



**PITEAU
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ALBERNI CLAYOQUOT REGIONAL DISTRICT
ALBERNI VALLEY LANDFILL
WATER QUALITY MONITORING PROGRAM
TO DECEMBER 2019
PORT ALBERNI, BC

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CONTENTS

RECORD OF AMENDMENTS	i
LIST OF TABLES	iv
LIST OF FIGURES	v
LIST OF APPENDICES	vi
1. INTRODUCTION	1
1.1 BACKGROUND	1
1.2 DESCRIPTION OF LANDFILL SITE	1
1.3 MONITORING PROGRAM HISTORY	3
1.4 SITE GEOLOGY	5
1.4.1 Bedrock	5
1.4.2 Surficial Sediments	5
2. DESCRIPTION OF THE MONITORING PROGRAM	7
2.1 MONITORING FREQUENCY AND PARAMETERS	7
2.1.1 New FWALC Guideline	7
2.2 SAMPLING METHODS	7
2.3 DESCRIPTION OF SAMPLING LOCATIONS	8
2.4 QUALITY ASSURANCE/QUALITY CONTROL	12
2.5 FIELD REVIEW	14
3. GROUNDWATER LEVEL MONITORING AND GROUNDWATER FLOW	15
3.1 GROUNDWATER FLOW IN BEDROCK	16
3.2 GROUNDWATER FLOW IN SURFICIAL SEDIMENTS	18
3.2.1 Landfill Expansion Areas and Bedrock Gap Along Stirling Arm Logging Road	18
3.2.2 Flow to North in Bedrock Trough	19
3.2.3 Groundwater Flow Beneath Original Landfill	20
4. WATER QUALITY MONITORING RESULTS	21
4.1 LEACHATE	21
4.1.1 Inorganic Chemistry	21
4.1.2 Organic Chemistry	23
4.1.3 Chemistry for South Expansion Area Leachate Drain	24
4.2 GROUNDWATER IN SURFICIAL SEDIMENTS	24
4.2.1 Southeast Side of Landfill	24
4.2.2 South Side of Landfill	25
4.2.3 West Side of Landfill	26
4.2.4 North Side of Landfill	26
4.3 GROUNDWATER IN BEDROCK	28
4.3.1 Background Chemistry	28
4.3.2 South Side of Landfill	31

4.3.3	East Side of Landfill	31
4.3.4	West Side of Landfill	33
4.3.5	North Side of Landfill	33
4.3.6	North East Side of Leachate Interception Channel	34
4.4	CREEKS	36
4.4.1	Heath Creek	36
4.4.2	McCoy Creek	36
4.4.3	Stevens Creek	37
4.4.4	Norris Creek	38
4.4.5	Christie Creek	39
4.5	DOMESTIC WELLS	40
5.	SUMMARY	41
6.	RECOMMENDATIONS	43
6.1	MONITORING PROGRAM	43
6.2	LEACHATE FLOW DATA	43
6.3	MONITORING WELL REPAIRS	44
6.4	RECOMMENDED DESIGN MODIFICATIONS AND MITIGATIVE MEASURES	44
7.	LIMITATIONS	45
8.	REFERENCES	46

LIST OF TABLES

Table 1	Alberni Valley Landfill 2019 Monitoring Program
Table 2	Summary of Leachate Impacts Based on Mean 2019 Concentrations
Table 3	Summary of 2019 Exceedances of GCDWQ and BC FWALC

LIST OF FIGURES

- | | |
|----------|---|
| Figure 1 | Landfill Location Map |
| Figure 2 | Site Plan |
| Figure 3 | Posted Groundwater Elevations and Interpreted Groundwater Flow Directions |
| Figure 4 | Hydrogeological Sections X-X' and Y-Y' through Original Landfill and South Expansion Area |
| Figure 5 | Hydrogeological Section Z-Z' through Original Landfill and South Expansion Area |

LIST OF APPENDICES

- APPENDIX A Water Elevation Monitoring Data Tables and Plots
- APPENDIX B Chemistry Monitoring Data Tables and Plots
- APPENDIX C Monitoring Data Tables for 2019 Duplicate Samples

1. INTRODUCTION

1.1 BACKGROUND

The Alberni Valley Landfill (AVL) is owned by the Alberni-Clayoquot Regional District (ACRD) and operated under Operational Certificate MR-00524, issued June 29, 2004. McGill & Associates Engineering Ltd. (McGill), provided landfill design and operational plans to the ACRD to the end of 2019, and Berry & Vale Contracting Ltd. operates the landfill. Piteau Associates Engineering Ltd. (Piteau) has overseen the AVL monitoring program since 1994 for McGill and the ACRD. The groundwater and surface water quarterly monitoring program is conducted to evaluate the impact of the landfill on the surrounding surface water and groundwater regime, and to recommend measures to mitigate any potential impact. This report has been prepared to summarize and assess the results of the 2019 program, along with relevant results from previous years.

1.2 DESCRIPTION OF LANDFILL SITE

The AVL is located on the west side of the Alberni Valley, near the crest of a wide ridge which separates the top end of Alberni Inlet from Sproat Lake (Figure 1). It is situated about 5 km west of Port Alberni at an elevation of about 80 m. Access is provided by Landfill Road off McCoy Lake Road or by the Stirling Arm logging road that passes along the south side of the property (Figure 2).

The original landfill footprint is situated in a natural basin within bedrock and is reported to be underlain by a clay layer that ponded water and formed a natural swamp on the site (Associated Engineering, 1973). Prior to landfilling, the majority of the site apparently drained to the north via a small seasonal creek (Stevens Creek) and a portion of the site would have drained to the east towards Christie Creek. A berm was constructed at the northwest corner of the landfill across the Stevens Creek drainage to prevent surface flow into this drainage course (Figure 2).

To maintain a drained condition in the base of the landfill and to convey water from behind the Stevens Creek berm to Christie Creek, a French Drain with a 200 mm diameter galvanized pipe was constructed through the centre of the swamp prior to landfilling (Figure 2). A 400 mm storm sewer pipe was installed above the galvanized pipe in the early 1990s to maintain drainage from the former sump located in the northwest corner of the landfill site. These drains have now been extended with a leachate pipeline. Until 2015, the pipeline discharged into the north leachate interception/conveyance channel, about 80 m west of the leachate aeration lagoon. In 2015, the pipeline was modified to convey discharge directly to the aeration lagoon as shown on Figure 2.

A concrete-lined leachate interception/conveyance channel was constructed around the north perimeter of the landfill site in 1995 (Figure 2). Any surface leachate seeps and shallow groundwater flow across the north perimeter of the landfill are collected in this channel. A sump

with a pump was also constructed behind the berm above Stevens Creek to lift any leachate accumulations not conveyed beneath the landfill by the storm sewer up into the north leachate interception/conveyance channel.

Contact water collected within the site is treated in a small aeration lagoon located on the east side of the site. Historically, this lagoon decanted to Christie Creek, but a pipeline was constructed in the late 1990s to convey the collected leachate to the Port Alberni sewage treatment lagoon. A flow equalization lagoon was constructed in 1996 to add 16,000 m³ (3.5 million lgal) of storage to handle any leachate flows in excess of the treatment capacity at the Port Alberni sewage lagoon. The pipeline was commissioned in early November 1998. It has an estimated capacity of about 115 L/s (1500 lpm), which is consistent with the maximum observed flow through this pipeline between 2014 and 2019. The current aeration lagoon was constructed, and the original aeration lagoon was decommissioned in 1998.

A possible leachate excursion towards the north property line was identified in groundwater monitoring data collected in 1997 and early 1998. In 1998, this area was investigated with an electromagnetic (EM) survey and two additional monitoring wells (MW98-9 and MW98-10) were installed in October of that year. Results of these investigations are included in the 1999 monitoring report (Piteau, 1999).

At the same time the monitoring wells were installed, an interception trench and sump were constructed to control migration of leachate across the north property boundary (Figure 2). Two pumps have been installed in the sump to maintain a drawn down condition in the trench. Both pumps are on level controls and operate on a demand basis. The pumps were commissioned in 1999.

The Landfill Expansion Area is divided into three parts, as indicated on Figure 2. There is a small area adjacent to the east side of the original landfill referred to as the East Expansion area, a large area adjacent to the south side of the original landfill, referred to as the South Expansion Area and an additional area adjacent to the north edge of the East Expansion Area referred to as the Northeast Expansion Area. Filling in the East Expansion Area began in 2004. The larger South Expansion Area is proposed for a future expansion. In 2000, a bypass logging road was constructed around the South Expansion Area and a perimeter containment embankment was constructed around the southeast corner of the landfill site. Landfilling was initiated in the Northeast Expansion Area in 2014.

A series of monitoring wells were drilled in the expansion areas in 2000, and three additional monitoring wells and four core holes were completed in 2002. A fourth monitoring well was also constructed in 2002 at a location to the northwest of the landfill. Additional monitoring wells were

completed by the leachate interception wells in the East Expansion Area in 2005 and 2015. Construction details for these new wells have been previously reported (Piteau, 2000, 2002b, 2007a and 2017a). Locations of the monitoring wells are shown on Figure 2.

Aggregate material has been continually sourced from the surficial sediments within the South Expansion Area and, in the summer of 2006, a French Drain was constructed as indicated on Figure 3. The French Drain was constructed to lower groundwater levels within the South Expansion Area.

The two leachate interception wells (PW-1 and PW-2) were constructed at the eastern edge of the East Expansion Area in late 2005. They were tested in February 2006, and commissioned in October 2007. PW-1 is intended to maintain a cone of depression in the bedrock groundwater flow regime to collect leachate that is seeping through bedrock towards the east boundary of the landfill property. PW-2 intercepts leachate flowing in the sand and gravel deposit at the toe of the East Expansion Area. These wells were twinned in 2015 to provide extra capacity and mechanical backup for the original two wells (Piteau, 2017a). The 2015 wells (PW15-1 and PW15-2) have not yet been put into regular service.

A seepage cut-off trench and berm were constructed at the northwest corner of the South Expansion Area in July 2007 (Figure 3). The trench was excavated west of BH00-3A in the topographic low between two bedrock outcrops. The design objective was to excavate to bedrock and backfill with low permeability fill to create a hydraulic barrier to groundwater flow and any potential leachate migration. The bedrock contact was much deeper than originally anticipated and could not be exposed over an approximately 3 m wide section. Sediments exposed at the base of the trench were dense well-graded moraine deposits, not the permeable sand and gravel encountered near surface. The trench was subsequently backfilled with imported low permeability fill and an earthen berm was constructed above the trench. An HDPE liner was installed on the upstream face of the berm and sealed with bentonite at its edges to provide an additional barrier against seepage.

The closest residences to the landfill are in the eight-lot subdivision at the east end of Lot 105 on the lower slopes of the Alberni Valley about 500 m from the site. These homes, along with those near McCoy Lake, are serviced with individual wells (shown as DW-1 through DW-6 and NORRIS on Figure 2).

1.3 MONITORING PROGRAM HISTORY

Piteau installed eight monitoring wells around the AVL in November of 1994, and recommended implementation of a quarterly sampling program to monitor potential leachate impacts to groundwater, surface waters, and selected domestic wells around and beyond the perimeter of the

site (Piteau, 1995). This monitoring program has been underway now for more than 20 years, and has been on a quarterly schedule since 1998.

In 1998, two monitoring wells were incorporated into the regular monitoring program to monitor leachate excursion towards the north boundary of the landfill property. Ten monitoring wells were constructed in the summer of 2000 as part of a hydrogeological investigation of two proposed landfill expansion areas (Piteau, 2000). One of these wells, located in the original landfill, was incorporated into the monitoring well network in 2000, and two more of these wells were added to the monitoring network in 2006.

As part of further hydrogeological investigations at the site in 2002, six additional monitoring wells were constructed at four sites. Two of these sites were incorporated into the monitoring program in 2002, and the other two were added in 2006. Four deeper piezometers were installed in boreholes drilled into bedrock with a diamond drill rig to explore the character of the bedrock beneath the landfill (CH-1 to CH-4), but these sites were not added to the monitoring program (Piteau, 2002b).

The two leachate interception wells and a monitoring well with two completions installed in the East Expansion Area in 2005 (Piteau, 2007a) were added to the monitoring program in 2008.

In November 2009, thirteen additional shallow monitoring wells were installed in the proposed South Expansion Area to measure water levels near the northwest seepage cut-off trench/containment berm constructed in 2007 and in the vicinity of the French Drain installed through the area in 2006. Water level data collected from these wells and chemistry data from the South Expansion Area Leachate Drain were first included in the water quality monitoring program in 2011.

Four additional monitoring wells were constructed in 2013 to provide water levels and background chemistry prior to deposition of waste in the Northeast Expansion Area (Piteau, 2014). These wells are situated outside the north leachate interception channel, around the perimeter of the proposed Northeast Expansion Area, and were incorporated into the monitoring program in 2014.

