reach (Photo 2). Background electrical conductivity was logged for several minutes before the slug injection to allow for the instrument to equilibrate and to measure background variability. Typically specific electrical conductance² was measured (logged) because the values are compensated for water temperature; however, in some cases, both specific and raw electrical conductivity were measured for comparative and QA/QC purposes. Pre-weighed bags of salt (NaCl) were dissolved into a graduated bucket of streamwater at the injection site. Once fully dissolved, the salt slug was injected at the upstream site and the electrical conductivity of the salt wave was measured at the downstream location at five second intervals. Two trials were conducted at each station and where possible, a secondary method of discharge measurement was also employed to validate the salt dilution measurement (i.e., volumetric discharge measurement).



Photo 2. Salt dilution gauging with the YSI ProPlus Multi-Meter during the winter at Mount Nansen.

² Specific electrical conductivity measured by the YSI ProPlus and the YSI 556 multi-meters are linearly compensated for temperature. The multi-meters are calibrated daily during each field visit before use.



The formula used to calculate discharge for the Mount Nansen salt slug injections was:

$$Q = \frac{1000M_s\Gamma_{g,25}}{\tau \sum(EC_m - EC_o)} \quad [4]$$

Where Q is discharge (m^3/s), M_s is the mass of salt (kg), $\Gamma_{g,25}$ is the gram conductivity assumed to be $2.01 \mu S/cm/m^3$ for background conductivities up to $1,730 \mu S/cm$ (Laberge Environmental Services 1999), τ is the time interval in seconds and EC_o and EC_m are the background conductivity and measured conductivity, respectively. The target peak specific conductance for the salt wave was an increase of 100-200% above EC_o where $EC_o < 50 \mu S/cm$ and an increase of 50% above EC_o , where $EC_o > 100 \mu S/cm$.

The passage of two salt slug injections is shown by the change in specific conductance (Figure 3). The resultant discharge was calculated from each trial using Equation [4] and averaged. The average estimated measurement accuracy for the salt dilution gauging method is $\pm 20\%$, however it should be noted that this will vary at each station/visit based on individual channel conditions.

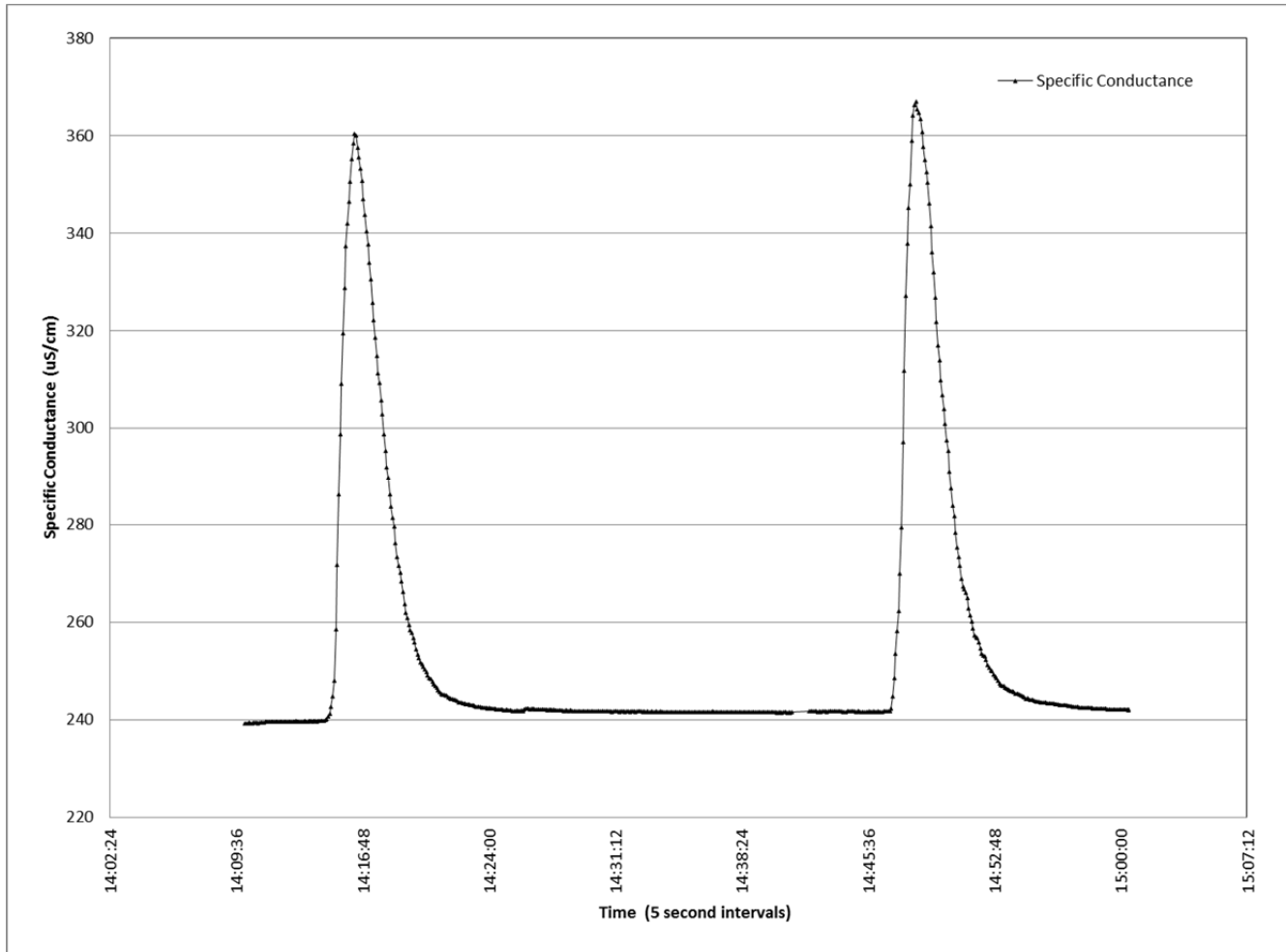


Figure 3. Typical specific conductance wave passage from two trials of salt slug dilution gauging at Mount Nansen (H-VC-DBC: February 11, 2013. $Q_{\text{salt}} = 0.077 \text{ m}^3/\text{s}$, $EC_0 = 239.9 \text{ } \mu\text{S}/\text{cm}$, $M_s = 0.800 \text{ kg}$ (both trials). Concurrent velocity-area discharge: $Q_{V-A} = 0.089 \text{ m}^3/\text{s}$).

2.3.3 Volumetric

Volumetric discharge measurement is ideal for low flows because all the streamflow is captured in a bucket of a known volume at a confined outlet or constriction in the channel. Channel constrictions created by culverts, pipes and weirs provided an opportunity to measure streamflow by measuring the time to fill a bucket of known volume. The volumetric method for measuring discharge was used at four stations at Mount Nansen where a culvert, pipe or free falling nappe at a weir was available (H-PC-U; H-PC-DSP; H-SEEP and H-DC-R). During extreme low flows it was also possible to obtain volumetric estimates at H-DX, H-DX+105 and H-DC-U1. Discharges were less than 26 L/s ($0.026 \text{ m}^3/\text{s}$), but more typically less than 7 L/s ($0.007 \text{ m}^3/\text{s}$). Typically a graduated 20 L bucket was used to measure five volumetric trials. The estimated measurement accuracy is $\pm 30 \%$.



The volumetric measurement method employed at H-SEEP (Tailings Dam Seepage Pond pump pipe outlet) is used to validate daily instantaneous measurements read at the flow meter attached to the pump that is used to manage water levels in the Seepage Pond. Daily flow meter readings were collected by the site maintenance crews and were provided by AAM; concurrent flow meter readings were collected when EDI was on site collecting volumetric measurements at the pipe outlet.

2.3.4 V- Notch Weir

Rated structures such as v-notch weirs are typically installed in streams where standard measurement methods cannot be employed. These structures are designed with a specific rating equation where discharge is directly related to the head distance above the v-notch. The 90° v-notch design is ideal for low flows such that large changes in head correspond with relatively small changes in discharge.

One hydrometric station at the Mount Nansen Site has a 90° thin plate v-notch weir which was installed in the upper Pony Creek watershed approximately 15 m upstream of the H-PC-U gauging station at an existing channel constriction (See Photo 1). The station required this approach for discharge measurement because of poor metering sites along this small, shallow, vegetated channel. Design and installation guidelines followed those described in RISC (2009).

The head over the weir crest was measured during each site visit, however it was determined that the measurement location was not sufficiently far upstream of the weir plate where the water surface is unaffected by draw-down. In an effort to compensate for this, 10% was added to each head measurement. Volumetric discharge measurements were used to validate the weir measurements. Discharge from the weir was initially calculated using a standardized rating structure equation for a fully contracted v-notch weir where:

$$Q = 1.370 h^{2.5} \quad [5]$$

Where Q is discharge in m^3/s and h is the height of water above the v-notch (head) (RISC 2009). Subsequently, a revised equation was proposed based on volumetric validation (Section 3.2.1.1).

The operating limits for thin plate v-notch weir structures are summarized in Table 4 with measurements from Weir Design 1 (June 23, 2011 to July 24, 2012) and Weir Design 2 (July 24, 2012 to present). Low flow discharge values outside of the operation limits are noted. Section 3.2.1.1 describes the results of the weir operation at H-PC-U including weir equation validation in more detail.

**Table 4. Design operating limits for v-notch weirs (from Table 6, RISC, 2009) and H-PC-U as-built design parameters and measurement ranges.**

Weir Design No.	Device Size	Max. h (m)	Max. Q ¹ (m ³ /s)	Min. h (m)	Min. Q ¹ (m ³ /s)	Debris Capacity	Sediment Capacity	Ratio h/p
V-Notch Design (RISC 2009)	90°	0.60	0.390	0.05	0.0008	Very Poor	Very Poor	≤1.2
1 As-built/2011/12 Measured Values	90°	0.155	0.016	0.039*	0.0004*	No Debris Issues	No Sediment Issues	1.2
2 As-built/2012/13 Measured Values	90°	0.092	0.010	0.062	0.0013	No Debris Issues	No Sediment Issues	0.23

Notes:

¹ - Excludes estimates of weir leakage.

* Minimum discharge measured at the weir is outside the rating structure accuracy range.

p = Depth of approach channel below the crest of the upstream side of the weir.

2.3.5 Winter Hydrometrics

Winter hydrologic measurements have lower accuracy than open channel measurements because the standard hydrometric methods are based on open channel hydraulic relationships between the impelling and resisting forces of flow. Ice increases the resistance to flow, slowing velocities and increasing the water surface elevation (backwater effect). Frazil ice, anchor ice, slush and ice jams influence the water surface profile and effective depth of flow in the channel. As a result, the relationship between stage and discharge changes during the winter. Cold temperatures frequently cause problems with measurement equipment, including continuous water level loggers. In the Yukon, winter measurement instruments are usually working at or beyond the cold temperature operating limits and resultant data must be carefully analyzed. All measurements collected when ice was observed in the channel were flagged in the data record with 'B'; the standard data flag used by the WSC indicating backwater or ice effects. Measurements influenced by ice were not included in the open water stage-discharge rating curve development.

Measuring discharge during the winter months at the Mount Nansen Site required the application of several different techniques depending on channel and ice conditions. All creeks were ice covered during the winter and the majority of the smaller creeks froze to the channel bed by mid-winter. Each early winter visit required checking for flow beneath the ice using an ice auger or axe. If flowing water was present, typically velocity-area and/or salt dilution gauging methods were used. Once a creek froze to bed, it was not visited again until the spring (April or May).

In Victoria Creek, the velocity-area and salt dilution methods were feasible throughout the winter (except at H-VC-REF where ice thicknesses were more prohibitive); salt dilution was used on the smaller creeks until they froze to bed. Regardless of the technique used, careful attention was paid to ice and flow conditions.

At the Mount Nansen Site, multiple layers of ice are often present with flow travelling between layers creating additional challenges. Further, because the winter flows are the lowest of the year, flow depths were often quite low causing increased difficulty for the velocity-area method. The ADV was used for all winter velocity-area measurements therefore there was no concern over frozen moving parts on the meter (Photo 3).



Photo 3. Winter velocity measurements using the Sontek FlowTracker meter on Victoria Creek.

2.3.6 Hydrometric Leveling Surveys

Hydrometric leveling surveys were conducted during each visit at stations where continuous data loggers were installed. The purpose of the survey was to tie the data logger water levels to the local station datum. Each station has a local, relative datum defined by benchmarks in close proximity to the data logger and stilling well. Three benchmarks were installed at each continuous station as per RISC (2009) Data Grade A



guidelines. Each survey included surveys with a level and rod for Benchmark 1 (BM1), Benchmark 2 (BM2), Benchmark 3 (BM3), the top of the staff gauge (TOS) and the water surface elevation (WATER). Benchmark 1 at every station was used to define the elevation of the local datum; the elevation BM1 was equal to 3.000 m above the station datum. The datum was always located below the elevation of zero flow. The benchmarks and the top of the staff gauge were regularly checked for shifting as a result of periglacial processes and survey error. While there was some apparent movement in the benchmark elevations and anomalous survey data, the water surface elevation data was carefully reviewed using staff gauge readings and the field records of stilling well maintenance (logger or staff gauge shifts) before applying local datum offsets to the raw data logger record; suspect data was excluded. All stage data is presented in metres referenced to the local datum (L.D.) unless otherwise noted.

2.3.7 Hydrometric Validation & QA/QC Program

The velocity-area, weir and volumetric hydrometric measurement methods are standardized by the WSC and the USGS and were used at Mount Nansen hydrometric stations where specific channel conditions were met. Many stations did not meet the criteria and alternative methods (e.g., salt dilution) were used. Concurrent velocity-area and salt dilution or volumetric and weir measurements allowed for the validation and calibration of various methods. In addition, these concurrent measurements facilitated uncertainty estimates.

Throughout the monitoring period, concurrent volumetric and weir measurements were made at H-PC-U to ensure the weir rating equation was performing adequately. Similarly, the velocity-area method was used at Victoria Creek stations during the winter when possible to validate discharges obtained by salt dilution gauging (the preferred method to use during winter). In Pony Creek and Dome Creek volumetric measurements were used to validate salt dilution measurements when there were appropriate flow/channel conditions to collect a volumetric measurement. The results of validation (where applicable) are described for each site in Section 3.

Quality control and quality assurance (QA/QC) checks began during the field visits. The FlowTracker ADV provides numerous QA/QC checks in real-time during velocity measurements that allow the field crew to increase the precision of the measurements. Upon return from the field, preliminary checks and reviews were made to the raw data and discharge calculations prior to the production of trip and monthly reports. A third round of QA/QC was conducted when data was entered into the hydrometric database and final QA/QC was conducted during the development of rating curves and hydrographs.

2.3.8 Rating Curve Development

Rating curves are based on open channel hydraulic relationships between stage (water level) and discharge. The y-axis represents the recorded stage level at the gauge and the x-axis the discharge. The rating curve



equation represents the hydraulic reaction of a smoothly varying channel with increasing stage (or a constant control point at all stages) (Maidment 1992). The rating curve equation [6] has the form:

$$Q = C(h + a)^N \quad [6]$$

Where Q is discharge in m^3/s , C is typically proportional to the channel width, $(h+a)$ represents the depth of water above the stage of zero flow (water level where flow becomes zero) and the value of N is a function of the channel geometry (Maidment 1992). If the pressure transducer is below the point of zero flow, the value of 'a' is negative; conversely a positive 'a' value indicates that it is above. Typically as the stage increases, the hydraulic control shifts from low flow hydraulic control to channel friction control or to ice related controls and as such, multiple rating curves are often required to accurately represent the full range of flows in the stream.

By taking the log of both sides of the rating curve equation [7],

$$\log Q = \log C + N \log(h + a) \quad [7]$$

the rating curve equation [6] takes the linear form $y=mx+b$ and can be fit to the discharge calibration points as a straight line. Rating curves may be developed using several different methods including fitting the calibration points by eye and the maximum likelihood solution. Given the small size of the channels at the Mount Nansen Site, and the small range of change in stage, and channel instabilities, the rating curves were developed by fitting by eye in the Aquarius Time-Series Software environment (Aquarius Informatics Inc.).

Rating curves were developed for stations with continuous water level loggers using surveyed water levels (stage) and instantaneous discharge measurements. The rating curves were considered preliminary if there were less than 10 rating measurements (RISC 1998), if the rating measurements did not capture an acceptable range of flows (i.e., 10 %-200 % of mean discharge (MD)), or if there was high rating curve error.

Rating curves were developed with rating measurements obtained when the channel was ice free; measurements obtained during ice conditions are reported simply as instantaneous measurements. For stations where there were no shifts to hydraulic controls or datum (due to benchmark repairs) between 2011 and 2012, 2011 rating measurements were included in the 2012 curves.

In 2012, the peak discharge was not captured; therefore, without field validation, a conservative approach was adopted for presenting the continuous hydrometric record in this report. Extending the rating curves to predict flood or low flows can introduce error into hydrologic analysis and therefore should be carefully considered in the context of channel hydraulic geometry. The rating curves extended beyond the 2012/13 discharge measurement using zero flow and bankfull elevation field data and professional judgment; as a result some continuous discharge hydrographs may exclude peak discharges due to the rating curve



definition. When high flows are validated by field measurements in 2013/14, rating curve extensions will be reconsidered.

2.3.9 Continuous Stage and Discharge

Continuous data loggers were established or re-established at 14 hydrometric stations, in five watersheds at the Mount Nansen Site in 2012/13. Ten of these stations were located at the same locations as the loggers installed in 2011; an additional four continuous stations were added in 2012/13 to capture flow in the Minnesota Creek watershed and additional locations on Victoria Creek. During the open water season in 2012 a combination of HOBO (Model: U20-001-04, Onset Corporation) and Solinst (Model Gold 3001, Solinst) pressure transducers were installed on site. In addition, a barometric and redundant barometric logger, ATM-DC2 (HOBO); ATM-DC3 (HOBO, short-term redundant) and ATM-DC4 (Solinst, redundant) were installed in the middle of the watershed near H-DC-B. All of the data loggers are non-vented pressure transducers that record water or air temperature and pressure; measurement accuracy details are located in Appendix B, Table B1.

The hydrostatic pressure data was compensated for atmospheric pressure using data from the barometric pressure logger located at ATM-DC2; data from the redundant barometric loggers was not required (Appendix B, Figure B1).

The water depth was calculated manually for the HOBO loggers submerged in the streams, using the following relationship from the Euler equation [8] where:

$$H = \frac{P}{\gamma} + z \quad [8]$$

Hydraulic head (H) or water depth, hydrostatic pressure (P) in Pa, the specific weight of water $\gamma = \rho g$ where ρ is the density of water at a given temperature (kg.m^{-3}), g is acceleration due to gravity (m.s^{-2}) and z is elevation above a datum. Density of water varies with temperature and given the wide range in stream temperatures throughout the year, the density was computed using the Thiesen-Scheel–Diesselhorst equation [9] (Maidment 1992):

$$\rho = 1000 \left[1 - \frac{t+288.94}{508929.2(t+68.12963)} (t - 3.9863)^2 \right] \quad [9]$$



Where t = temperature (°C). The Solinst logger records at stream sites did not require water depth conversions; depth is an automatic output from the record.

Continuous stage records were collected at 15 minute intervals or re-sampled to 15 minute intervals. Continuous discharge was calculated using the stage-discharge rating curve for each station; the continuous stage record (rather than discharge record) is presented for stations where developing reliable rating curves was challenging.

2.3.10 Hydrometric Data Management

Hydrometric data was compiled into a MS Access database after each visit to the Mount Nansen Site (EDI 12-Y-0129 Hydrology Database 2012_2013.accdb). This enabled efficient QA/QC and will facilitate easy data transfer to AAM. The hydrometric data base was designed to hold raw field data including hydrometric station metadata, station history, field measurements, survey data and data logger files. The database also includes a table with hydrometric data that was calculated and processed in external software programs such as Aquarius Time-Series Software and MS Excel: (12-Y-01129_tbl_rating_curve_data, EDI 12-Y-0129 Hydrology Database 2012_2013.accdb). The hydrometric database also contains tracking information such that each stage of QA/QC can be checked for completion.



2.4 SURFACE WATER QUALITY

There are currently a total of 26 water quality sampling sites at the Mount Nansen Site (Table 5). Of these, 22 were visited on a bi-weekly basis from April 2012 through October 2012, and then monthly from November 2012 through February 2013. The pit lake was sampled monthly throughout the 2012/13 sampling year. One site (Dry Creek) is located one valley to the west of the site and was sampled seasonally, when not frozen (two to three times per year). Three additional sites are seeps that were located on site by AAM during the 2012/13 sampling program (WQ-MS-S-08, WQ-DAM-SEEP and WQ-ADIT-SEEP), and these sites were sampled as requested (not included on regular sampling events, unless by request).

Table 5. Mount Nansen water quality site and sampling information.

Water Quality Site Name	Site ID	Site Location ¹		Sampling Frequency	Parameters Included in Lab Analysis ²
		Easting	Northing		
Pony Creek upstream	WQ-PC-U	388955	6881745	Bi-weekly ³	Standard Site Package
Pony Creek downstream	WQ-PC-D	389131	6881719	Bi-weekly ³	Standard Site Package
Pit Lake (3 samples)	WQ-PIT-1,2,3	388913	6881625	Monthly	Pit Lake Package
Dome Creek at DX	WQ-DC-DX	387674	6881127	Bi-weekly ³	Standard Site Package
Dome Creek at DX+105	WQ-DC-DX+105	387820	6881150	Bi-weekly ³	Standard Site Package
Dome Creek at D1	WQ-DC-D1	388167	6881059	Bi-weekly ³	Standard Site Package
Dome Creek at D1b	WQ-DC-D1b	388264	6880989	Bi-weekly ³	Standard Site Package
Upper Dome 1	WQ-DC-U1	388919	6880772	Bi-weekly ³	Standard Site Package
Upper Dome 2	WQ-DC-U2	388938	6880812	Bi-weekly ³	Standard Site Package
Upper Dome Creek	WQ-DC-U	389788	6880565	Bi-weekly ³	Standard Site Package
Dome Creek at Road	WQ-DC-R	391111	6880449	Bi-weekly ³	Standard Site Package
Tailings Pond	WQ-TP	389427	6880625	Bi-weekly ³	Standard Site Package
Seepage Pond Outlet Pipe	WQ-SEEP	389604	6880598	Bi-weekly ³	Standard Site Package, LT50
Mill Site Seep 03	WQ-MS-S-03	387884	6881121	Bi-weekly ³	Standard Site Package
Mill Site Seep 08	WQ-MS-S-08	387954	6881073	Bi-weekly ³ , Nov. 2012	Standard Site Package
Adit Seep	WQ-ADIT-SEEP	389081	6881709	Periodically, Sept. 2012	Standard Site Package
Dam Seep	WQ-DAM-SEEP	389551	6880591	Periodically, July 2012	Standard Site Package
Back Creek	WQ-BC	391626	6880901	Bi-weekly ³	Standard Site Package
Minnesota Creek	WQ-MN	392540	6879249	Bi-weekly ³	Standard Site Package
Victoria Creek Reference Site	WQ-VC-REF	391650	6881113	Bi-weekly ³	Standard Site Package
Upper Victoria Creek	WQ-VC-U	391626	6880872	Bi-weekly ³	Standard Site Package
Victoria Creek downstream Back Creek	WQ-VC-DBC	391633	6880740	Bi-weekly ³	Standard Site Package
Victoria upstream of Minnesota	WQ-VC-UMN	392413	6879244	Bi-weekly ³	Standard Site Package



Water Quality Site Name	Site ID	Site Location ¹		Sampling Frequency	Parameters Included in Lab Analysis ²
		Easting	Northing		
Victoria Creek at Road	WQ-VC-R	392431	6878802	Bi-weekly ³	Standard Site Package
Pump House Well	WQ-PW	391558	6880856	Bi-weekly ³	Standard Site Package, Drinking Water Package
Dry Creek	WQ-DRY	387621	6880579	Seasonally	Standard Site Package

¹ NAD 83, UTM Zone 8.

² Parameters included in various sampling packages are explained in greater detail in Table 6.

³ Surface water quality sample sites were visited bi-weekly from April 2012 to October 2012 and monthly from November 2012 through March 2013.

2.4.1 Field Sampling Methods

While at the Mount Nansen Site, a number of water quality tasks were performed including collection of *in-situ* data, photo documentation, and collection of samples for analysis at an accredited laboratory.

A YSI ProPlus multi-meter was used to collect *in-situ* data including water temperature (°C), pH (pH units) and specific conductivity (µS/cm); an Oakton Turbidity meter was used to collect turbidity data (NTU). Photos were taken to record site conditions including the flow stage (high, regular, low), turbidity, presence of ice, snow, or any unusual observations.

Finally laboratory-cleaned bottles were filled using clean techniques (nitrile gloves, appropriate bottle handling) and samples were filtered and preserved on site, as needed. These samples were then organized and packaged appropriately with packing material and ice packs. They were then turned over to Air North cargo for shipping and delivery to Exova, an analytical lab in Surrey, BC.

Sampling of the pit lake was slightly different than that of the watercourses. The pit lake was sampled on a monthly basis during the 2012/13 season. The same data including collection of field parameter data, photos and water collection for laboratory analysis was performed. On each sampling event three samples were collected; one from the surface, middle of the water column, and just above the bottom sediments; these water samples were collected using a Van Dorn sampling bottle. *In-situ* data were collected at regularly spaced depth intervals using the YSI.

2.4.2 Laboratory Analysis

For the 2012/13 sampling program all surface water quality laboratory analyses were conducted by Exova, in Surrey, BC. Most sampling locations include samples collected for laboratory analysis of routine parameters, nutrients, cyanide parameters, total and dissolved metals (Table 6). Exceptions include the pit lake, which is not sampled for cyanide parameters, but is sampled for chlorophyll *a*, the seepage pond outlet where an LT50 test is conducted once every two months, and the Pump House well which is sampled for drinking water parameters. Surface water quality samples were collected at the Mount Nansen Site on the



last two days of each site visit (or all on the last day, where possible). This was done to ensure that all samples arrived at Exova within the prescribed ‘holding times’ for each parameter. Within three days of sample collection at Mount Nansen all samples arrived at the laboratory. Turnaround time, between when the samples were provided to the lab and results received, was approximately two weeks.

Table 6. Laboratory analysis parameters included in various ‘packages’ created for surface water quality sampling at Mount Nansen.

Analysis Package	Parameters Included
Standard Site Package	Cyanides: Cyanate, Total Cyanide (as Strong Acid Dissociable), Weak Acid Dissociable, Thiocyanate Physical Tests: Conductivity, Hardness, pH, Total Dissolved Solids, Total Suspended Solids Anions and Nutrients: Bicarbonate, Carbonate, Hydroxide, Total Alkalinity, Total Ammonia, Chloride, Fluoride, Nitrate, Nitrite, Sulphate Total Metals: Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Phosphorus, Potassium, Selenium, Silicon, Silver, Sodium, Strontium, Sulfur, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc. Dissolved Metals: Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Phosphorus, Potassium, Selenium, Silicon, Silver, Sodium, Strontium, Sulfur, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc.
Pit Lake Package	Physical Tests: Conductivity, Hardness, pH, Total Dissolved Solids, Total Suspended Solids Anions and Nutrients: Bicarbonate, Carbonate, Hydroxide, Total Alkalinity, Total Ammonia, Chloride, Fluoride, Nitrate, Nitrite, Sulphate Total Metals: Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Phosphorus, Potassium, Selenium, Silicon, Silver, Sodium, Strontium, Sulfur, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc. Dissolved Metals: Aluminum, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Magnesium, Manganese, Mercury, Molybdenum, Nickel, Phosphorus, Potassium, Selenium, Silicon, Silver, Sodium, Strontium, Sulfur, Thallium, Tin, Titanium, Uranium, Vanadium, Zinc. Plant Pigments: Chlorophyll a, Pheopigments
Drinking Water Package	Physical Tests: True Colour, Conductivity, Hardness, pH, Total Dissolved Solids, Turbidity Anions and Nutrients: Alkalinity, Total, Chloride, Fluoride, Nitrate, Nitrite, Sulphate Total Metals: Aluminum, Antimony, Arsenic, Barium, Boron, Cadmium, Calcium, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Potassium, Selenium, Sodium, Uranium, Zinc.
LT50	LT50 test, 96-hr test to be conducted with Rainbow trout.



2.4.3 QA/QC Program

Due to the large amount of samples collected at the Mount Nansen Site, a rigorous QA/QC program has been established. Beginning in 2012 all surface water quality sampling was done in a 'blind' fashion. All sample bottles were labeled with a unique EDI identifier to prevent the laboratory from knowing whether it was a site sample, or a sample taken as part of the QA/QC program.

Each sampling visit included the collection of at least one replicate sample, a field blank sample, and a trip blank sample (representing 10% of the total sampling program on each sampling visit). A replicate sample was collected from a randomly selected water quality site to determine the accuracy of laboratory results across a site. The field blank sample, filled with deionized water on site, was used to determine if there was any contamination associated with sampling methodology. The trip blank sample was used to determine if there was any additional contamination with sample handling.

As part of the post trip QA/QC of laboratory analysis data collected at randomly selected replicate sites, replicate data was compared with the actual site data to determine if they were within acceptable limits (10%). Also, field and trip blank data were reviewed to ensure that concentrations of all potential contaminants was low to below detection limits; this data was also used to investigate determine if any abnormal spikes appeared in the analyses of established water quality sites. Any abnormalities found in the data were discussed with the analytical laboratory and resolved as necessary.

2.4.4 Data Management and Analysis

Upon receipt from the laboratory, data from each trip were reviewed to determine if there were any errors in laboratory reporting. Following this review, data were organized and uploaded to the Mount Nansen surface water quality database (MS Access, EDI 12-Y-0129 Water Quality 2012_2013.accdb). The database includes tables with historical data (dating back to 1999), information on units and guidelines for various parameters (described further below), water quality lab results data from each trip, and water quality site information (including location).

For the purpose of this data report, the data were reviewed and parameters of concern were graphed and compared with the Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of freshwater aquatic life (CCME AL; CCME 2012; Table 7), and with the effluent discharge standards outlined in Yukon Water Board Water license No. QZ94-004, issued to BYG Natural Resources Inc. on February 13, 1996 (Yukon Water Board 1996; Table 8). In addition, water quality results from the Pump House Well site (WQ-PW) were compared to the Health Canada Drinking Water Guidelines (Health Canada, 2012; Table 9).

Figures were created for all parameters to which CCME AL guidelines or effluent discharge standards apply (Appendix C, Figures C1 through C10). All figures associated with physical parameters, nutrient parameters and cyanide parameters are included in Appendix C. Due to the large amount of data associated with total metals concentrations, only those figures of metals of concern (i.e. those present at concentrations exceeding applicable guidelines/standards) are included in this report.



Table 7. CCME AL Guidelines applicable to Mount Nansen surface water quality sampling program.

Water Quality Parameter	CCME AL Guideline	Comments
Aluminum	0.1 mg/L	CCME is 0.1 at pH > 6.5, if pH is lower than 6.5, guideline is set at 0.005 mg/L
Ammonia	0.75 mg/L	Guideline is temperature and pH dependent. This represents a highly conservative guideline calculated for a pH of 8.5 and a water temperature of 0°C. Guideline decreases with increasing pH and temperature.
Arsenic	0.005 mg/L	-
Cadmium	0.000033 mg/L	Guideline is hardness dependent; this value is for a hardness of 100 mg/L, conservative for the Mount Nansen Site.
Chloride	120 mg/L	-
Chromium	0.0089 mg/L	-
Copper	0.002 mg/L	Guideline is hardness dependent; this value is for a hardness of 100 mg/L, conservative for the Mount Nansen Site.
Total Cyanide	0.005 mg/L	SAD Cyanide is used as a measure of total cyanide
Fluoride	0.120 mg/L	-
Iron	0.3 mg/L	-
Lead	0.003 mg/L	Guideline is hardness dependent; this value is for a hardness of 100 mg/L, conservative for the Mount Nansen Site.
Molybdenum	0.0073 mg/L	-
Nickel	0.1 mg/L	Guideline is hardness dependent; this value is for a hardness of 100 mg/L, conservative for the Mount Nansen Site.
Nitrate	13 mg/L	-
Nitrite	0.06 mg/L	-
pH	6.5 - 9.0	-
Selenium	0.001 mg/L	-
Silver	0.0001 mg/L	-
Thallium	0.0008 mg/L	-
Uranium	0.015 mg/L	-
Zinc	0.03 mg/L	-

Table 8. Mount Nansen effluent discharge standards, as outlined in Yukon Water License #QZ94-004 (Yukon Water Board 1996).

Water Quality Parameter	Effluent Discharge Standard
pH	6.0 to 8.5
Total Suspended Solids (TSS)	50 mg/L
Toxicity (LC50 – 96 hr. for rainbow trout, pH non-adjusted)	100%
WAD Cyanide	0.1 mg/L



Water Quality Parameter	Effluent Discharge Standard
Total (SAD) Cyanide	0.3 mg/L
Antimony (Total)	0.15 mg/L
Arsenic (Dissolved)	0.15 mg/L
Barium (Total)	1.0 mg/L
Cadmium (Total)	0.02 mg/L
Chromium (Total)	0.04 mg/L
Copper (Total)	0.2 mg/L
Iron (Total)	1.0 mg/L
Lead (Total)	0.1 mg/L
Manganese (Total)	0.5 mg/L
Mercury (Total)	0.005 mg/L
Nickel (Total)	0.3 mg/L
Silver (Total)	0.10 mg/L
Zinc (Total)	0.30 mg/L

Table 9. Health Canada Guidelines for Canadian Drinking Water applicable to Mount Nansen surface water quality sampling program.

Water Quality Parameter	Health Canada Drinking Water Guideline
Antimony (Total)	0.006 mg/L
Arsenic (Total)	0.010 mg/L
Barium (Total)	1.0 mg/L
Boron (Total)	5 mg/L
Cadmium (Total)	0.005 mg/L
Chloride (Dissolved)	250 mg/L (AO) *
Chromium (Total)	0.05 mg/L
Copper (Total)	1.0 mg/L (AO)
Cyanide (Total or SAD)	0.2 mg/L
Fluoride	1.5 mg/L
Iron (Total)	0.3 mg/L (AO)
Lead (Total)	0.010 mg/L
Manganese (Total)	0.05 mg/L (AO)
Mercury (Total)	0.001 mg/L
pH	6.5 to 8.5
Selenium (Total)	0.01 mg/L
Sodium (Dissolved)	200 mg/L (AO)



Water Quality Parameter	Health Canada Drinking Water Guideline
Sulphate	500 mg/L
Total Dissolved Solids (TDS)	500 mg/L
Uranium (Total)	0.02 mg/L
Zinc (Total)	5.0 mg/L (AO)
Total Coliforms	Maximum acceptable concentration of none detectable/100 mL

* AO – Aesthetic objective



3 RESULTS & DISCUSSION

3.1 METEOROLOGY

Meteorological data from the ATM-ROAD AAM station is summarized below for the April 1, 2012 to February 28, 2013 period. All data is plotted in Appendix A (Figures A1 to Figure A10) and represents raw, uncorrected hourly data downloaded directly from the meteorological station. The plotted data also includes data from October 2011 to November 2012. Selected summary statistics for air and ground temperature, rainfall, snow depth and wind direction and wind speed are provided in Table 10. Raw data are provided in Appendix E.

3.1.1 Air and Ground Temperature

In April 2012, minimum and maximum air temperatures were -9.1 °C to 6.2 °C, respectively (Table 10; Appendix A, Figure A1). From May 2012 to September 2012 mean monthly temperatures remained above zero degrees. Daytime high temperatures from May 2012 to September 2012 were around 20 °C with daytime lows dropping below zero. The maximum air temperature recorded from May 2012 to September 2012 was 22.8 °C on July 21, 2012. In October 2012, the mean monthly temperature was below zero degrees, -6.2 °C. From November 2012 to January 2013 there were large variations in air temperatures ranging from -36.4 °C (January 28, 2013) up to 3.9 °C (January 14, 2013). Mean monthly temperatures from November 2012 to January 2013 ranged from -13.3 °C to -18.4 °C. In February 2013, air temperature fluctuations were smaller ranging from -17.3 °C to 0.6 °C. The mean air temperature for February was -8.5 °C, which was much warmer for other months over the winter (November 2012 to January 2013).

The Carmacks Environment Canada meteorological station air temperature data from April 2012 to February 2013 is summarized in Table 11 for comparison. Note the minimum temperature recorded in Carmacks was much lower than at Mount Nansen, down to -44.6 °C (December 19, 2012). The maximum temperature recorded in Carmacks was much higher than Mount Nansen at 29.9 °C (June and July 2012).

Mean ground temperatures stayed below zero degrees over the spring until May 2012 when temperatures began to rise gradually (Table 10; Appendix A, Figure A1). Mean ground temperatures for June 2012 to August 2012 ranged from 12.3 °C to 14.6 °C. The maximum ground temperature recorded was 36.3 °C in July 2012. Temperatures dropped gradually from September 2012 onwards, until mean ground temperatures remained below zero degrees by mid-October. The minimum ground temperature recorded was -12.9 °C in October 2012, and was likely related to the minimal snow depth at that time of year, as snow provides an insulation layer against cold air temperatures. Mean ground temperatures from November 2012 to February 2013 ranged from -4.2 °C to -6.4 °C.



3.1.2 Precipitation

The hourly rainfall record shows numerous rainfall events through the summer, with the highest hourly rainfalls concentrated through late-June 2012 to August 2012, with rainfall events of up to 5.3 mm per hour (Appendix A, Figure A2 and Figure A3; Table 10). Monthly rainfall accumulation over June, July and August 2012 was 61.1 mm, 62.8 mm and 78.5 mm, respectively. Precipitation was lower on either side of this period, only 20.6 mm in May 2012 and 20.8 mm in September 2012. In early October 2012 precipitation began to fall as snow with little to no rainfall through February 2013. One exception was a rainfall event on January 14, 2013 (Appendix A, Figure A2) with an accumulation of 16.4 mm over the day and a maximum hourly rainfall intensity of 2.0 mm/hr. This event was attributed to warm air temperatures, as temperatures were above zero degrees for the day, reaching a maximum of 3.9 °C (Appendix A, Figure A1; Table 10).

Snow depth at the site dropped off sharply in early April 2012 and dropped to zero by mid-May 2012 (Appendix A, Figure A4). Note the snow depths in Table 10 and Figure A4 in Appendix A show a snow depth above zero through the summer. This data error was addressed on August 30, 2012 when the snow sensor was calibrated by Northern Avcom. Prior to this date an offset was applied to all snow data (for the purposes of this report, data has been left in its raw form). In the fall, snow began falling in October 2012 (Appendix A, Figure A4), with the snow depth gradually increasing to 64.5 cm by the end of February 2013 (Table 10). The highest snowfalls occurred in October 2012 and December 2012, with recorded snow depths increasing by 20 to 30 cm during these months, respectively. A detailed account of snow condition at the Mount Nansen Site for 2012/13 will be provided in a final snow survey report following the completion of the final snow surveys in April 2013.

3.1.3 Wind

Wind conditions at the Mount Nansen Site from April 2012 to September 2012 show the dominant wind directions as south, southwest and southeast (Appendix A, Figure A5). The highest wind speeds during this summer period also came from these directions, with a maximum wind speed of 10.5 m/s (37.8 km/h) (Appendix A, Figure A6 and Figure A8; Table 10). Wind direction is typically more variable in the winter (November 2012 to February 2013; Appendix A, Figure A7), with dominant winds from the southwest and northeast, with winds also from the south, southeast, and west. The highest wind speed recorded during the winter period was 11.5 m/s (41.4 km/h) (Table 10; Appendix A, Figure A8). The highest wind speeds occurred in February 2013, followed by January 2013 and September 2012 (Appendix A, Figure A8). Overall, average wind speeds were highest in May 2012 and September 2012, 3.5 m/s (12.6 km/h) and 3.3 m/s (11.9 km/h), respectively.



3.1.4 Radiation Fluxes

Net radiation is the balance of solar energy emitted from the sun in the form of shortwave radiation and longwave radiation emitted from the surface of the earth. In the north, latitude and sun angle influence the incidence of shortwave radiation; similarly, seasonal changes in ground surface cover (i.e., snow, green vegetation) influence longwave emissions. This balance of radiation fluxes is clearly visible in the Mount Nansen data (Appendix A, Figure A9), as ground surface attributes and sun angles change through the year. Net solar radiation fluctuated around 0 W/m² during the spring, and then increased up to 500 W/m² by May 2012. Net solar radiation remained high over the summer and declined gradually between August 2012 and November 2012. Net radiation remained around zero between November 2012 and February 2013.

3.1.5 Relative Humidity

Relative humidity at the site ranged from 30% to 100% (Appendix A, Figure A10). The largest fluctuations were through the summer, from April 2012 to September 2012, resulting from summer rainfall events combined with warmer, dryer weather. Fluctuations in relative humidity were smaller during the winter period from October 2012 to February 2013. A higher relative humidity was observed from October 2012 to February 2013. There were also frequent small increases in relative humidity through January 2013 and February 2013, likely caused by snow melt and/or evaporation due to air temperatures above zero degrees.

3.1.6 Historical Comparison

Meteorological data dating back to 2000 is available for the Mount Nansen Site, in addition to snow data dating back to 1976. From 2000 to 2006, a meteorological station was installed at the northeast edge of the Tailings Pond (ATM-TAILINGS, elevation 1,125 m). This station measured wind, precipitation, snow depth, temperature, relative humidity and solar radiation. Following damage to that station in 2006, a new station was installed outside the camp kitchen building (ATM-CAMP, elevation 1,250 m). This station operated from 2007 to 2011 and measured wind, rainfall, temperature and relative humidity. The records from both of these stations were summarized in EDI 2010, and are provided in Appendix A, Table A1 and Table A2. For the purposes of this report, data collected as part of the 2012/13 program are compared to these historical data records from 2000 to 2011.

Air temperatures over the course of the 2012/13 monitoring program were lower than average for several months compared to the historical ATM-CAMP and ATM-TAILINGS records (May, June, July, October, November, and December 2012). Mean monthly temperatures for April 2012, January 2013 and February 2013 were above average, while August 2012 and September 2012 were average. For extreme low and high temperatures recorded on site, the 2012/13 temperature record was milder compared to the -41.5 °C and



-47.7 °C, and the 25.4 °C and 27.1 °C recorded for the ATM-TAILINGS and ATM-CAMP meteorological records, respectively.

The mean monthly rainfalls over the course of the 2012/13 monitoring program were above average for June and August 2012, but below average for May, July, September and October 2012 compared to the available monthly precipitation data from the ATM-CAMP and ATM-TAILINGS stations. The highest monthly rainfall recorded on site was 119.8 mm in July 2008.



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Table 10. Summary of ATM-ROAD station hourly meteorological data from April 2012 to February 2013.

Month	Air Temperature (°C)			Ground Temperature (°C)			Rainfall (mm)		Snow Depth* (cm)		Wind Direction (degrees) Median	Wind Speed (m/s)	
	Min	Max	Mean	Min	Max	Mean	Max Hourly	Cumulative Monthly	Max	Mean		Max	Mean
Apr-2012	-9.1	6.2	0.1	-4.0	10.5	-0.3	0.7	2.5	68.7	49.3	139.5	7.5	2.4
May-2012	-4.8	15.3	2.8	-5.9	28.5	6.4	3.1	20.6	27.4	9.3	179.0	9.6	3.5
Jun-2012	-1.5	21.7	8.8	-3.1	34.5	13.0	4.3	61.1	3.8	2.9	170.8	7.2	2.7
Jul-2012	-0.1	22.8	10.0	1.8	36.3	14.6	5.3	62.8	5.6	2.9	193.3	7.9	2.6
Aug-2012	-0.9	19.2	9.3	-0.9	35.0	12.3	5.1	78.5	3.8	2.7	213.3	6.1	2.2
Sep-2012	-5.5	19.4	4.2	-3.0	17.5	4.3	3.0	20.8	1.0	0.0	194.5	10.5	3.3
Oct-2012	-17.8	13.4	-6.2	-12.9	9.5	-3.7	1.8	9.7	22.8	6.7	171.6	7.3	1.8
Nov-2012	-24.9	-2.9	-16.7	-9.8	-2.7	-6.1	0.3	0.3	34.2	26.1	129.7	5.8	1.6
Dec-2012	-32.1	-0.6	-18.4	-10.6	-3.4	-6.4	0.0	0.0	60.2	44.3	172.9	8.2	1.8
Jan-2013	-36.4	3.9	-13.3	-9.3	-0.5	-4.9	2.0	16.4	54.6	50.4	207.4	10.5	1.8
Feb-2013	-17.3	0.6	-8.5	-5.3	-3.6	-4.2	0.1	0.5	64.5	59.2	172.0	11.5	1.9

* The snow sensor was calibrated by Northern Avcom on August 30, 2012, thus data prior to this date would require a corrective offset be applied.



Table 11. Environment Canada Carmacks meteorological station (number 2100301) data summary for April 2012 to February 2013.

Month	Air Temperature (°C)		
	Minimum	Maximum	Mean
April	-12.9	14	2.5
May	-6.3	22.7	7.0
June	0.8	29.9	13.4
July	-0.5	29.9	14.2
August	-2.1	25.5	12.7
September	-7.2	25.7	7.9
October	-24.4	17.2	-5.3
November	-42.5	-5.5	-21.0
December	-44.6	1.3	-29.3
January	-43.1	2.2	-20.4
February	-30.4	5.4	-12.5



3.2 SURFACE WATER HYDROLOGY

Discharge measurements were obtained from each of the 20 hydrometric stations. The total number of instantaneous discharge measurements for each station ranged between 12 and 14 (Appendix B, Table B2). The onset of winter ice conditions began in early October 2012, however the timing of full ice cover or freezing to bed varied among stations. Stations that froze to the bed were verified for zero flow in November and December 2012. Once reported as frozen to bed, the station was not re-visited for the remainder of the winter. During winter, flow was observed at all Victoria Creek stations, H-SEEP and H-DC-M. All stations continued to be affected by ice as of February 12, 2013.

Discharge measurements collected during winter at the Mount Nansen Site are assumed to have increased uncertainty due to the backwater effect of ice on channel hydraulics therefore these measurements were excluded from the stage-discharge rating curves. The number of rating measurements for stations with continuous loggers ranged from seven to 13; professional judgment was used to exclude measurements based on site specific ice or channel stability conditions. Several rating curves use discharge values obtained from multiple measurement methods for a given stage.

Analysis of hydrometric leveling surveys for each site visit showed that there appeared to be some movement of benchmarks over time. At present, it is thought that the apparent movement is a result of seasonal changes to the ground surface (active layer). If required, adjustments were made to accommodate this when the water level logger data was adjusted to the local site datum. All corrections were documented in the hydrometric data processing software files, Aquarius Time-Series Software.

A full summary of the hydrometric monitoring record is in Appendix B, Table B2. The barometric pressure time-series, hydrographs and rating curves (organized by watershed and ordered in the upstream to downstream direction) are also in Appendix B. Full station descriptions including photographs and site sketches are presented in Appendix D. A copy of the hydrometric database containing all raw field data is located in Appendix E.

While the hydrometric gauging stations meet the majority of the criteria for data Grade A, the data grade is on average Grade B due to small channel sizes, discharge-rating accuracy, and challenging operating conditions at the site (see RISC 2009). The following sections describe the key results of the hydrologic monitoring at each gauging station.

3.2.1 Pony Creek Watershed

3.2.1.1 Upper Pony Creek (H-PC-U)

The Upper Pony Creek gauging station (H-PC-U) was originally established in 2009 to supplement the hydrogeological investigations on site (AECOM 2010). The gauging station is located in the upper watershed (elevation of 1227 m), draining an area of 0.84 km² that has been historically disturbed by mineral



exploration activity. Remnant landscape features (berms formed by trenching activities) constrain the channel at and upstream of the H-PC-U gauging station. Placer activity was active upstream and adjacent to the gauging station in 2012 and consisted of ground surface disturbance and several deep excavations near the creek.

The channel near the station was approximately 0.1 to 0.3 m deep and 0.25 to 0.75 m wide and there were shrubs, mosses and grasses along the banks of the channel which influence streamflow conveyance. The small channel size rendered the station unsuitable for standard velocity-area measurements and non-ideal for salt tracers at higher stages. The methods for discharge measurement at this station included using a v-notch weir, volumetric measurements, and salt dilution gauging. The volumetric measurements are considered to have the highest accuracy at this station followed by the weir and salt dilution gauging, respectively. There were several dates when the v-notch weir was either not in service or leaking (less than approximately 1.0 L/s) therefore salt dilution gauging, while not ideal, was used throughout the season for calibration to the other methods (when used) as a replicate measurement. In the fall, the last measurement was obtained on October 16, 2012; station was visited on November 15, 2012 however the channel was frozen to the bed and no discharge measurement could be obtained.

Ice was still present at the station on the May 14, 2012 visit, but had melted by May 29, 2012. The continuous data logger, which had been removed for the 2011/12 winter, was re-installed May 31, 2012 and winterized on September 18, 2012 such that several more weeks of the recession to baseflow could be obtained before freeze up. The effects of ice in the logger sensor began shortly after winterization and the continuous record was trimmed accordingly to remove spurious data. The water level logger was removed in December 2012.

The v-notch weir installed in 2011 (Weir Design 1) was replaced on July 24, 2012 (Weir Design 2) due to winter damage and leakage around the weir abutments. The new installation eliminated leakage around the new abutments; however the spring water levels were higher in the head pond than observed in 2011 causing water to overtop the containment berm on several occasions. Flow rate estimates of the leakage were obtained each time that overtopping was observed. It is assumed that the higher water levels were a result of the 2012 snowmelt dynamics, higher precipitation in the spring and possibly changes to surface water routing due to increased placer activity upstream of the station.

There were 15 station visits from May 1, 2012 to February 12, 2013 (Appendix B, Table B2; Table B3); the last two measurement events in 2012 verified zero flow due to ice. Twelve open water discharge measurements were selected to develop the rating curve for the continuous logger however the rating measurements produced a curve with high uncertainty. The sources of error are assumed to be associated with channel geometry and small range in stage near the stilling well. A rating curve was not produced for this station therefore only the stage record and instantaneous discharge measurements are presented in this report (Appendix B, Figure B2 and Figure B3).

Discharge measurements from the weir (Weir Design 2) ranged from 0.001 m³/s to 0.015 m³/s. Discharge measurements based on salt dilution gauging between May 1, 2012 and October 16, 2012 ranged from 0.002 m³/s to 0.017 m³/s, while volumetric measurements ranged from 0.002 m³/s to 0.004 m³/s. The highest



measured discharges occurred in mid-May while the lowest flows occurred in early spring and late fall (Appendix B, Table B3, Figure B2).

The 90° v-notch weir measurements were validated using volumetric measurements obtained at the weir outlet (Figure 4). The results indicated that the volumetric measurements for the original weir (Weir Design 1) were on average 1.4 times higher (n=6) than the discharges calculated using the weir equation. The volumetric discharge measurements obtained from the replacement weir (Weir Design 2, July 24, 2012) were on average 1.2 times higher (n=6) than those calculated with the standard weir equation (Figure 4).

A preliminary calibrated weir equation is proposed for Weir Design 2:

$$Q = 1.052h^{2.242} \quad [10]$$

Where Q is discharge (m³/s) and h is hydraulic head (m). The calibrated weir equation was based on a best-fit line (n = 6, R² = 0.85) through the volumetric discharge measurement values collected from the outlet of Weir Design 2 (Figure 4); the strength of the equation will increase with more concurrent measurements.

The salt dilution gauging produced discharges that were higher than the volumetric measurements in all cases except for May 29, 2012 and October 3, 2012. The over estimation of the salt tracer is likely associated with the influence of mosses and other vegetation on the channel banks on the passage of the salt slug. Small discharge magnitudes, such as those seen at this station (less than 15 L/s), generally have a higher level of uncertainty for all measurement methods.

Peak discharge during did not occur during the freshet, rather it occurred in August 2012 and was associated with a storm event; the peak rainfall for the season was August 9, 2012 at 03:00 (5.1 mm/hr) and peak stage at H-PC-U August 9, 2012 at 22:30. On August 28, 2012 at 01:25 the second highest stage was recorded, again, associated with a storm event. The freshet peak was the third highest stage recorded on June 14 at 17:00; followed by multiple smaller peaks in late June and early July. The main freshet event occurred over approximately five days whereas the duration of storm related events are 1 to 3 days depending on the storm length. This hydrologic behavior indicates that the watershed is highly responsive to storm events and that they can produce higher stages (and presumably higher discharges, but none of the peaks could be field verified) than the freshet event.

If a continuous water level logger is required at this station in 2013, it is recommended to re-locate the stilling well and logger upstream of the v-notch weir and conduct some earthworks maintenance on the weir head pond to increase capacity.

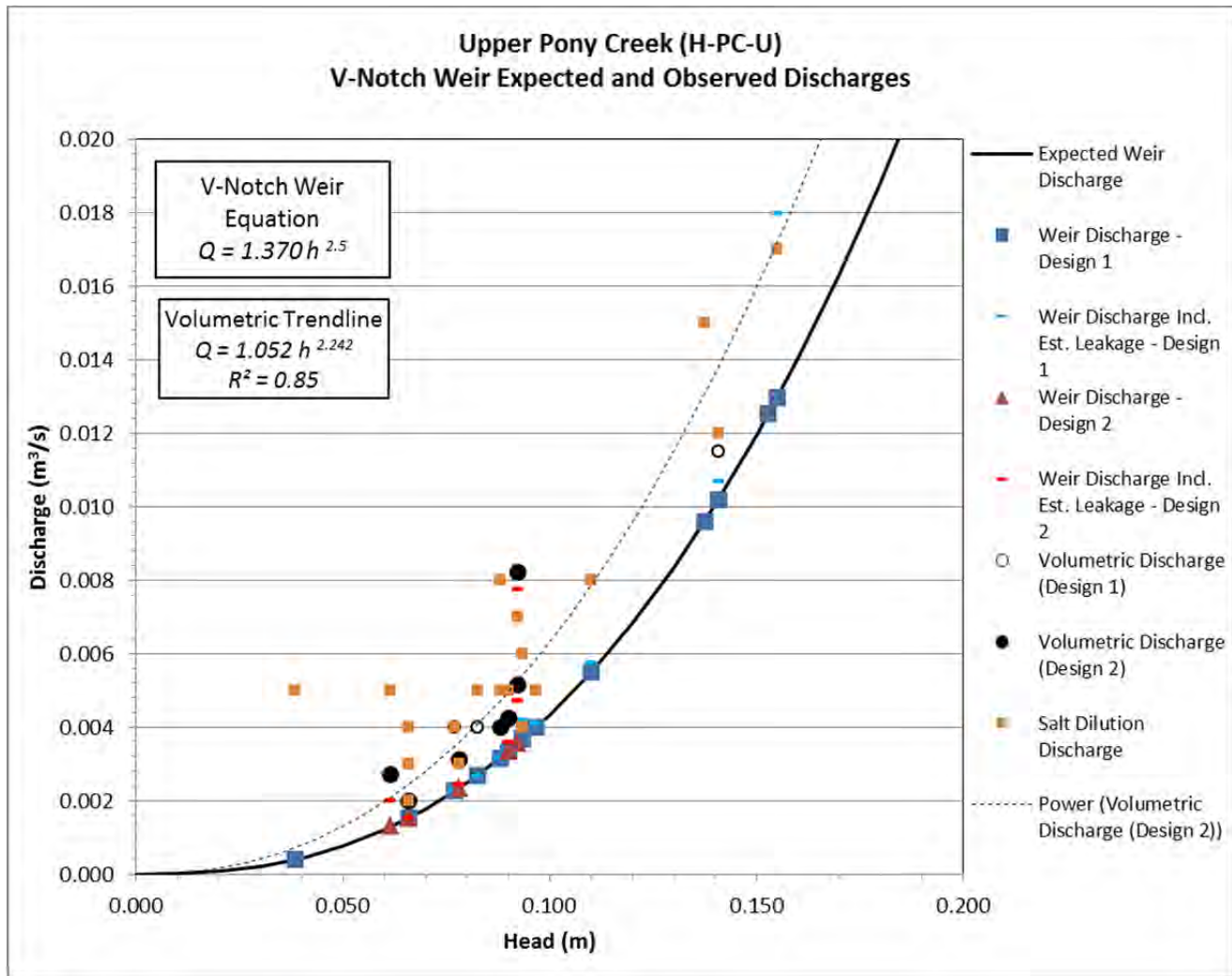


Figure 4. Upper Pony Creek (H-PC-U) V-notch weir expected and observed discharges with concurrent salt tracer and volumetric discharge measurements. Weir Design 1 (June 11, 2011 to July 24, 2012) and Weir Design 2 (July 24, 2011 to present) are shown. Note: Salt dilution gauging is conducted in the reach downstream of the weir and stilling well; Q_{salt} scatter associated with poor channel conditions.

3.2.1.2 Pony Creek Downstream of the Pit (H-PC-DSP)

A second hydrometric station on Pony Creek (H-PC-DSP) is located downstream of H-PC-U, below the Back Creek access road culvert. This station was established in 2009 along with H-PC-U to supplement the Mount Nansen hydrogeological investigations (AECOM 2010). Despite its namesake, this surface water gauging station does not appear to be down gradient of the pit and it is uncertain how much, if any, of the water at this station includes contributions from the open pit via a shallow groundwater connection. There is a small, stable rock weir downstream of the stilling well that was installed in 2011 to provide a channel control for the stilling well pool and facilitate continuous monitoring with the level logger.



Wetted widths for the stream at the station ranged from 0.15 to 0.50 m, while depths ranged from 0.05 to 0.20 m, making the station unsuitable for standard discharge measurement methods. Volumetric measurements were obtained from the road culvert outlet 15 m upstream of the stilling well, and salt dilution gauging was conducted with the injection site on the upstream side of the culvert to facilitate mixing. The channel branches into multiple channels downstream of the stilling well and re-converges upstream of the salt dilution electrical conductivity monitoring location. The volumetric measurements for this station are considered to have the highest accuracy due to the divergent channels in the salt dilution reach; salt dilution was used as a replicate measurement method. In the fall, the last measurement was obtained on October 16, 2012, after which the channel froze to the bed.

Ice was still present on the May 15, 2012 visit, however water was flowing and the data logger was re-installed in the stilling well. The small channel was ice free on May 28, 2012, similar to H-PC-U. A staff gauge shift occurred on the July 9, 2012 visit, due to sedimentation within the well. The data logger was winterized on September 18, 2012 prior to the onset of ice in the channel such that several more weeks of recession to baseflow data could be obtained before freeze-up. The effects of ice on the logger sensor began shortly after winterization and the continuous record was trimmed accordingly to remove spurious data. The station was visited on November 15, 2012, however the channel was frozen to the bed and no discharge measurement could be obtained. The water level logger was removed in December 2012.

Concurrent volumetric and salt tracer discharge measurements were obtained during each station visit. Similar to 2011/12 results, the discharge values obtained via the salt dilution method were higher than those obtained using the volumetric method. In 2012/13 the discharge obtained with the salt tracer was 1.2 to 5.0 times greater than that of the volumetric measurement (Figure 5). The discrepancy between these two measurement methods is thought to be due to salt dilution measurement errors resulting from channel geometry and bank vegetation influencing the passage of the salt tracer. Small discharge magnitudes such as those seen at this station (generally less than 12 L/s) have a higher level of uncertainty for all measurement methods. Although volumetric measurements were not feasible at the highest flows, the volumetric method is considered more accurate than the salt tracer at this station.

There were 16 station visits from April 17, 2012 to February 12, 2013 (Appendix B, Table B2; Table B3). Sixteen potential discharge measurements from the open water season (multiple methods) were selected to develop a rating curve for the continuous logger however the rating measurements produced a curve with high uncertainty. A rating curve was not produced for this station therefore only the stage record and instantaneous discharge measurements are presented in this report (Appendix B, Figure B4 and Figure B5). Based on volumetric measurements, discharge ranged from below reportable confidence levels ($<0.000 \text{ m}^3/\text{s}$) to $0.006 \text{ m}^3/\text{s}$ (excluding peak flows) between April 17, 2012 and February 12, 2013. In comparison, the salt dilution measurements ranged from $0.002 \text{ m}^3/\text{s}$ to $0.033 \text{ m}^3/\text{s}$ (including peak flows) for the same time period. The highest measured discharges occurred in late May; peak discharge occurred during the freshet on May 24, 2012 at 21:00. The lowest flows occurred in early spring before the upper watershed snowpack fully melted and in the fall as discharge receded to baseflow before freezing.



The rising and falling limbs of the freshet peak were comprised of strong diurnal fluctuations indicating that air temperature is a key factor in regulating the flow at this time of year for this station. The main freshet event occurred over approximately two weeks. The hydrologic behavior of this station is quite different than that of the upstream station, H-PC-U. A highly vegetated channel, a wet mossy floodplain and a deep pool upstream of the Pony Creek road crossing likely play a large role in attenuating storm flows in the summer and regulate the rate of melting ice/aufeis upstream of the station. The stage record from H-PC-DSP does indicate response to the storm events in July and August 2012, but the maximum stage associated with these events was not greater than the freshet.

Non-ideal channel conditions for continuous hydrometric data collection resulted in challenges for developing a rating curve with low uncertainty in 2012/13. These channel conditions warrant consideration of installing a v-notch weir which would improve the stage-discharge relationship at the continuous gauge. If a weir is installed, a continuous data logger could be installed in the head pond. Instantaneous measurements using volumetric and/or salt dilution are recommended to continue for this station in 2013.

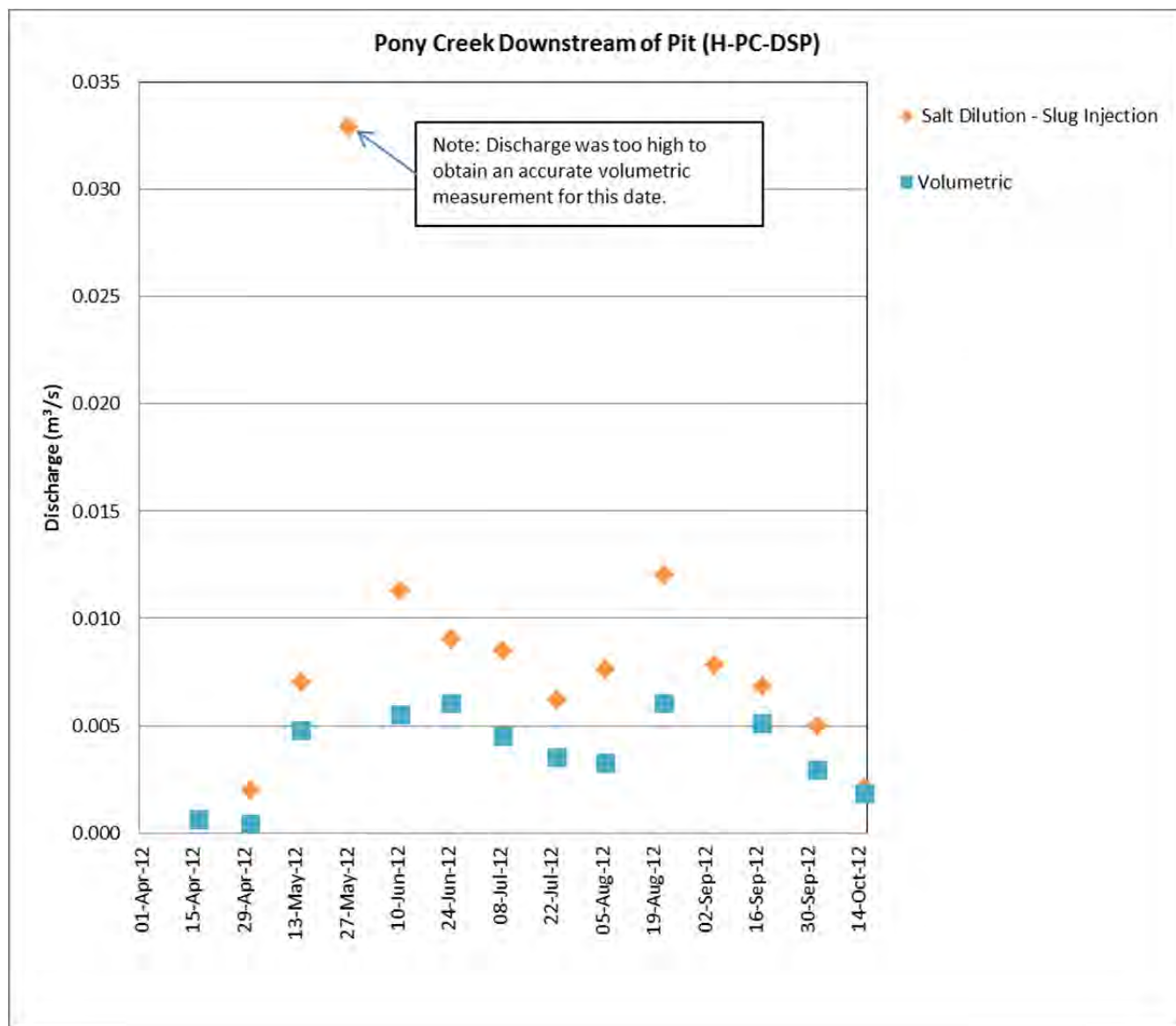


Figure 5. Comparison of salt dilution gauging and volumetric measurements collected at Pony Creek Downstream of Pit (H-PC-DSP) in 2012.

3.2.2 Dome Creek Watershed

3.2.2.1 H-DC-DX

The H-DC-DX station is the highest elevation hydrometric station in the Dome Creek watershed and has a very small contributing basin. The drainage area is 0.21 km^2 and it is assumed to be fed predominantly by groundwater. Located upstream of the mine site footprint, the station was originally established for water quality sampling (WQ-DC-DX) as an upstream control site.



The channel is poorly defined and braids through willow shrub, mosses and grasses. Average wetted width at the station is 0.10 m with an average depth of 0.07 m, making the station unsuitable for standard discharge measurement methods. This station is an instantaneous measurement station with no logger, stilling well, or staff gauge.

A total of 11 measurement events were completed from May 1, 2012 to February 12, 2013 (Appendix B, Table B2; Table B3). In 2012, ice remained over the channel for the May 1, 2012 and May 14, 2012 visits with low flows beneath the ice. In the winter the channel freezes to substrate relatively early in the fall; by the October 16, 2012 visit, the channel was covered in ice and snow with only a few centimeters of water (not measurable) flowing beneath the ice.

Salt dilution gauging was used for two trips (May 29, 2012 and June 12, 2012) until the volumetric method at the culvert downstream was deemed more suitable as an estimate of flows. Measurements from June 27, 2012 onward were collected from the culvert outlet until October 2, 2012 when the culvert was nearly 100% frozen, with only a trickle of water coming through the ice.

Discharge measurements ranged from below reportable confidence levels ($<0.000 \text{ m}^3/\text{s}$) to $0.007 \text{ m}^3/\text{s}$ between May 1, 2012 and September 17, 2012. The highest measured discharges occurred in the early fall whereas the remainder of the open water season maintained a constant discharge of $0.001 \text{ m}^3/\text{s}$. The hydrograph of instantaneous discharge measurements and associated data is shown in Appendix B, Figure B6.

In 2013 it is recommended to collect all discharge measurements at the culvert outlet for ease of measurement. Flow that enters the culvert is upstream of the mill site is representative of the upper Dome Creek watershed.

3.2.2.2 H-DC-DX+105

The H-DC-DX+105 station is located 105 m downstream of the H-DC-DX/WQ-DC-DX location (drainage area = 0.52 km^2). This station typically remains open for most of the winter as it receives groundwater through a seep near the mill. The channel is poorly defined with a bed of sand and silt. The channel averages 0.60 m wide and 0.05 m in depth, making the station unsuitable for standard discharge measurement methods.

This station is an instantaneous measurement station with no logger, stilling well, or staff gauge. A total of 12 measurement events were completed from May 1, 2012 to February 12, 2013. Salt tracer tests were used to characterize flow at the station on the May 1, May 14, May 29, and June 12, 2012 visits. Ice with open water areas was still present on the channel up to May 14, 2012 and completely disappeared by May 29, 2012.

The low discharges present after late June 2012 created shallow, slow moving water; salt dilution gauging in these conditions was difficult with higher uncertainty. Volumetric measurements replaced the salt dilution



gauging as measurement method for this station from June 27, 2012 to October 16, 2012. Water volumes were measured at the road culvert upstream used for H-DC-DX measurements. During the late spring and summer, the volume exiting the culvert was approximately the same as observed at the normal H-DC-DX+105 station indicating that the groundwater contributions to H-DC-DX+105 were very low (the groundwater spring is visible during winter). All volumetric measurements at the H-DC-DX+105 station are therefore estimates from the surrogate culvert location. In the fall, ice was began to form along the channel margins around October 16, 2012 and the flow at H-DC-DX+105 returned to baseflow; maintained by groundwater contributions. Both salt dilution gauging and volumetric measurements were obtained on October 16, 2012 to verify the relationship between the discharge locales during this transition. The salt and volumetric discharge values were both very low (< 4 L/s). Given the potential measurement error associated with each measurement method, discharge is assumed to be the same during this transition period. Volumetric measurements were thus discontinued with the onset of icing in the culvert and salt dilution gauging became the only measurement method feasible through the winter until February 12, 2013. Groundwater contributions at a spring downstream of the culvert maintained flow and open water during winter.

Discharge measurements from the culvert ranged from below reportable confidence levels (< 0.000 m³/s) to 0.007 m³/s from June 27, 2012 to October 16, 2012. Salt dilution discharge measurements ranged from 0.001 to 0.006 m³/s from May 1, 2012 to June 12, 2012 and October 16, 2012. Salt dilution gauging continued through the winter at this station, ranging from 0.001 m³/s to 0.003 m³/s. The hydrograph of instantaneous discharge measurements and associated data is shown in Appendix B, Figure B6.

The seasonal variation of flow at this station produces non-ideal channel conditions for consistent discharge measurement methods particularly during low summer flows. It is recommended that a review of the hydrometric measurement objectives for this station be conducted to identify whether alternative measurement methods should be pursued or discharge measurements be discontinued at this station.

3.2.2.3 H-DC-D1

The H-DC-D1 hydrometric station was originally established as a water quality site (WQ-DC-D1) downstream of the mill. The channel at the water quality site is poorly defined, braiding through dense willow shrubs, moss and grass therefore the hydrometric measurements were conducted approximately 5 m downstream where the channel was more clearly defined. The H-DC-D1 hydrometric station is an instantaneous station and does not include a data logger, stilling well or staff gauge.

At the station, the channel averages 0.35 m in width and 0.10 m in depth, making the station unsuitable for standard discharge measurement methods. In the winter, thick layers of ice cover the channel and extend into the surrounding vegetation, similar to the aufeis that develops lower in the watershed.



In late spring (April 18, 2012 and May 1, 2012), the channel was heavily braided under the ice and only volumetric measurements were taken at a suitable location. Later in the spring and during the open water season, salt dilution gauging was conducted.

The highest measured discharges occurred on May 29, June 12 and July 9, 2012 (Appendix B, Figure B6). In July, August, and September 2012 the discharge at H-DC-D1 was approximately $0.004 \text{ m}^3/\text{s}$ to $0.006 \text{ m}^3/\text{s}$; higher than measured at H-DC-DX and H-DX+105. Measurements at H-DC-D1 indicate responsiveness to storm events during the summer as shown by discharges measured in late August and early September. The lowest flows occurred in early spring prior to freshet and late fall as discharge receded to base-flow. The channel was frozen to substrate by November 14, 2012.

A total of 15 station visits were completed from April 18, 2012 to February 12, 2013 (Appendix B, Table B2; Table B3). Discharge measurements ranged from $0.004 \text{ m}^3/\text{s}$ to $0.011 \text{ m}^3/\text{s}$ based on salt tracer tests from May 14, 2012 to October 15, 2012. Early spring volumetric measurements were $0.001 \text{ m}^3/\text{s}$.

A review of the hydrometric measurement objectives for this station is recommended. While instantaneous hydrometric measurements using salt dilution gauging may continue at this station in 2013, the low magnitude discharges may be approximated using inferential hydrometric analysis techniques.

3.2.2.4 H-DC-D1b

The H-DC-D1b station was established as an instantaneous hydrometric station on July 9, 2012, after preliminary investigations on May 29, 2012 determined that there are two separate branches of Dome Creek in the vicinity of the H-DC-D1 station, including the channel at H-DC-D1 and another larger channel parallel to it where substantial flow had not previously been noted. As a result H-DC-D1b was established just downstream of the confluence of the two branches, approximately 80 m downstream of H-DC-D1. It is uncertain whether flow was not observed at H-DC-D1b because it was not present in previous years, or simply because it was obscured by the dense shrubs. AAM identified a new seep near the mill in 2012 with substantial flow upstream of H-DC-D1b at WQ-MS-S-08 supporting the lack of flow in previous years. However, the fact that the channel is moderately well defined supports the theory that water flowed in the channel in the past; whether or not the channel is natural or a result of mine activity is unknown. The surrounding area has been subject to historic mineral exploration activity, with an old tailings pond, wooden structures, and several earth berms, one of which causes the creek to flow subsurface for a short distance. In 2012, hydrometric measurements from the H-DC-D1b station may be more representative of surface flows originating from the upper Dome Creek watershed than H-DC-D1.

The channel at the hydrometric station averaged 0.35 m width and 0.13 m depth, making the station unsuitable for standard discharge measurement methods. Salt dilution gauging was the only feasible method of discharge measurement at this station.



Ice remained over parts of the channel during the May 29, 2012 investigation. The Dome Creek Valley experiences aufeis conditions in the area around this station similar to conditions lower in the watershed. In the fall, following the main open water season, ice started to form along the creek margins by October 2, 2012.

In July, August, September and October 2012 the discharge at H-DC-D1b was approximately $0.004 \text{ m}^3/\text{s}$ to $0.005 \text{ m}^3/\text{s}$ higher than measured at H-DC-D1. Measurements at H-DC-D1b indicate responsiveness to storm events during the summer as shown by discharges measured in late August and early September 2012. The lowest flows occurred in early spring prior to freshet and late fall as discharge receded to base-flow. The channel was frozen to substrate by November 14, 2012.

Nine hydrometric measurement events were completed between July 9, 2012 and February 12, 2013 (Appendix B, Table B2, Table B3); the last of which confirmed zero flow (frozen to bed) on November 14, 2012. Discharge measurements ranged from $0.008 \text{ m}^3/\text{s}$ to $0.013 \text{ m}^3/\text{s}$ based on salt tracer tests from July 9, 2012 to October 15, 2012 (Appendix B, Figure B6).

A review of the hydrometric measurement objectives for this station is recommended. While instantaneous hydrometric measurements using salt dilution gauging may continue at this station in 2013, the low magnitude discharges may be approximated using inferential hydrometric analysis techniques.

3.2.2.5 Upper Dome Creek 1 (H-DC-U1)

The H-DC-U1 station was established as a continuous gauging station in 2009. The channel lies on the south side of the flat Dome Creek Valley, upstream of the tailings pond, and appears to receive flow from seeps and surface water confined by old exploration trenches on the south side of the valley. H-DC-U1 contributes flow to the upstream end of the diversion channel that is routed around the tailings pond.

The channel is well defined and stable with a relatively low width to depth ratio in most sections in the vicinity of the gauge. The channel is on average 0.35 m in width and 0.17 m in depth, making the station unsuitable for standard discharge measurement methods. Salt dilution gauging was the only feasible method of measurement at this station due to channel conditions.

The channel freezes to the substrate in late fall and experiences aufeis conditions through the winter, which persist typically into mid-May. In 2012, the station was still frozen to substrate on May 15, 2012. On May 28, 2012 open water was observed and a salt tracer test could be completed. The continuous level logger was re-installed on May 31, 2012 in the existing stilling well. Ice had started forming at the station by October 2, 2012 and was visible in the continuous data logger record. A shift to benchmark 1 (BM 1) occurred on August 21, 2012; BM1 was subsequently moved three metres downstream to a more stable location. The data logger was removed in December 2012.

There were 15 station visits from May 28, 2012 to February 28, 2013 (Appendix B, Table B2, Table B3); eight of these measurements were selected to develop the rating curve for the station, however the rating



measurements had a high degree of scatter resulting in high rating curve uncertainty. This uncertainty is due to the challenges of accurately measuring stage and discharge in such small streams, exacerbated by the mining activity in the area and periglacial ground conditions. A rating curve was not produced for this station therefore only the stage record and instantaneous discharge measurements are presented in this report (Appendix B, Figure B7; Figure B8).

Discharge measurements were based on salt tracer tests, and ranged from 0.003 m³/s to 0.015 m³/s (Appendix B, Figure B8). The lowest measured discharge was collected on May 28, 2012 while ice was still present along the channel margins. The highest discharge was measured at the station in early August 2012; however the stage record indicates that there were four high stage events during that month, associated with summer rainstorm events. High stages were also recorded after the freshet (mid-June), in July 2012. Some of these rainstorm events were followed by sedimentation in and around the stilling well and required station maintenance, logger and staff gauge shifts.

A review of the hydrometric measurement objectives for this station is recommended. While instantaneous hydrometric measurements using salt dilution gauging may continue at this station in 2013, the low magnitude discharges may be approximated using inferential hydrometric analysis techniques.

3.2.2.6 Upper Dome Creek 2 (H-DC-U2)

The H-DC-U2 station was established in 2011 as a continuous gauging station. The station is located directly north of H-DC-U1 in a secondary channel of Dome Creek that was discovered when investigating the discrepancy between the magnitude of discharge between the diversion channel (H-DC-B) and H-DC-U1 stations. The channel is not well defined due to a high degree of channel instability with braiding and high sediment loads. The channel averages 0.89 m in width and 0.12 m in depth, making the station unsuitable for standard discharge measurement methods. The channel experiences aufeis conditions through the winter which persist typically into mid-May, similar in extent to H-DC-U1.

In 2012, the H-DC-U2 station had several issues with bank destabilization and heavy silt and organic sediment loads assumed to be associated with storm events. The destabilization caused numerous level logger and staff gauge shifts, with the well requiring frequent maintenance. A new station was installed slightly upstream (three metres) from the original 2011 location on May 28, 2012; it was believed that this location would have a more stable channel bed and bank. Sedimentation continued to cause level logger and staff gauge shifts on the next four trips. On July 23, 2012, the continuous gauging station was removed and the station converted to an instantaneous discharge station due to the instability of the channel. Analysis of the continuous data logger data indicated that given the large sediment loads experienced at the station in 2012, the rating curve and logger record could not be reconciled to account for sedimentation between visits and for all the maintenance and shifts that occurred. As such, only the instantaneous measurements are presented in this report.



Fifteen station visits were completed between May 1, 2012 and February 12, 2013 (Appendix B, Table B2; Table B3); the last two station visits confirmed zero flow (frozen to substrate) on November 14, 2012 and December 12, 2012. Eight rating measurements were selected for rating curve development; however the curve had a high degree of scatter resulting in high rating curve uncertainty. This uncertainty is due to the challenges of accurately measuring stage and discharge in such small streams, exacerbated by sedimentation and periglacial ground conditions. A rating curve and stage record were produced for this station therefore only the instantaneous discharge measurements are presented in this report (Appendix B, Figure B9).

Discharge measurements over this period ranged from 0.007 m³/s to 0.033 m³/s. The lowest flows occurred in early spring prior to freshet and in late fall as discharge returned to baseflow conditions. The highest flows occurred in late spring during freshet and during the early fall, the latter being associated with precipitation events.

A review of the hydrometric measurement objectives for this station is recommended. While instantaneous hydrometric measurements using salt dilution gauging may continue at this station in 2013, the low magnitude discharges may be approximated using inferential hydrometric analysis techniques.

3.2.2.7 Tailings Pond (H-TP)

A staff gauge was installed in the tailings pond in August 2012 by AAM; it was requested that EDI collect staff gauge measurements for the remainder of the open water season. Three staff gauge measurements were collected; these measurements are direct readings on the staff gauge and not corrected to any project site datum. The measurement dates were August 21, September 6 and September 17, 2012 (Appendix B, Table B3).

No changes to monitoring program are recommended.

3.2.2.8 Diversion Channel at the Bridge (H-DC-B)

The H-DC-B station was a continuous gauging station established at the downstream end of the diversion channel bridge by AECOM in 2009. The diversion channel diverts flow from the upper Dome Creek watershed along the north side of the tailings pond and then rejoins the natural Dome Creek channel downstream of the seepage pond (H-SEEP).

Over the 2011/12 winter season the channel had significant icing issues that continued into the spring of 2012. Aufeis filled the channel nearly up to the base of the bridge, and covering the stilling well. The ice was excavated on several occasions through the 2011/12 winter by maintenance crews, and the stilling well and survey benchmarks were destroyed in the process. During the 2012 open water season, re-grading was planned on the channel therefore the station was re-established as both a temporary continuous gauging station and an instantaneous station. The temporary continuous discharge gauging station was established



June 25, 2012 and was left until September 18, 2012 when the station was removed for re-grading. The continuous station was not re-installed due to the onset of winter.

In the spring, the ice was absent from the channel by April 30, 2012. In the fall, ice started forming on the bed and around boulders by September 18, 2012. The station experienced some sedimentation following storm events. The sources of the sediment were identified as eroding gullies on the upstream and downstream side of the bridge crossing and AAM was notified. Rip rap was installed in September 2012 to help stabilize the slope and reduce sedimentation. At the temporary gauging station, two staff gauge shifts occurred due to station maintenance following sedimentation around the well.

The channel averaged 1.27 m in width and 0.15 m in depth making the station generally unsuitable for standard discharge measurement methods; however, the velocity-area method was used with the ADV or Swiffer current meter on April 17, May 14, and May 28, 2012 when flows were high. Later in the season, shallow flows and the gravel and small cobble substrate interfered with instrumentation used for this method. Subsequently, salt tracer tests were identified as a more suitable measurement method.

A total of 16 station visits took place between April 17, 2012 and February 12, 2013 (Appendix B, Table B2; Table B3); seven of these measurements were selected to develop the rating curve, however the rating measurements had a high degree of scatter resulting in high rating curve uncertainty. A rating curve was not produced for this station therefore only the stage record and instantaneous discharge measurements are presented in this report (Appendix B, Figure B10).

The highest discharges measured were in the spring using the ADV and Swiffer (up to $0.064 \text{ m}^3/\text{s}$). Discharge measurements based on salt tracer tests ranged from $0.013 \text{ m}^3/\text{s}$ to $0.051 \text{ m}^3/\text{s}$; where the lowest flows were measured in late fall and over the summer (Appendix B, Figure B10). A comparison of discharges at this station with those upstream at H-DC-U1 (Appendix B, Figure B7) and H-DC-U2 (Appendix B, Figure B9) indicate that the hydrologic response of flows in the diversion channel do not appear to be strongly linked with the hydrologic behavior in the upper Dome Creek watershed. Several factors could account for this disparity including the influence (direct runoff and lack of vegetation) of mining infrastructure around the diversion channel; potential hydraulic connectivity between the tailing pond and the diversion channel; and discharge measurement uncertainty associated with salt dilution gauging in two very different stream morphologies.

It is recommended for this station to continue as an instantaneous hydrometric station in 2013 given the high likelihood that excavations of sediment or ice may occur in the diversion channel in the future that may impact the data logger.



3.2.2.9 Seepage Pond Outlet Pipe and Pond Staff Gauge (H-SEEP)

Water is pumped year round from the seepage pond, located downstream of the tailings dam, to Dome Creek through the seepage pond outlet pipe. Discharge from the pipe outlet has been measured using a volumetric gauging method since 2011.

Starting on July 23, 2012 the flow rates of the seepage pond pumps ('old' refers to pre-2012 and 'new' to post-2012, AAM) were also recorded at the time of measurement to be able to compare to the discharges from the outlet pipe. New pumps and pump/pipe configurations were set up throughout the season by the Site Operations Contractor to improve the accuracy of the pumping rates displayed. The staff gauge heights of the seepage pond and tailings pond were also recorded (Appendix B, Table B3).

A total of 18 station visits were conducted between April 17, 2012 and February 12, 2013. Every station visit included a discharge measurement; six included staff gauge readings at the seepage pond. Discharge measurements obtained using the volumetric method at the pipe outlet for this period ranged from 0.002 m³/s to 0.007 m³/s; however the pumping rate is generally maintained around 0.003 m³/s (Appendix B, Figure B11).

Daily instantaneous measurements collected by the Site Operations Contractor were obtained from AAM to compare to EDI measurements (Appendix B, Figure B11). Similarly, EDI measurements at the pipe outlet were compared to concurrent instantaneous measurements at the pump flow meters (Appendix B, Table B4). In general, the concurrently measurements obtained at the pipe outlet by EDI were more similar to the readings obtained from the new flow meter in the seepage pond pump house. The same conclusion may be drawn from the H-SEEP hydrograph (Appendix B, Figure B11).

No changes to monitoring program are recommended.

3.2.2.10 Middle Dome Creek (H-DC-M)

The middle Dome Creek station (H-DC-M) was established in 2011 by EDI as a continuous gauging station with the objective of monitoring the cumulative flow from the diversion channel and the seepage pond. The station is located downstream of the confluence of the diversion channel and the outflow from the seepage pond discharge pipe; and as such is regulated in part by pumping rates out of seepage pond. The station is at the same location as the upper Dome Creek water quality station (WQ-DC-U).

The channel is moderately well defined within fine grained substrate. There is more cobble sized material upstream towards the diversion channel confluence where stream energy is higher. The channel averages 1.08 m in width and 0.16 m in depth, making the station generally unsuitable for standard discharge measurement methods; however, the velocity-area method was used on the May 1, May 28, and June 11, 2012 sampling events when stage was high, while salt dilution gauging was used on the remaining trips as the channel condition was more suited to the latter method.



The stilling well had siltation issues during the open water season that were likely related to the sedimentation problems experienced upstream at H-DC-B. Station maintenance was performed on the June 25, July 9, and August 21, 2012 visits; staff gauge shifts were associated with these trips. A new staff gauge was installed on May 14, 2012 as the old staff gauge was too corroded to read and resulted in a staff gauge shift.

Ice was present in the channel up to the May 15, 2012 visit. In the fall, ice started forming on the margins by October 2, 2012. The data logger was winterized on September 18, 2012 and was left in over the winter period to monitor the low flow discharges exiting the area of the watershed most influenced by the Mount Nansen mine site.

Ice was a regular problem near the diversion channel bridge over the winter. There were 20 instances where heavy machinery was required to excavate ice from the diversion channel between November 10, 2012 and February 13, 2013 (Table 13). The excavations have been observed on site by EDI and AAM staff and have provided anecdotal evidence that the work creates a release of water from behind ice dams. This water is conveyed down the diversion channel and H-DC-M is the first hydrometric station that the surge would encounter. While the raw water level logger data from H-DC-M shows that there are anomalous, rapid increases in stage, these begin in October and do not overlap with the known dates of excavation; these peaks are assumed to be related ice processes occurring upstream in the diversion channel. There were no discernible increases in stage in the raw data on the dates shown in Table 13; however there is evidence that the release of water in the diversion channel may have flowed over the ice in some instances and/or altered the channel geomorphology beneath the ice near H-DC-M. Evidence for this was obtained on the January 14, 2013 site visit when it appeared that the data logger was no longer in the main flow of the channel beneath the ice. From October 25, 2012 to December 12, 2012 the data logger temperatures dropped well below zero and the pressure transducer signal was extremely erratic. It is likely that the data logger was frozen to the bed during this period and the logger record was removed for this period.

A total of 18 station visits were conducted between April 17, 2012 and February 12, 2013 (Appendix B, Table B2; Table B3); seven of these measurements were selected to develop the rating curve. The rating curve equation is shown in Table 12.

Table 12. Middle Dome Creek (H-DC-M) rating curve equations.

Stage (m)	Discharge (m ³ /s)	Offset (m)	Slope	Equation
1.556	0.005	1.5	-----	-----
1.701	0.060	1.5	1.986	$X = 1.44074 * (Y-1.5)^{1.98631}$
2.003	0.356	1.5	1.950	$X = 1.35912 * (Y-1.5)^{1.94996}$

Measured discharges ranged from 0.004m³/s to 0.054 m³/s, based on salt tracer tests and velocity-area measurements (there were three instances in the spring when channel conditions made it feasible to use the ADV) (Appendix B, Table B3).



The peak discharge stage measured by the continuous logger occurred on August 9, 2012 at 21:00 and was associated with a storm event (Appendix B, Figure B12; Figure B13). The second highest stage occurred May 23, 2012 at 22:15 (Appendix B, Figure B12; Figure B13). Similar to other stations in Dome Creek and Pony Creek the rising limb of the freshet shows highly diurnal signals that correlate with temperature. High stages are also observed in June and July 2012 also related to storm events. The lowest discharges measured were associated with late fall conditions during ice up, and the higher discharges were associated with late summer and fall rainstorm events. The highest discharge of 0.054 m³/s was measured using the velocity-area method on May 28, 2012 and was associated with the falling limb of the spring freshet.

Table 13. Summary of dates when diversion channel excavations occurred (data provided by AAM).