In 2015, two additional leachate interception wells and a monitoring well with two nested piezometers were installed close to the flow equalization lagoon (Piteau, 2017a). These wells were incorporated into the water level monitoring program in 2016.

A compilation and assessment of the results from two leachate drains, 16 monitoring well sites, two leachate interception wells and four surface water monitoring sites that were sampled in 2019 are presented in this report.

1.4 SITE GEOLOGY

1.4.1 Bedrock

Bedrock geology underlying the landfill has been mapped as Upper Triassic Karmutsen Formation (Geological Survey of Canada Map 17-1968, Paper 68-50). This formation is described as pillow-basalt and pillow breccia massive basalt flows with minor tuff and volcanic breccia. Massive basaltic rock is expected to have very low primary porosity and few fractures. This is consistent with bedrock outcrops in the area and the resistant nature of the rock noted during drilling of the monitoring wells. Drill cuttings were medium to dark gray in colour and displayed only minor variations in mineral content. Some zones of fracturing or faulting were encountered during drilling but most of the rock mass is interpreted to be massive with very few open fractures.

Two bedrock troughs, one beneath each of the East and South Expansion areas, were identified in the expansion area investigations. Inclined diamond drillholes were sited to recover rock cores from beneath these troughs, as they were identified as possible fault zones. The results indicated the rock mass beneath the troughs was more permeable than beneath the surrounding area, but was not permeable enough to be considered an exploitable aquifer. Potential seepage losses for the “worst case” fault interpretations were 0.1 L/s and 0.05 L/s for the East and South Expansion areas, respectively (Piteau, 2002b). Seepage in bedrock beneath these areas was interpreted to flow to the east towards Alberni Inlet.

1.4.2 Surficial Sediments

Surficial sediment cover for most of the original landfill area is limited to a thin veneer over bedrock (Figures 4 and 5). Areas of deeper sediments are present in channels or basins in the bedrock surface. As noted above, a clay layer was reported to underlie much of the swampy area in which the initial landfill footprint was developed. Four other areas, in which significant thicknesses of surficial sediments were found, are described in the following:

Landfill Expansion Areas

The proposed South Expansion Area (see extent on Figure 2) was used for gravel extraction until 2018, when all the available gravel had been mined out. The two monitoring wells installed in this area in 1994 (MW94-7 and MW94-8), and the investigation holes drilled in 2000, encountered bedrock at depths varying between about 5 m and 15 m (see sections on Figures 4 and 5). Sediments in these drillholes consisted of sand and gravel with variable silt content. A 2.4 m thick layer of silt was encountered at the bottom of MW94-8. Exposures in the borrow pits in this area exhibited cross-bedding, thus indicating a deltaic depositional environment. Bedrock outcrops bounded the sediment deposits to the south (Figures 2, 4 and 5).

The East Expansion Area (Figure 2) is located at the southeast corner of the original landfill. Investigation of this area indicated near surface deposits of silty sand or sand and gravel over either

very dense till or bedrock. Till is interpreted to be present under at least 60% of the area (Piteau, 2000).

Bedrock Gap along Stirling Arm Logging Road

MW94-4, located to the west of the landfill and on the north side of Stirling Arm Logging Road (Figure 2), encountered clayey sediments to 6.7 m depth. A thin layer of medium to coarse gravel was encountered between the base of the clay and the bedrock (Section Y-Y' on Figure 4). Artesian flow was encountered in this layer. The well was not centrally located in the gap due to the active logging road; hence, it may not have been located along the axis of the channel in the bedrock surface.

BH00-3A near the east end of this gap encountered sand and gravel sediments to 8.5 m depth with a thin till lens or layer at about 6.4 m depth (Piteau, 2000). It is not known if artesian flow is present in the sand and gravel layer between the base of the till and the bedrock as the well was screened 2.6 m into the bedrock.

Excavation for the seepage cut-off trench near BH00-3A in July 2007 did not encounter the bedrock contact beneath the centre of the gully. It is now understood that the bedrock is deeper than indicated by the pre-construction test pits, and that there is a narrow ravine in the bedrock surface between the two bedrock outcrops that bound the gap.

Low Area South and East of Flow Equalization Lagoon in Christie Creek Valley

This low area appears to be a broad bedrock channel infilled with surficial sediments. The channel is at least 13 m deep and appears to connect to the bedrock depressions, which trend in an easterly to southeasterly direction beneath the South and East expansion areas (Piteau, 2000). The northern border of this basin is indicated by bedrock exposures north of the leachate flow equalization lagoon (Figures 2 and 5); the southern and eastern extents are not defined. Sediments encountered in this basin consisted of silt and clayey silt over sand and gravel (Figure 4).

Bedrock Channel at MW94-6

MW94-6 was drilled to investigate a geophysical anomaly along the north edge of the landfill. Bedrock outcrops are present to the east and west of this location, but drilling revealed a channel approximately 7.3 m deep. Sediments that have infilled the bedrock channel consist of about 4 m of sandy clay over sandy gravel. A similar profile was encountered in MW98-9 (Figure 4).

2. DESCRIPTION OF THE MONITORING PROGRAM

2.1 MONITORING FREQUENCY AND PARAMETERS

Samples were collected from the monitoring network once in 1994, twice in 1995, twice in 1996 and three times in 1997. Since 1998, samples have been collected on a quarterly schedule.

Groundwater levels have been measured in accessible monitoring wells MW94-1 through MW94-7 since 1994, and in MW98-9 and MW98-10 since January 1999. Water levels have also been frequently measured in the 2000 series monitoring wells since late 2000. None of the 2000 series monitoring wells were sampled between 2002 and 2006 to allow them to reach equilibrium levels. Monitoring wells completed in 2002 and 2005 were added to the monitoring program in September 2002 and October 2008, respectively. Water levels have been monitored in the 2009 monitoring wells on a quarterly basis since January 2011. Monitoring wells installed in 2013 and 2015 were added to the water level monitoring program in January 2014 and April 2016, respectively.

Current monitoring program parameters are summarized in Table I. The last ten years of monitoring well elevation data is presented in this report in Tables A-1 through A-4 and time-series plots for the complete period of record are presented on Figures A-1 through A-9 in Appendix A. Tabulated summaries of analytical data are presented in Tables B-1 through B-29 for the last four years of data. Time-series plots present analytical monitoring data collected between 1994 and the end of 2019 on Figures B-1 through B-14 in Appendix B.

2.1.1 New FWALC Guideline

A new dissolved copper FWALC guideline approved in August 2019 supersedes the hardness-dependent total copper guideline (BC MOE, 2019). The new guideline is dependent on sample pH, temperature, dissolved organic carbon (DOC), humic acid content (HA), alkalinity, and major cation and anion concentrations.

For the 2019 reporting period, copper results have been compared against the now superseded total copper guideline, as DOC was not monitored in 2019, HA is not yet an available lab test, and major cation and anion concentrations were not measured at all sites.

2.2 SAMPLING METHODS

Groundwater samples were collected from monitoring wells using either weighted polyethylene plastic bailers or Waterra inertial foot valve pumps on HDPE tubing. Sample collection was by Piteau until October 1995, McGill from May 1996 to January 2006, and the ACRD thereafter.

Due to the low permeability of the rock mass, bedrock wells are very slow to respond. For this reason, static water levels are measured with an electric water level sounder one week before the samples are to be collected and the wells are then bailed or pumped to remove one well volume

and allowed to recover for one week in advance of sampling. This allows adequate time for formation water to accumulate in the wells.

A portable submersible pump is used to purge monitoring wells MW02-1D, MW02-1S, MW02-3D, MW02-3S, MW02-4, MW13-1D, MW13-1S, and MW13-2S. Other monitoring wells are purged using a plastic bailer or Waterra tubing with a foot valve. Prior to the discontinuation of sampling, the shallow standpipe SCKA (headwaters of Stevens Creek) was purged and sampled with a peristaltic pump. Leachate interception well samples from PW-1 and PW-2 are collected using the installed submersible pump from the outlet of the 50 mm diameter discharge pipe where the wells discharge to the leachate pond. If the pump is not operating at the time of sampling, the pump is switched on manually and the sample is collected once the water appearance stabilizes after a few minutes of pumping. All surface waters are grab sampled.

Samples for ammonia and Chemical Oxygen Demand (COD) are preserved with sulphuric acid (H_2SO_4) at the time of collection, and samples for total metals are preserved with nitric acid (HNO_3). Starting in April 2018, samples for dissolved metals were filtered with single-use 0.45 micron inline filters and preserved with nitric acid at the time of collection. Prior to April 2018, samples were not preserved until after they were filtered in the laboratory. All samples are stored with ice in a cooler and couriered to a commercial laboratory. Since 2014, all samples have been analyzed by AGAT Laboratories in Burnaby, BC.

Field measurements for electrical conductivity, temperature and pH are obtained using hand-held digital probes calibrated against known standards or buffer solutions.

2.3 DESCRIPTION OF SAMPLING LOCATIONS

The locations of all the sampled monitoring wells, the leachate sampling point, and sampling stations on Christie and Stevens creeks are shown on Figure 2. Due to the scale of the map, the sampling station on Heath Creek and the location of the well on Landfill Road are not shown. A detailed summary of each of the creek sampling points is given below.

Surface Water Stations

Heath Creek	Sampled on the south side (upstream) of McCoy Lake Road.
Stevens Creek	Sampled approximately 50 m downstream (north) of the clay berm on the northwest side of the original landfill area. Additional sampling sites at base of clay berm (SCKA) and in a pond halfway between the berm and the long-term sampling site (SCKB) added in April 2015.
Christie Creek D/S	Sampled near trail from flow equalization lagoon, and approximately 200 m downstream (northeast) from the lagoon.

Christie Creek U/S Sampled in the Christie Creek ditch by the driveway to the site of the decommissioned tire recycling facility.

Leachate Leachate flow from the French Drain beneath the original landfill area discharged via a pipe to the north concrete leachate interception channel until 2015. Prior to 2006, leachate samples were collected from the French drainpipe where it discharged to the leachate conveyance ditch. After 2006, leachate samples were collected downstream of the French Drainpipe's confluence with the concrete north leachate conveyance ditch, at the inlet to the leachate aeration lagoon. After July 2015, when the French Drainpipe was rerouted, leachate samples were collected directly from the pipe where it enters the aeration lagoon.

Leachate flow from the French Drain in the South Expansion Area is sampled where it discharges at surface. It has been sampled quarterly since February 2011.

McCoy and Norris creeks were dropped from the sampling program in late 1995 and early 1997, respectively. Potential impacts in the former are interpreted to be well below the resolution of a monitoring program. The latter creek is on private property and access is no longer being permitted to the sampling site.

A series of seeps surrounding the flow equalization lagoon were monitored for field parameters only in 1998 and 1999. The intent of this monitoring was to identify the seepage pathway between the landfill and Christie Creek, responsible for some residual impacts following the commissioning of the leachate pipeline. This program was terminated after a small containment berm was constructed on the southwest side of the surge lagoon to control this seepage.

Monitoring Wells

MW94-1 East of the original landfill. MW94-1D was removed from the sampling program in 2010, as it appeared to have a leaky connection to near surface groundwater. Both MW94-1D and MW94-1S were backfilled in May 2013 in preparation for landfilling over this area.

MW94-2 North side of the Stirling Arm Logging Road, approximately 20 m south of the flow equalization lagoon. This well was destroyed during construction of the landfill expansion area containment berm in July 2000.

MW94-3 North side of the Stirling Arm Logging Road, at the east end of the original landfill. This well was inaccessible for some time after the last water level was measured in 2005. It has subsequently been removed from the program as the standpipes are blocked above the water level.

MW94-4 North side of the Stirling Arm Logging Road, approximately 120 m west of the original landfill.

MW94-5	Approximately 60 m east of the clay berm on Stevens Creek, just north of the north leachate interception/conveyance channel. MW94-5D is plugged and has not been sampled since November 2009. MW94-5S is still sampled.
MW94-6	Approximately 120 m east of the clay berm, on the north side of the north leachate interception/conveyance channel.
MW94-7	On the Stirling Arm Logging Road, south of the centroid of the original landfill. This well was removed from the monitoring program after it was destroyed in the winter of 2008.
MW98-9	Approximately 25 m north of the north leachate interception channel.
MW98-10	Approximately 25 m north of the north leachate interception channel, 30 m east of MW98-9.
BH00-1C	Completed in base of waste, near middle of original landfill. This well was inaccessible from 2003 through 2012, due to a high casing stick-up but the casing was cut down and the well resurveyed in May 2013. The standpipe is bent or broken at a depth of 10 m below ground (mbg) but samples were collected for three of four monitoring events in 2015.
BH00-4A	On the north side of By-Pass Road, at southeast corner of the proposed South Expansion Area. Sampled quarterly since 2007, twice in 2006, and five times previously. Not sampled since February 2011 as the top of casing was too high above current ground and was not accessible. This well has since been destroyed.
BH00-7A	In the central portion of proposed South Expansion Area. Sampled once in 2006 and four times previously. Inaccessible from 2007 through 2012, the casing was cut down in 2013 to allow access to measure water levels. The standpipe is sheared off at 6 mbg.
BH00-11A	Located just outside the southeast corner of the landfill property and briefly included in the monitoring program. Well was destroyed by Weyerhaeuser road works, approximately four months after installation, so only one water quality sample was obtained.
MW02-1	On south side of By-Pass Road, in the old tire recycling facility. Sampled once in 2002, twice in 2006, and quarterly since 2007. The shallow piezometer was damaged in July 2015, and is no longer serviceable.
MW02-2	On south side of By-Pass Road, in the old tire recycling facility. Sampled twice in 2006 and quarterly since 2007. This well was not sampled after July 2011 due to vandalism. This well will require replacement prior to commencement of landfilling in the South Expansion Area.