Month	Day	Year
November	10	2012
November	21	2012
November	22	2012
December	16	2012
December	20	2012
December	22	2012
December	26	2012
December	27	2012
December	31	2012
January	1	2013
January	4	2013
January	6	2013
January	9	2013
January	11	2013
January	13	2013
January	14	2013
January	19	2013
January	21	2013
January	22	2013
February	3	2013
February	4	2013
February	5	2013
February	12	2013
February	16	2013
February	19	2013
February	20	2013



In 2013, it is likely that this station will require re-location or re-installation to accommodate changes to the channel geomorphology that occurred over the winter. As such, a re-evaluation of hydrometric measurement objectives should be conducted in order to determine the relative importance of this hydrometric station. If the hydrometric measurements are highly valued, a weir installation should be considered to measure discharge more precisely than the salt dilution gauging.

3.2.2.11 Dome Creek at the Road (H-DC-R)

The Dome Creek at Road gauging station (H-DC-R) was originally installed by AECOM in 2009 in a shallow channel with turbulent flow downstream of the Mount Nansen Road culvert. In 2011, EDI relocated the station to a more suitable water level logger location; a large pool three metres downstream of the AECOM location was selected to reduce the influence of turbulent flow on the pressure transducer.

The station lies within a broad, flat valley bottom, heavily vegetated with grasses. Channel braiding is common downstream of the 2011 water level logger location (confined channel). Near the end of the 2011 open water season, the large pool where the stilling well was located was filled with sediment when a large pulse of sediment travelled down the channel. The area was also heavily impacted by aufeis conditions over the winter 2011/12, as ice thicknesses reached over one metre. Road maintenance occurred intermittently through the winter to manage the icing issues across the road, with the road being re-routed around the downstream side of the culvert near or over the hydrometric station at times.

The station was re-located approximately 60 m downstream at the next viable gauging location on the May 28, 2012 visit as the original station was impacted by sedimentation and winter road-maintenance activities in 2011/12. There are no tributaries between the 2011 and 2012 locations therefore the discharge measured at the two locations is considered equivalent therefore the gauging station was not re-named. The rating curves at each location are defined only for each the relevant period of monitoring, which in this case corresponds with each year or period of stable channel conditions.

A stilling well with staff gauge and continuous data logger were installed in a well-defined channel that is expected to be viable again in the spring of 2013. Sedimentation was identified within the stilling well on the July 10, 2012 visit, and station maintenance was performed.

A combination of discharge gauging methods have been used at the station including, velocity-area volumetric, and salt dilution gauging. The vegetation and channel braiding create challenging gauging conditions for the current meter, which can therefore only be used during higher flows due to the channel's small configuration (average channel width and depth were 0.60 m and 0.19 m, respectively). Volumetric measurements on the other hand, could only be taken from the culvert outlet during lower flows when the flow can be captured in a 20 L bucket or 1 L bottle during very low flows. Thus salt dilution gauging was the dominant method at this station.



Ice was present along the channel even on the May 28, 2012 visit, as the aufeis which had covered the valley over the winter was still in the process of melting. In the fall, ice was developing along the channel on the October 2, 2012 visit. The data logger was removed on the December 2012 station visit.

Fourteen discharge measurements were obtained between April 17, 2012 and February 12, 2013 (Appendix B, Table B2 Table B3); nine of these measurements were selected to develop the rating curve (Table 14).

Table 14. Dome Creek at the Road (H-DC-R) rating equations.

Stage (m)	Discharge (m ³ /s)	Offset (m)	Slope	Equation
0.2747	0.002	0.16	-----	-----
0.6621	0.100	0.16	2.758	$X = 0.666494 * (Y - 0.16)^{2.75760}$
1.062	0.477	0.16	2.671	$X = 0.628053 * (Y - 0.16)^{2.67137}$

Measured discharge ranged from 0.021 m³/s to 0.071 m³/s based on salt tracers. The freshet peak was the highest discharge of the season and occurred on June 14, 2012 at 16:45, several weeks after the hydrometric stations higher in the watershed (Appendix B, Figure B14, Figure B15). This is due to the substantial amount of ice immediately upstream of this station that takes longer to melt. The lowest flows were observed during the fall and at times through the summer. Highest flows were observed in spring during freshet and towards the end of summer and beginning of fall. These latter flows were determined to be the result of high rainfall.

No changes to monitoring program are recommended.

3.2.3 Back Creek Watershed

3.2.3.1 Back Creek (H-BC)

The Back Creek continuous gauging station (H-BC) was established by AECOM in 2009. The narrow, deep channel is stable and entrenched into alluvial sediments of both the Back Creek and Victoria Creek floodplains. The creek is not considered to have a natural flow regime due to placer activity upstream which effectively regulates the hydrology by attenuating flow in sedimentation ponds upstream of the hydrometric station. Placer activity also frequently causes high suspended sediment loads and consequently sedimentation in the stilling well. Substantial sediment accumulation in the well can interfere with the water level logger therefore stilling well maintenance is required. Over the 2012 open water season, three well-maintenance events were required, where sediment was removed from the wells resulting in staff gauge shifts.



The wetted channel averages 1.30 m in width and 0.20 m in depth. At most stages, the small channel size renders station unsuitable for standard gauging methods. Salt dilution gauging was the most appropriate gauging method used at this station; however the velocity-area method was used on two trips, May 29, 2012 and June 12, 2012 when flows were higher.

Ice was still present on the May 15, 2012 visit, but had melted by May 29, 2012. The data logger was winterized on September 18, 2012; several layers of ice had developed by October 3, 2012, with flow occurring over and under the ice creating a backwater effect on the stage. The continuous logger record was corrected to stop on October 3, 2012. The creek typically freezes to substrate over the winter, and as such the data logger was removed for the winter on October 16, 2012, once the creek was frozen to bed.

A total of 14 measurement events took place between April 30, 2012 and February 12, 2012 (Appendix B, Table B2; Table B3); ten measurements were selected to develop the rating curve. The rating equations developed for Back Creek in 2012 are found in Table 15.

Table 15. Back Creek (H-BC) rating curve equations.

Stage (m)	Discharge (m ³ /s)	Offset (m)	Slope	Equation
1.630	0.001	1.62	-----	-----
1.893	0.063	1.62	1.252	$Q = 0.319 * (h-1.62)^{1.252}$
2.168	0.602	1.62	3.244	$Q = 4.239 * (h-1.62)^{3.244}$

The peak stage occurred on May 24, 2012 (20:30). Mean discharge (MD) for the 2012 open water season (MD2012) was 0.080 m³/s. Measured discharges for the station ranged from 0.027 m³/s (33 % MD2012) to 0.250 m³/s (313 %; MD2012) based on salt dilution gauging and velocity area measurements (Appendix B, Figure B16). The peak freshet stage was 2.307 m. The lowest discharges were observed in July 2012 and the late fall. The continuous record of open water stage ranged over 0.636 m (Appendix B, Figure B17) corresponding with estimated discharges between 0.010 m³/s and 0.600 m³/s.

No changes to the monitoring program are recommended.

3.2.4 Minnesota Creek Watershed

3.2.4.1 Minnesota Creek (H-MN)

The Minnesota Creek (H-MN) hydrometric station was added to the monitoring program in December 2011 as an instantaneous gauging station. Instantaneous discharge measurements re-started again at the station on April 17, 2012. On May 30, 2012 a continuous gauging station with a water level logger, and



stilling well was established approximately 80 m upstream of the confluence with Victoria Creek, beyond the potential influence of Victoria Creek backwater effects. A staff gauge was added to the station on the June 12, 2012 visit.

The channel is well defined with nearly vertical banks near the station and a cobble/gravel bed. The channel averaged 1.12 m in width and 0.41 m in depth. Salt dilution gauging was the best discharge measurement method at the station due to the narrow channel width; velocity-area was used once during high spring flows. A total of 14 measurement events were conducted between April 17, 2012 and February 12, 2013; nine measurements were used to develop the rating curve. The rating curve equation is shown in Table 16.

Table 16. Minnesota Creek (H-MN) rating curve equations.

Stage (m)	Discharge (m ³ /s)	Offset (m)	Slope	Equation
0.9095	0.006	0.5	-----	-----
1.086	0.114	0.5	8.461	$X = 10.4987 * (Y-0.5)^{8.46114}$
1.231	0.820	0.5	8.918	$X = 13.4031 * (Y-0.5)^{8.91813}$

Measured discharge values ranged from 0.012 m³/s to 0.234 m³/s. Low flows were observed during the early spring and late fall with high flows occurring in late spring and at times through the summer.

The channel was free of ice by the May 14, 2012 visit, with ice only present along the banks. Ice had formed across the channel at the station by October 3, 2012, but open water remained along riffle sections. The water level logger was removed during the December 2012 station visit.

No changes to monitoring program are recommended.

3.2.5 Victoria Creek Watershed

3.2.5.1 Victoria Creek Reference (H-VC-REF)

An instantaneous hydrometric gauging station was established at Victoria Creek reference (WQ-VC-REF) water quality station in November 2011. The station lies upstream of the Back Creek confluence and above the influence of the Mount Nansen Site. A continuous gauging station including a stilling well, water level logger and staff gauge was installed on May 30, 2012. The channel averaged 4.10 m wide and 0.25 m deep at the discharge measurement location and was suitable for the standard velocity-area measurement method during open water conditions. Salt tracers were used during the winter when thick ice conditions were prohibitive of the velocity-area method.



A total of 17 measurement events took place between May 2, 2012 and February 12, 2013; nine measurements were used to develop the rating curve. The rating curve equations are shown in Table 17.

During the open water season, discharge measurements with the ADV were conducted just upstream from the station. Measured discharges ranged from 0.418 m³/s to 1.597 m³/s; the lowest measured flows occurred in late fall and early spring and the highest flows occurring in late spring during freshet and throughout the summer.

Table 17. Victoria Creek Reference (H-VC-REF) rating curve equations.

Stage (m)	Discharge (m ³ /s)	Offset (m)	Slope	Equation
1.255	0.015	1.2	-----	-----
1.816	0.475	1.2	1.420	$X = 0.945289 * (Y-1.2)^{1.41949}$
2.12	1.933	1.2	3.498	$X = 2.58760 * (Y-1.2)^{3.49788}$
2.386	4.395	1.2	3.234	$X = 2.53134 * (Y-1.2)^{3.23424}$

Based on the water level logger data, a notable high flow event occurred August 10, 2012, this event was likely related to a rainstorm event (August 9, 2012). A sustained increase in turbidity and suspended sediment levels during September 2012 may indicate that a natural or anthropogenic activity occurred upstream. High suspended sediment caused sedimentation in the stilling well prior to the September 5 and September 18, 2012 visits. Subsequently, well maintenance was performed at the station on October 3, 2012 to remove sedimentation in the well, resulting in a staff gauge shift.

Salt tracer tests were conducted on the May 2 and May 15, 2012 visits as ice was still covering much of the channel (0.451 m³/s and 0.456 m³/s, respectively). Ice had melted by the May 30, 2012 visit. In the fall, ice was developing along the creek margins by the October 3, 2012 visit, and once thick ice covers the channel, salt tracers became the main measurement type at the station through the winter 2012/13.

No changes to the monitoring program are recommended.

3.2.5.2 Upper Victoria Creek (H-VC-U)

The Upper Victoria Creek continuous gauging station (H-VC-U) was established by AECOM in 2009. The station is located downstream of H-VC-REF, approximately 65 m upstream of the Back Creek confluence. The station is known to receive groundwater contributions, as thin ice and open water are observed through the winter. The channel was on average 5.0 m wide with an average depth of 0.22 m at the discharge measurement location and was suitable for the standard velocity-area measurement method during both



open water and winter conditions. Over the 2012 open water season, three well-maintenance events were required where sediment was removed from the wells resulting in staff gauge shifts (Appendix B, Table B2).

A total of 18 measurement events took place from April 16, 2012 to February 11, 2013. The rating curve equation is shown in Table 18. Concurrent salt tracer and velocity-area measurements were obtained for the winter measurement events (November 2012 to February 2013). Eleven measurements were added to the 2011 rating curve (total rating measurements = 22). The 2011 and 2012 rating curves were combined for this station because no changes to the benchmarks were required and the channel is relatively stable.

Table 18. Upper Victoria Creek (H-VC-U) rating curve equations.

Stage (m)	Discharge (m ³ /s)	Offset (m)	Slope	Equation
1.986	0.038	1.85	-----	-----
2.385	2.632	1.85	3.098	$X = 18.2757 * (Y - 1.85)^{3.09810}$
2.641	8.465	1.85	2.987	$X = 17.0539 * (Y - 1.85)^{2.98748}$

Discharge measurements ranged from 0.051 m³/s, to 1.643 m³/s (Appendix B, Table B3). The continuous stage record (Appendix B) indicates that stage ranged between 1.790 m to 2.689 m, however the site visits and discharge measurements noted previously covered a smaller range (2.108 m to 2.295 m) (Appendix B, Table B3). The key reason for the difference is that the freshet peak was relatively rapid and did not correspond with field visits. As a result, the peak stage and discharge was not field verified. High stages were documented in late spring during the freshet and throughout the summer. The freshet peak occurred on May 25, 2012 at 01:40 (Appendix B); the high stages in summer were associated with storm events including the large discharge event that produced high suspended sediment loads in mid-August (Appendix B). Low flows were documented in the early spring and late fall. In the spring, ice was present along the creek margins until May 15, 2012. In the fall, ice was developing along the margins by October 3, 2012. Discharge measurement events were conducted on a monthly basis throughout the winter season.

Station maintenance was conducted on September 5, September 18, and October 3, 2012 due to sediment accumulations in the well; over the season, the station experienced higher suspended sediment levels than normal, similar to observations at H-VC-REF.

The winterized water level logger was replaced on December 11, 2012 with a Solinst Gold model with a direct-read cable to facilitate downloading of the data logger during ice conditions. The continuous data record from January 15 to February 11, 2013 appeared to be adversely influenced by ice; evidenced by water temperatures below -1°C and a pronounced erratic decrease in pressure. Due to the ice effects on the logger the continuous stage record could not be adjusted to the local datum because a concurrent water level survey could not be obtained due to ice conditions. Therefore, the Solinst stage record is not presented (appended) in the H-VC-U stage hydrograph (Appendix B); rather, the record is presented in a separate stage time series plot that represents the water depths recorded by the logger.



No changes to the open water monitoring program are recommended; however it is recommended that the installation of the continuous winter water level logger be re-considered in 2013/14.

3.2.5.3 Victoria Creek Downstream of Back Creek (H-VC-DBC)

An instantaneous hydrometric gauging station was established on Victoria Creek downstream of Back Creek (H-VC-DBC) on November 2011 by EDI. A continuous gauging station was installed on April 30, 2012, which included a stilling well, water level logger and staff gauge. The channel had an average width of 4.8 m and depth of 0.25 m at the discharge measurement location and was suitable for the standard velocity-area measurement method during open water conditions. The channel around the station had thin ice during the winter of 2012/13, therefore it was possible to obtain concurrent salt dilution gauging and velocity-area measurements were obtained from November 2012 to February 2013.

A total of 18 measurement events were conducted from April 17, 2012 to February 11, 2013. Measured discharge ranged from 0.066 m³/s to 1.751 m³/s. Fourteen of these measurements were selected to develop the rating curve. The rating curve is presented in Table 19. High stages were documented in late spring during the freshet and throughout the summer. The freshet peak occurred on May 25, 2012 at 01:15 (Appendix B); however the discharge magnitude was not field verified. High stages in summer were associated with storm events. The lowest flows measured occurred in late winter and early spring. Ice along the margins was still present on May 15, 2012, and ice began forming again by October 3, 2012. Discharge measurements were conducted throughout the winter on a monthly basis. Stilling well maintenance was required on September 18, 2012 due to sedimentation, resulting in a shift to the staff gauge.

Table 19. Upper Victoria Creek (H-VC-DBC) rating curve equations.

Stage (m)	Discharge (m ³ /s)	Offset (m)	Slope	Equation
1.681	0.178	1.316	----	----
2.048	2.090	1.316	3.538	$X = 6.30234 * (Y - 1.316)^{3.53797}$
2.315	9.631	1.316	4.913	$X = 9.67846 * (Y - 1.316)^{4.91302}$

The continuous data logger was left in place over the winter because it was expected that this station would not freeze to substrate due to the channel geometry and may act as a surrogate for H-VC-U, if H-VC-U became frozen to substrate, however this did not occur therefore the winter logger data is not included in this report.

No changes to the open water monitoring program are recommended; however it is recommended that the installation of the continuous winter water level logger be re-considered in 2013/14.



3.2.5.4 Victoria Creek Upstream of Minnesota Creek (H-VC-UMN)

An instantaneous hydrometric gauging station was established on Victoria Creek upstream of Minnesota Creek (H-VC-UMN) in November 2011. The station is located in a straight reach, upstream of the Minnesota Creek confluence. During winter, ice is relatively thin in this area and groundwater flux to the channel may be occurring. A continuous gauging station was installed on May 1, 2012, which included a stilling well, HOBO data logger and staff gauge. The channel averaged 5.7 m in width and 0.20 m in depth at the discharge measurement location and was suitable for the standard velocity-area measurement method during open water conditions. Salt tracers were used during ice conditions.

A total of 19 measurement events were conducted between April 17, 2012 and February 12, 2013; of those, nine discharge measurements were used to develop the rating curve. The rating curve is shown in Table 20.

Table 20. Victoria Creek Upstream of Minnesota Creek (H-VC-UMN) rating curve equations.

Stage (m)	Discharge (m ³ /s)	Offset (m)	Slope	Equation
1.382	0.019	0.979	-----	-----
1.780	1.214	0.979	6.037	$X = 4.63406 * (Y - 0.979)^{6.03671}$
1.954	3.684	0.979	5.647	$X = 4.25022 * (Y - 0.979)^{5.64705}$
2.140	9.980	0.979	5.708	$X = 4.25676 * (Y - 0.979)^{5.70783}$

Measured discharge values ranged from 0.117 m³/s to 1.754 m³/s Appendix B, Table B3). High stages were documented in late spring during the freshet and throughout the summer. The freshet peak occurred on May 25, 2012 at 03:00 (Appendix B); however the discharge magnitude was not field verified. High stages in summer were associated with storm events. The lowest flows measured occurred in late winter and early spring. Ice was generally clear of the channel on the May 1, 2012 visit, and in the fall, ice was forming again by October 3, 2012. Discharge measurements were conducted throughout the winter on a monthly basis using salt dilution gauging and/or the velocity-area method depending on channel conditions. The data logger was removed on December 11, 2012.

No changes to the monitoring program are recommended.

3.2.5.5 Victoria Creek at Road (H-VC-R)

The Victoria Creek at Road (H-VC-R) station was established in July 2011 as a continuous gauging station. It is located 90 m downstream of the Mount Nansen Road culvert in a meandering section of the channel. The channel averaged 6.7 m in width and 0.25 m in depth at the discharge measurement location and was suitable for the standard velocity-area measurement method during open water conditions. Salt tracers were used during ice conditions.



During the 2011/12 winter, the logger installed at the station froze to the bed. The logger was re-deployed in the stilling well once the channel was ice free on May 29, 2012. The staff gauge was also replaced at that time, due to damage from the ice over the winter.

A total of 18 measurement events were conducted between April 16, 2012 and February 11, 2013; 15 measurements were used to develop the rating curve. The benchmarks and channel remained stable over the winter therefore the 2011 and 2012 rating curves have not shifted. The rating curve equations are shown in Table 21.

Table 21. Victoria Creek at Road (H-VC-R) rating curve equations.

Stage (m)	Discharge (m ³ /s)	Offset (m)	Slope	Equation
1.849	0.057	1.51	----	----
2.196	4.015	1.51	6.041	$X = 39.1267 * (Y-1.51)^{6.04113}$
2.307	9.974	1.51	6.067	$X = 39.5133 * (Y-1.51)^{6.06722}$

Discharge values ranged from 0.60 m³/s to 1.942 m³/s (Appendix B, Table B3). High stages were documented in late spring during the freshet and throughout the summer. The freshet peak occurred on May 25, 2012 at 02:45 (Appendix B); however the discharge magnitude was not field verified. High stages in summer were associated with storm events. The lowest flows measured occurred in late winter and early spring. Station maintenance was conducted on the July 23, 2012 and August 7, 2012 visits due to siltation in the well, and staff gauge shifts occurred. The channel was ice free on the May 29, 2012 visit, and in the fall ice was developing along the creek margins on October 3, 2012.

The winterized water level logger was replaced on December 10, 2012 with a Solinst Gold model with a direct-read cable to facilitate downloading of the data logger during ice conditions. The continuous data record from October 1, 2012 to February 11, 2013 appeared to be adversely influenced by ice; evidenced by water temperatures below -1°C and a pronounced erratic decrease in pressure. Due to the ice effects on the logger the continuous winter stage record (Solinst) could not be adjusted to the local datum because a concurrent water level survey could not be obtained due to ice conditions. Therefore, the Solinst stage record is not presented (appended) in the H-VC-R stage hydrograph (Appendix B); rather, the record is presented in a separate stage time series plot that represents the water depths recorded by the logger.

No changes to the open water monitoring program are recommended; however it is recommended that the installation of the continuous winter water level logger be re-considered in 2013/14.



3.3 SURFACE WATER QUALITY

Surface water quality results for all sampling sites are discussed on a watershed basis; for example, all Victoria Creek sites are discussed together, moving from upstream to downstream sampling sites. A list detailing each site and its respective parameters of concern, and a cross-reference to the corresponding report section in which site results are discussed was compiled for ease of reference (Table 22).

A summary of the surface water quality sampling record is in Appendix C, Table C1. Graphical depictions of parameters of concern are presented by watershed, and are found on Appendix C, Figure C1 through C10. Full site descriptions including photographs and sketches are presented in Appendix D. A copy of the surface water quality database containing all data is in Appendix E.

Table 22. Summary of surface water quality parameters of concern, presented by site.

Site ID	Parameters present at concentrations that exceed CCME AL guidelines or Mount Nansen effluent discharge standards	Discussed in Report Section
WQ-PC-U	SAD cyanide, aluminum, cadmium, manganese, iron	3.3.1
WQ-PC-D	cyanide, aluminum, arsenic, cadmium, copper, iron, zinc	3.3.1
WQ-PIT	aluminum, arsenic, cadmium, copper, iron, lead, silver, manganese, zinc	3.3.2
WQ-DC-DX	cyanide, aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, silver, zinc	3.3.3
WQ-DC-DX+105	cyanide, aluminum, arsenic, cadmium, copper, iron, manganese, zinc	3.3.3
WQ-DC-D1	cyanide, aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, silver, zinc	3.3.3
WQ-DC-D1b	cyanide, aluminum, arsenic, cadmium, iron, manganese, silver, zinc	3.3.3
WQ-DC-U1	cyanide, aluminum, arsenic, cadmium, copper, iron, manganese, zinc	3.3.3
WQ-DC-U2	cyanide, aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, silver, zinc	3.3.3
WQ-DC-U	cyanide, aluminum, arsenic, cadmium, chromium, copper, iron, manganese, silver, zinc	3.3.4
WQ-DC-R	cyanide, aluminum, arsenic, cadmium, copper, iron, lead, manganese, silver, zinc	3.3.4
WQ-TP	cyanide, aluminum, arsenic (total and dissolved), cadmium, copper, iron, lead, manganese silver, zinc	3.3.5
WQ-SEEP	cyanide, arsenic, cadmium, copper, iron, manganese	3.3.5
WQ-MS-S-03	cyanide, aluminum, arsenic, cadmium, copper, iron, lead, manganese, silver, zinc	3.3.6
WQ-MS-S-08	cyanide, aluminum, arsenic (total and dissolved), cadmium, iron, lead, manganese, zinc	3.3.6
WQ-ADIT-SEEP	cyanide, cadmium	3.3.6
WQ-DAM-SEEP	cyanide, arsenic, cadmium, copper, iron, manganese, TSS	3.3.6
WQ-BC	cyanide, aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese,	3.3.7



Site ID	Parameters present at concentrations that exceed CCME AL guidelines or Mount Nansen effluent discharge standards	Discussed in Report Section
	nickel, silver, TSS, zinc	
WQ-MN	cyanide, aluminum, cadmium, copper, iron, manganese	3.3.8
WQ-VC-REF	cyanide, aluminum, arsenic, cadmium, copper, iron, manganese, silver	3.3.9
WQ-VC-U	cyanide, aluminum, arsenic, cadmium, copper, iron, lead, manganese, silver, zinc	3.3.9
WQ-VC-DBC	cyanide, aluminum, arsenic, cadmium, copper, iron, lead, manganese, silver, zinc	3.3.9
WQ-VC-UMN	cyanide, aluminum, arsenic, cadmium, copper, iron	3.3.9
WQ-VC-R	cyanide, aluminum, arsenic, cadmium, copper, iron	3.3.9
WQ-PW	NA	3.3.10
WQ-DRY	none	3.3.11

3.3.1 Pony Creek Watershed

Pony Creek was sampled at two sites, upstream and downstream of any potential groundwater or seepage inputs from the pit lake (WQ-PC-U and WQ-PC-D). The pH at WQ-PC-U ranged from 7.06 to 7.81, while at WQ-PC-D it was slightly more acidic, with values ranging from 6.48 to 7.73. The water hardness was similar at both sites, with values ranging between 100 and 200 mg/L CaCO₃, indicating that the water was ‘slightly hard’. The total suspended solids (TSS) concentrations were very low, often below laboratory detection (< 2 mg/L) at WQ-PC-U, while they were slightly higher at WQ-PC-D, ranging from 2 to 83 mg/L; one sample collected at WQ-PC-D on September 6, 2013 (83 mg/L) exceeded the site effluent discharge standard outlined in the water license (50 mg/L). The TSS concentrations showed no seasonal trend, indicating that sporadic high values may have been due to rainfall events.

All nutrient parameters including nitrate, nitrite and ammonia were present at very low concentrations, more than an order of magnitude below guidelines, and are not considered a concern. The CCME AL guidelines for nitrate and nitrite are 13 mg/L and 0.06 mg/L, respectively (CCME 2012). The guideline for ammonia is dependent on temperature and pH (higher temperatures and increasing pH result in a more restrictive guideline; CCME 2012), and for the Mount Nansen Site the guideline ranges from approximately 2 to 7 mg/L NH₃. An extremely conservative value of 1.0 mg/L was used to graph the CCME AL guideline for ammonia for all sites; this value corresponds to a pH of 8.0 and a temperature of 10.0°C, which represents the highest temperature and pH data commonly collected from the Mount Nansen Site.

The concentration of strong acid dissociated cyanide (‘SAD’ cyanide) was compared with the CCME AL guideline for total cyanide (0.005 mg/L). All cyanide parameter concentrations were generally very low, as expected since the mill or tailings facilities are located in the adjacent Dome Creek watershed. However, there were some samples with concentrations that exceeded the CCME AL guideline at both the upstream and downstream sites; generally these concentrations were only slightly above the guideline. There were two events, July 25, 2012 and September 19, 2012, where the concentrations at WQ-PC-D were significantly



above the CCME AL guideline for total cyanide (0.005 mg/L) with concentrations of 0.024 and 0.020 mg/L, respectively. Concentrations from both sample sites were below the effluent discharge standards for SAD (0.3 mg/L) and WAD cyanide (0.1 mg/L). The source of the cyanide in these samples is unknown as the Pony Creek watershed is not downstream of the mill and tailings pond facilities.

There were a number of metals present in the Pony Creek watercourse that were present at concentrations exceeding the CCME AL guidelines and the effluent discharge standards (Appendix C, Figure C1). In general, the metals concentrations were higher at the WQ-PC-D site.

Aluminum – Aluminum concentrations exceeded the CCME AL guideline (0.1 mg/L) at both WQ-PC-U and WQ-PC-D in the spring and early summer months. For the rest of the open water season all samples had aluminum concentrations far below guideline. Higher concentrations earlier in the year were likely due to snow-melt and subsequent run-off into the watercourse.

Arsenic – A small number of samples from the WQ-PC-D site had arsenic concentrations that exceeded the CCME AL guideline (0.005 mg/L), generally earlier in the open water season. No samples from WQ-PC-U exceeded the guideline.

Cadmium – Nearly all samples from the WQ-PC-D site exceeded the CCME AL guideline (hardness dependent, approximately 0.00004 mg/L for this site). Conversely, cadmium concentrations at WQ-PC-U either met, or were below the guideline. Concentrations of cadmium in all samples collected from both Pony Creek sites were below the site effluent discharge standard.

Copper - Nearly all samples from the WQ-PC-D site had copper concentration that exceeded the CCME AL guideline (0.002 mg/L). Copper concentrations in all samples from WQ-PC-U were below the CCME AL guideline. Concentrations of copper in all samples collected from both Pony Creek sites were below the site effluent discharge standard.

Iron - Iron concentrations exceeded the CCME AL guideline (0.1 mg/L) at both WQ-PC-U and WQ-PC-D in the spring and early summer months. For the rest of the open water season all concentrations were below guideline. One sample collect at WQ-PC-U (1.15 mg/L) on May 30, 2012 exceeded the site effluent discharge standard (1.0 mg/L).

Manganese – Concentrations of manganese at the WQ-PC-U and WQ-PC-D sites were generally below the site effluent discharge standard (0.5 mg/L), however one sample, collected on May 30, 2012 had a concentration of 0.751 mg/L, which exceeds the guideline.

Zinc – Zinc concentrations in the majority of samples collected at WQ-PC-D exceeded the CCME AL guideline (0.03 mg/L) by a small measure; these concentrations were relatively constant throughout the open water period. Zinc concentrations from all samples from WQ-PC-U were below guideline. The zinc concentration in one sample from WQ-PC-D collected on May 2, 2012, had a concentration of 0.591 mg/L, which exceeds the effluent discharge standard (0.3 mg/L).



3.3.2 Brown-McDade Pit Lake

The pH in the pit lake decreased, or became more alkaline, with depth; surface pH ranged from 7.4 to 8.1, while pH from the bottom samples ranged from 6.8 to 7.6. Water hardness followed the opposite trend, increasing with depth. Water hardness at the surface was between 464 and 1350 mg/L, while hardness at the bottom of the water column ranged from 1220 to 2020 mg/L. Water clarity was high during all times of the year, with TSS concentrations from all depths generally less than 10 mg/L. The TSS concentrations, particularly samples from the bottom of the water column were highest in samples from October through January (no sample collected in November due to ice safety concerns). This may have been due to mobilization of bottom sediment associated with fall turn-over.

Historically there was some concern with the nutrient status of the pit lake, due to its blue/green water colour; as a result chlorophyll *a* and phaeophytin analyses were included in the program. A review of the 2012/13 results together with other nitrogen compounds and total phosphorus indicates that nutrient concentrations in the pit lake are very low; the pit lake is an oligotrophic (low nutrient) system.

There are a number of metals present in the pit lake at concentrations that exceed CCME AL guidelines (Appendix C, Figure C2). Higher concentrations of aluminum, arsenic, copper, iron, lead and manganese in samples collected in October through January are likely associated with elevated TSS concentrations noted in these same samples.

Aluminum, iron, lead and silver – Concentrations of these metals were generally below both CCME AL and effluent discharge standards. However, concentrations were greater in samples collected from the bottom of the water column in October 2012 through January 2013. Aluminum concentrations exceeded the CCME AL guideline (0.1 mg/L) in December 2012 and January 2013. Iron concentrations exceeded the CCME AL guideline (0.3 mg/L) and the effluent discharge standard (1.0 mg/L) in December 2012 and January 2013. The lead concentrations in samples collected in December 2012 and January 2013 slightly exceeded the CCME AL guideline (0.007 mg/L), but not the effluent discharge standard (0.1 mg/L). The silver concentrations were also elevated in December 2012 and January 2013, slightly above the CCME AL guideline (0.0001 mg/L), but not the effluent discharge standard (0.10 mg/L). These elevated concentrations of aluminum, iron, lead and silver were likely associated with elevated TSS seen in samples collected during the same time period; this hypothesis is supported by concentrations of dissolved metals for the same time period, which remained low.

Arsenic – The arsenic concentration in nearly all samples collected from all depths exceeded the CCME AL guideline for arsenic (0.005 mg/L). There does not appear to be any correlation with depth. Concentrations did increase in samples collected from the bottom of the water column in October 2012 through January 2013.

Cadmium – All samples collected from all depths exceeded the CCME AL guideline for cadmium (hardness dependent, approximately 0.00002 mg/L for this site), but not the effluent discharge standard (0.02 mg/L). Concentrations generally increased slightly with water column depth.



Copper – In general copper concentrations were below the CCME AL guideline (0.002 mg/L), however there were a few slight exceedances, all which were associated with samples taken from the middle or bottom of the water column. Concentrations did increase in samples collected from the bottom of the water column in October 2012 through January 2013. Copper concentrations did not vary greatly with respect to depth or time of sampling.

Manganese – Manganese concentrations in samples collected from the bottom of the water column periodically exceeded the effluent discharge standard (0.5 mg/L). Concentrations were highest in spring and fall/early winter.

Zinc – Concentrations in samples collected from all depths during all sampling events exceeded the CCME AL guideline for zinc (0.03 mg/L); concentrations ranged from 0.4 to 1.5 mg/L. In general higher concentrations were noted in samples collected from the bottom of the water column in spring and early summer and again in late fall/early winter.

Concentrations of aluminum, iron, lead, silver and manganese did periodically exceed the applicable CCME AL guidelines and effluent discharge standards in the 2012/13 season; however, concentrations of these metals appear to be associated with seasonal increases in TSS. There were no corresponding increases in dissolved fractions of these metals. Therefore, the source of these metals is likely the sediments underlying the pit lake; concentrations in the water column increase when these sediments are mobilized. Of greater concern in the water column of the pit lake are concentrations of arsenic, cadmium, copper and zinc. These metals are present throughout all depths of the water column in concentrations that routinely exceeded all applicable guidelines.

3.3.3 Upper Dome Creek Watershed

The Upper Dome Creek watershed includes all sampling sites on Dome Creek upstream of the Tailings Pond; WQ-DC-DX is upstream of the mill facilities, WQ-DC-DX+105, WQ-DC-D1, WQ-DC-D1b, WQ-DC-U1, and WQ-DC-U2 are all down gradient of the mill facilities. The pH moving downstream through the Dome Creek sites was fairly consistently between 6.24 and 8.15; the most alkaline values were noted at sites WQ-DC-D1 and WQ-DC-D1b. Water in Dome Creek was very hard (> 450 mg/L) at all sites in nearly all samples. The TSS concentration in Dome Creek was highly variable at all sites, ranging between 2 and >1000 mg/L; concentrations, particularly those from WQ-DC-U2, routinely exceeded the effluent discharge standard during the open water season. Dome Creek is a small watercourse that is likely heavily affected by snow melt and rainfall events that cause run-off material entering the watercourse to greatly influence the TSS concentration. The TSS concentrations in samples collected from WQ-DC-DX+105 from November 2012 through February 2013 (following formation of ice) were markedly lower; other sites in the Upper Dome Creek watershed were not sampled during this period as they were frozen to substrate.

Nutrient parameters including nitrate, nitrite and ammonia were present at low concentrations, far below guidelines, and are not considered a concern.



SAD Cyanide – Concentrations of some samples exceeded the CCME AL guideline for total cyanide (0.005 mg/L) at all sites; however the highest concentrations were routinely seen at WQ-DC-DX+105 (range of 0.004 to 0.024 mg/L) and WQ-DC-D1 (range of 0.004 mg/L to 0.21 mg/L). The highest concentrations were in samples collected between June 2012 and October 2012, when the watercourses were ice-free. The source of SAD cyanide in Dome Creek appears to be the surrounding sediments.

Aluminum, arsenic, cadmium, and iron – Concentrations of these metals were commonly present in surface water quality samples collected in the upper Dome Creek Valley in concentrations that exceed the CCME AL guidelines (Appendix C, Figure C3). Concentrations were generally lowest in WQ-DC-DX, which is up-gradient of the mill facilities; conversely, WQ-DC-DX+105 which is located directly downstream of the mill facilities often had the highest concentrations, likely due to its proximity to the mill and the small size of the watercourse. The iron concentrations in the majority of samples from all sites also exceeded the effluent discharge standard (1.0 mg/L)

Chromium – A small number of samples, collected from WQ-DC-DX, WQ-DC-D1 and WQ-DC-U2 had chromium concentrations that exceeded the CCME AL guideline (0.089 mg/L). None of these concentrations exceeded the effluent discharge standard (0.04 mg/L).

Copper – Copper concentrations for most sites were generally below the CCME AL guideline (0.002 mg/L). The exception to this was the concentrations in samples from WQ-DC-U2, which ranged from 0.002 to 0.034 mg/L, and exceeded the CCME AL guideline in all but two samples. Also, concentrations in samples collected under ice at WQ-DC-DX+105 in January 2012 through February 2013 were below the guideline. Copper concentrations in all samples from all sites were below the effluent discharge standards.

Lead - A number of samples, collected from WQ-DC-DX, WQ-DC-D1 and WQ-DC-U2 had lead concentrations that exceeded the CCME AL guideline (0.003 mg/L). None of these concentrations exceeded the effluent discharge standard (0.04 mg/L).

Manganese – Manganese concentrations in nearly all samples from WQ-DC-DX+105, many samples from WQ-DC-D1, WQ-DC-D1b, and WQ-DC-U2 exceeded the effluent discharge standard for manganese (0.5 mg/L). Concentrations from WQ-DC-DX and WQ-DC-U1 were generally below the discharge standard.

Silver – Silver concentrations a small number of samples collected from WQ-DC-DX, WQ-DC-D1, WQ-DC-D1b and WQ-DC-U2 slightly exceeded the CCME AL guideline (0.0001 mg/L). Concentrations of all samples were below the effluent discharge standard.

Zinc - Concentrations of zinc varied widely between the sites. Concentrations from samples collected at WQ-DC-DX and WQ-DC-U1 were below the CCME AL guideline (0.03 mg/L). Concentrations in samples collected from WQ-DC-U2 were above the CCME AL guideline, but below the effluent discharge standard, and concentrations in samples collected from WQ-DC-DX+105, WQ-DC-D1 and WQ-DC-D1b were above the CCME AL and effluent discharge standards.

Concentrations of metals in surface water quality samples collected from the Upper Dome Creek watershed indicate that this area is heavily contaminated with heavy metals. Generally, the lowest concentrations were



noted in samples from WQ-DC-DX, which is upstream of the mill facilities, indicating that mine infrastructure is the likely source of much of the contamination. It appears that the sediments through which the watercourse flows contain aluminum, arsenic, cadmium, iron and zinc. There may be some attenuation of these metals to the sediments as the highest concentrations were often noted in samples collected from the WQ-DC-DX+105, WQ-DC-D1 and WQ-DC-D1b, and not from the most downstream sites, WQ-DC-U1 and WQ-DC-U2.

3.3.4 Lower Dome Creek Watershed

The lower Dome Creek watershed includes sites downstream of the tailings pond and associated facilities; these sites include WQ-DC-U and WQ-DC-R. Samples could not be collected from WQ-DC-R between November 2012 and February 2013 because it was frozen to substrate. Data from WQ-SEEP was also included in the graphical representation since the outflow from the seepage outlet pipe enters the Dome Creek Valley just upstream from the DC-U site (Appendix C, Figure C4), however data from WQ-SEEP will be discussed in section 3.3.5.

The pH in the lower Dome Creek sites was highly consistent; values generally ranged between 7.5 and 7.9. As noted at the upper sites, water was very hard, with hardness concentrations >450 mg/L. The TSS concentrations were more consistent than at the upper sites, ranging from 32 to 427 mg/L at the WQ-DC-U sites and 2 to 178 mg/L at the WQ-DC-R site; concentrations in many samples from both sites exceeded the effluent discharge standard (50 mg/L). TSS concentrations at both sites decreased to below the effluent discharge standard after ice formation, when interaction with surface run-off and surrounding sediments would have decreased.

All nutrient parameters including nitrate and nitrite were low, far below guidelines, and are not considered a concern. Ammonia concentrations at WQ-DC-U increased following freeze-up but because the guideline for ammonia also increased with decreasing temperature the concentrations were well below guideline.

SAD Cyanide – Concentrations of all samples exceeded the CCME AL guideline for total cyanide (0.005 mg/L) at both sites; this is likely due to input from the seepage outlet pipe immediately upstream of DC-U. Concentrations at WQ-DC-U ranged from 0.008 to 0.68 mg/L, while at WQ-DC-R they ranged from 0.006 to 0.088 mg/L. SAD cyanide concentrations were higher in samples from WQ-DC-U under ice in samples collected from November 2012 to February 2013; concentrations from November 2012, January and February 2013 exceeded the effluent discharge standard (0.3 mg/L).

Aluminum – Concentrations in nearly all samples collected between April 2012 and October 2012 from both sites exceeded the CCME AL guideline for aluminum (0.1 mg/L). Aluminum concentrations in samples collected from WQ-DC-U under ice from November 2012 through February 2013 were below the CCME AL guideline.

Arsenic and iron - Concentrations in all samples collected from both sites exceeded the CCME AL guidelines for both arsenic (0.005 mg/L) and iron (0.3 mg/L), as well as the effluent discharge standard for iron (1.0 mg/L)



Cadmium – Cadmium concentrations from WQ-DC-U ranged from 0.00016 to 0.00054 mg/L and nearly all samples exceeded the CCME AL guideline (hardness dependent, approximately 0.0002 mg/L for this site). Concentrations from WQ-DC-R ranged from 0.00009 mg/L to 0.00052 mg/L, and only occasionally exceeded the guideline. Concentrations from all samples were below the effluent discharge standard (0.02 mg/L).

Copper – Concentrations from both sites ranged above and below the CCME AL guideline (0.002 mg/L). There was one sampling event on July 11, 2012 where concentrations at both WQ-DC-U and WQ-DC-R were considerably higher, with concentrations of 0.019 and 0.012 mg/L respectively.

Chromium, lead and silver – Concentrations of these parameters were generally below the CCME AL guidelines (0.0089 mg/L for chromium, 0.007 mg/L for lead, and 0.0001 mg/L for silver). However, very rarely concentrations of these metals exceeded CCME AL, but not effluent discharge standards. These instances were extremely rare and were likely associated with rainfall events that introduced increase TSS to the watercourse.

Manganese – Concentrations of manganese at both WQ-DC-U and WQ-DC-R exceeded the effluent discharge standard (0.5 mg/L) in all samples collected through the 2012/13 sampling program.

Silver – Silver concentrations were generally below the guideline at both sites, save for a few events in May and June 2012, where concentrations at both sites were slightly elevated above the CCME AL guideline (0.0001 mg/L), possibly due inputs associated with spring melt and subsequent runoff.

Zinc – Zinc concentrations at both WQ-DC-U and WQ-DC-R generally exceeded the CCME AL guideline (0.03 mg/L) in spring and summer sampling; samples taken from the end of August 2012 through October 2012 all had zinc concentrations below the guideline, and concentrations in samples collected under the ice at WQ-DC-U were the lower still. No samples from either site had zinc concentrations that exceeded the effluent discharge standard.

Metals of concern in the lower Dome Creek watershed include aluminum, arsenic, cadmium, copper, iron, manganese, and to a lesser extent, zinc. The most likely source of contamination to the Dome Creek watershed are the mill site and tailings facilities. Total metals concentrations in Dome Creek (upper and lower watersheds) are associated with two sources; the TSS concentrations in the water column, and the surrounding sediments and soils. In general, total metals concentrations in the lower Dome Creek watershed were lower than those in the upper Dome Creek watershed. Solids suspended in the water column that account for a substantial portion of the total metals concentrations in the Upper Dome Creek watershed. Dissolved metals concentrations are more consistent, indicating that TSS is partially responsible for differences in metals concentrations moving downstream along Dome Creek. The suspended sediments would have, in part, settled before reaching the lower Dome Creek sampling sites; total metals concentrations decrease with the settling of this material. In addition to TSS concentrations, it is likely that the surrounding soils and sediments in the lower Dome Creek watershed have lower concentrations of heavy metals due to increasing distance from sources of contaminants. There may have been some minor effects on water quality associated with trenching activities in the diversion channel, however, these were



likely restricted to short-term spikes in turbidity. Increases in TSS concentrations and/or total metals concentrations were not noted in sample data collected from WQ-DC-U or WQ-DC-R during winter months when excavation activities occurred; on the contrary concentrations of most total metals were lower in the winter months.

3.3.5 Tailings Pond and Seepage Pond Outlet Pipe

Data from the tailings pond (WQ-TP) and the seepage pond outlet pipe (WQ-SEEP) are discussed together since the seepage pond is composed of water that has seeped from the tailings pond through the dam (Appendix C, Figure C5).

The pH in the tailings pond is slightly alkaline, with values that range from 7.51 to 8.07, while pH from the seepage pond was more acidic with values that ranged from 6.26 to 7.64. Water from both sites can be considered ‘very hard’ with hardness concentrations that ranged from 399 to 807 mg/L at WQ-TP pond and 581 to 853 mg/L at WQ-SEEP. In general the TSS concentration was low (< 10 mg/L) in the tailings pond, with some allowance for variations during spring melt and rainfall events; TSS concentration in WQ-SEEP samples was fairly constant, from 20 to 34 mg/L.

Concentrations of nitrate and nitrite from all samples from WQ-TP and WQ-SEEP, were very low, far below guidelines, and are not considered a concern. Concentrations of ammonia were low in samples from WQ-TP; however, concentrations of ammonia from samples collected from WQ-SEEP were among the highest on site, ranging from 2.5 to 5.9 mg/L. The CCME AL guideline for ammonia is both temperature and pH dependent. During the summer months when the water temperature at WQ-SEEP was as high as 8°C, and the pH was approximately 7, the guideline is approximately 10 mg/L. During winter sampling, water temperature approached 0°C, and pH remained constant at 7, therefore the guideline is 23 mg/L. Therefore, the ammonia concentrations in samples collected from WQ-SEEP were below the applicable CCME AL guideline.

In general SAD cyanide concentrations from WQ-SEEP were higher than concentrations from WQ-TP. SAD cyanide concentrations from all samples taken from WQ-SEEP exceeded the CCME AL guideline for total cyanide (0.005 mg/L) as well as the effluent discharge standard (0.3 mg/L). SAD cyanide concentrations from WQ-TP varied about the CCME AL guideline concentration, and there were sporadic exceedances of the CCME AL guideline, but not the effluent discharge standard. This was likely due to the presence of cyanide in the sediments lining the tailings pond, to which the seepage water is exposed.

Aluminum – In general, aluminum concentrations in all samples from both WQ-TP and WQ-SEEP were below the CCME AL guideline for aluminum (0.1 mg/L); however one sample from WQ-TP collected on May 30 had a concentration of 0.2 mg/L.

Arsenic – Arsenic concentrations in all samples from both sites exceeded the CCME AL guideline (0.005 mg/L). One sample collected in February 2013 from WQ-TP exceeded the effluent standard (0.15 mg/L).



Cadmium - Cadmium concentrations were higher in samples from WQ-TP than WQ-SEEP, however all samples from both sites exceeded the CCME AL guideline (hardness dependent, but approximately 0.0002 mg/L for these sites).

Copper – While copper concentrations of all samples exceeded the CCME AL guideline (0.002 mg/L), the concentrations of samples taken from WQ-SEEP only slightly exceeded the guideline.

Iron – Iron concentrations were higher in samples from WQ-SEEP than WQ-TP. Iron concentrations at WQ-SEEP were more than an order of magnitude greater than the CCME AL guideline (0.3 mg/L), while concentrations in samples from WQ-TP were generally below the guideline.

Lead – Lead concentrations in samples from WQ-TP collected between May 2012 and October 2012 generally exceeded the CCME AL guideline (0.003 mg/L). Concentrations from WQ-SEEP samples were considerably lower, and did not exceed the guideline.

Manganese – Concentrations of manganese were higher in samples from WQ-SEEP, than those in samples from WQ-TP. Concentrations in all samples from WQ-SEEP, and most from WQ-TP exceeded the effluent discharge standard.

Silver – Nearly all of the total silver samples that were collected from WQ-TP exceeded the CCME AL guideline (0.0001 mg/L); only the sample collected on August 8, 2012 was below the guideline. Concentrations of total silver were notably higher in the spring/early summer and again in early fall and appeared to correspond to higher TSS concentrations, particularly in the spring/early summer. Total silver concentrations at WQ-SEEP were all below the CCME AL guideline.

Zinc – All samples from WQ-TP had total zinc present at concentrations that exceeded the CCME guideline (0.03 mg/L). Zinc concentrations in all samples from WQ-SEEP were below the CCME AL guideline.

LT50 – All results from LT50 samples through the 2012/13 season have been positive. No tests were failed.

Most of the total metals previously identified as of concern at the Mount Nansen Site exceeded the CCME AL guidelines at WQ-TP and WQ-SEEP. In general, concentrations of arsenic, cadmium, copper, lead, silver and zinc were higher in samples from WQ-TP; lower concentrations at WQ-SEEP were likely due to the adsorbing of metals to sediments as the water from the tailings pond seeps through the bottom sediments and dam material into the seepage pond. Alternatively, iron concentrations were higher in samples from WQ-SEEP, indicating that the sediments through which the water passed between the tailings pond and the seepage pond may act as a source of iron. Concentrations of aluminum, cadmium, copper and zinc were all highest in spring/early summer, and steadily decreased until stabilizing at the end of July; these concentrations may be attributable to inputs associated with snow melt/spring runoff.



3.3.6 Seep Sites: WQ-MS-S-03, WQ-MS-S-08, WQ-ADIT-SEEP, WQ-DAM-SEEP

WQ-MS-S-03 was identified in 2011 and included in the surface water quality program for the 2012/13 sampling season. The pH of the samples at this site was largely neutral, with values ranging from 6.9 to 7.77. Water hardness ranged from 564 to 861 mg/L, indicating that the water at this site was very hard. The TSS concentration varied widely, between 2 to 212 mg/L.

All nutrient parameters including nitrate, nitrite and ammonia were present at low concentrations, far below guidelines, and are not considered a concern.

Concentrations of SAD cyanide in samples from WQ-MS-S-03 were generally below the CCME AL guideline (0.005 mg/L), however, there was one sample collected on July 11, 2012 that had a concentration of 0.008 mg/L.

There were a number of metals with concentrations exceeding the CCME AL guidelines. Of these, aluminum, copper, lead and silver were generally present at low concentrations, but increased in samples with elevated TSS. However, arsenic, cadmium, iron and zinc concentrations routinely exceeded the applicable guidelines (Appendix C, Figure C6).

Aluminum – Aluminum concentrations varied above and below the guideline, following the concentration of TSS. Concentrations ranged from 0.005 to 0.346 mg/L, and three of the 11 samples collected had concentrations that exceeded the CCME AL guideline (0.1 mg/L).

Arsenic – All samples collected at WQ-MS-S-03 had arsenic concentrations that exceeded the CCME AL guideline (0.005 mg/L). Concentrations ranged from 0.0479 to 0.364 mg/L.

Cadmium - All samples collected at WQ-MS-S-03 had cadmium concentrations that exceeded the CCME AL guideline (hardness dependent, approximately 0.00017 mg/L for this site). Concentrations ranged from 0.00538 to 0.0299 mg/L.

Copper – Copper concentrations were generally below the CCME guideline (0.002 mg/L), however, a small number of samples, associated with high TSS concentration exceeded the guideline. Concentrations ranged from 0.001 mg/L to 0.0136 mg/L.

Iron - All samples collected had iron concentrations that exceeded the CCME AL guideline (0.3 mg/L). Concentrations ranged from 0.327 to 4.46 mg/L.

Lead - Lead concentrations were generally below the CCME guideline (0.003 mg/L), however, a small number of samples, associated with high TSS concentration exceeded the guideline. Concentrations ranged from 0.0007 to 0.0024 mg/L.

Silver - Silver concentrations were generally below the CCME guideline (0.0001 mg/L), however, a small number of samples, associated with high TSS concentration exceeded the guideline. Concentrations ranged from 0.00001 mg/L to 0.00037 mg/L.



Zinc - All samples collected had zinc concentrations that exceeded the CCME AL guideline (0.03 mg/L). Concentrations ranged from 1.16 to 2.32 mg/L.

WQ-MS-08 was only sampled on one occasion, on November 15, 2012; though it was to be added to the regular bi-weekly sampling schedule, it had frozen to such an extent that sampling was not possible in mid-December 2012. Therefore, very little analysis of the data can be conducted. The results collected were compared to applicable CCME AL and effluent discharge standards. Parameters of concern include total cyanide, aluminum, arsenic (total and dissolved), cadmium, iron, lead, manganese, zinc.

WQ-DAM-SEEP was only sampled on one occasion, on July 11, 2012. Therefore, very little analysis of the data can be conducted. The results collected were compared to applicable CCME AL and effluent discharge standards. Parameters of concern include total cyanide, arsenic, cadmium, copper, iron, manganese, total suspended solids.

WQ-ADIT-SEEP was only sampled on one occasion, on September 19, 2012. Therefore, very little analysis of the data can be conducted. The results collected were compared to applicable CCME AL and effluent discharge standards. Parameters of concern include total cyanide and cadmium.

3.3.7 Back Creek Watershed

Back Creek is a tributary to Victoria Creek, flowing into Victoria approximately 10 m downstream of the WQ-VC-U site. The sampling site on Back Creek (WQ-BC) is located approximately 25 m up from the confluence with Victoria Creek. Back Creek is a small watercourse that is heavily, though sporadically, affected by placer mining activities upstream. The TSS concentrations varied widely throughout the 2012/13 sampling program due to effects from the upstream placer mining; consequently the total metals concentrations also increased sharply during placer releases (Appendix C, Figure C7). Back Creek was sampled until October 2012, when it froze to substrate and samples could no longer be collected.

The pH in Back Creek was largely neutral, with values falling between 7.08 and 8.03; accordingly the alkalinity ranged from 35 to 100 mg/L with the majority of the values falling between 80 and 100 mg/L. The water hardness ranged from a low of 52 to a high of 170 mg/L; 78% of the samples had hardness between 100 and 200 mg/L, indicating that the water at WQ-BC was moderately hard. As described above the TSS concentrations were affected by upstream activities and varied widely between 2 and 25,900 mg/L. The higher TSS concentrations all occur in samples collected between May 2012 and August 2012.

All nutrient parameters including nitrate, nitrite and ammonia were present at low concentrations, far below guidelines, and are not considered a concern.

There were two samples from Back Creek (June 27 and September 19, 2012), with SAD cyanide concentrations of 0.02 and 0.042 mg/L, respectively, which exceeded the CCME AL guideline for total cyanide (0.005 mg/L).



There were a number of metals present at concentrations that exceeded the CCME AL guidelines; the highest concentration of all metals listed below occurred on July 11, 2012 and coincided with an extreme spike in TSS (25,900 mg/L). Though there was some rainfall at this time, it was not sufficient rain to cause this increase in TSS; it was more likely associated with placer activity.

Aluminum – Concentrations generally ranged from 0.107 to 12 mg/L, with the exception of 569 mg/L, which was the concentration in the sample collected on July 11, 2012. Concentrations in all samples exceeded the CCME AL guideline (0.1 mg/L).

Arsenic – Concentrations ranged from 0.0024 to 3.41 mg/L; concentrations in 11 of 14 samples taken exceeded the CCME AL guideline (0.005 mg/L).

Barium and nickel – concentrations of these two metals exceeded the CCME AL guidelines (1 mg/L and 0.1 mg/L) only on one occasion, July 11, 2012, when the TSS concentration was 25,900 mg/L.

Cadmium – The total cadmium concentrations at WQ-BC ranged from 0.00017 to 0.0628 mg/L; all concentrations exceeded the hardness-dependent guidelines that ranged from 0.000019 to 0.000052 mg/L.

Chromium – The chromium concentration exceeded the CCME AL guideline (0.0089 mg/L) in only three samples, all between June 2012 July 2012, and all were associated with high TSS concentrations; one sample also had a concentration of 0.062 mg/L, which exceeded the effluent discharge standard (0.04 mg/L).

Copper – Concentrations ranged from 0.0019 to 1.5 mg/L; just over 40% of the samples taken had copper concentrations that exceeded the CCME AL guideline (0.002 mg/L).

Iron – Iron concentrations ranged from 0.138 to 995 mg/L; all but one sample (April 2012) exceeded the CCME AL guideline (0.3 mg/L),

Lead – Lead concentrations ranged from 0.0004 to 3.56 mg/L; just over 40% exceeded the CCME AL guideline (0.003 mg/L). Those samples with high total lead concentrations were also those with high TSS concentrations.

Manganese – Concentrations of manganese ranged from 0.266 mg/L to 31.7 mg/L; these concentrations routinely exceeded the effluent discharge standard (0.5 mg/L).

Silver – Concentrations ranged from 0.00001 to 0.0272 mg/L; only 4 of the 14 samples (all between May and August) taken exceeded the CCME AL guideline (0.0001 mg/L)

Zinc – The majority of the samples had zinc concentrations below the CCME AL guideline. However, concentrations ranged from 0.0048 to 7.58 mg/L, and 5 of the 14 samples exceeded the CCME AL guideline (0.03 mg/L).

Back Creek regularly had concentrations of many metals that exceeded both the CCME AL and effluent discharge standards during the open water season. High concentrations of total metals were generally



associated with elevated TSS concentrations; numerous spikes in TSS concentrations appeared to be associated with placer mining activities upstream.

3.3.8 Minnesota Creek Watershed

Minnesota Creek flows into Victoria Creek from the east (side opposite Mount Nansen Site). It is unlikely that this stream is affected by activities at Mount Nansen; however, since it flows into Victoria Creek, its surface water quality can have implications on the surface water quality of Victoria Creek. The surface water quality sampling site (WQ-MN) is located approximately 25 m upstream from the confluence with Victoria Creek. Minnesota Creek was sampled until November 2012, when it froze to substrate and samples could no longer be collected.

The pH in Minnesota Creek was slightly below neutral, with values that ranged from 6.23 to 7.39; the alkalinity ranged from 10 to 63 mg/L. The hardness concentration was low, from 20 to 66 mg/L, and therefore can be described as 'soft' water; this is distinct from all other sample sites included in this program, which had hard water. Water was generally clear, with low TSS concentrations from 1 to 13 mg/L.

All nutrient parameters including nitrate, nitrite and ammonia were present at low concentrations, far below guidelines, and are not considered a concern.

The SAD cyanide concentrations exceeded the CCME AL guideline for total cyanide (0.005 mg/L) in 6 of the 15 samples taken. Concentrations ranged from 0.004 to 0.062 mg/L; the highest concentration was in the sample collected on November 15, 2012.

Total and dissolved metals concentrations were similar, as expected due to the low TSS concentration (Appendix C, Figure C8). There were a few metals with concentrations that met or exceeded the CCME AL guidelines:

Aluminum – The total aluminum concentrations at WQ-MN ranged from 0.026 to 0.237 mg/L, 12 of the 15 samples collected had aluminum concentrations that slightly exceeded the guideline of 0.1 mg/L.

Cadmium – The CCME AL guideline for total cadmium is derived by using a formula based on hardness. Since water at WQ-MN was soft, the guideline applied to this site is the most restrictive of all surface water quality sites in the 2012/13 program. Cadmium concentrations on site ranged from 0.00001 to 0.00006 mg/L, and the guidelines ranged from 0.000008 to 0.000023 mg/L. Concentrations exceeded the guideline in 14 of the 15 samples collected. No samples had cadmium concentrations that exceeded the effluent discharge standard (0.02 mg/L).

Copper – The total copper concentrations ranged from 0.002 to 0.005 mg/L, with only one sample, collected on August 8 (0.005 mg/L), exceeding the guideline (0.002 mg/L). No samples had copper concentrations that exceeded the effluent discharge standard (0.2 mg/L).



Iron – The total iron concentrations ranged from 0.639 to 4.06 mg/L. All samples in the 2012/13 period of record exceeded the CCME AL guideline of 0.3 mg/L. All but two samples exceeded the effluent discharge standard (1.0 mg/L).

Manganese – Only one sample, collected on April 18, 2012, had a concentration (0.669 mg/L) that exceeded the effluent discharge standard (0.5 mg/L).

In general, metals concentrations in samples collected at WQ-MN were low. There are naturally elevated concentrations in the area for aluminum, cadmium, copper and iron; they are assumed to be naturally occurring as the watercourse does not drain an area affected by mining or other industrial activity. Though elevated with respect to CCME AL, the concentrations of these metals are not higher than those noted in downstream sampling locations on Victoria Creek. Therefore, they are unlikely to have a detrimental impact on water quality in the receiving environment.

3.3.9 Victoria Creek Watershed

There are a total of five surface water quality sampling sites on Victoria Creek; WQ-VC-REF, WQ-VC-U, WQ-VC-DBC, WQ-VC-UMN, and WQ-VC-R. The data collected from these five sites were graphed together to better describe changes to surface water quality as the water travels downstream (Appendix C, Figure C9). Victoria Creek is the largest watercourse included in the 2012/13 surface water quality sampling program; samples continue to be collected through the winter months, as it has not frozen to substrate.

The pH was highly consistent moving downstream in Victoria Creek with values that ranged from 6.76 to 7.92; therefore the slightly acidic condition from Minnesota Creek had no effect on the pH in Victoria Creek downstream of the confluence. This is likely reflective of the quantity of the inflow from Minnesota Creek compared with the quantity of water in Victoria Creek. Water hardness in Victoria Creek slightly increased moving downstream; concentrations at the reference site (WQ-VC-REF) ranged from 36 to 94 mg/L (described as moderately soft), while at the road site (WQ-VC-R), the farthest downstream site, the concentrations ranged from 44 to 214 mg/L (described as slightly hard). There was an unexplained spike in TSS in Victoria Creek that was noted during the September 5, 2012 sampling visit, and the effects were noted at all sites through October; however, the downstream sites were less affected, either due to settling out of sediments or increased dilution.

All nutrient parameters at all sampling sites on Victoria Creek, including nitrate, nitrite and ammonia were present at low concentrations, far below guidelines, and are not considered a concern.

The concentration of strong acid dissociated cyanide ('SAD' cyanide) was compared with the CCME AL guideline for total cyanide (0.005 mg/L). A number of sites on Victoria Creek had SAD cyanide concentrations that exceeded the CCME AL guideline; however, all samples with elevated SAD cyanide concentrations can be considered isolated events, as there does not appear to be any strong seasonal or temporal trends.



A number of sites had total metals present at concentrations exceeding the CCME AL guidelines; the concentrations of many metals in all Victoria Creek sites appears to have been affected by the TSS spike that occurred in early September 2012.

Aluminum – Aluminum concentrations at all sites regularly exceeded the CCME AL guideline (0.1 mg/L), however, the highest concentrations were in samples taken from September 5, 2012 when concentrations from all sites exceeded the guideline by a large margin (4.90, 5.51, 5.47, 2.83, and 2.72 mg/L, respectively moving downstream through the sample sites); this increase corresponds with the sudden increase in TSS concentrations. Aluminum concentrations decreased from October 2012 through February 2013, and the aluminum concentrations in samples from all Victoria Creek sampling sites were below the CCME AL guideline from December 2012 through February 2013.

Arsenic – Concentrations from WQ-VC-REF and WQ-VC-U were generally below the CCME AL guideline (0.005 mg/L), save for during the September 5, 2012 high TSS event. However, samples from WQ-VC-DBC, WQ-VC-UMN, and WQ-VC-R all regularly exceeded the CCME AL guideline. Arsenic concentrations also decreased from October 2012 through February 2013, and concentrations from all Victoria Creek sample sites were below the CCME AL guideline for that period of time.

Cadmium – Cadmium concentrations in samples collected at WQ-VC-REF and WQ-VC-U were generally below the CCME AL guideline (hardness dependent, but approximately 0.00002 mg/L), save for during the TSS increase that occurred on September 5, 2012. However, samples from WQ-VC-DBC, WQ-VC-UMN, and WQ-VC-R all regularly exceeded the CCME AL guideline. Concentrations at all sites decreased during under-ice conditions, and concentrations were similar between all sites on Victoria Creek during this time.

Copper – In general copper concentrations were below, or in the case of a small number of samples from WQ-VC-DBC and WQ-VC-R, slightly above the CCME AL guideline for copper (0.002 mg/L). However, the TSS increase in September also resulted in a spike in copper concentrations at all Victoria Creek sites. Concentrations in samples from all sites were consistently far below the effluent discharge standard (0.2 mg/L).

Iron – Iron concentrations at all sites, though most notably at WQ-VC-DBC and WQ-VC-UMN, regularly exceeded the CCME AL guideline (0.3 mg/L). All sites had increased concentrations (above the CCME AL guideline), as a result of the TSS increase in September 2012; the TSS increase appears to have not affected the downstream sites to the same extent as the upstream sites, either due to settling out of sediments or increased dilution. Iron concentrations in samples from all sites decreased between November 2012 through February 2013, and concentrations were similar between all sites on Victoria Creek during this time.

Lead – A small number of samples from WQ-VC-DBC exceeded the CCME AL guideline for lead (0.003 mg/L) in July and August 2012. These concentrations correspond with increases in the TSS concentration, and are likely attributable to inputs from Back Creek. Additionally, concentrations in samples from WQ-VC-REF, WQ-VC-U and WQ-VC-DBC all exceeded the CCME AL guideline during the September 5, 2012 sampling event associated with a large increase in TSS concentration.



Manganese – Concentrations of manganese in samples from WQ-VC-REF, WQ-VC-U and WQ-VC-DBC all exceeded the effluent discharge standard (0.5 mg/L) collected on May 31, 2012. No other samples from any site during any 2012/13 sampling event exceeded the effluent discharge standard.

Silver – Silver concentrations from all sites were generally below the CCME AL guideline (0.001 mg/L). However on September 5, 2012 concentrations at the three upper Victoria Creek sites exceeded the guideline with concentrations of 0.00014 mg/L (WQ-VC-REF), 0.00018 mg/L (WQ-VC-U), and 0.00015 mg/L (WQ-VC-DBC).

Zinc – Zinc concentrations from all sites were generally below the CCME AL guideline (0.3 mg/L), however there were two exceedances, both on September 5, 2012 at WQ-VC-U and WQ-VC-DBC, with concentrations of 0.0423 and 0.0382 mg/L. These were likely associated with the increase in TSS concentration. Zinc concentrations in samples from all sites decreased between November 2012 through February 2013, and concentrations were similar between all sites on Victoria Creek during this time.

In general, concentrations of metals in the Victoria Creek watershed were lower than other watersheds included in this surface water sampling program. When concentrations of various metals did exceed applicable guidelines, these increased concentrations were generally associated with increases in TSS, either from Back Creek, or unknown upstream sources. The source of the sudden increase in TSS noted during the September 5, 2012 sampling event is unknown, and could have been a natural event (small landslide), or anthropogenic (potentially associated with placer mining activities). Exceptions to the above comments are aluminum and cadmium concentrations, which regularly exceeded the CCME AL guidelines during open water season sampling. Concentrations of these metals decreased during winter months (when sampling occurs under ice), and are therefore likely due to inputs from surrounding sediments.

3.3.10 Pump House Well

The pump house well is located near the Upper Victoria Creek sampling site. The water samples collected from the pump house well (WQ-PW) site are tested for all the same parameters as the other sites as well as for drinking water parameters including bacterial coliforms. Key parameters are graphed for easier review of results (Appendix C, Figure C10).

Total coliform and *Escherichia coli* (E.coli) were both present at concentrations below detection (<1 mpn/100 mL). The total heterotrophic count was < 2 mpn/100 mL in all samples save that collected on July 11, which has a concentration of >738 mpn/mL. In comparison to all other bacterial data collected, this one-time concentration was considered extremely high and probably implies a level of sample contamination. Therefore, total coliform and E. coli are not considered a concern at this time.

The pH was generally neutral, with values that ranged from 6.7 to 8.1, and alkalinity ranged from 154 to 175 mg/L. The hardness is described as slightly hard, with values just below 200 mg/L. The suspended sediment load (TSS) was very low in all samples, often falling below detection at <2 mg/L.



All nutrient parameters including nitrate, nitrite and ammonia were present at very low concentrations, more than an order of magnitude below guidelines, and are not considered a concern.

Total and dissolved metals concentrations were similar, as expected due to the low TSS concentration. No metal concentrations exceeded the Health Canada Drinking Water Quality guidelines in any samples.

3.3.11 Dry Creek Watershed

Since the streambed was frozen during the attempted fall sampling at the end of September 2012, the Dry Creek reference site was only sampled twice during the 2012/13 sampling season. The pH values were 7.3 and 7.6, indicating that the water was close to neutral. Water hardness was 144 and 149 mg/L, and therefore the water was moderately hard. The water was very clear, with TSS concentrations of < 2 mg/L.

All nutrient parameters including nitrate, nitrite and ammonia were present at low concentrations, far below guidelines, and are not considered a concern.

There were no metal concentrations that exceeded the CCME AL guidelines.



4 CONCLUSIONS & RECOMMENDATIONS

4.1 METEOROLOGY CONCLUSIONS AND RECOMMENDATIONS

The new meteorological station (ATM-ROAD) provided a complete record of meteorological data for the 2012/13 monitoring program. In June 2012, it was identified that the snow sensor was not calibrated; this issue was corrected by Northern Avcom in August 2012. The data has effectively supported the surface water program by providing meteorological context for surface water hydrology and water quality results.

The 2012/13 meteorological record was mild compared to other data available for the Mount Nansen Site (2000-2011), with fewer air temperature extremes and less monthly precipitation overall. In general, mean monthly temperatures were warmer than average during April 2012, January 2013 and February 2013, but were cooler than average for May, June, July, October, November and December. The extreme minimum and maximum hourly air temperatures recorded in 2012/13 were -36.4 °C and 22.8 °C, compared to the historical extremes recorded on site of -47.7 °C and 27.1 °C. In general, the 2012/13 monthly precipitation was below average for May 2012, July 2012, September 2012 and October 2012 but above average for June 2012 and August 2012.

It is recommended that the Mount Nansen meteorological station continue to collect meteorological data in the 2013/14 to support the surface water monitoring programs as well as other work on site. Maintenance of the station and calibration of any sensors or instrumentation should be conducted according to equipment specifications as determined by Northern Avcom and AAM.

4.2 SURFACE WATER HYDROLOGY CONCLUSIONS AND RECOMMENDATIONS

The surface water hydrometric monitoring program collected instantaneous and continuous stage and discharge data. This data informed the magnitude, timing and duration of surface water flows during the open water season in each watershed and the hydrologic response of each watershed to the spring freshet, storm events and freeze-up. The smaller watersheds (Pony Creek, Dome Creek, Back Creek and Minnesota Creek) were ice free later in the season than Victoria Creek; stations in these watersheds were also located at higher elevations and tended to have larger aufeis formations which were slower to melt than snow. During the 2012/13 monitoring season, all hydrometric stations were ice free by the start of June and ice was observed in all channels at the beginning of October indicating the surface water channels at Mount Nansen Site were completely ice free for four months. Hydrologic responses to storm events in the summer were visible in the continuous stage records. Smaller watersheds showed flashy hydrologic responses to storm events, particularly when antecedent soil conditions may have been saturated due to melt or prior storms. Freshet and storm time lags were visible in the continuous records from Victoria Creek stations when compared to the other watersheds. The smaller watercourses froze to the channel bed during the winter while Victoria Creek continued to flow beneath the ice cover.



Continuous hydrometric logger records were generally trimmed to October 3, 2012 because despite winterization efforts, the data records showed a high amount of fluctuation that could not be reconciled with surveyed water levels. Instantaneous discharge measurements throughout the winter were successful and provided a more accurate description of winter low flows than the continuous records.

Diversion channel excavations did not appear to have an influence on the continuous water level records collected at hydrometric stations downstream; however at H-DC-M any potential influences on during the winter months were obscured by major changes to channel routing beneath the ice.

There are four main recommendations associated with the surface water hydrology monitoring program:

1. A complete review of the hydrometric monitoring objectives for each watershed/station with AAM prior to the onset of the open water season (May 2013). The purpose of the review would be to optimize the hydrometric network and monitoring program. An optimized network could reduce the number of stations and could focus on high quality data at stations (i.e., standard hydrometric monitoring procedures are best suited for measuring flows greater than approximately $0.1 \text{ m}^3/\text{s}$). If hydrographs are required in small streams, weirs or flumes should be installed to improve stage and discharge measurement accuracy.
2. The hydrologic monitoring program was originally designed to coincide with the existing surface water quality program and schedule. While this scheduling rationale provides hydrologic context for the surface water quality results, in 2012, the site visits (and therefore instantaneous discharge measurements) did not coincide with the peak freshet discharge. In the spring of 2013, additional site visits to measure high flows should be considered such that the peak flows can be confirmed and the rating curves extended with increased certainty.
3. Numerous hydrometric stations were impacted by sedimentation in 2012. The smaller of these channels (e.g., Dome Creek) were impacted the greatest due to the lack of channel capacity to convey the high sediment loads and active sediment sources. This introduced potential error into the continuous water level logger records. It is recommended that assessment and stabilization of the sediment sources or discontinuing continuous measurement (in favor of instantaneous measurement) at the impacted hydrometric stations be considered.
4. Although winterized, the continuous water level loggers left in during winter showed substantial fluctuations with the onset of colder temperatures and ice in the channel. cursory information was obtained from these records such as relative changes in stage and timing of ice-related surges in stage, but a stage-discharge relationship could not be developed with certainty. Based on these lessons learned and the limited usefulness of the data, EDI has revised its previous recommendation of keeping in winterized continuous data loggers and recommends to re-considering the continuous logger installations over winter.



4.2.1 Station Specific Recommendations

The following section re-iterates specific hydrometric station recommendations described in Section 3.2.

H-PC-U: If a continuous water level logger is required at this station in 2013, it is recommended to re-locate the stilling well and logger upstream of the v-notch weir and conduct some earthworks maintenance on the weir head pond to increase capacity.

H-PC-DSP: Non-ideal channel conditions for continuous hydrometric data collection resulted in challenges for developing a rating curve with low uncertainty in 2012/13. These channel conditions warrant consideration of installing a v-notch weir which would improve the stage-discharge relationship at the continuous gauge. If a weir is installed, a continuous data logger could be installed in the head pond. Instantaneous measurements using volumetric and/or salt dilution are recommended to continue for this station in 2013.

H-DC-DX: In 2013 it is recommended to collect all discharge measurements at the culvert outlet for ease of measurement. Flow that enters the culvert is upstream of the mill site is representative of the upper Dome Creek watershed.

H-DC-DX+105: The seasonal variation of flow at this station produces non-ideal channel conditions for consistent discharge measurement methods particularly during low summer flows. It is recommended that a review of the hydrometric measurement objectives for this station be conducted to identify whether alternative measurement methods should be pursued or discharge measurements be discontinued at this station.

H-DC-D1; H-DC-D1b; H-DC-U1; H-DC-U2: A review of the hydrometric measurement objectives for these stations is recommended. While instantaneous hydrometric measurements using salt dilution gauging may continue at these stations in 2013, the low magnitude discharges may be approximated using inferential hydrometric analysis techniques.

H-DC-B: It is recommended for this station to continue as an instantaneous hydrometric station in 2013 given the high likelihood that excavations of sediment or ice may occur in the diversion channel in the future that may impact the data logger.

H-DC-M: In 2013, it is likely that this station will require re-location or re-installation to accommodate changes to the channel geomorphology that occurred over the winter. As such, a re-evaluation of hydrometric measurement objectives should be conducted in order to determine the relative importance of this hydrometric station. If the hydrometric measurements are highly valued, a weir installation should be considered to measure discharge more precisely than the salt dilution gauging.

H-VC-U; H-VC-DBC; H-VC-R: No changes to the open water monitoring program are recommended; however it is recommended that the installation of the continuous winter water level logger be re-considered in 2013/14.



H-TP; H-SEEP; H-DC-R; H-BC; H-MN; H-VC-REF; H-VC-UMN: No changes to monitoring program are recommended.

4.3 SURFACE WATER QUALITY CONCLUSIONS AND RECOMMENDATIONS

There are continued high concentrations of metals including cadmium, arsenic, copper, iron and zinc at many surface water sampling sites on the Mount Nansen site. In general the highest concentrations are seen in the upper Dome Creek watershed surrounding the mill and tailings facilities. Following this area, concentrations are higher in the lower Dome Creek area, Pony Creek, and finally were lowest in the Victoria Creek and Minnesota Creek watersheds. Therefore, in general, metals concentrations decrease moving downstream through watersheds on the Mount Nansen Site, away from the mill and tailings facilities. This likely occurs through the settling of suspended sediment and dilution factors (dilution attributable to upstream Victoria Creek and Minnesota Creeks).

Back Creek remains heavily impacted by upstream activities. These activities result in increased TSS concentrations, and associated concentrations of total metals. The concentrations of dissolved metals in Back Creek remain low (below applicable guidelines).

Concentrations of some metals including arsenic, cadmium and zinc remain elevated in the Brown-McDade pit lake. The source of these metals is the surrounding rock and sediment. As lake conditions (ex., temperature, oxygen, pH) alter slightly throughout the year there is likely continued movement of metals between the water column and surrounding sediments.

Cyanide continues to be detected on site; concentrations are highest in the seepage pond outlet and Dome Creek downstream of the seepage outlet; this is to be expected as cyanide was used in the mill site, and the following years of mill operation/discharge the sediments of the tailings pond likely act as a sink/source of cyanide. However, the presence of cyanide is also noted in areas that are not directly affected by mill site including Pony and Back creeks. At this time, the source of that cyanide is not known; it may be in part due to the movement of material around the site or contamination of machinery during or after active mining operations.

Drinking water quality of water from pump house well is of high quality, and is suitable for human consumption.

There are three main recommendations associated with the surface water quality sampling program:

1. An annual review of the surface water quality program should be undertaken, focussing on the data requirements for the project prior to the onset of the open water season (May 2013).
2. Within the greater context of the Dome Creek watershed, there is little difference in the surface water quality in WQ-DC-D1 and WQ-DC-D1b. Also, the amount of water flowing in the area of WQ-DC-D1 is considerably less than at WQ-DC-D1b. Therefore, as initially planned, it is



recommended that the surface water quality station at WQ-DC-D1 be discontinued in favour of continued sampling at WQ-DC-D1b.

3. Drinking water quality at the pump house well site (WQ-PW) has continued to meet all Health Canada Drinking Water Quality Standards. Therefore, there are three recommendations associated with this site:
 - The site should be sampled only for drinking water specific parameters (all analytical laboratories maintain such a package designed to sample for parameters as required by Health Canada; this package includes total metals).
 - Sampling of chemical parameters need only occur at most on a seasonal basis (four times per calendar year); there is no current legislation in Yukon that governs the timing of this sampling, however, upcoming legislation for mine work camps is to require sampling of chemical parameters no more than once annually (pers. comm. Yukon Environmental Health).
 - It is recommended that sampling for total and fecal coliforms continue on a regular (i.e. monthly) basis. This is not required under any current legislation, however it can be done at very low cost because there is continued access to the site for other surface water sampling, and sample analysis is provided by the Yukon Government at no cost.



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5.2 SPATIAL DATA

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Disclaimer:

Maps presented in this document are a geographical representation of known features. Although the data collected and presented herein has been obtained with the utmost attention to quality, this document is not an official land survey and should not be considered for spatial calculation. EDI Environmental Dynamics Inc. does not accept any liability for errors, omissions or inaccuracies in the data.



APPENDIX A METEOROLOGICAL DATA

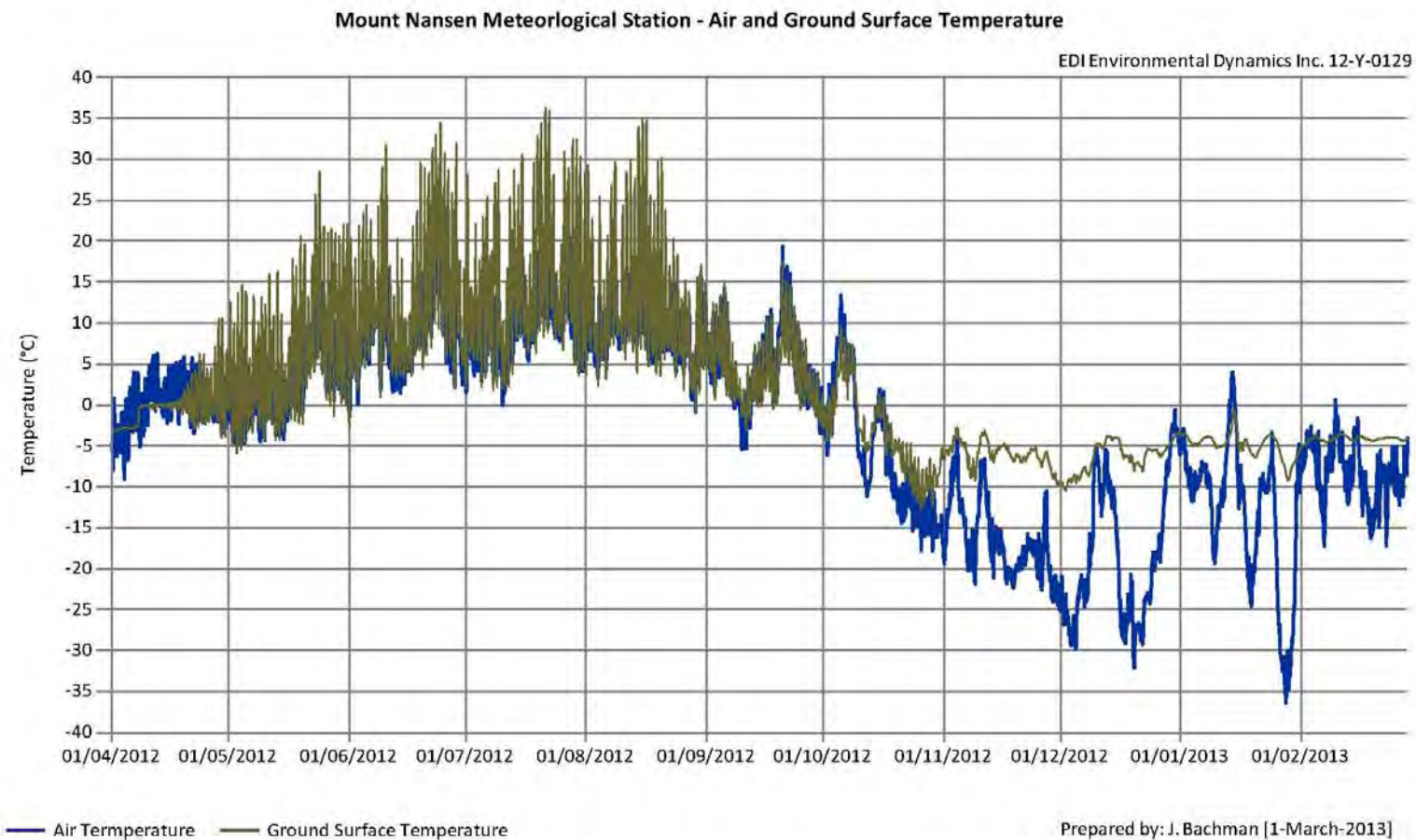


Figure A1. Air and ground surface temperature at the Mount Nansen Meteorological Station from April 2012 to February 2013.

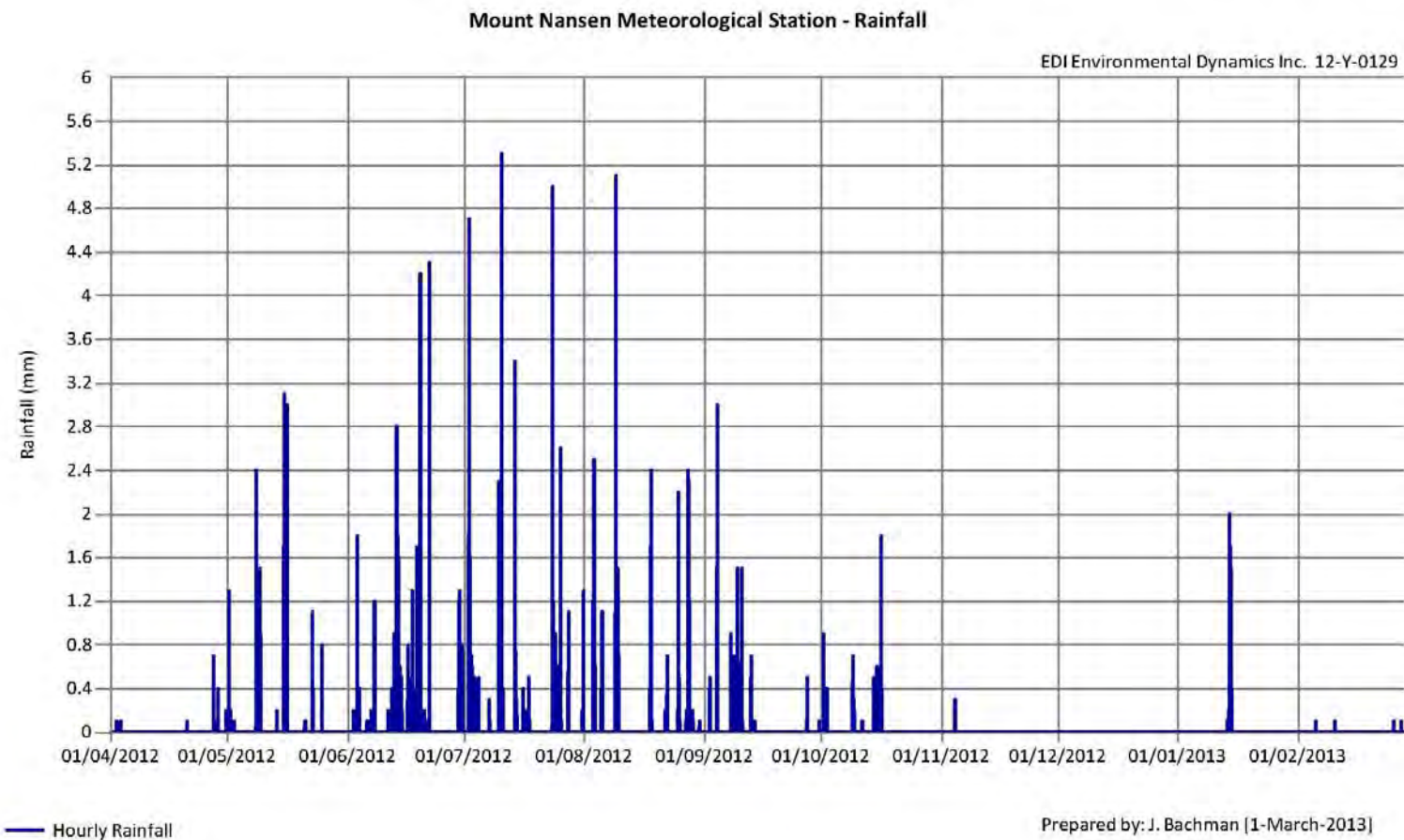


Figure A2. Hourly rainfall at the Mount Nansen Meteorological Station from April 1, 2012 to February 28, 2013.

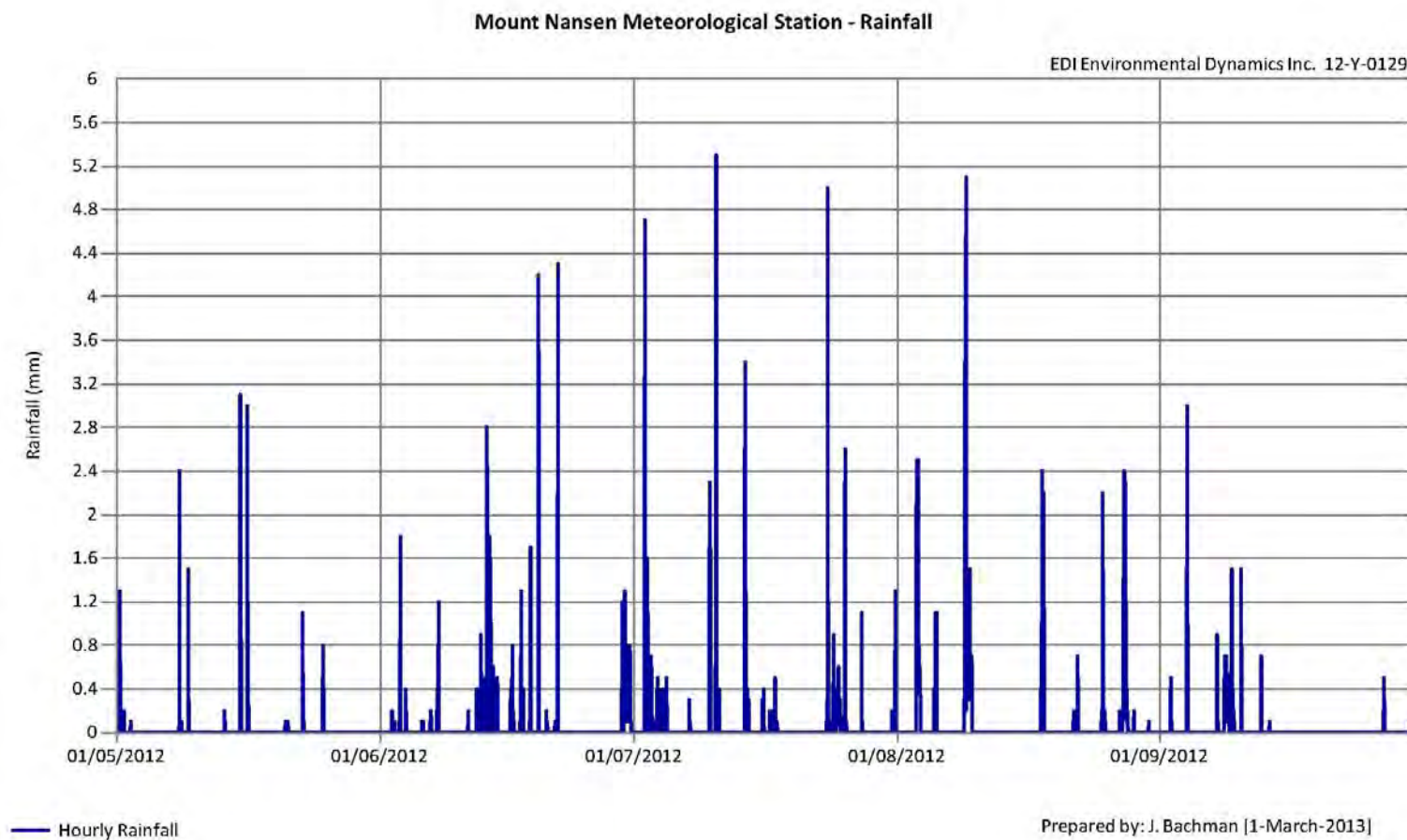


Figure A3. Hourly rainfall at the Mount Nansen Meteorological Station from May 1, 2012 to October 1, 2012.