MW02-3	On embankment immediately east of the flow equalization lagoon. Sampled quarterly since 2002 as a replacement for MW94-2.
MW02-4	On landfill access road, about 600 m WNW of original landfill footprint. Sampled quarterly since 2002.
PW-1	Approximately 25 m north of temporary leachate containment berm at east end of East Expansion Area. Sampled quarterly starting in October 2008.
PW-2	At east end of East Expansion Area, approximately 30 m north of temporary leachate containment berm. Sampled quarterly starting in October 2008.
MW05-1	On edge of flow equalization lagoon, east of East Expansion Area and approximately 5 m east of temporary leachate containment berm. Sampled quarterly starting in October 2008.
MW13-1	On the northeast side of the North Leachate Interception Channel. First sample collected in June 2013. Quarterly sampling began in December 2014 for both completions. Starting in 2017, sampling at MW13-1d was reduced to an annual.
MW13-2	On the north side of the North Leachate Interception Channel, approximately 150 m northwest of MW13-1. First sample collected in June 2013. Quarterly sampling began in December 2014. Sampling at MW13-2d was discontinued in 2017.

Monitoring wells monitored for water levels only:

MW94-8	Located in the centre of the South Expansion Area, this well was last monitored in 2006 and has since been buried.
BH00-1A, BH00-2A	These wells are located in the South Expansion Area (A suffix BH00-5A, BH00-6A, denotes South Expansion Area) and were installed to measure hydraulic BH00-7A, BH00-8A properties of the bedrock and hydraulic gradients. Water levels are measured approximately quarterly. Access to several of the sites has been lost and sometimes regained over the years. The sites that are currently accessible are BH00-1A, BH00-5A, BH00-6A, BH00-7A and BH00-8A.
BH00-5B	Located in the East Expansion Area (B suffix), access was lost to this well in 2007.
BH00-2C	This well was installed to measure water levels below the waste in the centre of the original landfill. This casing was cut down in May 2013 to improve accessibility, which prevented monitoring since June 2001. The standpipe is blocked at 3.2 mbg.

- MW09-01 to MW09-05 Located to the west and east side of the seepage cutoff berm to measure hydraulic gradient across this structure (Figure 3). Water levels measured in November 2009 and quarterly since 2011, except for MW09-05, which was destroyed in late 2011/early 2012. These wells have never been sampled.
- MW09-06 to MW09-13 Located in South Expansion Area to determine hydraulic gradients towards the French Drain (Figure 3). Water levels measured in November 2009, and quarterly since 2011. These piezometers are gradually mined out as the surface is prepared for landfilling in the South Expansion Area. MW09-06, MW09-07 and MW09-12, were destroyed in 2012, MW09-08 and MW09-11 were destroyed in 2016, and MW09-09 and MW09-13 were destroyed in 2018, so only MW09-10 is still monitored.
- PW15-1, PW15-2 These pumping wells were constructed as backup leachate wells for PW-1 and PW-2 at east end of East Expansion Area. These wells will be monitored for water levels only until they are put into service. At that time, one sample will be collected from each of PW-1 and PW15-1, and PW-2 and PW15-2, depending on which wells are operational at the time of sampling. Water levels measured quarterly since April 2016.
- MW15-1 Located north of Flow Equalization Lagoon to demonstrate leachate control in this area. Water levels measured quarterly since April 2016.

Domestic Wells

A well located at 7396 McCoy Lake Road, west of Heath Creek, was first sampled on October 2, 2000 at the request of the residents. Quarterly sampling was conducted at this site for three years but only one sample was submitted for a detailed potability analysis each year. Additional sampling involved measuring electrical conductance (EC), pH and temperature in the field. Sampling was terminated in 2003 at the request of the residents.

Private wells monitored in the area to the northeast of the landfill (Figure 2) until 1996 are no longer monitored at the request of the property owners.

2.4 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance/quality control (QA/QC) processes incorporated in the monitoring program included measures by both the analytic laboratory and by field personnel collecting surface water and groundwater samples. The laboratory component includes analysis of quality control samples to define precision and accuracy, and to demonstrate contamination control for the type of samples and parameters under investigation. These measures include analysis of laboratory replicates, method blanks, and certified reference materials.

QA/QC inherent in the field program to ensure sample integrity include prevention of cross contamination and introduction of foreign contaminants during sampling through the use of new latex or nitrile gloves and dedicated sampling equipment at each sample location and use of unused sample containers provided by the project laboratory.

The field program also included collection and analysis of one field-duplicate sample for every ten samples collected to verify analytical precision (i.e., repeatability). The relative percent difference (RPD) between the sample and the duplicate was calculated in accordance with the following equation:

$$RPD = \frac{(C_1 - C_2)}{(C_1 + C_2)/2} \times 100\%$$

where:

- RPD is relative percent difference;
- C1 is the larger of the two observed values; and
- C2 is the smaller of the two observed values.

RPD values below about 35% are generally desirable, and values of up to about 65% are considered acceptable. For the nine field duplicate samples collected in 2019, all calculated RPDs were below 35%, with the following exceptions (Appendix C):

- The January 2019 samples from MW02-1D had calculated RPDs above 52% for all ten dissolved metals where concentrations were measured above the detection limits (Table C-1). The concentrations are all close to the detection limit and well below the guidelines, with the exceptions of copper and zinc. Dissolved copper had a calculated RPD of 69% and the duplicate sample concentration of 0.0035 mg/L exceeded the superseded total copper FWALC guideline of 0.002 mg/L. The RPD for dissolved zinc was 59% and the duplicate sample concentration of 0.011 mg/L exceeded the 0.0075 mg/L FWALC guideline.
- The April 2019 samples from MW98-9 had calculated RPDs of 43% and 51% for dissolved arsenic (both below 0.005 mg/L FWALC) and dissolved vanadium (no guideline). RPDs were also calculated for instances where just one of the samples had a non-detect result for dissolved chromium (67%), cobalt (129%), copper (86%), iron (198%) and manganese (198%). Of these, chromium was measured at the FWALC of 0.001 mg/L for the primary sample, and iron and manganese were measured above their respective guidelines for the duplicate sample.
- The RPDs for dissolved copper at MW94-4S (October 2019) and total copper at the South Expansion Leachate drain (April 2019) were 46% and 42%, with all concentrations below the hardness-dependent superseded total copper guideline.

- The RPDs for ammonia at MW98-9 for April 2019, MW94-4S for October 2019, MW13-1S for January 2019, and Christie Creek U/S for April 2019 were 120%, 67%, 35%, and >67%, respectively (Tables C-1, C-2 and C-3). The highest measured concentration was 0.1 mg/L-N at MW13-1S, well below the 1.8 mg/L-N FWALC; and
- The RPD for TOC at the South Expansion Leachate Drain in April 2019 was 74%. TOC does not have a guideline (Table C-4).

2.5 FIELD REVIEW

A field review of the AVL monitoring program was conducted in October 2019 by Piteau and are described in a draft technical memorandum issued on November 13, 2019 (Piteau, 2019b). The objective of the field review was to verify that the sampling procedures comply with standard practices, and that sampling locations are as documented in the reports. The work involved:

- Assessing sampling procedures and field data collection through demonstrations and interview;
- Touring equipment storage facilities;
- Verifying surface water sampling locations; and
- Checking conditions of sample sites.

As with any large monitoring program, the field review identified some areas for improvement. The following changes were recommended:

1. Dedicated bailers should be used;
2. Dedicated peristaltic pump tubing and jugs should be used;
3. The water quality meter should be calibrated before each sampling event, as follows:
 - a. A three-point calibration for pH using pH 4, 7, and 10 solutions;
 - b. Calibration for electrical conductivity (EC);
4. The water quality meter probes should be rinsed with de-ionized (DI) water between samples;
5. Water samples should be collected immediately after purging three well volumes, except for bedrock wells with low recovery rates, which can be purged dry and sampled one week later;
6. Purchasing a HydroLift-2 to assist with operating the Waterra pumps, and increasing use of Waterra pumps if purchased; and
7. Original field notes should be permanently retained.

3. GROUNDWATER LEVEL MONITORING AND GROUNDWATER FLOW

Water level data for the monitoring well network at the landfill site are tabulated in Tables A-1 through A-4 and are presented as time-series plots on Figures A-1 through A-9. Groundwater elevations based on observations in October 2019, and interpreted equipotentials, are included on Figure 3.

Water elevations and interpreted piezometric surfaces on an east/west and two north/south sections through the landfill site are shown on Figures 4 and 5. Data used for the interpretations on the sections were those collected on October 2019, or the last available winter data for monitoring wells that have been destroyed, or are no longer accessible. Groundwater elevations posted on the plan on Figure 3 were observed in October 2019, unless otherwise indicated.

Due to the low permeability of the rock mass and slow response time of the monitoring wells, they must be left for extended periods of time to obtain true static levels. The slowly responding wells include MW94-1D, -1S, -2D and -6D, BH00-2A, -3A, -4A, -6A and -8A, MW02-1D, and MW13-1D, 2D and 2S (Figures A-1 to A-5, and A-9).

BH00-1A, -3A, -4A, -6A and -8A display a declining trend between January 2001 and April 2002 (Figure A-5). None of these wells were bailed at that time so the declines are interpreted to be a pore pressure reduction associated with dilation of the rock mass in response to removal of aggregates from the area surrounding these wells. Following that time, all the monitoring wells in the expansion area ("A" suffix denotes South Expansion Area) display rising trends, until mid-2003 or -2004, when static levels were finally attained (Figure A-5). Slight seasonal fluctuations were apparent in the data from 2004 to early 2006, including a possible slight decline in some wells that can be attributed to the dry weather experienced in the previous three years. Well BH00-4A was bailed for sampling on a quarterly basis from July 2006 to February 2011, and did not fully recover between sampling events. It has not been monitored since February 2011, as the well collar has been buried.

All monitoring wells in the South Expansion Area displayed a dramatic water level drop in the summer of 2006, in response to sampling. The responsive monitoring wells also displayed drawdown response following the construction of a French Drain in the fall of 2006 (Figure A-5). Elevations in MW94-7 displayed the same drop in response to the French Drain, but MW94-4S did not (Figure A-2). A short-term rise in water levels recorded in MW02-1S, MW94-4D and, to a lesser extent in many other wells in January 2010, was likely related to wetter-than-normal conditions in the antecedent period. Water levels in 2019 were within the historical envelope documented since 2007.

October 2007 water levels in bedrock in the South Expansion Area were all below 71 m elevation, except for BH00-5A-S, which is screened in fractured bedrock at about 72 m elevation. Except for BH00-4A, which has been sampled regularly since 2006, piezometric levels in the 2000 series monitoring wells in the South Expansion Area now range from about 68 m to 72 m. Water levels in some of the 2009 series piezometers, installed in overburden in the South Expansion Area, range from 68 to 74 m and typically fluctuate up to 2 m annually (Table A-4 and Figure A-6). Monitoring wells exhibiting the higher heads are typically located more than 30 m from the French Drain. The French Drain constructed in mid-2006 now represents the most significant groundwater discharge feature in the area.

With the exception of the data from MW94-1 and MW05-1, piezometric data display either very little vertical gradient (shallow and deep piezometers have very similar readings) or a downward recharge gradient (shallow piezometer has a higher head than the lower piezometer). This indicates that the site is a groundwater recharge area. Levels reported for MW94-1D were often anomalous, likely reflecting a leak into the standpipe near the collar of this monitoring well (Piteau, 1999). The elevated head in BH00-3A, in the summer of 2007 (Figure 4 and Figure A-5), indicates groundwater in bedrock is flowing into the South Expansion Area from beneath the ridge to the southwest. This monitoring well has been inaccessible since October 2007. Data for MW05-1 has generally indicated an upward gradient since the summer of 2010, except for August 2014 when PW-1 was operating and October 2019 when PW15-1 was operating (Table A-3 and Figure A-7). The upward gradient is attributed to the partial effectiveness of interception well PW-2, which has lowered the hydraulic head in surficial sediments and the relative ineffectiveness of interception well PW-1, which is not currently inducing a head reduction in the bedrock.