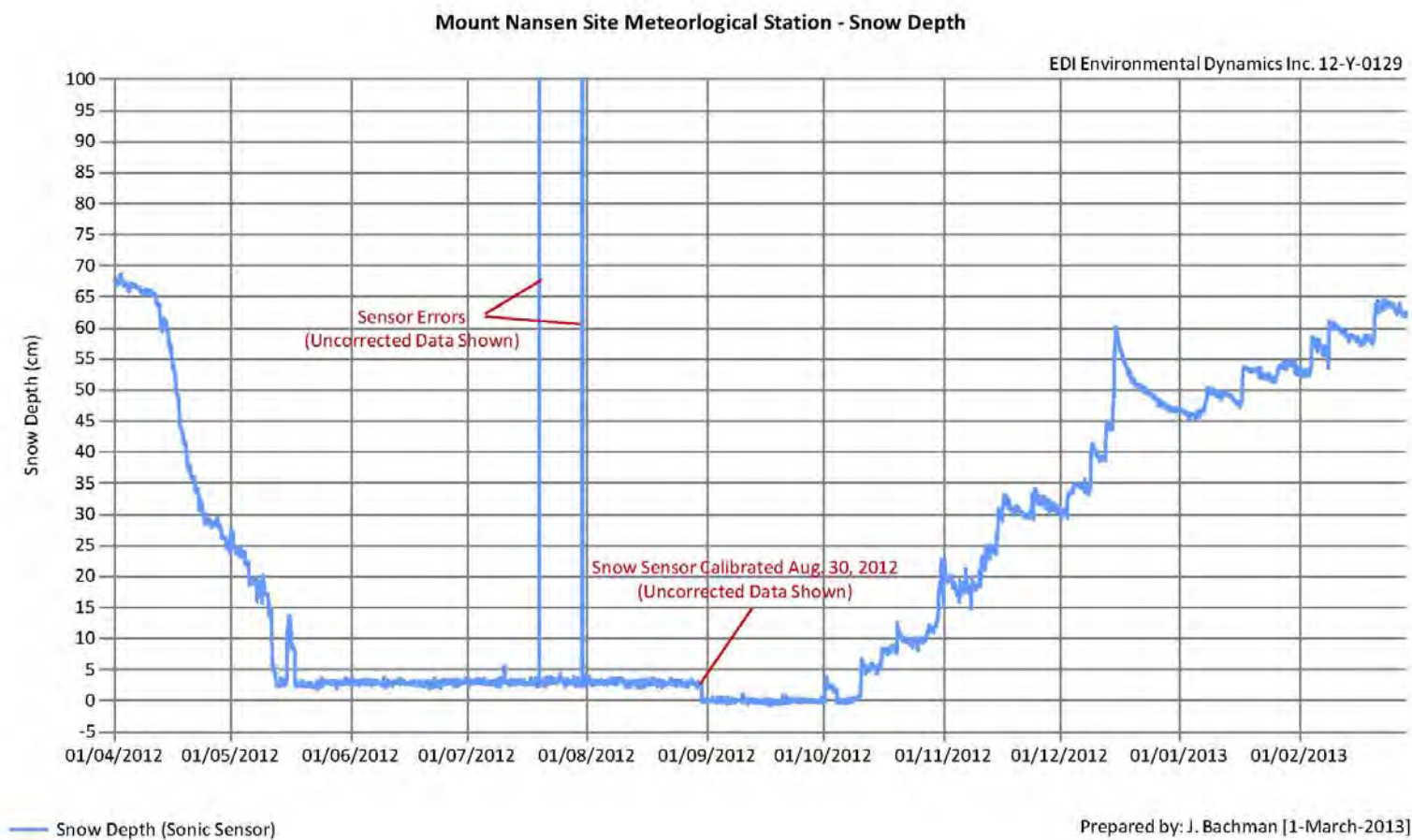


Figure A4. Snow depth at the Mount Nansen Meteorological Station from April 1, 2012 to February 28, 2013.

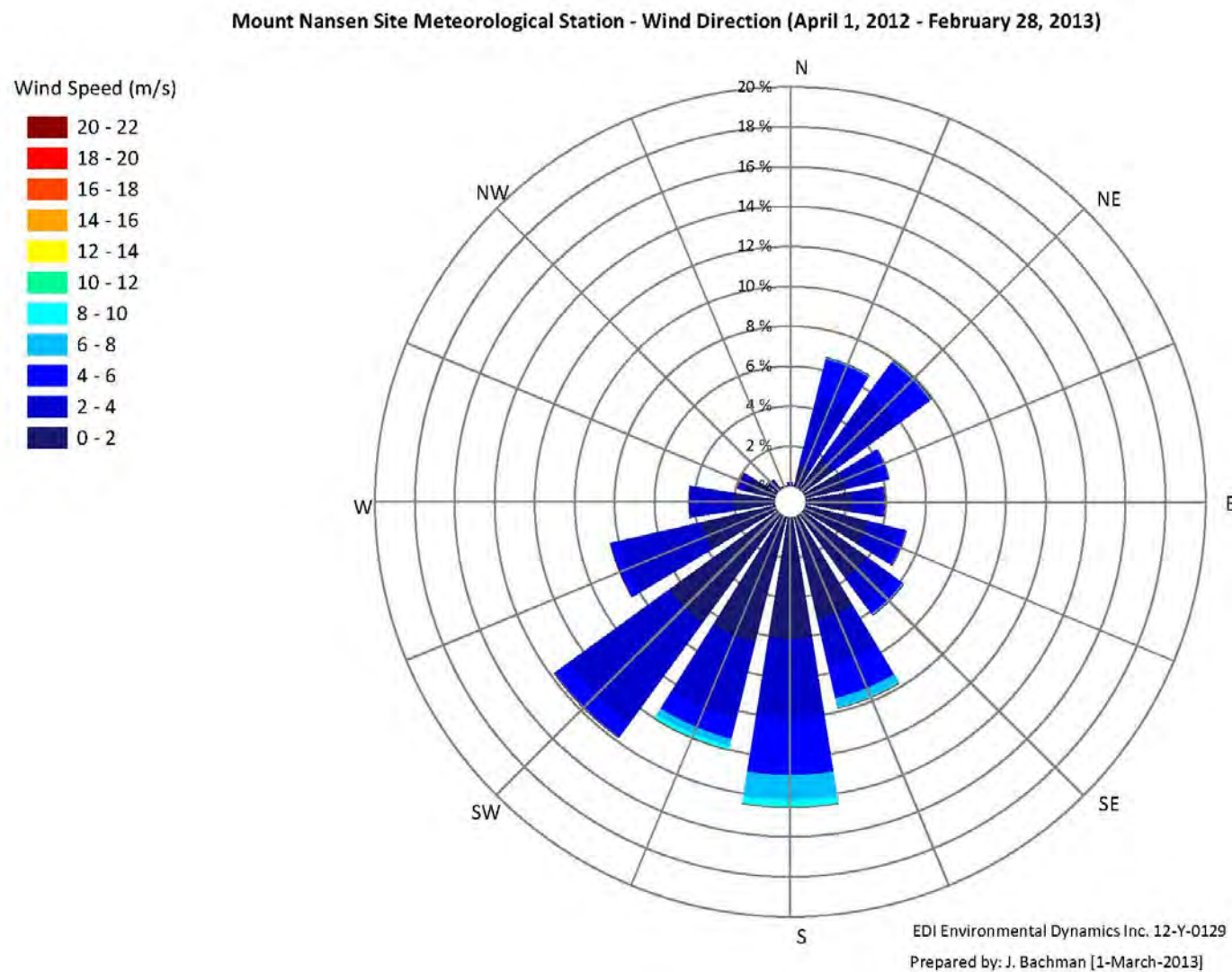


Figure A5. Wind direction and wind speed at the Mount Nansen Meteorological Station from April 1, 2012 to February 28, 2013.

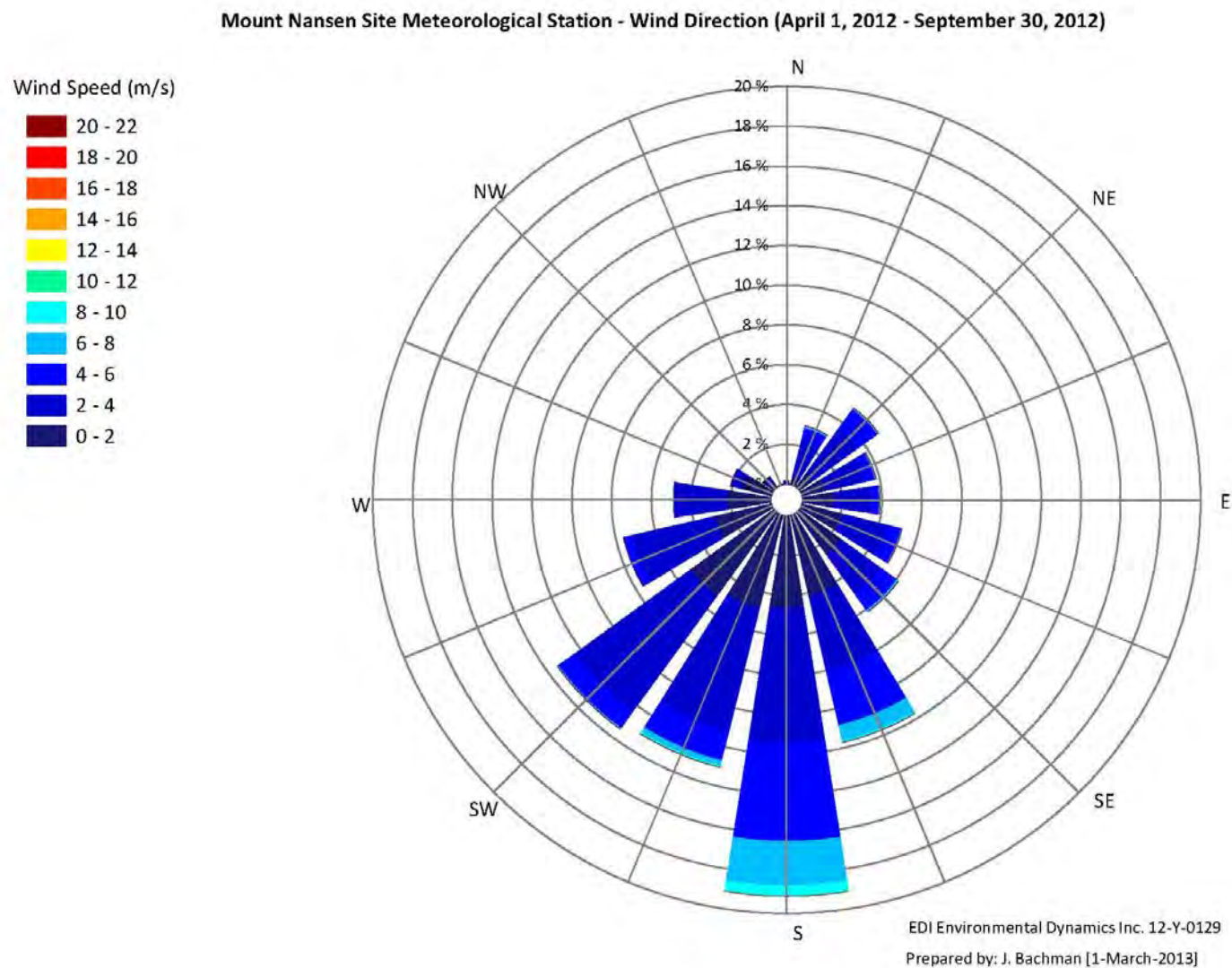


Figure A6. Wind direction and wind speed at the Mount Nansen Meteorological Station from April 1, 2012 to September 30, 2012.

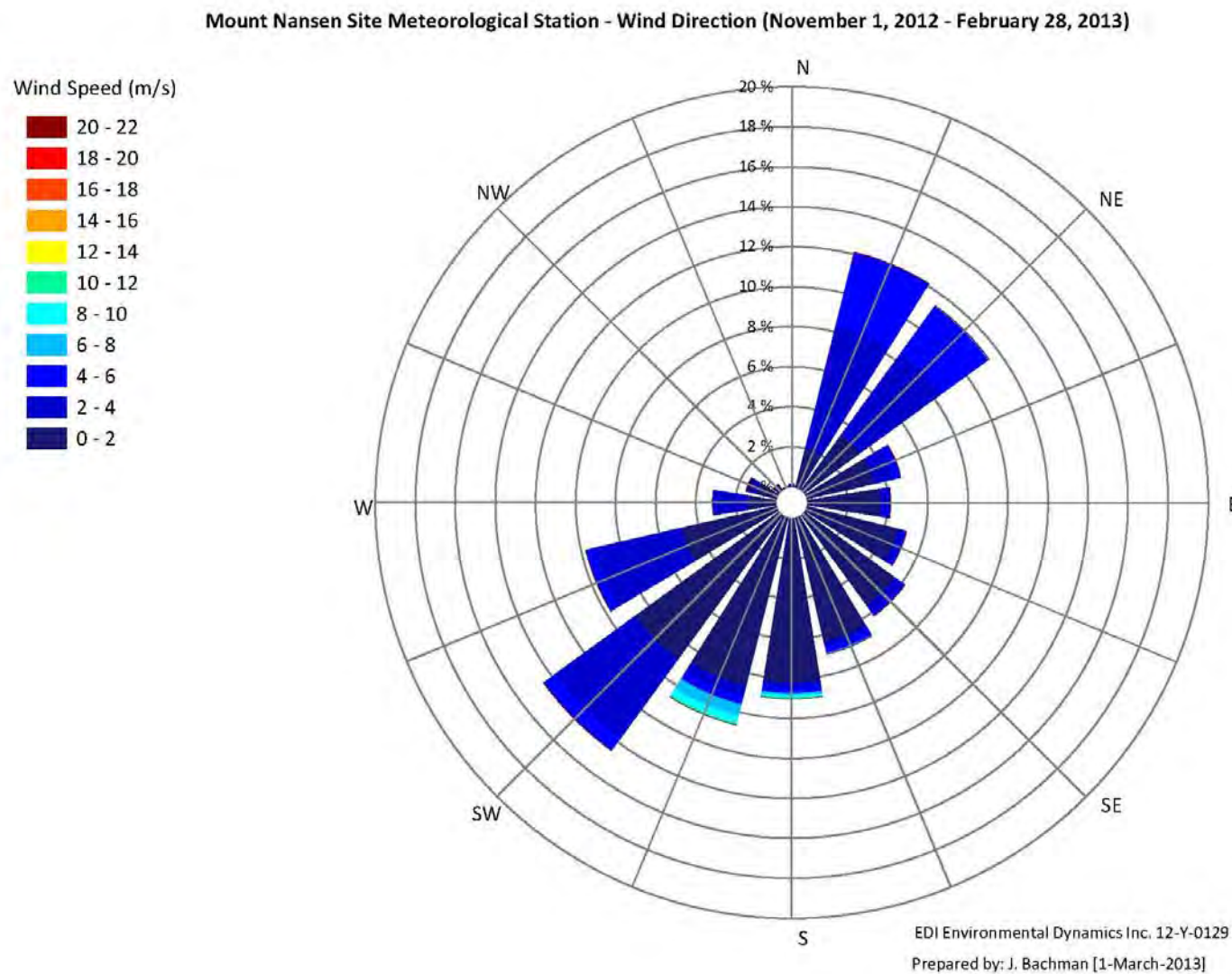


Figure A7. Wind direction and wind speed at the Mount Nansen Meteorological Station from November 1, 2012 to February 28, 2013.

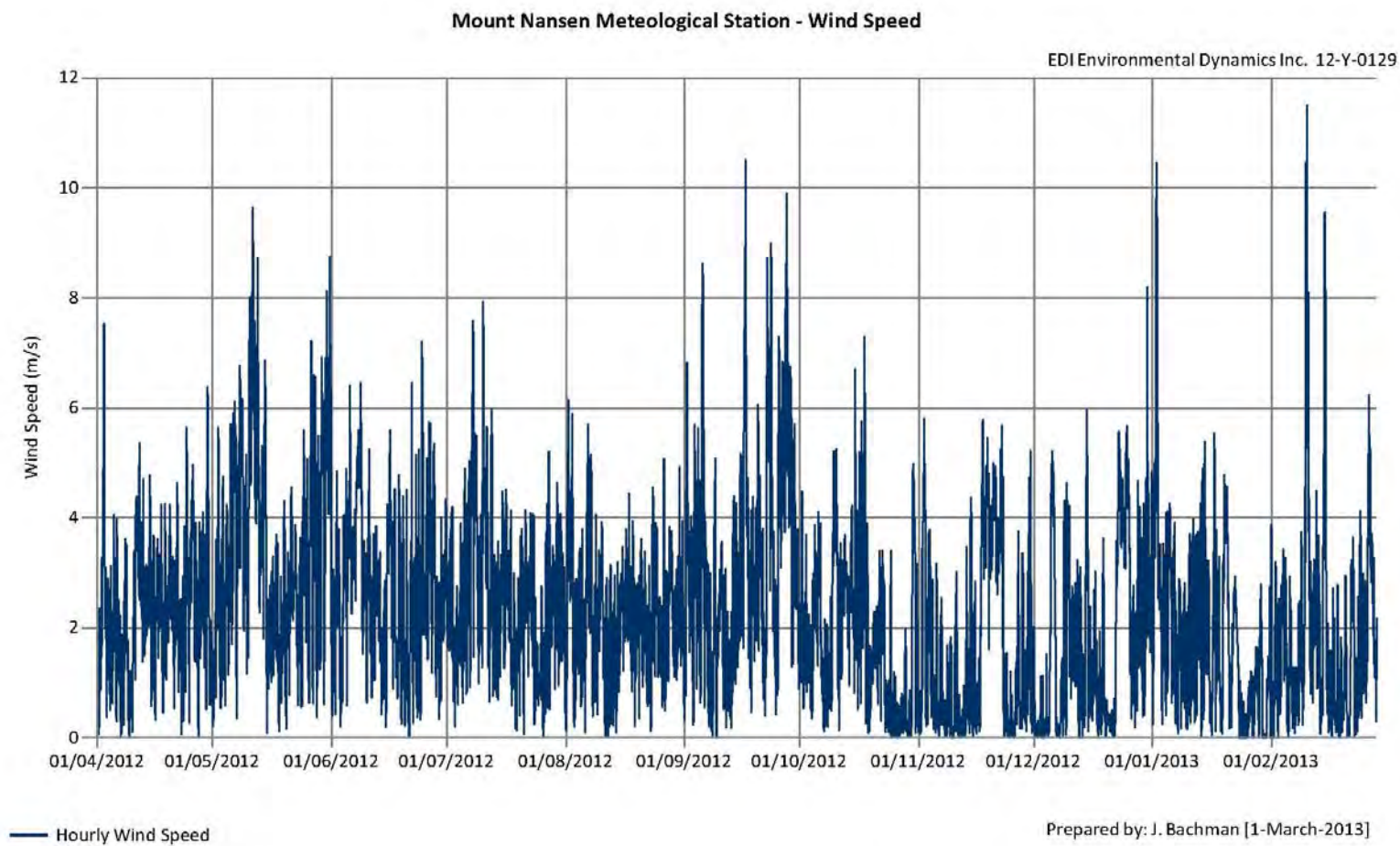


Figure A8. Wind speed at the Mount Nansen Meteorological Station from April 1, 2012 to February 28, 2013.

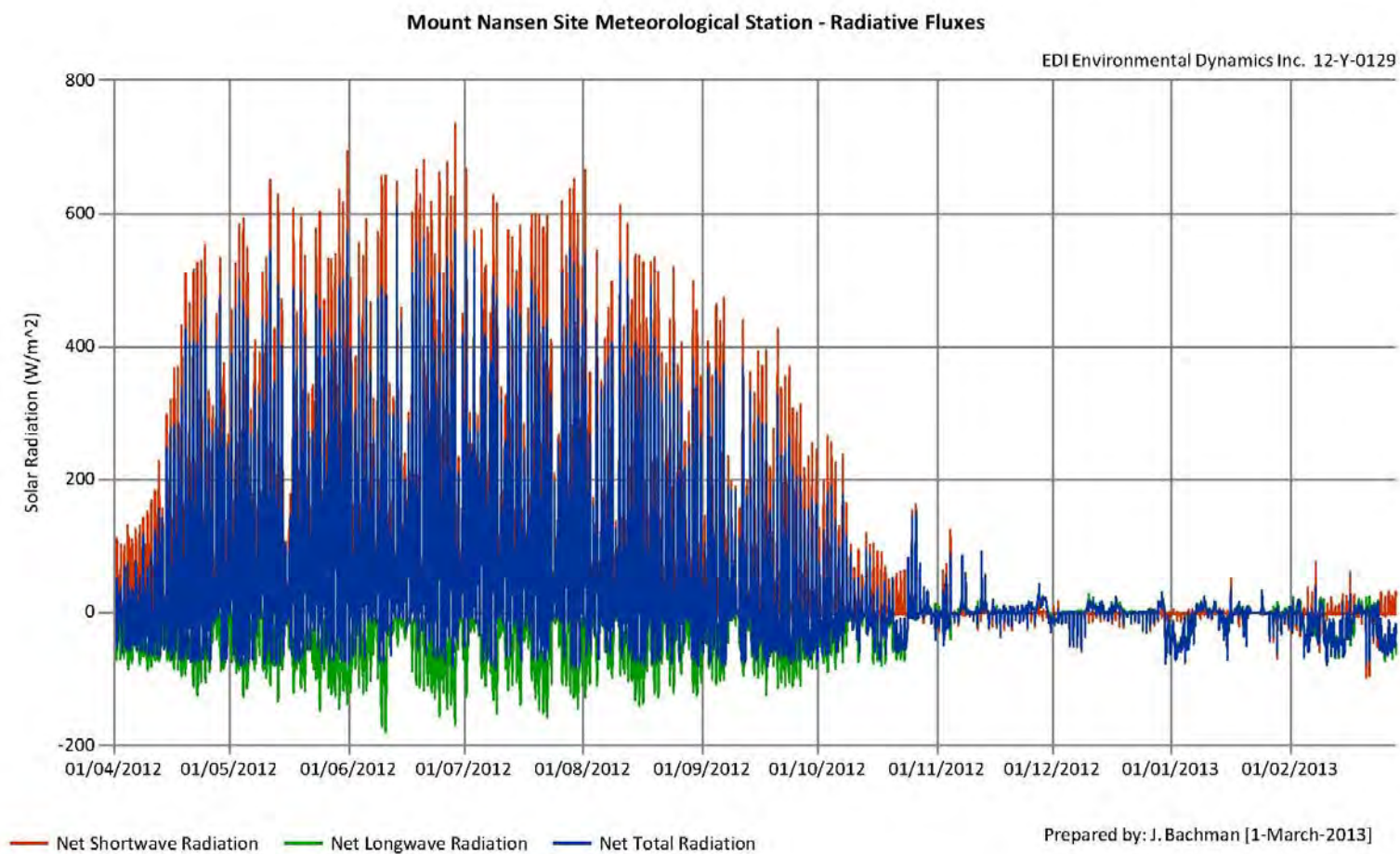


Figure A9. Radiative fluxes at the Mount Nansen Meteorological Station from April 1, 2012 to February 28, 2013.

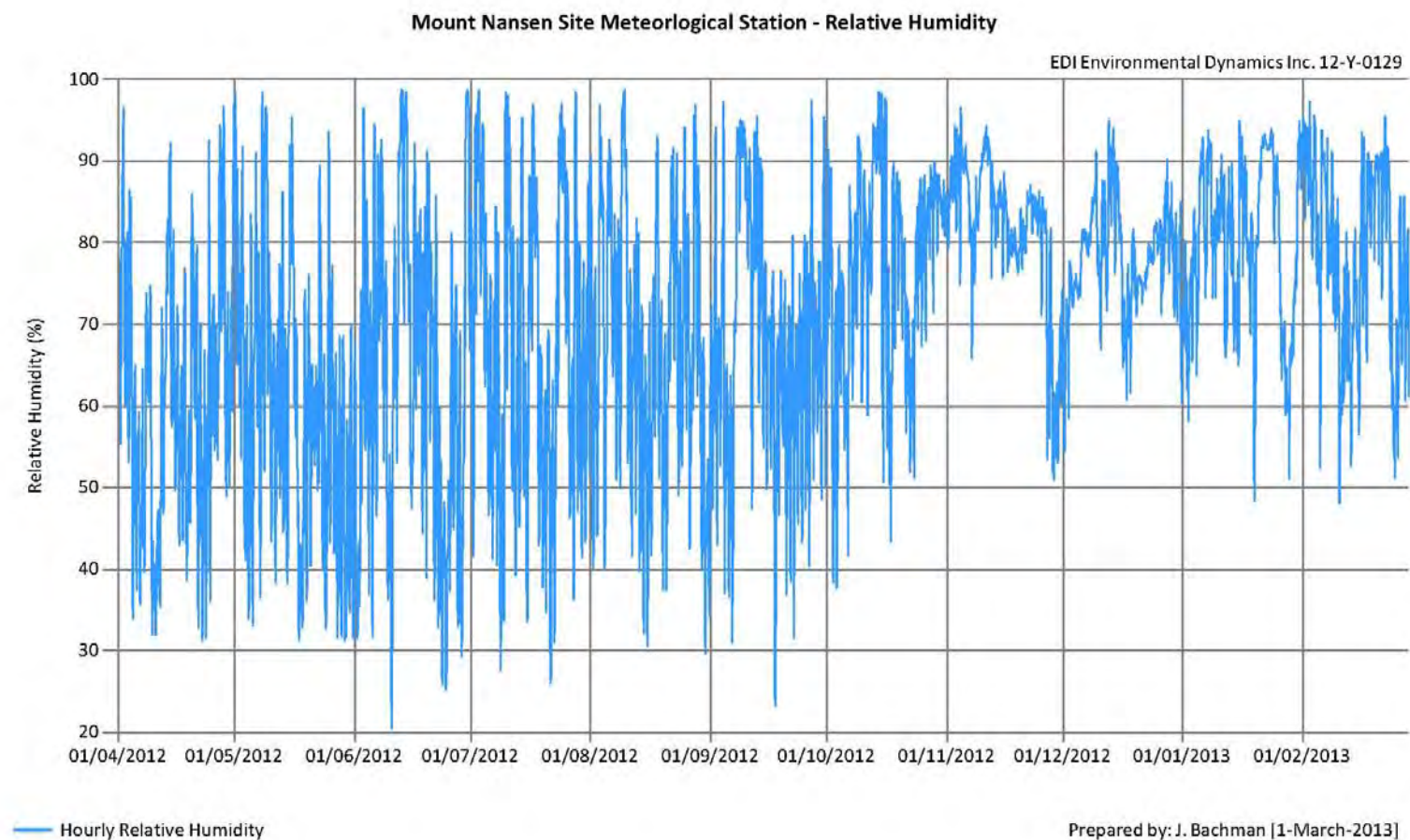


Figure A10. Relative humidity at the Mount Nansen Meteorological Station from April 1, 2012 to February 28, 2013.



Table A1. Mean monthly air temperatures and minimum and maximum temperature recordings for Mount Nansen from the ATM-TAILINGS and ATM-CAMP meteorological stations (EDI 2010).

Temperature (°C)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ATM-TAILINGS (2000-2003)												
Mean Temp.	-11.2	-10.3	-9.9	-3.2	3.6	10.2	11.8	9.5	3.9	-1.2	-7.6	-14.6
Monthly Min.	3.0	2.6	4.3	17.3	21.8	23.2	25.0	25.4	18.5	20.1	6.3	2.2
Monthly Max.	-41.5	-26.4	-32.5	-23.5	-14.5	0.5	1.5	-2.5	-10.1	-17.9	-29.0	-31.8
ATM-CAMP (2007-2009)												
Mean Temp.	-22.5	-18.0	-13.5	-1.8	6.2	10.7	12.4	9.3	4.5	5.0	-11.2	-16.7
Monthly Min.	4.4	4.2	6.2	13.6	23.6	25.6	27.1	22.5	18.7	7.2	-1.1	0.8
Monthly Max.	-45.4	-47.7	-36.5	-18.8	-5.2	-2.7	0.1	-3.4	-9.8	-23.4	-24.4	-41.3

Table A2. Mean monthly precipitation and minimum and maximum monthly precipitation values for Mount Nansen from the ATM-TAILINGS and ATM-CAMP meteorological stations (EDI 2010).

Precipitation (mm)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ATM-TAILINGS (2000 to 2003)												
Mean Precipitation	7.0	4.3	7.8	7.0	30.7	48.0	67.0	75.0	38.6	15.7	11.9	12.4
Monthly Min.	7.1	7.0	16.0	10.0	48.0	68.0	88.0	117.0	85.0	25.8	13.0	15.0
Monthly Max.	7.0	1.0	4.0	7.0	20.0	29.0	52.0	38.0	5.0	4.0	10.0	8.6
ATM-CAMP (2008-2009)												
Mean Precipitation	n/a	n/a	n/a	n/a	n/a	53.8	66.6	38.7	28.4	n/a	n/a	n/a
Monthly Min.	n/a	n/a	n/a	n/a	n/a	53.8	119.8	45.6	31.4	n/a	n/a	n/a
Monthly Max.	n/a	n/a	n/a	n/a	n/a	53.8	13.4	31.8	25.4	n/a	n/a	n/a



APPENDIX B SURFACE WATER HYDROLOGY DATA



Table B1. Hydrometric instrument accuracy.

Units	Instrument Accuracy
Acoustic Doppler Velocimeter (ADV)	± 1%
Swoffer Current Meter	± 1%
Staff Gauge	± 1 mm
Survey Rod	± 1 mm
Measuring Tape	± 1 mm
YSI ProPlus Multi-Meter - Temperature	± 0.2 °C
YSI ProPlus Multi-Meter - Specific Conductivity	0.5% of reading or 0.001 µs/cm, whichever is greater
Stop Watch	± 0.01 s
HOBO Pressure Transducer- Pressure	± .03 kPa ; ± 0.003 m
HOBO Pressure Transducer- Temperature	± 0.37 (at 20C) (-20 to -50C Op. Range)
Solinst Barologger	± 0.001 m
Solinst Pressure Transducer - Pressure	± 0.003 m
Solinst Pressure Transducer - Temperature	± 0.05 °C (-10 to +40 C Comp. Range)
Graduated Bucket	± .5 L
Lab Scale	± .00005 kg



Table B2. Hydrometric station monitoring record from April 1, 2012 to February 12, 2013.

Hydrometric ID	Discharge Measurement Start Date	Discharge Measurement End Date ¹	Total # Discharge Measurements	# Rating Measurements	Logger Type	Logger Serial #	Logger Start Date	Logger End Date	Winter Data Logger?	Rating Curve Status ²	Hydrometric Surveys Conducted?	Discharge Measurement Method
ATM-DC-2	N/A	N/A	N/A	N/A	HOBO	9896533	14-Dec-11	Ongoing	Yes	N/A	No	N/A
ATM-DC-3	N/A	N/A	N/A	N/A	HOBO	9858715	15-Oct-12	14-Nov-12	Yes	N/A	No	N/A
ATM-DC-4	N/A	N/A	N/A	N/A	Solinst	11041027	14-Nov-12	Ongoing	Yes	N/A	No	N/A
H-PC-U	01-May-12	16-Oct-12	13	12*	Solinst	21050018	31-May-12	10-Dec-12	No	Preliminary	Yes	Salt Tracer, Volumetric, Weir
H-PC-DSP	07-Jun-11	16-Oct-12	12	19*	HOBO	9896531	14-May-12	10-Dec-12	No	Preliminary	Yes	Salt Tracer, Volumetric
H-DC-DX	01-May-12	16-Oct-12	12	N/A	HOBO	N/A	N/A	N/A	No	N/A	No	Salt Tracer, Volumetric
H-DX+105	01-May-12	Ongoing	13	N/A	HOBO	N/A	N/A	N/A	No	N/A	No	Salt Tracer, Volumetric
H-DC-D1	18-Apr-12	15-Oct-12	14	N/A	HOBO	N/A	N/A	N/A	No	N/A	No	Salt Tracer, Volumetric
H-DC-D1b	09-Jul-12	15-Oct-12	8	N/A	HOBO	N/A	N/A	N/A	No	N/A	No	Salt Tracer
H-DC-U1	28-May-12	15-Oct-12	13	8	Solinst	21049528	31-May-12	10-Dec-12	No	Preliminary	Yes	Salt Tracer
H-DC-U2	28-May-12	15-Oct-12	13	N/A	Solinst	21045354	28-May-12	23-Jul-12	No	Preliminary	Yes	Salt Tracer
H-TP	21-Aug-12	17-Sep-12	3	N/A	HOBO	N/A	N/A	N/A	No	N/A	No	Staff Gauge
H-SEEP	17-Apr-12	Ongoing	14	N/A	HOBO	N/A	N/A	N/A	No	N/A	No	Volumetric, Pumphouse Flow Meters, Staff Gauge
H-DC-B	17-Apr-12	15-Oct-12	14	7	Solinst	21049137	11-Jun-12	18-Sep-12	No	Preliminary	Yes	Salt Tracer
H-DC-M	17-Apr-12	11-Dec-12	14	9	HOBO	9896528	17-Apr-12	11-Dec-12	No	Preliminary	Yes	ADV, Salt Tracer
H-DC-M	11-Dec-12	Ongoing	3	0	Solinst (Winter, Direct Read Cable)	1050018	11-Dec-12	Ongoing	Yes	Preliminary	Yes	Salt Tracer
H-DC-R	01-May-12	15-Oct-12	14	9	Solinst	21041103	29-May-12	10-Dec-12	No	Preliminary	Yes	ADV, Salt Tracer, Volumetric
H-BC	30-Apr-12	15-Nov-12	14	9	HOBO	9908153	15-May-12	03-Oct-12	No	Preliminary	Yes	ADV, Salt Tracer
H-MN	17-Apr-12	Ongoing	14	9	HOBO	9908128	30-May-12	10-Dec-12	No	Preliminary	Yes	ADV, Salt Tracer
H-VC-REF	17-Nov-11	Ongoing	13	9	HOBO	9908152	30-May-12	10-Dec-12	No	Preliminary	Yes	ADV, Salt Tracer
H-VC-U	16-Apr-12	11-Dec-12	13	9	HOBO	9908154	30-Apr-12	11-Dec-12	Yes	Preliminary	Yes	ADV, Salt Tracer
H-VC-U	11-Dec-12	Ongoing	3	0	Solinst (Winter, Direct Read Cable)	21049522	11-Dec-12	Ongoing	Yes	Preliminary	Yes	ADV, Salt Tracer
H-VC-DBC	17-Apr-12	11-Dec-12	14	13	HOBO	9896521	30-Apr-12	11-Dec-12	No	Preliminary	Yes	ADV, Salt Tracer
H-VC-DBC	11-Dec-12	Ongoing	3	0	Solinst (Winter, Direct Read Cable)	21049137	11-Dec-12	Ongoing	Yes	Preliminary	Yes	ADV, Salt Tracer



H-VC-UMN	14-Apr-12	Ongoing	14	13	HOBO	9896527	01-May-12	11-Dec-12	No	Preliminary	Yes	ADV, Salt Tracer
H-VC-R	02-May-12	11-Dec-12	14	13	HOBO	9896522	02-May-12	11-Dec-12	No	Preliminary	Yes	ADV, Salt Tracer
H-VC-R	11-Dec-12	Ongoing	3	0	Solinst (Winter, Direct Read Cable)	1041103	11-Dec-12	Ongoing	Yes	Preliminary	Yes	ADV, Salt Tracer

Notes:

1 - 'Ongoing' indicates that measurements will continue to be collected during the winter if channel conditions are appropriate for measurement.

2 - 'Rating Curve Status' indicates the condition of the rating curve where 'Preliminary' indicates that there are less than 10 rating measurements (RISC 2009); OR the rating measurements did not capture an acceptable range of flows (i.e., 10 %-200 % of mean discharge (MD)); OR there was high degree of rating curve uncertainty.



Table B3. Hydrometric data summary for each measurement event from April 1, 2012 to February 12, 2013.

MID	HID	Measurement Date	Measurement Time (HH:MM)	Measurement Type	Staff Gauge (m) +/- 2 mm	Logger Stage (m) +/- 3 mm	Water Surface Elevation (m, L.D.) +/- 5 mm	Water Surface Elev.- Logger Stage	Average Logger Adjustment to Local Datum	Discharge (m³/s)	Unit Discharge (m³/s/km²)	Data Flag
228	H-PC-U	01-May-12	12:45	V	-	-	-	-	-	0.002	1.79E-03	B
227	H-PC-U	01-May-12	12:45	SS	-	-	-	-	-	0.003	3.57E-03	B/S
631	H-PC-U	01-May-12	13:45	W	-	-	-	-	-	0.001	1.19E-03	B/E
374	H-PC-U	14-May-12	15:30	V	0.353	-	-	-	-	0.004	4.30E-03	B
373	H-PC-U	14-May-12	15:30	SS	0.353	-	-	-	-	0.004	4.52E-03	B
632	H-PC-U	14-May-12	16:30	W	0.353	-	-	-	-	0.002	2.38E-03	E
308	H-PC-U	29-May-12	12:52	SS	0.394	-	2.076	-	-	0.017	2.00E-02	
633	H-PC-U	29-May-12	13:52	W	0.394	-	2.076	-	-	0.015	1.79E-02	E
279	H-PC-U	11-Jun-12	13:08	SS	0.302	-	2.431	-	-	0.005	5.99E-03	S
634	H-PC-U	11-Jun-12	13:08	W	0.302	-	2.431	-	-	0.003	3.57E-03	E
635	H-PC-U	27-Jun-12	19:00	W	0.300	-	2.453	-	-	0.002	2.38E-03	E
263	H-PC-U	27-Jun-12	19:00	V	0.300	-	2.453	-	-	0.004	4.76E-03	
262	H-PC-U	27-Jun-12	19:00	SS	0.300	-	2.453	-	-	0.005	5.95E-03	
239	H-PC-U	09-Jul-12	15:52	SS	0.306	-	2.457	-	-	0.005	5.71E-03	
636	H-PC-U	09-Jul-12	15:52	W	0.306	-	2.457	-	-	0.003	3.57E-03	E
637	H-PC-U	24-Jul-12	8:06	W	0.325	-	2.468	-	-	0.002	2.38E-03	E
390	H-PC-U	24-Jul-12	8:06	V	0.325	-	2.468	-	-	0.004	4.38E-03	
389	H-PC-U	24-Jul-12	8:06	SS	0.325	-	2.468	-	-	0.005	5.55E-03	
638	H-PC-U	06-Aug-12	17:42	W	0.336	-	2.467	-	-	0.002	2.38E-03	E
434	H-PC-U	06-Aug-12	17:42	V	0.336	-	2.467	-	-	0.002	2.07E-03	
433	H-PC-U	06-Aug-12	17:42	SS	0.336	-	2.467	-	-	0.005	5.81E-03	
639	H-PC-U	22-Aug-12	17:28	W	0.358	-	2.488	-	-	0.004	4.76E-03	E
450	H-PC-U	22-Aug-12	17:28	SS	0.358	-	2.488	-	-	0.007	8.33E-03	
451	H-PC-U	22-Aug-12	17:28	V	0.358	-	2.488	-	-	0.004	4.76E-03	
640	H-PC-U	05-Sep-12	17:57	W	0.355	-	2.481	-	-	0.007	8.33E-03	E
493	H-PC-U	05-Sep-12	17:57	V	0.355	-	2.481	-	-	0.004	5.00E-03	
492	H-PC-U	05-Sep-12	17:57	SS	0.355	-	2.481	-	-	0.007	8.01E-03	
501	H-PC-U	19-Sep-12	12:21	V	0.348	-	2.481	-	-	0.004	4.85E-03	
500	H-PC-U	19-Sep-12	12:21	SS	0.348	-	2.481	-	-	0.005	5.80E-03	
641	H-PC-U	19-Sep-12	12:21	W	0.348	-	2.481	-	-	0.003	3.57E-03	E
550	H-PC-U	03-Oct-12	18:43	V	0.329	-	2.461	-	-	0.003	4.05E-03	B
549	H-PC-U	03-Oct-12	18:43	SS	0.329	-	2.461	-	-	0.003	3.08E-03	B
642	H-PC-U	03-Oct-12	18:43	W	0.329	-	2.461	-	-	0.002	2.38E-03	E



MID	HID	Measurement Date	Measurement Time (HH:MM)	Measurement Type	Staff Gauge (m) +/- 2 mm	Logger Stage (m) +/- 3 mm	Water Surface Elevation (m, L.D.) +/- 5 mm	Water Surface Elev.- Logger Stage	Average Logger Adjustment to Local Datum	Discharge (m ³ /s)	Unit Discharge (m ³ /s/km ²)	Data Flag
603	H-PC-U	16-Oct-12	19:19	SS	0.322	-	2.504	-	-	0.002	2.62E-03	B
602	H-PC-U	16-Oct-12	19:19	V	0.322	-	2.504	-	-	0.002	2.14E-03	B
643	H-PC-U	16-Oct-12	19:19	W	0.322	-	2.504	-	-	0.001	1.19E-03	E
608	H-PC-U	15-Nov-12	15:05	N		-		-	-	0.000	0.00E+00	
648	H-PC-U	10-Dec-12	18:14	N		-		-	-	0.000	0.00E+00	
209	H-PC-DSP	17-Apr-12	15:31	V	-	-	-	-	-	0.001	6.23E-04	B
226	H-PC-DSP	01-May-12	10:40	V	0.355	-	-	-	-	0.000	4.00E-04	B
225	H-PC-DSP	01-May-12	10:40	SS	0.355	-	-	-	-	0.002	2.00E-03	B
314	H-PC-DSP	15-May-12	17:50	SS	0.22	-	2.417	-	-	0.007	7.00E-03	B
315	H-PC-DSP	15-May-12	17:50	V	0.22	-	2.417	-	-	0.005	4.79E-03	B/E
310	H-PC-DSP	28-May-12	15:05	SS	0.305	-	2.503	-	-	0.033	3.29E-02	
281	H-PC-DSP	11-Jun-12	12:09	SS	0.223	-	2.419	-	-	0.011	1.13E-02	
282	H-PC-DSP	11-Jun-12	12:09	V	0.223	-	2.419	-	-	0.006	5.50E-03	
264	H-PC-DSP	25-Jun-12	17:56	SS	0.223	-	2.429	-	-	0.009	9.00E-03	
265	H-PC-DSP	25-Jun-12	17:56	V	0.223	-	2.429	-	-	0.006	6.00E-03	
236	H-PC-DSP	09-Jul-12	14:59	V	0.215	-	2.424	-	-	0.005	4.51E-03	SH-SG
235	H-PC-DSP	09-Jul-12	14:59	SS	0.215	-	2.424	-	-	0.009	8.52E-03	SH-SG
395	H-PC-DSP	24-Jul-12	11:00	SS	0.208	-	2.409	-	-	0.006	6.20E-03	
396	H-PC-DSP	24-Jul-12	11:00	V	0.208	-	2.409	-	-	0.004	3.50E-03	
415	H-PC-DSP	06-Aug-12	16:30	SS	0.208	-	2.406	-	-	0.008	7.62E-03	
416	H-PC-DSP	06-Aug-12	16:30	V	0.208	-	2.406	-	-	0.003	3.26E-03	
452	H-PC-DSP	22-Aug-12	16:27	SS	0.235	-	2.413	-	-	0.012	1.20E-02	
453	H-PC-DSP	22-Aug-12	16:27	V	0.235	-	2.413	-	-	0.006	6.00E-03	
490	H-PC-DSP	05-Sep-12	16:45	SS	0.23	-	2.417	-	-	0.008	7.83E-03	
505	H-PC-DSP	18-Sep-12	19:14	V	0.235	-	2.431	-	-	0.005	5.06E-03	
504	H-PC-DSP	18-Sep-12	19:14	SS	0.235	-	2.431	-	-	0.007	6.83E-03	
552	H-PC-DSP	03-Oct-12	16:47	V	0.216	-	2.427	-	-	0.005	5.00E-03	B
551	H-PC-DSP	03-Oct-12	16:47	SS	0.216	-	2.427	-	-	0.003	2.92E-03	B
585	H-PC-DSP	16-Oct-12	17:17	V	0.199	-	2.391	-	-	0.002	1.80E-03	B
584	H-PC-DSP	16-Oct-12	17:17	SS	0.199	-	2.391	-	-	0.002	2.10E-03	B
609	H-PC-DSP	15-Nov-12	14:30	N	-	-	-	-	-	0.000	0.00E+00	
647	H-PC-DSP	12-Dec-12	14:34	N	-	-	-	-	-	0.000	0.00E+00	
229	H-DC-DX	01-May-12	17:37	V	-	-	-	-	-	0.000	2.61E-04	B
368	H-DC-DX	14-May-12	12:00	V	-	-	-	-	-	0.000	5.37E-04	B



MID	HID	Measurement Date	Measurement Time (HH:MM)	Measurement Type	Staff Gauge (m) +/- 2 mm	Logger Stage (m) +/- 3 mm	Water Surface Elevation (m, L.D.) +/- 5 mm	Water Surface Elev.- Logger Stage	Average Logger Adjustment to Local Datum	Discharge (m ³ /s)	Unit Discharge (m ³ /s/km ²)	Data Flag
361	H-DC-DX	29-May-12	11:48	SS	-	-	-	-	-	0.001	7.27E-03	
353	H-DC-DX	12-Jun-12	18:02	SS	-	-	-	-	-	0.001	4.88E-03	
336	H-DC-DX	09-Jul-12	18:20	V	-	-	-	-	-	0.001	3.51E-03	
572	H-DC-DX	23-Jul-12	18:30	V	-	-	-	-	-	0.001	2.56E-03	
448	H-DC-DX	21-Aug-12	19:05	V	-	-	-	-	-	0.001	4.88E-03	
467	H-DC-DX	04-Sep-12	18:30	V	-	-	-	-	-	0.001	5.37E-03	
520	H-DC-DX	17-Sep-12	18:05	V	-	-	-	-	-	0.007	3.41E-02	
543	H-DC-DX	02-Oct-12	19:15	V	-	-	-	-	-	0.000	1.51E-03	B
610	H-DC-DX	15-Nov-12	8:30	N	-	-	-	-	-	0.000	0.00E+00	B/X
223	H-DC-DX+105	01-May-12	16:40	SS	-	-	-	-	-	0.002	1.97E-03	B
380	H-DC-DX+105	14-May-12	15:38	SS	-	-	-	-	-	0.002	1.86E-03	B
359	H-DC-DX+105	29-May-12	10:43	SS	-	-	-	-	-	0.006	6.39E-03	
351	H-DC-DX+105	12-Jun-12	17:10	SS	-	-	-	-	-	0.004	4.05E-03	
343	H-DC-DX+105	27-Jun-12	15:06	V	-	-	-	-	-	0.001	7.67E-04	
573	H-DC-DX+105	23-Jul-12	18:30	V	-	-	-	-	-	0.001	5.75E-04	
417	H-DC-DX+105	06-Aug-12	20:17	V	-	-	-	-	-	0.001	7.45E-04	
449	H-DC-DX+105	21-Aug-12	19:05	V	-	-	-	-	-	0.001	1.10E-03	
468	H-DC-DX+105	04-Sep-12	18:30	V	-	-	-	-	-	0.001	1.20E-03	
521	H-DC-DX+105	17-Sep-12	18:05	V	-	-	-	-	-	0.007	7.67E-03	
544	H-DC-DX+105	02-Oct-12	19:15	V	-	-	-	-	-	0.000	3.40E-04	B
580	H-DC-DX+105	16-Oct-12	15:25	V	-	-	-	-	-	0.000	2.52E-05	B
579	H-DC-DX+105	16-Oct-12	16:40	SS	-	-	-	-	-	0.004	4.82E-03	B
611	H-DC-DX+105	15-Nov-12	14:03	SS	-	-	-	-	-	0.003	3.29E-03	B/UR
653	H-DC-DX+105	11-Dec-12	11:35	SS	-	-	-	-	-	0.003	3.29E-03	B
665	H-DC-DX+105	14-Jan-13	18:19	SS	-	-	-	-	-	0.003	3.29E-03	B
678	H-DC-DX+105	12-Feb-13	15:15	SS	-	-	-	-	-	0.001	1.10E-03	B
218	H-DC-D1	18-Apr-12	9:30	V	-	-	-	-	-	0.001	9.12E-04	B/S
231	H-DC-D1	01-May-12	16:10	V	-	-	-	-	-	0.001	1.38E-03	B/E
379	H-DC-D1	14-May-12	16:50	SS	-	-	-	-	-	0.004	4.40E-03	B
355	H-DC-D1	29-May-12	8:21	SS	-	-	-	-	-	0.011	1.25E-02	
349	H-DC-D1	12-Jun-12	15:59	SS	-	-	-	-	-	0.008	8.79E-03	
337	H-DC-D1	27-Jun-12	14:13	SS	-	-	-	-	-	0.006	6.59E-03	
334	H-DC-D1	09-Jul-12	16:51	SS	-	-	-	-	-	0.009	9.89E-03	
567	H-DC-D1	23-Jul-12	17:51	SS	-	-	-	-	-	0.006	6.57E-03	



MID	HID	Measurement Date	Measurement Time (HH:MM)	Measurement Type	Staff Gauge (m) +/- 2 mm	Logger Stage (m) +/- 3 mm	Water Surface Elevation (m, L.D.) +/- 5 mm	Water Surface Elev.- Logger Stage	Average Logger Adjustment to Local Datum	Discharge (m ³ /s)	Unit Discharge (m ³ /s/km ²)	Data Flag
418	H-DC-D1	06-Aug-12	19:36	SS	-	-	-	-	-	0.006	6.42E-03	
446	H-DC-D1	21-Aug-12	17:51	SS	-	-	-	-	-	0.007	7.69E-03	
494	H-DC-D1	04-Sep-12	17:21	SS	-	-	-	-	-	0.007	8.04E-03	
518	H-DC-D1	17-Sep-12	17:20	SS	-	-	-	-	-	0.007	7.53E-03	
539	H-DC-D1	02-Oct-12	18:36	SS	-	-	-	-	-	0.006	6.59E-03	B
600	H-DC-D1	15-Oct-12	18:53	SS	-	-	-	-	-	0.000	0.00E+00	B/X
613	H-DC-D1	14-Nov-12	17:00	N	-	-	-	-	-	0.000	0.00E+00	B/X
357	H-DC-D1b	29-May-12	9:14	SS	-	-	-	-	-	0.006	4.08E-03	B/S
332	H-DC-D1b	09-Jul-12	17:44	SS	-	-	-	-	-	0.009	6.67E-03	
569	H-DC-D1b	23-Jul-12	17:00	SS	-	-	-	-	-	0.010	6.96E-03	
410	H-DC-D1b	06-Aug-12	19:05	SS	-	-	-	-	-	0.010	7.13E-03	
444	H-DC-D1b	21-Aug-12	18:25	SS	-	-	-	-	-	0.012	8.55E-03	
476	H-DC-D1b	04-Sep-12	17:00	SS	-	-	-	-	-	0.013	9.24E-03	
516	H-DC-D1b	17-Sep-12	16:50	SS	-	-	-	-	-	0.011	7.70E-03	
541	H-DC-D1b	02-Oct-12	18:14	SS	-	-	-	-	-	0.010	6.77E-03	B
575	H-DC-D1b	15-Oct-12	18:19	SS	-	-	-	-	-	0.008	5.56E-03	B
614	H-DC-D1b	14-Nov-12	17:07	N	-	-	-	-	-	0.000	0.00E+00	B/X
565	H-DC-U1	01-May-12	0:00	N	-	-	-	-	-	-	-	B/X
607	H-DC-U1	15-May-12	12:00	N	-	-	-	-	-	-	-	B/X
312	H-DC-U1	28-May-12	18:19	SS	0.343	-	1.419	-	-	0.003	1.41E-03	B/S
283	H-DC-U1	11-Jun-12	16:18	SS	0.300	-	1.389	-	-	0.005	2.29E-03	SH-L
268	H-DC-U1	25-Jun-12	16:00	SS	0.291	-	1.380	-	-	0.005	2.44E-03	S
237	H-DC-U1	09-Jul-12	13:35	SS	0.293	-	1.409	-	-	0.005	2.42E-03	
397	H-DC-U1	23-Jul-12	15:12	SS	0.294	-	1.421	-	-	0.005	2.36E-03	
420	H-DC-U1	06-Aug-12	15:03	SS	0.325	-	1.440	-	-	0.015	7.07E-03	
442	H-DC-U1	21-Aug-12	15:31	SS	0.335	-	1.485	-	-	0.008	3.90E-03	SH-SG/SH-L
480	H-DC-U1	04-Sep-12	15:20	SS	0.344	-	1.440	-	-	0.009	4.22E-03	
514	H-DC-U1	17-Sep-12	15:16	SS	0.331	-	1.415	-	-	0.007	3.42E-03	
537	H-DC-U1	02-Oct-12	16:44	SS	0.352	-	1.484	-	-	0.007	3.41E-03	B
588	H-DC-U1	15-Oct-12	16:31	SS	0.331	-	1.422	-	-	0.005	2.44E-03	B
615	H-DC-U1	14-Nov-12	14:50	N	-	-	-	-	-	-	-	B/X
650	H-DC-U1	12-Dec-12	8:45	N	-	-	-	-	-	-	-	B/X
562	H-DC-U2	01-May-12	14:50	SS	-	-	-	-	-	0.014	6.88E-03	B
371	H-DC-U2	15-May-12	13:04	SS	-	-	-	-	-	0.007	3.41E-03	B



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296	H-DC-U2	28-May-12	16:43	SS	0.510	-	2.361	-	-	0.033	1.60E-02	B
285	H-DC-U2	11-Jun-12	16:56	SS	0.432	-	2.299	-	-	0.011	5.37E-03	SH-SG/SH-L
266	H-DC-U2	25-Jun-12	16:45	SS	0.271	-	2.285	-	-	0.013	6.34E-03	SH-SG/SH-L
233	H-DC-U2	09-Jul-12	14:18	SS	0.276	-	2.293	-	-	0.011	5.37E-03	SH-SG
403	H-DC-U2	23-Jul-12	15:48	SS	0.208	-	2.288	-	-	0.016	7.90E-03	SH-SG/SH-L
424	H-DC-U2	06-Aug-12	15:37	SS	-	-	2.317	-	-	0.011	5.51E-03	
440	H-DC-U2	21-Aug-12	16:40	SS	-	-	1.485	-	-	0.015	7.32E-03	
478	H-DC-U2	04-Sep-12	16:10	SS	-	-	-	-	-	0.032	1.57E-02	
512	H-DC-U2	17-Sep-12	15:52	SS	-	-	-	-	-	0.015	7.22E-03	
535	H-DC-U2	02-Oct-12	15:58	SS	-	-	-	-	-	0.012	5.61E-03	B
591	H-DC-U2	15-Oct-12	17:15	SS	-	-	-	-	-	0.008	3.90E-03	B
616	H-DC-U2	14-Nov-12	15:20	N	-	-	-	-	-	-	-	
664	H-DC-U2	12-Dec-12	10:00	N	-	-	-	-	-	-	-	
217	H-DC-B	17-Apr-12	15:58	CM	-	-	-	-	-	0.064	2.12E-02	B
560	H-DC-B	30-Apr-12	12:49	SS	-	-	-	-	-	0.028	9.27E-03	
370	H-DC-B	14-May-12	15:59	SS	-	-	-	-	-	0.025	8.28E-03	
369	H-DC-B	14-May-12	15:59	CM	-	-	-	-	-	0.032	1.06E-02	
363	H-DC-B	28-May-12	15:02	ADV	-	-	-	-	-	0.048	1.59E-02	
347	H-DC-B	11-Jun-12	15:00	SS	-	-	-	-	-	0.017	5.63E-03	
256	H-DC-B	25-Jun-12	12:43	SS	0.219	-	2.836	-	-	0.022	7.38E-03	
241	H-DC-B	09-Jul-12	12:40	SS	0.150	-	2.878	-	-	0.021	6.95E-03	SH-SG
399	H-DC-B	23-Jul-12	14:11	SS	0.102	-	2.879	-	-	0.020	6.65E-03	SH-SG
411	H-DC-B	06-Aug-12	14:00	SS	0.121	-	2.891	-	-	0.051	1.70E-02	SH-SG
438	H-DC-B	21-Aug-12	13:58	SS	0.120	-	2.876	-	-	0.017	5.63E-03	
482	H-DC-B	04-Sep-12	14:40	SS	0.131	-	2.869	-	-	0.042	1.38E-02	
525	H-DC-B	18-Sep-12	8:50	SS	0.174	-	2.911	-	-	0.030	9.99E-03	B
533	H-DC-B	02-Oct-12	14:48	SS	-	-	-	-	-	0.020	6.62E-03	B/E
604	H-DC-B	15-Oct-12	15:00	SS	-	-	-	-	-	0.013	4.30E-03	B/E
617	H-DC-B	13-Nov-12	17:27	N	-	-	-	-	-	0.000	0.00E+00	B/X
652	H-DC-B	11-Dec-12	16:45	N	-	-	-	-	-	0.000	0.00E+00	B/X
645	H-TP	21-Aug-12	13:38	SG	0.770	-	-	-	-	-	-	
469	H-TP	06-Sep-12	8:47	SG	0.765	-	-	-	-	-	-	
646	H-TP	17-Sep-12	14:42	SG	0.776	-	-	-	-	-	-	
216	H-DC-M	17-Apr-12	16:05	SS	0.220	0.327	1.649	1.322	1.385	0.018	5.49E-03	B/SH-SG



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327	H-DC-M	01-May-12	15:17	ADV	0.236	0.280	1.672	1.392		0.035	1.07E-02	B
320	H-DC-M	15-May-12	14:41	SS	0.198	0.230	1.616	1.386		0.019	5.83E-03	B
298	H-DC-M	28-May-12	13:50	ADV	0.231	0.285	1.662	1.377		0.054	1.65E-02	
287	H-DC-M	11-Jun-12	14:17	ADV	0.194	0.194	1.604	1.410	1.423	0.020	6.07E-03	
258	H-DC-M	25-Jun-12	14:50	SS	0.194	0.190	1.617	1.427		0.027	8.28E-03	SH-SG
243	H-DC-M	09-Jul-12	11:45	SS	0.188	0.195	1.625	1.430		0.023	7.08E-03	SH-SG
405	H-DC-M	23-Jul-12	12:59	SS	0.178	0.208	1.627	1.419		0.023	7.03E-03	
413	H-DC-M	06-Aug-12	13:16	SS	0.197	0.228	1.658	1.430		0.030	9.08E-03	
454	H-DC-M	21-Aug-12	12:50	SS	0.194	0.223	1.645	1.422		0.043	1.32E-02	SH-SG
484	H-DC-M	04-Sep-12	13:30	SS	0.209	0.260	1.659	1.399	1.434	0.037	1.14E-02	
510	H-DC-M	17-Sep-12	13:52	SS	0.194	0.211	1.651	1.440		0.031	9.47E-03	
531	H-DC-M	02-Oct-12	13:46	SS	0.163	0.175	1.627	1.452		0.019	5.92E-03	B
593	H-DC-M	15-Oct-12	13:47	SS	0.166	0.181	1.627	1.446		0.022	6.75E-03	B
618	H-DC-M	13-Nov-12	15:47	SS	0.128	-	1.590	-	-	0.005	1.53E-03	B
654	H-DC-M	11-Dec-12	17:45	SS	-	Solinst logger	-	-	-	0.004	1.23E-03	B
666	H-DC-M	14-Jan-13	16:45	SS	-	Solinst logger	-	-	-	0.005	1.53E-03	B
681	H-DC-M	12-Feb-13	13:46	SS	0.132	Solinst logger	1.596	-	-	0.004	1.23E-03	B/E
215	H-SEEP	17-Apr-12	17:38	V/SG	-	-	-	-	-	0.007	-	
221	H-SEEP	01-May-12	14:42	V/SG	-	-	-	-	-	0.003	-	
366	H-SEEP	15-May-12	15:36	V/SG	-	-	-	-	-	0.003	-	
364	H-SEEP	30-May-12	7:58	V/SG	-	-	-	-	-	0.003	-	
346	H-SEEP	11-Jun-12	15:18	V/SG	-	-	-	-	-	0.003	-	
339	H-SEEP	25-Jun-12	14:45	V/SG	-	-	-	-	-	0.002	-	
331	H-SEEP	09-Jul-12	12:26	V/SG	-	-	-	-	-	0.003	-	
571	H-SEEP	23-Jul-12	13:47	V/SG	0.328	-	-	-	-	0.004	-	
436	H-SEEP	06-Aug-12	13:48	V/SG	0.338	-	-	-	-	0.004	-	
437	H-SEEP	21-Aug-12	13:38	V/SG	0.254	-	-	-	-	0.004	-	
470	H-SEEP	04-Sep-12	13:45	V/SG	0.258	-	-	-	-	0.003	-	
527	H-SEEP	17-Sep-12	14:42	V/SG	-	-	-	-	-	0.003	-	
530	H-SEEP	02-Oct-12	14:25	V/SG	0.318	-	-	-	-	0.004	-	
590	H-SEEP	15-Oct-12	14:30	V/SG	0.098	-	-	-	-	0.003	-	
629	H-SEEP	13-Nov-12	17:01	V/SG	-	-	-	-	-	0.003	-	B
649	H-SEEP	12-Dec-12	12:45	V/SG	-	-	-	-	-	0.004	-	B
667	H-SEEP	14-Jan-13	17:30	V/SG	-	-	-	-	-	0.003	-	B



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680	H-SEEP	12-Feb-13	14:40	V/SG	-	-	-	-	-	0.003	-	B
219	H-DC-R	17-Apr-12	12:45	SS	-	-	-	-	-	0.029	6.44E-03	B
564	H-DC-R	01-May-12	18:10	ADV	-	-	-	-	-	0.084	1.86E-02	B
375	H-DC-R	15-May-12	16:26	SS	-	-	-	-	-	0.045	1.00E-02	B
306	H-DC-R	28-May-12	14:40	SS	0.532	-	0.581	-	-	0.059	1.31E-02	B
288	H-DC-R	11-Jun-12	18:11	SS	0.375	-	0.484	-	-	0.026	5.68E-03	
260	H-DC-R	26-Jun-12	13:36	SS	0.392	-	0.442	-	-	0.026	5.78E-03	
254	H-DC-R	10-Jul-12	12:12	SS	0.349	-	0.513	-	-	0.028	6.16E-03	SH-SG
402	H-DC-R	23-Jul-12	12:00	V	0.289	-	0.467	-	-	0.026	5.87E-03	
401	H-DC-R	23-Jul-12	12:00	SS	0.289	-	0.407	-	-	0.027	5.90E-03	
422	H-DC-R	06-Aug-12	11:50	SS	0.365	-	0.541	-	-	0.042	9.38E-03	
457	H-DC-R	21-Aug-12	12:02	SS	0.375	-	0.539	-	-	0.048	1.07E-02	
496	H-DC-R	04-Sep-12	12:51	SS	0.418	-	0.590	-	-	0.071	1.58E-02	
508	H-DC-R	17-Sep-12	12:56	SS	0.356	-	0.529	-	-	0.040	8.82E-03	
528	H-DC-R	02-Oct-12	12:47	SS	0.254	-	0.427	-	-	0.021	4.67E-03	B
577	H-DC-R	15-Oct-12	12:17	SS	0.284	-	0.485	-	-	0.030	6.67E-03	B
619	H-DC-R	13-Nov-12	13:35	N	-	-	-	-	-	0.000	0.00E+00	B
651	H-DC-R	10-Dec-12	20:30	N	-	-	-	-	-	0.000	0.00E+00	B
558	H-BC	30-Apr-12	18:30	SS	0.370	-	-		-	0.094	9.04E-03	B
321	H-BC	15-May-12	9:15	SS	0.295	0.409	1.867	1.458	1.458	0.059	5.67E-03	B
302	H-BC	29-May-12	18:10	ADV	0.392	0.510	2.023	1.513	1.513	0.250	2.40E-02	SH-SG
293	H-BC	12-Jun-12	13:36	ADV	0.245	0.345	1.868	1.523		0.054	5.17E-03	
272	H-BC	26-Jun-12	17:25	SS	0.250	0.617	1.858	1.241		0.049	4.71E-03	
252	H-BC	10-Jul-12	15:25	SS	0.224	0.236	1.918	1.682	1.682	0.041	3.98E-03	SH-SG/S
391	H-BC	24-Jul-12	18:15	SS	0.200	0.309	1.887	1.578		0.057	5.49E-03	
408	H-BC	07-Aug-12	14:12	SS	0.252	0.291	1.919	1.628		0.121	1.17E-02	SH-SG
461	H-BC	22-Aug-12	14:57	SS	0.250	0.295	1.929	1.634		0.095	9.13E-03	
486	H-BC	05-Sep-12	14:20	SS	0.235	0.355	1.925	1.570		0.074	7.16E-03	
502	H-BC	18-Sep-12	16:32	SS	0.240	0.306	1.894	1.588		0.056	5.37E-03	
554	H-BC	03-Oct-12	14:20	SS	0.406	-	2.065	-	-	0.027	2.55E-03	B
582	H-BC	16-Oct-12	12:40	SS	0.388	-	2.025	-	-	0.028	2.64E-03	B
625	H-BC	15-Nov-12	12:37	N	-	-	-	-	-	0.000	0.00E+00	B/X
214	H-MN	17-Apr-12	9:35	SS	-	-	-	-	-	0.012	9.69E-04	B
220	H-MN	01-May-12	10:00	SS	-	-	-	-	-	0.234	1.84E-02	B



MID	HID	Measurement Date	Measurement Time (HH:MM)	Measurement Type	Staff Gauge (m) +/- 2 mm	Logger Stage (m) +/- 3 mm	Water Surface Elevation (m, L.D.) +/- 5 mm	Water Surface Elev.- Logger Stage	Average Logger Adjustment to Local Datum	Discharge (m ³ /s)	Unit Discharge (m ³ /s/km ²)	Data Flag
382	H-MN	14-May-12	13:13	SS	-	-	-	-	-	0.218	1.72E-02	
305	H-MN	31-May-12	8:58	ADV	-	0.626	1.040	0.414	-	0.036	2.86E-03	
344	H-MN	12-Jun-12	10:40	SS	0.454	0.607	1.004	0.397	-	0.028	2.22E-03	
276	H-MN	26-Jun-12	8:50	SS	0.512	0.654	1.060	0.406	-	0.077	6.06E-03	
250	H-MN	10-Jul-12	10:12	SS	0.530	0.683	1.075	0.392	-	0.092	7.24E-03	SH-SG
393	H-MN	24-Jul-12	14:55	SS	0.625	0.779	1.138	0.359	-	0.178	1.40E-02	
429	H-MN	07-Aug-12	10:12	SS	0.607	0.757	1.129	0.372	-	0.197	1.55E-02	
464	H-MN	22-Aug-12	10:20	SS	0.572	0.724	1.094	0.370	-	0.164	1.29E-02	
488	H-MN	05-Sep-12	9:40	SS	0.558	0.713	1.090	0.377	-	0.141	1.11E-02	
506	H-MN	18-Sep-12	11:50	SS	0.528	0.678	1.052	0.374	-	0.095	7.51E-03	
546	H-MN	03-Oct-12	10:00	SS	0.545	0.653	1.077	0.424	-	0.064	5.04E-03	B
586	H-MN	16-Oct-12	9:16	SS	0.490	0.535	1.027	0.492	-	0.053	4.18E-03	B
627	H-MN	14-Nov-12	14:44	SS	-	-	0.948	-	-	0.015	1.18E-03	B
662	H-MN	11-Dec-12	11:00	N	-	-	-	-	-	0.000	0.00E+00	B
222	H-VC-REF	02-May-12	13:15	SS	-	-	-	-	-	0.451	7.05E-03	B
365	H-VC-REF	15-May-12	10:48	SS	-	-	-	-	-	0.456	7.13E-03	B
300	H-VC-REF	30-May-12	12:15	ADV	0.815	0.949	2.027	1.078	1.079	1.462	2.28E-02	
290	H-VC-REF	12-Jun-12	14:28	ADV	0.624	0.750	1.829	1.079		0.508	7.94E-03	
270	H-VC-REF	26-Jun-12	15:27	ADV	0.690	0.804	1.883	1.079		0.785	1.23E-02	
245	H-VC-REF	10-Jul-12	16:45	ADV	0.698	0.713	1.899	1.186	1.186	0.844	1.32E-02	SH-SG
385	H-VC-REF	24-Jul-12	18:22	ADV	0.844	0.853	2.063	1.210	1.242	1.597	2.49E-02	
426	H-VC-REF	07-Aug-12	15:10	ADV	0.710	0.715	1.935	1.220		0.903	1.41E-02	
456	H-VC-REF	22-Aug-12	15:10	ADV	0.728	0.676	1.972	1.296		0.994	1.55E-02	SH-L
475	H-VC-REF	05-Sep-12	15:21	ADV	0.688	0.648	1.937	1.289	1.292	0.863	1.35E-02	
524	H-VC-REF	18-Sep-12	17:50	ADV	0.668	0.628	1.919	1.291		0.722	1.13E-02	
553	H-VC-REF	03-Oct-12	15:18	ADV	0.532	0.512	1.903	1.391		0.569	8.90E-03	B/SH-SG
598	H-VC-REF	15-Oct-12	18:20	ADV	0.469	0.400	1.825	1.425	1.391	0.418	6.53E-03	B
621	H-VC-REF	15-Nov-12	11:25	SS	0.395	0.208	1.730	1.522		0.196	3.06E-03	B/UR
658	H-VC-REF	11-Dec-12	14:50	SS	-	-	-	-	-	0.109	1.70E-03	B/E
668	H-VC-REF	15-Jan-13	18:11	SS	-	-	-	-	-	0.096	1.50E-03	B
682	H-VC-REF	11-Feb-13	17:02	SS	0.352	-	-	-	-	0.074	1.16E-03	B/E
213	H-VC-U	16-Apr-12	17:56	ADV	0.159	-	-	-	-	0.051	7.89E-04	B
232	H-VC-U	30-Apr-12	17:45	ADV	0.290	0.413	2.119	1.706	1.735	0.412	6.38E-03	B
319	H-VC-U	15-May-12	11:32	ADV	0.278	0.398	2.108	1.710		0.296	4.58E-03	B



MID	HID	Measurement Date	Measurement Time (HH:MM)	Measurement Type	Staff Gauge (m) +/- 2 mm	Logger Stage (m) +/- 3 mm	Water Surface Elevation (m, L.D.) +/- 5 mm	Water Surface Elev.- Logger Stage	Average Logger Adjustment to Local Datum	Discharge (m ³ /s)	Unit Discharge (m ³ /s/km ²)	Data Flag
301	H-VC-U	30-May-12	14:10	ADV	0.433	0.549	2.273	1.724		1.329	2.06E-02	-
291	H-VC-U	12-Jun-12	12:59	ADV	0.314	0.411	2.152	1.741		0.533	8.25E-03	-
271	H-VC-U	26-Jun-12	16:25	ADV	0.354	0.453	2.195	1.742		0.774	1.20E-02	-
247	H-VC-U	10-Jul-12	14:50	ADV	0.362	0.469	2.203	1.734		0.863	1.34E-02	-
384	H-VC-U	24-Jul-12	16:51	ADV	0.451	0.554	2.295	1.741		1.643	2.54E-02	-
432	H-VC-U	07-Aug-12	13:05	ADV	0.374	0.469	2.223	1.754		0.901	1.40E-02	-
459	H-VC-U	22-Aug-12	13:48	ADV	0.387	0.483	2.235	1.752		1.016	1.57E-02	-
472	H-VC-U	05-Sep-12	13:44	ADV	0.355	0.456	2.189	1.733		0.831	1.29E-02	SH-SG
499	H-VC-U	18-Sep-12	15:45	ADV	0.348	0.439	2.191	1.752		0.799	1.24E-02	SH-SG
556	H-VC-U	03-Oct-12	13:22	ADV	0.278	0.337	2.182	1.845	-	0.610	9.44E-03	SH-SG /B
595	H-VC-U	16-Oct-12	13:10	ADV	0.236	0.232	2.136	1.904	-	0.407	6.30E-03	
623	H-VC-U	15-Nov-12	9:20	SS	-	0.113	-	-	-	0.205	3.17E-03	B
622	H-VC-U	15-Nov-12	9:28	ADV	-	0.113	-	-	-	0.239	3.70E-03	B
656	H-VC-U	11-Dec-12	13:53	SS	-	(HOBO 0.081) 0.253	-	-	-	0.103	1.59E-03	B
657	H-VC-U	11-Dec-12	15:47	ADV	-	(HOBO 0.081) 0.253	-	-	-	0.145	2.24E-03	B
699	H-VC-U	15-Jan-13	16:29	SS	-	Solinst logger	-	-	-	0.091	1.41E-03	B
670	H-VC-U	16-Jan-13	9:56	SS	-	Solinst logger	-	-	-	0.085	1.32E-03	B
671	H-VC-U	16-Jan-13	10:00	ADV	-	Solinst logger	-	-	-	0.094	1.46E-03	B
683	H-VC-U	11-Feb-13	15:28	ADV	-	Solinst logger	-	-	-	0.073	1.13E-03	B/E
684	H-VC-U	11-Feb-13	15:28	SS	-	Solinst logger	-	-	-	0.074	1.15E-03	B/E
212	H-VC-DBC	17-Apr-12	13:45	SS	-	-	-			0.066	8.80E-04	B
324	H-VC-DBC	30-Apr-12	16:02	ADV	0.510	0.647	1.827	1.180	1.181	0.492	6.56E-03	
318	H-VC-DBC	15-May-12	13:07	ADV	0.489	0.62	1.798	1.178		0.387	5.16E-03	
303	H-VC-DBC	30-May-12	15:00	ADV	0.698	0.816	2.001	1.185		1.552	2.07E-02	
292	H-VC-DBC	12-Jun-12	12:14	ADV	0.538	0.673	1.845	1.172		0.589	7.85E-03	
274	H-VC-DBC	26-Jun-12	17:35	ADV	0.580	0.715	1.898	1.183		0.858	1.14E-02	
249	H-VC-DBC	10-Jul-12	13:25	ADV	0.594	0.746	1.899	1.153		0.886	1.18E-02	
388	H-VC-DBC	24-Jul-12	16:07	ADV	0.690	0.828	2.015	1.187		1.751	2.34E-02	
431	H-VC-DBC	07-Aug-12	12:15	ADV	0.602	0.736	1.934	1.198		1.054	1.41E-02	
460	H-VC-DBC	22-Aug-12	12:55	ADV	0.622	0.738	1.937	1.199	1.190	1.095	1.46E-02	
473	H-VC-DBC	05-Sep-12	12:00	ADV	0.608	0.695	1.927	1.232		0.890	1.19E-02	
523	H-VC-DBC	18-Sep-12	14:34	ADV	0.556	0.680	1.886	1.206	1.206	0.806	1.08E-02	SH-SG
557	H-VC-DBC	03-Oct-12	12:28	ADV	0.495	-	1.815	-		0.510	6.79E-03	B
596	H-VC-DBC	16-Oct-12	11:58	ADV	0.489	-	1.824	-		0.436	5.81E-03	B



MID	HID	Measurement Date	Measurement Time (HH:MM)	Measurement Type	Staff Gauge (m) +/- 2 mm	Logger Stage (m) +/- 3 mm	Water Surface Elevation (m, L.D.) +/- 5 mm	Water Surface Elev.- Logger Stage	Average Logger Adjustment to Local Datum	Discharge (m ³ /s)	Unit Discharge (m ³ /s/km ²)	Data Flag
624	H-VC-DBC	14-Nov-12	17:00	SS		-	1.775	-		0.196	2.61E-03	B/UR
659	H-VC-DBC	11-Dec-12	12:47	SS		Solinst logger	-	-		0.148	1.97E-03	B
660	H-VC-DBC	11-Dec-12	14:11	ADV		Solinst logger	-	-		0.165	2.20E-03	B
672	H-VC-DBC	15-Jan-13	13:50	SS		Solinst logger	-	-		0.097	1.29E-03	B
673	H-VC-DBC	15-Jan-13	14:44	ADV		Solinst logger	-	-		0.124	1.65E-03	B
685	H-VC-DBC	11-Feb-13	14:15	ADV	0.387	Solinst logger	1.747	-		0.089	1.19E-03	B/E
686	H-VC-DBC	11-Feb-13	14:16	SS	0.387	Solinst logger	1.747	-		0.077	1.03E-03	B/E
211	H-VC-UMN	17-Apr-12	10:42	ADV	-	-	-	-	-	0.117	1.41E-03	B
325	H-VC-UMN	01-May-12	11:51	ADV	0.758	0.898	1.719	0.821	0.827	0.481	5.77E-03	S
317	H-VC-UMN	14-May-12	13:20	ADV	0.760	0.907	1.725	0.818		0.735	8.82E-03	
304	H-VC-UMN	30-May-12	10:25	ADV	0.860	0.990	1.816	0.826		1.657	1.99E-02	
294	H-VC-UMN	12-Jun-12	9:34	ADV	0.720	0.870	1.695	0.825		0.602	7.21E-03	
275	H-VC-UMN	26-Jun-12	8:55	ADV	0.769	0.907	1.746	0.839		0.985	1.18E-02	
248	H-VC-UMN	10-Jul-12	10:54	ADV	0.765	0.911	1.714	0.803		0.949	1.14E-02	
387	H-VC-UMN	24-Jul-12	14:08	ADV	0.875	1.019	1.838	0.819		1.754	2.10E-02	SH-SG
428	H-VC-UMN	07-Aug-12	10:45	ADV	0.788	0.933	1.765	0.832		1.084	1.30E-02	
463	H-VC-UMN	22-Aug-12	11:13	ADV	0.786	0.938	1.766	0.828		1.166	1.40E-02	
471	H-VC-UMN	05-Sep-12	10:18	ADV	0.797	0.913	1.764	0.851		1.031	1.24E-02	
522	H-VC-UMN	18-Sep-12	12:38	ADV	0.752	0.892	1.738	0.846		0.877	1.05E-02	
548	H-VC-UMN	03-Oct-12	10:49	ADV	0.710	0.815	1.694	0.879		0.454	5.44E-03	B
597	H-VC-UMN	16-Oct-12	10:05	ADV	0.705	0.775	1.679	0.904		0.512	6.14E-03	B/MI
626	H-VC-UMN	14-Nov-12	13:10	SS	0.886	0.684	1.637	0.953		0.335	4.02E-03	B
661	H-VC-UMN	11-Dec-12	10:15	SS	-	-	-	-	-	0.112	1.34E-03	B
674	H-VC-UMN	15-Jan-13	9:59	SS	-	-	-	-	-	0.054	6.47E-04	B/F
675	H-VC-UMN	15-Jan-13	10:49	ADV	-	-	-	-	-	0.105	1.26E-03	B/O
689	H-VC-UMN	12-Feb-13	9:45	SS	0.598	-	-	-	-	0.070	8.39E-04	B/E
688	H-VC-UMN	12-Feb-13	9:45	ADV	0.598	-	-	-	-	0.076	9.11E-04	B/E
210	H-VC-R	16-Apr-12	15:30	ADV	-	-	-	-	-	0.106	1.08E-03	B
326	H-VC-R	02-May-12	9:50	ADV	0.485	0.550	2.044	1.494	1.494	0.756	7.73E-03	
316	H-VC-R	15-May-12	14:50	ADV	0.444	0.517	1.986	1.469		0.547	5.60E-03	B/S
299	H-VC-R	29-May-12	16:55	ADV	0.599	0.713	2.111	1.398	1.398	1.913	1.96E-02	SH-SG
295	H-VC-R	12-Jun-12	8:30	ADV	0.492	0.611	2.008	1.397		0.580	5.94E-03	
278	H-VC-R	26-Jun-12	11:05	ADV	0.534	0.642	2.042	1.400		0.964	9.87E-03	
330	H-VC-R	10-Jul-12	8:50	ADV	0.530	0.639	2.038	1.399		0.950	9.73E-03	



MID	HID	Measurement Date	Measurement Time (HH:MM)	Measurement Type	Staff Gauge (m) +/- 2 mm	Logger Stage (m) +/- 3 mm	Water Surface Elevation (m, L.D.) +/- 5 mm	Water Surface Elev.- Logger Stage	Average Logger Adjustment to Local Datum	Discharge (m ³ /s)	Unit Discharge (m ³ /s/km ²)	Data Flag
386	H-VC-R	24-Jul-12	12:25	ADV	0.548	0.667	2.106	1.439	1.440	1.942	1.99E-02	SH-SG
427	H-VC-R	07-Aug-12	8:22	ADV	0.495	0.610	2.051	1.441		1.146	1.17E-02	SH-SG
466	H-VC-R	22-Aug-12	8:20	ADV	0.505	0.627	2.080	1.453	1.451	1.315	1.35E-02	
474	H-VC-R	05-Sep-12	7:50	ADV	0.491	0.615	2.064	1.449		1.079	1.10E-02	
498	H-VC-R	18-Sep-12	10:10	ADV	0.472	0.593	2.035	1.442	1.442	0.956	9.78E-03	
545	H-VC-R	03-Oct-12	8:20	ADV	0.428	0.489	1.988	1.499		0.456	4.67E-03	B
599	H-VC-R	16-Oct-12	8:20	ADV	0.431	0.495	2.003	1.508		0.529	5.41E-03	B
628	H-VC-R	14-Nov-12	10:00	SS	0.399	0.445	1.965	1.520		0.167	1.71E-03	
655	H-VC-R	10-Dec-12	13:10	SS	-	0.416	-	-	-	0.126	1.29E-03	
676	H-VC-R	14-Jan-13	13:41	SS	-	-	-	-	-	0.086	8.80E-04	
677	H-VC-R	14-Jan-13	14:12	ADV	-	-	-	-	-	0.093	9.52E-04	
691	H-VC-R	11-Feb-13	12:30	SS	0.334	-	-	-	-	0.071	7.27E-04	
690	H-VC-R	11-Feb-13	12:31	ADV	0.334	-	-	-	-	0.060	6.14E-04	

Notes:

MID = Measurement ID (unique measurement identifier in hydrometric database)

HID = Hydrometric ID (Unique hydrometric station identifier in hydrometric database)

L.D. = Local datum

Measurement Methods: ADV = Acoustic Doppler Velocimeter; SS = Salt dilution gauging, Slug injection method; V = Volumetric; CM = Current meter (Swoffer); W = Weir; N = No measurement obtained.

Data Flags: B = Backwater conditions, associated with ice in channel; MI = Missing measurement; SH-SG = Staff gauge shift; SH-L = Logger shift; E = Estimate; X = Discharge measurement not appropriate for channel conditions; UR = Under review; SG = Staff gauge only



Table B4. Discharge measurements from the H-SEEP pipe outlet and seepage pond flow meters (old and new) and Tailings pond staff gauge (H-TP) from April 17, 2012 to February 12, 2013.

Hydrometric Station	Time hh:mm	H-SEEP (Pipe Outlet)			H-SEEP (Old Flow Meter)		H-SEEP (New Flow Meter)		H-SEEP Staff Gauge m	H-TP Tailings Pond Staff Gauge m	Notes
		(m ³ /s)	L/s ¹	L/min	m ³ /s	L/min ¹	m ³ /s	L/min ¹			
17-Apr-2012	17:38	0.007	7.2	430	-	-	-	-	-	-	
01-May-2012	14:42	0.003	3.1	186	-	-	-	-	-	-	
15-May-2012	15:36	0.003	2.6	156	-	-	-	-	-	-	
30-May-2012	7:58	0.003	2.7	162	0.002	112.3	0.003	171.0	-	-	
11-Jun-2012	15:18	0.003	2.6	156	0.002	106.4	0.003	156.4	-	-	
25-Jun-2012	14:45	0.002	1.9	116	0.002	125.0	0.003	188.9	-	-	
09-Jul-2012	12:26	0.003	2.9	174	0.003	171.2	0.002	120.0	-	-	
23-Jul-2012	13:47	0.004	3.6	216	0.002	148.6	0.004	210.9	0.328	-	
06-Aug-2012	13:48	0.004	3.5	210	0.002	142.3	0.003	205.0	0.338	-	
21-Aug-2012	13:38	0.004	3.6	217	0.003	150.5	0.004	218.9	0.254	0.770	
05-Sep-2012	13:45	0.003	3.3	198	-	-	0.004	227.5	0.258	0.765	Tailings Pond staff gauge was recorded on Sept 6/12 at 8:47.
17-Sep-2012	14:42	0.003	3.5	210	0.003	154.5	0.004	224.3	0.265	0.766	
02-Oct-2012	14:25	0.004	3.6	216	0.003	160.0	0.004	227.9	ice	ice	
16-Oct-2012	14:30	0.003	3.4	204	-	-	0.003	202.3	ice	ice	Flow meters have been repositioned by DES with pipe, old flow meter not installed at the time of reading.
13-Nov-2012	17:00	0.003	3.2	192	-	-	0.004	213.3	ice	ice	Old flow meter removed.
12-Dec-2012	12:45	0.004	3.5	210	-	-	0.003	197.4	ice	ice	
14-Jan-2012	17:30	0.003	3.1	186	-	-	0.003	201.4	ice	ice	
12-Feb-2013	14:45	0.003	2.9	172	-	-	0.003	199.7	ice	ice	

Notes:
¹ – Units of direct measurement.



Table B5. Hydrometric survey data summary of adjustments from April 17, 2012 to February 12, 2012.

Station	Date Effective	BM1 m (L.D.)	BM2 m (L.D.)	BM3 m (L.D.)	TOS m (L.D.)	Bed-Casing (m)	Bolt-Casing (m)	Logger-Bolt (m)	Logger Distance off Bed* (m)	Estimated Bankfull Elevation** m (L.D.)	Zero Flow Elevation** m (L.D.)
H-PC-U	29-May-12	3.000	3.533	3.839	3.096	1.197	0.030	1.135	0.032		2.096
H-PC-U	11-Jun-12		3.563	3.874	3.133	1.230					2.133
H-PC-U	27-Jun-12		3.582	3.894	3.156						2.156
H-PC-U	9-Jul-12			3.883	3.141	1.200					2.141
H-PC-U	24-Jul-12			3.893	3.135						2.135
H-PC-U	22-Aug-12										
H-PC-U	5-Sep-12		3.573								
H-PC-U	19-Sep-12		3.579			1.191					
H-PC-DSP	15-May-12	3.000	3.152	3.684	3.202	1.240	0.031	1.175	0.034		2.202
H-PC-DSP	11-Jun-12		3.161	3.656		1.230			0.024		
H-PC-DSP	18-Sep-12										
H-PC-DSP	16-Oct-12		3.174	3.676	3.209	1.220			0.014	poorly defined	2.209
H-DC-U1	28-May-12	3.000	2.850	4.216	3.262	1.650	0.045	1.530	0.075		2.262
H-DC-U1	11-Jun-12	3.000		4.226	3.268	1.770		1.695	0.030		2.268
H-DC-U1	25-Jun-12			4.235	3.275						2.275
H-DC-U1	9-Jul-12		2.858	4.244	3.291	1.850			0.110		2.291
H-DC-U1	23-Jul-12		2.871	4.275	3.300						2.300
H-DC-U1	6-Aug-12		2.863	4.282		1.860			0.120		
H-DC-U1	21-Aug-12		1.666	3.090	2.091	1.870			0.130		1.091
H-DC-U1	5-Sep-12		1.657		2.085						1.085
H-DC-U2	28-May-12	3.000	4.062	4.796	2.874	1.210	0.050	1.125	0.035		1.874
H-DC-U2	11-Jun-12		4.046	4.788	2.916	1.240			0.065		1.916
H-DC-U2	25-Jun-12		4.033	4.781	3.025	1.220			0.045		2.025
H-DC-U2	23-Jul-12		4.006	4.766		0.990					
H-DC-B	25-Jun-12	3.000	3.352	3.068	3.625	1.235	0.050	1.080	0.105		
H-DC-B	9-Jul-12				3.730	1.250		1.165	0.035		2.730
H-DC-B	23-Jul-12				3.775	1.235			0.020		2.775
H-DC-B	6-Aug-12				3.763	1.235					2.763
H-DC-B	21-Aug-12				3.761						2.761
H-DC-B	4-Sep-12									n/a	
H-DC-M	17-Apr-12	3.000	2.415		2.437	1.245				n/a	1.437
H-DC-M	1-May-12			2.727		1.239					
H-DC-M	15-May-12		2.411		2.430	1.195					1.430
H-DC-M	28-May-12				2.426	1.185					1.426
H-DC-M	11-Jun-12				2.422	1.190					1.422
H-DC-M	25-Jun-12		2.416		2.428	1.136					1.428
H-DC-M	9-Jul-12		2.424	2.743	2.446	1.200	0.040	1.120	0.040		1.446
H-DC-M	23-Jul-12		2.433	2.752	2.460	1.190					1.460
H-DC-M	21-Aug-12		2.429	2.747		1.210					
H-DC-M	4-Sep-12			2.733							
H-DC-M	17-Sep-12			2.725	2.472	1.200	0.050	1.130	0.020		1.472



Station	Date Effective	BM1 m (L.D.)	BM2 m (L.D.)	BM3 m (L.D.)	TOS m (L.D.)	Bed-Casing (m)	Bolt-Casing (m)	Logger-Bolt (m)	Logger Distance off Bed* (m)	Estimated Bankfull Elevation** m (L.D.)	Zero Flow Elevation** m (L.D.)
H-DC-M	2-Oct-12		2.434	2.721		1.215					
H-DC-M	15-Oct-12		2.328								
H-DC-R	28-May-12	3.000	2.920	2.318	1.058	1.210	0.051	1.125	0.034		0.058
H-DC-R	10-Jul-12		2.925	2.311	1.166	1.260		1.175	0.034		0.166
H-DC-R	23-Jul-12		2.948	2.315	1.176	1.325			0.099		0.176
H-DC-R	6-Aug-12		2.933		1.171	1.320				1.071	0.171
H-DC-R	18-Sep-12										
H-DC-R	15-Oct-12			2.303							
H-VC-REF	30-May-12	3.000	2.984	3.058	2.209	1.240	0.050	1.155	0.035		1.209
H-VC-REF	10-Jul-12					1.120		1.037	0.033		
H-VC-REF	24-Jul-12		2.992	3.048	2.214						1.214
H-VC-REF	7-Aug-12		3.000	3.053	2.226	1.150					1.226
H-VC-REF	22-Aug-12		3.011		2.238	1.070		0.914	0.106		1.238
H-VC-REF	5-Sep-12		3.018		2.244	1.028					1.244
H-VC-REF	18-Sep-12				2.246						1.246
H-VC-REF	3-Oct-12				2.352	1.235		0.905	0.280	2.292	1.352
H-VC-REF	15-Oct-12					1.180			0.225		
H-VC-U	16-Apr-12	3.000	3.372		2.839	1.244	0.051	1.175	0.018		1.839
H-VC-U	30-Apr-12		3.367	3.249		1.234	0.051	1.175	0.008		
H-VC-U	26-Jun-12				2.846						1.846
H-VC-U	7-Aug-12		3.363			1.220		1.145	0.024		
H-VC-U	5-Sep-12				2.851	1.215					1.851
H-VC-U	18-Sep-12				2.851					2.331	1.851
H-VC-U	3-Oct-12				2.899	1.250					1.899
H-VC-U	5-Sep-12					1.275					
H-VC-U	18-Sep-12		3.360	3.244	2.892	1.315					
H-VC-U	16-Oct-12					1.255	0.051	1.170	0.034		
H-VC-U	11-Dec-12				2.886						
H-VC-U	12-Feb-13										
H-VC-DBC	30-Apr-12	3.000	3.025	2.916	2.316	1.240	0.050	1.135	0.055		1.316
H-VC-DBC	24-Jul-12			2.906	2.310	1.242					1.310
H-VC-DBC	7-Aug-12				2.316	1.240					1.316
H-VC-DBC	22-Aug-12										
H-VC-DBC	18-Sep-12				2.338	1.240		1.130	0.060	2.068	1.338
H-BC	15-May-12	3.000	2.989	3.058	2.585	1.246	0.025	1.170	0.051		1.585
H-BC	29-May-12				2.606 (pre-shift 2.581)	1.160					1.606
H-BC	26-Jun-12		2.997	3.063	2.612	1.208					1.612
H-BC	10-Jul-12		3.006	3.076	2.675 (pre-shift 2.624)	1.265		1.191	0.051		1.675
H-BC	24-Jul-12		2.999		3.070						
H-BC	7-Aug-12				2.651 (pre-shift 2.676)	1.265	0.023	1.185	0.057	2.451	1.651
H-BC	22-Aug-12		2.995								
H-BC	18-Sep-12										



Station	Date Effective	BM1 m (L.D.)	BM2 m (L.D.)	BM3 m (L.D.)	TOS m (L.D.)	Bed-Casing (m)	Bolt-Casing (m)	Logger-Bolt (m)	Logger Distance off Bed* (m)	Estimated Bankfull Elevation** m (L.D.)	Zero Flow Elevation** m (L.D.)
H-VC-UMN	1-May-12	3.000	3.001	2.682	1.973	1.235	0.041	1.170	0.024		0.973
H-VC-UMN	7-Jul-12			2.676							
H-VC-UMN	24-Jul-12				1.979					2.029	0.979
H-VC-UMN	18-Sep-12										
H-MN	30-May-12	3.000	2.321	2.739		1.220	0.050	1.135	0.035		
H-MN	12-Jun-12			2.731	1.554	1.245					0.554
H-MN	26-Jun-12			2.727							
H-MN	10-Jul-12			2.724	1.549	1.220			0.035		0.549
H-MN	22-Aug-12			2.718	1.533						0.533
H-MN	18-Sep-12		2.315	2.720	1.529	1.205			0.020	1.319	0.529
H-VC-R	2-May-12	3.000	3.433		2.556	1.160		1.115	0.045		1.556
H-VC-R	15-May-12			3.177	2.515	1.200					1.515
H-VC-R	29-May-12				2.515	1.210	0.050	1.125	0.035		1.515
H-VC-R	24-Jul-12				2.558	1.220					1.558
H-VC-R	7-Aug-12				2.568	1.220				2.498	1.568
H-VC-R	18-Sep-12										
H-VC-R	16-Oct-12		3.428		2.564	1.240		1.140	0.050		1.564

Notes:

* Continuous data logger record adjusted with this offset value.

** Aided in rating curve development in the absence of field validated peak and low flows.

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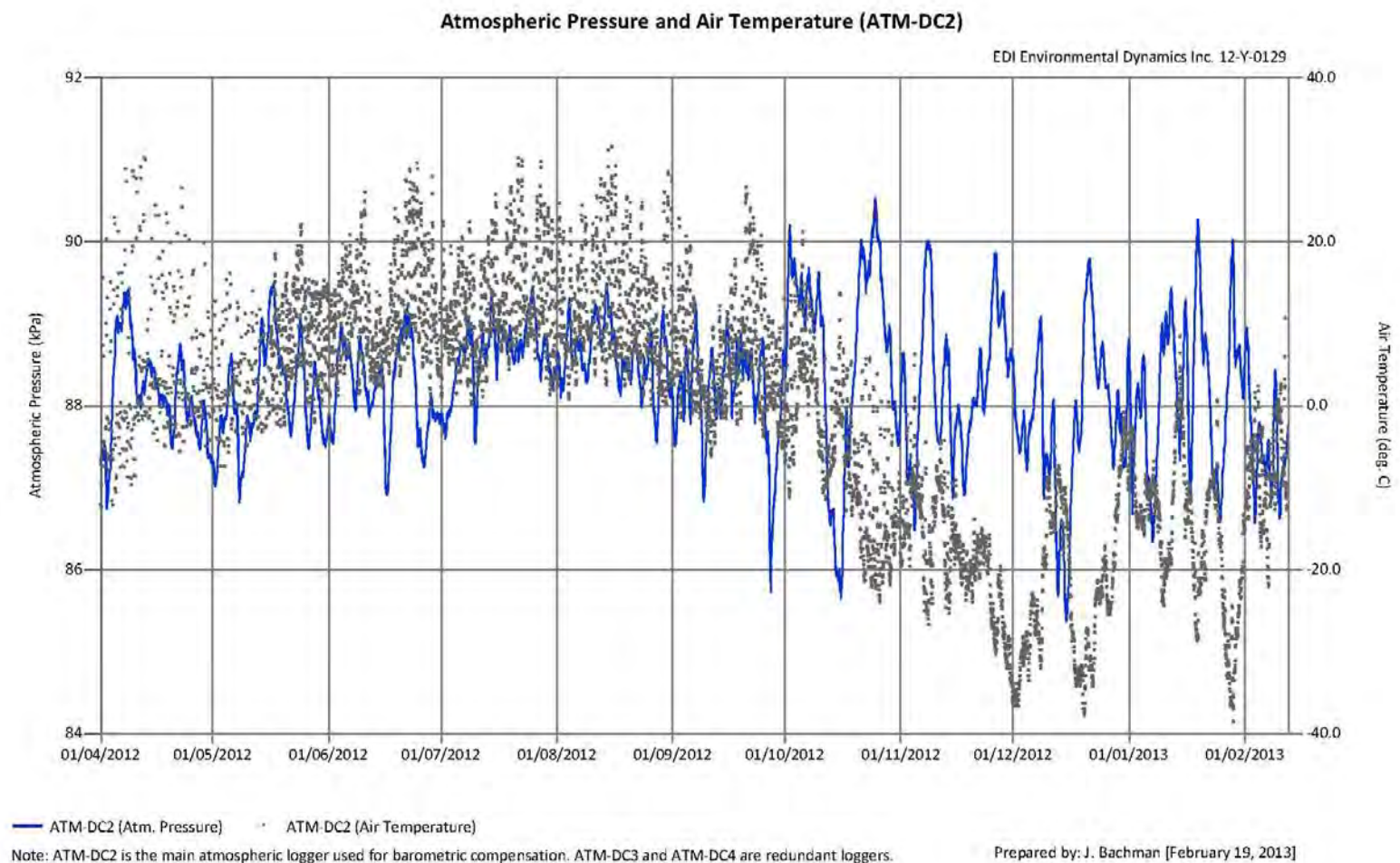


Figure B1. Atmospheric pressure and air temperature.

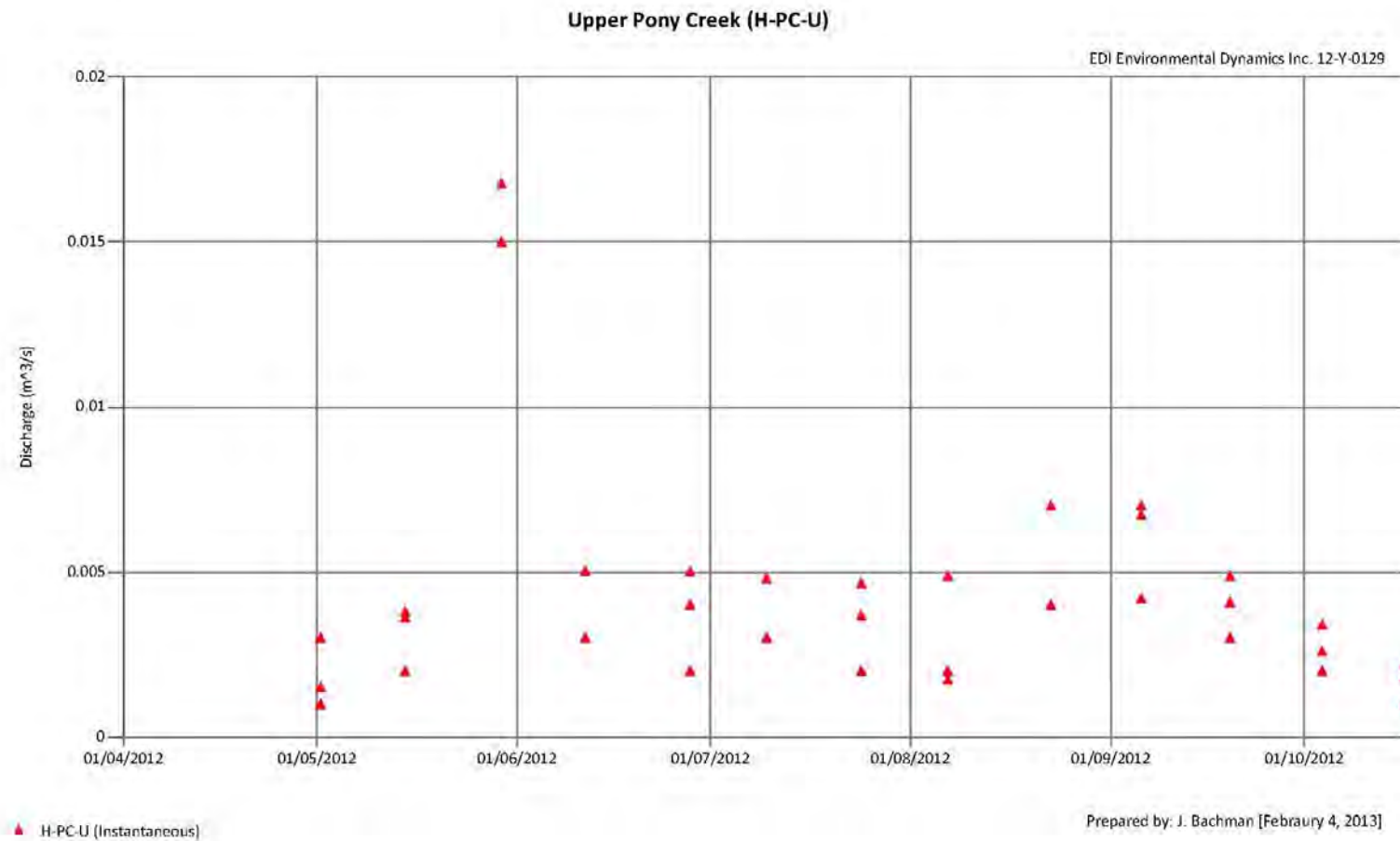


Figure B2. Upper Pony Creek (H-PC-U) hydrograph.

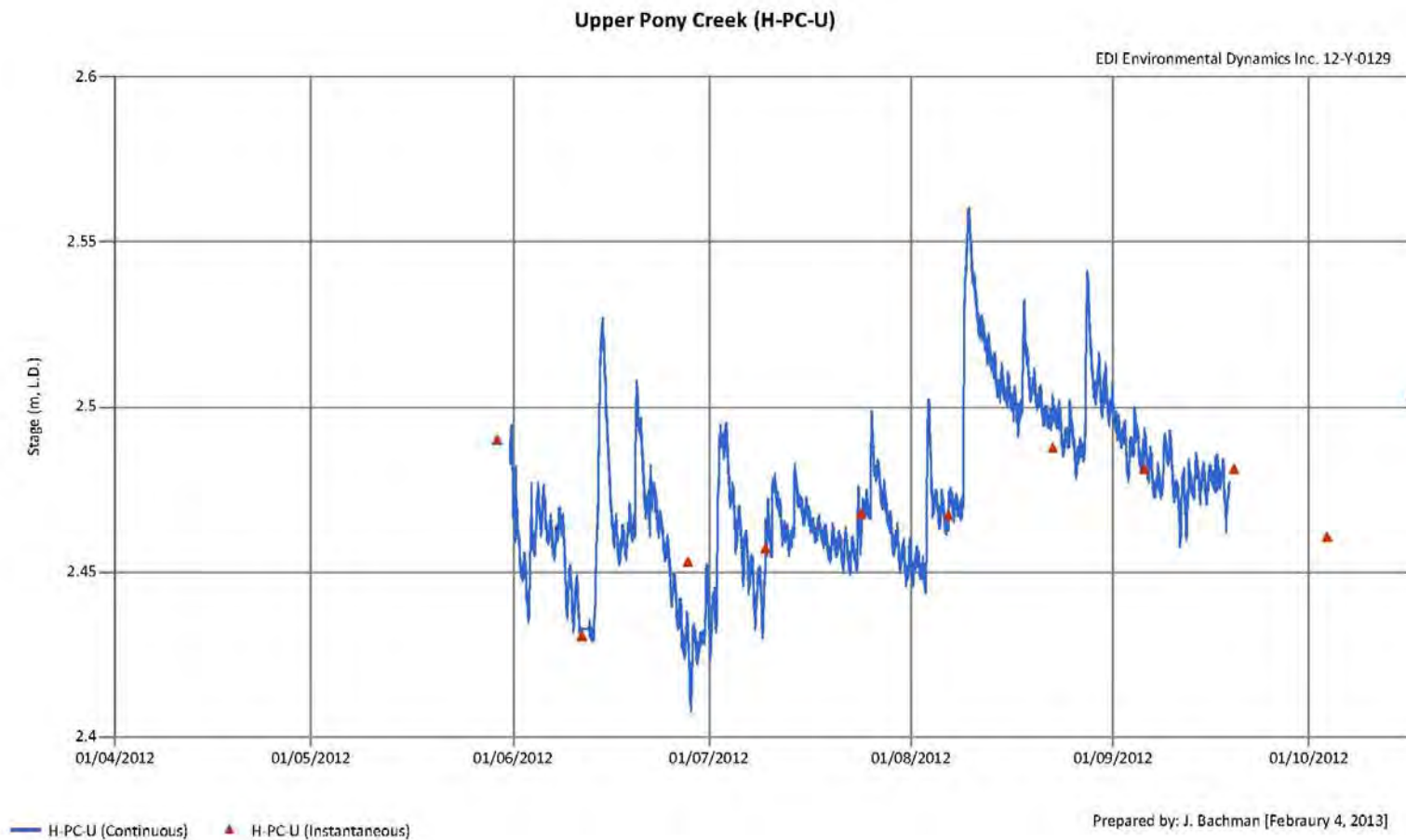


Figure B3. Upper Pony Creek (H-PC-U) stage.

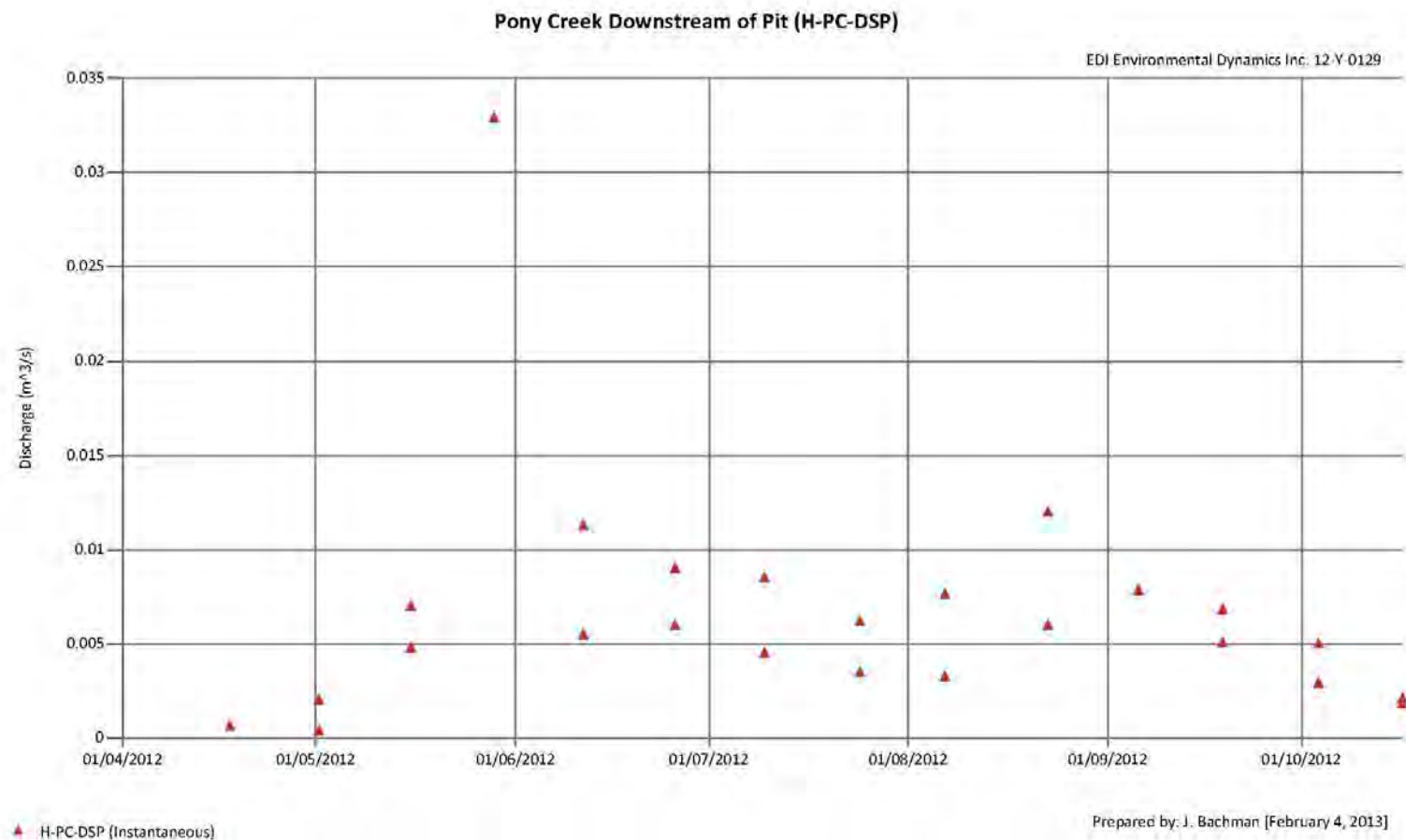


Figure B4. Pony Creek Downstream of Pit (H-PC-DSP) hydrograph.

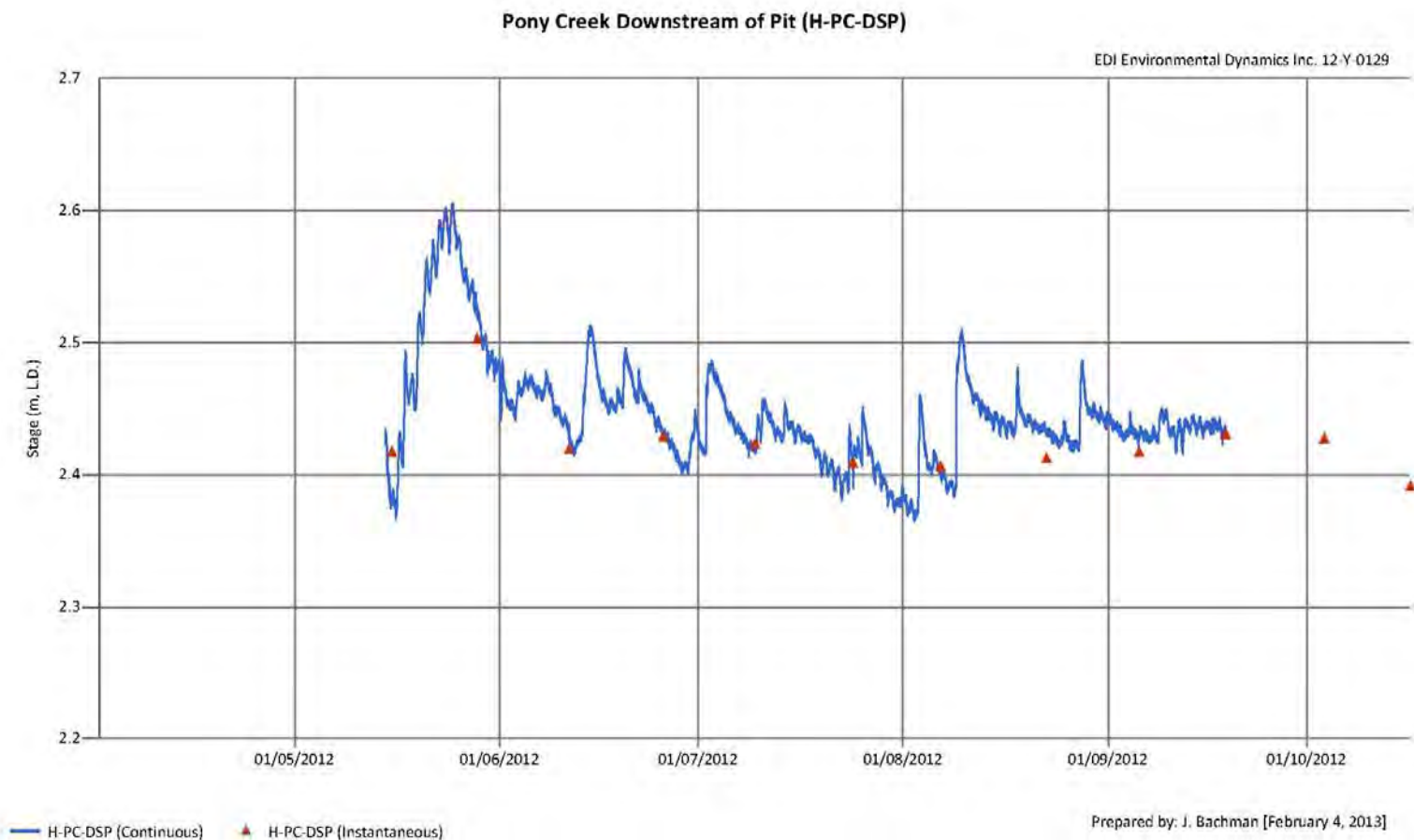


Figure B5. Pony Creek downstream of pit (H-PC-DSP) stage.

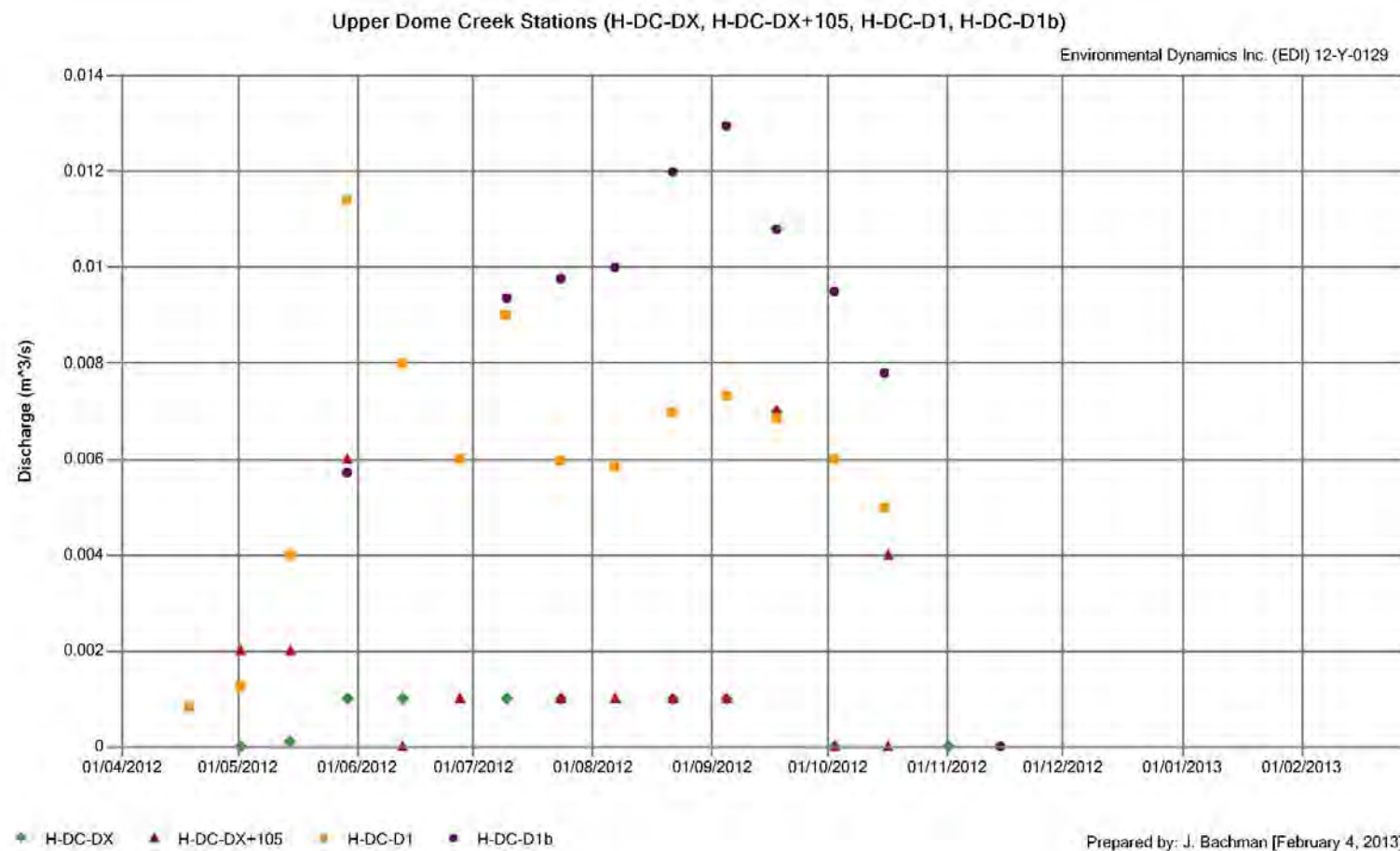


Figure B6. Upper Dome Creek stations (H-DC-DX, H-DC-DX+105, H-DC-D1, and H-DC-D1b) hydrograph.

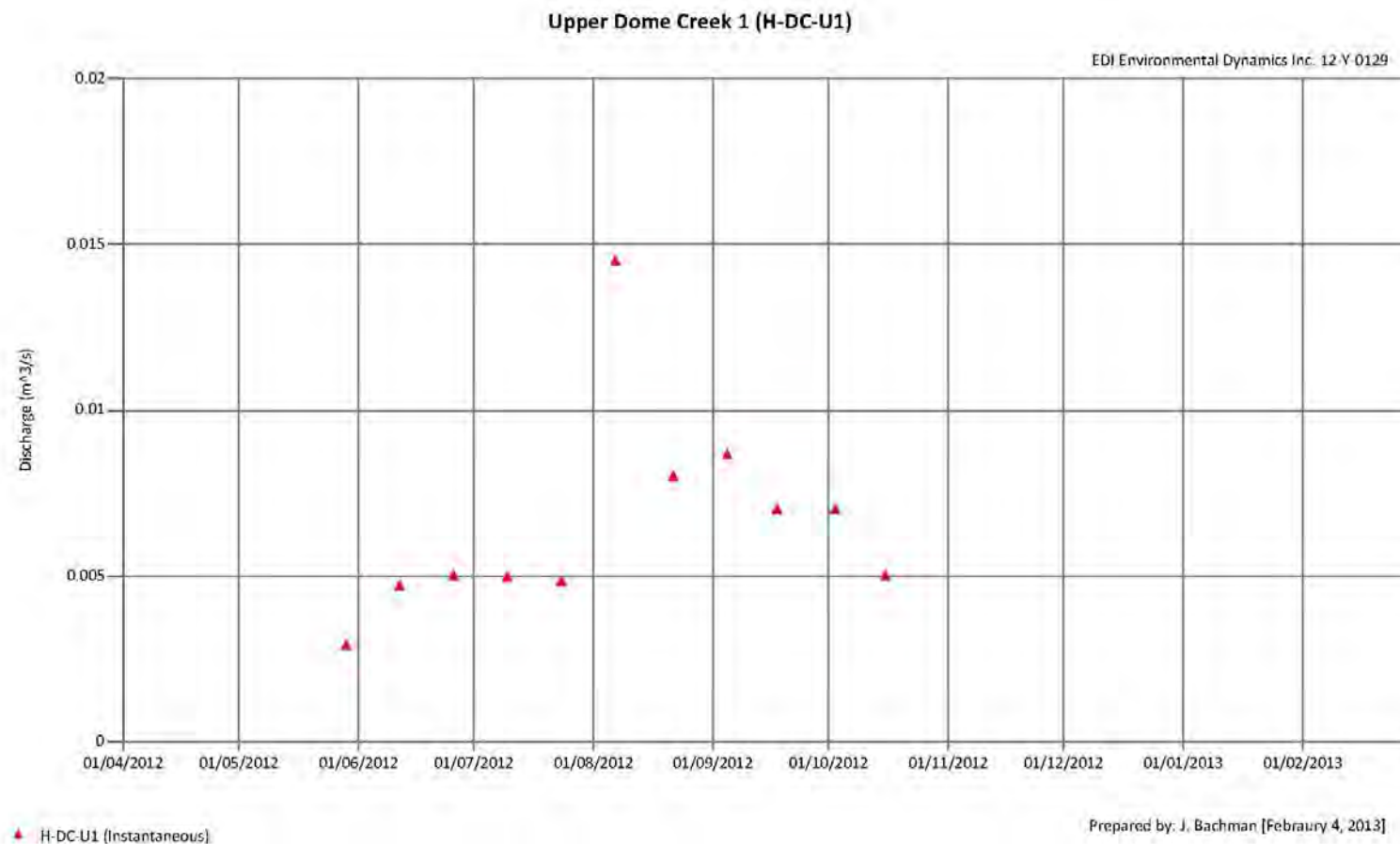


Figure B7. Upper Dome Creek 1 (H-DC-U1) hydrograph.

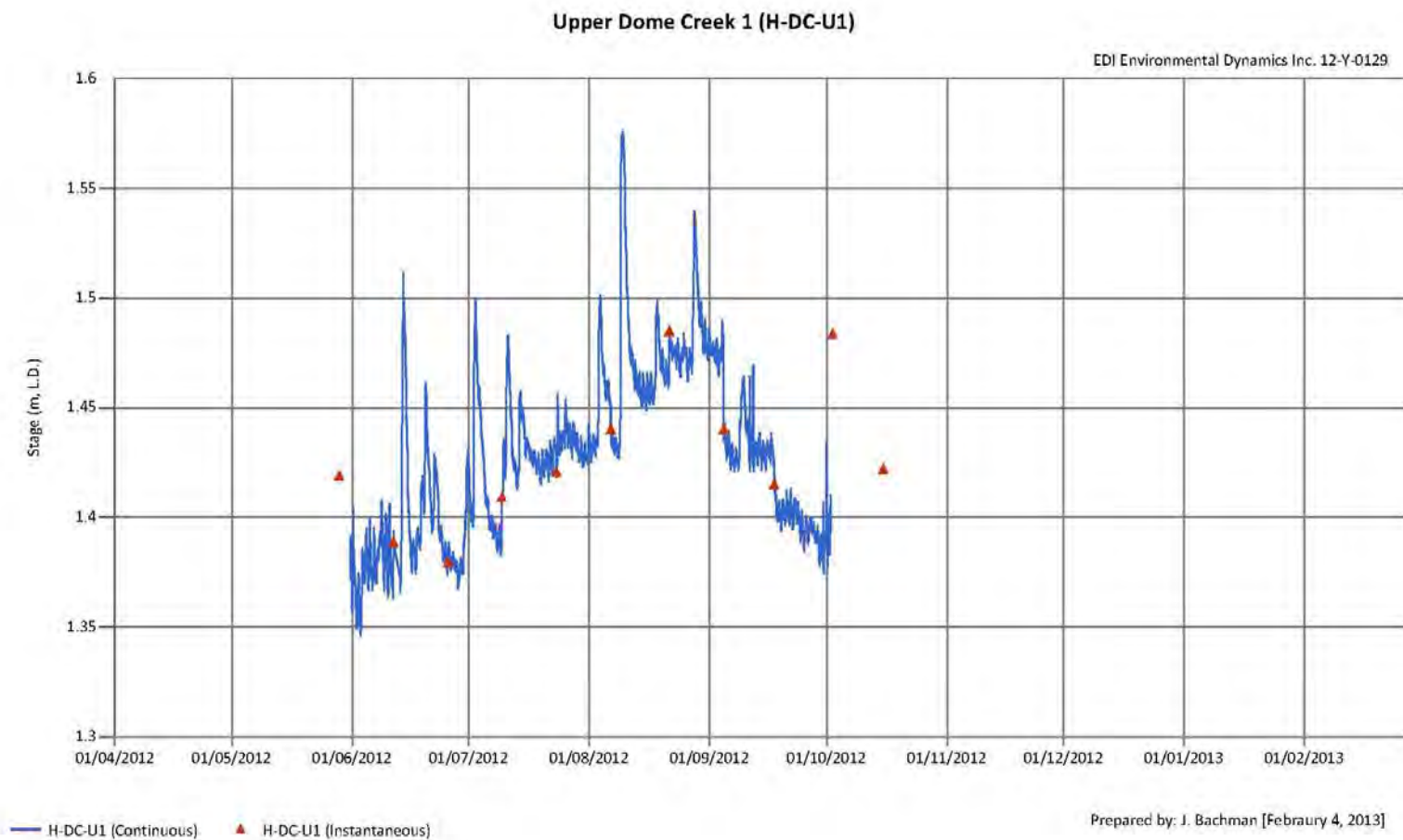


Figure B8. Upper Dome Creek 1 (H-DC-U1) stage.

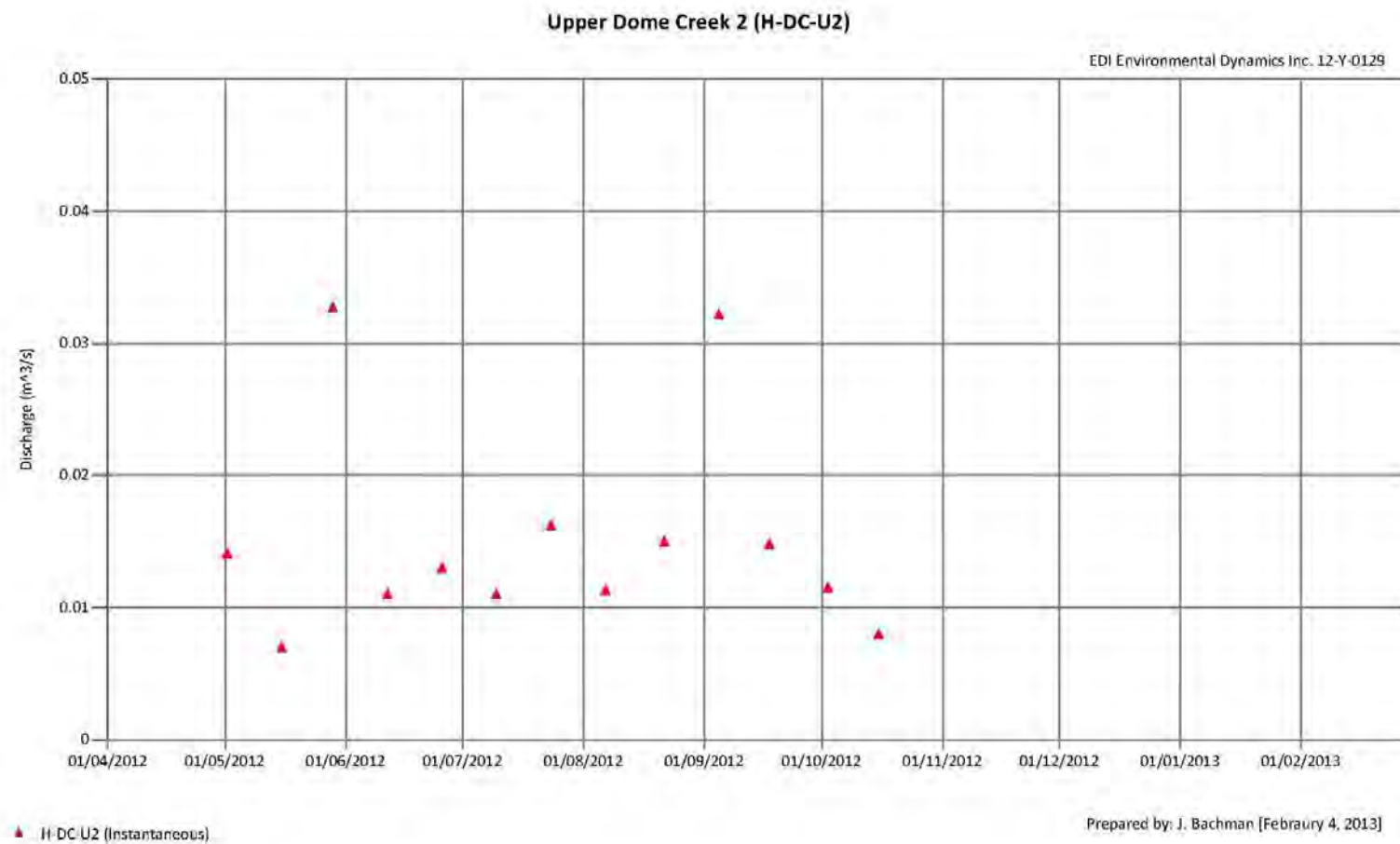


Figure B9. Upper Dome Creek 2 (H-DC-U2) hydrograph.

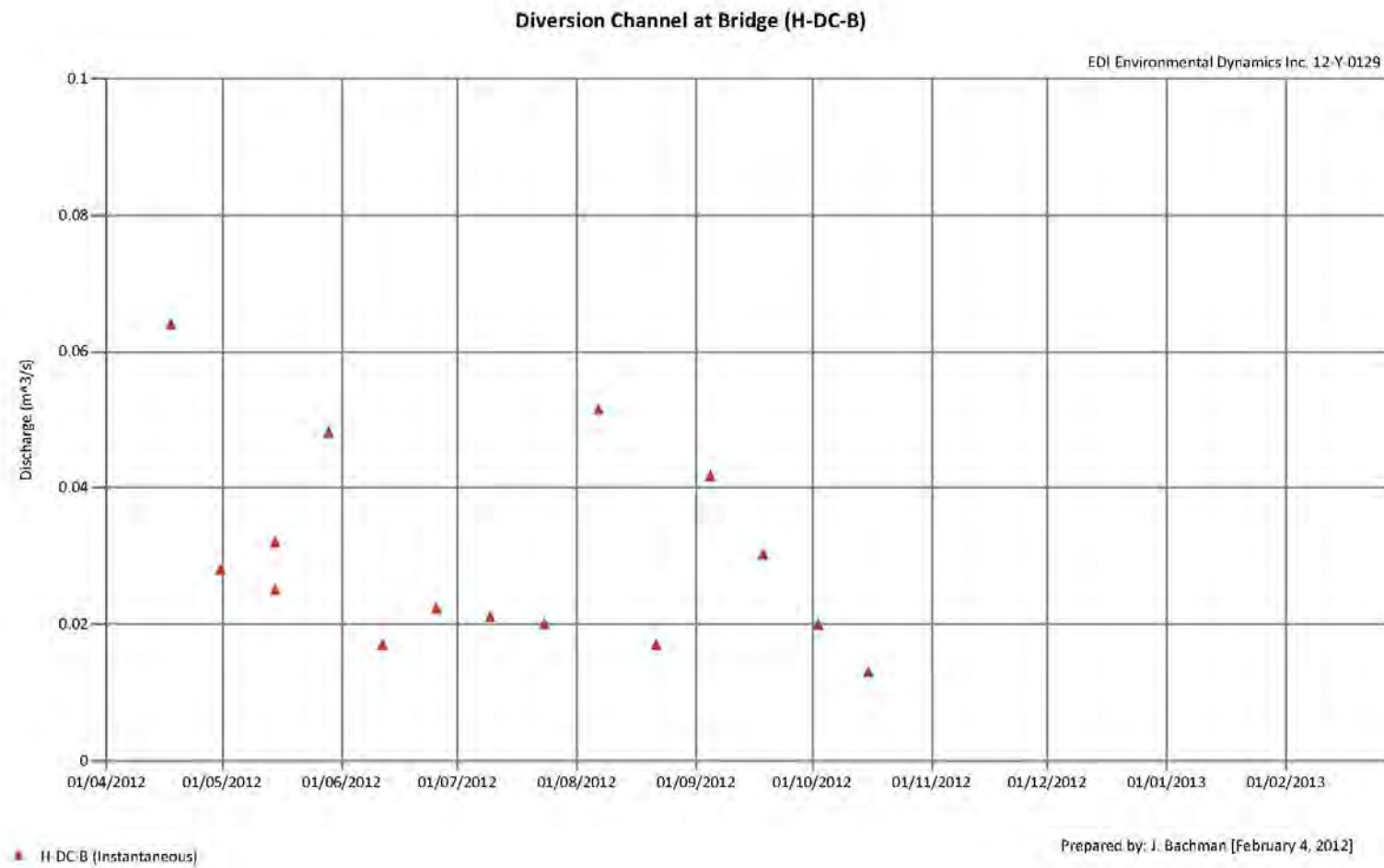


Figure B10. Upper Dome Creek 2 (H-DC-U2) stage.

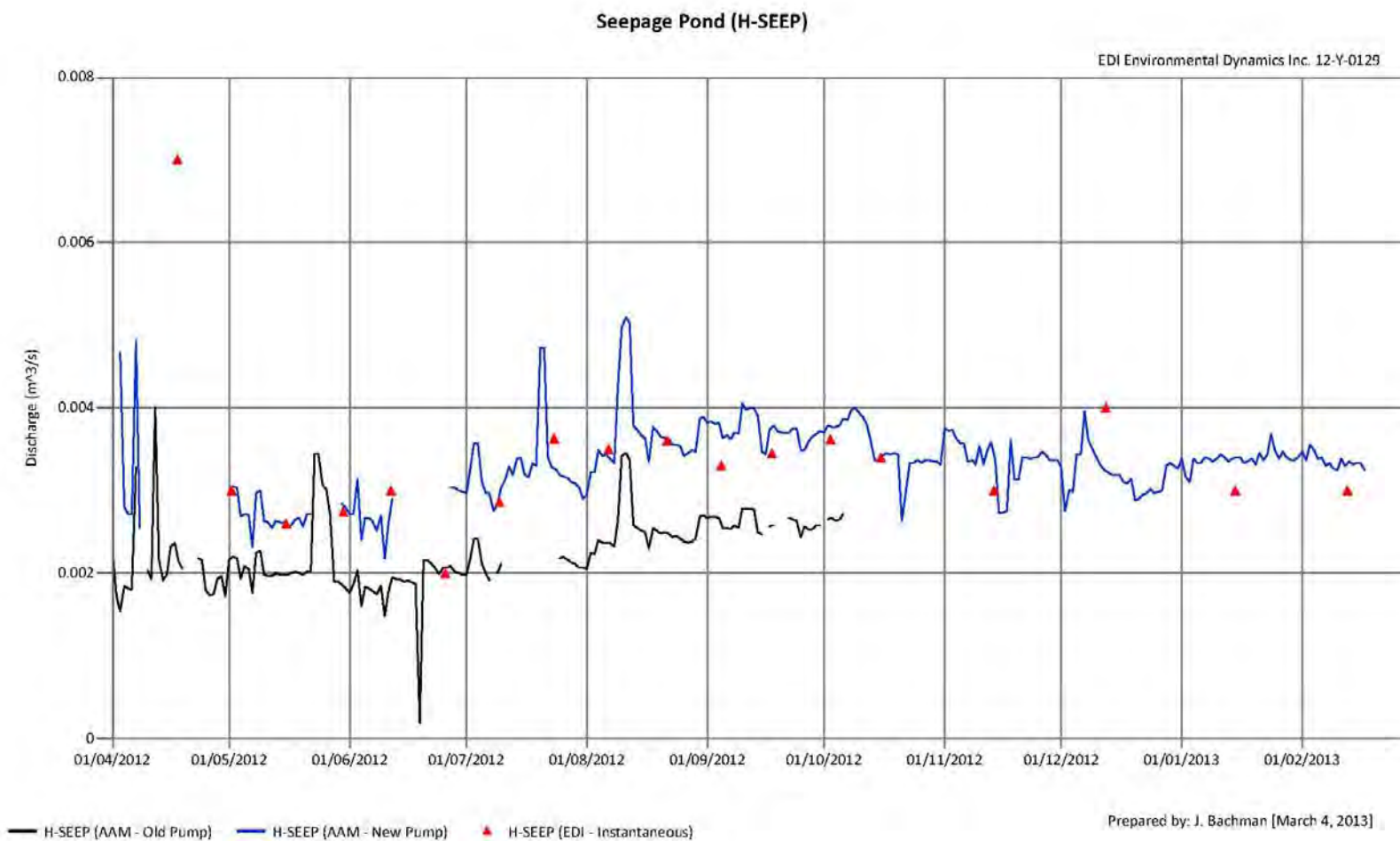


Figure B11. Seepage Pond (H-SEEP) hydrograph.

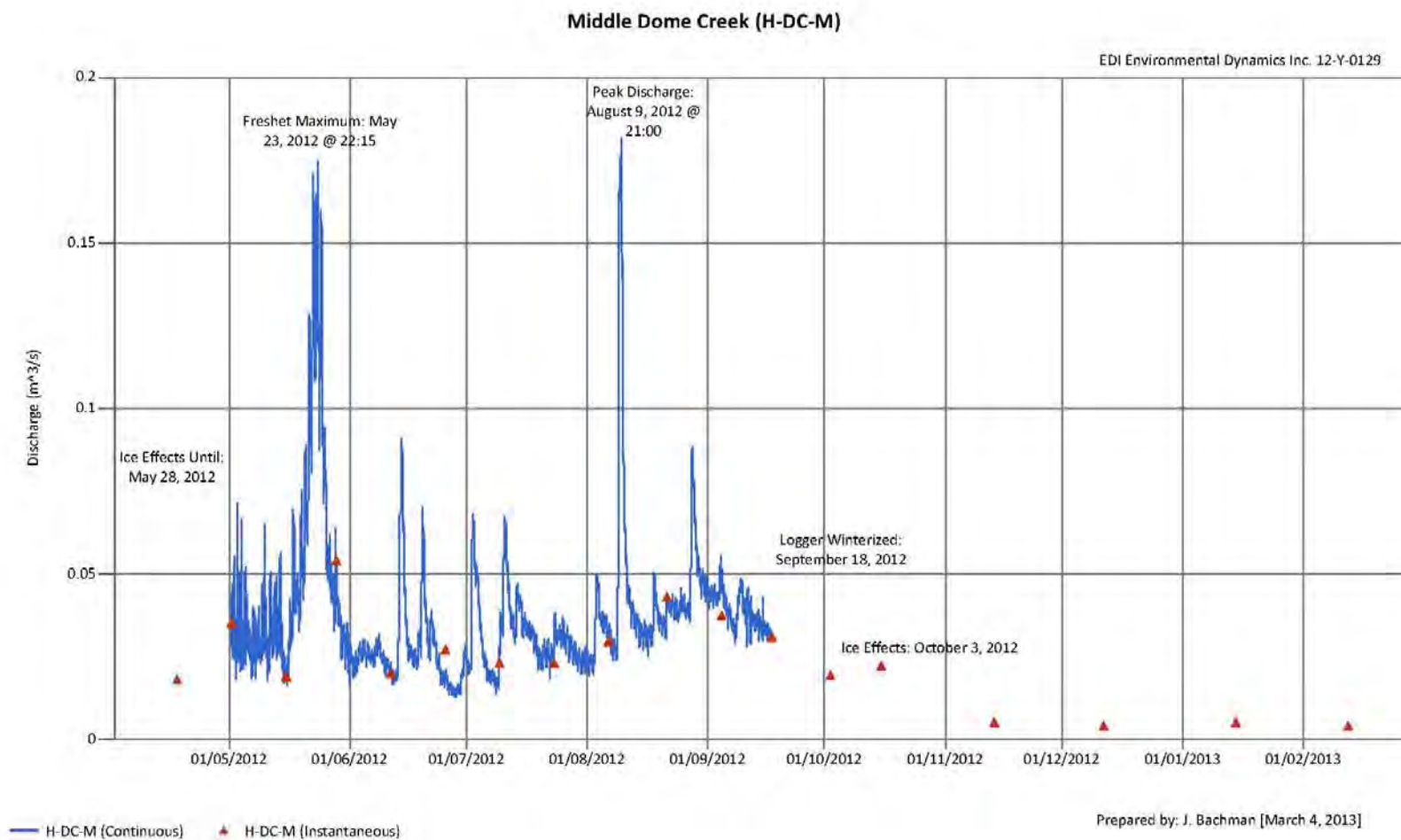


Figure B12. Middle Dome Creek (H-DC-M) hydrograph.

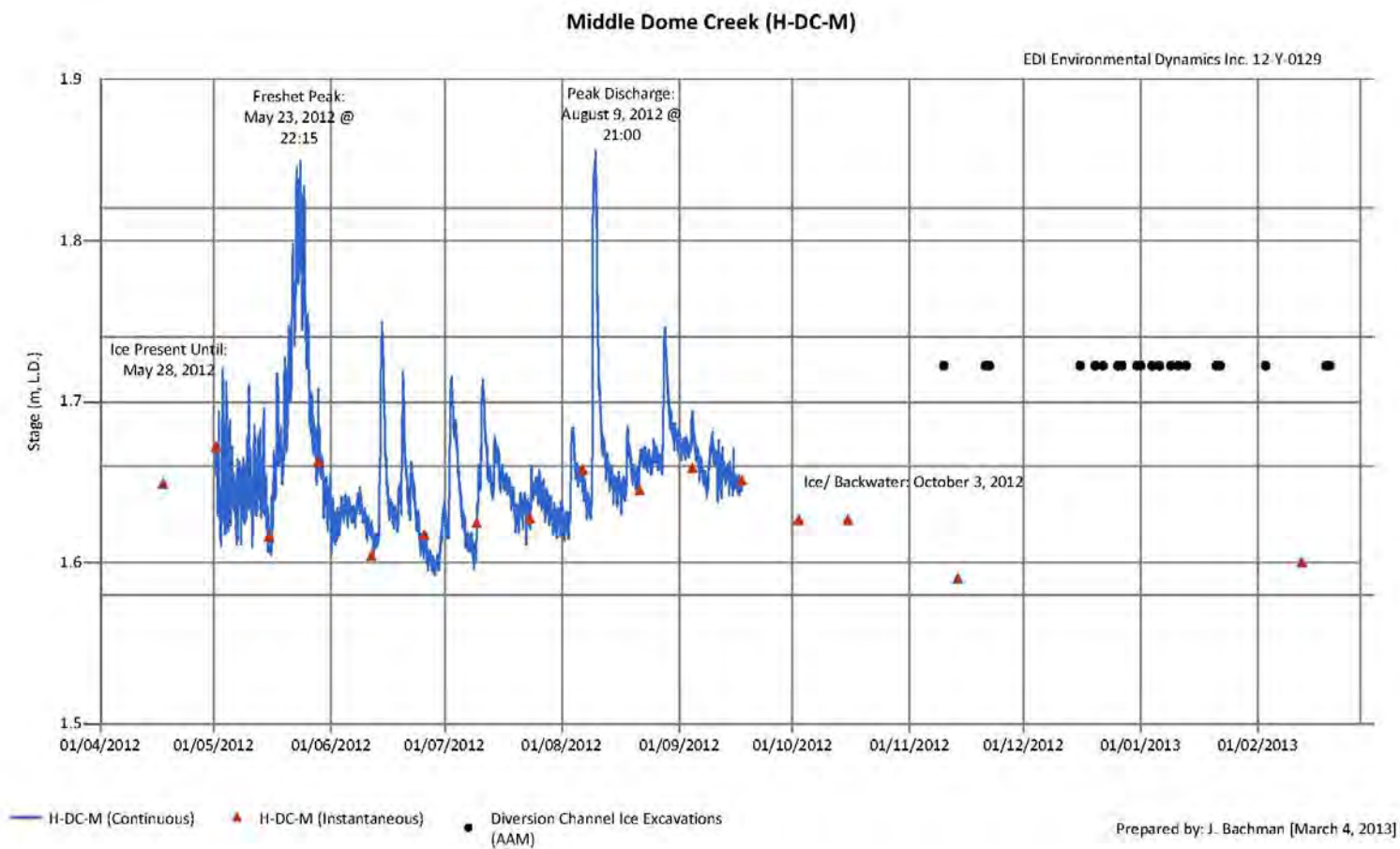


Figure B13. Middle Dome Creek (H-DC-M) stage.

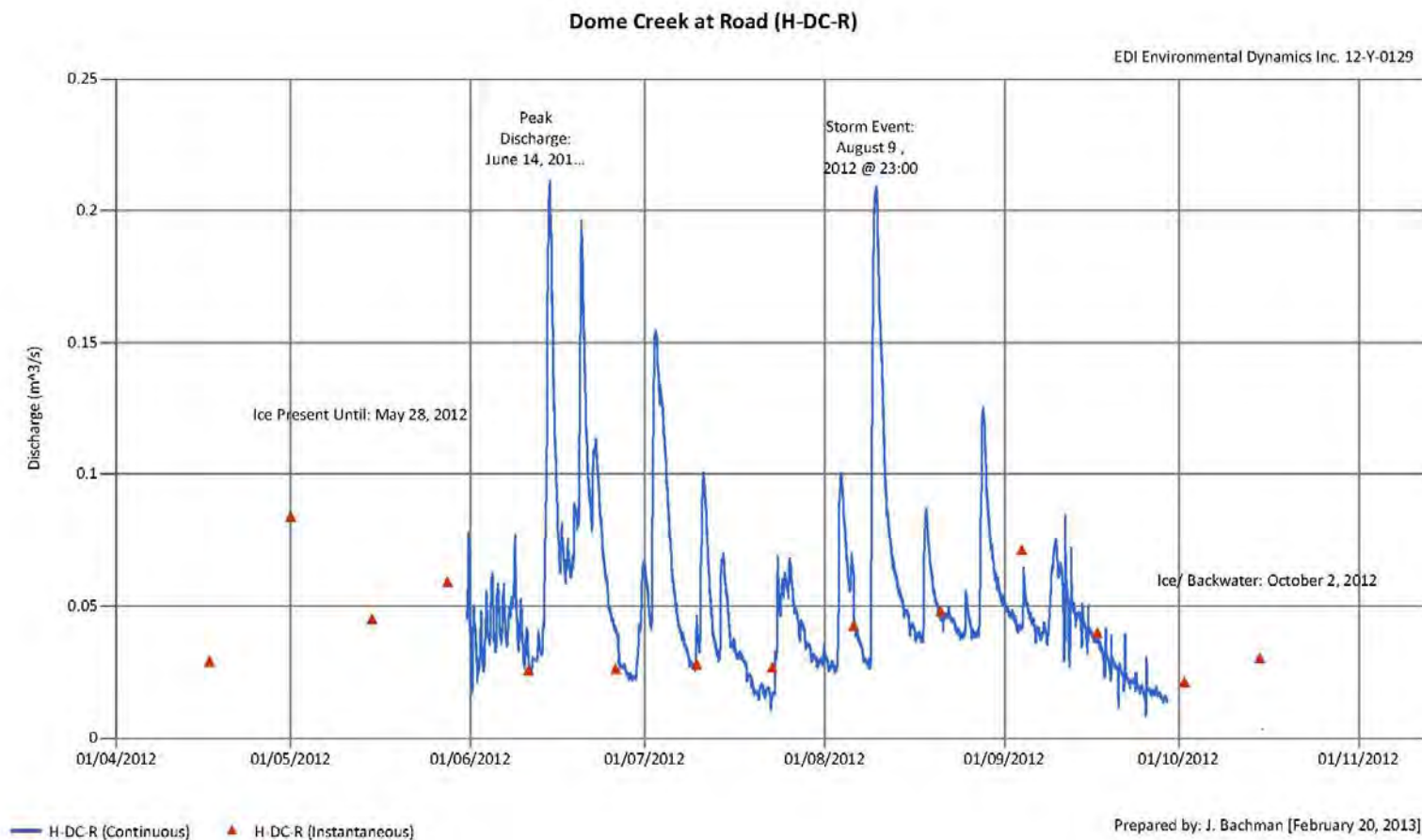


Figure B14. Dome Creek at Road (H-DC-R) hydrograph.

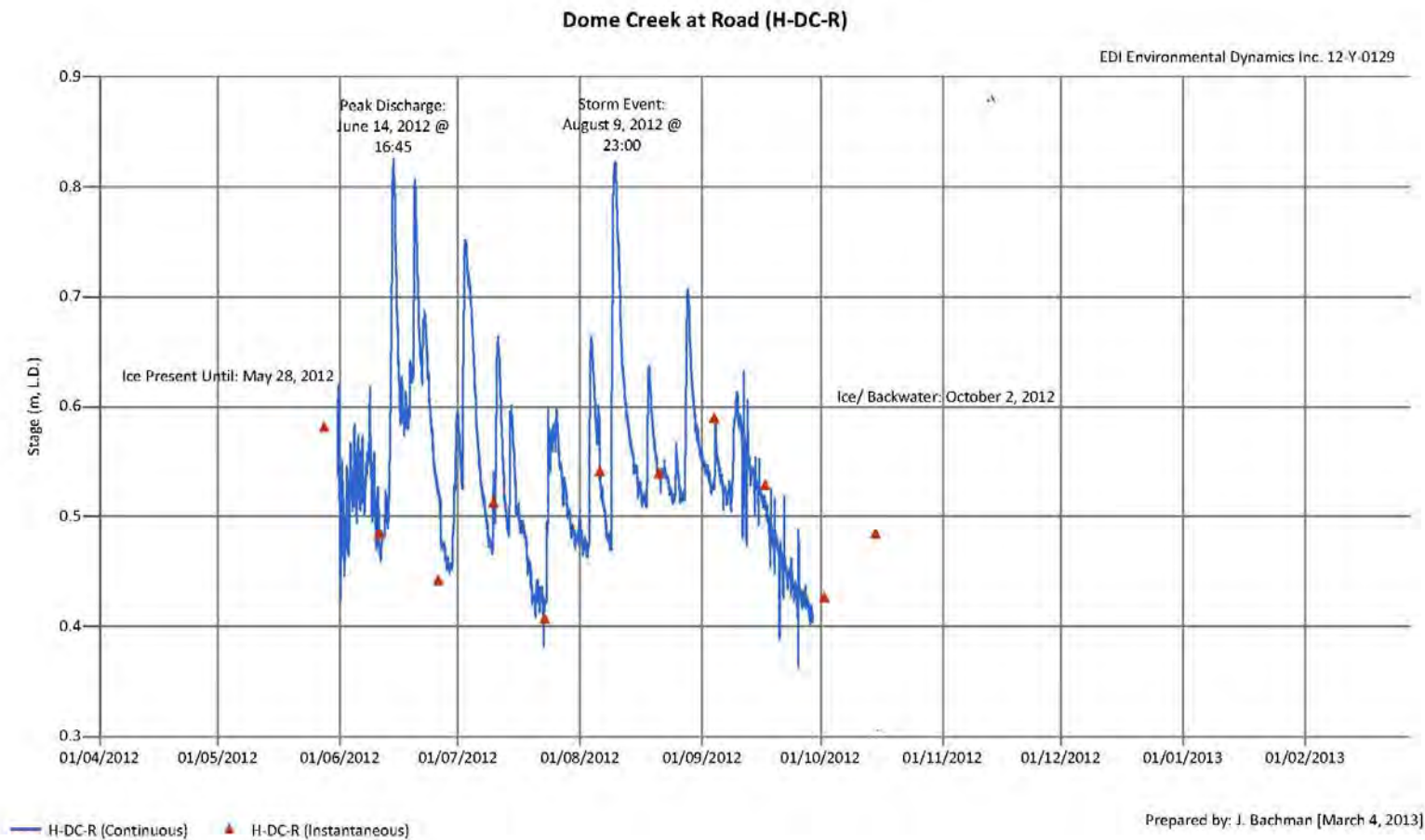


Figure B15. Dome Creek at Road (H-DC-R) stage.

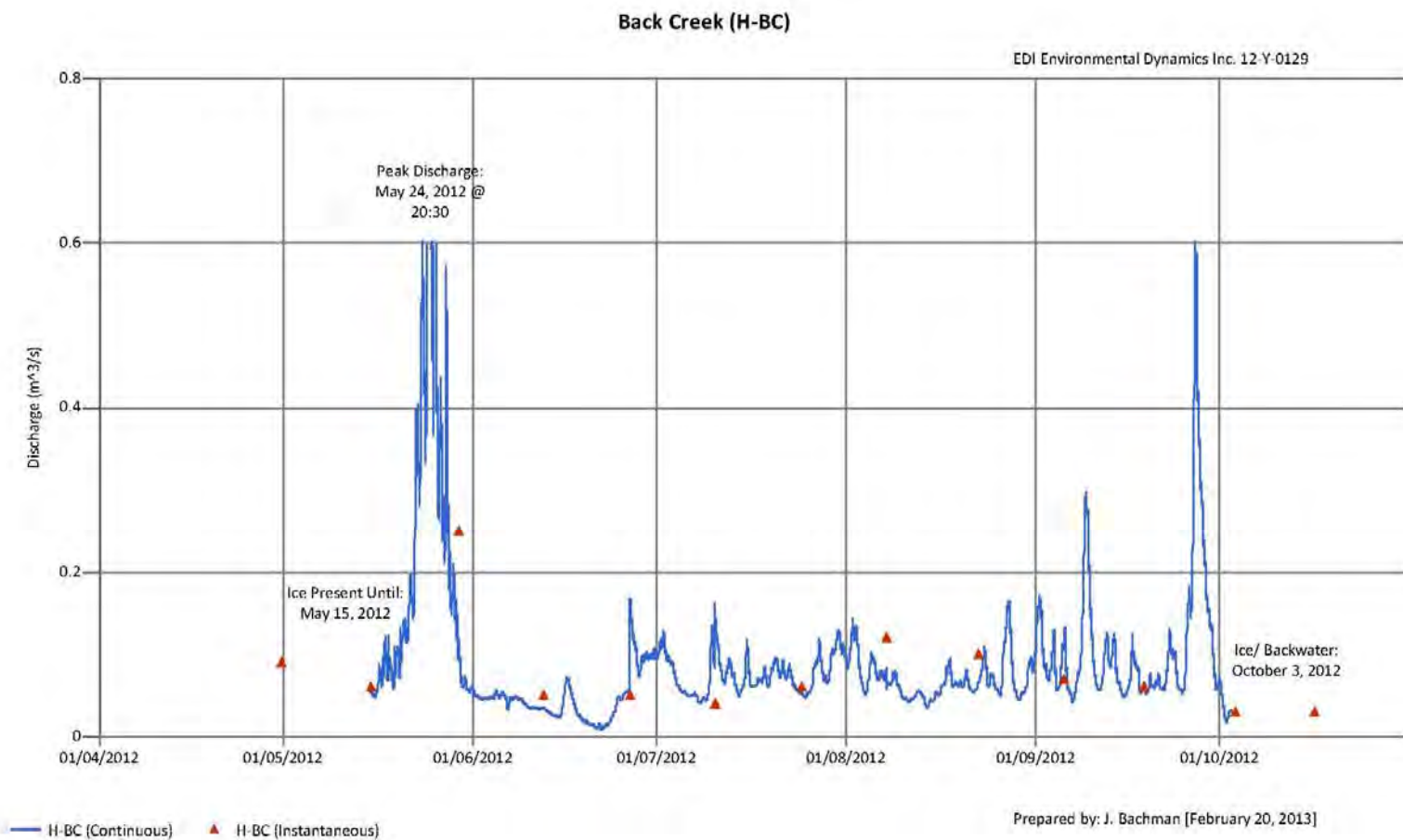


Figure B16. Back Creek (H-BC) hydrograph.

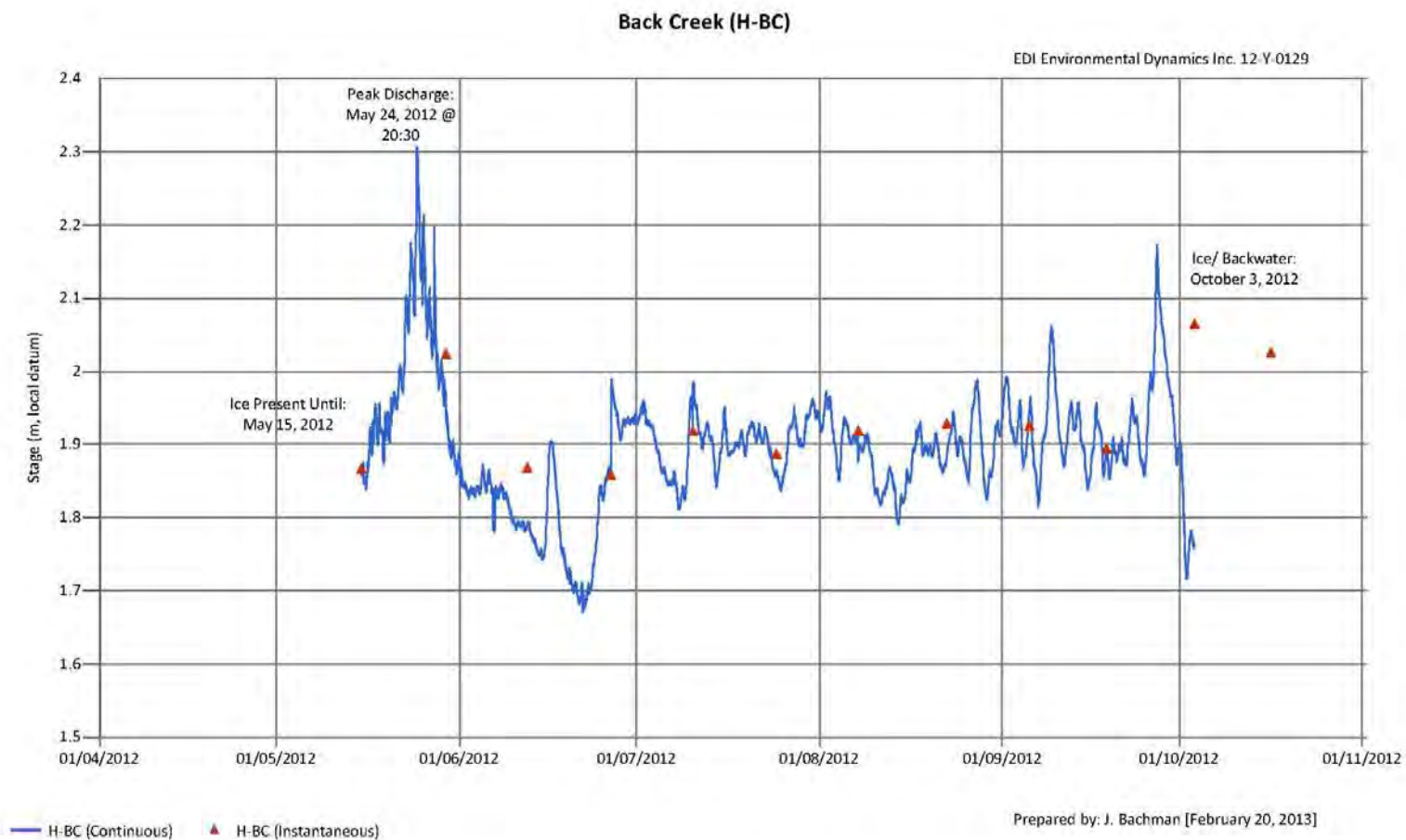


Figure B17. Back Creek (H-BC) stage.

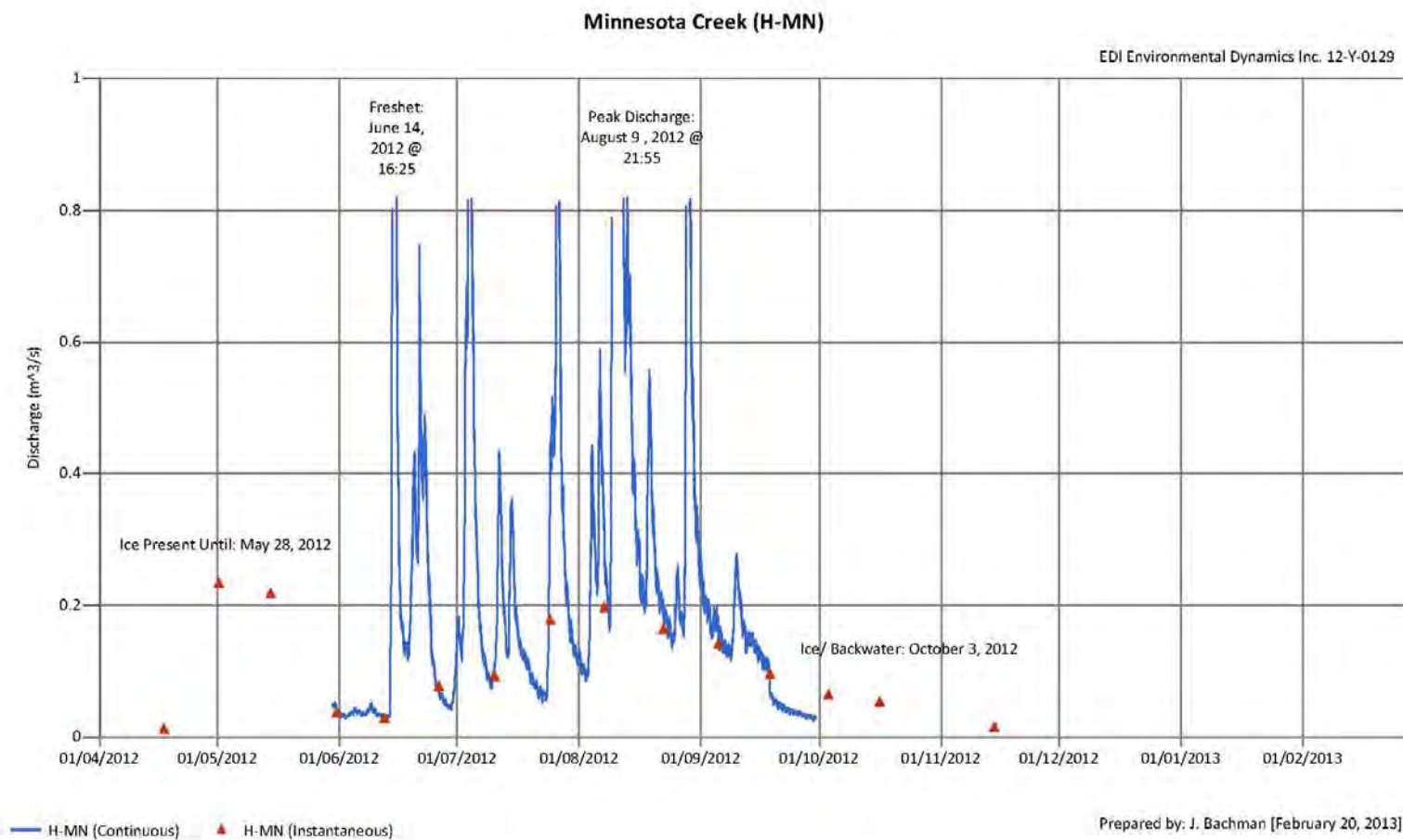


Figure B18. Minnesota Creek (H-MN) hydrograph.

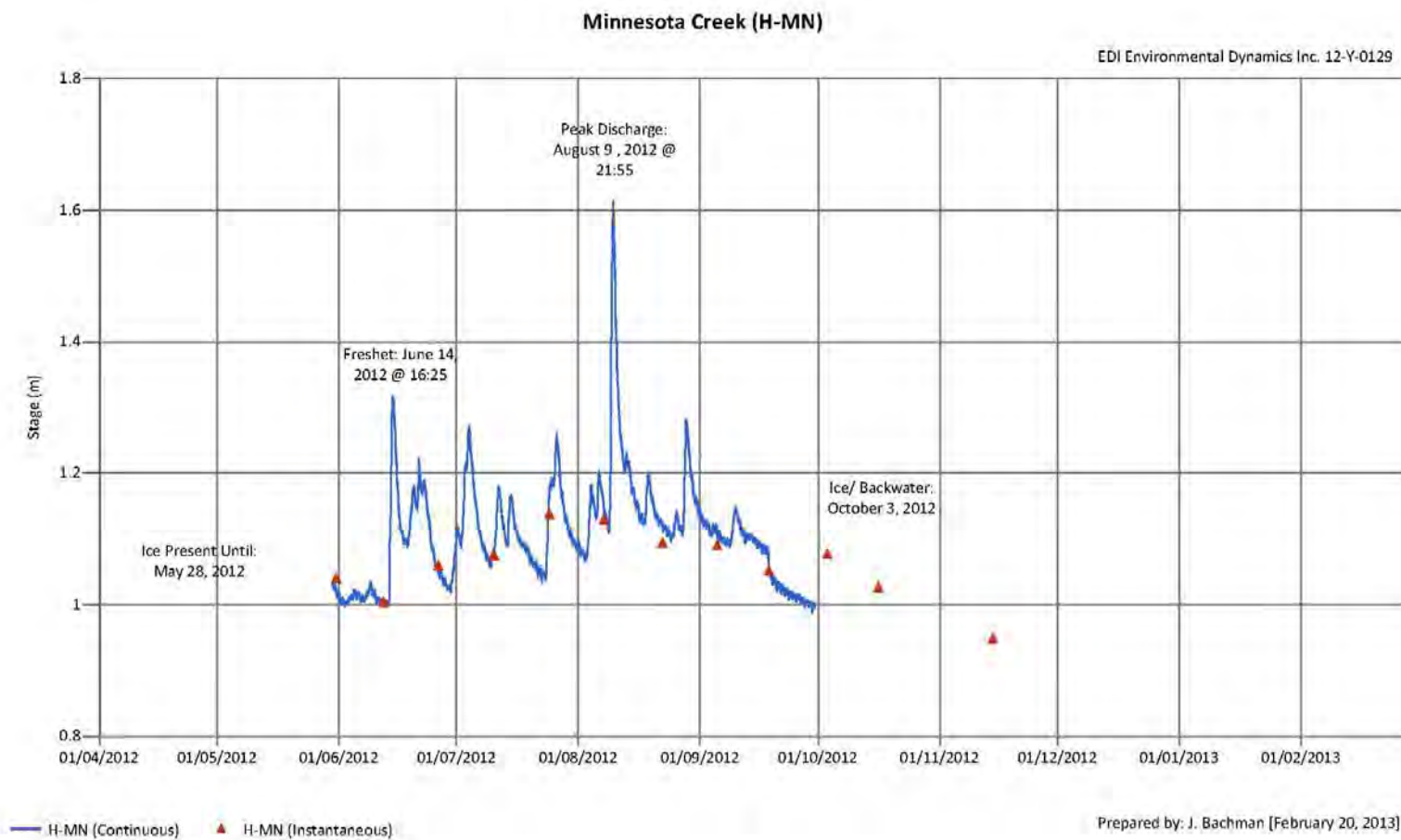


Figure B19. Minnesota Creek (H-MN) stage.

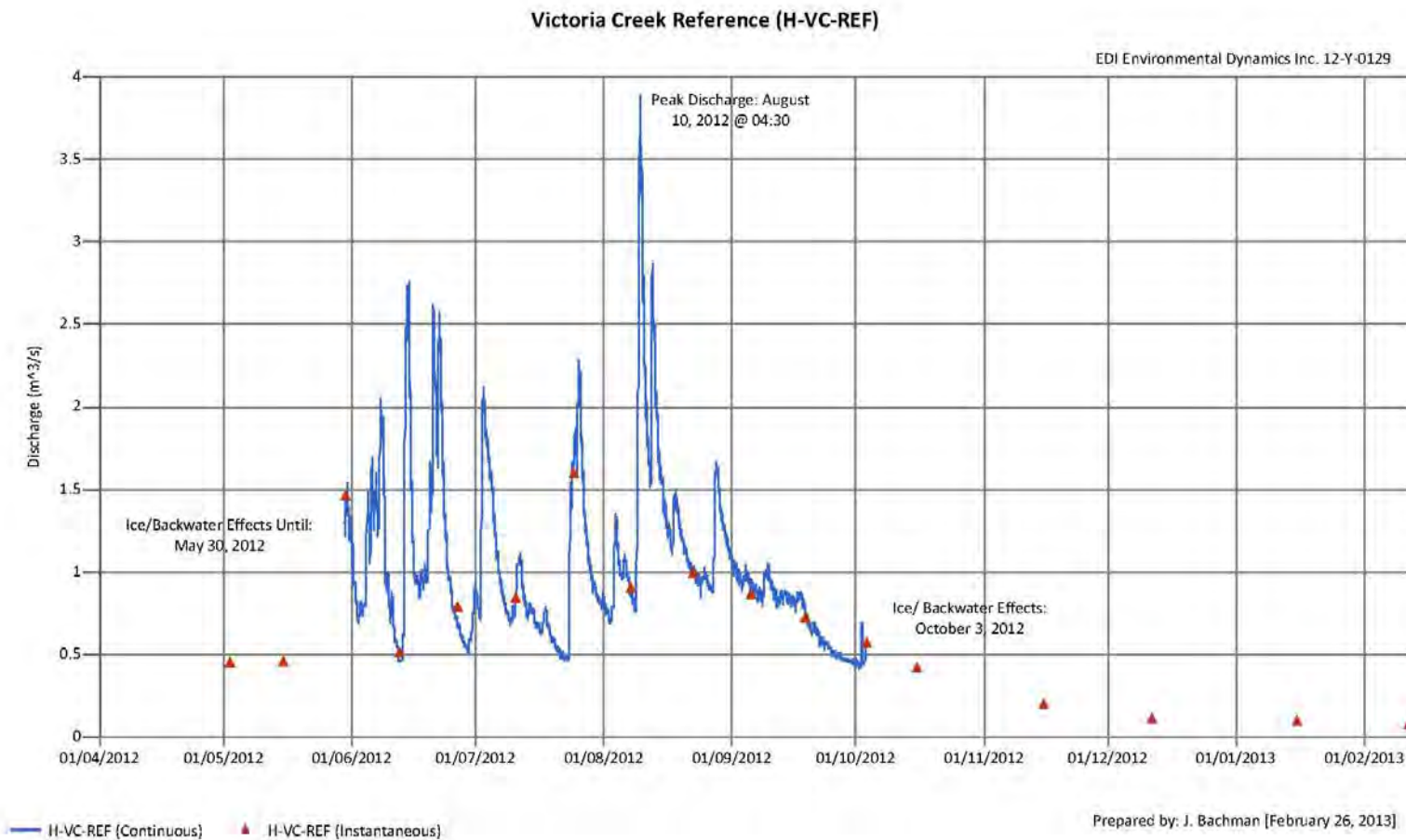


Figure B20. Victoria Reference (H-VC-REF) hydrograph.

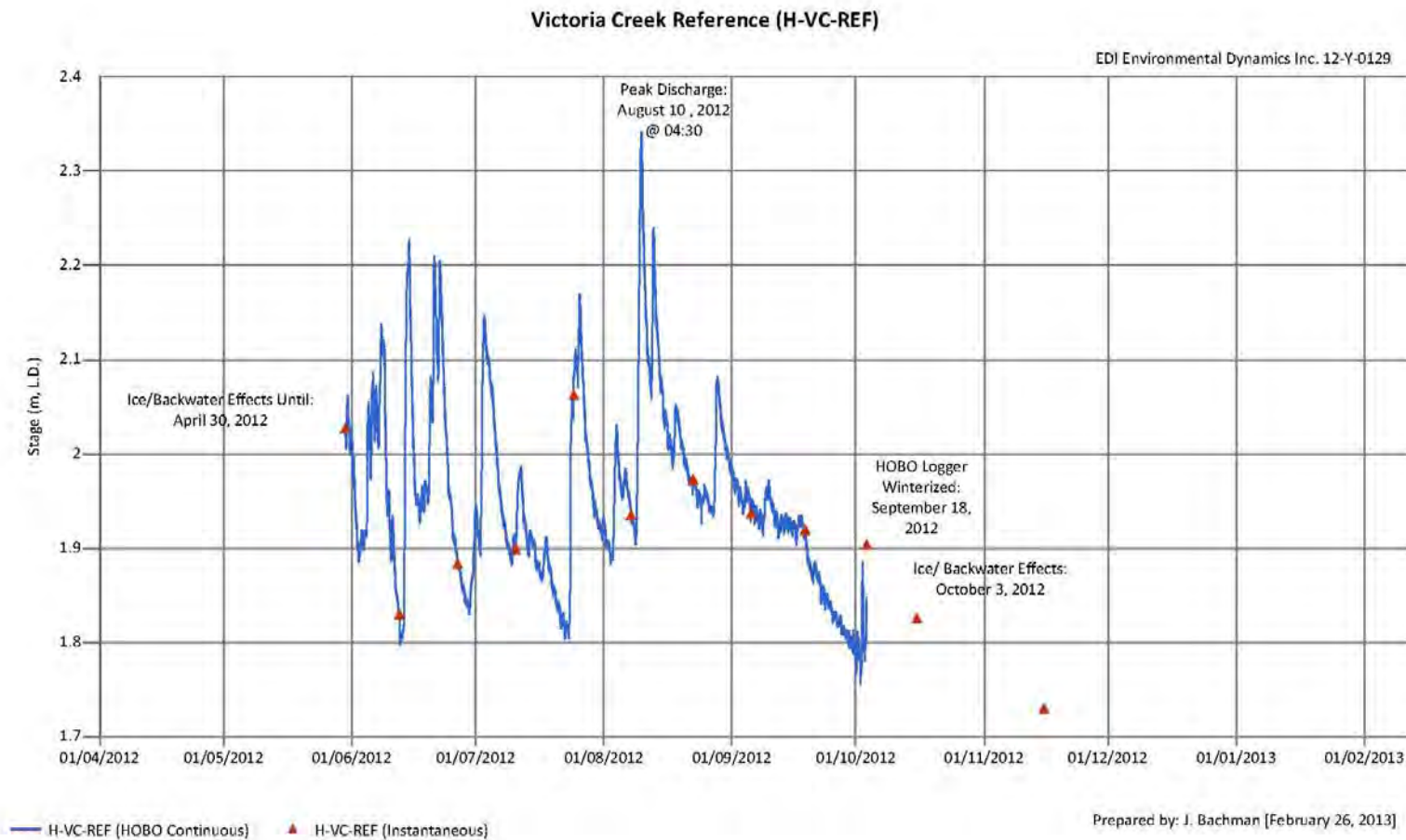


Figure B21. Victoria Reference (H-VC-REF) stage.

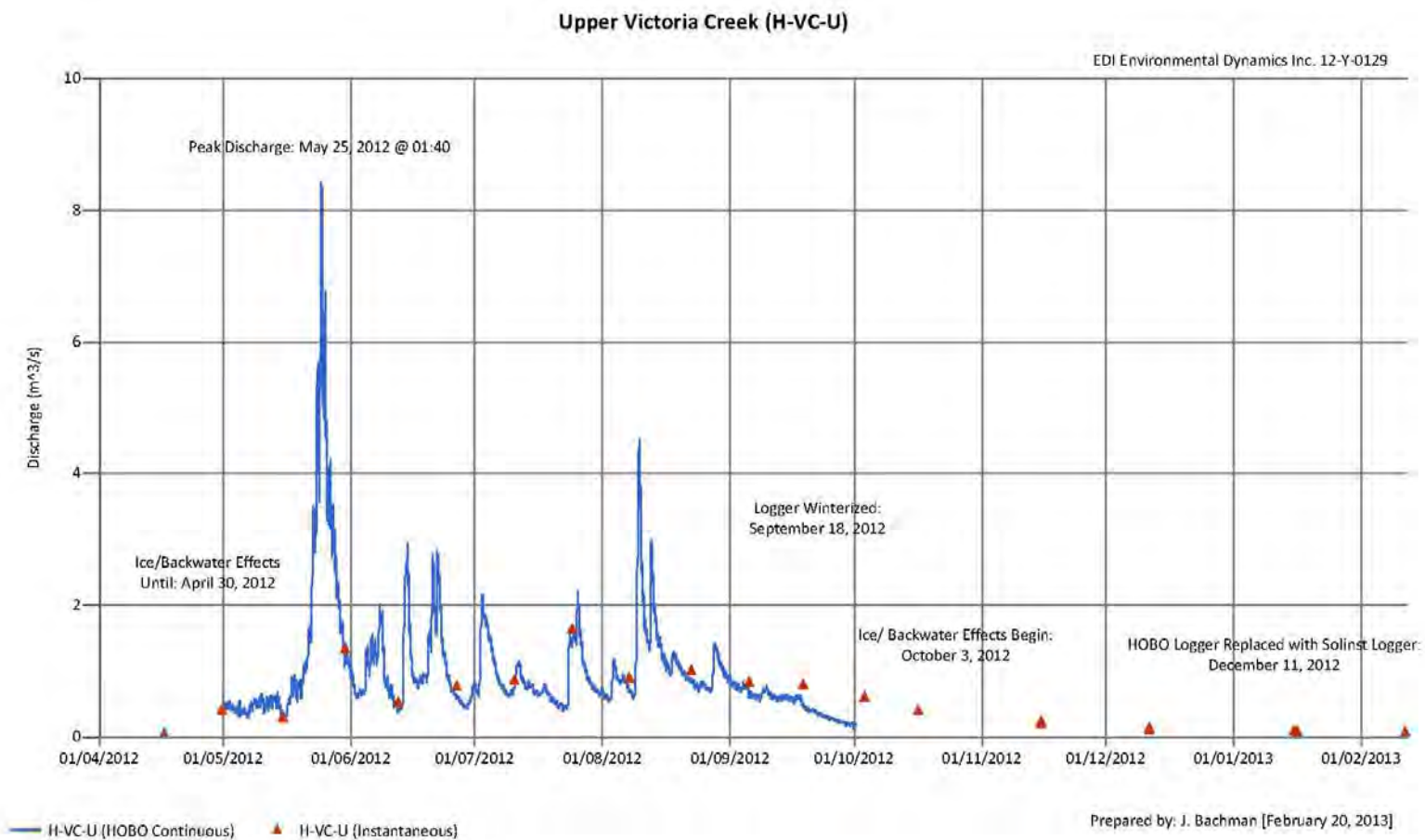


Figure B22. Upper Victoria Creek (H-VC-U) hydrograph.