3.1 GROUNDWATER FLOW IN BEDROCK

Groundwater flow in bedrock beneath the original landfill area is interpreted to be to the north, northwest, southeast and east, and flow beneath most of the expansion areas is interpreted to be to the east and southeast, except for the extreme western edge, where westward groundwater flow is interpreted. A flow divide is interpreted to bisect the original landfill area (Figure 3). Groundwater flow in bedrock on the west side of the interpreted flow divide is interpreted to be to the west and, on the east side flow is interpreted to be southeasterly to easterly. The hydraulic gradient has been very flat since the French Drain was installed.

A local flow divide interpreted near MW94-1 in the past was removed in 2004, based on a drop in water levels that year to the 65.4 to 67.9 m range that has been observed in the shallow standpipe since that time (Figures 3 and 5). The flow divide has been extended to the north along the north leachate interception ditch, based on the hydraulic heads measured in MW13-1 and MW13-2. Only MW13-1S exhibits a consistent trend among the four monitoring wells with “MW13” prefixes with quarterly sampling (Figure A-9). The data record for this monitoring well indicates very little

seasonal variability. Neither MW13-1D and MW13-2S fully recover between quarterly sampling events, indicating they are completed in a very low permeability rock mass. Since 2017 they have only been sampled once or twice annually, so have demonstrated greater recovery between sampling events. MW13-2D exhibits elevated heads during high precipitation periods, and the heads measured when this monitoring well is not regularly sampled are the highest bedrock heads measured at the site (78.7 m in October 2019). However, the much lower heads measured after quarterly sampling (most of 2015 and 2016) indicate that recharge varies over time, and that outside of recharge periods, this monitoring well recovers very slowly. This suggests a very low hydraulic conductivity rock mass. It is possible that some fractures may receive recharge during very wet weather, possibly associated with high flows in the leachate channel. A network of relatively shallow fractures may provide a conduit for this recharge to seep down through the rock mass, to the depth of the MW13-2D completion. Recharge along this pathway appears to be highly variable and infrequent, but does affect heads when it occurs.

From 2010 to 2018 the lowest bedrock hydraulic heads other than in MW94-6D, MW13-1D and MW13-2S, and 2D, where a true static water level is not always attained between sampling events, have typically been in MW02-3D and MW05-1D, and in the two bedrock leachate interception wells PW-1 and PW15-1. In 2009 and 2010, the lowest bedrock heads were maintained in PW-1 and MW05-1D, due to the drawdown effect of PW-1. However, this well appeared to stop operating after the spring of 2010.

In 2013, a pumping test was performed on PW-1 to assess whether a decline in well efficiency had resulted in a decline in effectiveness. Results of the test indicate the hydraulic efficiency of the well has not declined since it was constructed, and the decline in effectiveness is likely due to operational issues (Piteau, 2014). A datalogger recording water levels in PW-1 since July 2014 confirmed that PW-1 only operates during sample collection events (Figure A-7). In December 2019, Fyfe Well & Water Services (Fyfe) found the pump to be inoperable and thus removed it, but a subsequent pumping test indicated no decline in effectiveness of the well (Fyfe, 2020).

PW15-1 was constructed in 2015 to provide mechanical backup to PW-1. Based on the recent water levels measured in these monitoring wells and the data logger record from PW-1, it appears PW15-1 operated from May to early November of 2019. For the period when PW15-1 was in operation, approximately 5 to 16 m of drawdown was measured at PW-1 and MW05-1D (Table A-3 and Figure A-7).

When PW-1 and PW15-1 are not operating, groundwater flow in bedrock beneath the east edge of the landfill is upwards towards the surficial sediments and easterly towards Christie Creek. However, when the system is operating properly, a controlling gradient is induced in the bedrock flow regime and the wells are an effective interception measure (Figure 4). Based on the water

level record available from PW-1, it appears the pumping configuration in October 2019 provided effective interception of leachate (Figure A-7).

The flow regime in bedrock is interpreted to be very slow moving due to the low hydraulic conductivity of the rock mass and low hydraulic gradient (0.06 m/m) to the ultimate discharge area along the shore of Alberni Inlet (Piteau, 1995, 2000 and 2002b). As a result of the low bedrock permeability, a very high component of the groundwater flow beneath the area is expected to perch above the rock and seep through surficial sediments. Much of the groundwater flow that seeps to depth should be intercepted by the bedrock wells when they are operating within the design elevation range. However, much of this flow would seep past the wells when they are not operating effectively.

3.2 GROUNDWATER FLOW IN SURFICIAL SEDIMENTS

Groundwater flow in surficial sediments is limited to the areas discussed below.

3.2.1 Landfill Expansion Areas and Bedrock Gap Along Stirling Arm Logging Road

The most significant groundwater flow in the area will occur in the surficial sediments beneath the South and East Expansion areas. These sediments are very permeable and are saturated over a thickness of up to about 12 m (Figure 4). The water table in the surficial sediments in this area has historically fluctuated over an annual range of 1 to 2.5 m, with highs occurring in the late winter (see MW94-2S and MW94-3S on Figure A-1; and MW94-7S on Figure A-2). Following installation of the French Drain in the South Expansion Area in autumn 2006, piezometric levels have declined to slightly below El. 70 m (Figures 3 and A-5).

The most recent water levels for the 13 shallow standpipes installed in November 2009 are plotted on Figure 3. Interpreted equipotentials exhibit a steep gradient towards the French Drain, indicating it is effectively collecting the groundwater flow from this area (Figure 3). An easterly groundwater flow across the cut-off structure at the northwest corner of the expansion area is also indicated by the October 2019 piezometric data (Figures 3 and 4) consistent with the interpretation reported previously (Piteau, 2011 through 2018). No seepage losses are interpreted to occur from the Southeast Expansion Area through this cut-off structure due to the hydraulic gradient towards the landfill.

The water level in MW94-4S has consistently been artesian. Prior to the construction of the French Drain, this was explained by a groundwater flow regime recharged within the South Expansion Area which flowed towards Heath Creek via the bedrock gap (Figures 4 and 6). However, since the French Drain was installed and the seepage cut-off berm has also been constructed to divert any flow away from this pathway, hydraulic heads in the expansion area have been lower than at MW94-4S. The artesian condition is therefore attributed to a localized flow regime.

Most groundwater beneath the South Expansion Area is interpreted to flow to the northeast, east and southeast with flow occurring in two directions from a flow divide, which has been interpreted through the area at the approximate location of the seepage cut-off berm (Figure 3). The largest component of the flow in surficial sediments beneath the expansion area discharges to the French Drain, which controls the water table at approximately 69 m-geod. (Figure A-5). Christie Creek and the PW-2 leachate interception well (Figure 2) are the interpreted discharge points for any groundwater flow in surficial sediments beneath the South Expansion Area that does not seep into the French Drain. When the pump in PW-2 is operating properly, it induces a significant gradient from MW02-3S back towards MW05-1S and the well.

Water levels measured with a datalogger installed in PW-2 since July 2014 indicate the level at PW-2 is rarely maintained at the El. 64.5 to 64.8 m operating level recommended by Piteau (2007a) and is only very slightly below and sometimes above the elevation measured at MW02-3 on the east berm of the flow equalization lagoon (Figures 3 and A-8). If PW-2 is not operated at a sufficiently low level for prolonged periods, the hydraulic gradient towards the well will not be sustained. This well must operate within a lower elevation range on a consistent basis to be effective.

Well testing completed at PW-2 in May 2013 indicated no decline of well efficiency since a previous test in 2005 (Piteau, 2014). An inspection in December 2019 found the pump in PW-2 to be in poor condition, but results of a step pumping test conducted by Fyfe indicated the well efficiency had not declined (Fyfe, 2020). PW-2 was twinned to provide redundancy in 2015 but the second well (PW15-2) has not yet been put into service. If these wells are operated as intended, the system should be an effective leachate control measure (Piteau, 2017a).

3.2.2 Flow to North in Bedrock Trough

Some northward groundwater flow is interpreted to occur across the north perimeter of the landfill along sand and gravel sediments that have infilled the base of a bedrock trough identified in this area (at MW94-6). Recharge to this localized flow regime would be very limited due to the confinement provided by the overlying silt and clay moraine sediments (Section X-X', Figure 4).

As indicated on the hydrographs (Figures A-3 and A-4), piezometric levels were very high in the vicinity of MW94-6 and MW98-9 in 2001. This suggested that the interception trench was not functioning as intended. Subsequent inspection by McGill personnel indicated that the power supply to the pumps had been interrupted and this was subsequently remedied. Water level data collected from 2002 through 2019 indicate that the interception trench has been an effective leachate control measure, except for brief intervals in the summer of 2005, winter of 2006, January 2008, April 2015 through April 2016, January 2017 and July 2019. The system was working normally in October 2019.

3.2.3 Groundwater Flow Beneath Original Landfill

The groundwater flow regime beneath the original landfill is interpreted to follow the bedrock topography to the southwest. Initial water levels measured in BH00-1C and BH00-2C, both with screen completion zones at the base of the waste at the bedrock contact, indicated groundwater levels similar to those measured outside of the landfill footprint at MW94-5 and MW94-6S (Figures 4 and A-3). Casings were subsequently raised on BH00-1C and BH00-2C in anticipation of placing an additional lift of waste on the landfill. When the casings were cut down in 2013 to re-establish access to the monitoring wells, both standpipes were found to be bent or broken a few metres below the trafficked surface from which the wells were originally drilled. Recent water levels measured in the wells are indicative of a perched water table at the approximate level of the trafficked surface and are not considered representative of the groundwater flow regime beneath the landfill.

4. WATER QUALITY MONITORING RESULTS

4.1 LEACHATE

Leachate quality is monitored where the leachate drain flows into the aeration lagoon and at the discharge point from the South Expansion Area Leachate Drain (Figure 2). Due to the low permeability of the landfill foundation, most of the leachate from the landfill naturally seeps into the two drains.

Dilution at the sampling point for the main leachate drain is minimal (about 2:1) and the analytic results for samples collected at this location are considered to be representative of leachate. Two monitoring wells, BH00-1C and BH00-2C, were also installed within the original landfill footprint during the summer of 2000 (Piteau, 2000). Samples of undiluted leachate were collected from BH00-1C three times in 2001. The casing was raised in the summer of 2001 in preparation for placement of the next lift of waste. No waste was deposited in this area, and this well was inaccessible until the casing was cut down in May 2013 to allow access once again.

BH00-2C was dry from August 2000 until November 2001, when it became inaccessible. Water levels have been measured since it was recovered in mid-2004, but both standpipes are believed to be broken at depth: BH00-1C at approximately 10 mbg; and BH002-C at approximately 3 mbg. Three leachate samples were collected from BH00-1C in 2015, but due to the poor condition of the standpipe, no sampling has been recommended or completed since then.

Samples collected from the South Expansion Area Leachate Drain are representative of very dilute leachate due to a very small area of the catchment that has been covered with waste. The analytic results for these samples are discussed in Section 4.1.3.

4.1.1 Inorganic Chemistry

Leachate analytic data and water quality objective exceedances for 2019 are summarized in Tables II and III. Full reports are presented in Tables B-1 through B-5 and time-series plots are included as Figures B-1, B-2 and B-3 in Appendix B.

The leachate sampled from the leachate drain is characterized by neutral pH, high EC and alkalinity, and high concentrations of chloride, iron, manganese and ammonia (Tables II and B-1). In July of 2019, when concentrations are typically highest due to the dry summer weather, no liquid was present in the drain, and thus no samples were collected at this location.

Chloride concentrations in the leachate drain discharge have ranged between about 10 and 210 mg/L, with samples collected during the summer of 2001 displaying the highest levels to date (Figure B-1). Recent concentrations have continued to decline from the 183 mg/L peak concentration observed in 2004. Chloride concentrations measured in 2019 averaged 66.7 mg/L

and were stable over the year with no major dilution events. In general, peak chloride levels are measured during the dry months of May and July, and no sample was collected in July 2019 as the site was dry. Historical chloride concentrations in the undiluted leachate sampled from BH00-1C in 2000 and 2001 were typically about 5 to 52% higher than the drain discharge but 2015 BH00-1C chloride concentrations averaged less than half of the leachate drain discharge (Table B-2 and Figure B-1).

Ammonia concentration data since 1990 show a steady rise to about 152 mg/L-N prior to 1994 and then a decreasing trend to less than 40 mg/L-N in 1998. Another generally rising trend followed between 1998 and 2016 (Figure B-2). The decline observed from 2017 to 2019 is consistent with the trend in chloride concentrations (Figure B-1) and can be attributed to waste placement, and the lack of summer 2018 and 2019 samples, when concentrations are generally elevated. Ammonia concentrations ranged between 13.8 and 31.9 mg/L-N in 2019 (Tables II, III and B-1).

Ammonia concentrations in the first two samples from BH00-1C in 2000 and 2001 ranged between 123 and 143 mg/L-N (Figure B-2), which is about twice the concentration sampled in the leachate drain at that time. Ammonia in the March and June 2001 samples was much lower and these data are considered inaccurate. 2015 ammonia and nitrate results from BH00-1C average 3.7 mg/L and 25.1 mg/L, respectively, indicating nitrification and oxidation have occurred. As BH00-1C is blocked at approximately 10 m depth, and exhibits a perched water level, it is likely intercepting water from a relatively aerobic zone in the landfill via a breakage in the tubing. It is no longer sampled.