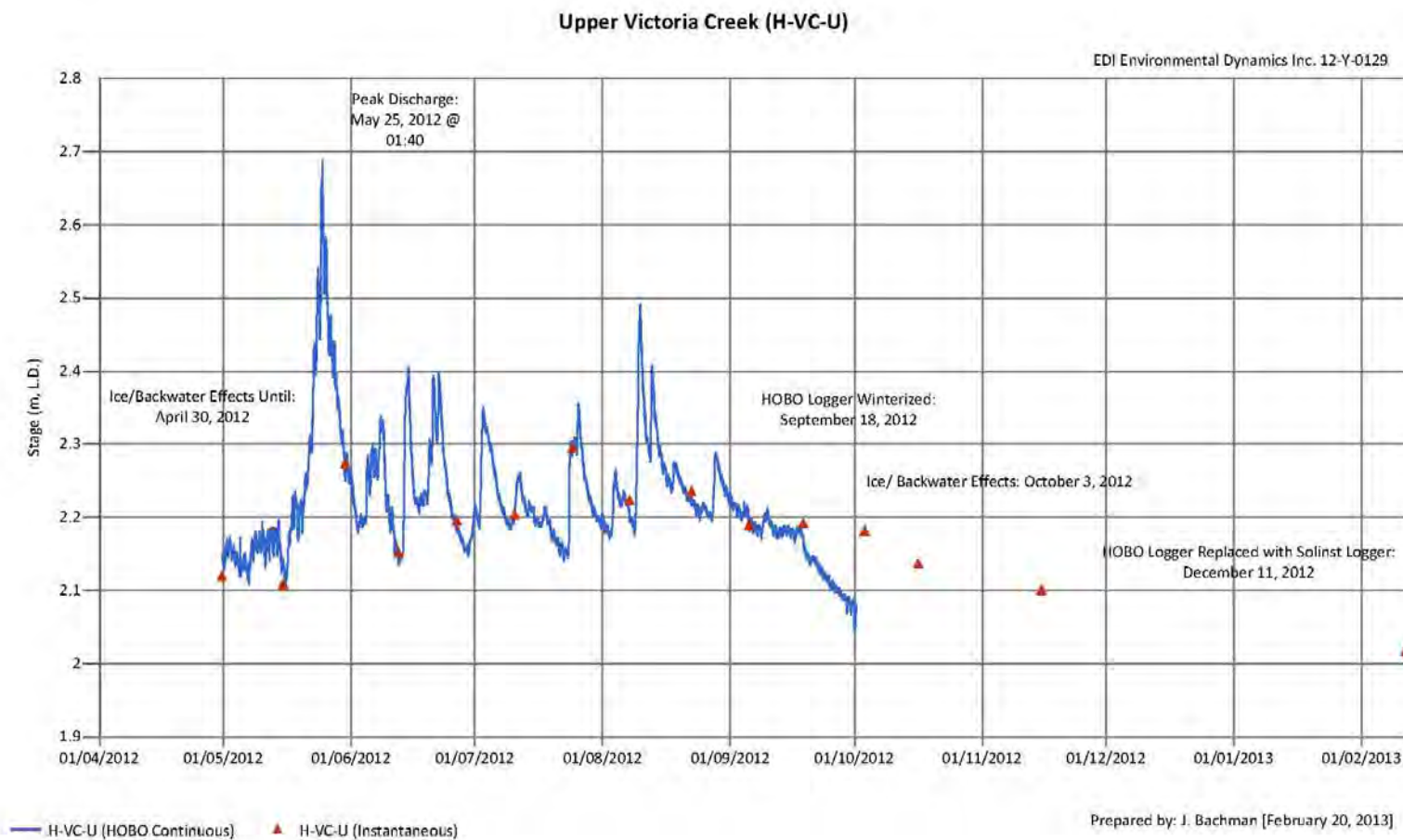


Figure B23. Upper Victoria Creek (H-VC-U) stage.

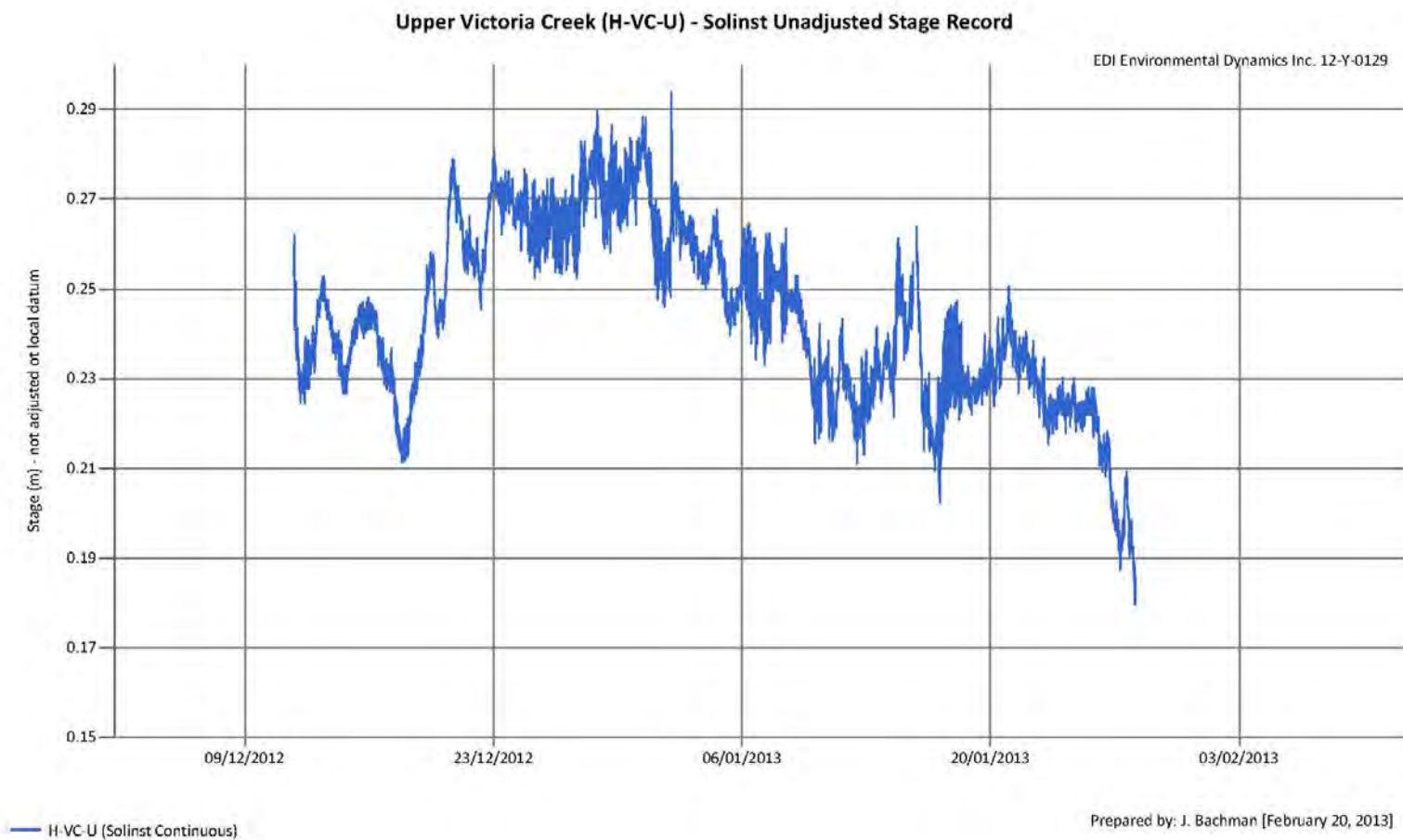


Figure B24. Upper Victoria Creek (H-VC-U) stage; Solinst unadjusted stage record.

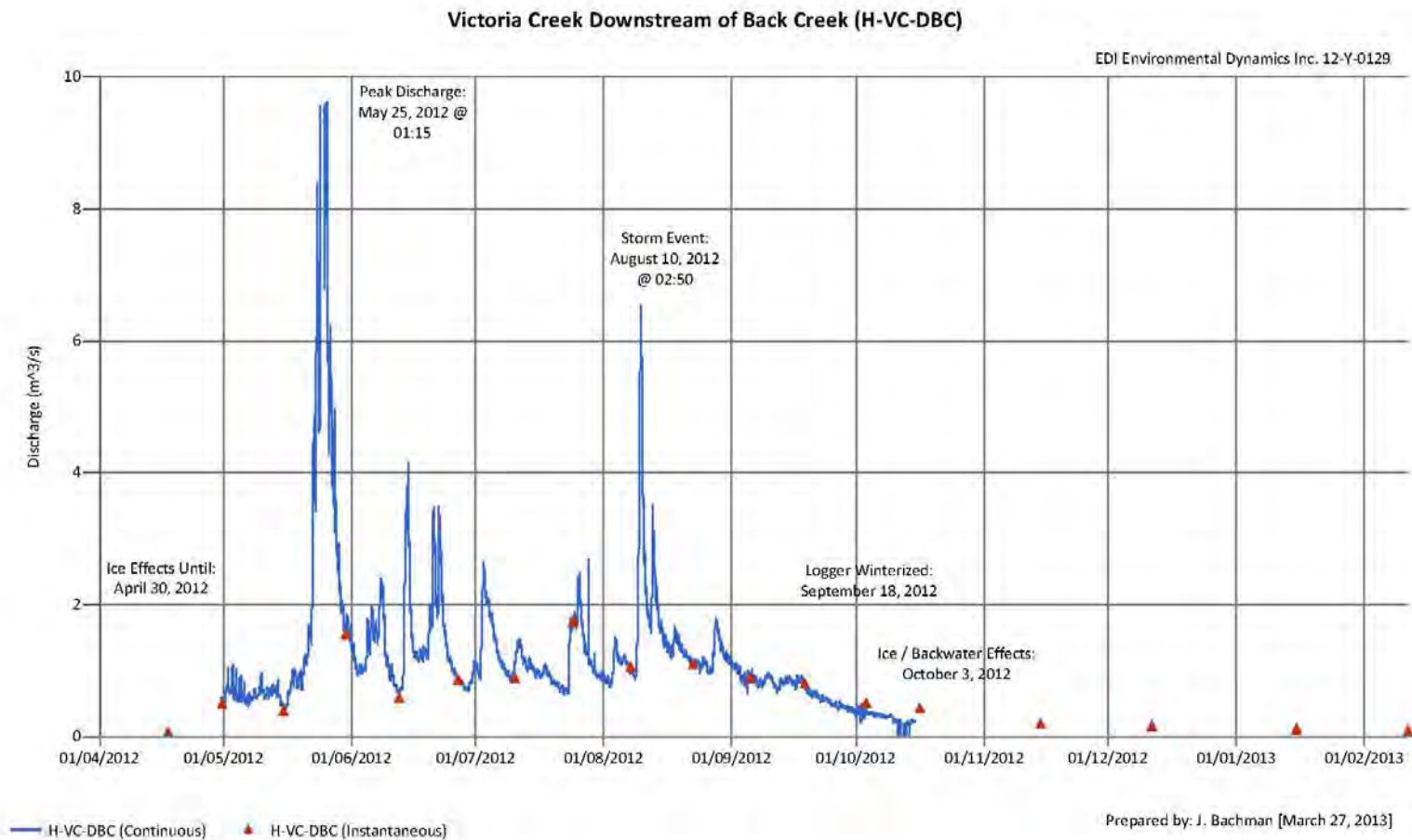


Figure B25. Victoria Creek Downstream of Back Creek (H-VC-DBC) hydrograph.

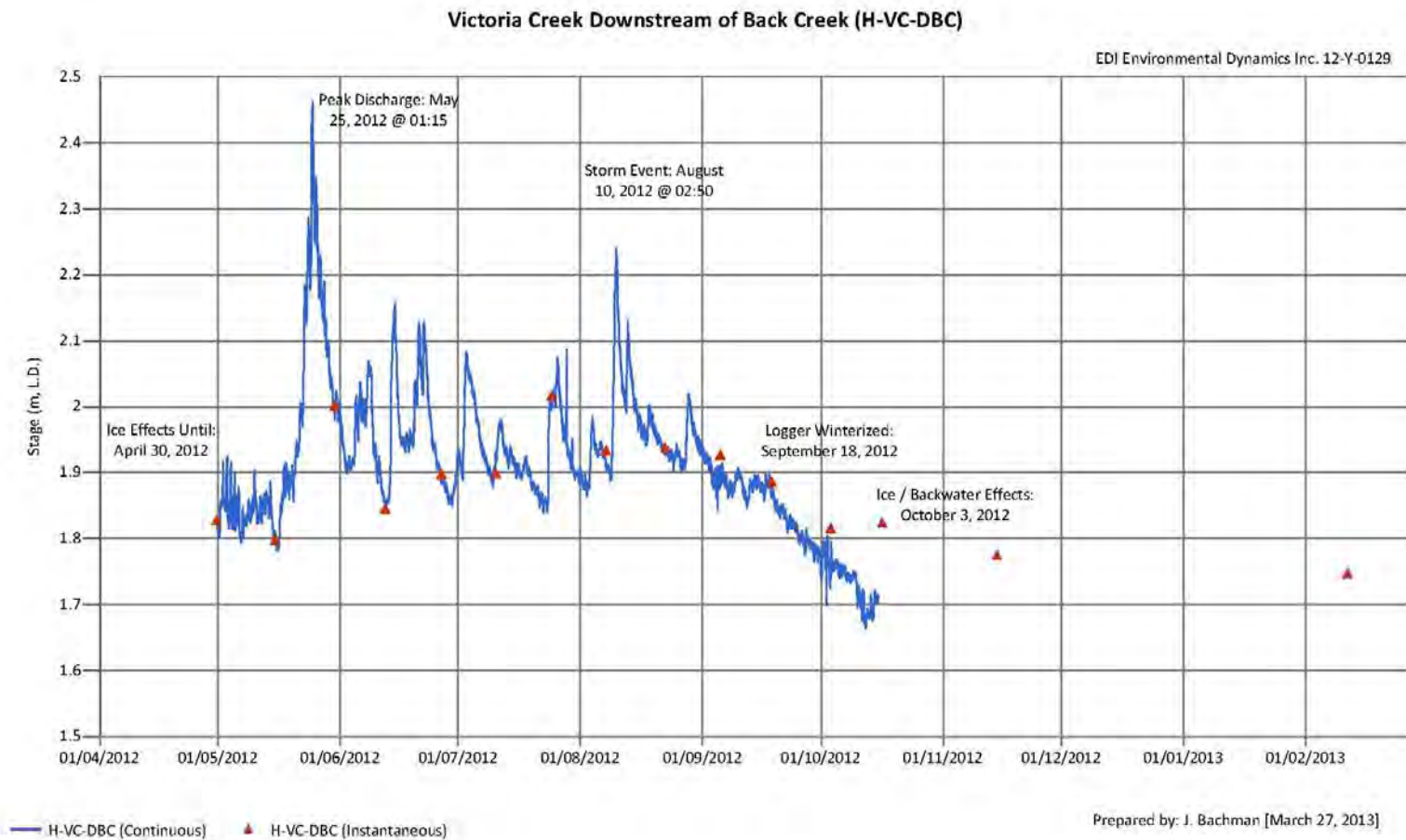


Figure B26. Victoria Creek Downstream of Back Creek (H-VC-DBC) stage.

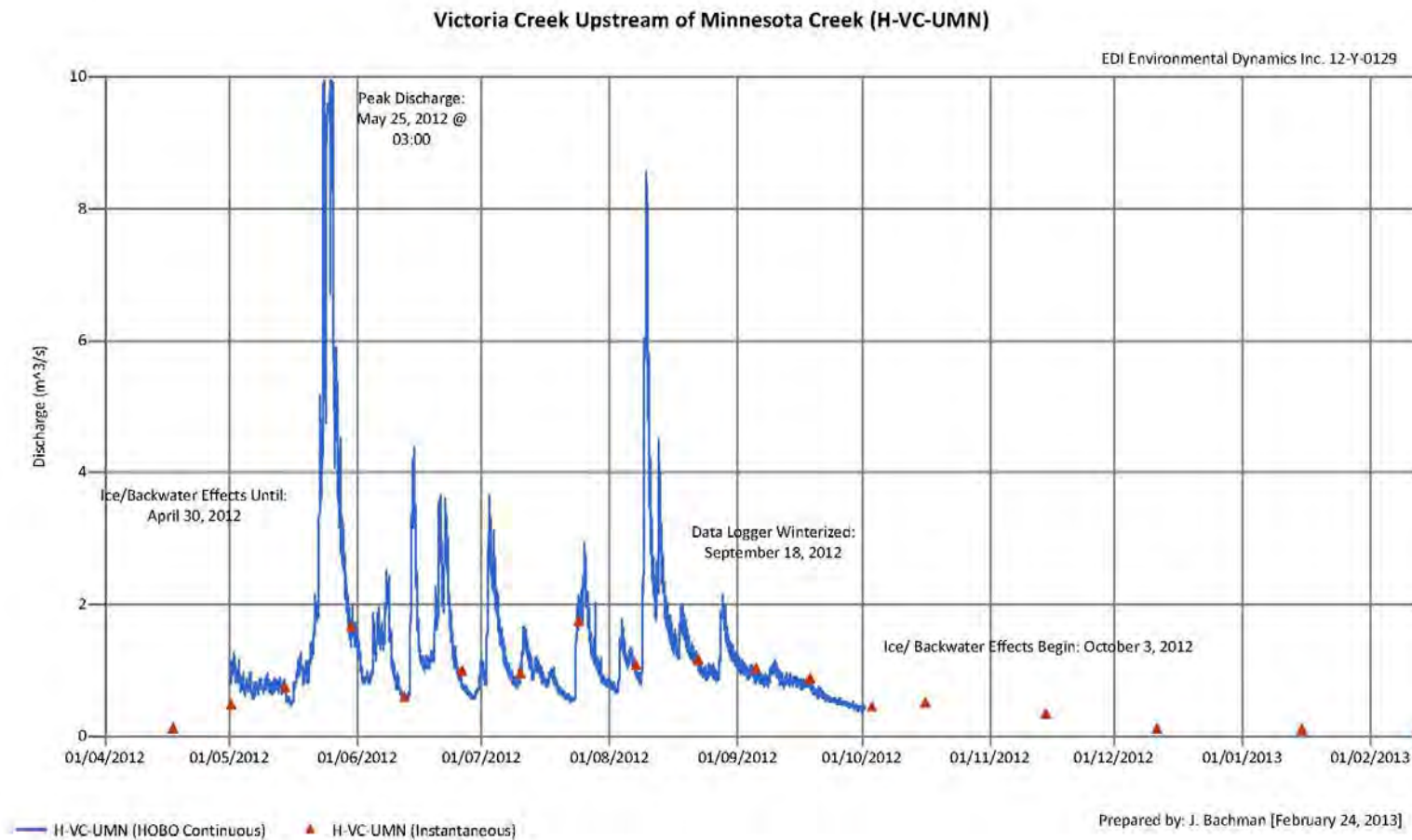


Figure B27. Victoria Creek Upstream of Minnesota Creek (H-VC-UMN) hydrograph.

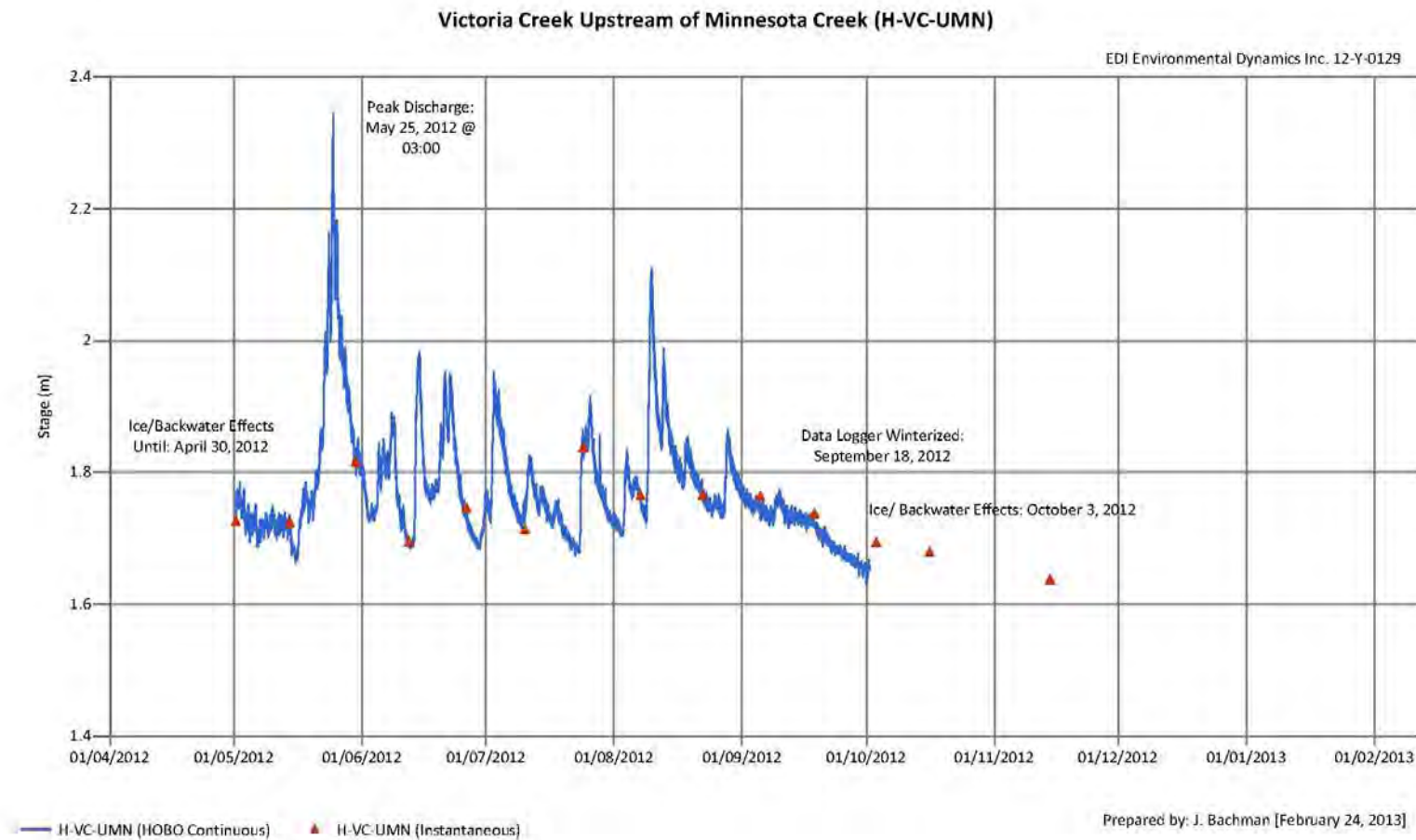


Figure B28. Victoria Creek Upstream of Minnesota Creek (H-VC-UMN) stage.

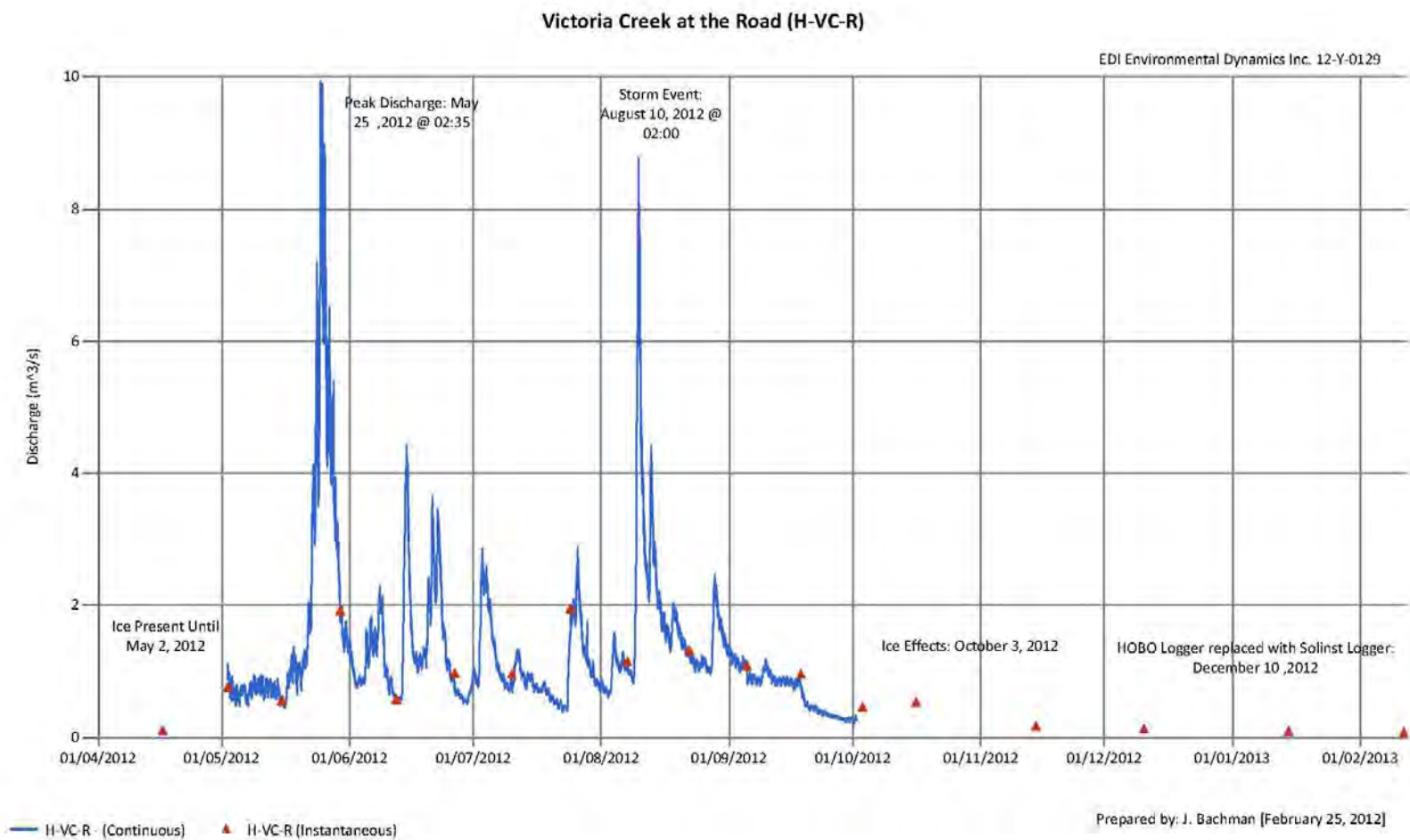


Figure B29. Victoria Creek at Road (H-VC-R) hydrograph.

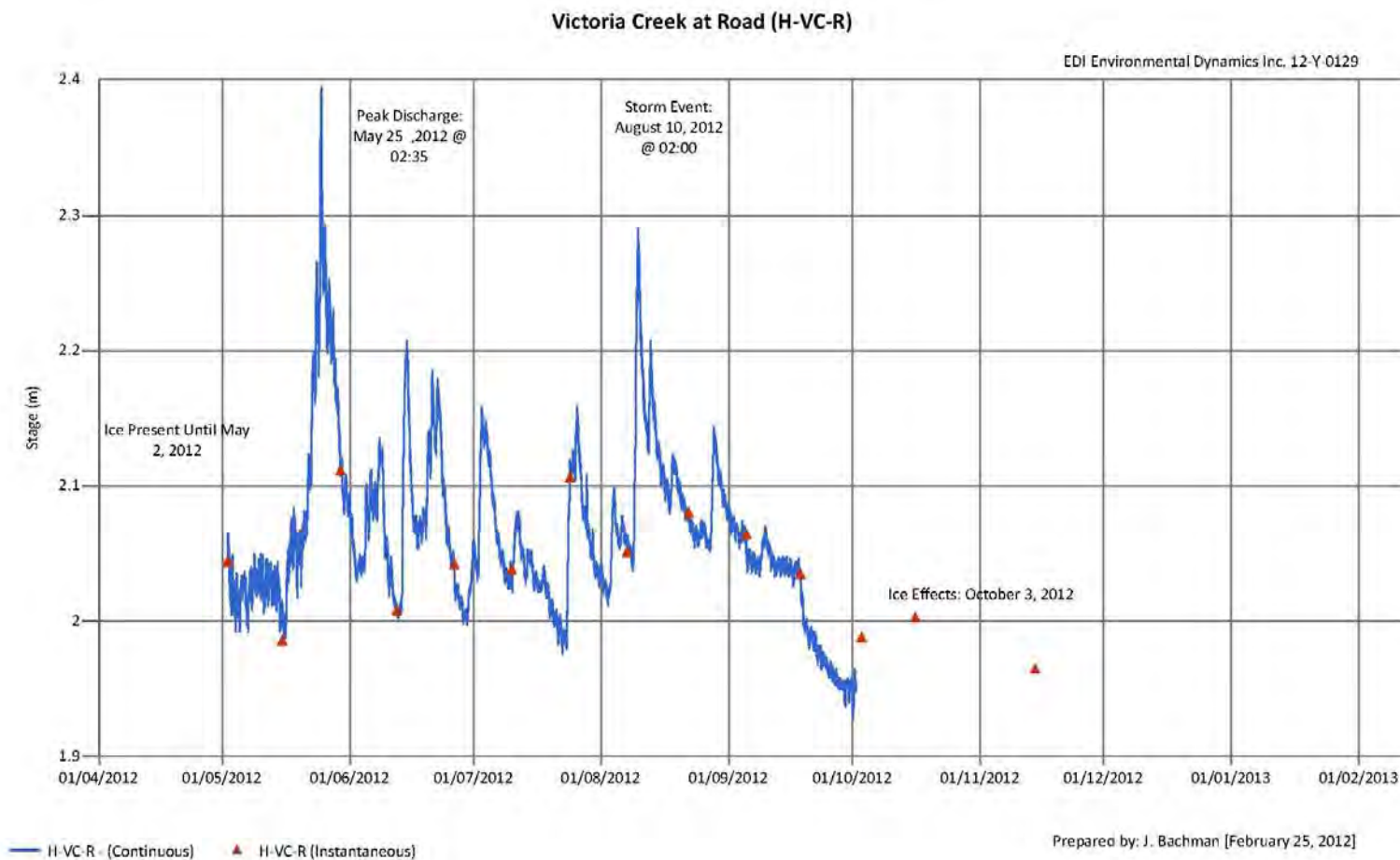


Figure B30. Victoria Creek at Road (H-VC-R) stage.

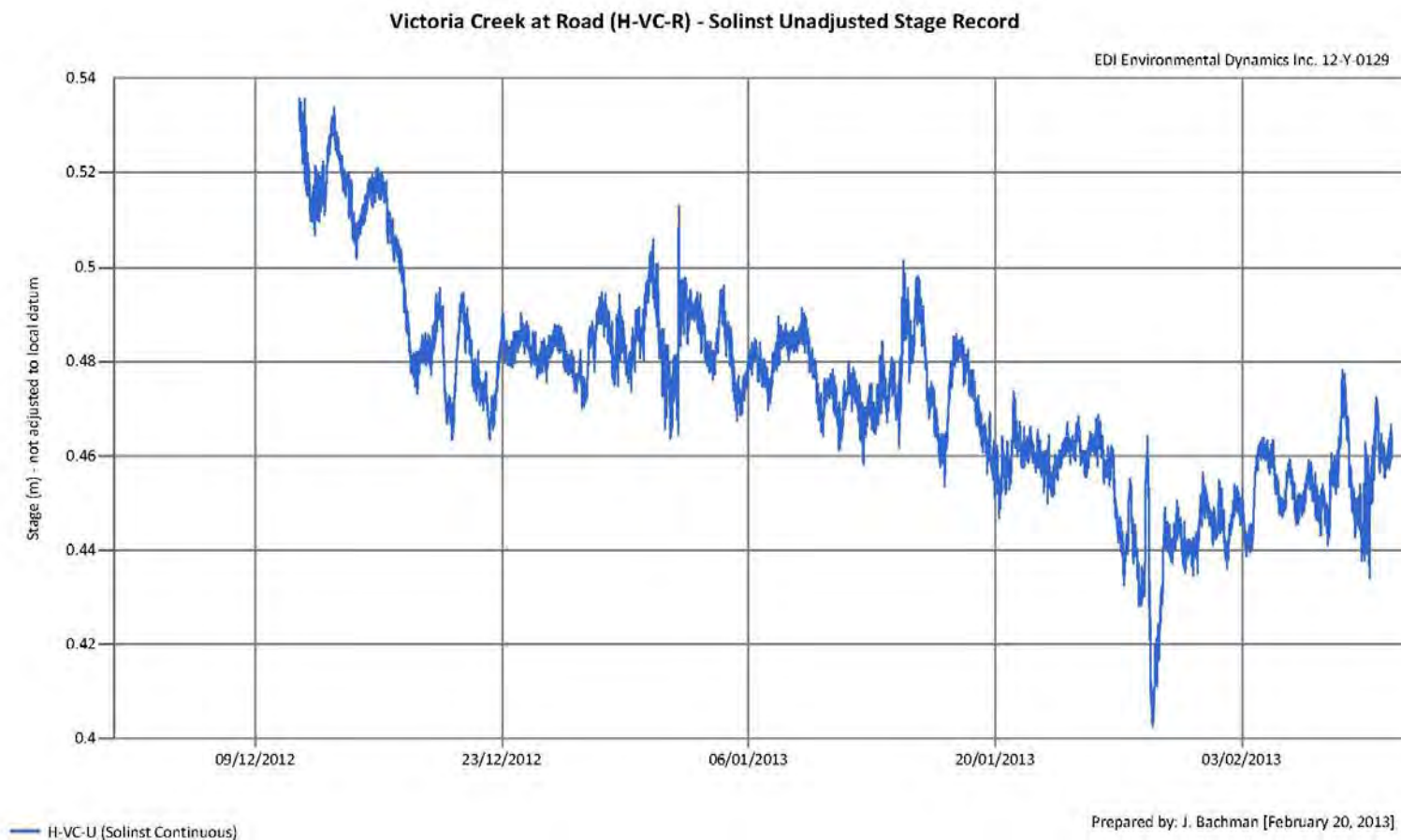


Figure B31. Victoria Creek at Road (H-VC-R) stage; Solinst Unadjusted Stage Record.



APPENDIX C SURFACE WATER QUALITY DATA



Table C1. Record of surface water quality samples collected in 2012/13.

Water Quality Site ID	Sample Date	EDI Identifier	LT50 (Y/N)	QA/QC site
WQ-DC-D1	18/04/2012	0129-120418-001	NO	NO
WQ-MS	18/04/2012	0129-120418-002	NO	NO
WQ-SEEP	18/04/2012	0129-120418-003	YES	NO
WQ-DC-U	18/04/2012	0129-120418-005	NO	NO
WQ-DC-DX+105	18/04/2012	0129-120418-006	NO	NO
WQ-VC-U	18/04/2012	0129-120418-007	NO	NO
WQ-VC-UMN	18/04/2012	0129-120418-008	NO	NO
WQ-MN	18/04/2012	0129-120418-009	NO	NO
WQ-VC-R	18/04/2012	0129-120418-010	NO	NO
WQ-DC-R	18/04/2012	0129-120418-012	NO	NO
WQ-PW	18/04/2012	0129-120418-020	NO	NO
WQ-BC	18/04/2012	0129-120418-022	NO	NO
WQ-VC-DBC	18/04/2012	0129-120418-023	NO	NO
Trip Blank	18/04/2012	0129-120418-014	NO	YES
Field Blank	18/04/2012	0129-120418-018	NO	YES
WQ-VC-R	02/05/2012	0129-120502-015	NO	NO
WQ-MN	02/05/2012	0129-120502-016	NO	NO
WQ-VC-UMN	02/05/2012	0129-120502-021	NO	NO
WQ-PW	02/05/2012	0129-120502-001	NO	NO
WQ-DC-D1	02/05/2012	0129-120502-007	NO	NO
WQ-DC-DX+105	02/05/2012	0129-120502-011	NO	NO
WQ-SEEP	02/05/2012	0129-120502-009	YES	NO
WQ-DC-U	02/05/2012	0129-120502-010	NO	NO
WQ-DC-DX	02/05/2012	0129-120502-013	NO	NO
WQ-DC-R	02/05/2012	0129-120502-006	NO	NO
WQ-PC-D	02/05/2012	0129-120502-020	NO	NO
WQ-PC-U	02/05/2012	0129-120502-003	NO	NO
WQ-VC-U	02/05/2012	0129-120502-017	NO	NO
WQ-VC-DBC	02/05/2012	0129-120502-018	NO	NO
WQ-BC	02/05/2012	0129-120502-004	NO	NO
WQ-VC-REF	02/05/2012	0129-120502-005	NO	NO
Trip Blank	02/05/2012	0129-120502-019	NO	YES
WQ-PC-U-r	02/05/2012	0129-120502-008	NO	YES
Field Blank	02/05/2012	0129-120502-002	NO	YES
WQ-SEEP-r	02/05/2012	0129-120502-014	NO	YES
WQ-SEEP-r	18/04/2012	0129-120418-004	NO	YES
WQ-VC-DBC-r	18/04/2012	0129-120418-011	NO	YES
WQ-DC-U2	16/05/2012	0129-120516-009	NO	NO
WQ-VC-R	16/05/2012	0129-120516-021	NO	NO



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Water Quality Site ID	Sample Date	EDI Identifier	LT50 (Y/N)	QA/QC site
WQ-MN	16/05/2012	0129-120516-022	NO	NO
WQ-PC-D	16/05/2012	0129-120516-011	NO	NO
WQ-PC-U	16/05/2012	0129-120516-008	NO	NO
WQ-DC-D1	16/05/2012	0129-120516-013	NO	NO
WQ-DC-DX+105	16/05/2012	0129-120516-005	NO	NO
WQ-VC-REF	16/05/2012	0129-120516-003	NO	NO
WQ-BC	16/05/2012	0129-120516-007	NO	NO
WQ-DC-R-r	16/05/2012	0129-120516-016	NO	YES
WQ-PW	16/05/2012	0129-120516-001	NO	NO
WQ-VC-DBC	16/05/2012	0129-120516-002	NO	NO
WQ-VC-U	16/05/2012	0129-120516-004	NO	NO
Trip Blank	16/05/2012	0129-120516-020	NO	YES
Field Blank	16/05/2012	0129-120516-019	NO	YES
WQ-SEEP	16/05/2012	0129-120516-010	NO	NO
WQ-DC-U	16/05/2012	0129-120516-014	NO	NO
WQ-SEEP-r	16/05/2012	0129-120516-012	NO	YES
WQ-VC-UMN	16/05/2012	0129-120516-018	NO	NO
WQ-DC-R	16/05/2012	0129-120516-015	NO	NO
WQ-DRY	30/05/2012	0129-120530-009	NO	NO
WQ-DC-D1	30/05/2012	0129-120530-006	NO	NO
WQ-DC-D1b	30/05/2012	0129-120530-007	NO	NO
WQ-DC-DX+105	30/05/2012	0129-120530-011	NO	NO
WQ-DC-DX	30/05/2012	0129-120530-008	NO	NO
WQ-PC-D	30/05/2012	0129-120530-005	NO	NO
WQ-PC-U	30/05/2012	0129-120530-010	NO	NO
WQ-VC-R	31/05/2012	0129-120531-015	NO	NO
WQ-VC-R-r	31/05/2012	0129-120531-014	NO	YES
WQ-MN	31/05/2012	0129-120531-021	NO	NO
WQ-VC-UMN	31/05/2012	0129-120531-012	NO	NO
WQ-DC-R	31/05/2012	0129-120531-018	NO	NO
WQ-VC-DBC	31/05/2012	0129-120531-022	NO	NO
WQ-VC-U	31/05/2012	0129-120531-017	NO	NO
WQ-BC	31/05/2012	0129-120531-020	NO	NO
WQ-VC-REF	31/05/2012	0129-120531-019	NO	NO
WQ-PW	31/05/2012	0129-120531-004	NO	NO
WQ-DC-U	31/05/2012	0129-120531-025	NO	NO
WQ-SEEP	31/05/2012	0129-120531-023	NO	NO
Field Blank	31/05/2012	0129-120531-016	NO	YES
WQ-TP	31/05/2012	0129-120531-027	NO	NO
WQ-DC-U1	31/05/2012	0129-120531-024	NO	NO
WQ-DC-U2	31/05/2012	0129-120531-028	NO	NO



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Water Quality Site ID	Sample Date	EDI Identifier	LT50 (Y/N)	QA/QC site
WQ-TP-r	31/05/2012	0129-120531-026	NO	YES
Trip Blank	31/05/2012	0129-120531-013	NO	YES
WQ-VC-UMN	12/06/2012	0129-120614-019	NO	NO
WQ-MN	12/06/2012	0129-120614-020	NO	NO
WQ-BC	12/06/2012	0129-120614-022	NO	NO
WQ-VC-REF	12/06/2012	0129-120614-023	NO	NO
WQ-VC-DBC	12/06/2012	0129-120614-025	NO	NO
WQ-VC-U	12/06/2012	0129-120614-021	NO	NO
WQ-DC-U1	13/06/2012	0129-120614-015	NO	NO
WQ-DC-R	13/06/2012	0129-120613-011	NO	NO
WQ-DC-U	13/06/2012	0129-120614-017	NO	NO
WQ-DC-U-r	13/06/2012	0129-120614-018	NO	YES
WQ-SEEP	13/06/2012	0129-120614-005	YES	YES
WQ-TP	13/06/2012	0129-120614-016	NO	NO
WQ-DC-U2	13/06/2012	0129-120613-012	NO	NO
Field Blank	13/06/2012	0129-120614-013	NO	YES
WQ-PIT1	13/06/2012	0129-120614-001	NO	NO
WQ-PIT2	13/06/2012	0129-120614-003	NO	NO
WQ-PIT3	13/06/2012	0129-120614-002	NO	NO
WQ-VC-R	13/06/2012	0129-120614-014	NO	NO
WQ-MS	13/06/2012	0129-120613-009	NO	NO
WQ-DC-DX+105	13/06/2012	0129-120613-007	NO	NO
WQ-PW	13/06/2012	0129-120614-004	NO	NO
WQ-PC-DS	13/06/2012	0129-120613-008	NO	NO
WQ-PC-DS-r	13/06/2012	0129-120613-006	NO	YES
WQ-PC-U	13/06/2012	0129-120614-024	NO	NO
WQ-DC-D1	13/06/2012	0129-120613-010	NO	NO
Trip Blank	13/06/2012	0129-120614-027	NO	YES
WQ-DC-DX	13/06/2012	0129-120614-026	NO	NO
WQ-MN	26/06/2012	0129-120627-011	NO	NO
WQ-SEEP	27/06/2012	0129-120627-008	NO	NO
WQ-VCR	26/06/2012	0129-120626-012	NO	NO
WQ-DC-R	26/06/2012	0129-120627-014	NO	NO
WQ-VC-R	26/06/2012	0129-120627-019	NO	NO
WQ-BC	26/06/2012	0129-120627-018	NO	NO
WQ-VC-U	26/06/2012	0129-120627-017	NO	NO
WQ-MS	27/06/2012	0129-120626-006	NO	NO
WQ-DC-DX+105	27/06/2012	0129-120627-013	NO	NO
WQ-DC-DX	27/06/2012	0129-120627-022	NO	NO
Field Blank	27/06/2012	0129-120626-001	NO	YES
WQ-PC-D	27/06/2012	0129-120627-023	NO	NO



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WQ-VC-DBC	27/06/2012	0129-120627-009	NO	NO
WQ-VC-DBC	27/06/2012	0129-120627-021	NO	YES
WQ-DC-U	27/06/2012	0129-120627-015	NO	NO
WQ-DC-U	27/06/2012	0129-120627-020	NO	YES
WQ-PC-U	27/06/2012	0129-120627-024	NO	NO
WQ-PW	27/06/2012	0129-120627-007	NO	NO
WQ-VU-UMN	27/06/2012	0129-120627-025	NO	NO
WQ-TP	27/06/2012	0129-120626-005	NO	NO
WQ-DC-U2	27/06/2012	0129-120626-003	NO	NO
WQ-DC-U1	27/06/2012	0129-120626-002	NO	NO
WQ-DC-D1	27/06/2012	0129-120626-004	NO	NO
Trip Blank	27/06/2012	0129-120627-026	NO	YES
WQ-MN	10/07/2012	0129-120710-004	NO	NO
WQ-VC-DBC	10/07/2012	0129-120710-009	NO	NO
WQ-VC-UMN	10/07/2012	0129-120710-005	NO	NO
WQ-VC-U	10/07/2012	0129-120710-006	NO	NO
WQ-BC	10/07/2012	0129-120710-008	NO	NO
WQ-VC-REF	10/07/2012	0129-120710-010	NO	NO
WQ-PIT1	11/07/2012	0129-120711-001	NO	NO
WQ-PIT2	11/07/2012	0129-120711-002	NO	NO
WQ-PIT3	11/07/2012	0129-120711-003	NO	NO
WQ-VC-R	11/07/2012	0129-120711-019	NO	NO
WQ-VC-R-r	11/07/2012	0129-120711-018	NO	YES
WQ-DC-R	11/07/2012	0129-120711-020	NO	NO
WQ-DC-U	11/07/2012	0129-120711-021	NO	NO
WQ-PW	11/07/2012	0129-120711-007	NO	NO
WQ-SEEP	11/07/2012	0129-120711-015	NO	NO
WQ-SEEP-DAM	11/07/2012	0129-120711-023	NO	NO
WQ-DC-U1	11/07/2012	0129-120711-027	NO	NO
WQ-TP	11/07/2012	0129-120711-024	NO	NO
WQ-DC-U2	11/07/2012	0129-120711-022	NO	NO
WQ-PC-D	11/07/2012	0129-120711-016	NO	NO
WQ-DC-D1	11/07/2012	0129-120711-011	NO	NO
WQ-PC-U	11/07/2012	0129-120711-012	NO	NO
WQ-DC-D1b	11/07/2012	0129-120711-031	NO	NO
WQ-PC-U-r	11/07/2012	0129-120711-017	NO	YES
WQ-DC-DX+105	11/07/2012	0129-120711-029	NO	NO
WQ-DC-DX	11/07/2012	0129-120711-028	NO	NO
WQ-MS	11/07/2012	0129-120711-025	NO	NO
Trip Blank	11/07/2012	0129-120711-013	NO	YES
WQ-VC-UMN	24/07/2012	0129-120724-001	NO	NO



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Water Quality Site ID	Sample Date	EDI Identifier	LT50 (Y/N)	QA/QC site
WQ-MN	24/07/2012	0129-120724-004	NO	NO
WQ-PW	25/07/2012	0129-120725-007	NO	NO
WQ-VC-R	25/07/2012	0129-120725-020	NO	NO
WQ-MS	25/07/2012	0129-120725-012	NO	NO
WQ-DC-D1	25/07/2012	0129-120725-026	NO	NO
WQ-DC-D1b	25/07/2012	0129-120725-023	NO	NO
WQ-DC-U1	25/07/2012	0129-120725-024	NO	NO
WQ-DC-U2	25/07/2012	0129-120725-025	NO	NO
WQ-TP	25/07/2012	0129-120725-022	NO	NO
WQ-SEEP	25/07/2012	0129-120725-021	NO	NO
WQ-DC-U	25/07/2012	0129-120725-017	NO	NO
WQ-DC-U-r	25/07/2012	0129-120725-016	NO	YES
WQ-VC-DBC	24/07/2012	0129-120724-002	NO	NO
WQ-VC-U	24/07/2012	0129-120724-003	NO	NO
WQ-BC	24/07/2012	0129-120724-005	NO	NO
WQ-VC-REF	24/07/2012	0129-120724-006	NO	NO
WQ-PC-D	25/07/2012	0129-120725-013	NO	NO
WQ-PC-U	25/07/2012	0129-120725-011	NO	NO
WQ-DC-DX	25/07/2012	0129-120725-009	NO	NO
WQ-DC-DX-r	25/07/2012	0129-120725-010	NO	YES
WQ-DC-DX+105	25/07/2012	0129-120725-008	NO	NO
WQ-DC-R	25/07/2012	0129-120725-019	NO	NO
Field Blank	25/07/2012	0129-120725-015	NO	YES
WQ-VC-R	07/08/2012	0129-120807-010	NO	NO
WQ-MN	07/08/2012	0129-120807-009	NO	NO
WQ-VC-UMN	07/08/2012	0129-120807-006	NO	NO
WQ-VC-DBC	07/08/2012	0129-120807-004	NO	NO
WQ-VC-U	07/08/2012	0129-120807-005	NO	NO
WQ-BC	07/08/2012	0129-120807-008	NO	NO
WQ-VC-REF	07/08/2012	0129-120807-011	NO	NO
WQ-DC-U	08/08/2012	0129-120808-017	NO	NO
WQ-PIT1	08/08/2012	0129-120808-001	NO	NO
WQ-PIT2	08/08/2012	0129-120808-003	NO	NO
WQ-PIT3	08/08/2012	0129-120808-002	NO	NO
WQ-DC-R	08/08/2012	0129-120808-016	NO	NO
WQ-DC-R-r	08/08/2012	0129-120808-019	NO	YES
WQ-SEEP	08/08/2012	0129-120808-012	YES	NO
WQ-TP	08/08/2012	0129-120808-014	NO	NO
WQ-DC-U1	08/08/2012	0129-120808-013	NO	NO
WQ-DC-U2	08/08/2012	0129-120808-015	NO	NO
WQ-MS	08/08/2012	0129-120808-026	NO	NO



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Water Quality Site ID	Sample Date	EDI Identifier	LT50 (Y/N)	QA/QC site
WQ-DC-DX+105	08/08/2012	0129-120808-027	NO	NO
WQ-DC-DX	08/08/2012	0129-120808-024	NO	NO
WQ-PW	08/08/2012	0129-120808-007	NO	NO
Field Blank	08/08/2012	0129-120808-022	NO	YES
Trip Blank	08/08/2012	0129-120808-018	NO	YES
WQ-PC-D	08/08/2012	0129-120808-023	NO	NO
WQ-PC-U	08/08/2012	0129-120808-025	NO	NO
WQ-PC-U-r	08/08/2012	0129-120808-028	NO	YES
WQ-DC-D1	08/08/2012	0129-120808-021	NO	NO
WQ-DC-D1b	08/08/2012	0129-120808-020	NO	NO
WQ-VC-U	22/08/2012	0129-120822-004	NO	NO
WQ-BC	22/08/2012	0129-120822-008	NO	NO
WQ-VC-REF	22/08/2012	0129-120822-006	NO	NO
WQ-DRY	22/08/2012	0129-120822-009	NO	NO
WQ-VC-R	22/08/2012	0129-120822-001	NO	NO
WQ-MN	22/08/2012	0129-120822-002	NO	NO
WQ-VC-UMN	22/08/2012	0129-120822-003	NO	NO
WQ-VC-DBC	22/08/2012	0129-120822-005	NO	NO
WQ-DC-U1	23/08/2012	0129-120823-022	NO	NO
WQ-DC-U2	23/08/2012	0129-120823-021	NO	NO
WQ-PC-D	23/08/2012	0129-120823-017	NO	NO
WQ-PC-U	23/08/2012	0129-120823-016	NO	NO
WQ-DC-R	23/08/2012	0129-120823-023	NO	NO
WQ-DC-U	23/08/2012	0129-120823-026	NO	NO
WQ-TP	23/08/2012	0129-120823-018	NO	NO
WQ-SEEP	23/08/2012	0129-120823-025	NO	NO
WQ-SEEP-r	23/08/2012	0129-120823-024	NO	YES
WQ-DC-D1	23/08/2012	0129-120823-020	NO	NO
WQ-DC-D1-r	23/08/2012	0129-120823-019	NO	YES
WQ-DC-D1b	23/08/2012	0129-120823-011	NO	NO
WQ-MS	23/08/2012	0129-120823-013	NO	NO
WQ-DC-DX+105	23/08/2012	0129-120823-014	NO	NO
WQ-DC-DX	23/08/2012	0129-120823-010	NO	NO
WQ-PW	23/08/2012	0129-120823-007	NO	NO
Field Blank	23/08/2012	0129-120823-012	NO	YES
Trip Blank	23/08/2012	0129-120823-027	NO	YES
WQ-VC-R	05/09/2012	0129-120905-009	NO	NO
WQ-MN	05/09/2012	0129-120905-008	NO	NO
WQ-UMN	05/09/2012	0129-120905-010	NO	NO
WQ-VC-DBC	05/09/2012	0129-120905-011	NO	NO
WQ-VC-U	05/09/2012	0129-120905-005	NO	NO



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Water Quality Site ID	Sample Date	EDI Identifier	LT50 (Y/N)	QA/QC site
WQ-BC	05/09/2012	0129-120905-006	NO	NO
WQ-VC-REF	05/09/2012	0129-120905-007	NO	NO
WQ-DC-R	06/09/2012	0129-120906-021	NO	NO
WQ-DC-U	06/09/2012	0129-120906-029	NO	NO
WQ-TP	06/09/2012	0129-120906-027	NO	NO
WQ-DC-U1	06/09/2012	0129-120906-028	NO	NO
WQ-DC-U2	06/09/2012	0129-120906-023	NO	NO
WQ-SEEP	06/09/2012	0129-120906-030	NO	NO
WQ-DC-D1	06/09/2012	0129-120906-024	NO	NO
WQ-PC-D	06/09/2012	0129-120906-025	NO	NO
WQ-PC-D-r	06/09/2012	0129-120906-017	NO	YES
WQ-PC-U	06/09/2012	0129-120906-016	NO	NO
WQ-DC-D1b	06/09/2012	0129-120906-020	NO	NO
WQ-DC-DX+105	06/09/2012	0129-120906-022	NO	NO
WQ-MS	06/09/2012	0129-120906-019	NO	NO
WQ-DC-DX	06/09/2012	0129-120906-018	NO	NO
WQ-DX-r	06/09/2012	0129-120906-015	NO	YES
Field Blank	06/09/2012	0129-120906-013	NO	YES
Trip Blank	06/09/2012	0129-120906-026	NO	YES
WQ-PIT1	06/09/2012	0129-120906-001	NO	NO
WQ-PIT2	06/09/2012	0129-120906-002	NO	NO
WQ-PIT3	06/09/2012	0129-120906-003	NO	NO
WQ-PW	06/09/2012	0129-120906-004	NO	NO
WQ-PW	19/09/2012	0129-120919-004	NO	NO
WQ-DC-U	19/09/2012	0129-120919-010	NO	NO
WQ-SEEP	19/09/2012	0129-120919-009	YES	NO
WQ-TP	19/09/2012	0129-120919-020	NO	NO
WQ-DC-U1	19/09/2012	0129-120919-018	NO	NO
WQ-DC-U2	19/09/2012	0129-120919-021	NO	NO
WQ-PC-D	19/09/2012	0129-120919-012	NO	NO
WQ-ADIT-SEEP	19/09/2012	0129-120919-030	NO	NO
WQ-VC-R	18/09/2012	0129-120918-006	NO	NO
WQ-MN	18/09/2012	0129-120918-008	NO	NO
WQ-VC-UMN	18/09/2012	0129-120918-002	NO	YES
WQ-VC-DBC	18/09/2012	0129-120918-001	NO	NO
WQ-VC-U	18/09/2012	0129-120918-003	NO	NO
WQ-BC	18/09/2012	0129-120918-005	NO	NO
WQ-VC-REF	18/09/2012	0129-120918-007	NO	NO
WQ-DC-R	19/09/2012	0129-120919-014	NO	NO
WQ-DC-D1	19/09/2012	0129-120919-016	NO	NO
WQ-PC-U	19/09/2012	0129-120919-015	NO	NO



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Water Quality Site ID	Sample Date	EDI Identifier	LT50 (Y/N)	QA/QC site
WQ-PC-U-r	19/09/2012	0129-120919-017	NO	YES
WQ-D1B	19/09/2012	0129-120919-019	NO	NO
WQ-MS	19/09/2012	0129-120919-022	NO	NO
WQ-DC-DX+105	19/09/2012	0129-120919-013	NO	NO
WQ-DC-DX	19/09/2012	0129-120919-023	NO	NO
WQ-DC-U-r	19/09/2012	0129-120919-011	NO	YES
Field Blank	19/09/2012	0129-120919-026	NO	YES
Trip Blank	19/09/2012	0129-120919-027	NO	YES
WQ-DC-U2	04/10/2012	0129-121004-022	NO	NO
WQ-PC-D	04/10/2012	0129-121004-026	NO	NO
WQ-PC-U	04/10/2012	0129-121004-027	NO	NO
WQ-DC-D1b	04/10/2012	0129-121004-018	NO	NO
WQ-DC-D1B-r	04/10/2012	0129-121004-025	NO	YES
WQ-DC-D1	04/10/2012	0129-121004-017	NO	NO
WQ-MS	04/10/2012	0129-121004-023	NO	NO
WQ-DC-DX+105	04/10/2012	0129-121004-016	NO	NO
WQ-DC-DX	04/10/2012	0129-121004-013	NO	NO
WQ-VC-R	03/10/2012	0129-121003-005	NO	NO
WQ-MN	03/10/2012	0129-121003-006	NO	NO
WQ-VC-UMN	03/10/2012	0129-121003-011	NO	NO
WQ-VC-DBC	03/10/2012	0129-121003-007	NO	NO
WQ-VC-U	03/10/2012	0129-121003-008	NO	NO
WQ-BC	03/10/2012	0129-121003-009	NO	NO
WQ-VC-REF	03/10/2012	0129-121003-010	NO	NO
WQ-PW	04/10/2012	0129-121004-004	NO	NO
WQ-DC-U	04/10/2012	0129-121004-019	NO	NO
WQ-SEEP	04/10/2012	0129-121004-012	NO	NO
WQ-SEEP-r	04/10/2012	0129-121004-020	NO	YES
WQ-TP	04/10/2012	0129-121004-014	NO	NO
WQ-DC-U1	04/10/2012	0129-121004-021	NO	NO
WQ-PIT3	04/10/2012	0129-121004-003	NO	NO
WQ-PIT2	04/10/2012	0129-121004-002	NO	NO
WQ-PIT1	04/10/2012	0129-121004-001	NO	NO
WQ-DC-R	04/10/2012	0129-121004-015	NO	NO
Trip Blank	04/10/2012	0129-121004-024	NO	YES
Field Blank	04/10/2012	0129-121004-028	NO	YES
WQ-VC-R	16/10/2012	0129-121017-002	NO	NO
WQ-MN	16/10/2012	0129-121017-003	NO	NO
WQ-VC-UMN	16/10/2012	0129-121017-006	NO	NO
WQ-DC-R	16/10/2012	0129-121017-007	NO	NO
WQ-DC-R-r	16/10/2012	0129-121017-009	NO	YES



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WQ-PW	16/10/2012	0129-121017-004	NO	NO
WQ-VC-DBC	16/10/2012	0129-121017-011	NO	NO
WQ-VC-DBC-r	16/10/2012	0129-121017-020	NO	YES
WQ-BC	16/10/2012	0129-121017-013	NO	NO
WQ-VC-REF	16/10/2012	0129-121017-017	NO	NO
Field Blank	16/10/2012	0129-121017-025	NO	YES
Trip Blank	16/10/2012	0129-121017-026	NO	YES
WQ-VC-U	16/10/2012	0129-121017-016	NO	NO
WQ-DC-U1	16/10/2012	0129-121017-014	NO	NO
WQ-DC-U2	16/10/2012	0129-121017-018	NO	NO
WQ-TP	16/10/2012	0129-121017-023	NO	NO
WQ-SEEP	16/10/2012	0129-121017-022	NO	NO
WQ-DC-U	16/10/2012	0129-121017-019	NO	NO
WQ-PC-D	16/10/2012	0129-121017-021	NO	NO
WQ-PC-U	16/10/2012	0129-121017-001	NO	NO
WQ-DC-DX	16/10/2012	0129-121017-024	NO	NO
WQ-DC-DX+105	16/10/2012	0129-121017-005	NO	NO
WQ-DC-D1b	16/10/2012	0129-121017-012	NO	NO
WQ-MS	16/10/2012	0129-121017-015	NO	NO
WQ-DC-D1	16/10/2012	0129-121017-010	NO	NO
WQ-SEEP	15/11/2012	0129-121115-005	YES	NO
Trip Blank	15/11/2012	0129-121115-006	NO	YES
WQ-DC-U1	14/11/2012	0129-121115-007	NO	NO
WQ-DC-DX+105-r	15/11/2012	0129-121115-009	NO	YES
WQ-TP	15/11/2012	0129-121115-010	NO	NO
WQ-DC-U	15/11/2012	0129-121115-011	NO	NO
WQ-PW	15/11/2012	0129-121115-014	NO	NO
WQ-VC-U	15/11/2012	0129-121115-016	NO	NO
WQ-MS-S-03	15/11/2012	0129-121115-018	NO	NO
WQ-DX+105	15/11/2012	0129-121115-020	NO	NO
Field Blank	15/11/2012	0129-121115-022	NO	YES
WQ-VC-REF	15/11/2012	0129-121115-023	NO	NO
WQ-MS-S-08	15/11/2012	0129-121115-024	NO	NO
WQ-VC-DBC	15/11/2012	0129-121115-025	NO	NO
WQ-MN	15/11/2012	0129-121115-026	NO	NO
WQ-VC-R	15/11/2012	0129-121115-027	NO	NO
WQ-VC-UMN	15/11/2012	0129-121115-028	NO	NO
WQ-PIT1	12/12/2012	0129-121212-001	NO	NO
WQ-PIT2	12/12/2012	0129-121212-002	NO	NO
WQ-PIT3	12/12/2012	0129-121212-003	NO	NO
WQ-PW	12/12/2012	0129-121212-004	NO	NO



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Water Quality Site ID	Sample Date	EDI Identifier	LT50 (Y/N)	QA/QC site
Trip Blank	12/12/2012	0129-121212-005	NO	YES
WQ-VC-R-r	12/12/2012	0129-121212-007	NO	YES
Field Blank	12/12/2012	0129-121212-009	NO	YES
WQ-DC-DX+150	12/12/2012	0129-121212-010	NO	NO
WQ-VC-UMN	11/12/2012	0129-121212-012	NO	NO
WQ-SEEP	12/12/2012	0129-121212-013	NO	NO
WQ-VC-R	12/12/2012	0129-121212-014	NO	NO
WQ-TP	12/12/2012	0129-121212-015	NO	NO
WQ-VC-REF	12/12/2012	0129-121212-016	NO	NO
WQ-MS-S-03	12/12/2012	0129-121212-017	NO	NO
WQ-VC-U	12/12/2012	0129-121212-018	NO	NO
WQ-VC-DBC	12/12/2012	0129-121212-019	NO	NO
WQ-DC-U	12/12/2012	0129-121212-021	NO	NO
WQ-PIT1	16/01/2013	0129-130116-001	NO	NO
WQ-PIT2	16/01/2013	0129-130116-002	NO	NO
WQ-PIT3	16/01/2013	0129-130116-003	NO	NO
Field Blank	15/01/2013	0129-130115-013	NO	YES
Trip Blank	16/01/2013	0129-130116-005	NO	YES
WQ-SEEP	15/01/2013	0129-130115-006	YES	NO
WQ-TP	15/01/2013	0129-130115-015	NO	NO
WQ-DC-DX+105	15/01/2013	0129-130115-016	NO	NO
WQ-PW	16/01/2013	0129-130116-004	NO	NO
WQ-DC-U	15/01/2013	0129-130115-012	NO	NO
WQ-VC-U	15/01/2013	0129-130115-009	NO	NO
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WQ-VC-R	15/01/2013	0129-130115-010	NO	NO
WQ-VC-DBC	15/01/2013	0129-130115-011	NO	NO
WQ-VC-UMN	15/01/2013	0129-130115-007	NO	NO
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WQ-PW	13/02/2013	0129-130213-004	NO	NO
WQ-PIT1	13/02/2013	0129-130213-001	NO	NO
WQ-PIT2	13/02/2013	0129-130213-002	NO	NO
WQ-PIT3	13/02/2013	0129-130213-003	NO	NO
WQ-VC-R	12/02/2013	0129-130212-008	NO	NO
WQ-VC-UMN	12/02/2013	0129-130212-009	NO	NO
WQ-VC-DBC	12/02/2013	0129-130212-006	NO	NO
WQ-VC-U	12/02/2013	0129-130212-007	NO	NO
WQ-VC-REF	12/02/2013	0129-130213-005	NO	NO
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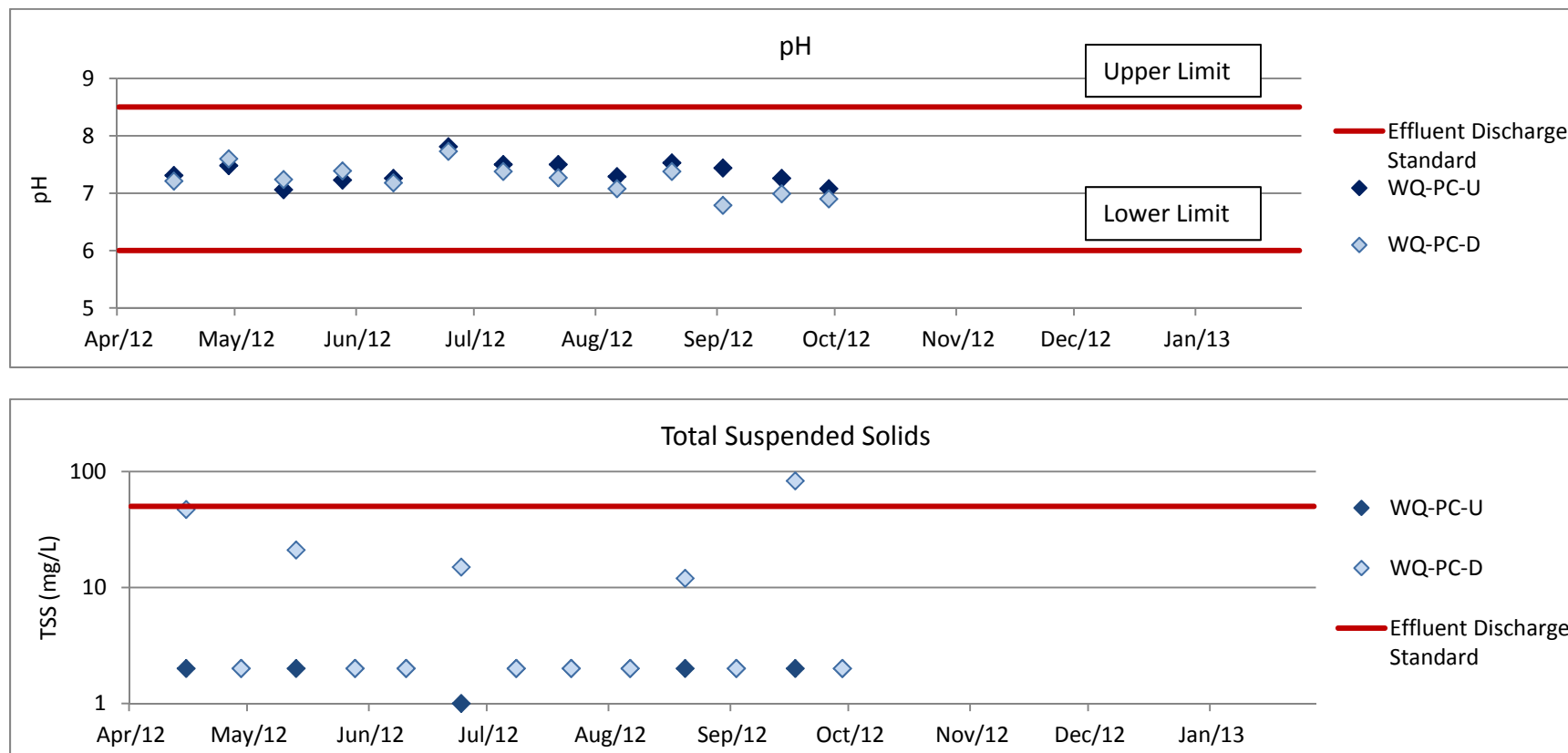


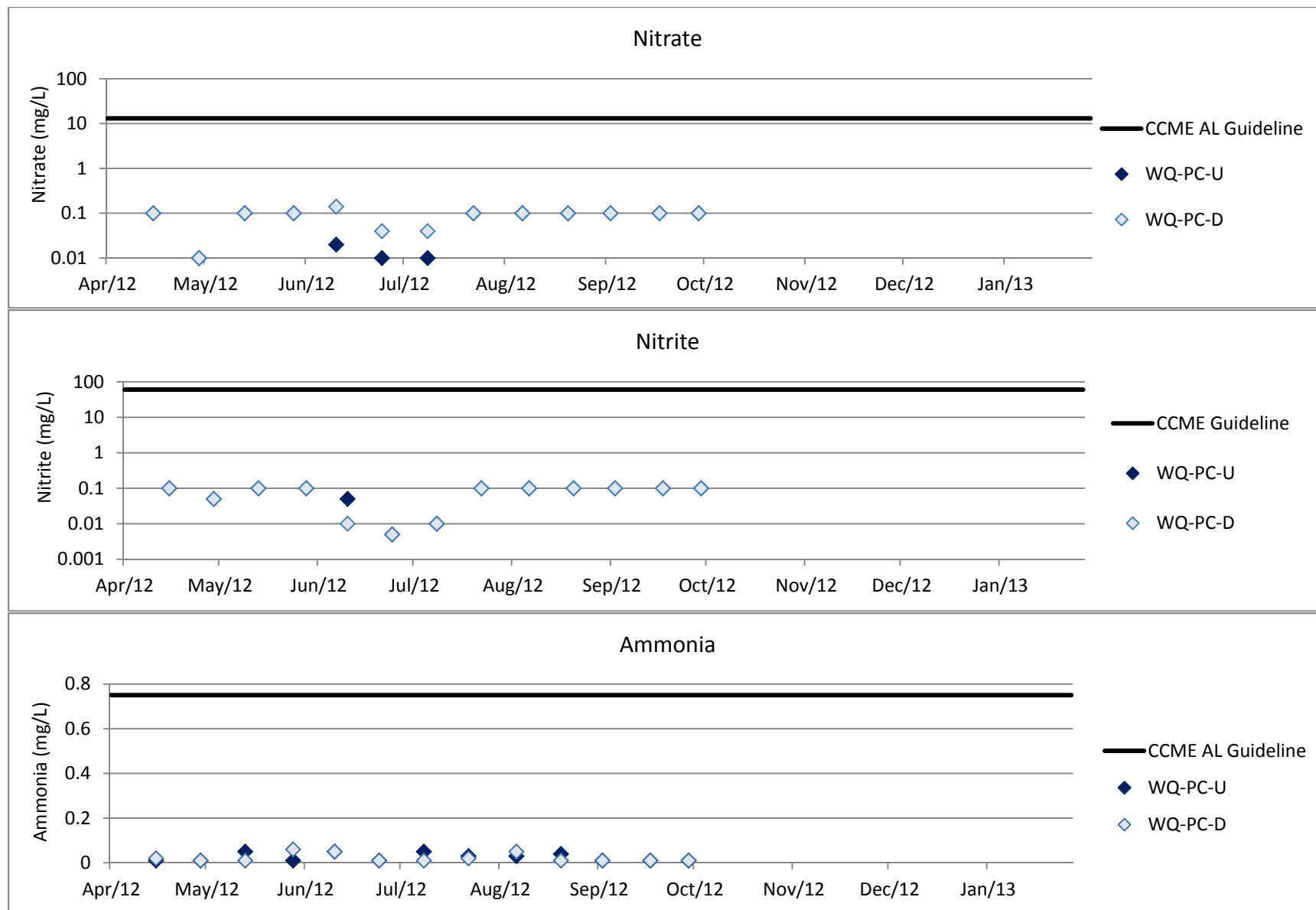
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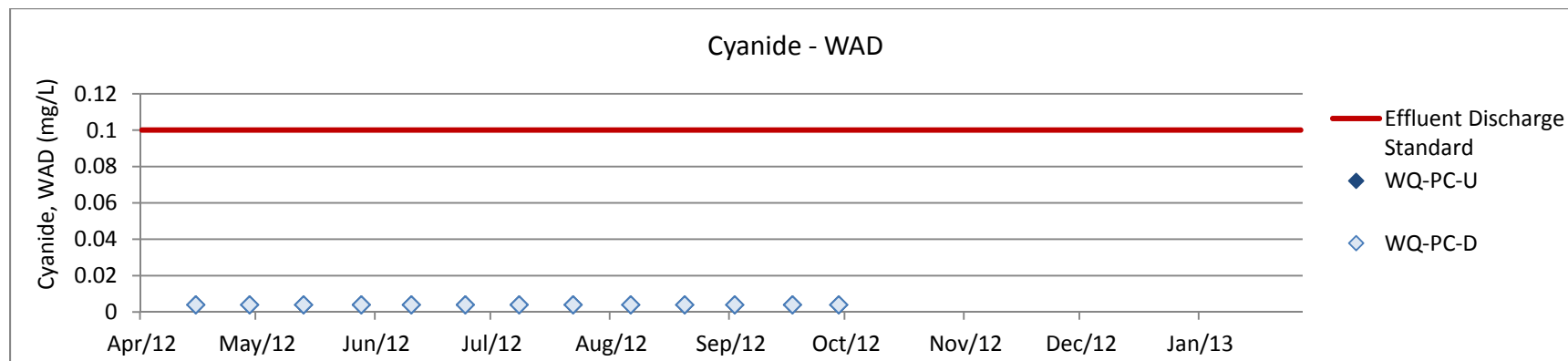
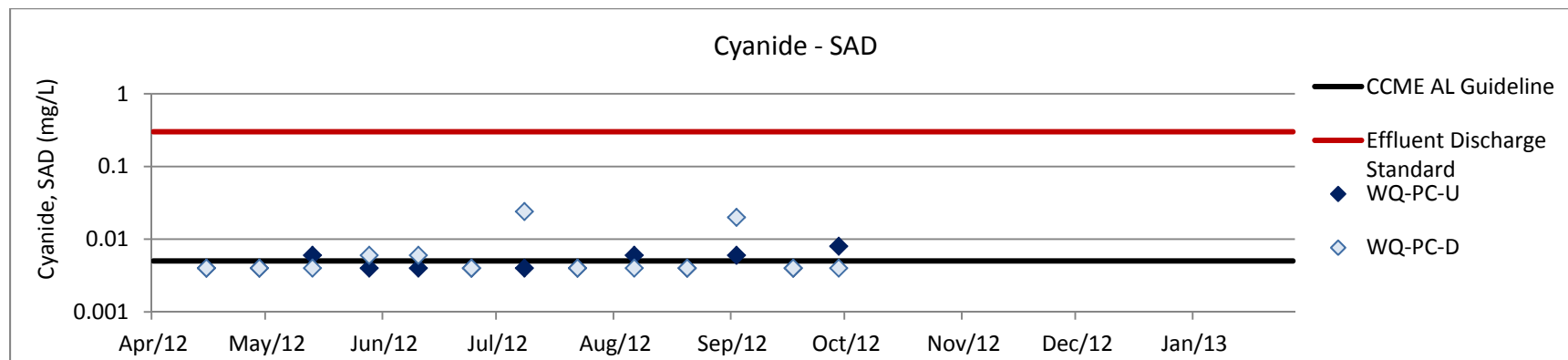
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Trip Blank	12/02/2013	0129-130212-015	NO	YES

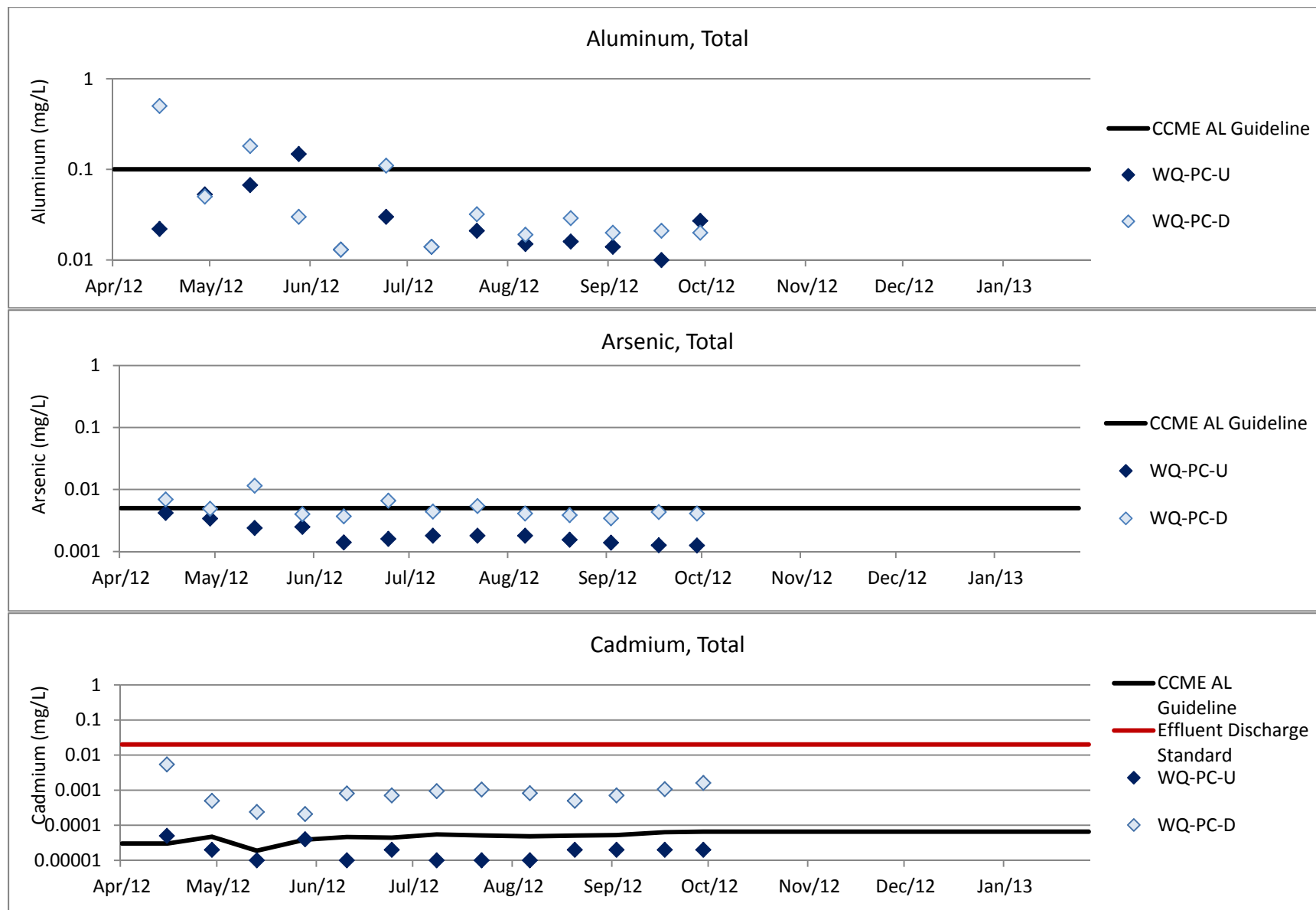


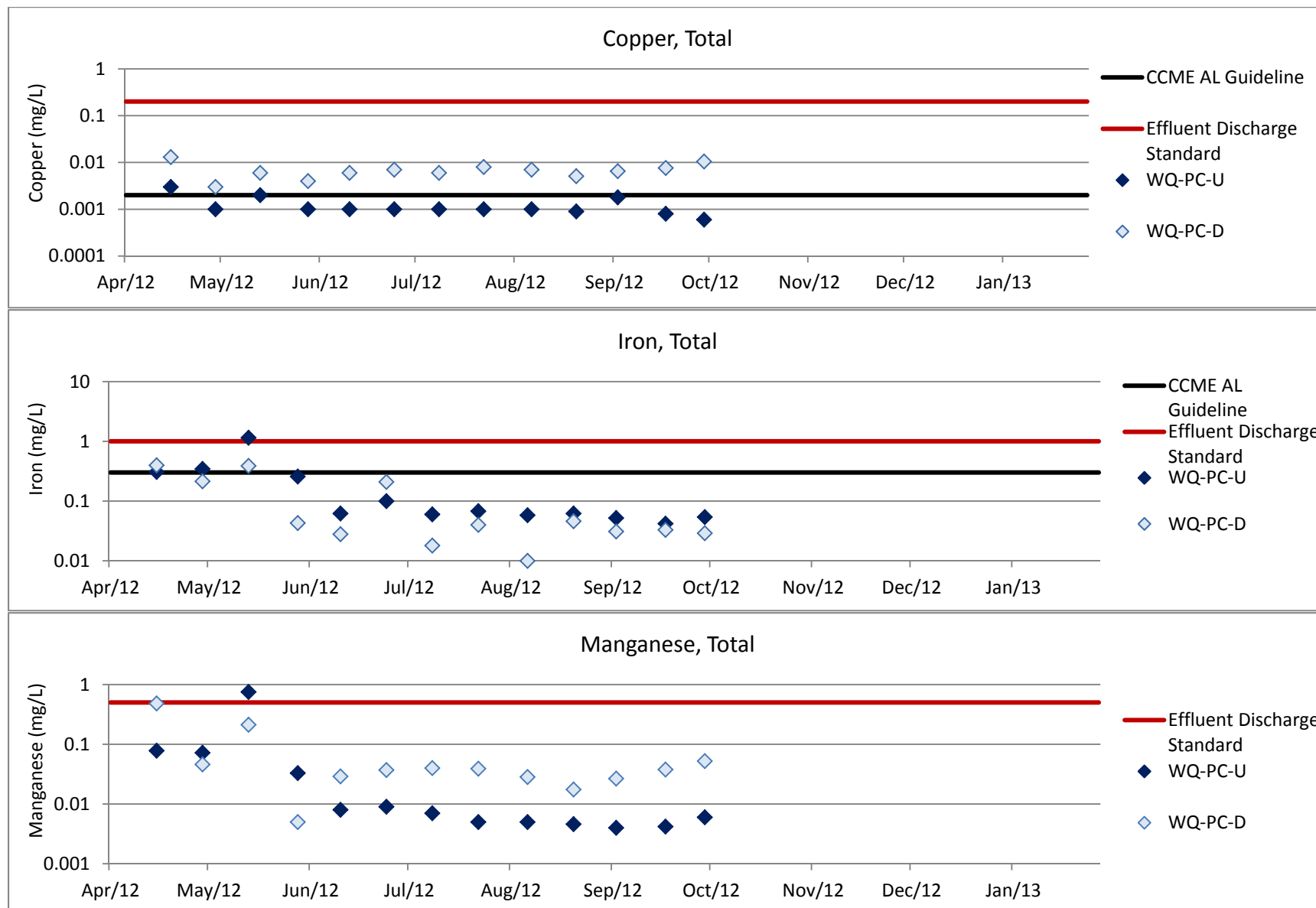
Figure C1. Pony Creek surface water quality figures.











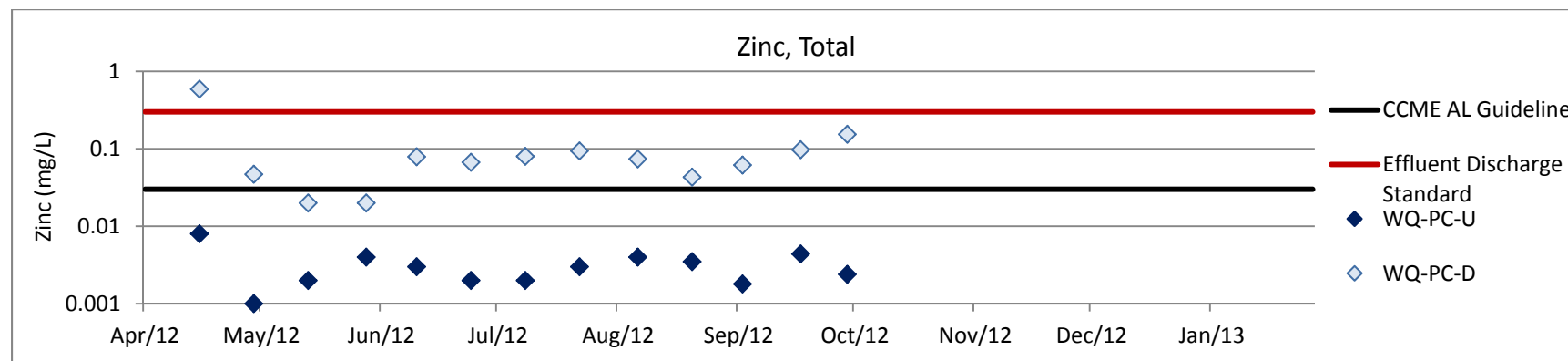
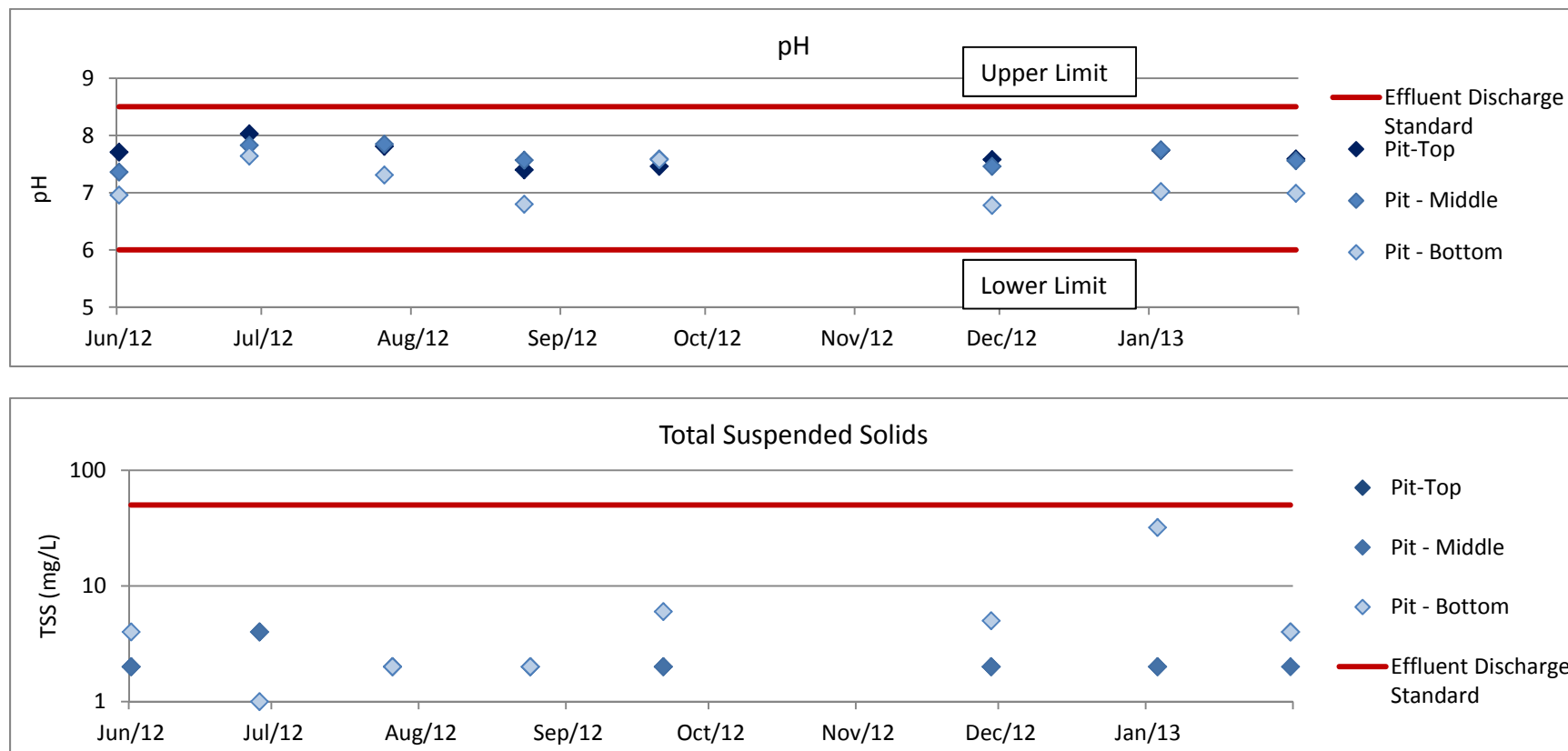
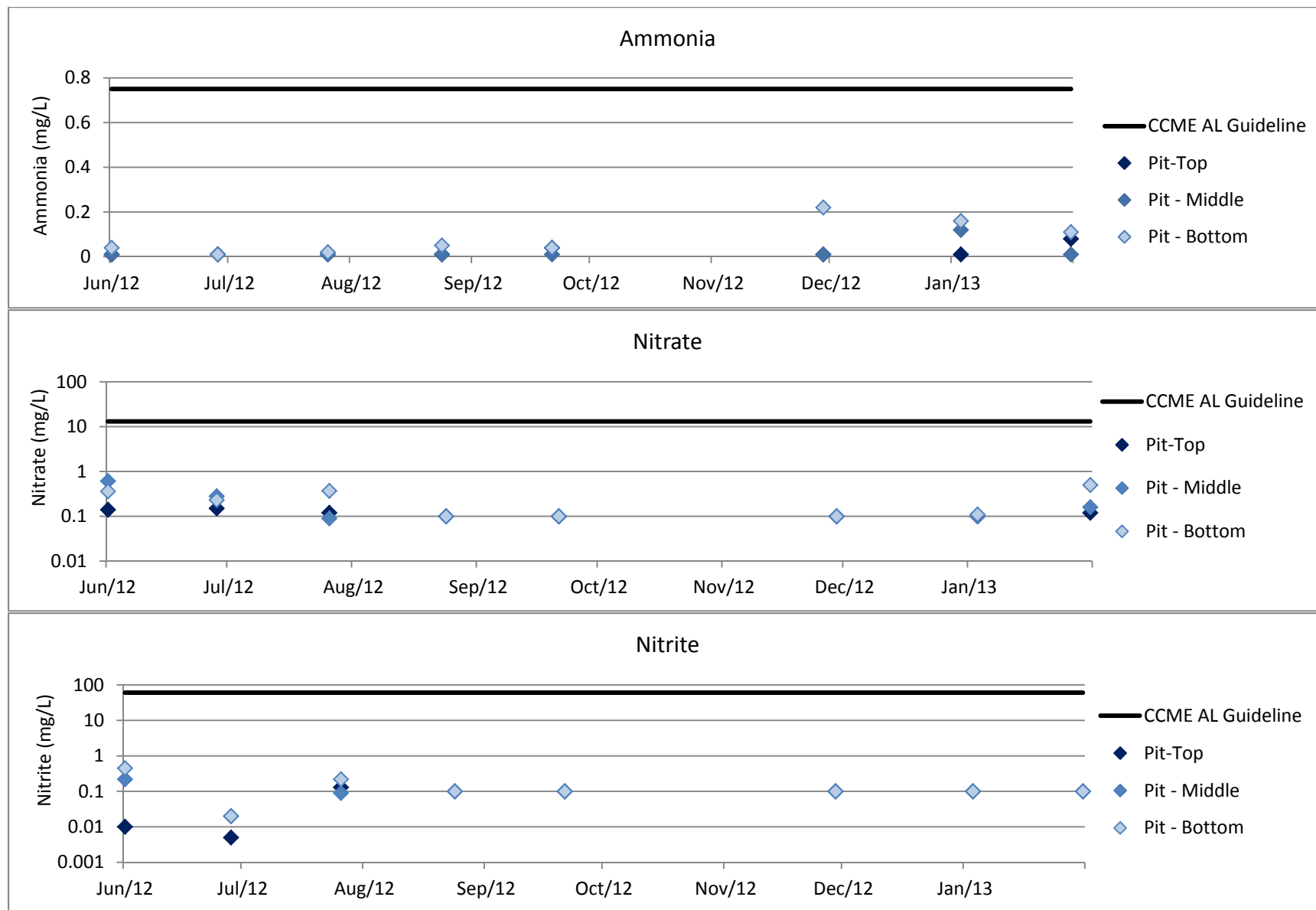
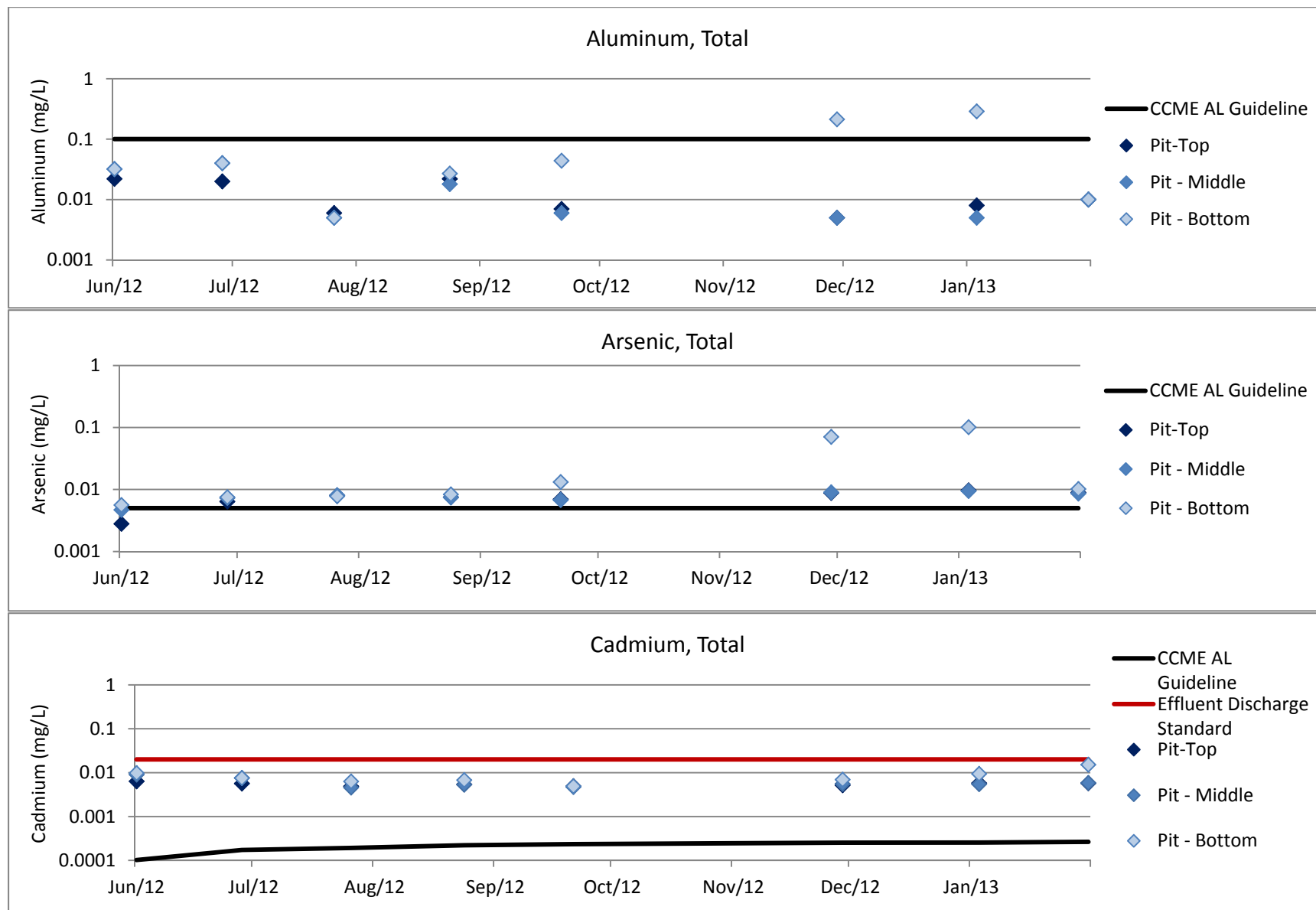


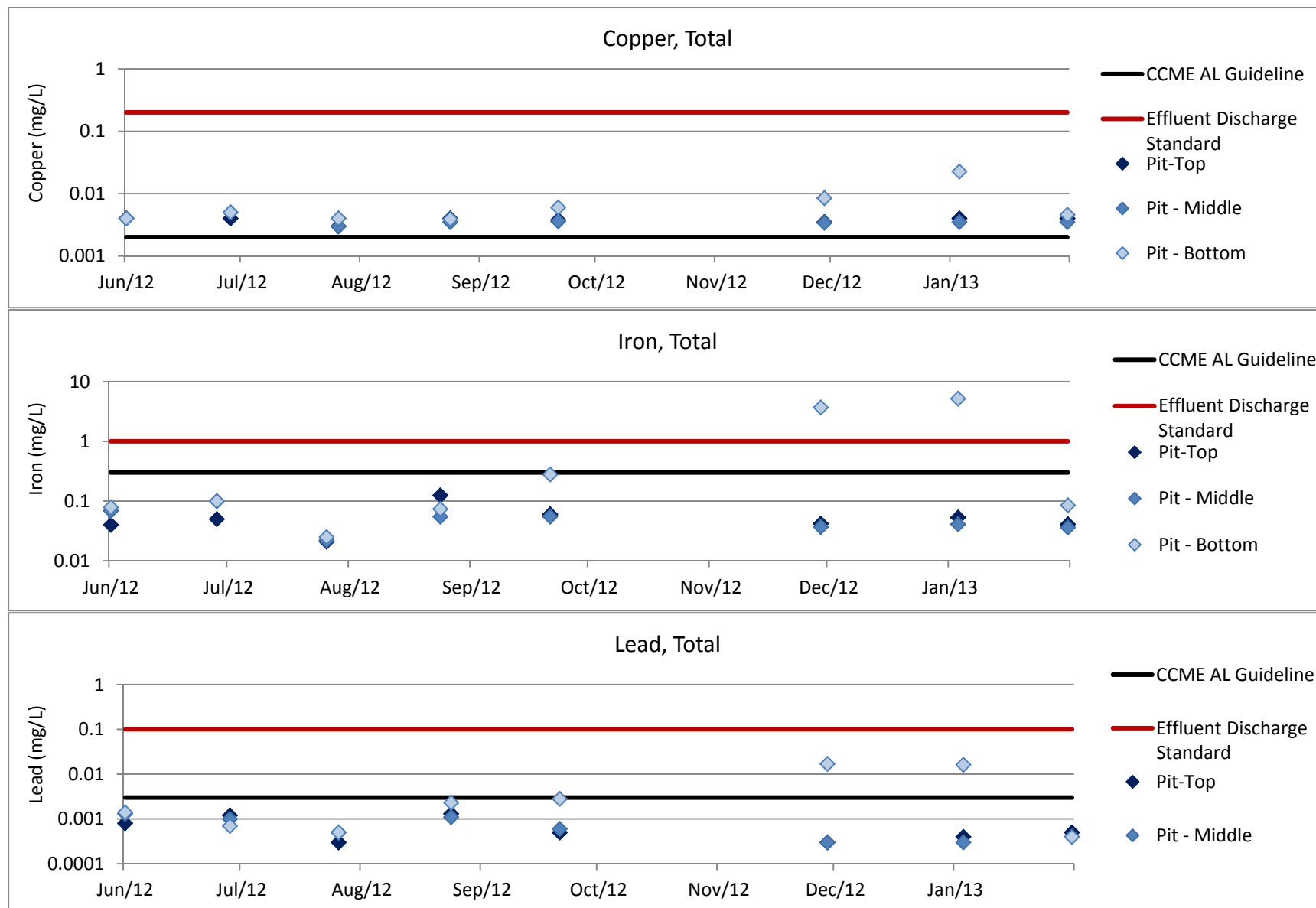


Figure C2. Brown-McDade pit lake surface water quality figures.









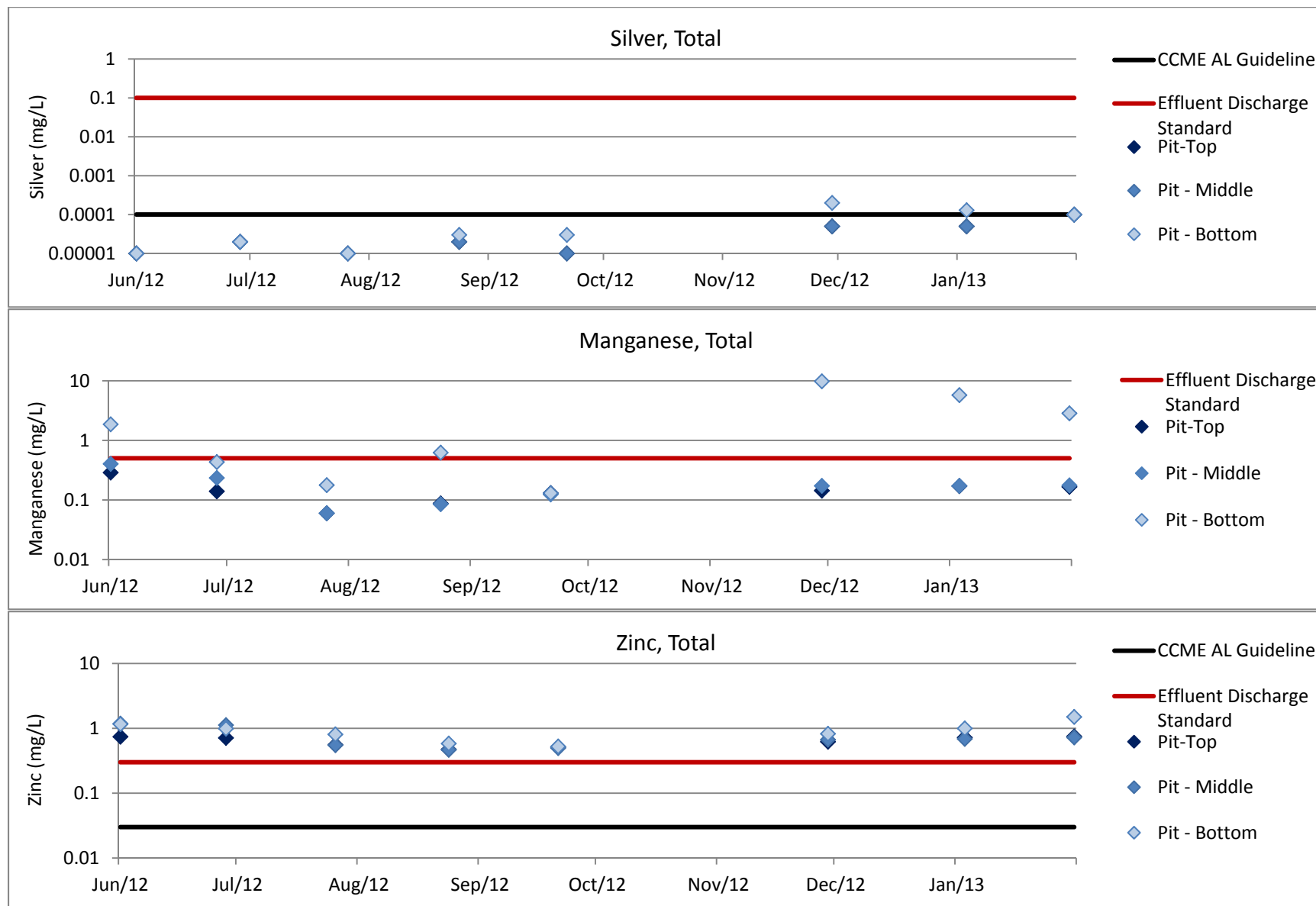
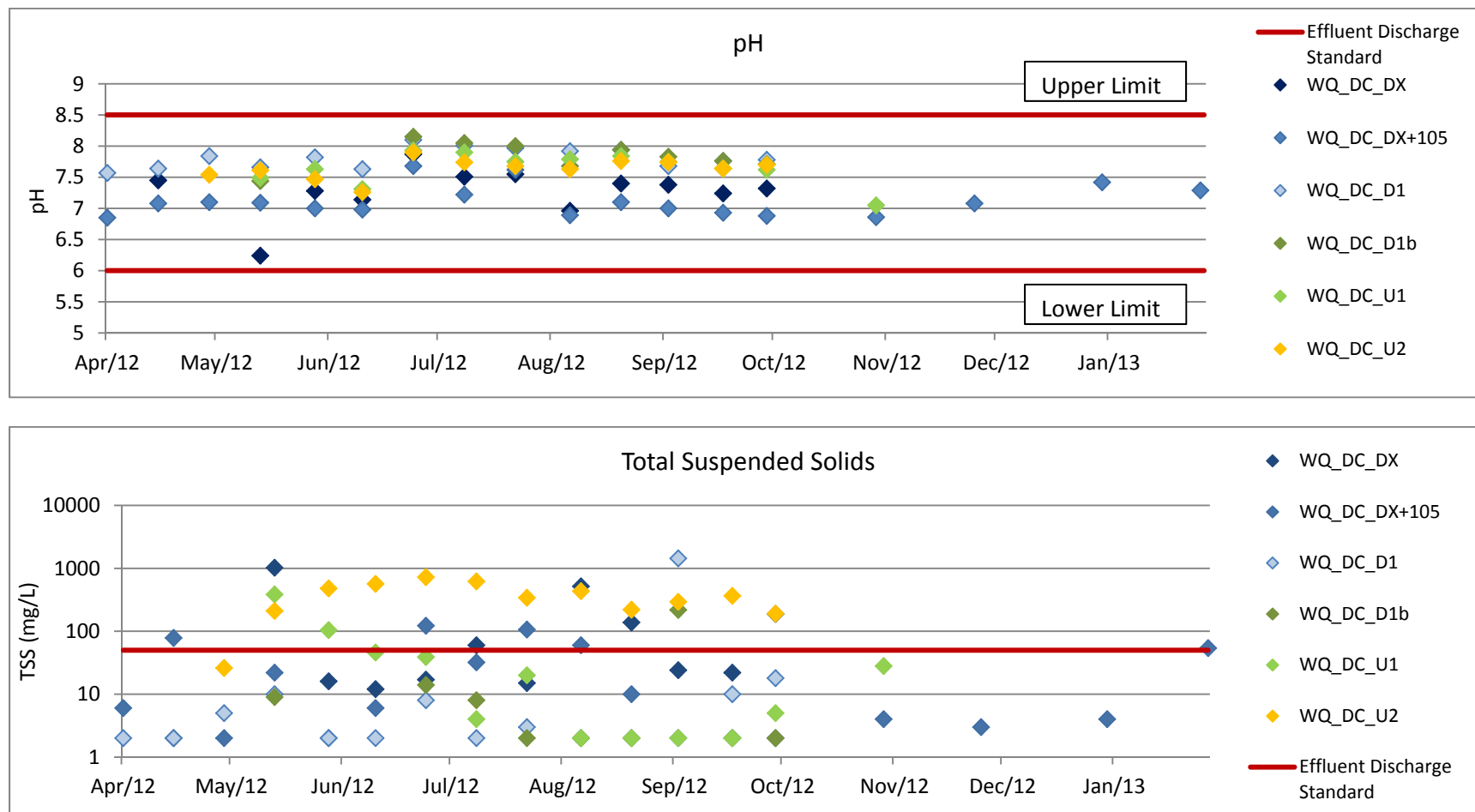
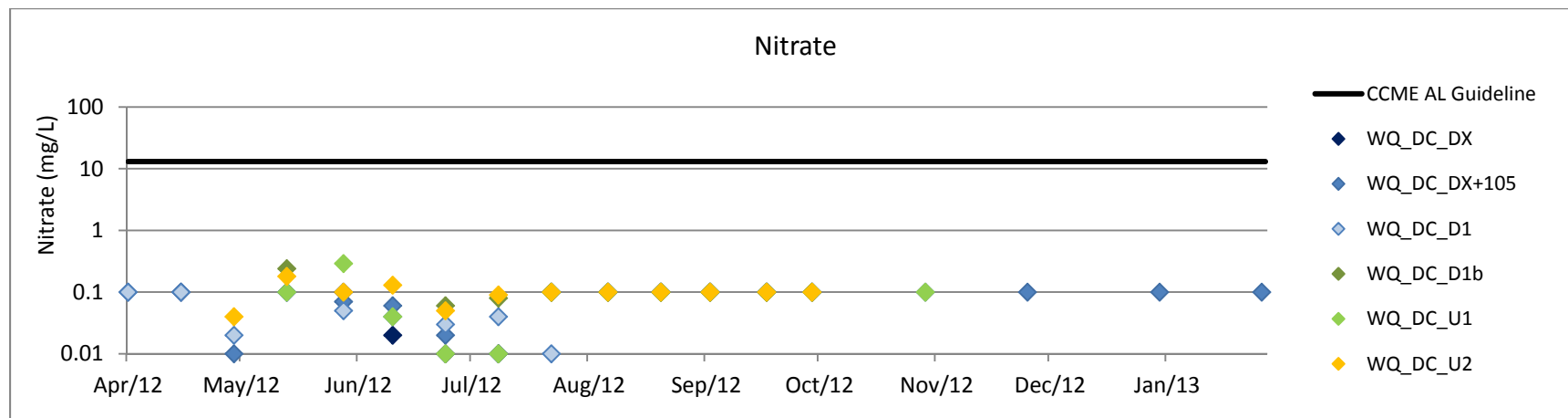
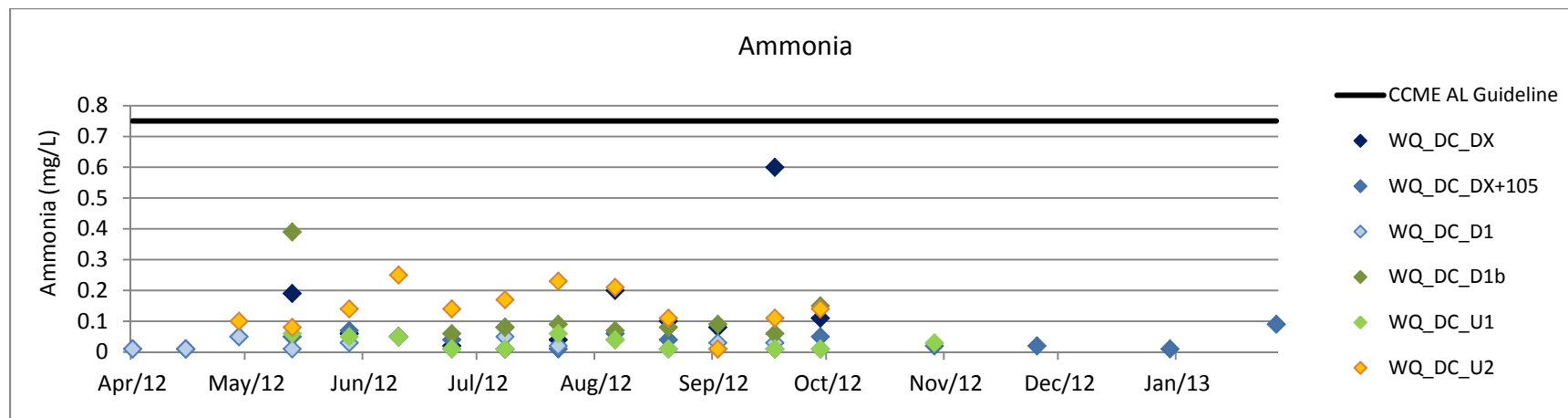
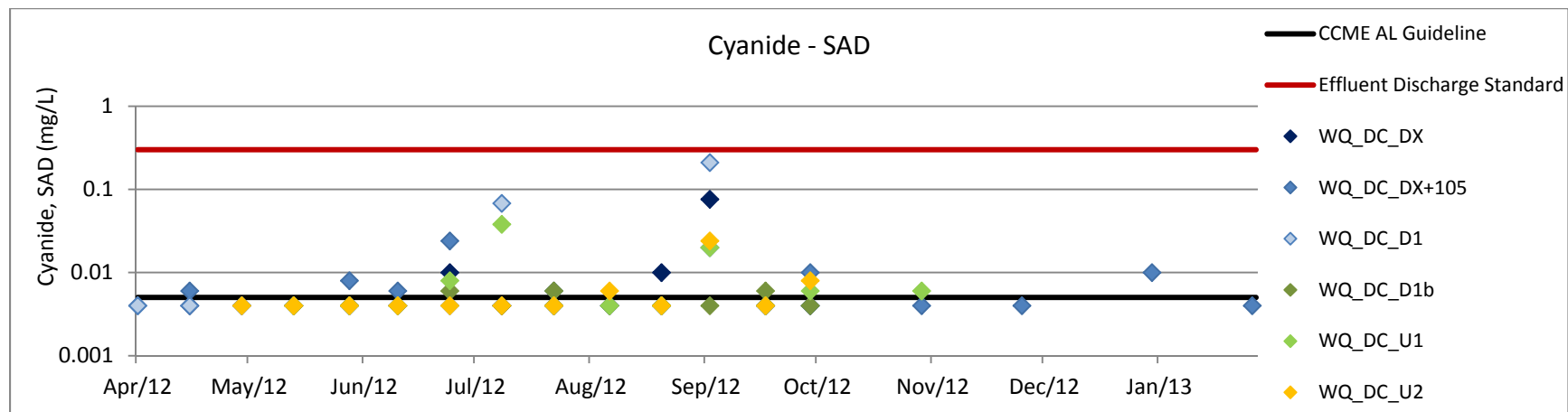
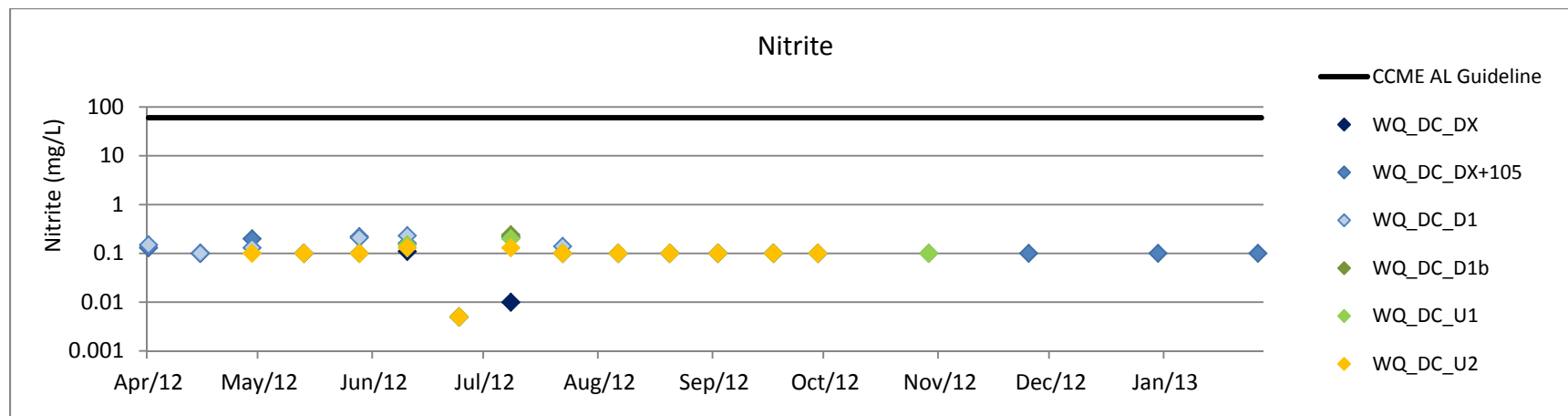


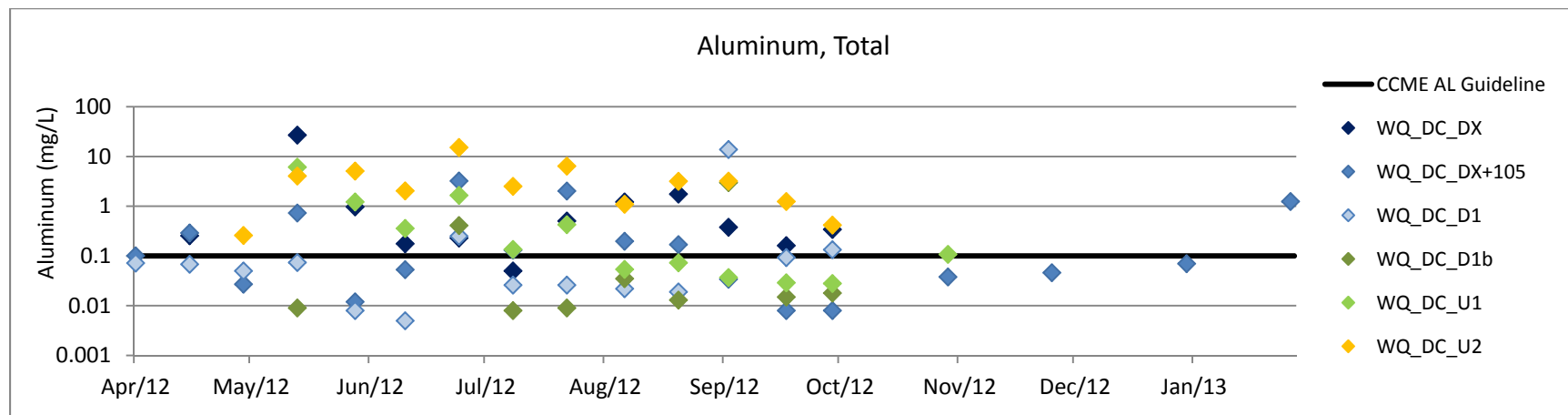
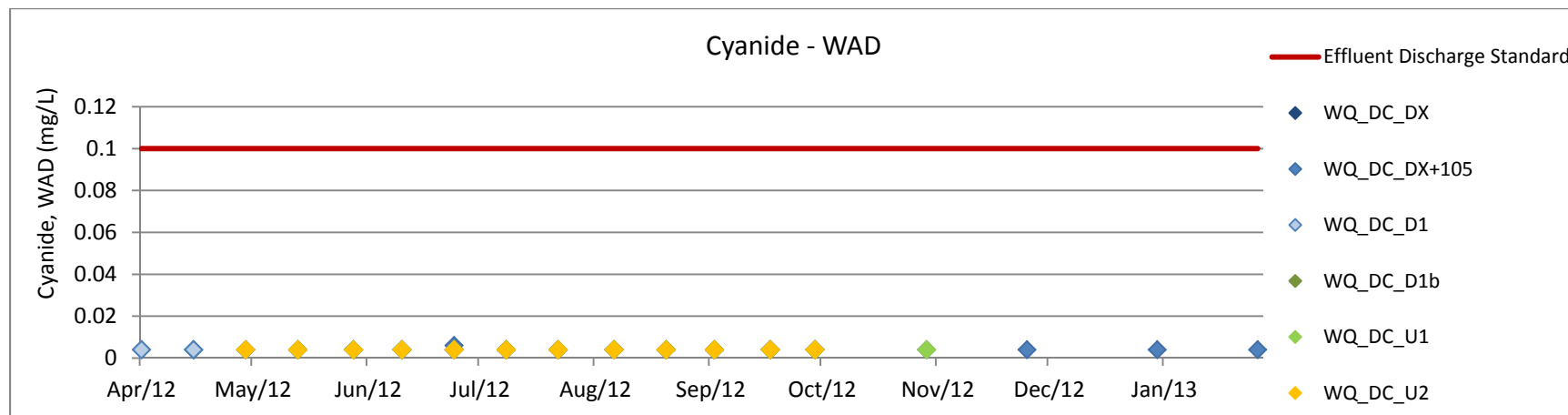


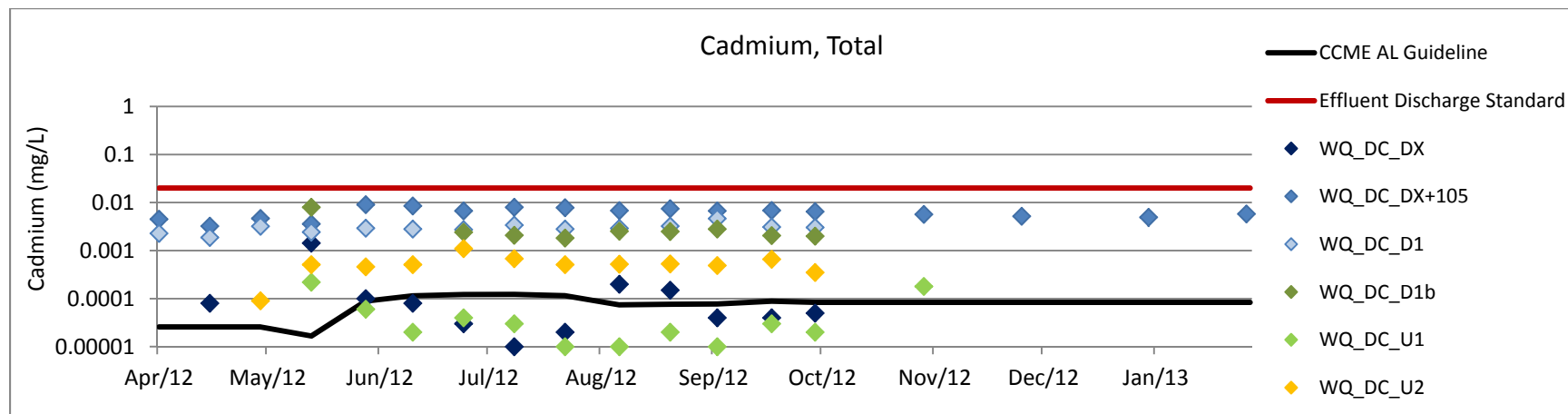
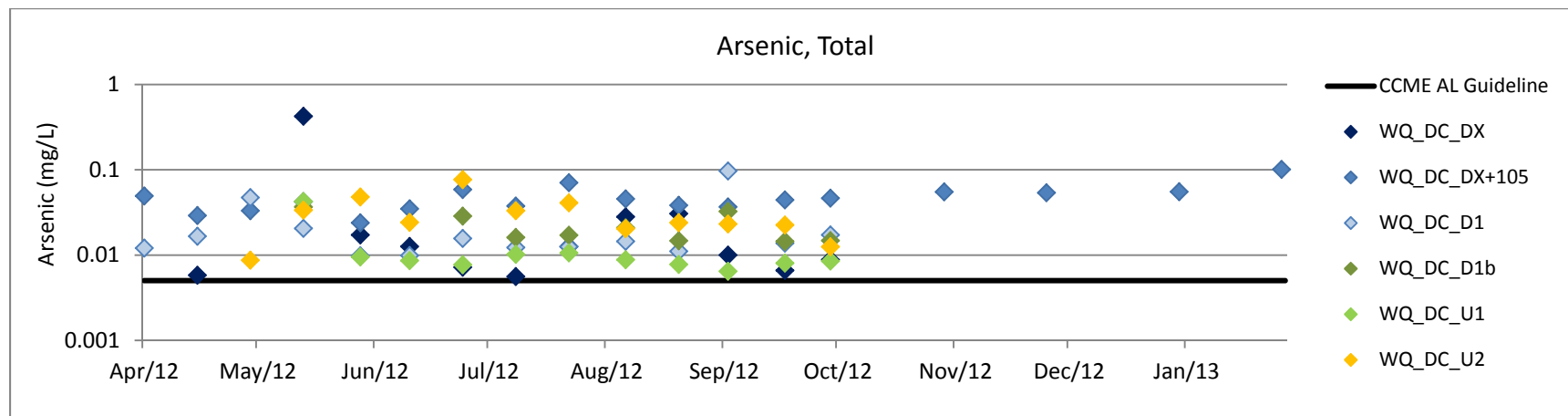
Figure C3. Upper Dome Creek watershed surface water quality figures.

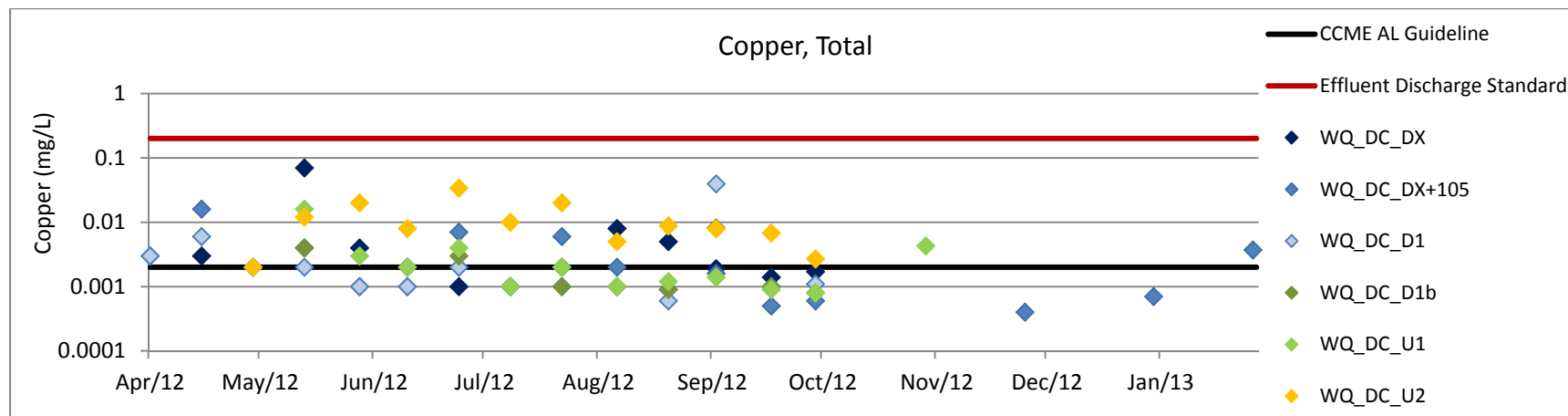
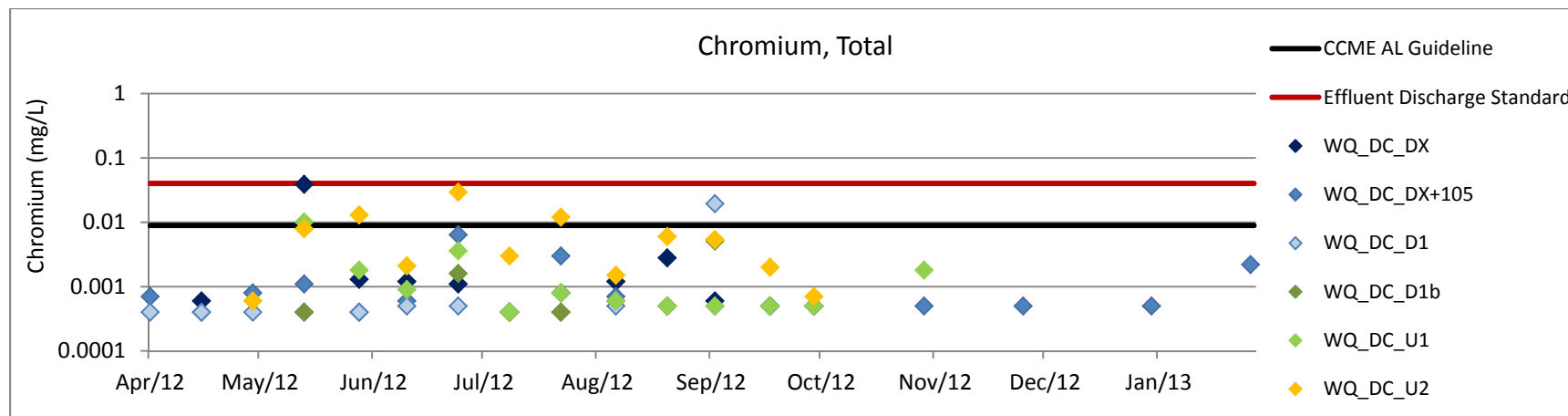


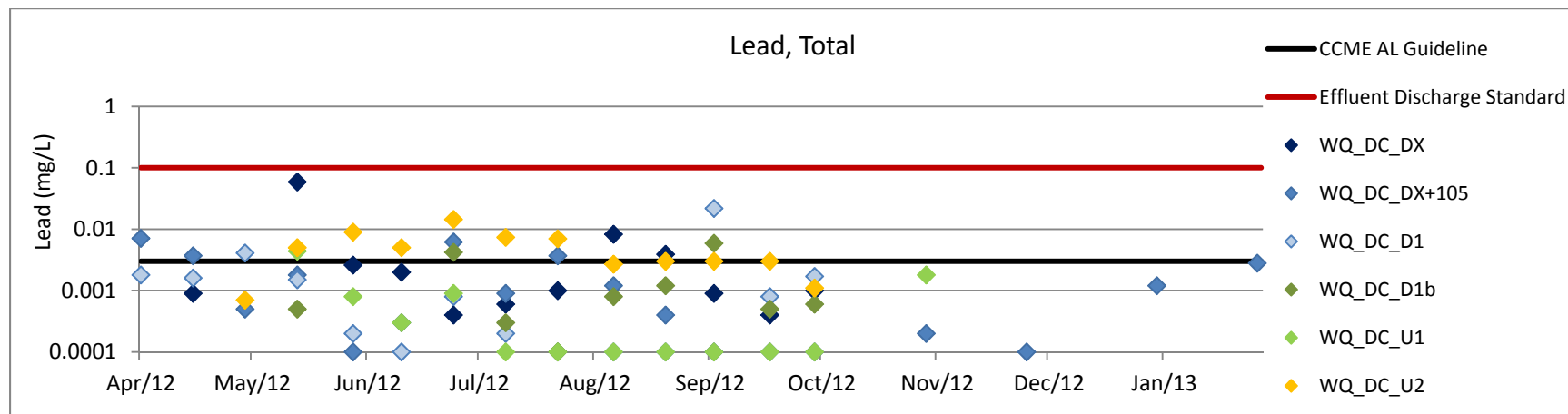
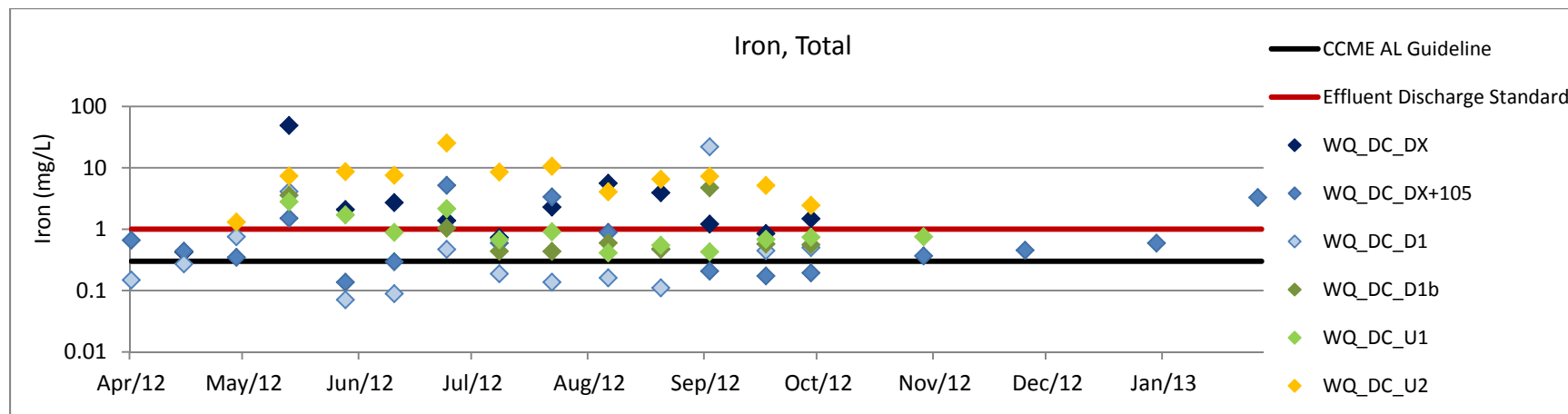


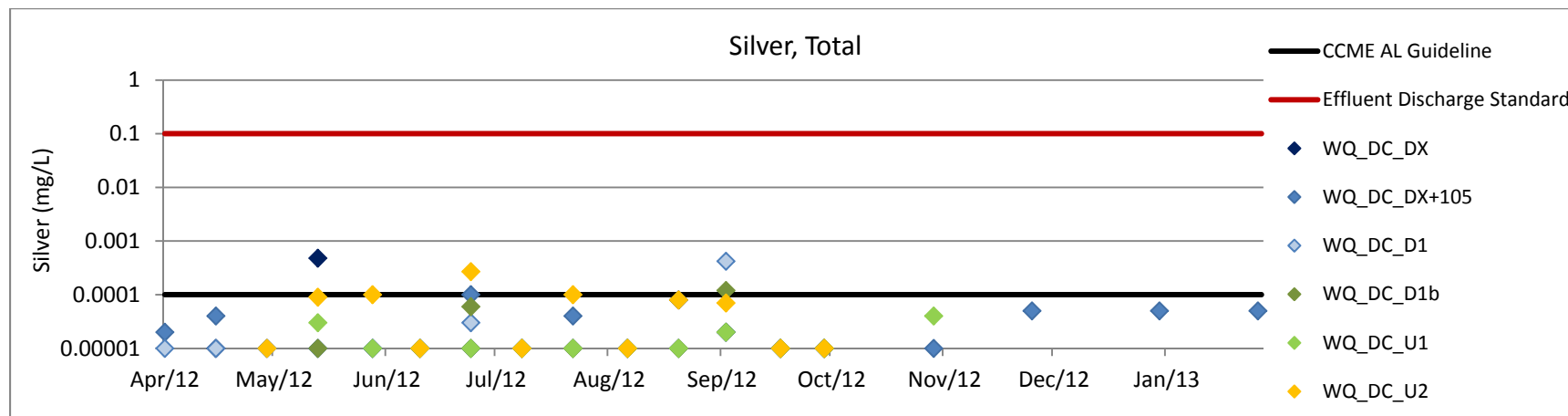
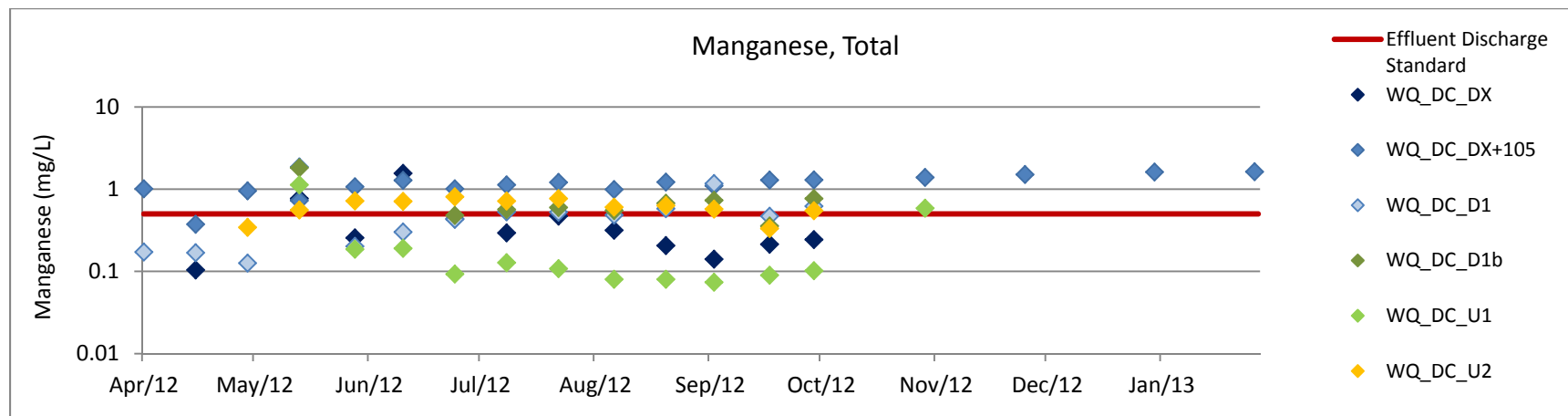












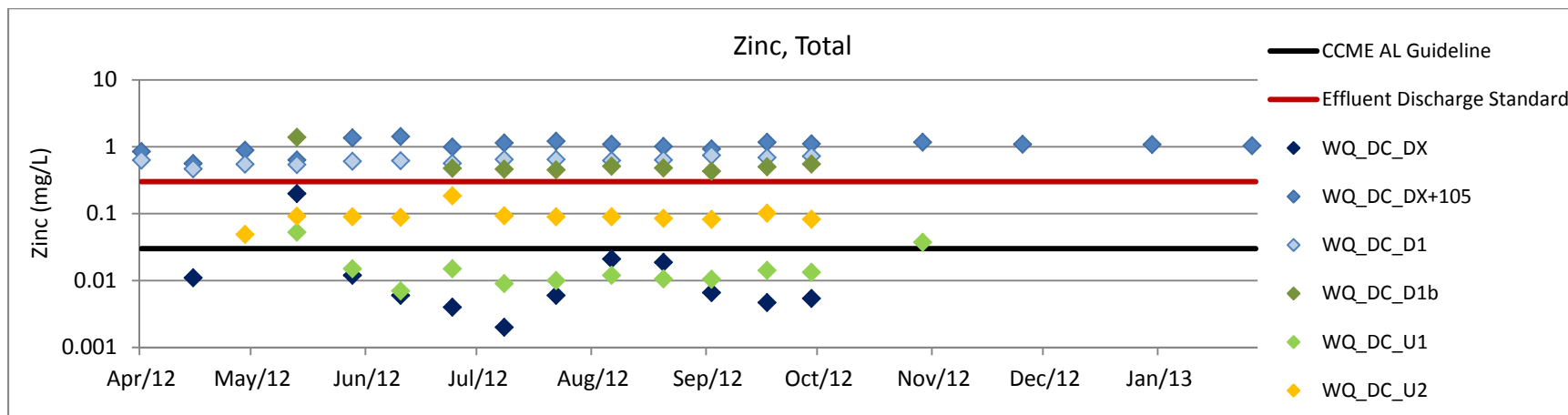
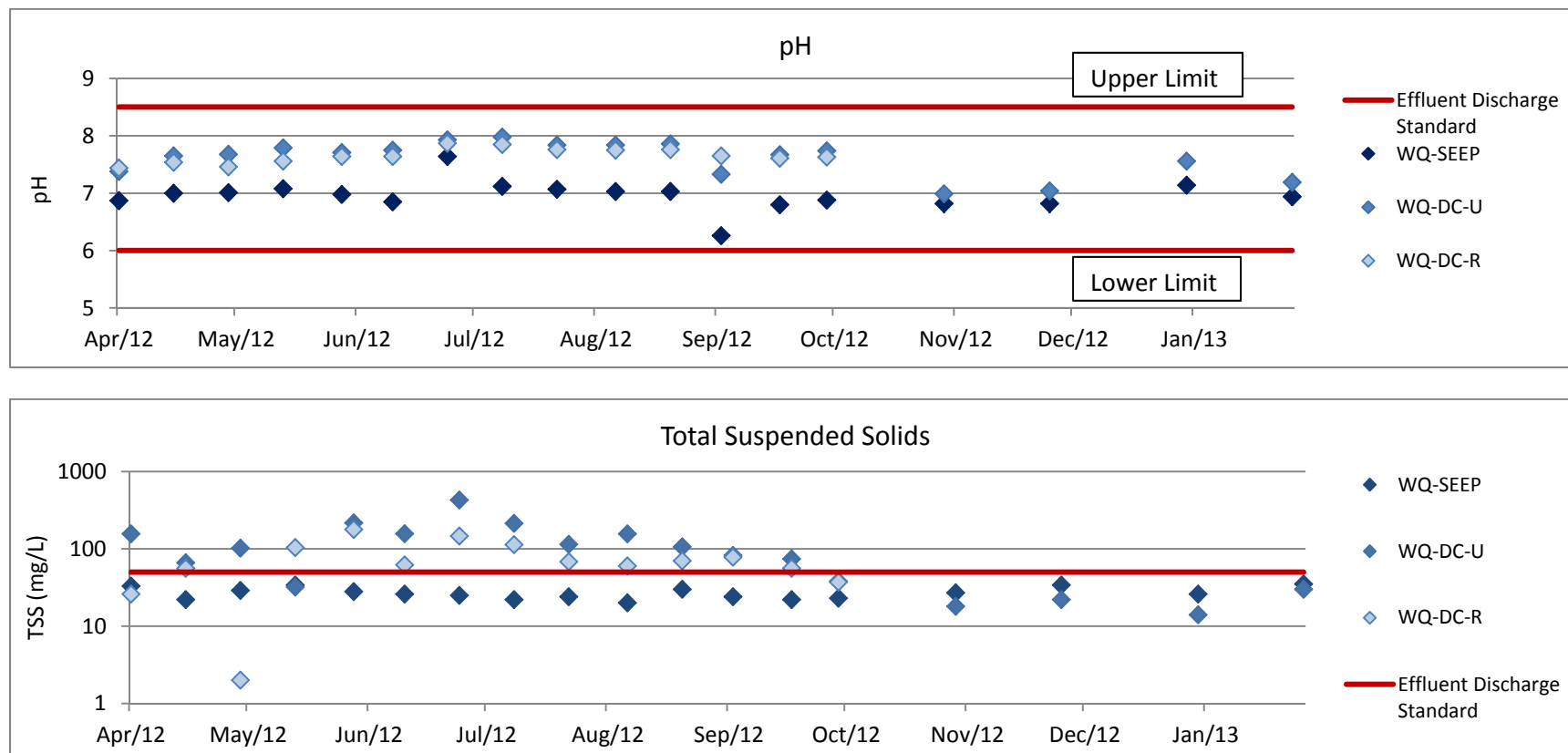
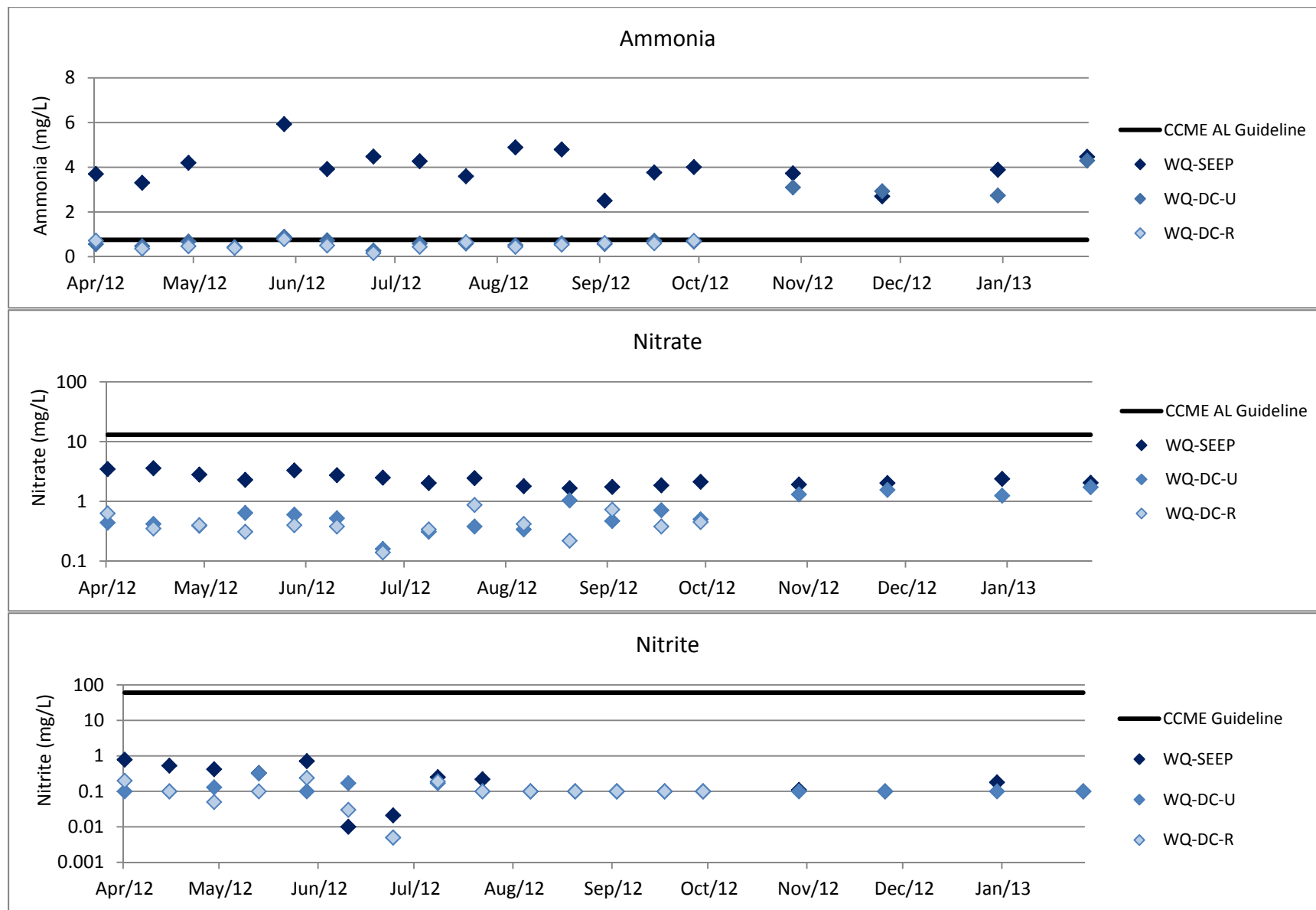
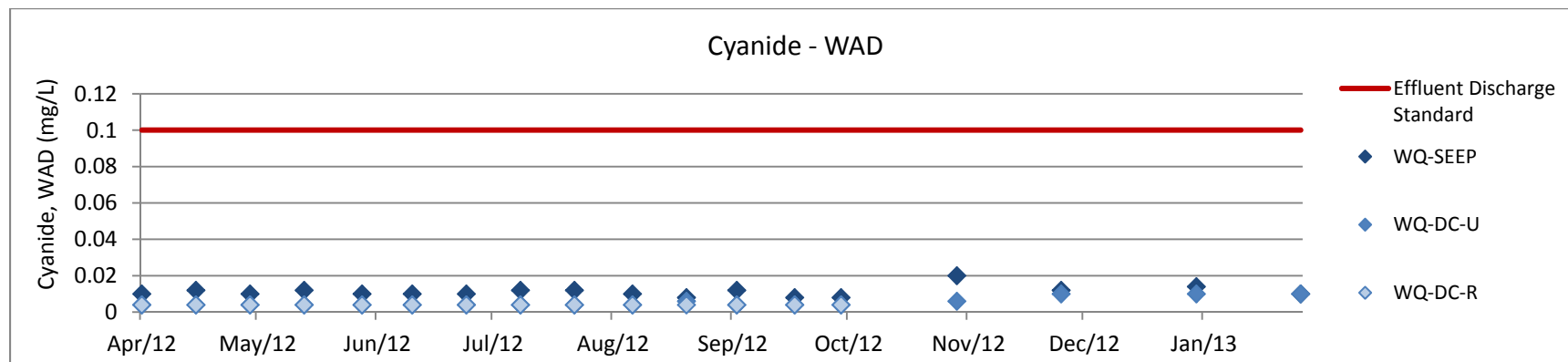
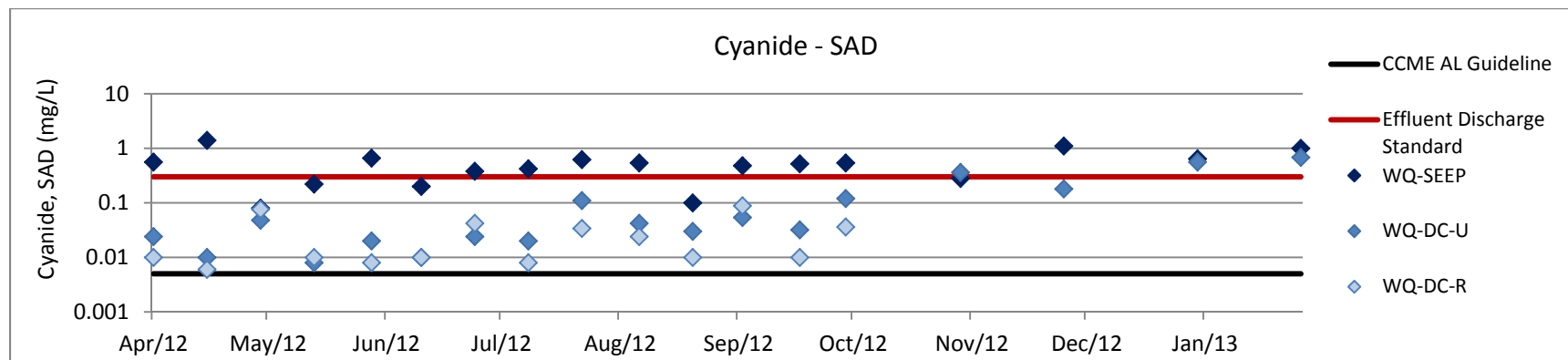


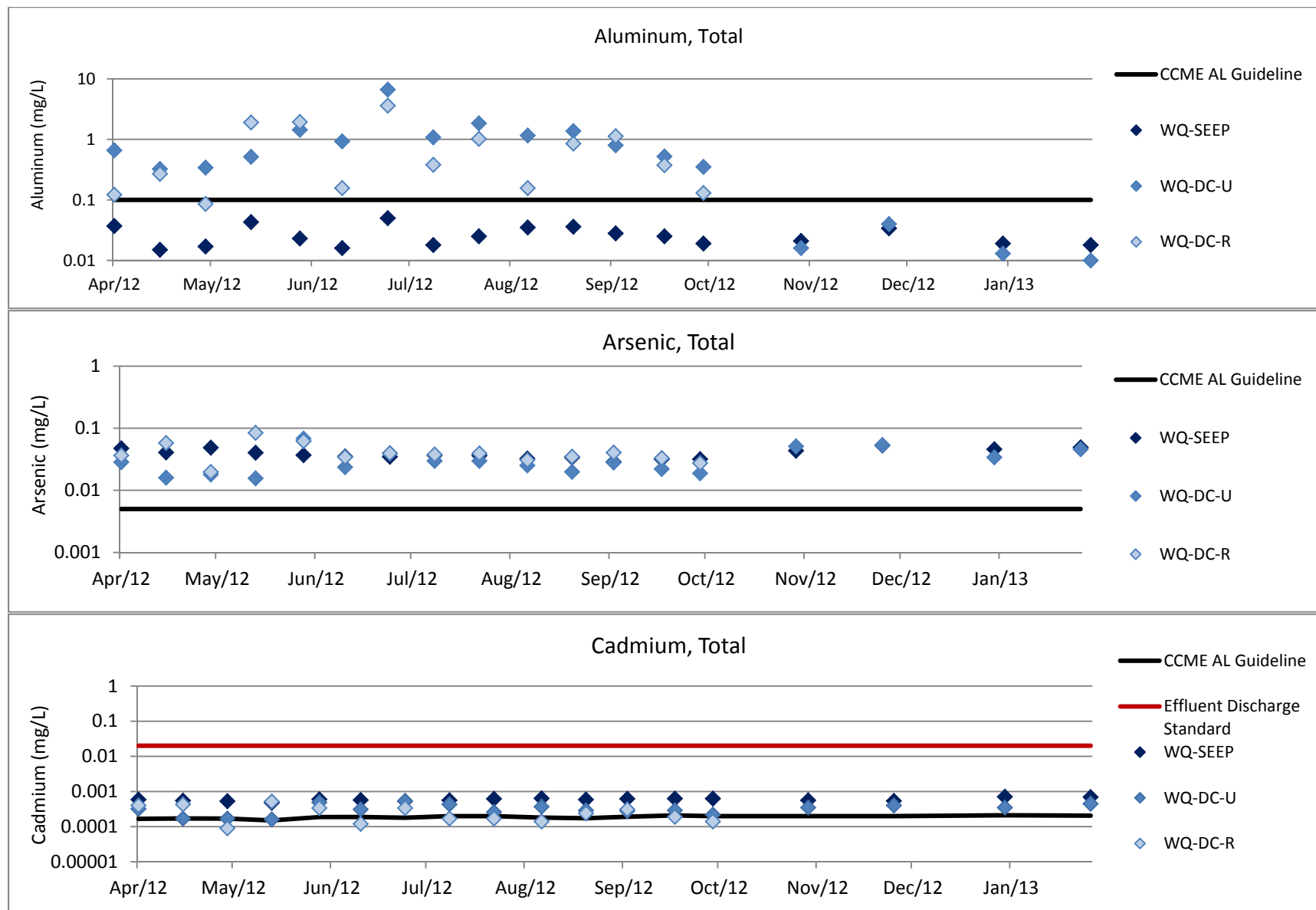


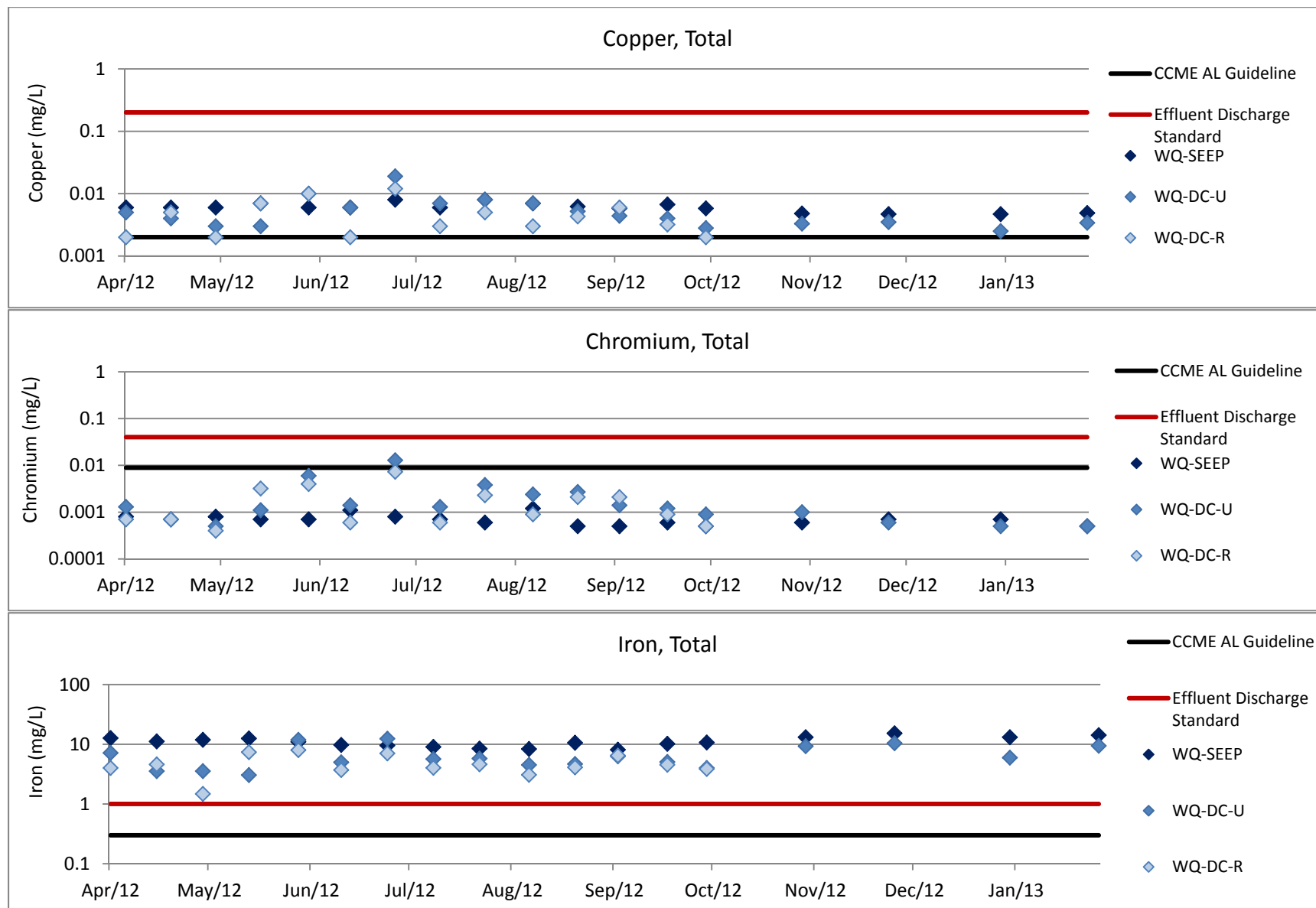
Figure C4. Lower Dome Creek watershed surface water quality figures.

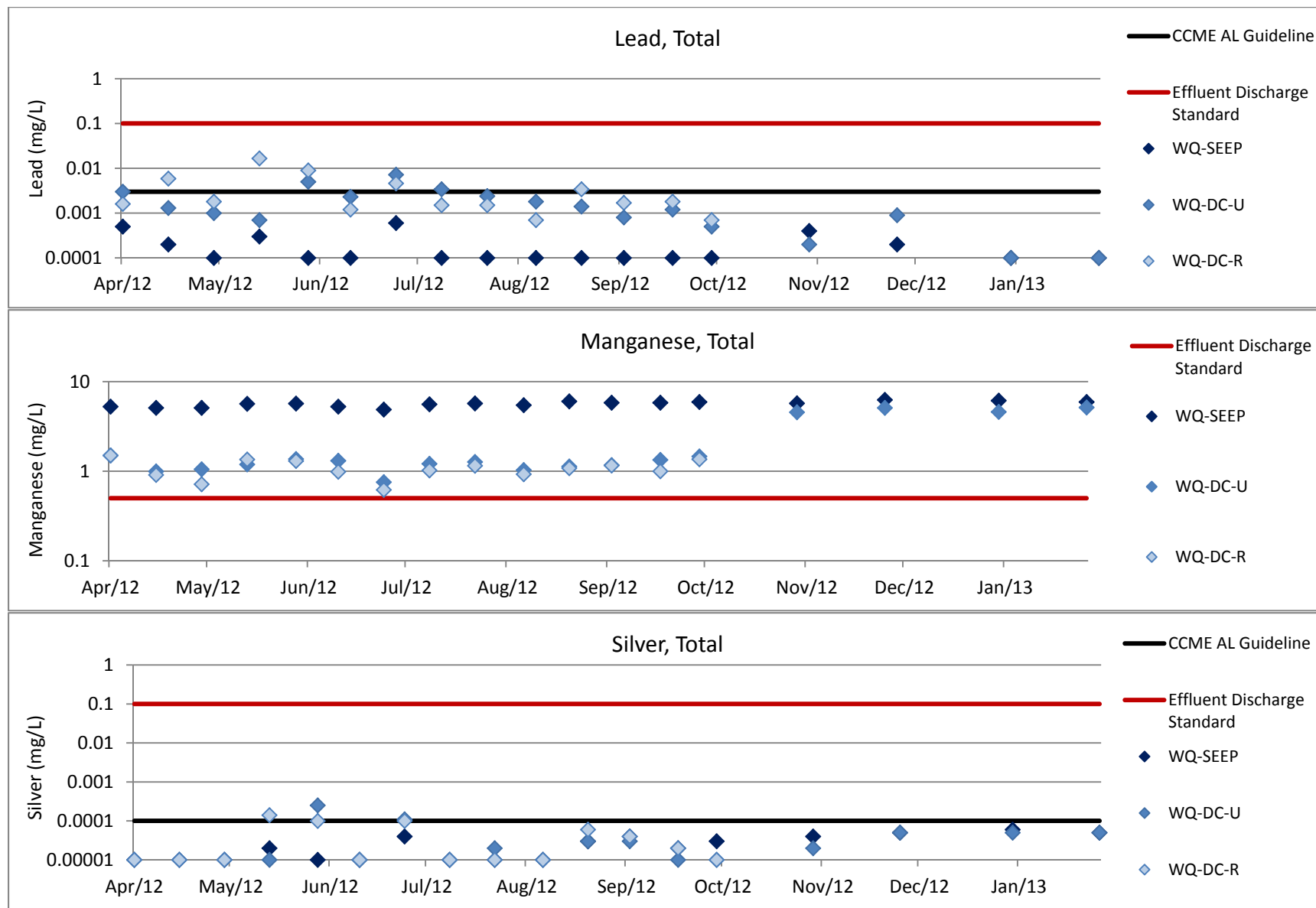












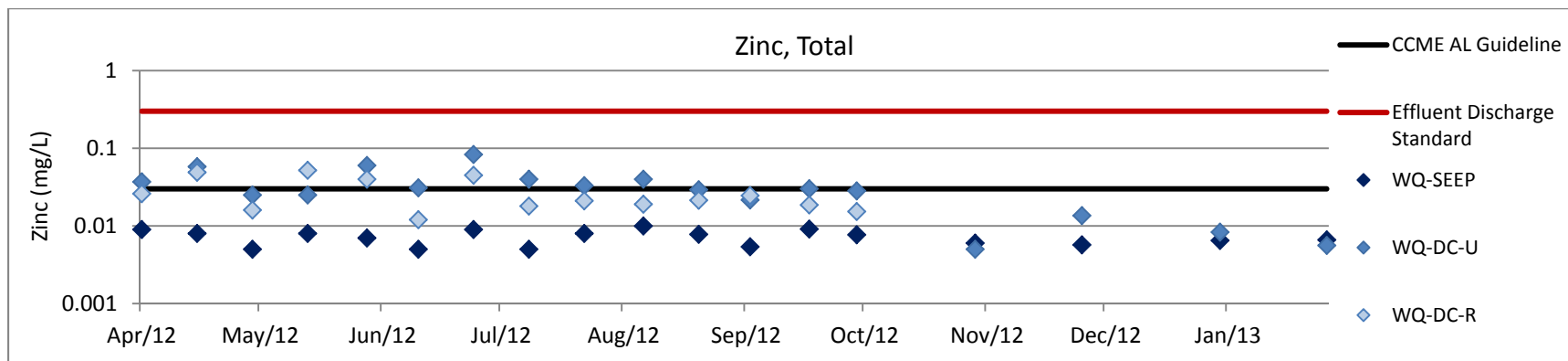
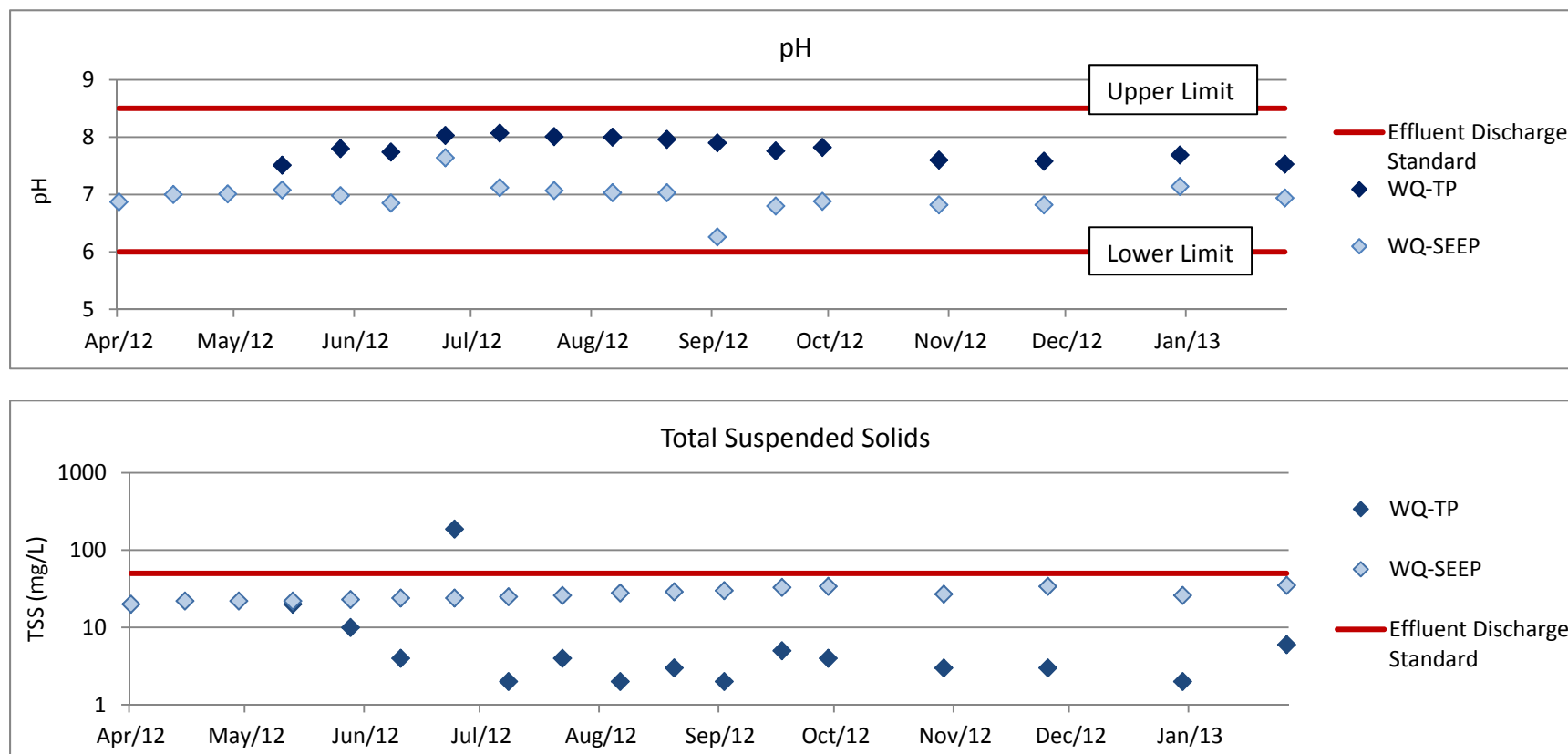
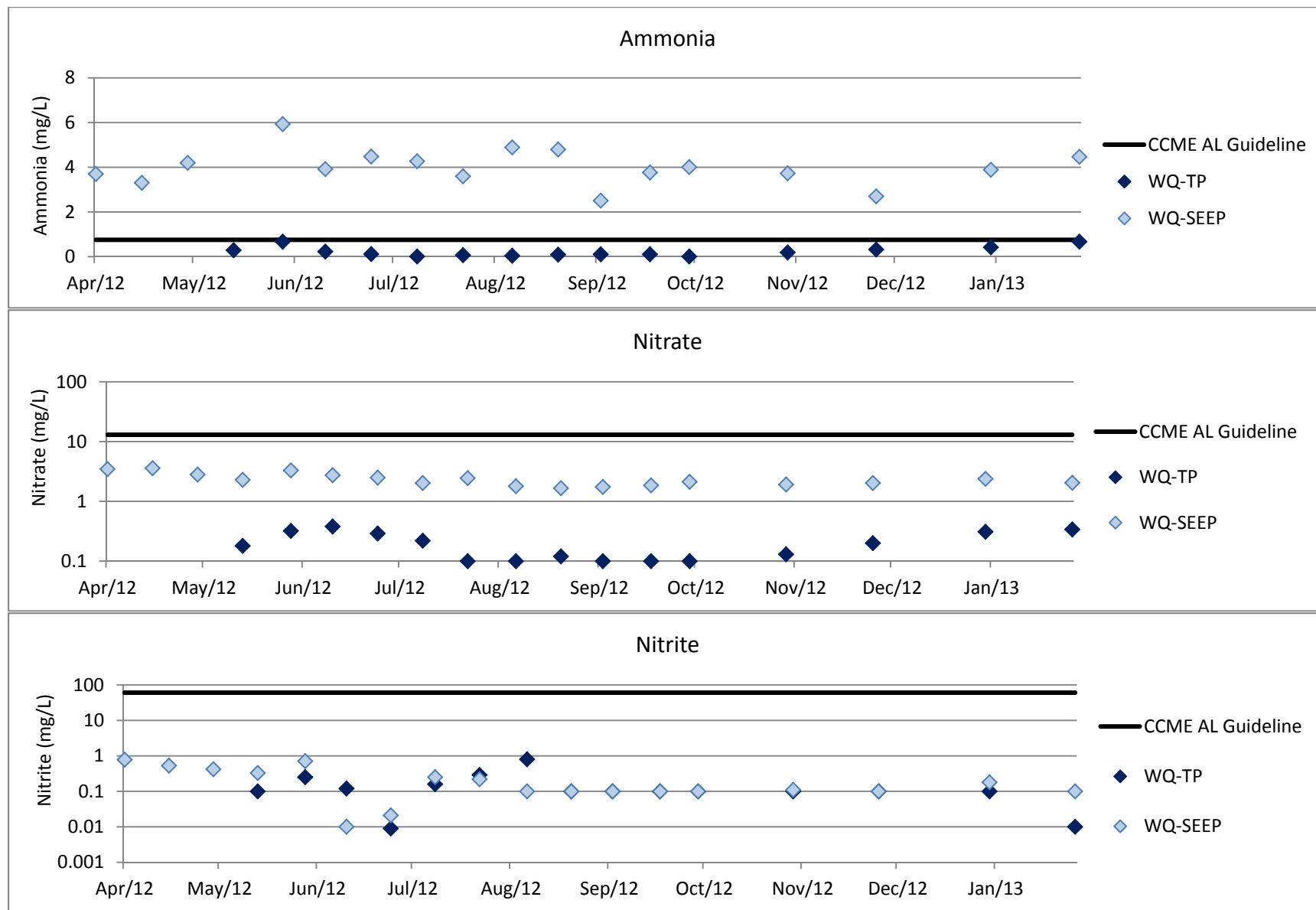
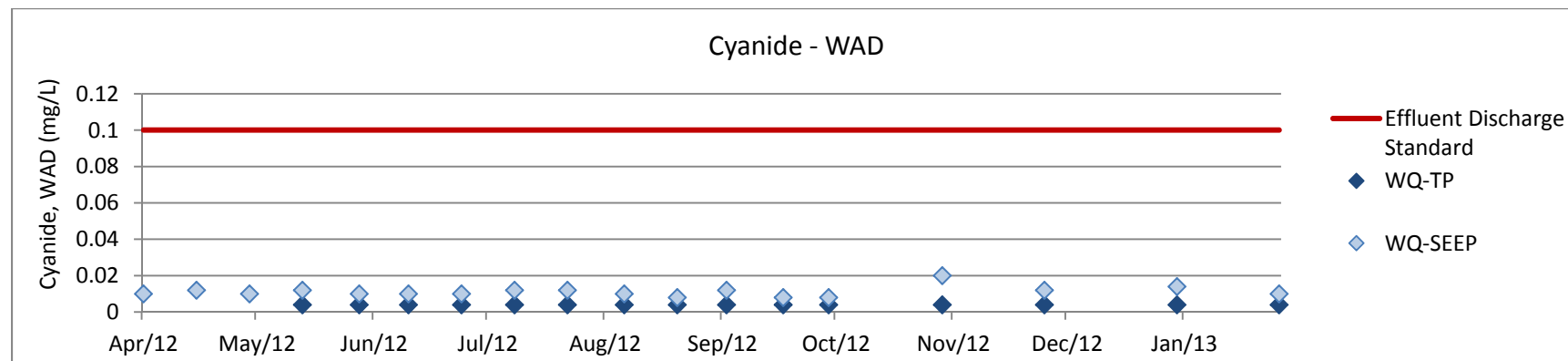
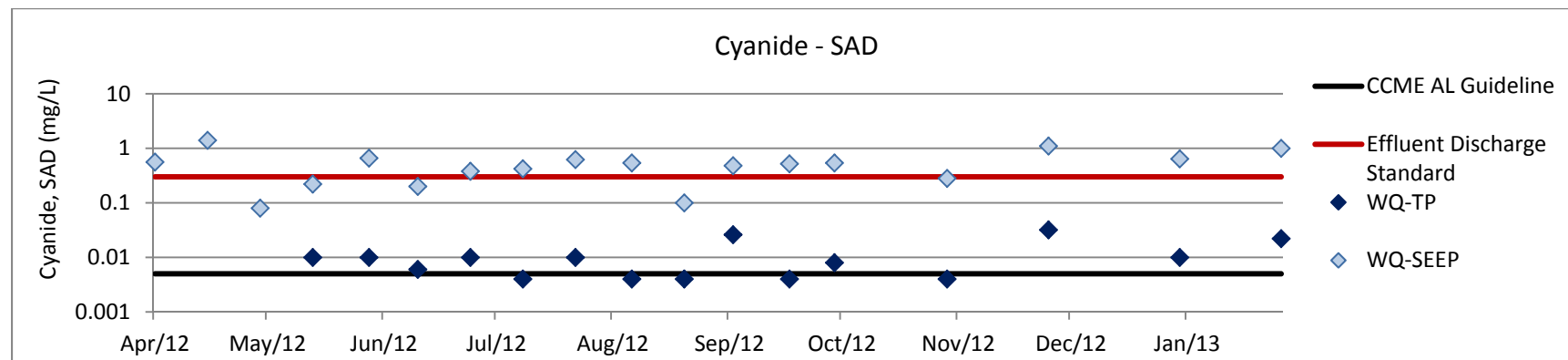


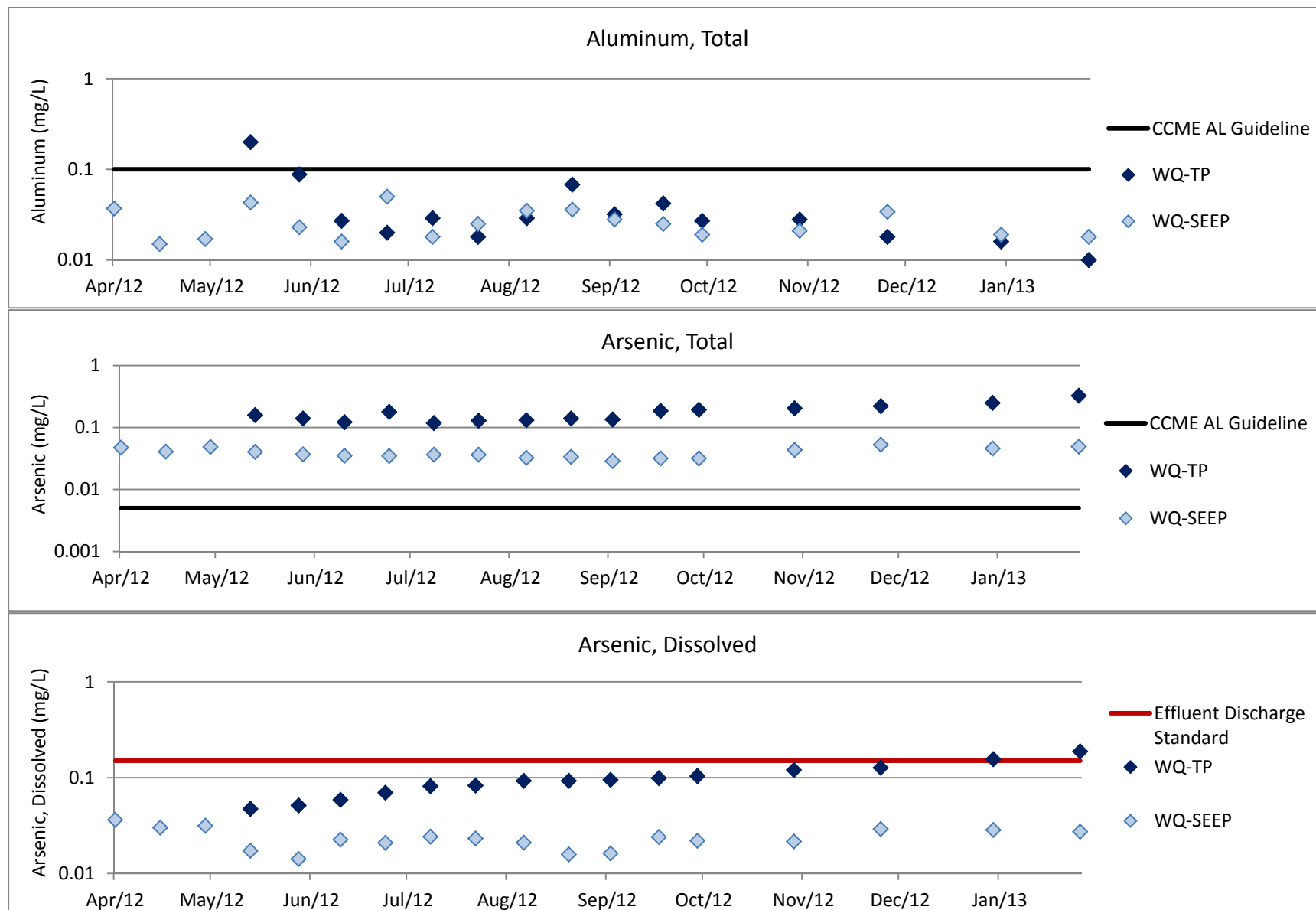


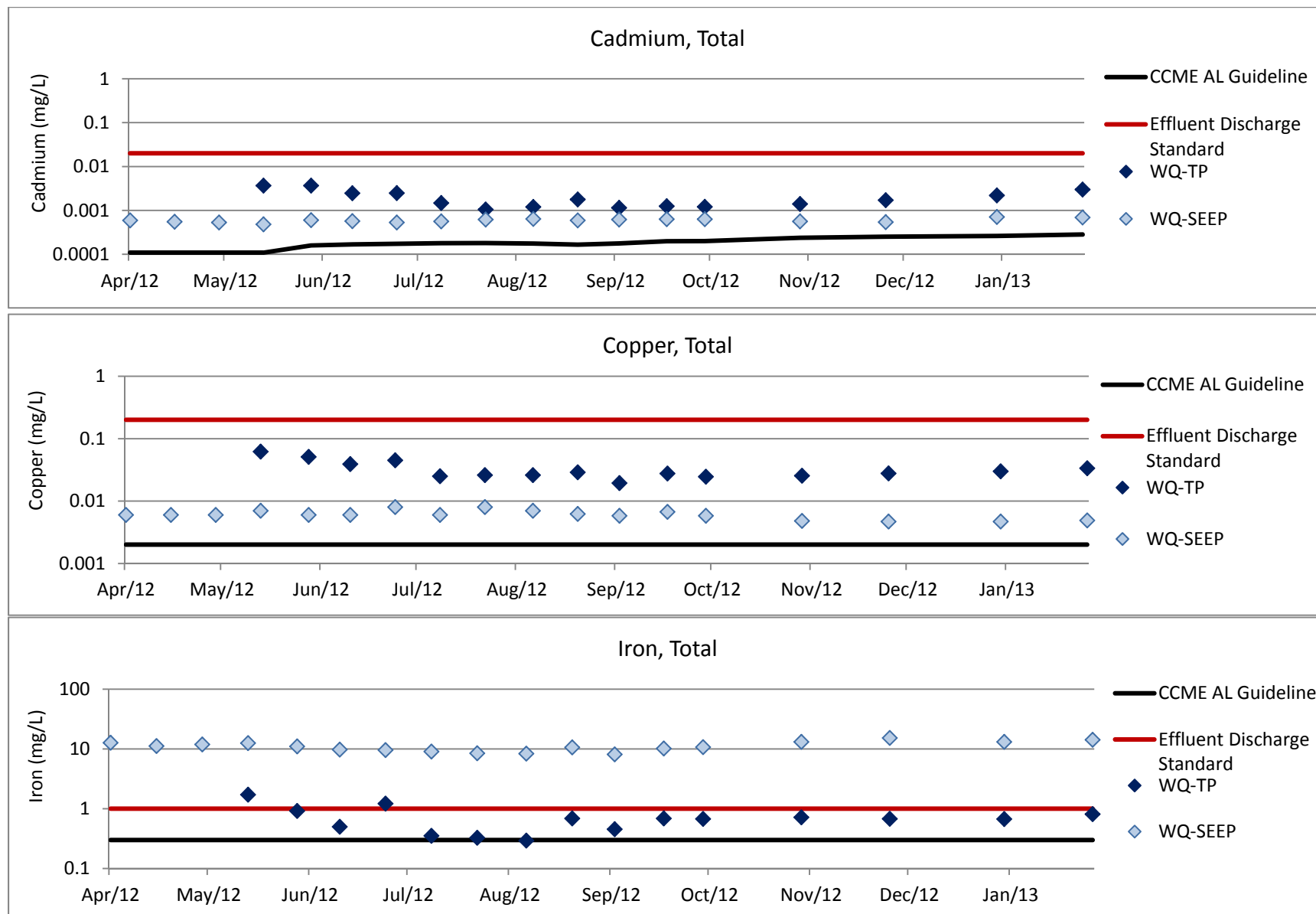
Figure C5. Tailings Pond and Seepage Pond Outlet Pipe surface water quality figures.