Iron and manganese are the only two metals in the leachate that have chronically exceeded receiving water criteria with concentrations that are multiple orders of magnitude greater than the aesthetic objectives (AO) in the Guidelines for Canadian Drinking Water Quality (GCDWQ) (Table B-1). The results are also compared to freshwater aquatic life criteria (FWALC). Leachate sampled in 2019 exceeded the iron and manganese FWALC for all three sampling events with results ranging as high as 17.3 mg/L-Iron for the January sampling event and 7.79 mg/L-Manganese for the October sampling event (Tables B-1 and III).

Copper has exceeded the superseded FWALC, which varies between 0.004 mg/L and 0.03 mg/L depending on hardness, on four occasions. The last exceedance (0.007 mg/L) occurred in January 2005. All other monitored metal concentrations have remained below GCDWQ and FWALC, except for multiple chromium and boron concentrations exceeding the FWALC (Table III), a single cadmium FWALC exceedance in July of 1999, and mercury concentrations that met or slightly exceeded the FWALC on one or two occasions in 2010, 2011, 2014 through 2016, 2018, and 2019.

The COD of the leachate drain discharge has ranged between 20 and 220 mg/L-O since 1998, except for very high values of 445, 534 and 614 mg/L-O recorded for the July 2009, December 2015 and November 2016 samples, respectively. The elevated results were most likely due to contamination of the sample with some suspended sediment. This represents an improvement from 1993/1994, when about 50% of the COD values exceeded 250 mg/L-O. The 2019 COD concentrations ranged between 79 and 141 mg/L-O.

At 3,860 mg/L-O, COD in the initial leachate sample from BH00-1C was much greater than in the leachate drain, likely reflecting solids associated with the high turbidity in the sample. Subsequent samples displayed COD values between about 300 and 500 mg/L-O, typical of concentrated leachate. Samples from BH00-1C in 2015 ranged from 70 to 240 mg/L-O with a mean concentration of 146 mg/L-O (Table B-2).

Overall, the leachate strength appears to be relatively constant, subject to some seasonal and climatic variations. At this time, the data does not indicate any increasing trends that would raise concerns regarding future changes in the leachate character.

4.1.2 Organic Chemistry

Samples for organic chemistry analysis have been collected from the leachate drain since November 1994. One sample was collected from BH00-1C in January 2015. Results of these analyses, summarized in Tables B-3 and B-4, have consistently demonstrated that volatile organic compounds, acid extractable compounds and chlorinated phenols are not leaching from the landfill at a concerning rate.

Of the 24 suites of data collected from the leachate drain to date, only ethylbenzene, toluene and 1,4-dichlorobenzene have exceeded GCDWQ MACs or AOs, or FWALC. The most recent exceedances of 1,4-dichlorobenzene and ethylbenzene were 1.1 µg/L in July 2017 and 2.3 µg/L in April 2008, respectively, compared to the respective GCDWQ AOs of 1 µg/L and 1.6 µg/L. Neither parameter has exceeded the GCDWQ MAC or FWALC. Toluene has exceeded the FWALC of 0.5 µg/L in 35% of the samples collected over the past 10 years but has not exceeded the 24 µg/L AO since November 1994 (39.9 µg/L) and has never exceeded the 60 µg/L MAC (Table B-3). The 2019 result was 2 µg/L, exceeding the FWALC of 0.5 µg/L. Benzene has also been detected at very low concentrations, the highest (3.7 µg/L) occurring in April 2005. The MAC for benzene is 5 µg/L, and the 2019 result was below the detection limit of 0.5 µg/L. Acetone, and 2-Butanone were also detected in the 2019 sample; however, there are no aquatic life or drinking water criteria defined for these compounds.

Pentachlorophenol has only exceeded the 0.002 mg/L detection limit on one occasion (November 1994). The historical detection exceeded the FWALC of 0.0005 mg/L but not the drinking water MAC of 0.06 mg/L or AO of 0.03 mg/L (Table B-4). The 2010 to 2019 detection limits

were at the FWALC and the recent non-detect results indicate that pentachlorophenol concentrations are in compliance with the objective. One sample for phenols and extractables was collected and analyzed in 2019. For these parameters, only phenol and m&p Cresol were detected. Phenol was measured at 6.9 µg/L, well below the FWALC of 50 µg/L. There are no aquatic life or drinking water criteria for m&p Cresol at this time.

All the results for the BH00-1C sample collected in January 2015 were non-detect.

4.1.3 Chemistry for South Expansion Area Leachate Drain

Samples for inorganic chemistry analysis have been collected from the South Expansion Area Leachate Drain since 2011. All data for the past four years are tabulated in Table B-5. The mean of the 2019 results for key leachate indicators are summarized in Table II, and all exceedances are summarized in Table III. All 2019 results were below the receiving water criteria with the exception of manganese (at concentrations up to 2.2 times the FWALC), ammonia (concentrations up to 1.8 times the FWALC), and chromium (January 0.0014 mg/L concentration 1.4 times the working FWALC). The ammonia exceedances indicate that leachate is being intercepted by the drain but overall chemistry is indicative of a low strength dilute leachate. Discharge from the French Drain is conveyed into the flow equalization lagoon.

One sample was collected from the South Expansion Area Leachate Drain in 2019 for organic analyses. Consistent with results since sampling began in 2016, none of the parameters analyzed for were detected (Tables B-3 and B-4).

4.2 GROUNDWATER IN SURFICIAL SEDIMENTS

Eleven monitoring wells and one production well sampled as part of the current or former monitoring program are completed in surficial sediments. These wells are PW-2, MW94-2S, MW94-3S, MW94-4S, MW94-6S, MW94-7S, MW98-9, MW98-10, MW02-1S, MW02-2, MW02-3S and MW05-1S. Nine of these wells are located along the southwest, south or southeast sides of the landfill. MW94-6, MW98-9 and MW98-10 are located on the north side (Figure 2). These wells provide information along the potential seepage pathways in surficial sediments that have been identified at the site.

4.2.1 Southeast Side of Landfill

Groundwater quality at MW02-3S and MW94-3S, two of the four overburden monitoring wells along the south and east sides of the landfill, does not indicate evidence of significant impact from leachate prior to 2017. Nitrate concentrations in MW94-2S and MW94-3S have not exceeded 0.73 mg/L, and chloride concentrations have typically remained below 4 mg/L, which is considered to be background for the area (Figures B-4, B-5, B-6 and B-7 in Appendix B). Samples from MW02-3S, sampled as the replacement well for MW94-2S since 2002, have displayed a very similar chemistry to MW94-2S. Chloride concentrations at MW02-3S remained below 5 mg/L

until 2016, after which the chloride concentrations have risen, with peak values of 101 and 73.1 mg/L measured in July 2018 and July 2019 respectively. (Table III, Table B-8 and Figure B-4).

Relative to the full record for MW02-3S, other leachate indicators have also been elevated for sampling events in recent years. Electrical conductivity and TDS were elevated in July 2016, October 2017, April and July 2018, and July 2019. The July 2018 and 2019 samples were collected after a period of very dry weather as evidenced by the dry leachate drain, and at 772 and 560 mg/L, TDS exceeded the GCDWQ (500 mg/L) in July 2018 and July 2019 respectively. Nitrate was also measured at concentrations ranging up to 2.77 mg/L-N in July 2017, but all 2019 concentrations for nitrate and ammonia were below 1 mg/L-N. A manganese exceedance of the GCDWQ criterion occurred with the elevated TDS in July 2019, at a concentration of 0.317 mg/L. The copper concentration of 0.0074 mg/L in July 2019 slightly exceeded the superseded 0.006 mg/L FWALC guideline based on the average hardness of 150 mg/L-CaCO₃, but remained below the 0.0165 mg/L guideline based on the sample hardness of 413 mg/L CaCO₃. Based on the apparent increase in EC and the elevated chloride events in recent years, there is a slight increase in the leachate impact at this well, possibly due to the limited operation of the shallow leachate interception wells PW-2 and PW15-2 (Table II and Figures B-4 and B-5).

Results for samples collected from MW05-1S up until 2014 exhibited relatively low nitrate and ammonia concentrations, but elevated chloride and total dissolved solids (TDS) concentrations. In late 2015 and early 2016, nitrate concentrations in MW05-1S were elevated above normal, corresponding with a period when PW-2 was in operation (Figures A-8 and B-5 and Table B-22). In 2017, nitrate and ammonia dropped back to the levels seen prior to 2015 and in 2019 averaged <0.11 and <0.05 mg/L-N, respectively. The two nitrate FWALC exceedances in 2016 have not been repeated since. Chloride and TDS concentrations were relatively constant in 2019, with respective mean values of 9.11 and 235 mg/L (Figure B-4 and Tables II and B-22).

Based on the datalogger record and water levels measured prior to sampling in 2019, PW-2, which intercepts groundwater and leachate flow in overburden, was not in operation prior to any of the quarterly sampling events (Figure A-8). Samples from PW-2 in 2019 exhibited record high chloride concentrations ranging from 120 to 400 mg/L and ammonia concentrations ranging from 26.8 mg/L to 112 mg/L-N (Table B-23 and Figures B-3 and B-4).

4.2.2 South Side of Landfill

Chloride concentrations in MW94-7S samples were nominally about 1 mg/L until October 1999. Thereafter they increased to 19.5 mg/L in 2000, and then decreased to about 5 mg/L in the latter half of 2002 (Figure B-6). A steep rise was recorded during 2003 with concentrations fluctuating between 30 and 40 mg/L and these concentrations were sustained through 2004. From the start of 2005 through July of 2006 concentrations declined to between 18.8 and 10.7 mg/L, with the

exception of a peak concentration of 35.8 mg/L in October 2006. In 2007 and 2008, chloride concentrations ranged from 1.74 to 24.3 mg/L with the peak concentration in July 2007 and the lowest concentration measured in the winter. MW94-7S was destroyed in the winter of 2008 and has not been replaced.

Ammonia concentrations in MW94-7S decreased to 0.42 mg/L-N in October 2005, down from 1.58 mg/L-N in the previous year, but rose back to 1.67 mg/L in October 2006. In 2007 and 2008, ammonia levels remained low, ranging between 0.87 and <0.01 mg/L-N. The nitrate concentration increased from 0.08 mg/L-N at the end of 2004 to 6.1 mg/L-N in April 2005, followed by a decline to 1.19 mg/L-N in October 2005. The slightly elevated trend continued through to 2008, with nitrate concentrations ranging between 1.06 and 4.44 mg/L-N. Nitrate concentrations in MW94-7S have not exceeded the MAC for drinking water (Figure B-7). The increase in leachate indicator parameters that occurred in October 2006 is attributed to the construction of the French Drain in 2006, since this will have induced southward flow into the French Drain.

MW02-1S and MW02-2 are both completed in sediments on the south side of the South Expansion Area (Figure 2). Data for both monitoring points have exhibited baseline chemistry since sampling began in 2003 (Tables II, B-18 and B-20 and Figures B-6 and B-7). MW02-1S and MW02-2 were damaged and have not been sampled since 2011 and 2015, respectively.

4.2.3 West Side of Landfill

Groundwater chemistry at the MW94-4S site has displayed elevated chloride concentrations with peak values ranging between 26 to 30 mg/L in 1997 (Figure B-6). The chloride concentrations have since dropped. They averaged 8.0 mg/L in 2019 (Table II) and have been very consistent for the past nine years. Nitrate concentrations have historically remained near or below 0.05 mg/L-N (Figure B-7 and Table B-10), this trend continued in 2019 samples. A slightly elevated nitrate result in November 2016 (0.517 mg/L-N) was accompanied by lower chloride, elevated conductivity and unusual exceedances of arsenic, chromium and iron. Metals exceedances in 2019 included arsenic and boron over the FWALC, although the FWALC for arsenic is not considered relevant for groundwater. The absence of any prolonged nitrate or ammonia impact indicates a non-leachate source for the slightly elevated chloride concentration. Monitoring well MW94-4S is located just off the Stirling Arm Logging Road and is likely affected by road maintenance practices.

4.2.4 North Side of Landfill

Monitoring data for the MW94-6S well, located on the north side of the landfill, exhibit a strongly increasing chloride concentration trend from 1995 until April 1999 (Figure B-8). The concentration then declined from a peak of 113 mg/L in April 1999 to between 30 and 40 mg/L in 2002. A slight increasing trend was observed from 2002 through 2005 with a concentration peak of 94.5 mg/L measured in July 2005. Since then, chloride concentrations have been consistently below 60 mg/L

and exhibit a general declining trend. Chloride concentrations measured in 2019 averaged 7.2 mg/L and remain consistent with this trend (Table B-13 and Figure B-8).