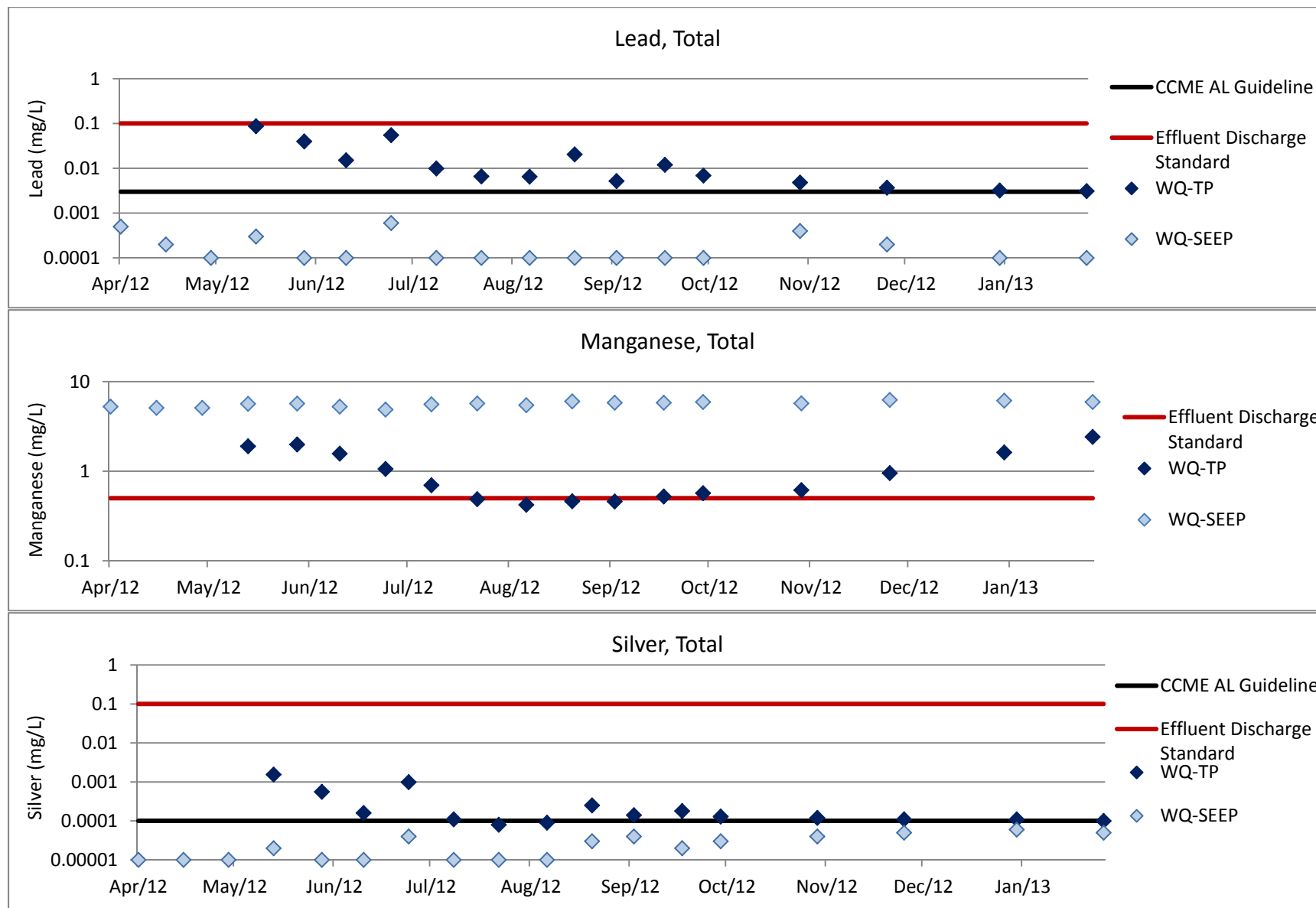












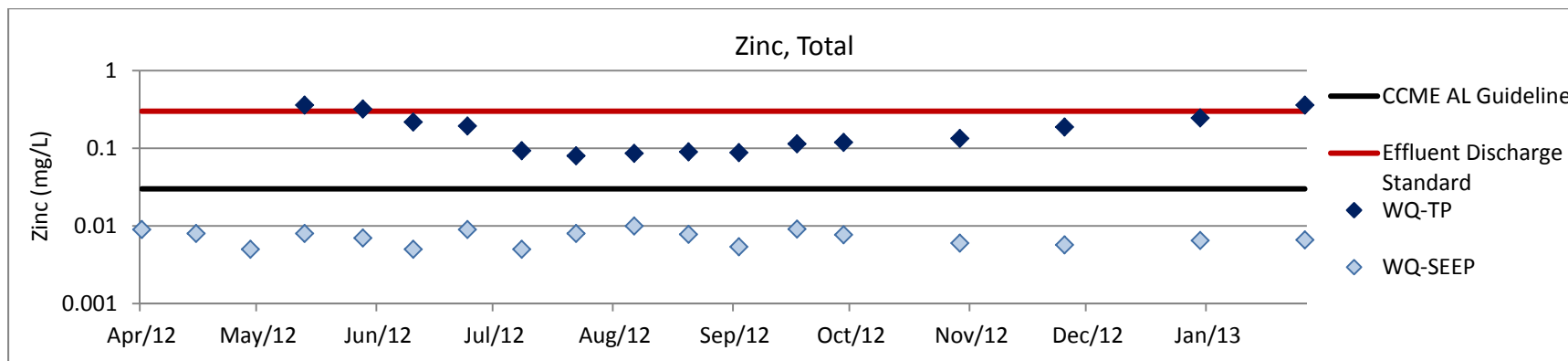
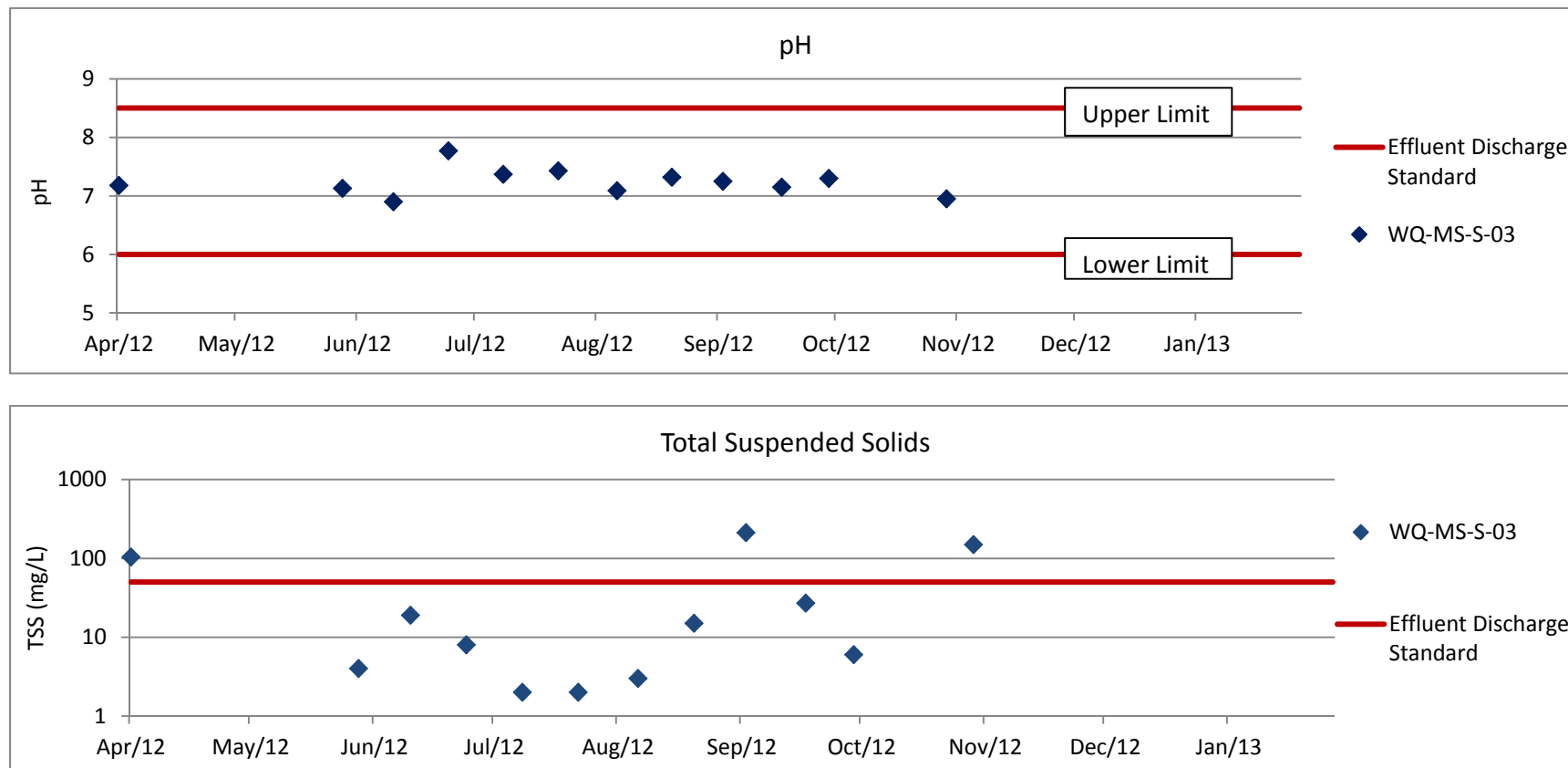
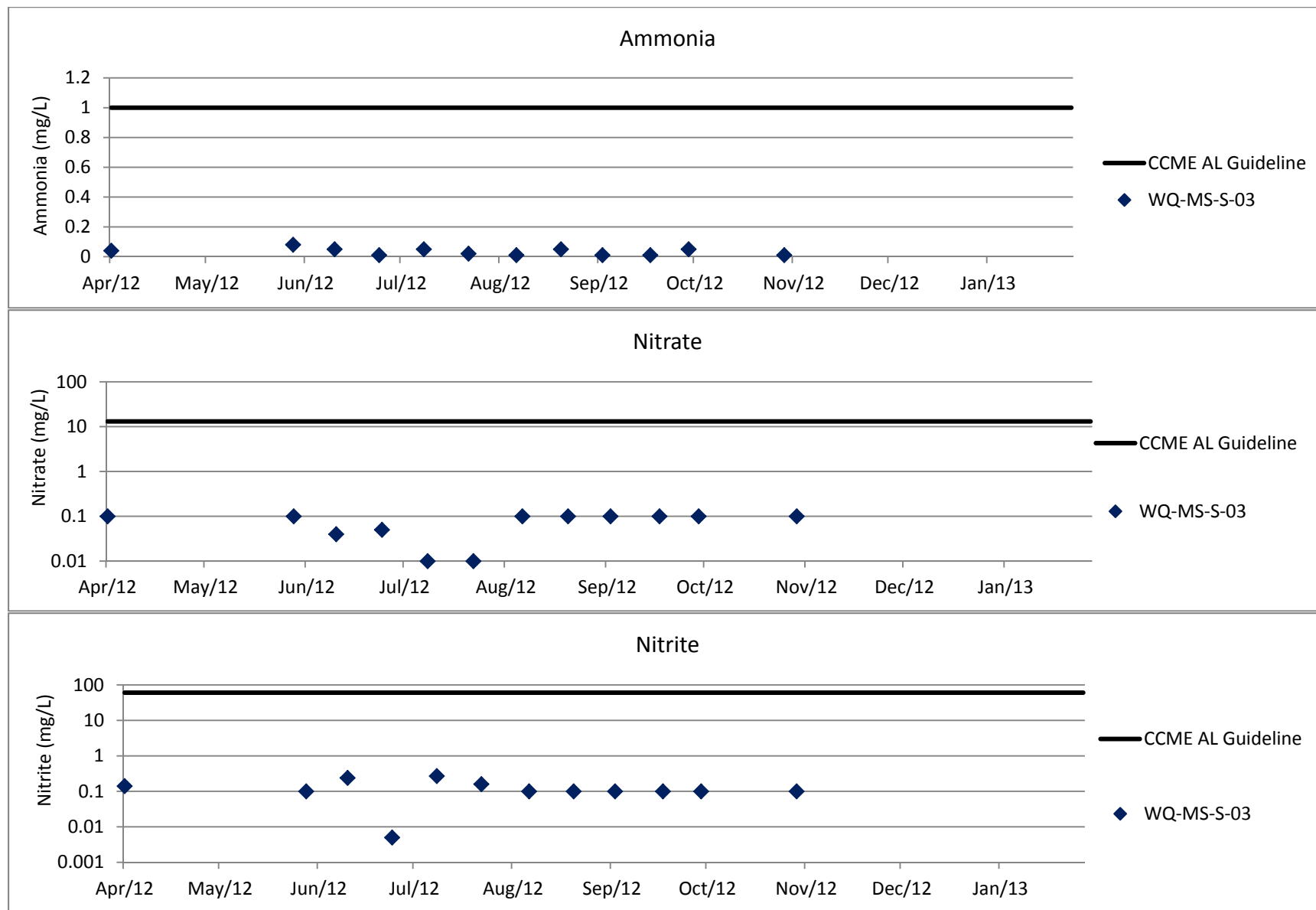
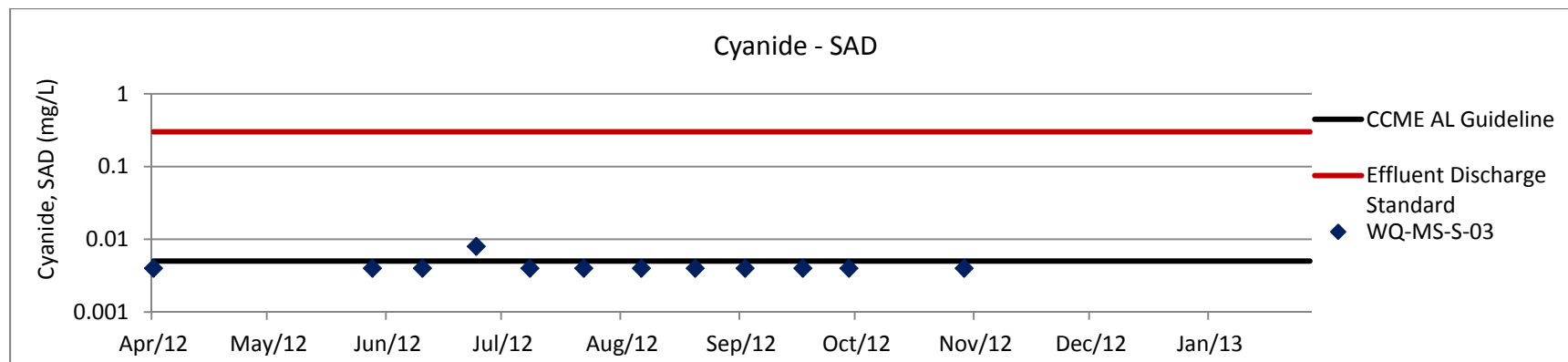
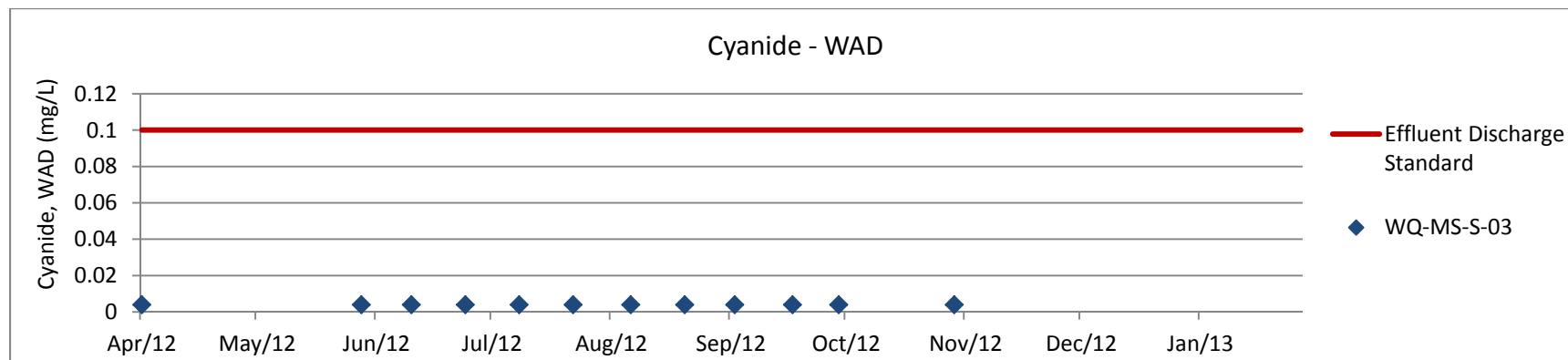


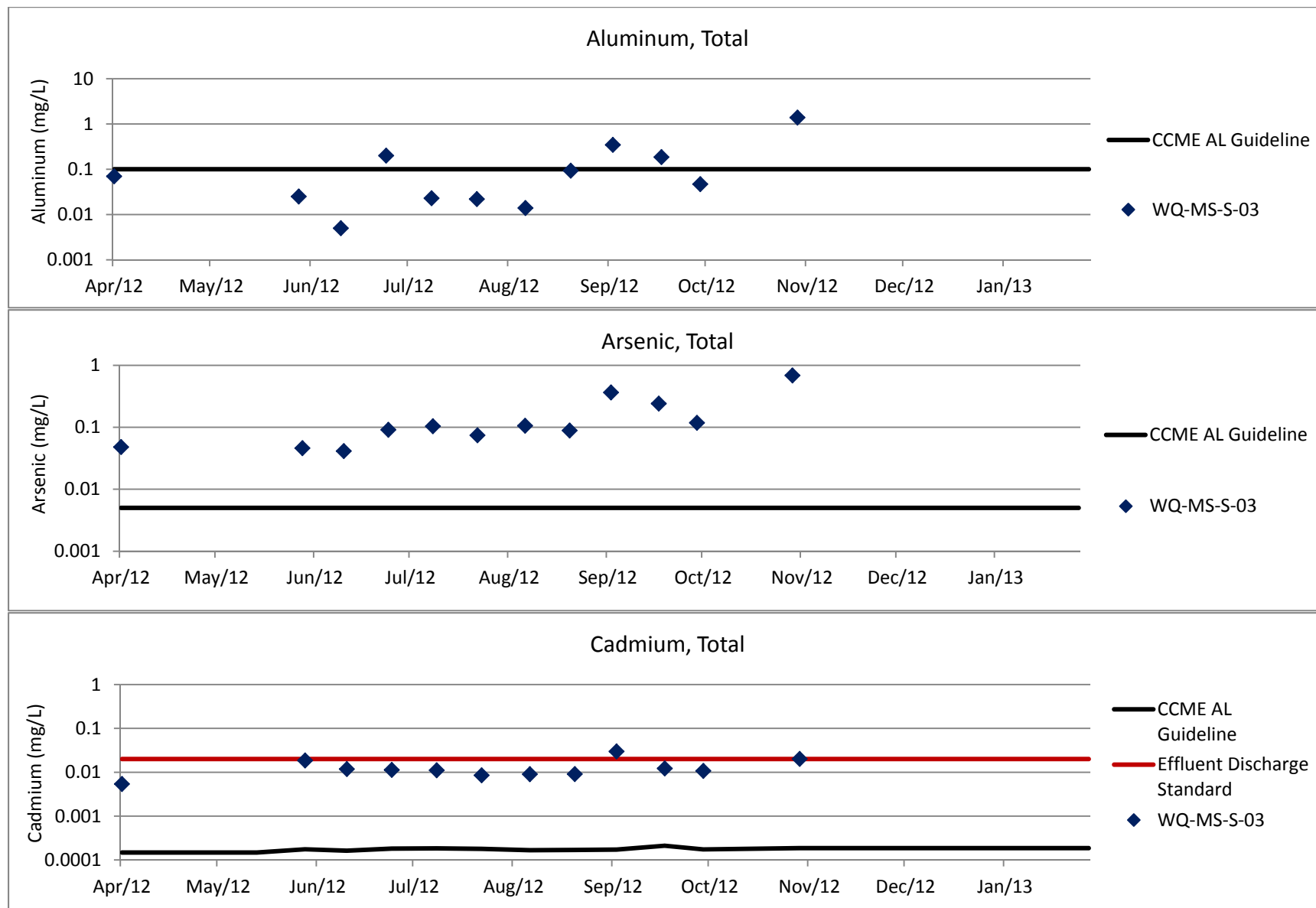


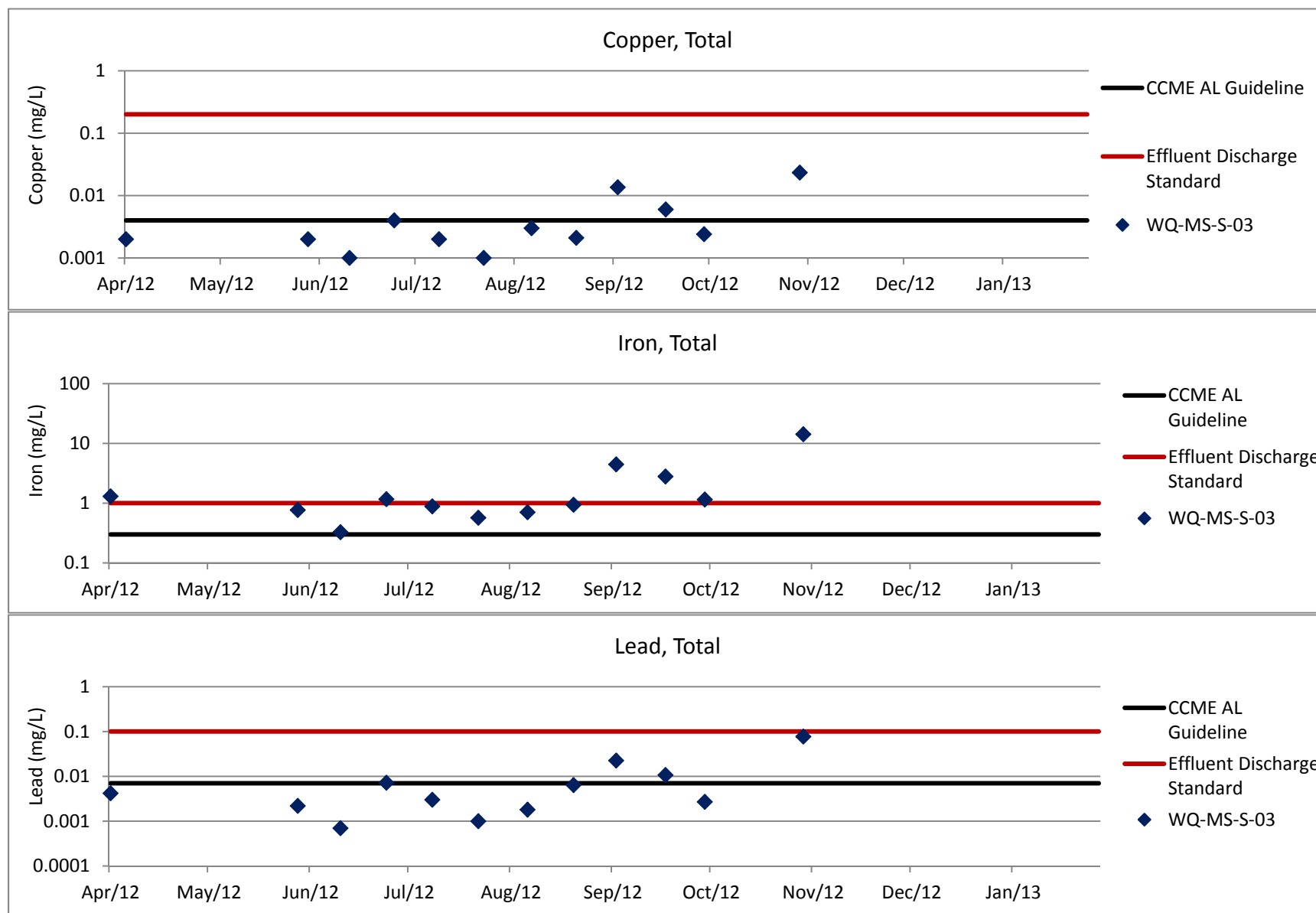
Figure C6. WQ-MS-S-03 surface water quality figures.











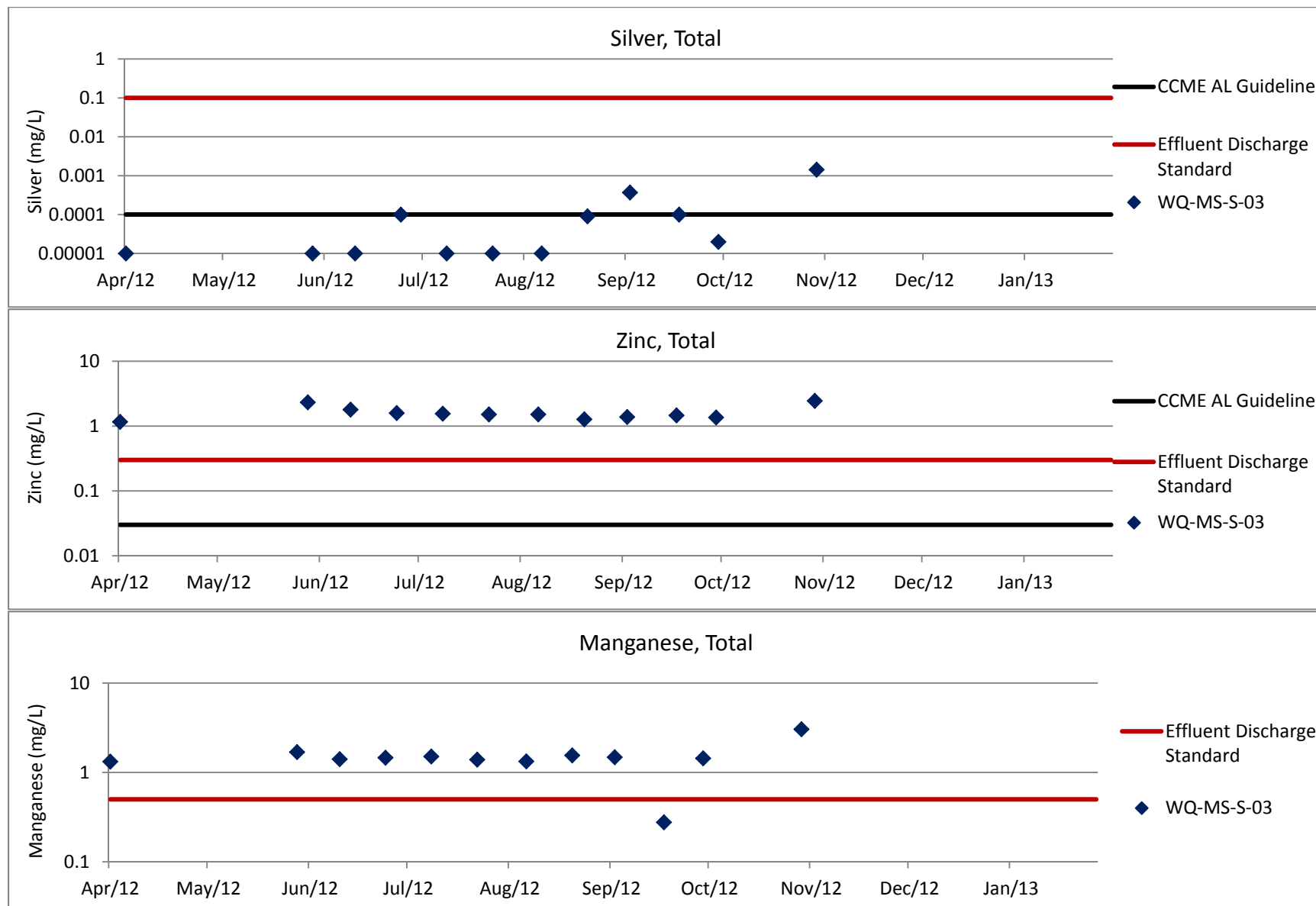
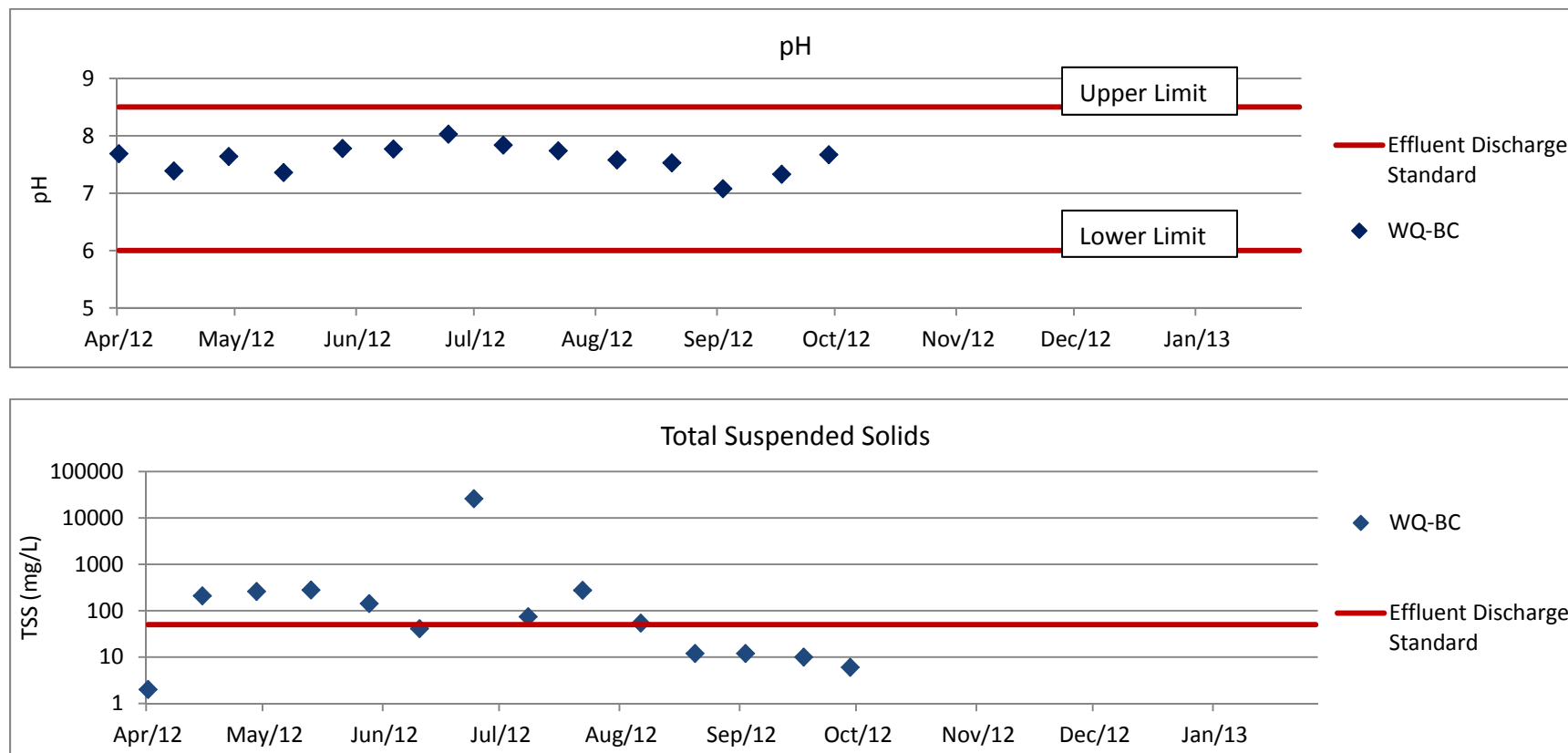
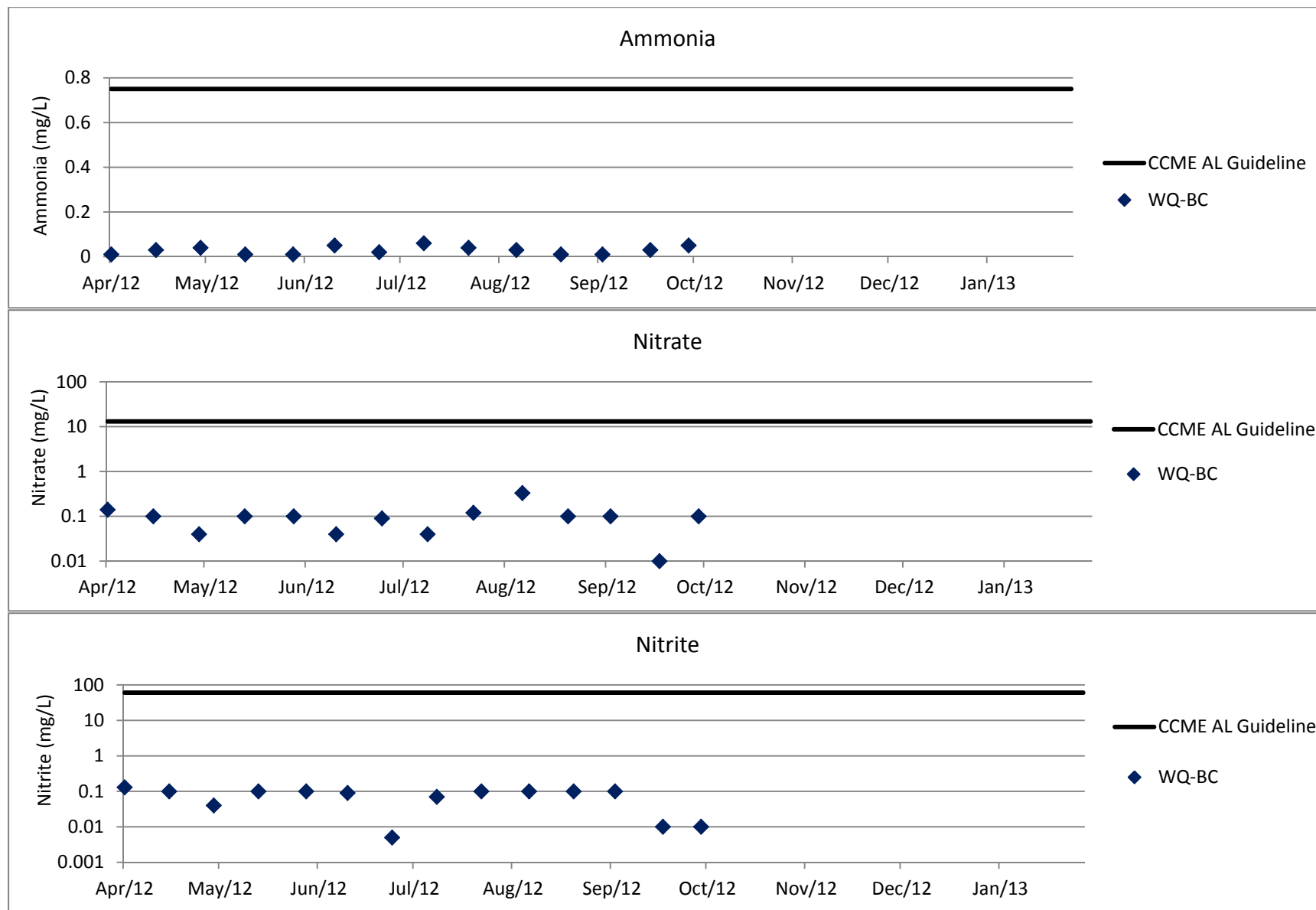
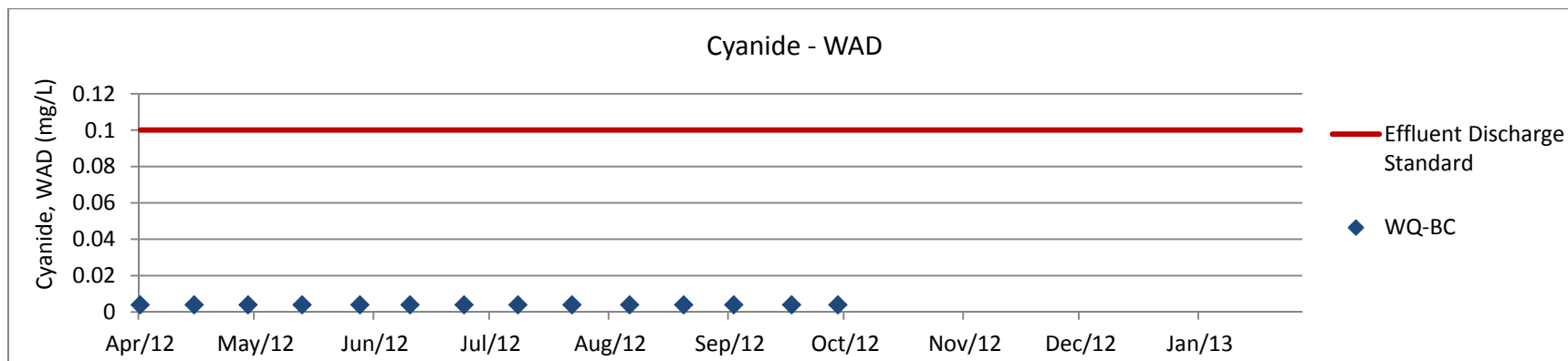
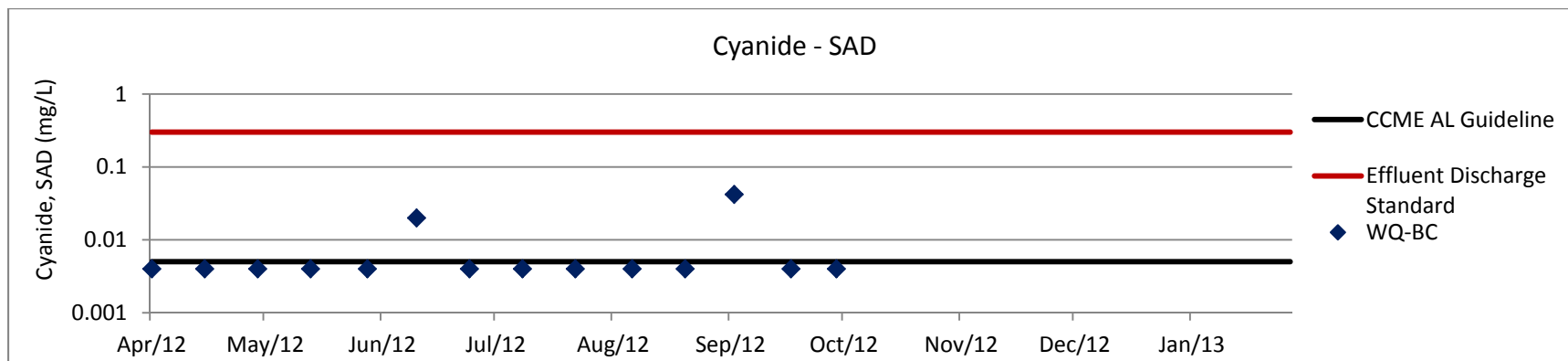


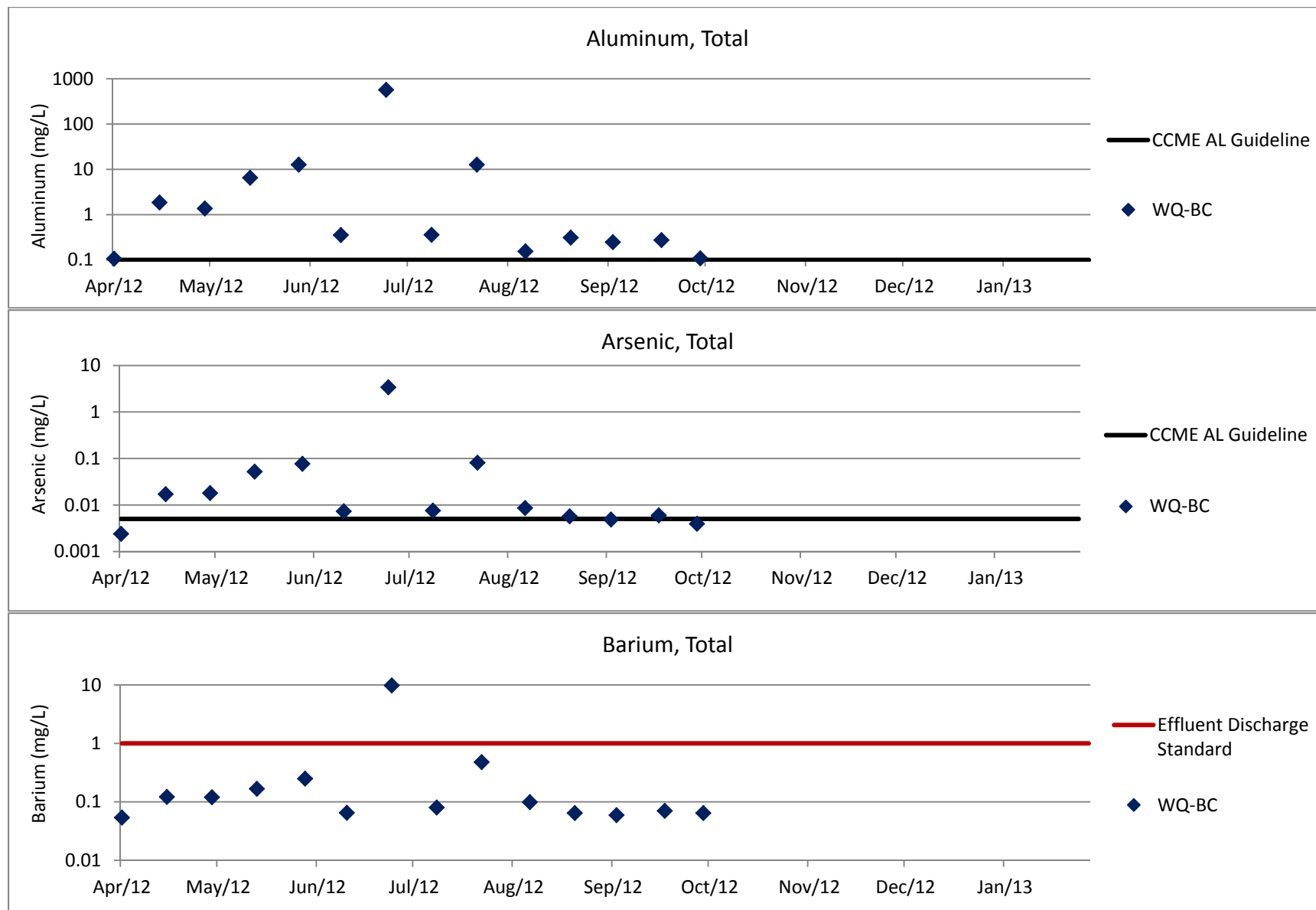


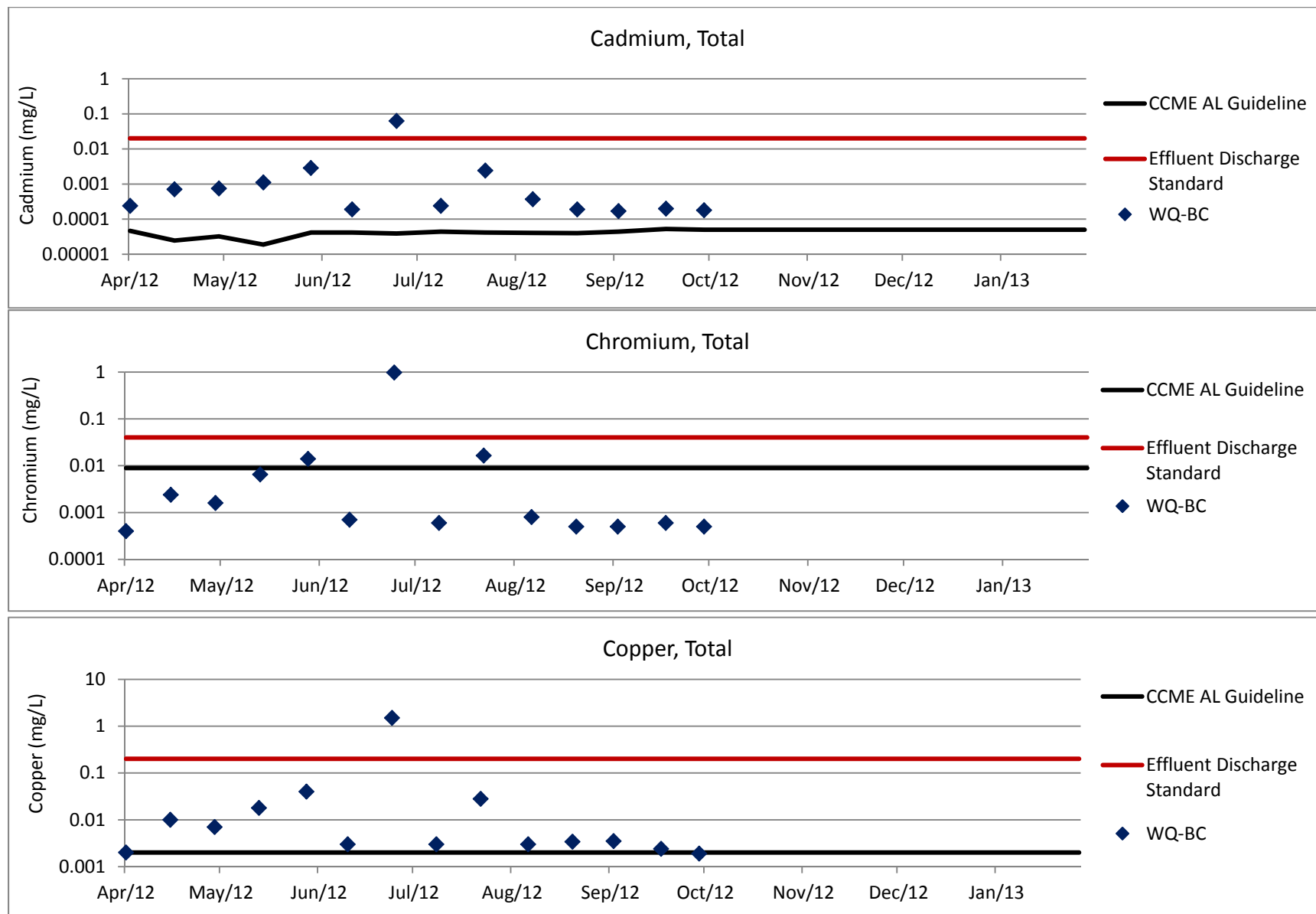
Figure C7. Back Creek surface water quality figures.

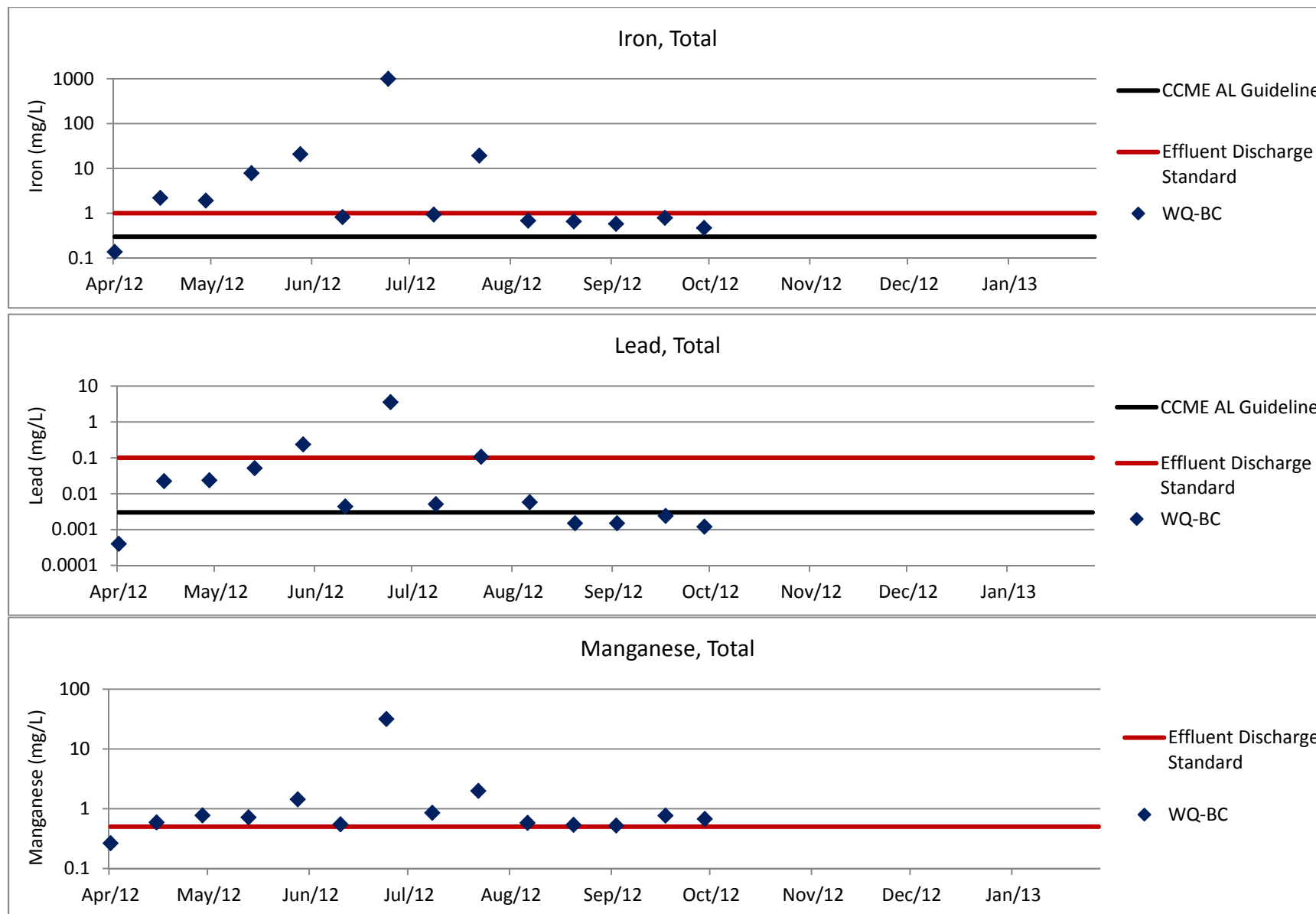












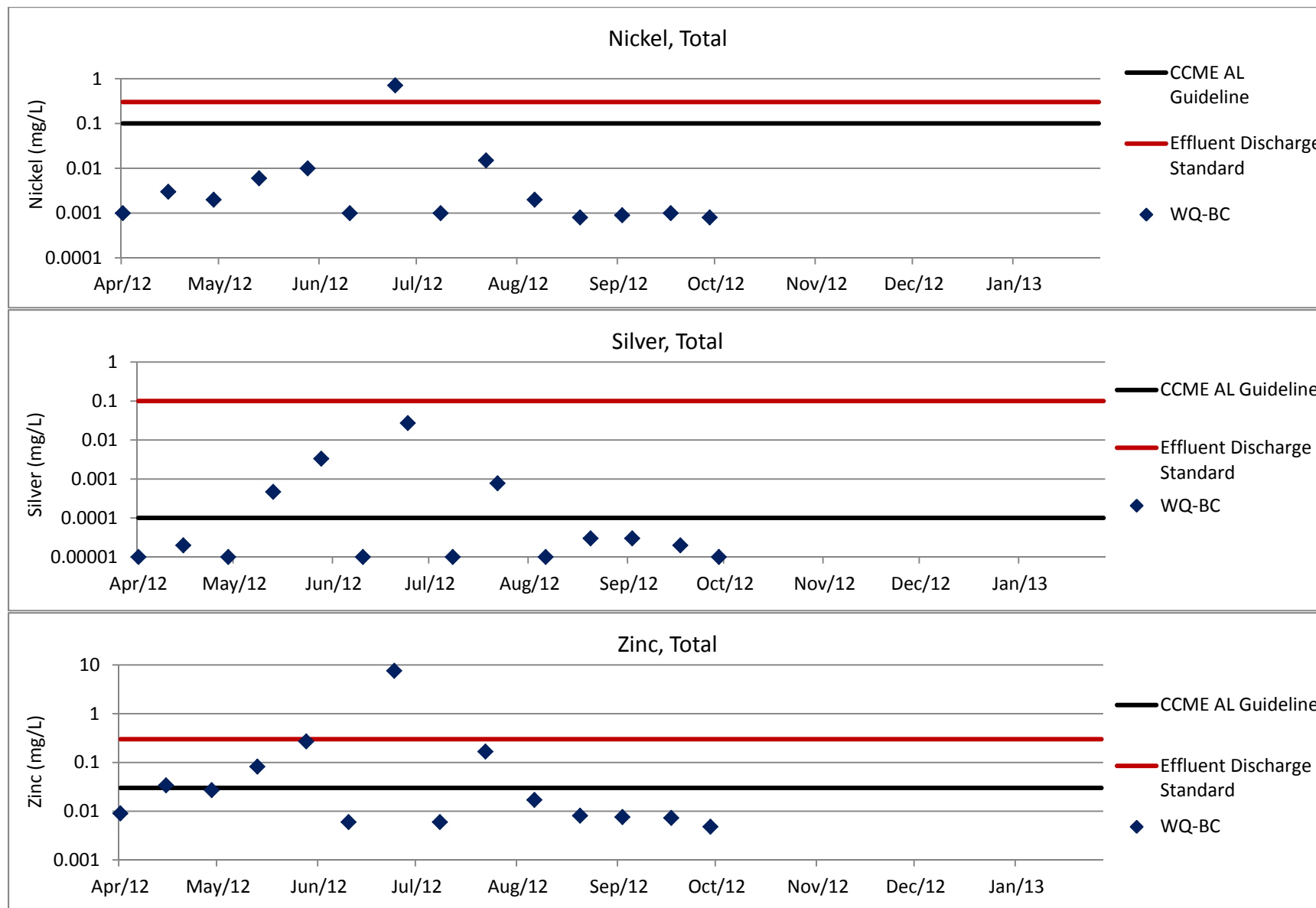
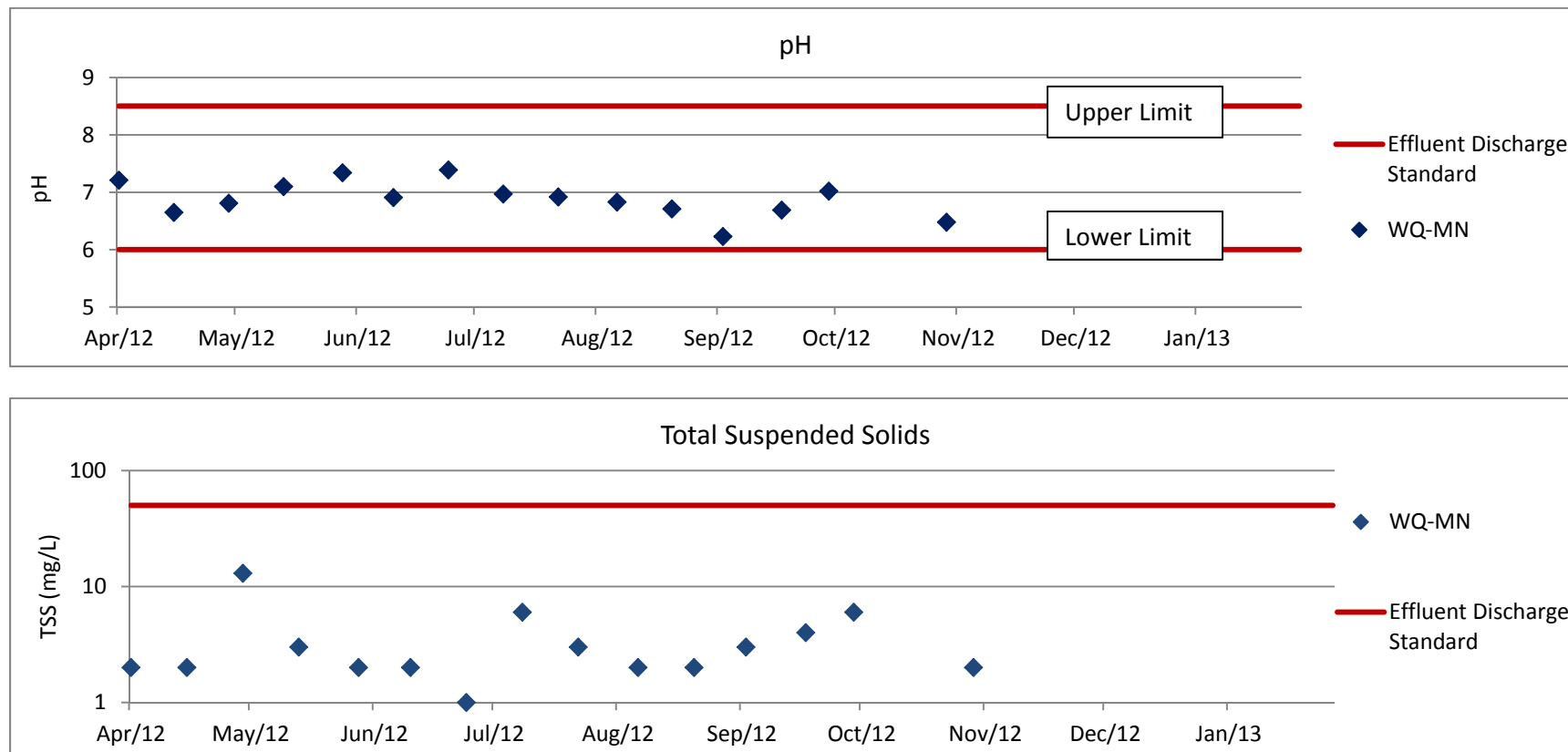
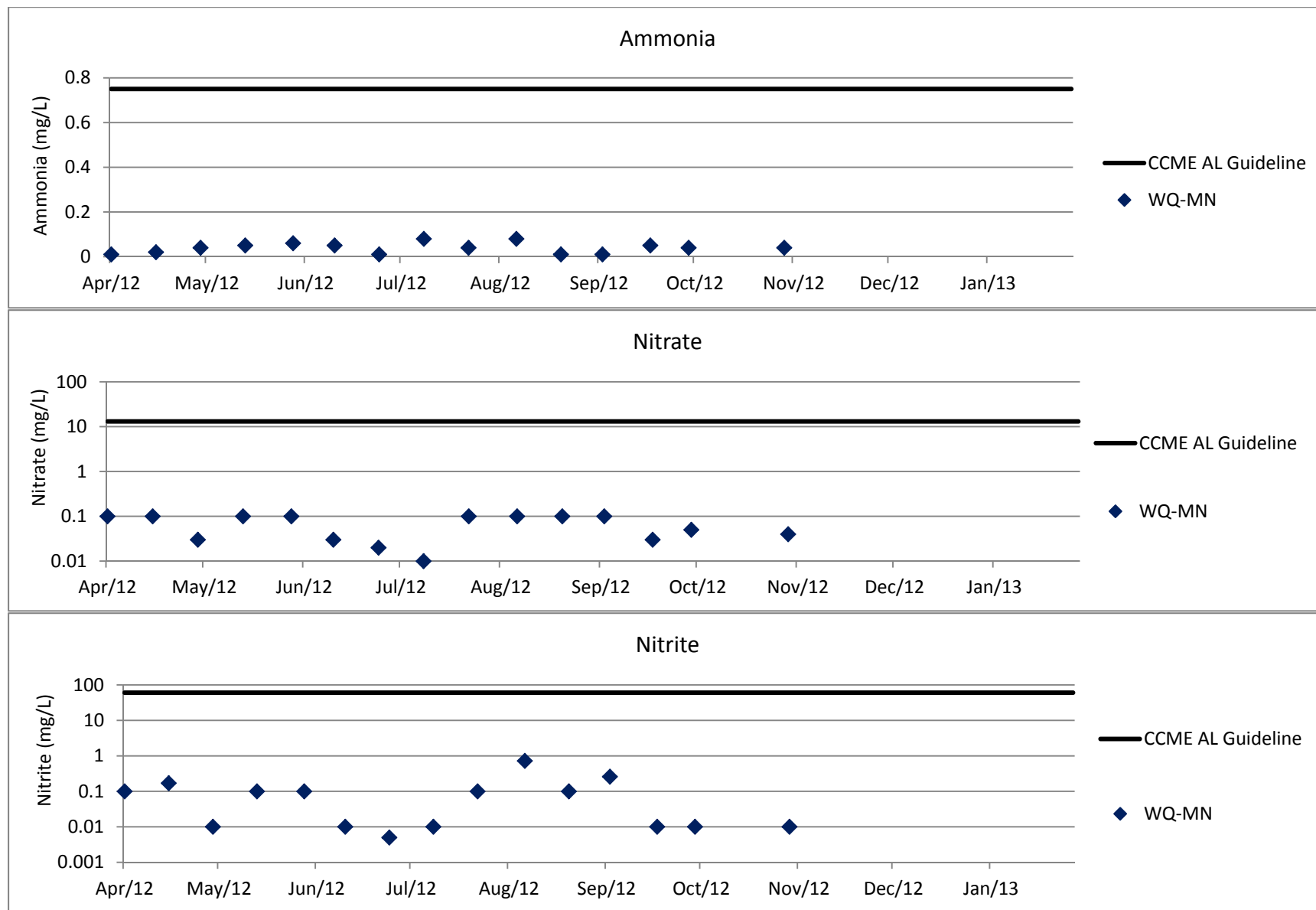
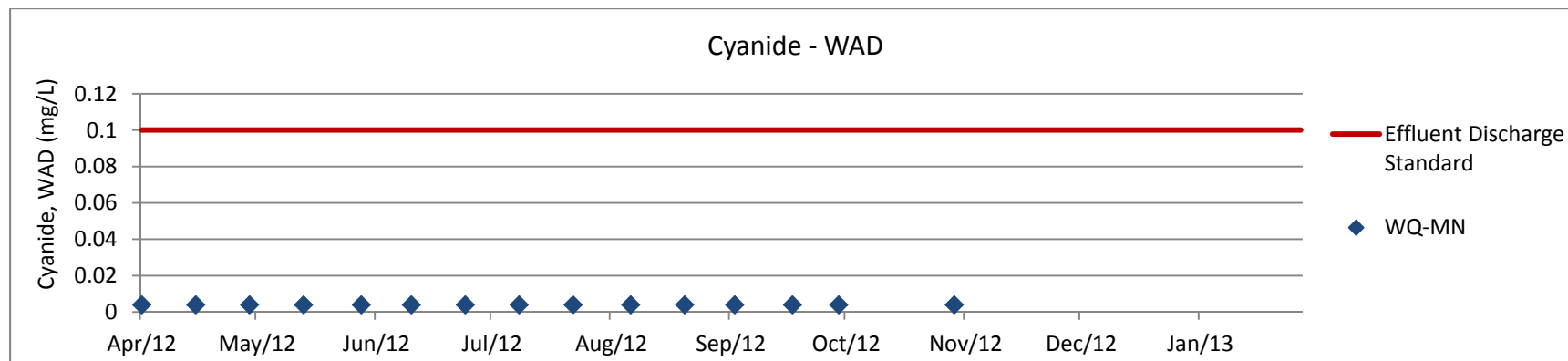
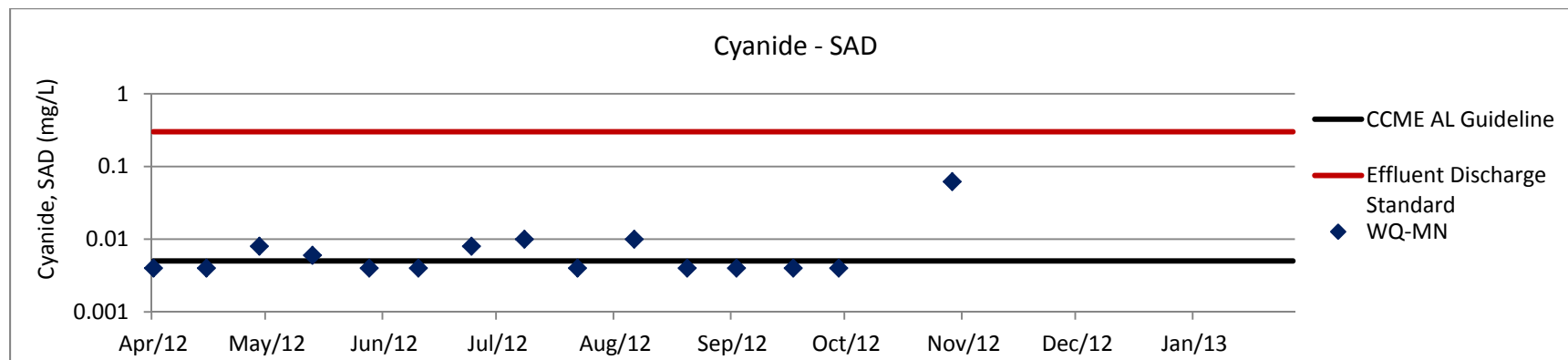


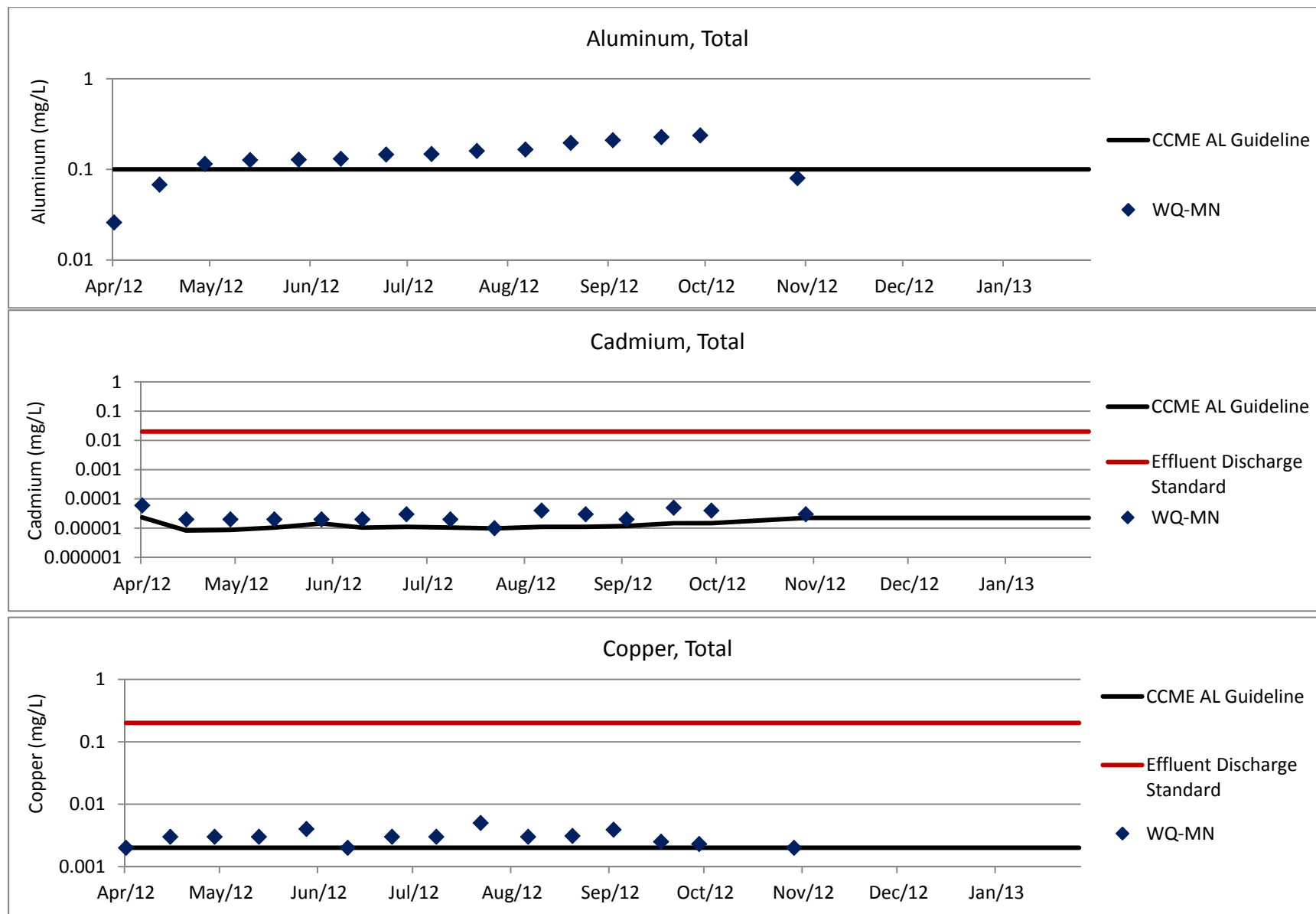


Figure C8. Minnesota Creek surface water quality figures.









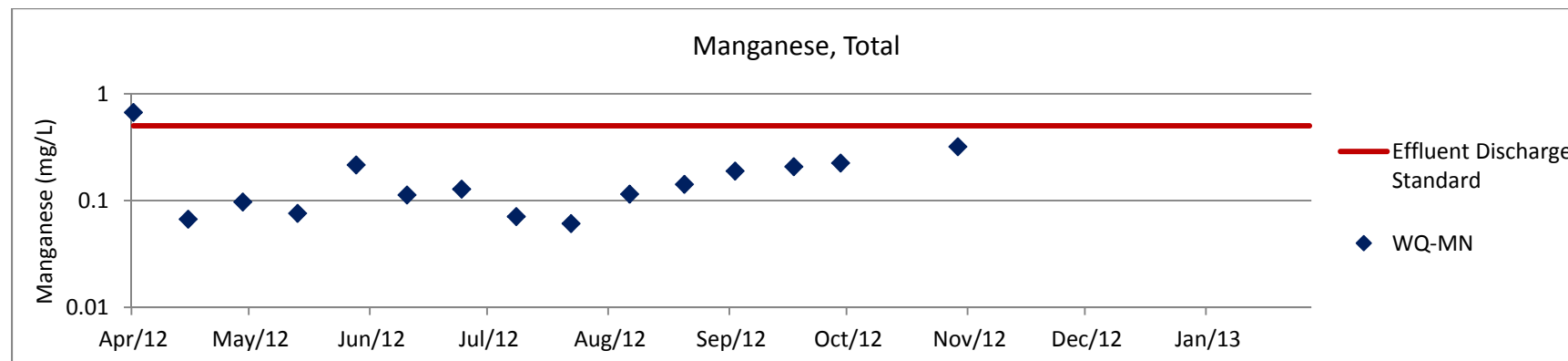
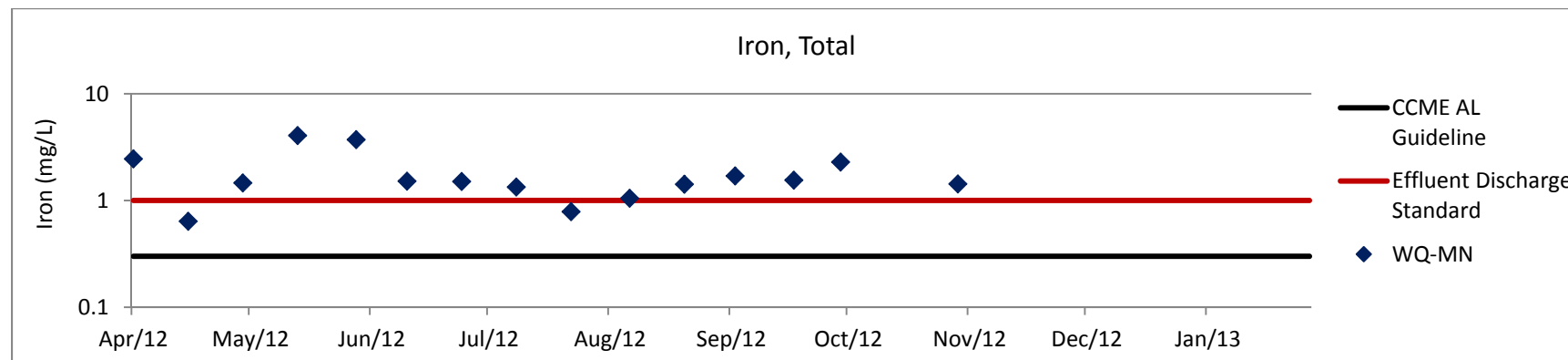
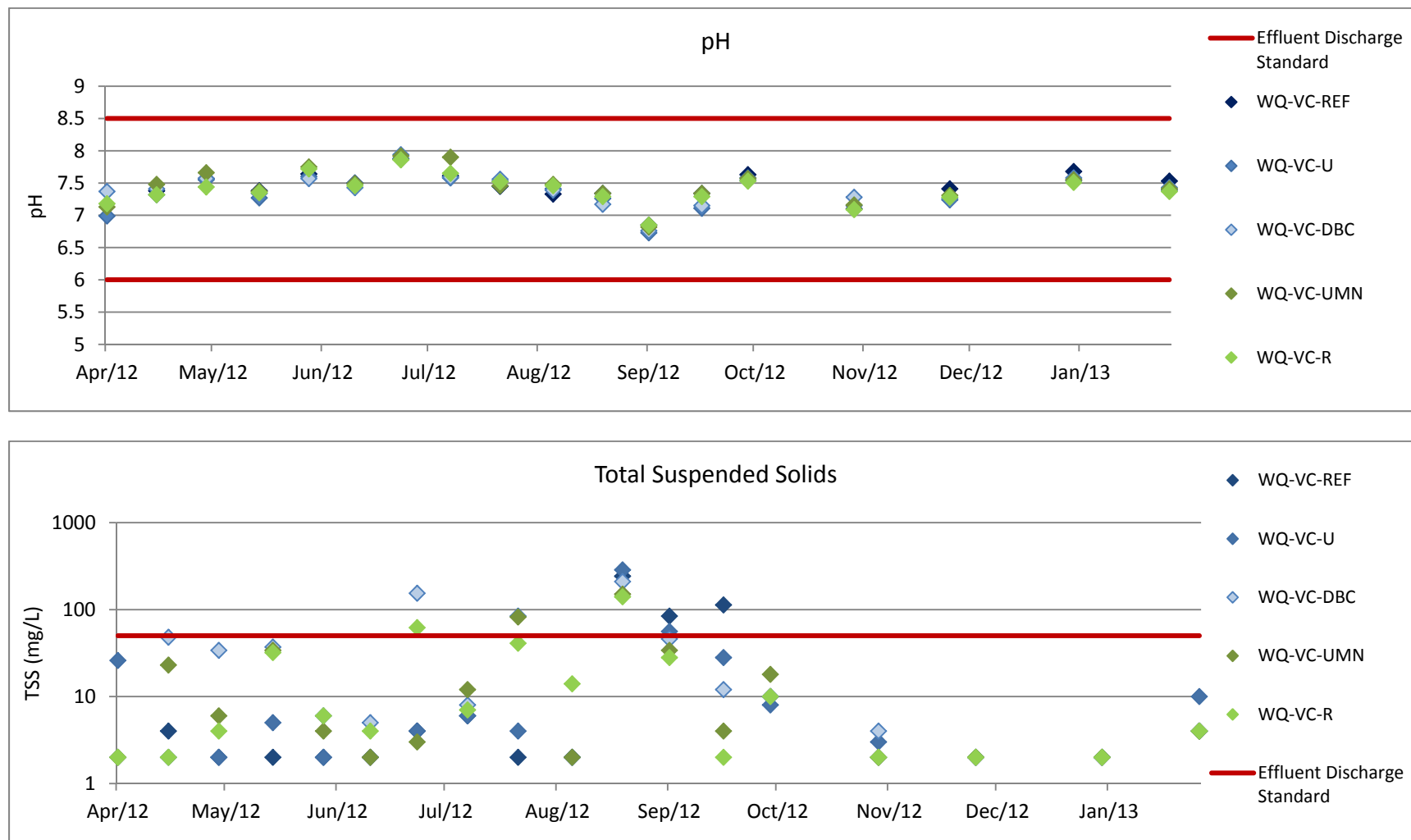
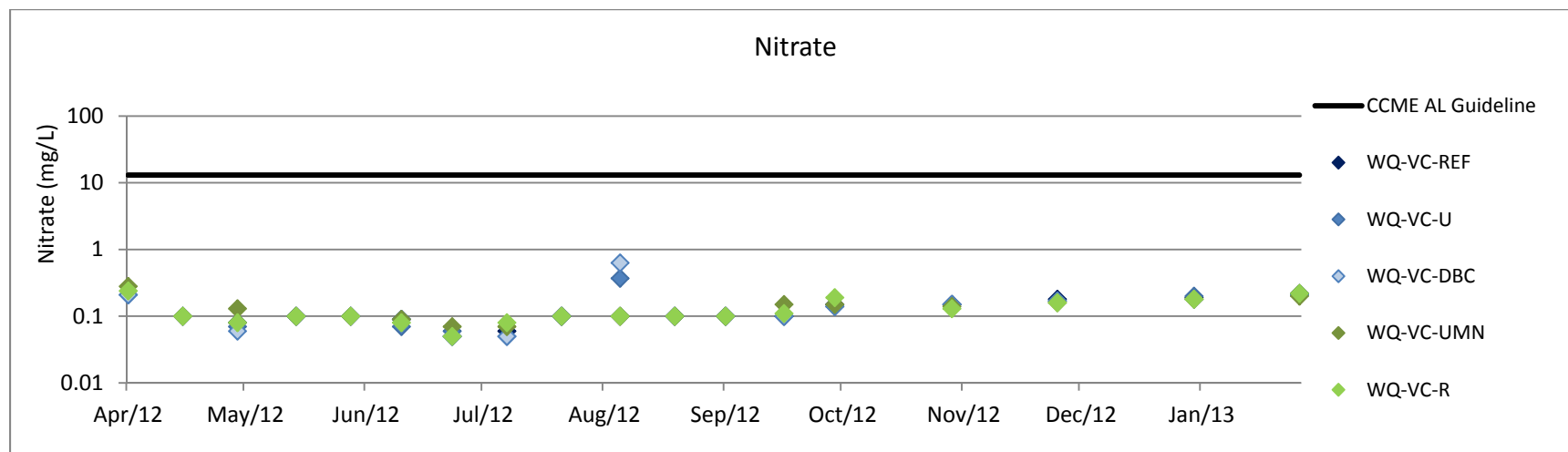
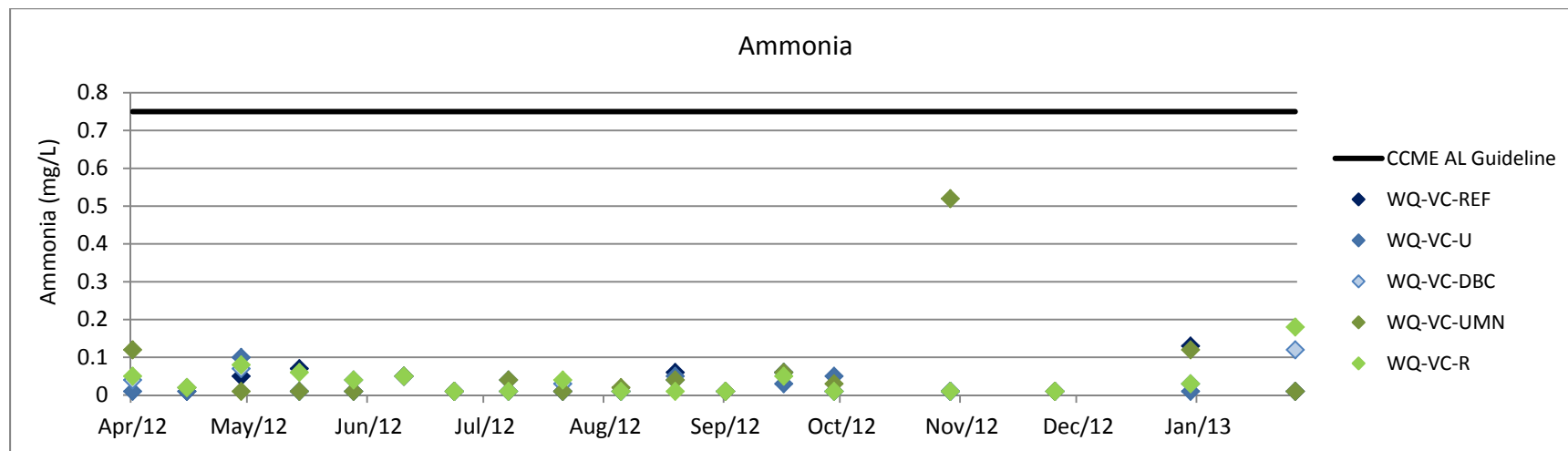
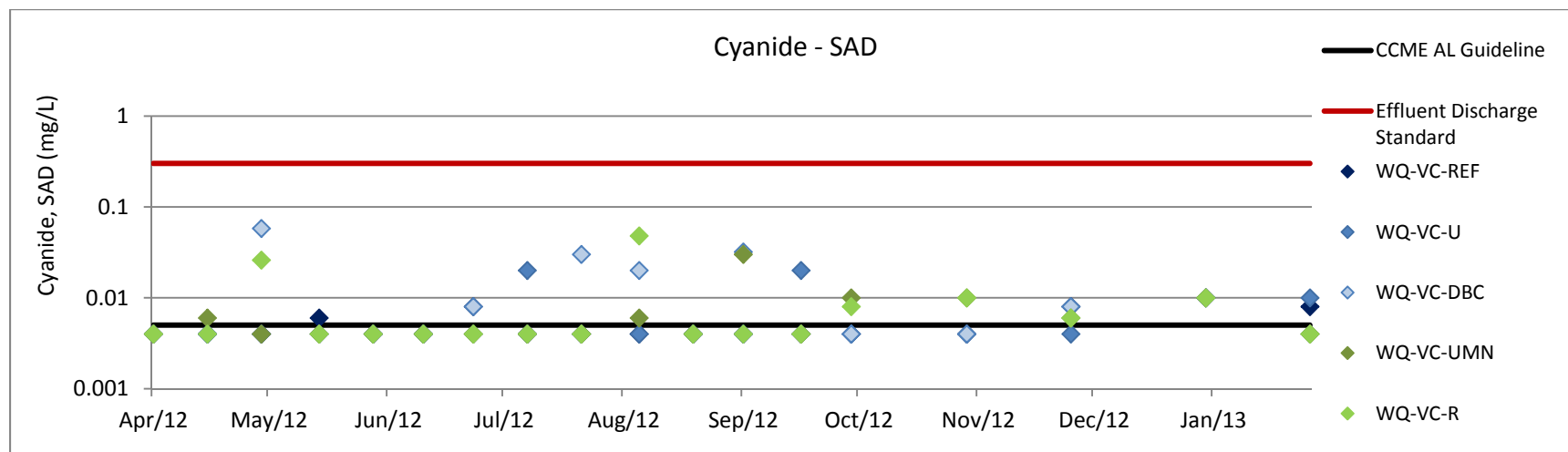
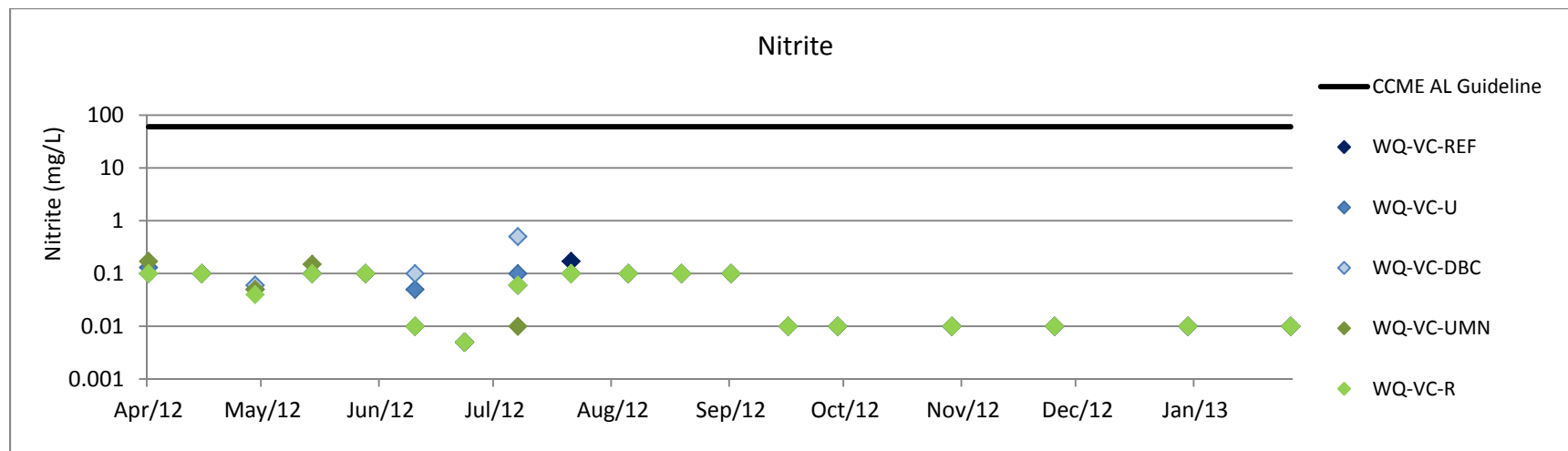


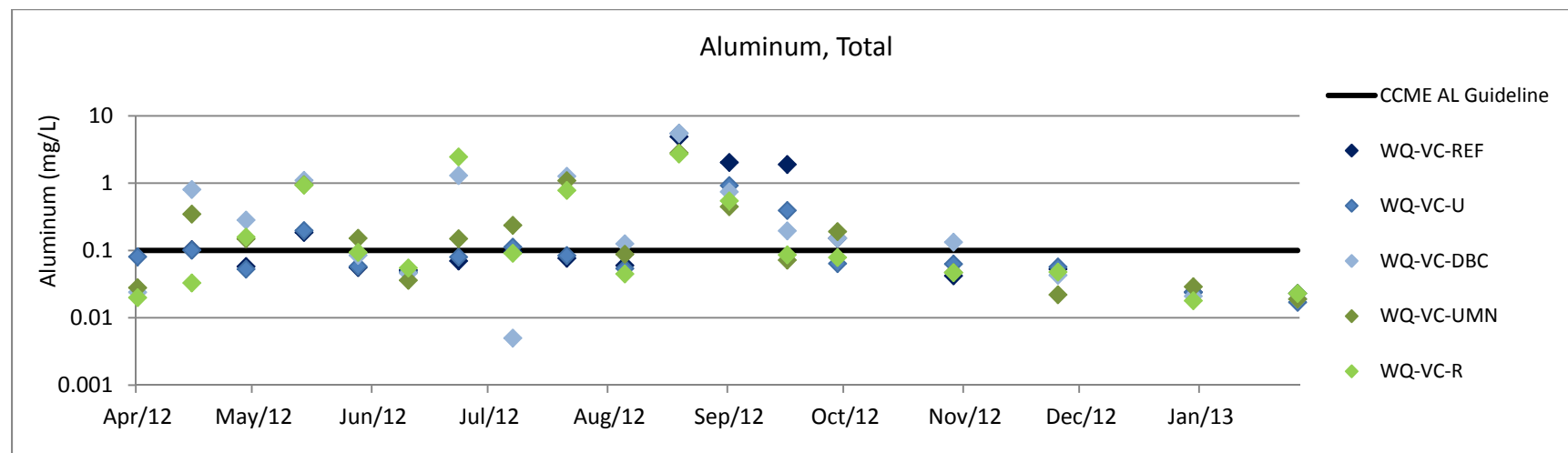
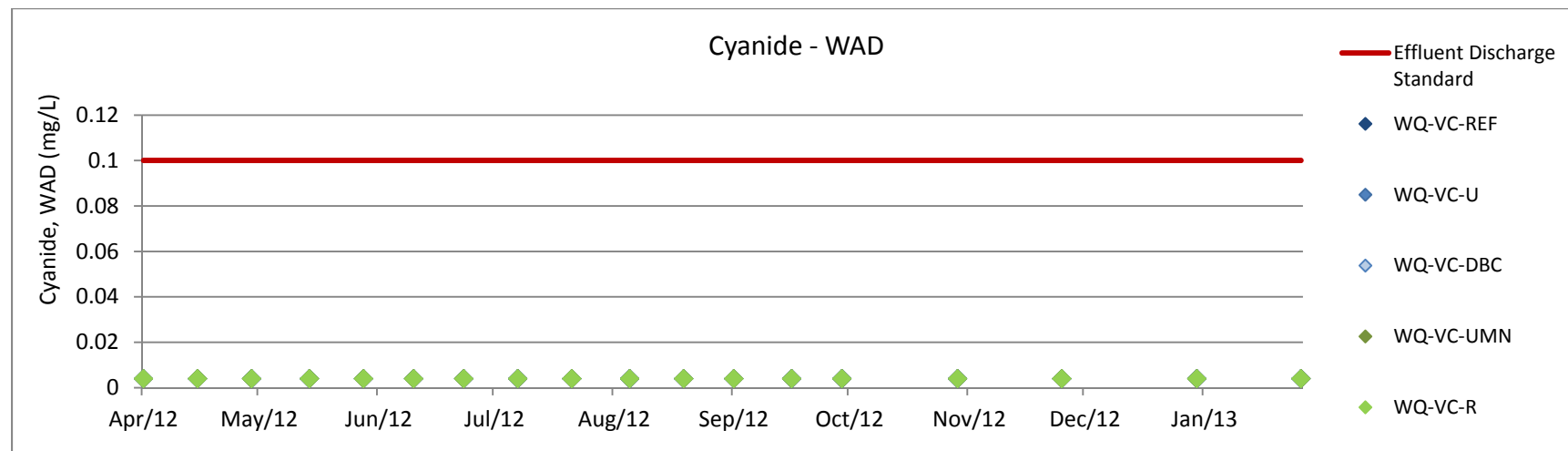


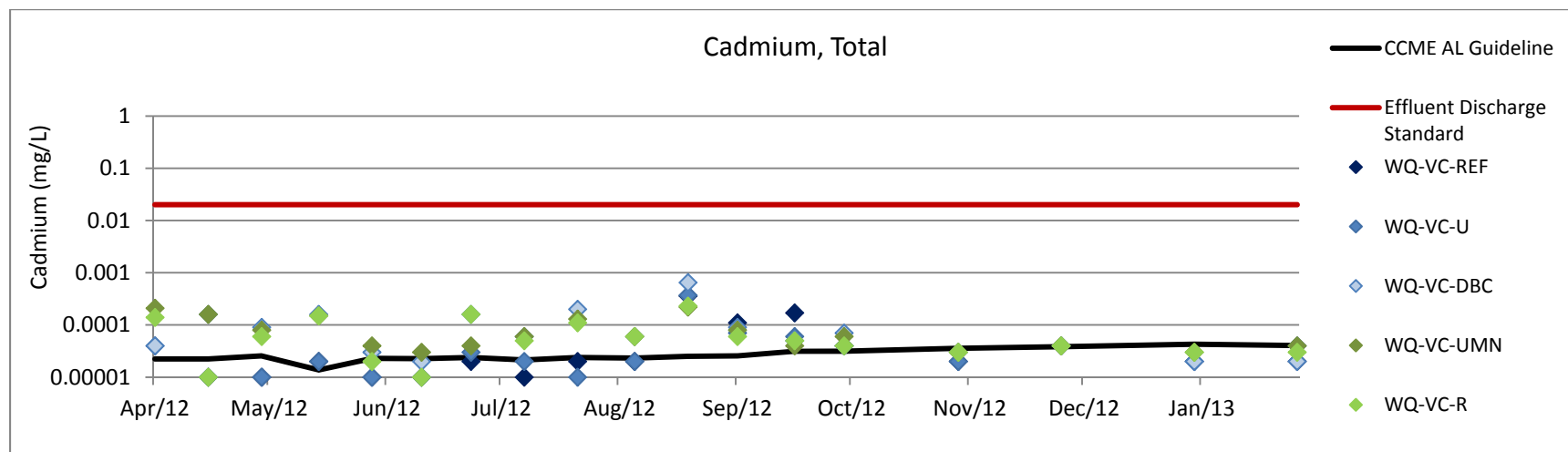
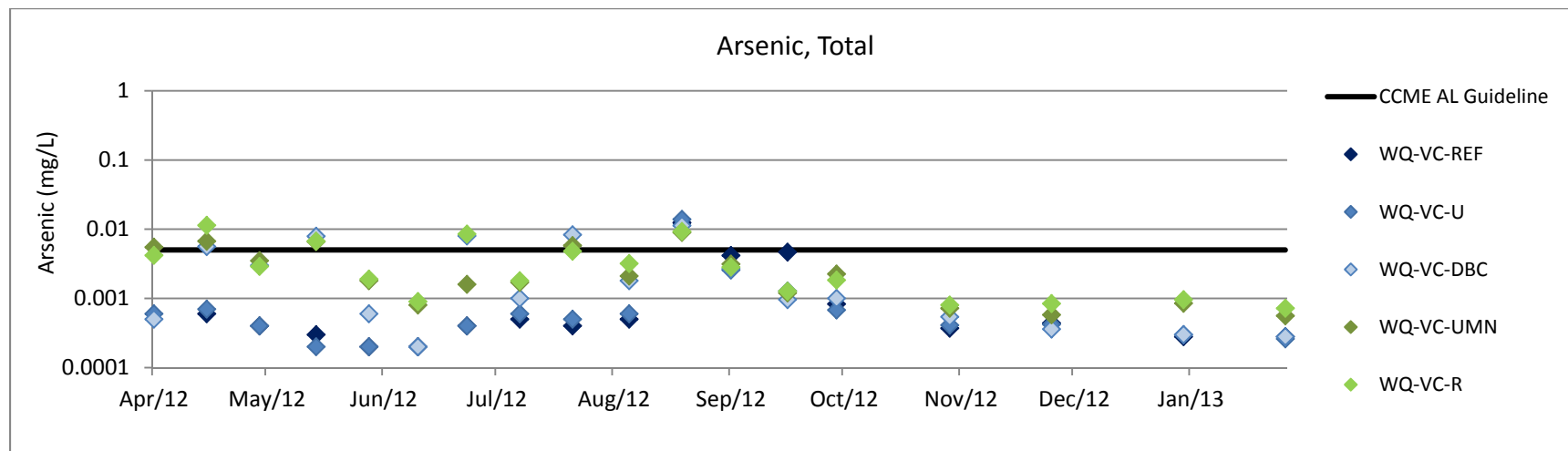
Figure C9. Victoria Creek surface water quality figures.