As with MW94-4S and MW94-7S, there was no corresponding increase in nitrate or ammonia concentrations with the increase in chloride in the early monitoring record at MW94-6S (Figure B-9 and Table B-13). The latter concentrations were at essentially background levels until April 1999, when ammonia concentrations began to rise. Ammonia concentrations increased between April 1999 and April 2002, when a peak concentration of 37.5 mg/L-N was reached, and then dropped back to less than 4 mg/L-N in the latter part of 2002. They have generally ranged between 10 and 37.2 mg/L-N since that time (Table B-13 and Figure B-9) and averaged 11.0 mg/L-N in 2019 (Table II).

Increases in chloride concentrations in MW94-6S from 1997 to 1999, and corresponding increases in chloride and ammonia concentrations from 2001 to 2002, suggest a leachate excursion was occurring in this area. Chloride concentrations peaked in 1999, 2004 and 2005 and ammonia concentrations peaked in 2002, 2005 and 2007, but both have been decreasing to lows not measured since 2002. The lag between the peak chloride levels and the increased ammonia levels is likely due to retardation (absorption) of ammonia along the flow path. Retardation processes (ion exchange) are indicated by elevated calcium and magnesium concentrations. Recent concentrations of ammonia continue to exceed the FWALC of 1.8 mg/L-N, but flow past this point is expected to be intercepted by the leachate interception trench, located immediately downgradient of this monitoring site (Figure 2).

Manganese and TDS have chronically exceeded AO's for drinking water in MW94-6S (Table B-13 and Piteau, 2007). Dissolved manganese concentrations initially exhibited an increasing trend from 1995 to a peak concentration of 25 mg/L in October 2007, and have fluctuated below 8.5 mg/L since 2012, and ranged between 3.45 and 5.18 mg/L in 2019. TDS displayed an increasing trend until 2000 when values between 1060 and 1070 mg/L were recorded. TDS concentrations declined slightly to below 500 mg/L in 2004, and maintained a stable trend since 2005. TDS concentrations in 2019 averaged 313 mg/L, with all concentrations remaining below the GCDWQ AO (500 mg/L).

Iron concentrations in MW94-6S first exceeded the GCDWQ AO in 2000 and have consistently exceeded it since 2006. The maximum occurred in October 2006 at 55.9 mg/L. Concentrations dropped to below 30 mg/L from 2009 to 2016. In 2018 and 2019, iron concentrations were elevated compared to recent years, with 2019 values ranging from 34.5 to 52.5 mg/L, possibly due to the drier than average weather.

Other than exceedances of dissolved arsenic above the FWALC, which is not considered relevant for groundwater, and one instance of dissolved chromium measured at the working FWALC, no other exceedances were reported for MW94-6S in 2019.

Data for MW98-9 (Table B-15) are also plotted on Figures B-8 and B-9 and summarized in Tables II and III. The plots indicate that leachate impacts at MW98-9 were similar to MW94-6S until 1999. Following commissioning of the leachate interception trench, water quality at MW98-9 improved throughout 2000, as indicated by a large reduction in chloride concentration and generally low nitrogen concentrations, and concentrations have remained low in recent years. Exceptions are attributed to the malfunction of the leachate interception trench pumps in 2001, and periods of drier than average weather. Ammonia concentrations have not exceeded the FWALC (1.8 mg/L-N) since 2006, and were less than 0.08 mg/L-N in 2019. Chloride concentrations averaged 1.8 mg/L in 2019 (Table II), in the lower portion of the historical range. Cadmium, chromium, copper and mercury concentrations have exceeded the FWALC, but are well below the GCDWQ MAC (Table B-15). As the leachate concentrations were similar, or lower, the concentrations observed in MW98-9 are considered to be background.

Chloride, nitrate and ammonia monitoring data for MW98-10 indicate that there are no significant leachate impacts at this location. Chloride concentrations have not exceeded 2.5 mg/L in the past ten years (Table B-16 and Figure B-8). Nitrate concentrations typically peak in the winter months after the autumn rains and have been measured slightly above the FWALC of 3 mg/L-N on three occasions: January 2000 (3.9 mg/L-N); December 2010 (3.3 mg/L-N) ; and December 2018 (3.2 mg/L-N) (Table B-16 and Figure B-9). Ammonia concentrations remained at or below 0.05 mg/L-N in 2019. Similar to MW98-9 and MW94-6S, some chromium, copper, mercury, and zinc concentrations have met or exceeded the FWALC but not the GCDWQ.

4.3 GROUNDWATER IN BEDROCK

4.3.1 Background Chemistry

Chemistry data have been previously reported for seven BH2000 series wells, two MW2002 series wells and four core holes (CH series), which were all completed in bedrock underlying the expansion areas to the south and east of the original landfill footprint (Piteau, 2002b and 2007b). Some of these wells, notably CH-3, CH-4, MW02-3D and BH00-1A, -3A and 5B, are relatively close to the landfill and may be slightly impacted by leachate. The other wells are considered to be sufficiently remote to be unaffected. Background chemistry data available for the 2019 reporting period includes samples collected from MW02-1D and MW02-4. The latter well is located about 600 m WNW from the original landfill footprint (Figure 2). Water quality results collected from BH00-4A until access was lost in 2011 are also presented for comparison. Note that although the MW13-series wells are not considered to be affected by the landfill, they are discussed separately

in Section 4.3.6. The results of the analyses for BH00-4A, MW02-1D and MW02-4 are summarized in Tables B-17, B-19 and B-21, respectively.

As summarized in previous reports, historical chloride concentrations in bedrock for all the 2000 series monitoring wells range from 1.5 to 22 mg/L, with the highest concentrations (>15 mg/L) recorded in BH00-3A, -4A and -6A. The elevated chloride concentration in BH00-3A is possibly attributable to leachate, but similar concentrations were detected in BH00-4A, completed in a low permeability rock mass more than 250 m from the current landfill limits. Background chloride concentrations for groundwater in bedrock beneath the site are therefore interpreted to range up to about 20 mg/L. At 90.7 mg/L, the chloride concentration in groundwater sampled from BH00-4A in February 2011 appears to be anomalous (Figure B-8). As this monitoring well has not been sampled since the anomalous result, the result will have to be reviewed in the context of future monitoring data before it can be verified. It is noted that the last two sulphate results, and the most recent chloride result for BH00-4A, also appear anomalous. The remainder of the results appear to be consistent with previous trends (Table B-17).

Chloride concentrations at MW02-4 have ranged from about 50 to 125 mg/L since 2003 when it was first included in the sampling program, with elevated values up to 210 mg/L in 2009 and 2010. Many of the 2010 concentrations exceeded those measured in the concentrated leachate sample from the leachate drain (Figure B-8). In 2019, chloride concentrations at MW02-4 ranged from 84.5 to 89.8 mg/L, while sodium and sulphate concentrations ranged between 54.3 and 58.3 mg/L, and 13.0 to 14.9 mg/L, respectively (Table B-21). As this well is located on the side of the landfill access road, the elevated chloride and sodium concentrations are attributed to road maintenance practices or possibly natural background.

TDS was very high in BH00-1A, BH00-4A and BH00-6A in 2001 and 2006, and exceeded the drinking water AO of 500 mg/L in the latter two wells. Sodium and sulphate concentrations were also very high in these wells, ranging from 124 to 612 mg/L and 93 to 340 mg/L, respectively (Piteau, 2007b). Drinking water AO's were only exceeded in BH00-4A, located farthest from the landfill. Only BH00-4A was sampled from 2006 to 2011 and it has not been sampled since. Results in 2011 exceeded the FWALC for pH and the dissolved metals discussed below (Table B-17).

Nitrate concentrations in all but BH00-4A and BH00-6A were below or only slightly above the detection limit. Nitrate concentrations for BH00-4A and BH00-6A have ranged between <0.25 and 2.6 mg/L-N. Except for the one early high result, all concentrations in BH00-4A were below 1.0 mg/L-N. Trace concentrations of ammonia were typically detected (0.02 to 0.05 mg/L-N in 2010/2011) and are attributed to a natural source (Table B-17).

Results for MW02-1D, located south of the proposed expansion area, display a much less mineralized chemistry (Table B-19). Sulphate concentrations have historically been much lower than in MW02-4, with concentrations in 2019 below 5 mg/L. Sulphate concentrations in recent years have been close to those measured in the past, but since late 2016, sodium concentrations have been elevated to levels not seen since the well was first sampled in 2002. Sodium concentrations in 2019 ranged from 1.98 mg/L to 36.5 mg/L, still generally below those in MW02-4. Groundwater at the MW02-1D location may be better “flushed” than at the other background sites.

Dissolved metal concentrations vary significantly between samples, with iron, manganese, boron, copper, zinc, mercury, cadmium and arsenic all exceeding receiving water criteria on more than one occasion and sometimes at multiple sites (Tables B-17, B-19 and B-21). Iron concentrations have exceeded receiving water criteria in three of the eight background monitoring wells and manganese concentrations have exceeded the criterion in five of the eight monitoring wells. Zinc concentrations have exceeded the hardness-dependent FWALC of 0.0075 mg/L four times in the BH00-4A sampling record and five times at MW02-1D. Mercury has exceeded the FWALC, but not the drinking water MAC, in three of the core four holes (CH-series; Piteau, 2002b), MW02-1D and MW02-3D. Copper was also detected at concentrations more than the FWALC in three of the core holes (Piteau, 2002b) and in MW02-1D. Cadmium has exceeded the FWALC in BH00-04A and MW02-1D, at concentrations higher than observed in the leachate. The apparently elevated concentrations of metals are attributed to rock mineralogy, localized dissolution of these metals due to disturbances caused by the drilling process, and natural interactions between the rock and groundwater.

At MW02-1D, manganese concentrations have exceeded the AO but not the FWALC. Arsenic has chronically exceeded the MAC (0.01 mg/L) at BH00-4A. Arsenic concentrations initially exhibited a rising trend, but this is attributable to disturbances during drilling of this well, since rising or elevated concentrations sometimes occur due to slight changes to the flow regime caused by the drilling disturbance and the flushing action of sampling the well. Arsenic concentrations eventually stabilized in BH00-4A at about 0.03 mg/L, above the 0.01 mg/L MAC.

No metal concentrations have exceeded receiving water criteria at MW02-4, except iron and manganese in the November 2016 sample, and mercury measured at the FWALC in the April 2018 sample. All other 2016 through 2019 results for these three parameters were close to or below detection limits (Table B-21).

Based on the above, background chemistry of groundwater in the AVL area can be characterized as sodium bicarbonate-sulphate type, with varying TDS reflective of the residence time in the ground and the mineralogy of the rock mass along the groundwater flow path. Background chloride concentrations are interpreted to range from 2 to 20 mg/L and are likely higher near MW02-4. Ammonia concentrations are less than 0.5 mg/L-N.

4.3.2 South Side of Landfill

Chloride data to 2005 for MW94-3D exhibited an increase from between 2 and 4 mg/L prior to early 2000 to a peak of 13 mg/L in July 2002. The increase to 18 mg/L in October 2005 (Figure B-4), reflected the onset of waste placement in the adjacent East Expansion Area. Nitrate and ammonia concentrations in MW94-3D remained at background levels (Figure B-5), suggesting very minimal leachate impact up to that point in time. This well was lost to the east landfill expansion in late 2005.

Only one set of detailed analyses was conducted on samples collected from MW94-7S and MW94-7D in 1996, and the results did not display any indications of leachate impact (Figures B-6 and B-7). Based on the similarity between the water quality in MW94-7S and -7D, it is expected that groundwater quality in the latter would mirror that in the former.

As noted in Section 4.3.1, all other monitoring wells in bedrock to the south of the landfill are located far enough from the active landfilling areas to be considered representative of background water quality at this time.

4.3.3 East Side of Landfill

Chloride and nitrate concentrations measured in samples from MW94-1S were both relatively low, averaging 3 mg/L and 1 mg/L-N, respectively, from 1995 to 2013, with the following exceptions (Figures B-4 and B-5):

- A nitrate concentration of 5 mg/L-N in July 1995 accompanied by a chloride concentration of 7.5 mg/L; and
- Elevated nitrate and chloride concentrations in 2003 and 2004, peaking at 6 mg/L-N (nitrate) and 55.7 mg/L (chloride) in January 2004.

Increases in both nitrate and chloride concentrations prior to 2006 suggest an increased leachate impact at this location. Leachate impact was attenuated in 2006, as indicated by a decrease of both nitrate and chloride concentrations.

Chloride and nitrate concentrations at MW94-1D displayed similar trends to those at MW94-1S, with peak chloride and nitrate concentrations of 120 mg/L and 16 mg/L-N, respectively, measured in late 2003 or early 2004 (Figures B-4 and B-5). Concentrations decreased in 2005 and fluctuated between 3.9 and 8.2 mg/L (chloride) and <0.02 to 0.67 mg/L-N (nitrate) for the last year of monitoring data in 2010. Surface water contamination, due to a leaky upper seal in the piezometer, is interpreted to be the cause of the impacted water quality and the wide variation in sampling results in the lower installation.

Monitoring data have not been available for MW94-2D since July 2000 when this well was destroyed during construction of the landfill expansion area containment berm. Data for the four years before that time displayed a very consistent chloride concentration of about 13 mg/L (Figure B-4). The nitrate concentration varied between the detection limit and about 1 mg/L-N over the same period, and has been consistently above 0.75 mg/L-N since October 1998 (Figure B-5). The data indicate a very slight, but detectable, leachate impact may have occurred at this site, although the nominal 13 mg/L chloride concentration could be a background level.

Samples collected from MW02-3D between 2002 and 2010 indicated no significant leachate impact, with nitrate/ammonia concentrations below 0.5 mg/L-N and chloride concentrations below 5 mg/L (Figures B-4 and B-5). From 2010 to 2018, nitrate/ammonia concentrations remained below 0.5 mg/L-N. In 2019, peak concentrations of 1.01 and 0.77 mg/L-N were measured in July and October respectively. Meanwhile, chloride concentrations have risen from 2010 to 2019, averaging 61.5 mg/L in 2019 (Tables II and B-9). Rising trends in chloride and nitrate may be attributed to limited operation of the bedrock leachate interception well system since 2010.

Arsenic concentrations in MW94-2D varied between 0.002 to 0.019 mg/L and met or exceeded the 0.01 mg/L MAC for twelve of the seventeen samples collected from 1994 to 2002. These arsenic concentrations were much higher than observed in the concentrated leachate, and are attributed to the background chemistry of the volcanic rocks. They are at a level that would be of concern for any domestic wells completed in bedrock in this area.

Arsenic concentrations have remained below 0.003 mg/L in MW02-3D (Table B-9). Except for one copper exceedance in October 2006, the only metal results for this monitoring well that exceeded AO or MACs over the past ten years are iron and manganese. Iron exceeded its AO and FWALC for the July and October 2019 sampling events, and all four sampling events in 2019 had manganese AO and MAC exceedances. Manganese concentrations have not exceeded the FWALC. Chromium in groundwater sampled from MW02-3D exceeded the FWALC in October 2012 and January 2013, but has never exceeded the GCDWQ MAC.

MW05-1D monitoring data are available from November 2008 (Table B-22). Chloride concentrations have ranged from 11 mg/L to 64.8 mg/L and were on a general rising trend until late 2010 while PW-1 was in operation, and a level or slightly declining trend thereafter when operation of PW-1 has been limited (Figures A-7 and B-4). These trends suggest operation of leachate interception well PW-1 induced shallow groundwater to seep down into bedrock in the area surrounding the well. The deep piezometer chloride concentrations rose above the decreasing shallow piezometer concentrations in late 2009 (Figure B-4). Chloride concentrations in MW05-1D then stabilized at about 55 mg/L for a few years before declining. They averaged 33.2 mg/L in 2019 (Figure B-4 and Table II). Nitrate and ammonia concentrations ranged up to 0.384 and

0.04 mg/L-N, respectively, in 2019 (Tables II, B-22 and Figure B-5). A very slight apparent rise in ammonia concentration may be following the rise in chloride concentrations noted in previous years. A similar lag effect was noted earlier in MW94-6S (Section 4.2.4), which may reflect retardation of ammonia relative to chloride, following an excursion of leachate through a natural flow medium with some ion exchange capacity.

Leachate interception well PW-1 was first monitored in November 2008. In 2019, chloride concentrations from this well averaged 41.0 mg/L and were lower than peak chloride levels measured in previous years (Table II and Figure B-4). Nitrate concentrations have remained at background levels while ammonia concentrations have displayed a large variation, with highs of 26.6 mg/L-N in 2009 and 14.1 mg/L-N in 2012, and with most of the intervening concentrations below the FWALC of 1.8 mg/L-N (Figure B-5). None of the 2019 nitrate or ammonia concentrations exceeded the FWALC (Tables III and B-23). Up until 2018, TDS has stabilized in the 600 to 800 mg/L range, with values for all samples collected exceeding the 500 mg/L GCDWQ criteria. In 2019, TDS decreased from 602 mg/L in January to 490 mg/L in October. Elevated chloride and TDS concentrations in groundwater samples from PW-1 indicate that when pumping, this well intercepts relatively deep groundwater flow that has been affected by leachate that has seeped into the bedrock.

4.3.4 West Side of Landfill

Monitoring data for bedrock piezometer MW94-4D displayed very similar chloride data to MW94-4S, which is screened in shallower material. Chloride peaked at about 27 mg/L in May 1997, and has since decreased to the current range of 5 to 10 mg/L (Table B-11 and Figure B-6). Nitrate concentrations were greater than those measured in MW94-4S and exhibited an overall increasing trend until late 2002, when a peak of about 1.6 mg/L-N was reached. Nitrate concentrations have fluctuated below 1 mg/L-N since 2009 (Figure B-7). Although current monitoring data indicate some very minor leachate impact in MW94-4D, leachate migration in this direction is not considered to be significant. Piezometric data discussed in Section 3.2.1 indicate that there is no shallow leachate migration in this direction.

4.3.5 North Side of Landfill

Data for MW94-5S and MW94-6D indicate very minor indications of leachate impact (Tables B-12 and B-14).

Chloride concentrations reached the 30 mg/L range in both the MW94-5 piezometers in 1996 or 1997. Concentrations in the shallow piezometer have since decreased to background levels (Figure B-8), likely due to the commissioning of the north leachate interception channel. Nitrate and ammonia concentrations in MW95-5S have been consistently below 1.5 mg/L-N and 0.4 mg/L-N, respectively (Table B-12). Chloride concentrations in MW94-5D were historically elevated at the

site but dropped from about 40 mg/L prior to commissioning of the interception channel to 19.8 mg/L in 2008, when this well was noted to be plugged. Elevated concentrations of nitrate or ammonia were not detected in MW94-5D (Figure B-9).

Chloride concentrations in MW94-6D have been at background levels throughout the monitoring record, except for the first two samples collected in 1994 and 1995 (Figure B-8). The nitrate concentration reached 8 mg/L-N in July 1995, but has not exceeded 3 mg/L-N since 2000. It averaged 1.01 mg/L-N in 2019 (Tables II and B-14 and Figure B-9). Ammonia concentrations spiked up to about 3 mg/L-N in April 1998, and were followed by a ten-year fluctuation between the detection limit (0.01 mg/L-N) and 0.32 mg/L-N. The ammonia concentration reported for November 2008 (7 mg/L-N) was confirmed to be anomalous, based on the results of the 2009 sampling program, which ranged between 0.12 and 1.58 mg/L-N. Ammonia concentrations measured in 2019 ranged from <0.01 to 0.16 mg/L-N. Elevated nitrate concentrations measured in 1994 and early 1995 were accompanied by slightly elevated chloride concentrations (11 to 13 mg/L). Elevated chloride concentrations have not been observed since that time (Figure B-8).

Based on data for MW94-5S, MW94-5D and MW94-6D, leachate impacts to groundwater in bedrock at the north property line are interpreted to be very slight. Trends noted at MW94-6D will continue to be monitored to evaluate further leachate effect.

Arsenic concentrations in MW94-6D average about 0.03 mg/L and have exceeded the MAC of 0.010 mg/L almost continuously since the first analysis was run in September 1996. As with the arsenic in MW94-2D, this is attributed to a natural source. Arsenic concentrations were discussed in the 2000 monitoring report (Piteau, 2001). Concentrations of boron and copper have frequently exceeded the FWALC, but have remained below their respective GCDWQ limits (Table III). In the past five years, some samples from MW94-6D have also exceeded the FWALC, but not the GCDWQ, for cadmium, manganese, mercury and zinc (Table B-14). Additionally, iron has exceeded the FWALC and GCDWQ in samples in 2016 and 2019 and lead exceeded the FWALC and GCDWQ for two of four samples in 2019.

4.3.6 North East Side of Leachate Interception Channel

The four monitoring wells installed on the northeast side of the leachate interception channel were added to the quarterly monitoring program in December 2014. Samples collected are indicative of a sodium-sulphate type chemistry with a very high total dissolved solids concentration and a high EC (Tables II, B-24, B - 25 and B-26). MW13-2D was removed from the program in 2017, and the sampling frequency at MW13-1D was reduced to annual. The two shallow sites were sampled once in 2017, twice in 2018, but returned to quarterly sampling in 2019.

Groundwater in MW13-1D and MW13-1S is highly mineralized (Tables B-24 and B-26). Since TDS and EC continue to decline in samples collected from these wells, metals and major ion chemistry

is likely still affected by drilling, and is still not indicative of actual groundwater chemistry. Chloride concentrations have stabilized at about 70 mg/L in MW13-1D, and 40 mg/L in MW13-1S. These concentrations are slightly higher than background concentrations observed elsewhere, and likely indicate these monitoring wells are located close to a groundwater flow divide where the flow regime is poorly flushed (see interpreted divide on Figure 3). However, a longer data record is required to confirm this.

Groundwater in MW13-2D has exhibited a large variation in water quality, with TDS varying from 58 to 4180 mg/L and chloride concentrations varying from <1 to 307 mg/L. The chemistry in MW13-2S shows similar variability. There is too much variation in the small data record collected to date to isolate the cause (Figure B-10 and Tables B-25 and B-26), but recharge events following high precipitation events may cause discrete dilution events. As the high TDS and chloride levels are not generally accompanied by elevated nitrate and ammonia concentrations and, and the wells are located over 150 m from the original landfill footprint in a direction interpreted to be perpendicular to the groundwater flow gradient, the highly mineralized groundwater is attributed to either background quality or residual effects from drilling. Prior to December 2015, ammonia had not been detected above 0.01 mg/L-N at MW13-2S. Ammonia concentrations increased to 0.13 mg/L-N in December 2016, and to 1.7 mg/L-N in July 2017, slightly below the FWALC of 1.8 mg/L. Nitrate had not been detected above the detection limit of 0.005 mg/L-N in this well. Five of six samples collected since had very low chloride concentrations and EC measurements, and all had low concentrations of ammonia (0.05 mg/L-N) and nitrate (0.15 mg/L-N). Based on the 2016 and 2017 ammonia concentrations, and early water level trends noted when the well was first installed, it is possible MW13-2S has a discrete connection to the leachate interception/conveyance channel.

MW13-2D cannot be fully purged prior to sampling due to a bailer stuck in the piezometer about 30 m below ground. As such, water samples collected from this piezometer are not considered representative of typical groundwater quality.

Exceedances of the FWALC and/or GCDWQ criteria in the 2019 sample at MW13-1D have been noted for iron and manganese (Table III). Additionally, the GCDWQ criteria for TDS and Sulphate was exceeded at MW13-2S in July 2019. In previous years, exceedances of TDS, sulphate, arsenic, chromium, and uranium were also noted for the four monitoring wells on the northeast side of the leachate interception channel (Tables B-24 through B-26). It is likely that some of the exceedances (e.g., arsenic) are associated with water-rock interactions that occurred during drilling and may drop over time once the groundwater chemistry has stabilized. All elevated metals are attributed to background bedrock chemistry and are not considered to be landfill effects.

4.4 CREEKS

4.4.1 Heath Creek

Heath Creek is located west of the landfill, opposite to the interpreted principal direction of subsurface leachate migration (Figure 3). There have been no indications of leachate impact to Heath Creek (Table B-27). Chloride concentrations have remained below 10 mg/L since 1996, except for two anomalies in 2005 and 2010. In 2019, chloride concentrations ranged from 2.51 to 5.45 mg/L and were within the historic range.

Nitrate and ammonia concentrations have not exceeded 0.3 mg/L-N in Heath Creek since the start of the monitoring record and ammonia concentrations are typically less than 0.15 mg/L-N (Table B-27 and Figure B-13).

Total iron concentrations have exceeded the GCDWQ AO of 0.3 mg/L on eleven occasions in the monitoring record with the maximum of 3.25 mg/L occurring in November 2001. The last exceedance, at 0.31 mg/L, occurred in October 2018. The FWALC of 1 mg/L has only been exceeded twice. Total manganese concentrations have exceeded the GCDWQ AO of 0.02 mg/L on twelve occasions in the sampling record, but all concentrations have been below the 0.74 mg/L FWALC except once in May 1997 (1.15 mg/L). The last AO exceedance occurred in December 2014. The elevated concentration of manganese in the December 2014 sample corresponds with elevated iron and phosphorus and is likely due to sediment in the sample. Other than the December 2014 results for iron and manganese and the January 2016 iron result, iron and manganese concentrations have complied with all FWALC and GCDWQ since April 2007 (Table B-26). The total zinc concentration of 0.013 mg/L measured in May 2013 exceeded the 0.0075 mg/L FWALC for the first time since October 2003. This exceedance also corresponds with elevated iron and phosphorous results and could be due to sediment in the sample. All measured parameters in 2019 were below FWALC and GCDWQ with the exception of pH and chromium measured in January 2019 (Table III).