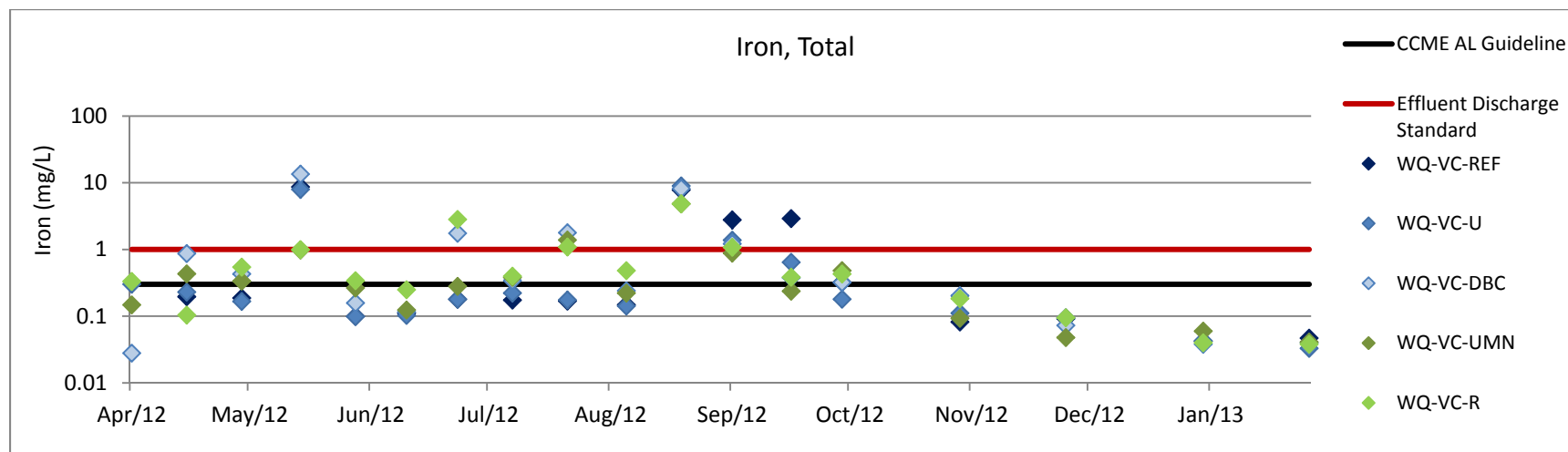
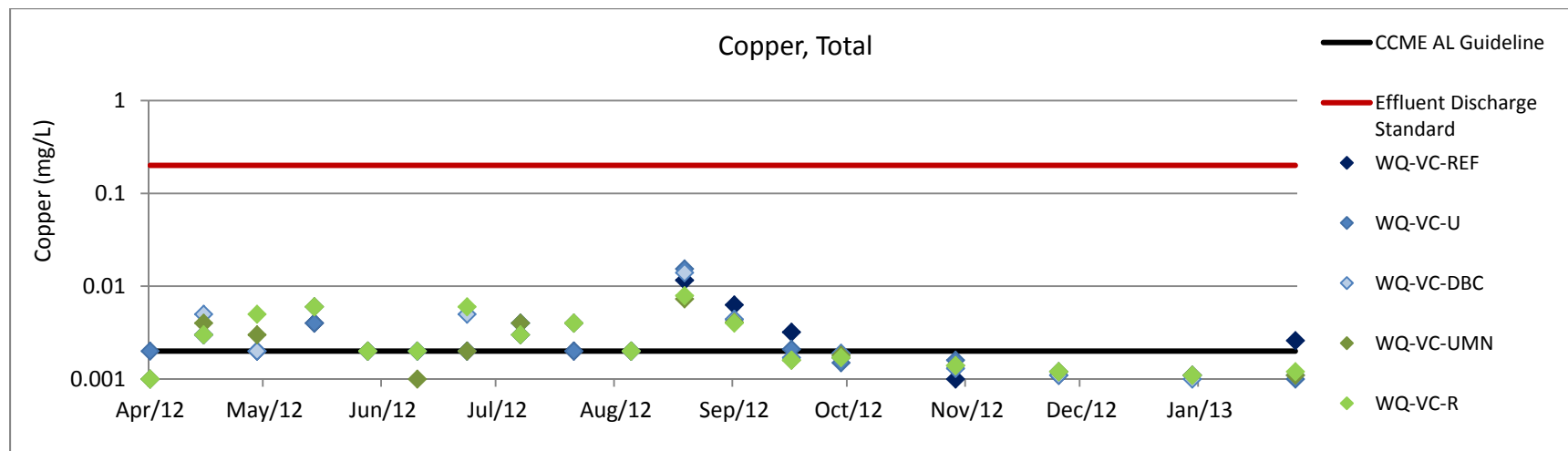


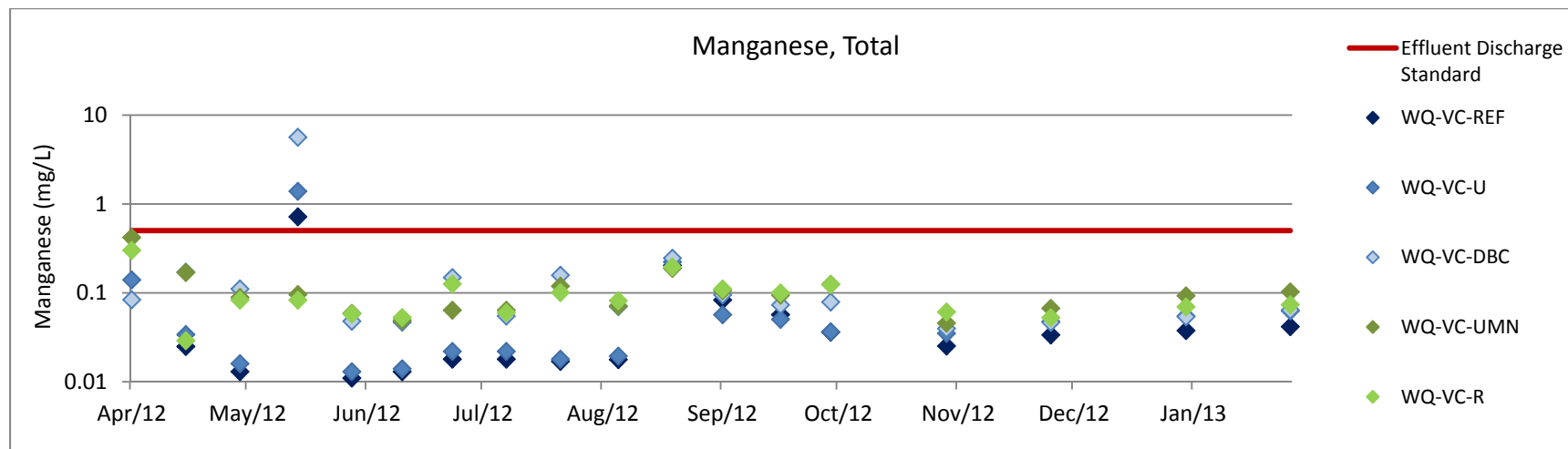
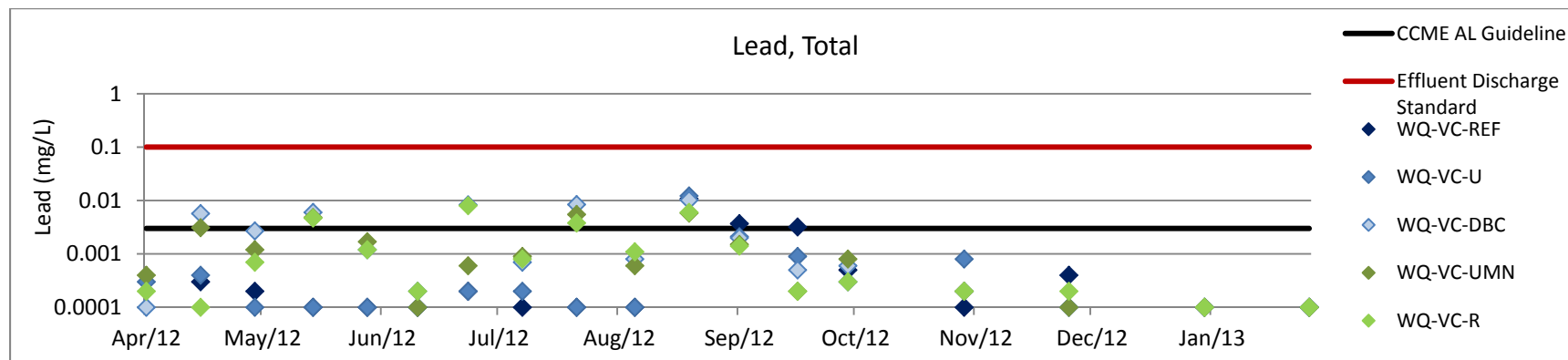












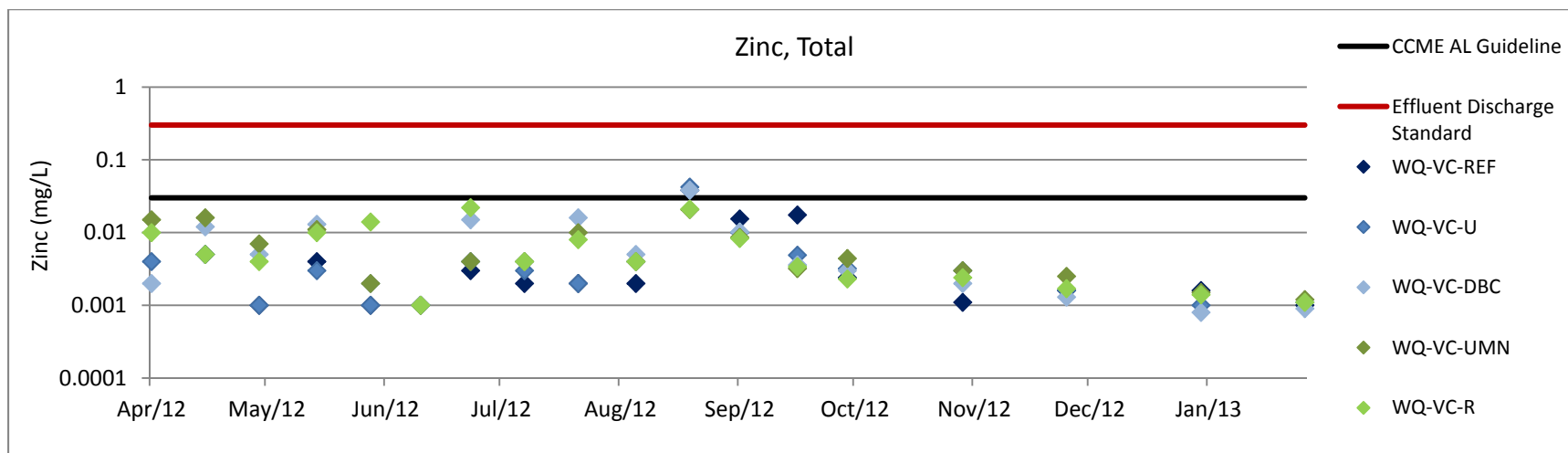
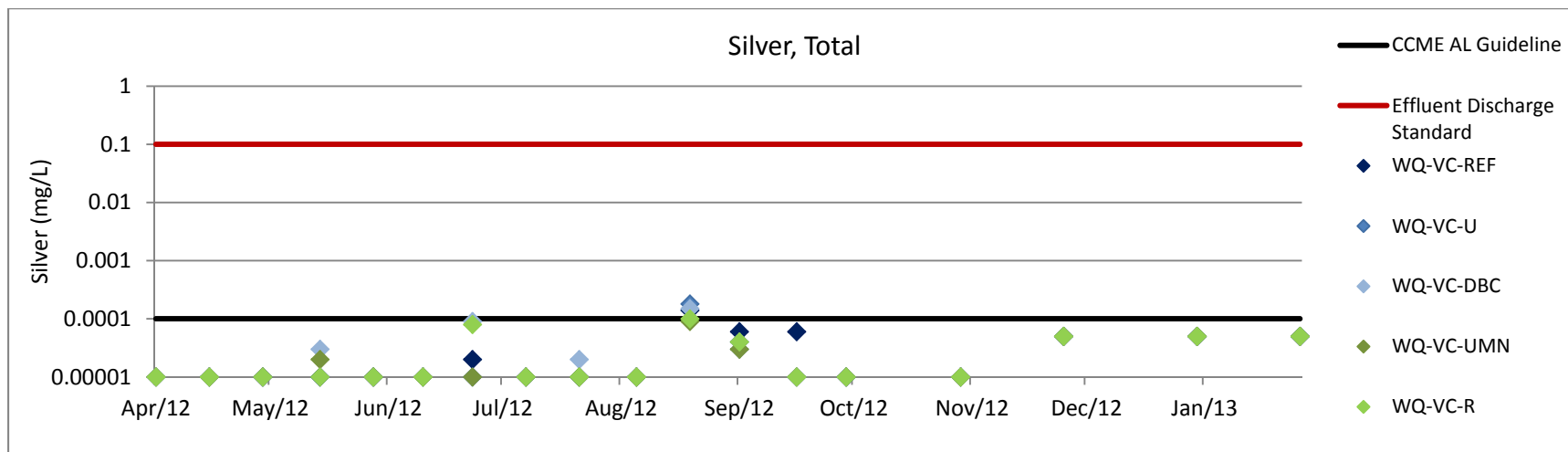
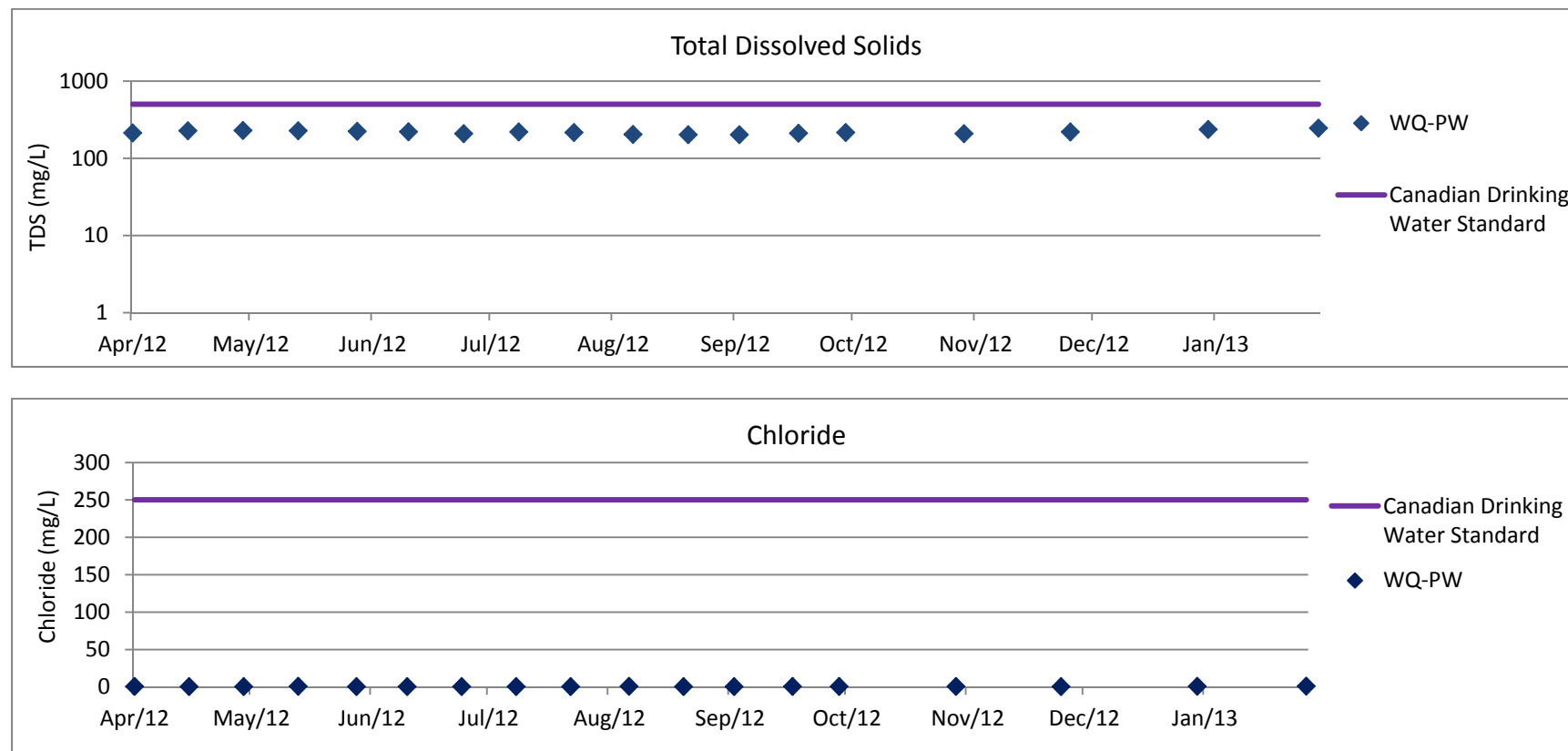
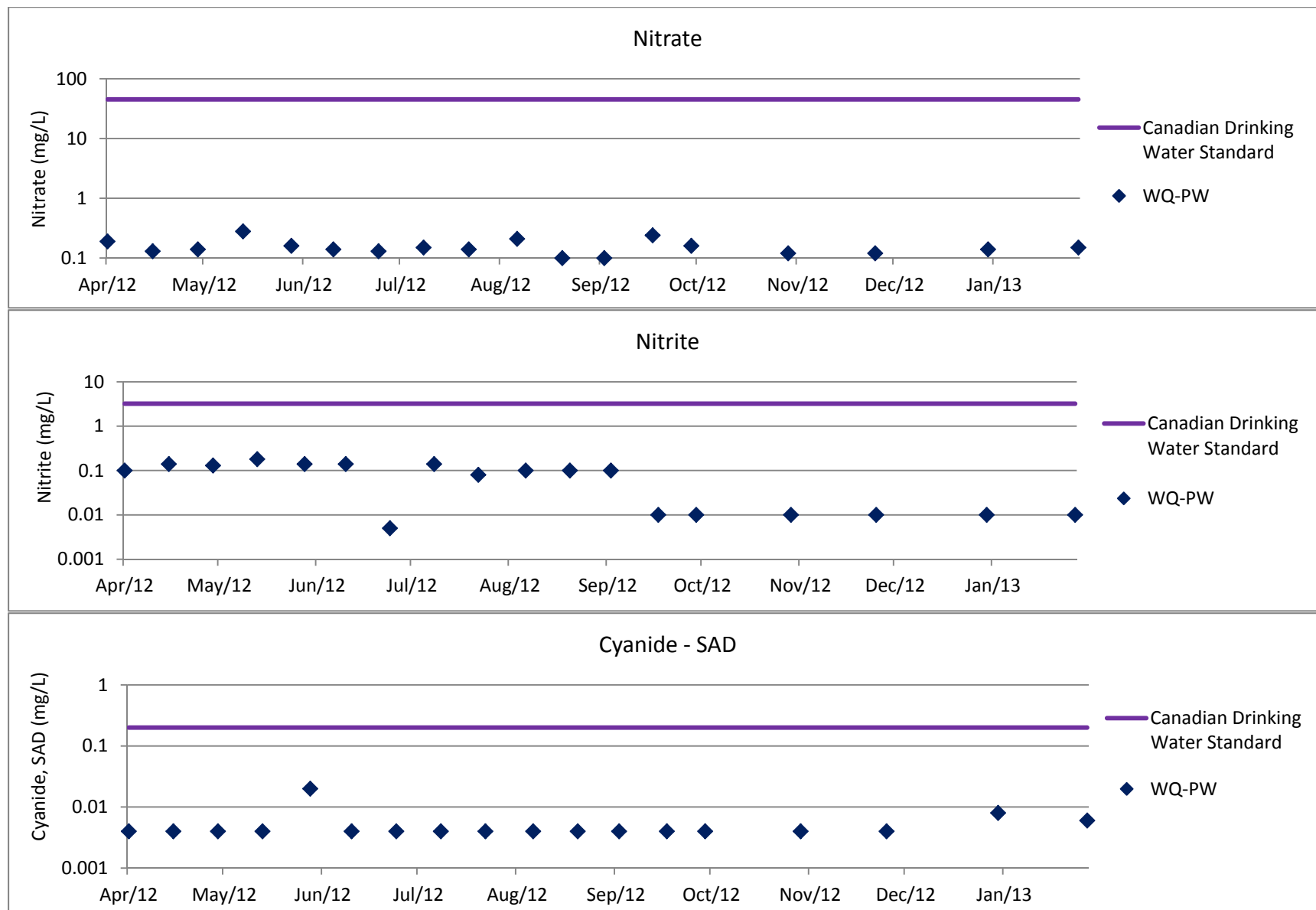




Figure C10. Pump House Well water quality figures.





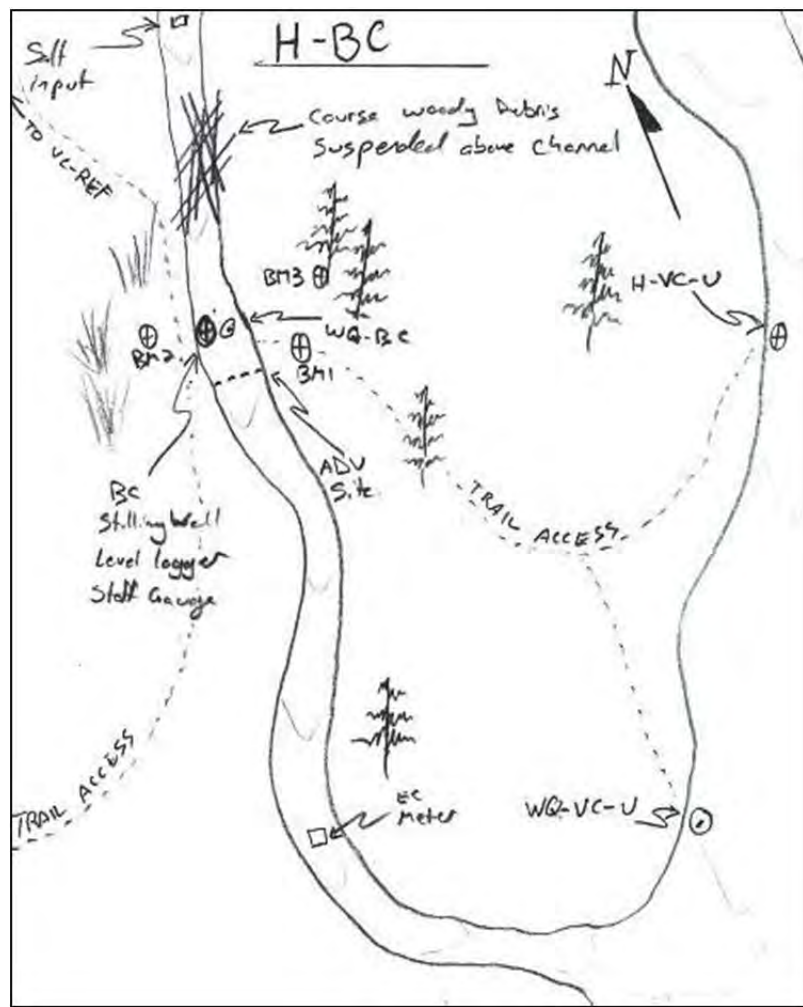


APPENDIX D SITE DESCRIPTIONS



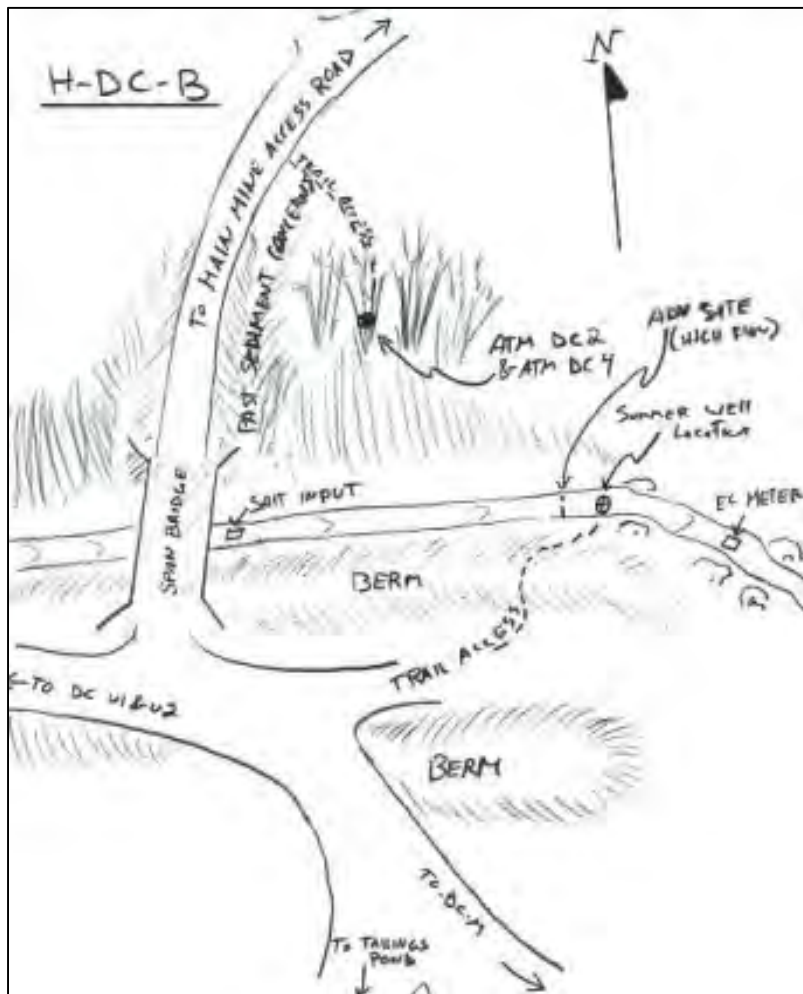
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Identifier	H-BC, WQ-BC
Location	E 390626, N 6880901
Station Type	Hydrology, Water Quality



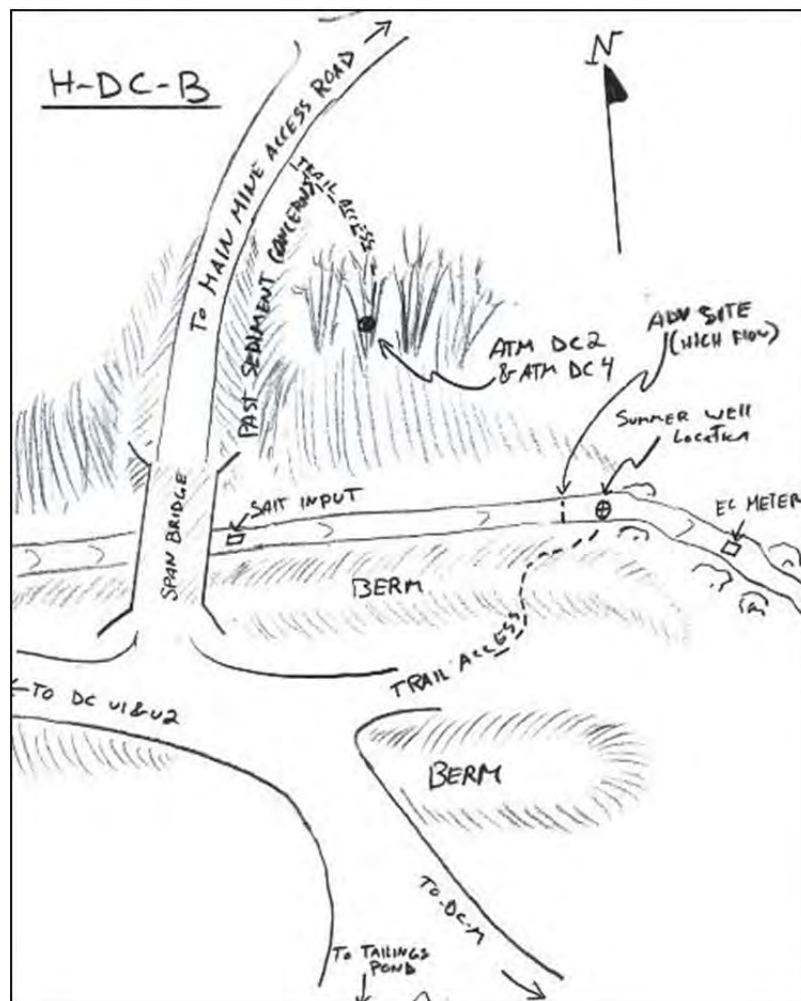


Name	Atmospheric at Diversion Channel
Identifier	ATM-DC2, ATM-DC3, ATM-DC4
Location	E 389476, N 6880792
Station Type	Barometric



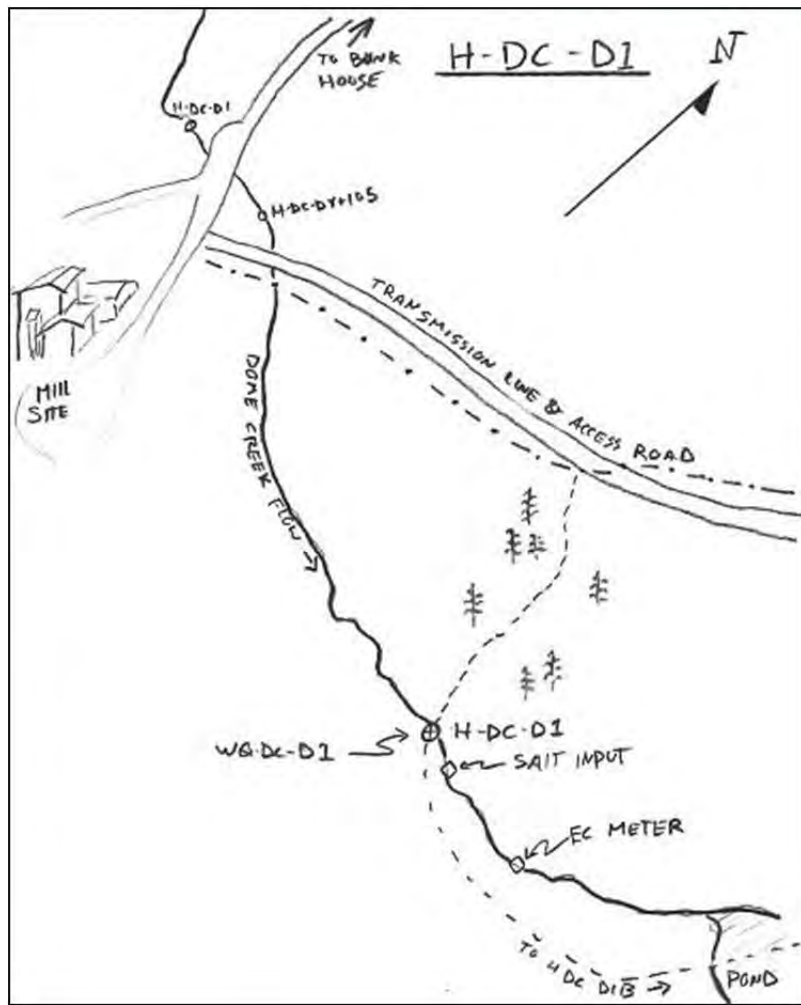


Name	Diversion Channel at Bridge
Identifier	H-DC-B
Location	E 389480, N 6880780
Station Type	Hydrology



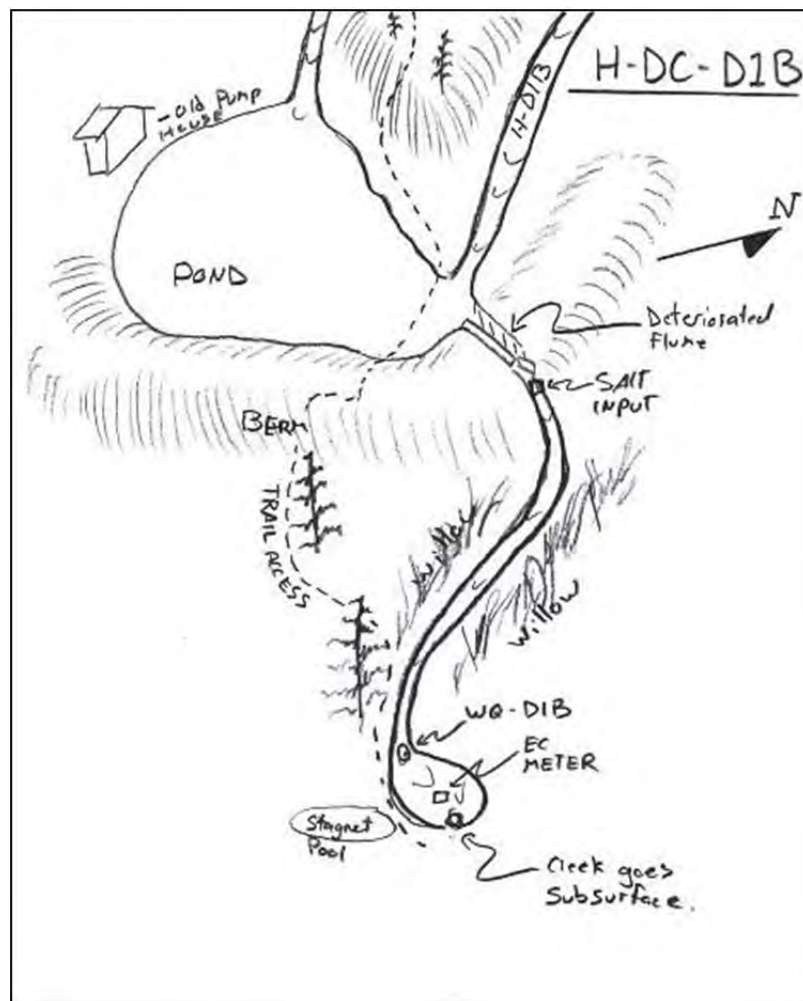


Name	Dome Creek at D1
Identifier	H-DC-D1, WQ-DC-D1
Location	E 388167, N 6881059
Station Type	Hydrology, Water Quality



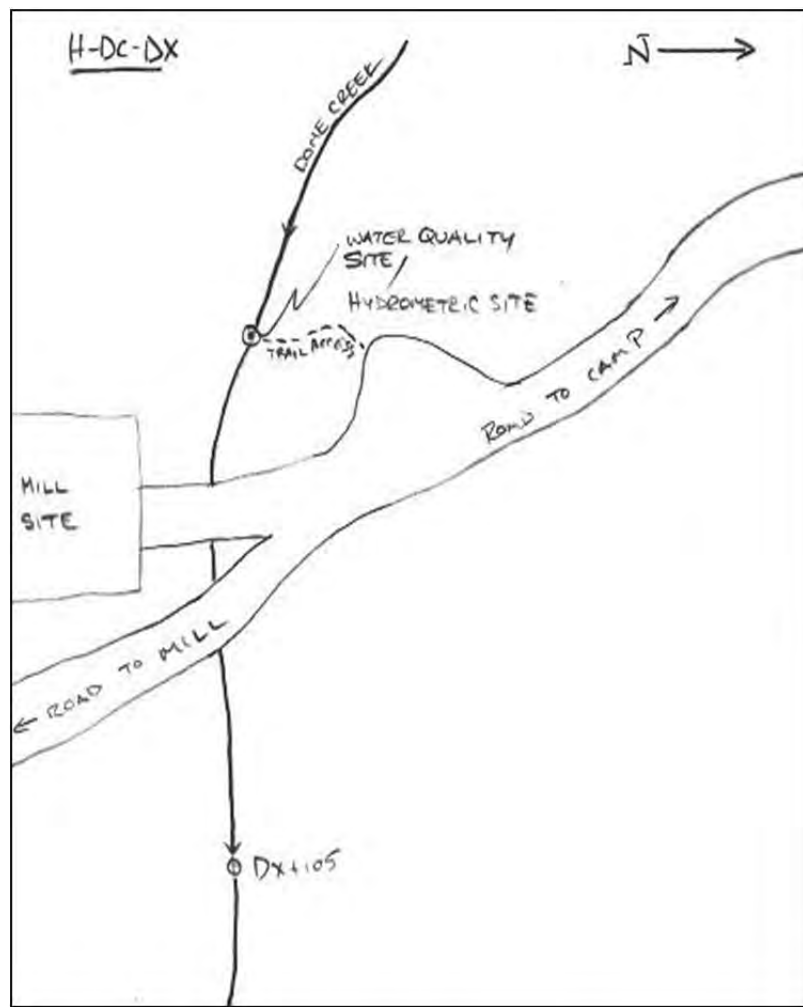


Name	Dome Creek at D1b
Identifier	H-DC-D1b, WQ-DC-D1b
Location	E 388262, N 6881000
Station Type	Hydrology, Water Quality



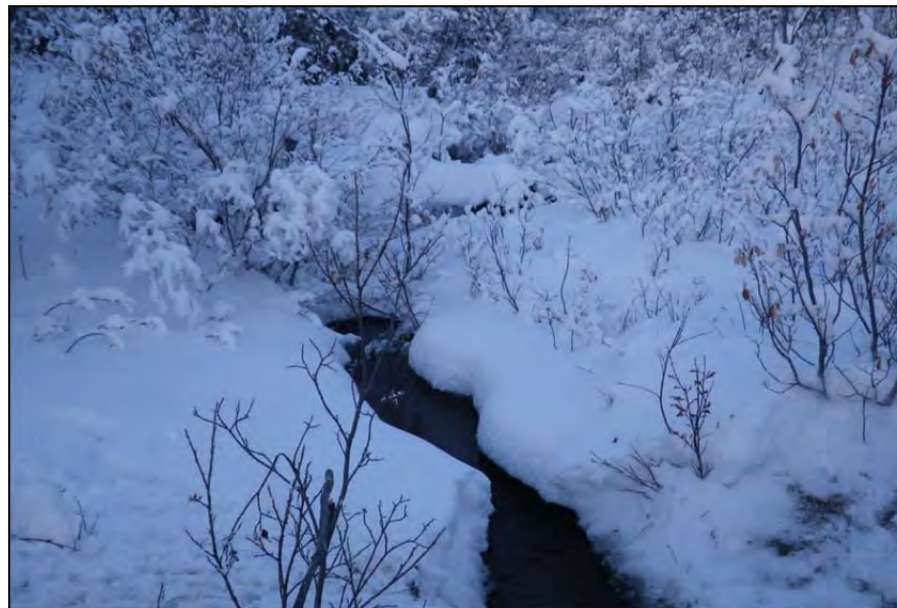
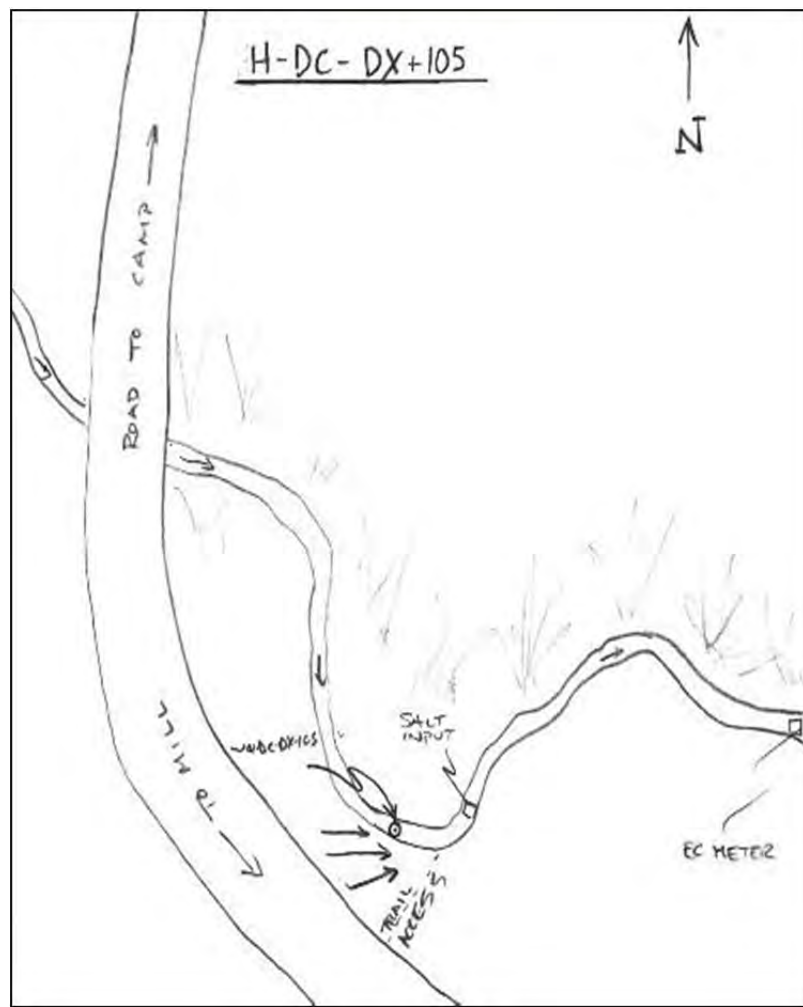


Name	Dome Creek at DX
Identifier	H-DC-DX, WQ-DC-DX
Location	E 387675, N 6881127
Station Type	Hydrology, Water Quality



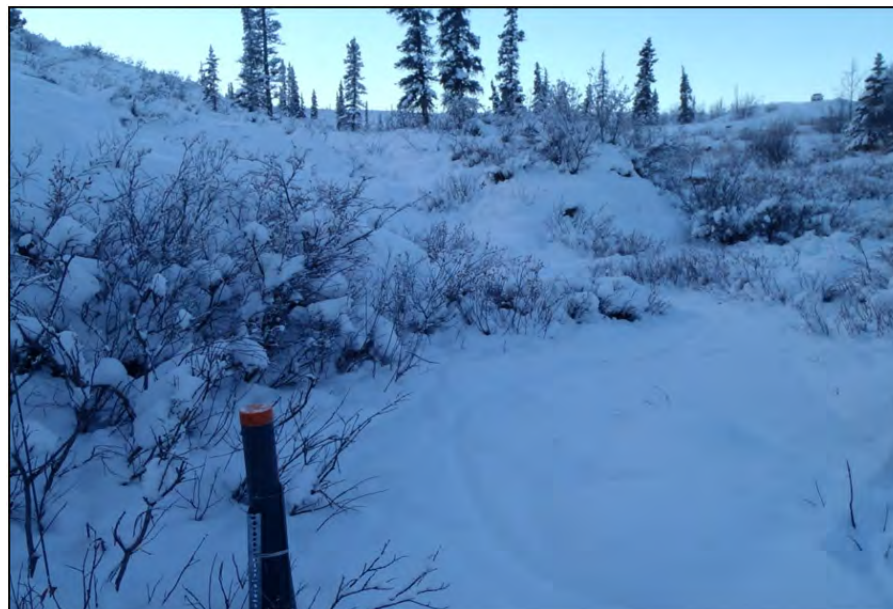
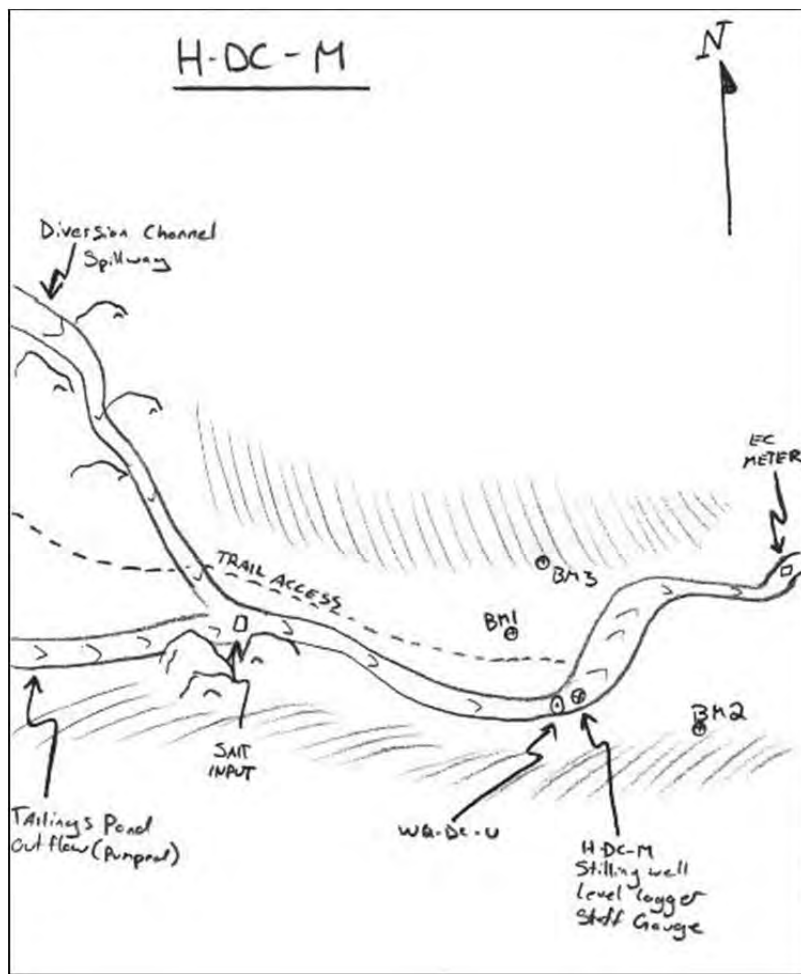


Name	Dome Creek at DX+105
Identifier	H-DC-DX+105, WQ-DX+105
Location	E 387820, N 6881150
Station Type	Hydrology, Water Quality





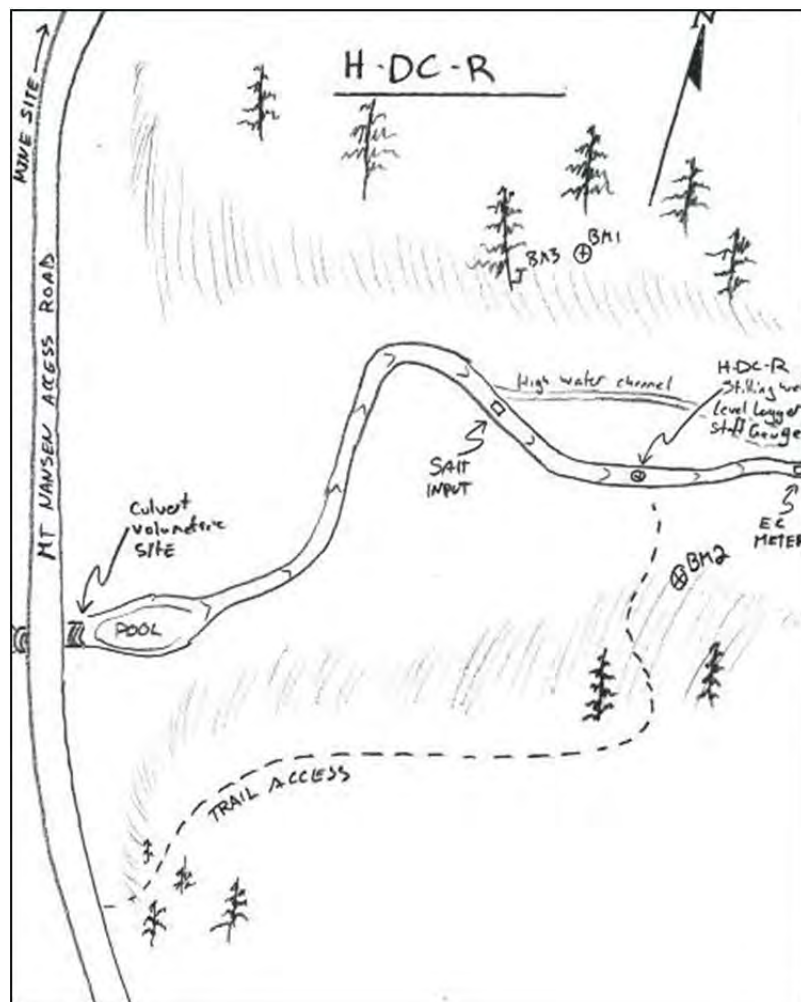
Name	Middle Dome Creek (H)/ Upper Dome Creek (WQ)
Identifier	H-DC-M, WQ-DC-U
Location	E 389788.4, N 6880565
Station Type	Hydrology, Water Quality





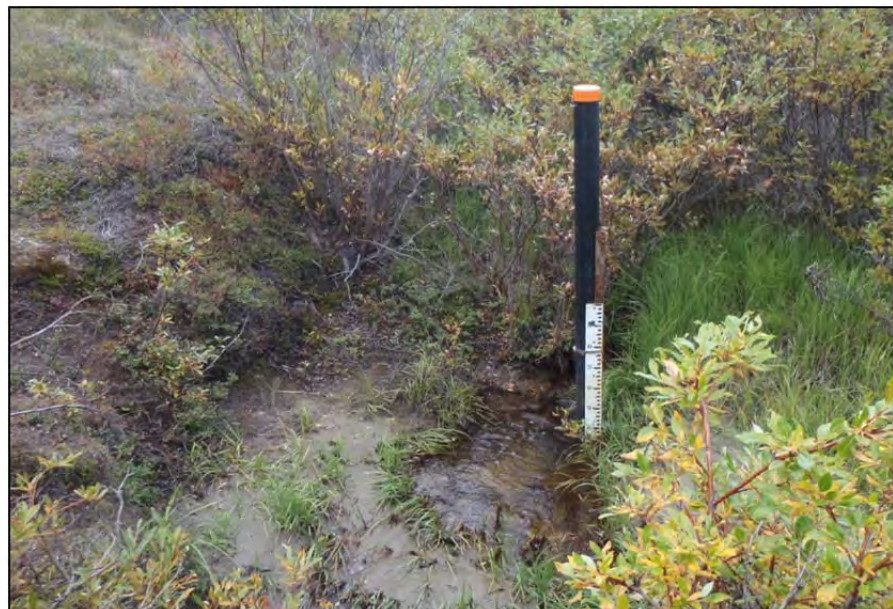
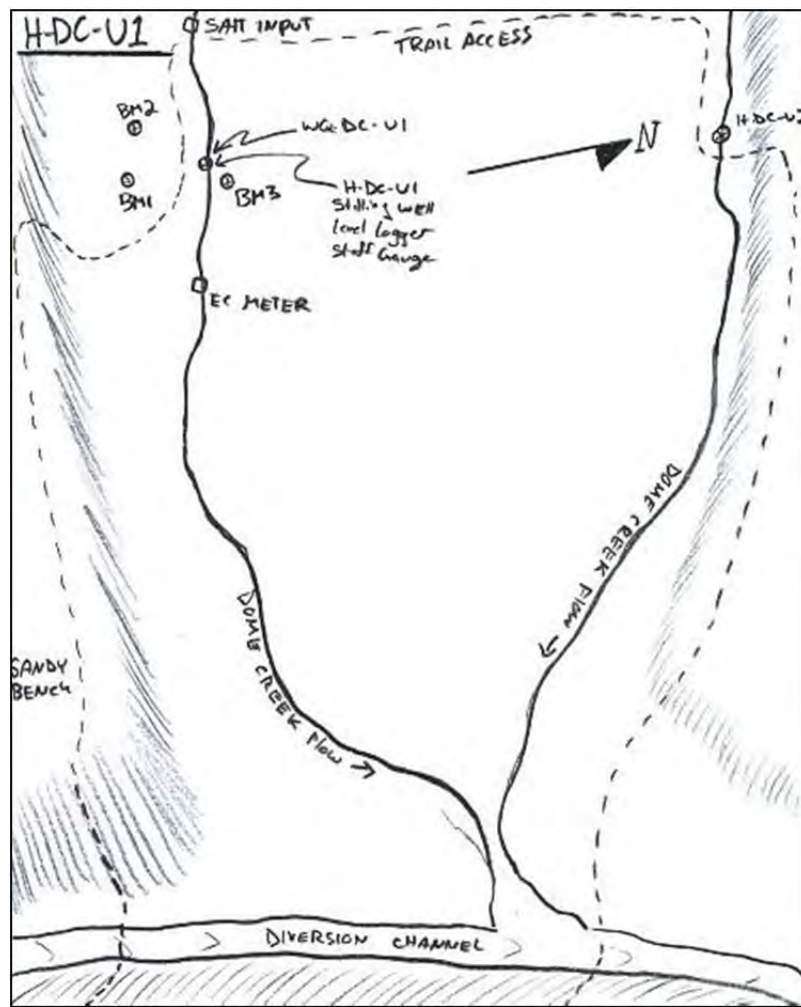
Mount Nansen Site Data Report: Surface Water and Meteorological Monitoring, 2012/13

Name	Dome Creek at Road
Identifier	H-DC-R
Location	E 392540, N 6879249
Station Type	Hydrology



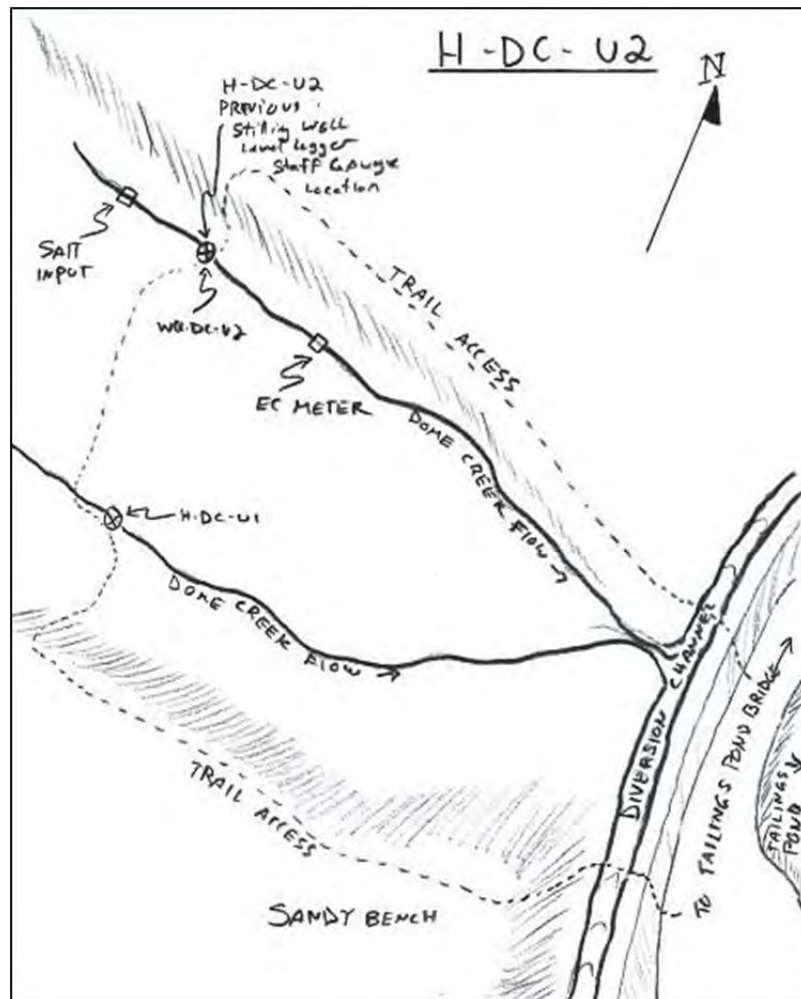


Name	Upper Dome Creek 1
Identifier	H-DC-U1, WQ-DC-U1
Location	E 388919, N 6880772
Station Type	Hydrology, Water Quality





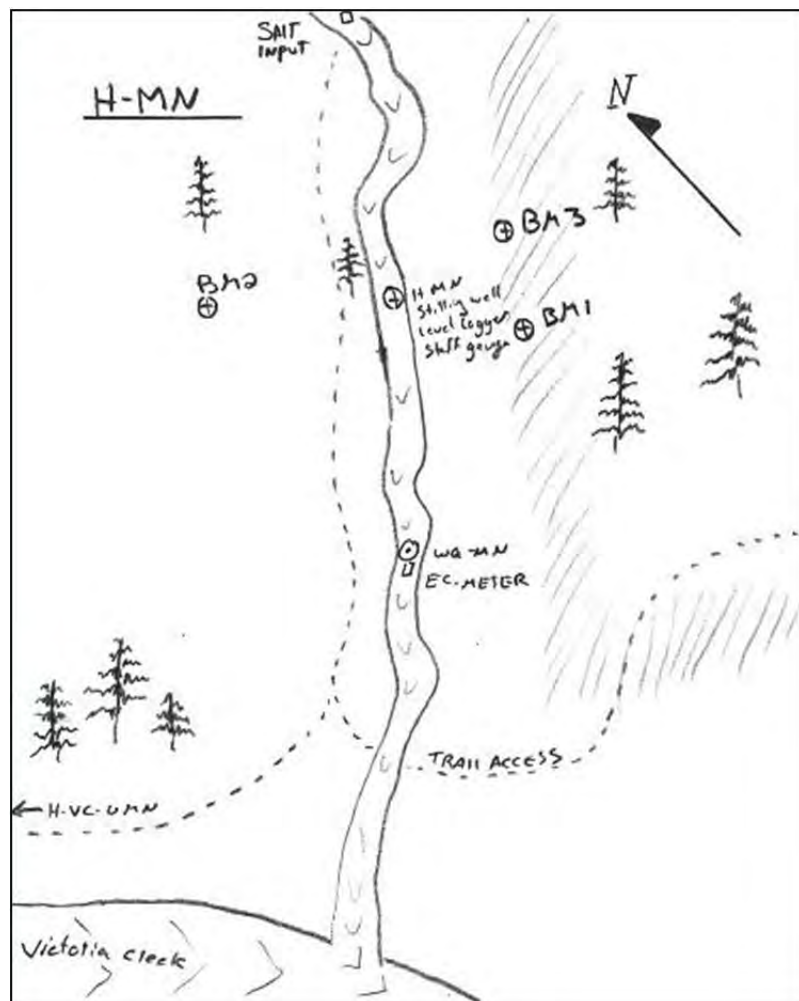
Name	Upper Dome Creek 2
Identifier	H-DC-U2, WQ-DC-U2
Location	E 388937, N 6880819
Station Type	Hydrology, Water Quality





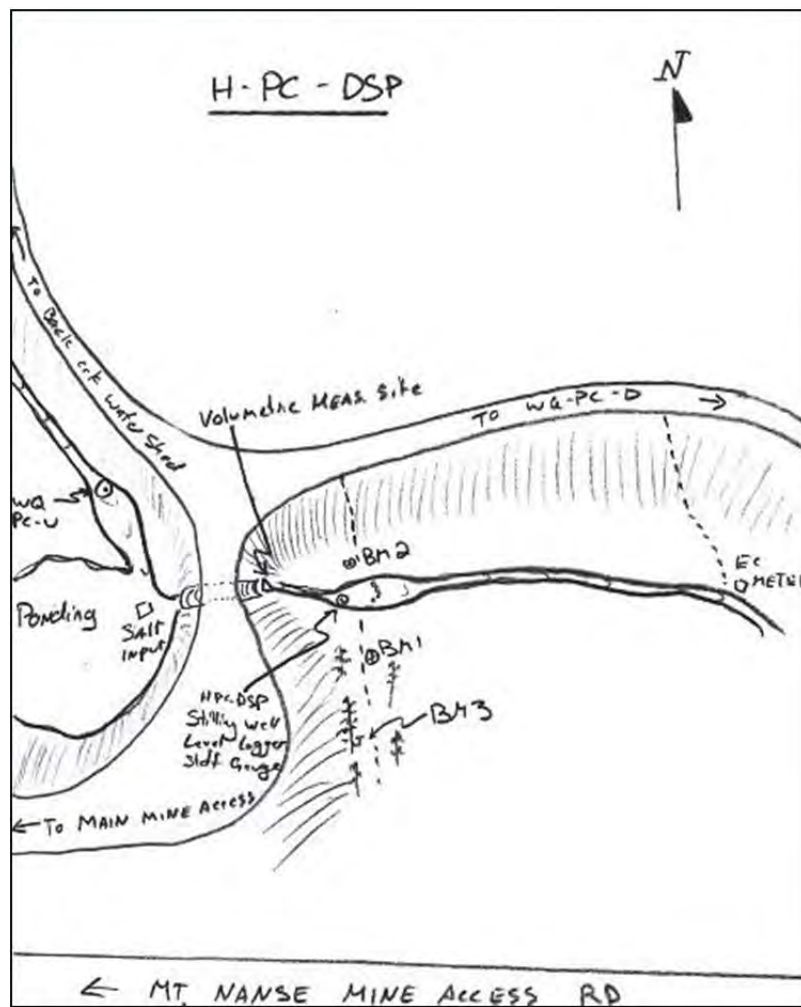
Mount Nansen Site Data Report: Surface Water and Meteorological Monitoring, 2012/13

Name	Minnesota Creek
Identifier	H-MN, WQ-MN
Location	E 392530, N 6879235
Station Type	Hydrology, Water Quality





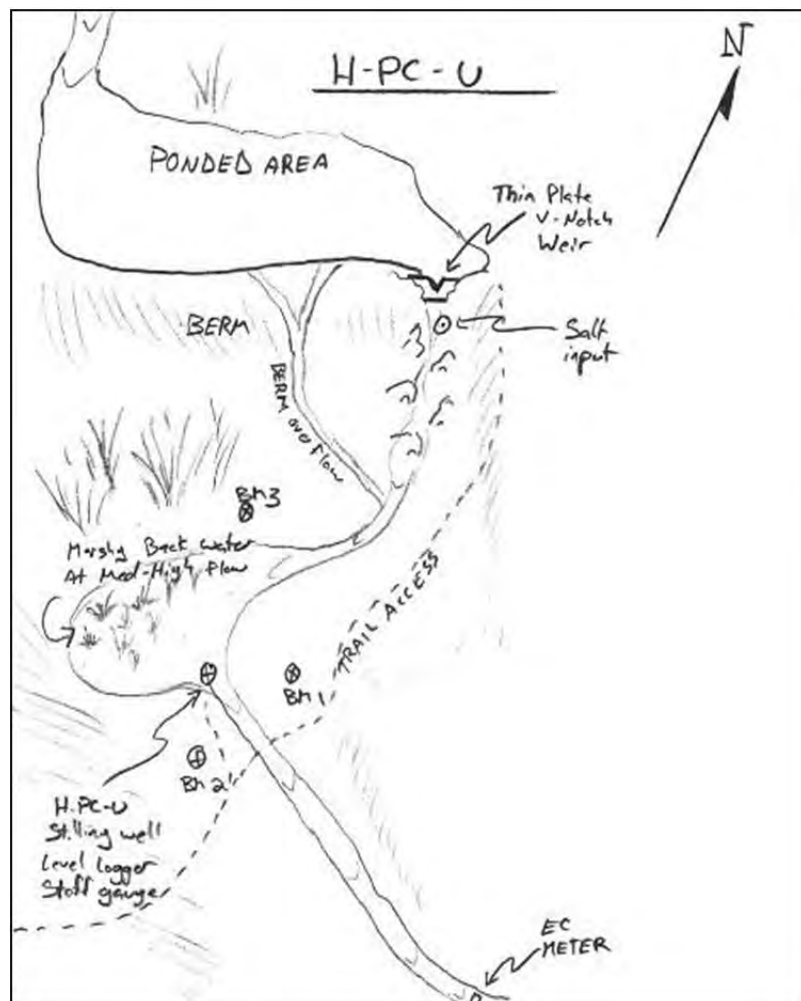
Name	Pony Creek Downstream of Pit
Identifier	H-PC-DSP
Location	E 388987, N 6881930
Station Type	Hydrology





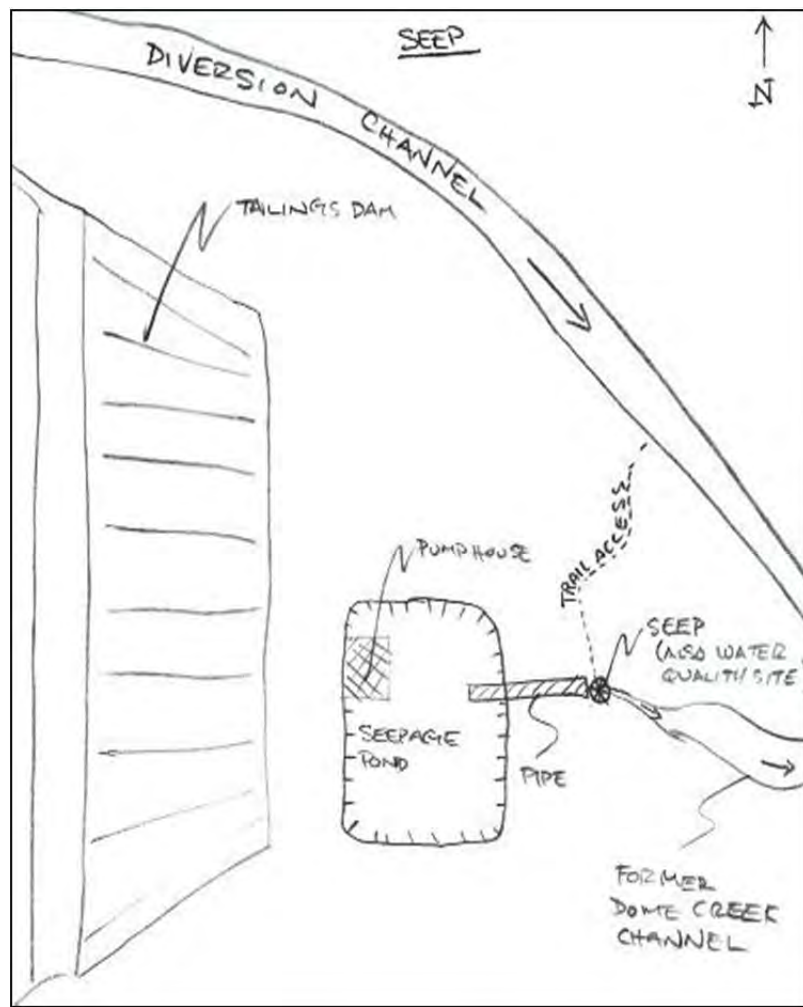
Mount Nansen Site Data Report: Surface Water and Meteorological Monitoring, 2012/13

Name	Upper Pony Creek
Identifier	H-PC-U
Location	E 388709, N 6881930
Station Type	Hydrology



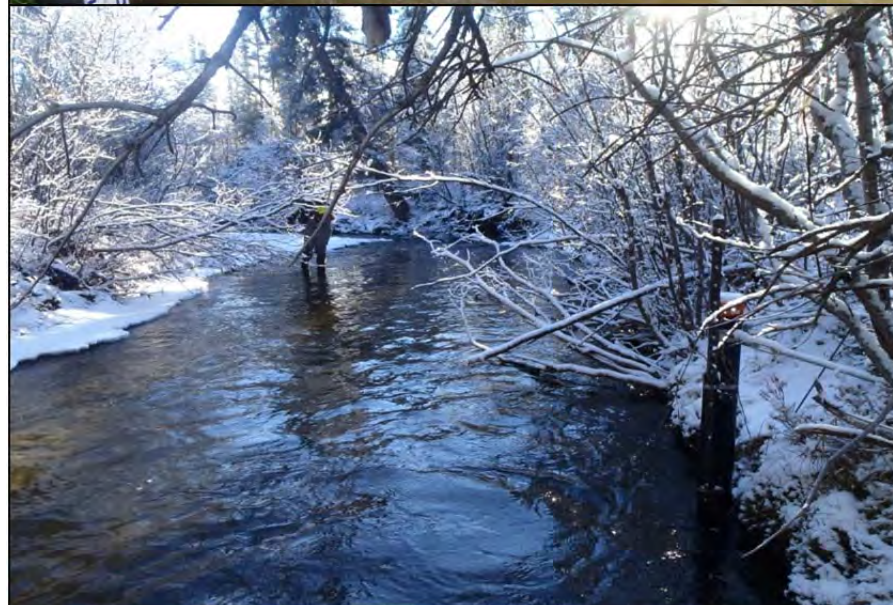
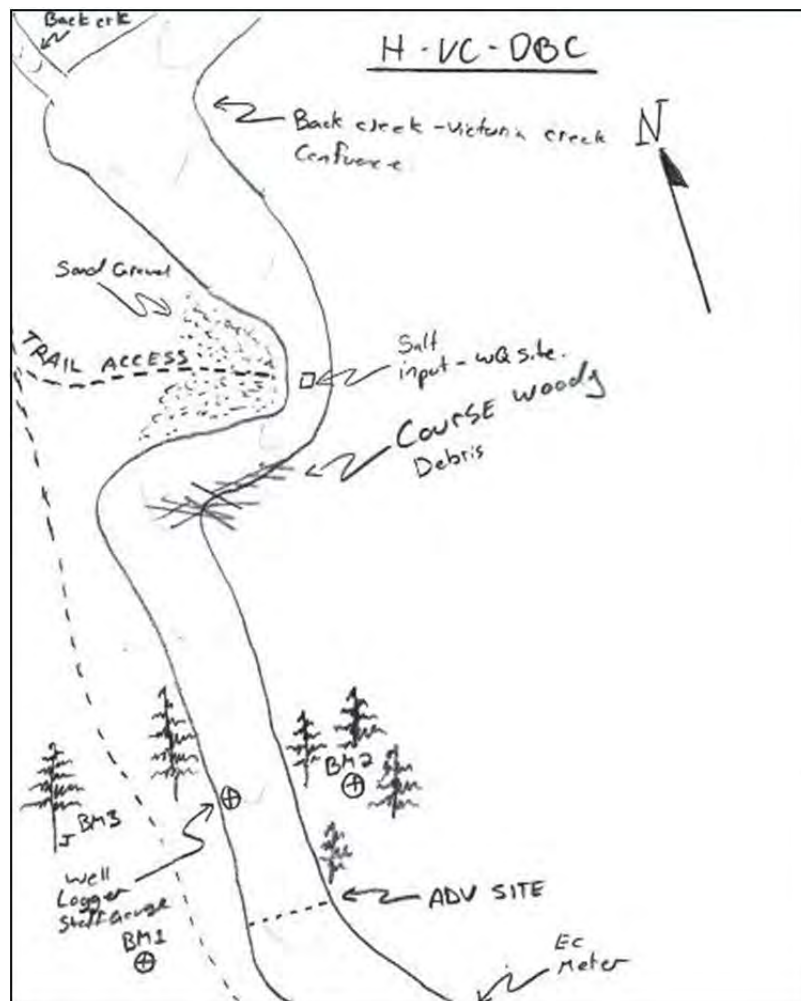


Name	Seepage Pond Outflow Pipe
Identifier	H-SEEP, WQ-SEEP
Location	E 391626, N 6880901
Station Type	Hydrology, Water Quality



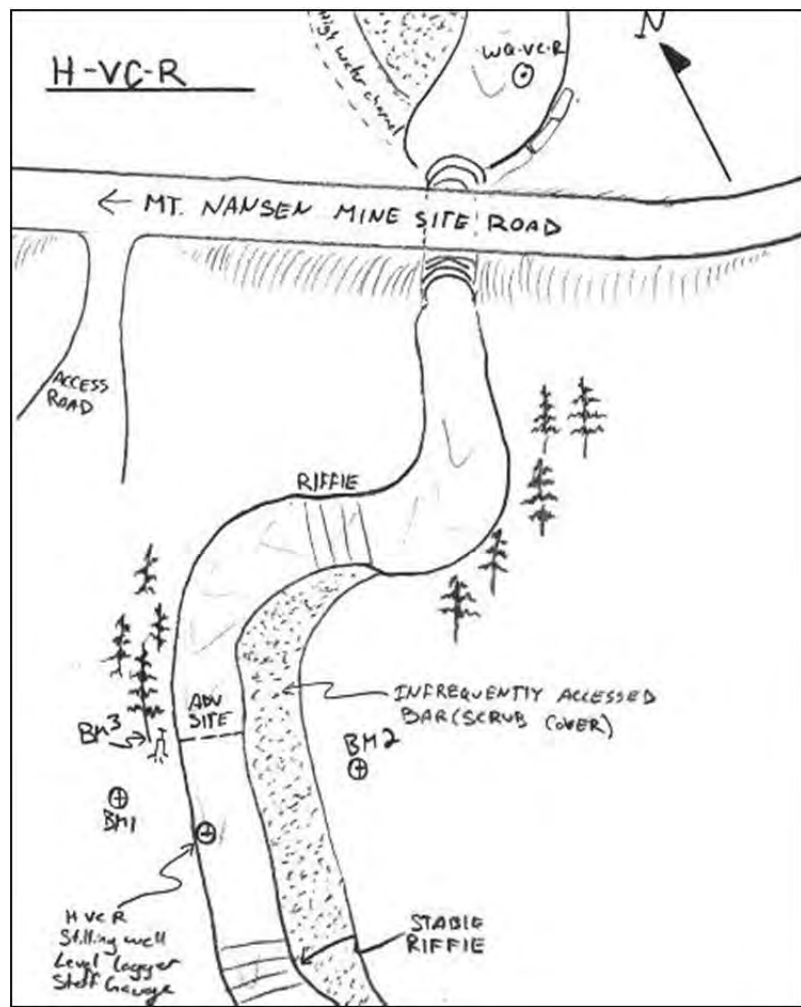


Name	Victoria Creek downstream of Back Ck
Identifier	H-VC-DBC
Location	E 391634, N 6880781
Station Type	Hydrology



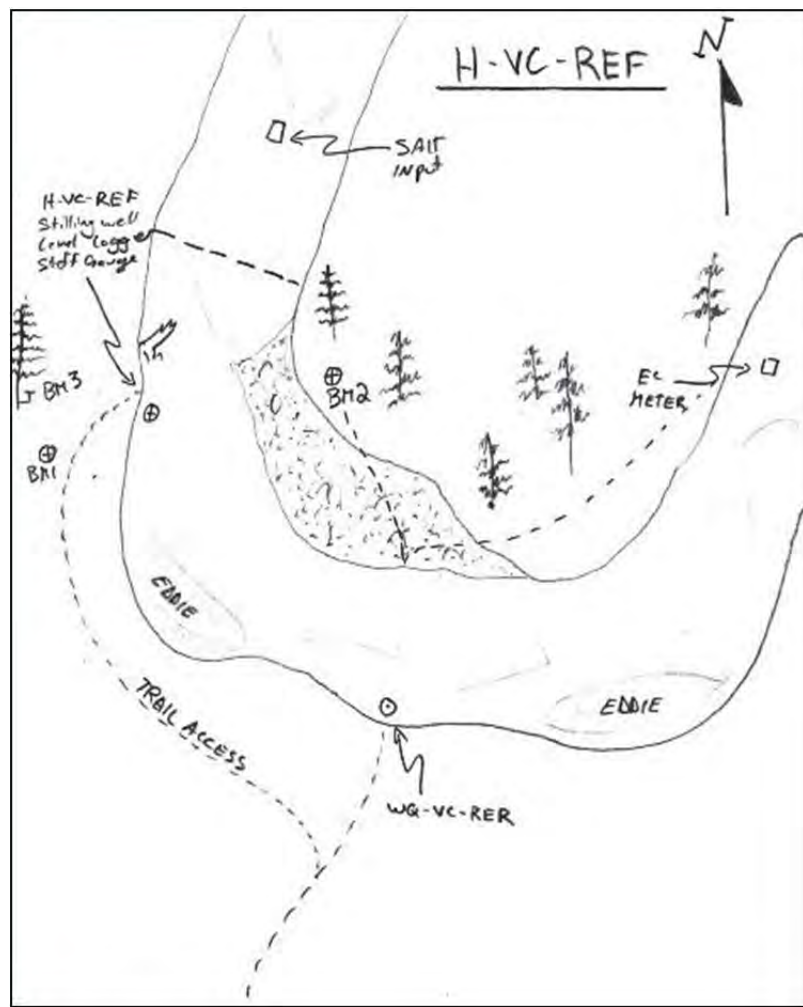


Name	Victoria Creek at Road
Identifier	H-VC-R
Location	E 392305, N 6878755
Station Type	Hydrology





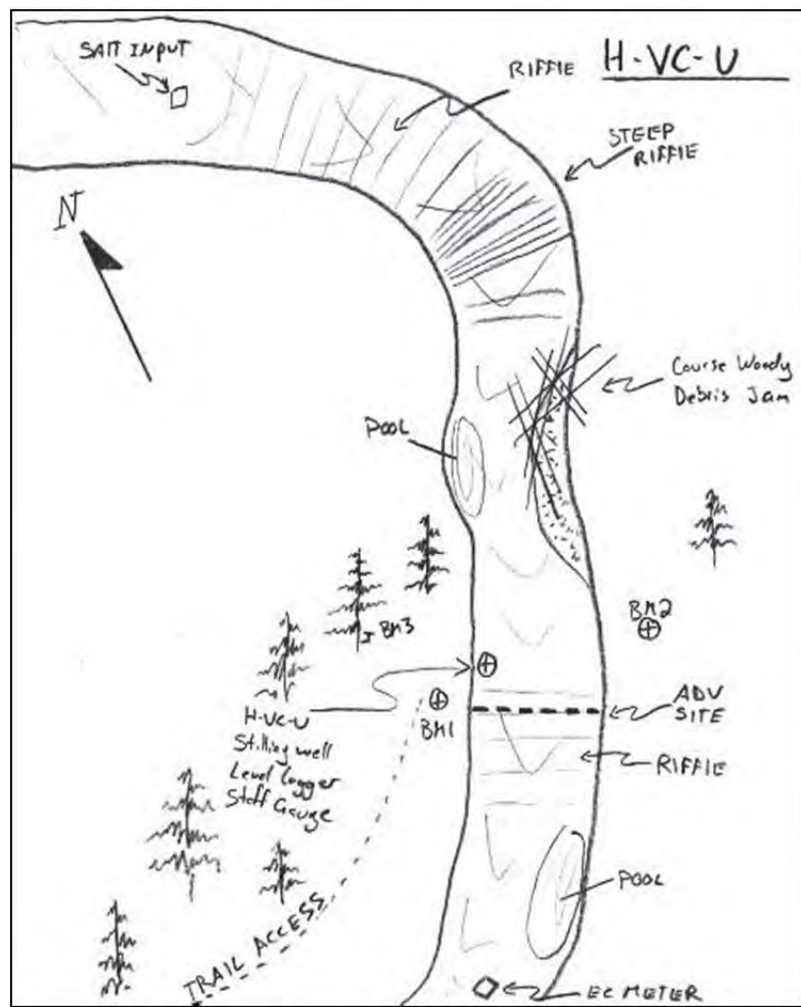
Name	Victoria Creek Reference
Identifier	H-VC-REF, WQ-VC-REF
Location	E 391650, N 6881113
Station Type	Hydrology, Water Quality





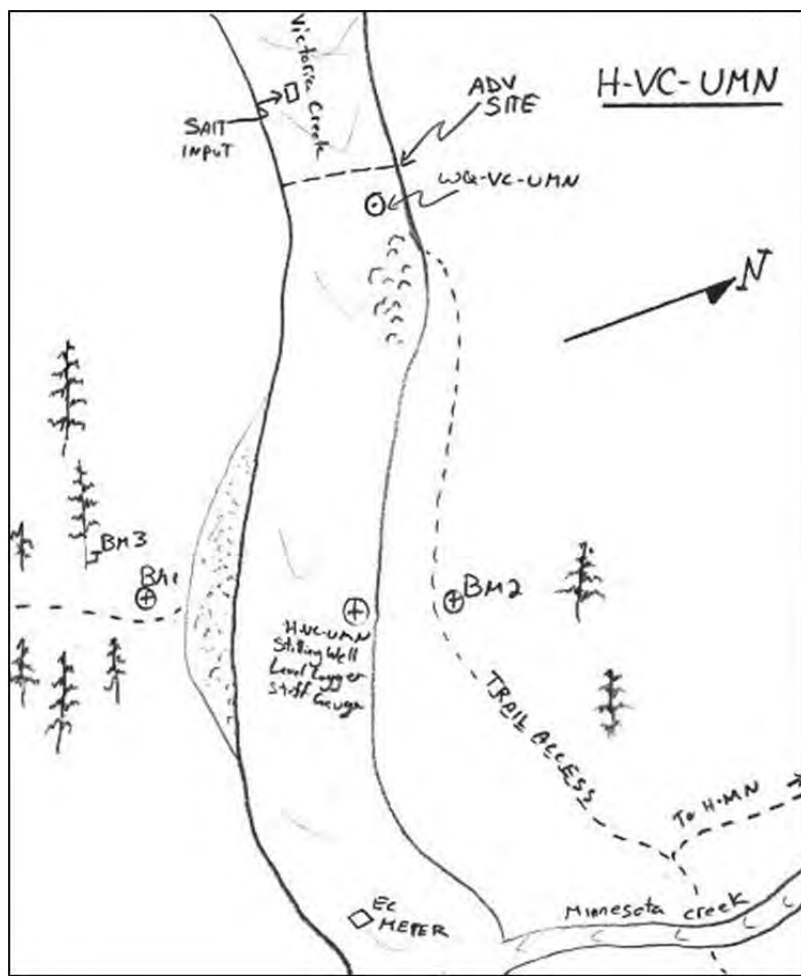
Mount Nansen Site Data Report: Surface Water and Meteorological Monitoring, 2012/13

Name	Upper Victoria Creek
Identifier	H-VC-U
Location	E 391667, N 6880882
Station Type	Hydrology





Name	Victoria Creek Upstream of Minnesota Creek
Identifier	H-VC-UMN, WQ-VC-UMN
Location	E 392413, N 6879244
Station Type	Hydrology, Water Quality





Name	Adit Seep
Identifier	WQ-ADIT-SEEP
Location	E 389086, N 6881711
Station Type	Water Quality





Name	Dome Creek at Road
Identifier	WQ-DC-R
Location	E 391110, N 6880449
Station Type	Water Quality





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Name	Dry Creek
Identifier	WQ-DRY-REF
Location	E 387621, N 6880578
Station Type	Water Quality





Name	Mill Seep 03
Identifier	WQ-MS-S-03
Location	E 387884, N 6881120
Station Type	Water Quality





Name	Mill Seep 08
Identifier	WQ-MS-S-08
Location	E 387954, N 6881073
Station Type	Water Quality





Name	Pony Creek Downstream
Identifier	WQ-PC-D
Location	E 389130, N 6881718
Station Type	Water Quality





Name	Pony Creek Upstream
Identifier	WQ-PC-U
Location	E 388955, N 6880856
Station Type	Water Quality





Name	Pit Lake
Identifier	WQ-PIT
Location	E 388913, N 6881625
Station Type	Water Quality





Name	Pump House Well
Identifier	WQ-PW
Location	E 391557, N 6880855
Station Type	Water Quality





Name	Tailings Pond
Identifier	WQ-TP, H-TP
Location	E 389427, N 6880625
Station Type	Water Quality





Name	Victoria Creek Downstream of Back Creek
Identifier	WQ-VC-DBC
Location	E 391632, N 6880826
Station Type	Water Quality





Name	Victoria Creek at Road
Identifier	WQ-VC-R
Location	E 392430, N 6878802
Station Type	Water Quality





Name	Upper Victoria Creek
Identifier	WQ-VC-U
Location	E 396126, N 6880871
Station Type	Water Quality





APPENDIX E DATABASES