4.4.2 McCoy Creek

McCoy Creek, sampled downstream of Heath Creek and McCoy Lake on four occasions in 1994 to 1996, displayed a slightly elevated chloride concentration (12.4 mg/L) in October 1996. The three previous samples displayed background chloride concentrations. Ammonia and nitrate concentrations were consistently very low (<0.1 and <0.2 mg/L-N, respectively). Sampling data collected to October 1996 did not display any leachate impacts and since this site was downstream of Heath Creek where dilution would be greater and agricultural runoff would represent an additional source of contaminants, it was removed from the monitoring program.

4.4.3 Stevens Creek

Stevens Creek is the most likely of all the local creeks to be affected by seepage from the landfill as it rises just below the berm located at the northwest corner of the landfill footprint (Figure 2). The water quality in this creek has displayed some slight leachate impacts on occasion. To assess whether this is due to seepage beneath the berm, in 2015 additional sampling locations (SCKA and SCKB) were added between the toe of the berm and the Stevens Creek station. SCKA comprises a standpipe installed in a hand-dug hole (0.9 m deep) at the toe of the berm, and SCKB is in a pond where groundwater discharges midway between SCKA and the Stevens Creek sampling site situated about 20 m downstream (Figure 2). These sites were sampled five times between April 2015 and November 2016 (Table B-28).

Chloride concentrations in Stevens Creek have ranged up to 55.7 mg/L with the maximum concentration to date occurring on October 7, 2002 (Figure B-12). Concentrations for the three sampling events in 2019 averaged 3.6 mg/L (Table II).

Nitrate concentrations at the Stevens Creek sampling site in 2019 fluctuated between 0.096 and 0.268 mg/L-N. The maximum concentration (4.58 mg/L-N) occurred in October 2005 (Figure B-13) and may have reflected the drier than average 2004/2005 winter, and/or a partial malfunction of the leachate lift station upstream of the clay berm at the upper reaches of Stevens Creek. Nitrate concentrations in Stevens Creek have not exceeded the FWALC (3 mg/L-N) since the autumn of 2008.

The highest ammonia concentration reported for the Stevens Creek station was 1.8 mg/L-N and occurred in the winter of 1993 (Figure B-13). Concentrations remained at or below 0.04 mg/L-N in 2019, well below the 1.8 mg/L-N FWALC.

For the five metals analyzed in 2019 at the original Stevens Creek site, all parameters were within guidelines except for manganese in the April and October samples (Tables III and B-28). A sample could not be collected in July, when concentrations are typically highest, as the creek was dry.

Elevated COD levels of 124 and 87 mg/L-O were measured in the July 1999 and March 2000 samples from Stevens Creek. These readings are anomalous in comparison to previous and subsequent data. The high values are likely due to the inclusion of some organic matter in the sample. COD results for 2019 were all below detection limits (Table B-28).

Chloride concentrations measured at SCKA in 2015 and 2016 were consistently greater than at Stevens Creek, while concentrations at SCKB were similar to the Stevens Creek site (Figure B-12). Ranging between 0.072 and 1.19 mg/L-N and 0.181 to 0.31 mg/L-N, respectively, nitrate concentrations in at SCKA and SCKB were slightly elevated, compared to the Stevens Creek

sampling site. As with nitrate, ammonia concentrations in SCKA and SCKB were slightly elevated, with concentrations ranging up to 1.55 and 0.22 mg/L-N, respectively. All five total metals' FWALC were exceeded for the January 2016 SCKA sample, with all exceeding the GCDWQ, except cadmium and chromium. Iron and manganese exceeded the guidelines in the May and November samples as well. The SCKA results were collected from a standpipe and were not field-filtered. Consequently, the metals results may be positively biased by the presence of turbidity. The May 2016 sample from SCKB displayed an iron exceedance of the GCDWQ AO and a manganese exceedance of both the GCDWQ AO and the FWALC. Except for the May 2016 data, SCKB results have all been below applicable FWALC, and metal concentrations were typically similar to and sometimes lower than the original Stevens Creek sample, suggesting natural background variability.

Results from the SCKA sampling site indicate that leachate seepage beneath the clay berm between the landfill and Stevens Creek is the likely source of a high proportion of the chloride, nitrate, ammonia and manganese concentrations measured at the Stevens Creek sampling station. The metals results are not considered reliable due to the high turbidity. Deeper leachate seepage, and background groundwater chemistry, appear to control the Stevens Creek chemistry, which is very dilute in comparison to samples from SCKA. SCKA and SCKB were both dry in July 2015, when many of the metals exceedances were reported for Stevens Creek, so the exceedances could not be directly compared with data from these upstream locations. The 2016 manganese exceedance in Stevens Creek (0.115 mg/L) correlates with the elevated manganese in SCKA (1.98 mg/L), but the manganese concentration in SCKB was very low (0.046 mg/L).

Analytic results for samples collected at SCKA, SCKB, and the Stevens Creek station indicate that some leachate is seeping under the clay berm above Stevens Creek, but that at least a portion of the metal concentrations measured at the original Stevens Creek sampling site can be attributed to natural background. SCKA and SCKB were removed from the quarterly sampling program in 2017.

4.4.4 Norris Creek

Norris Creek, located about 500 m northeast of the landfill footprint, was sampled between November 1994 and May 1997 (Figure 2), when sampling was terminated due to lack of access. Leachate indicator parameters reflect essentially background concentrations over the sample period, with chloride concentrations varying between 0.6 and 3.2 mg/L, and nitrate concentrations varying between <0.05 and 1.5 mg/L-N. The highest chloride and nitrate levels coincided, and were in samples collected in the fall of 1995 when groundwater from the boggy area at the head of this creek would have been a principal source of the low flow. The chloride and nitrate concentrations are considered to be background levels for a boggy environment.

4.4.5 Christie Creek

Christie Creek received discharge from the aeration lagoon prior to November 1998. It was therefore significantly affected by leachate prior to that time. Prior to November 1998, chloride concentrations ranged from 11 to 98 mg/L, and ammonia concentrations ranged from <0.02 to 17.3 mg/L-N (Figures B-12 and B-13). Ammonia concentrations were typically below 10 mg/L-N but reached a peak of 17.3 mg/L-N in January 1998 (Figure B-13).

Christie Creek water quality has shown a dramatic improvement since the leachate pipeline was commissioned in late 1998 and shallow seepage around the south side of the flow equalization lagoon was addressed with a berm in late 1999. Since that time, ammonia concentrations in the downstream samples have typically ranged below 0.12 mg/L-N with the exception of concentrations of 0.58 mg/L-N on September 13, 2001, 0.4 mg/L-N in October 2006, and 2.31 mg/L-N in July 2009. The sample collected at the Christie Creek Upstream (U/S) station on September 13, 2001 had an ammonia concentration of 2.4 mg/L-N, indicating a source upstream of the landfill. Ammonia concentrations at the Christie Creek stations in 2019 were very low, with the highest measured values of 0.04 mg/L-N in October at both stations. The Christie Creek Downstream (D/S) sampling station was inaccessible in January 2019, and could not be sampled. Christie Creek U/S was dry in July 2019 (Table B-29) and could not be sampled. Ammonia concentrations at Christie Creek D/S last exceeded FWALC in July 2009, during drier than usual conditions.

Nitrate concentrations have ranged between <0.005 and 0.43 mg/L-N for both the upstream and downstream stations for 2008 through 2019, and do not indicate any landfill effects (Table B-29).

Concentrations at Christie Creek U/S since 2009 have remained below 2.4 mg/L. Chloride concentrations at Christie Creek D/S are typically very similar to the upstream results and have remained below 2.8 mg/L since 2009, with the exception of a 3.38 mg/L concentration measured in July 2019 (Figure B-12 and Table B-29). Concentrations are typically highest in the summer due to dry weather.

COD concentrations over the period of record have varied from <10 mg/L-O to 169 mg/L-O. After the leachate pipeline was commissioned and prior to 2008, COD results had generally been less than 20 mg/L-O. At the downstream station a COD of 158 mg/L-O was sampled in January 2008; a site maximum between two non-detection events. At the same time, the upstream COD concentration measured 169 mg/L-O, suggesting upstream influences. The downstream February 2010 COD concentration again peaked at 157 mg/L-O but the upstream result on that day was below the detection limit. It is noteworthy that the peak concentrations occur in the winter months at both sites. COD concentrations for 2019 were <10 mg/L-O for both sites, except for July 2019 at Christie Creek D/S, where the COD concentration was 31 mg/L-O (Table B-29). Christie Creek U/S was dry for this sampling event. COD should continue to be monitored closely at both locations.

The manganese FWALC has only been exceeded during the dry summer months at Christie Creek D/S, while the lower GCDWQ criterion has been exceeded on a nearly chronic basis. Manganese concentrations at Christie Creek U/S have also exceeded the FWALC. The downstream samples usually have higher concentrations of manganese when data for both sites are available. Manganese concentrations at the downstream site could be due to the landfill or to a natural source located between the two sampling sites, but generally comply with the FWALC.

Iron concentrations at the Christie Creek D/S station frequently exceed GCDWQ and FWALC. Iron concentrations at the Christie Creek U/S station have exceeded GCDWQ or FWALC for about one third of the sampling events since late 2005. Recent recorded iron exceedances at the upstream station were in January 2012, October 2013, December 2014 and December 2015, with concentrations of 0.576, 0.354, 0.376 and 0.34 mg/L, respectively. The concentrations at the downstream station were 1.05, 1.43, 0.548 and 0.43 mg/L on the corresponding dates. The varying difference between the upstream and downstream results indicates the elevated values are likely due to natural background variability but may include some leachate effects.

As in Heath and Stevens creeks, zinc concentrations have chronically exceeded the FWALC of 0.0075 mg/L. These exceedances are attributed to background chemistry as the results for Christie Creek U/S typically exceed the results for Christie Creek D/S. Upstream zinc concentrations have exceeded the FWALC for almost all sampling events since 2009 (Table B-29).

A cadmium concentration of 0.00025 mg/L was recorded at the Christie Creek D/S in December 2015, and exceeds the hardness-dependent cadmium FWALC of 0.00009 mg/L. As all other cadmium results at both sampling sites have been below the FWALC, the December 2015 result is considered anomalous.

4.5 DOMESTIC WELLS

Seven wells, all located on the east end of Lot 105 (Figure 2), were monitored briefly from November/December 1994 to May 1996, after which, access to the sites was no longer permitted. Domestic well monitoring continued at one well located at 7396 McCoy Lake Road, located on the north side of Heath Creek, about 1 km northwest of the landfill footprint. At the owner's request, sampling was discontinued at this site on January 2003. Monitoring results for the seven domestic wells located on Lot 105 were presented in previous reports and are not included herein.

The domestic well supplying the residence at 7396 McCoy Lake Road was sampled for potability analysis on three occasions between October 2000 and April 2002. All three samples exhibited near pristine water quality.

5. SUMMARY

1. Groundwater flow beneath the original landfill is interpreted to be principally to the north, southeast and east, and flow beneath the South and East Expansion areas is principally to the east and southeast. Flow in bedrock beneath the northeast portion of the landfill is southeast and south. Seepage rates and quantities are interpreted to be very low due to the limited extent and thickness of permeable surficial sediments over the bedrock and the low permeability of the bedrock. Construction of the French Drain in the South Expansion Area, and the seepage cut-off wall/berm across the trough of surficial sediments underlying the southwest corner of the landfill, appear to have arrested seepage migration towards Heath Creek.
2. Current leachate indicator concentrations are typical for a landfill of this size and age. Samples from the French Drain in the South Expansion Area indicate no significant landfill effects have occurred in this area except for slightly elevated ammonia concentrations.
3. Significant leachate impacts have only been detected in 4 of the 11 monitoring wells that are screened within surficial sediments. The most significant impacts north of the landfill at MW94-6S and MW98-9 were addressed by the north interception trench commissioned in late 1999. The French Drain (2006) and seepage cut-off wall/berm (2007) constructed in the South Expansion area appear to have mitigated minor leachate impacts at MW94-4S to the west of the landfill. Minor effects at MW05-1S can be mitigated with the operation of PW-2 and PW15-2, as described below.
4. Monitoring data for the network of monitoring wells screened in bedrock and the bedrock pumping well (PW-1) sampled in 2019 indicate no leachate impacts have occurred to the south and only slight leachate impacts have occurred to the west, north, northeast and east of the present landfill footprint.
5. When operating properly, the interception wells control the migration of leachate towards Christie Creek. PW-2 has not been maintaining a low enough level to provide sustained hydraulic control over leachate in surficial sediments for over half of the monitoring events since 2009, and none of the sampling events since 2016. PW15-2, the second shallow leachate interception well, has not yet been put into operation. PW-1, the original bedrock pumping well, also appears to have been mostly non-operational between 2011 and 2019. Water level data indicate PW15-1, the second bedrock well, was operating from May to November 2019. Rising chloride concentrations in MW02-3D since early 2010 (83.7 mg/L in October 2019) likely reflect leachate migration in bedrock that is not being intercepted by the bedrock wells, due to the intermittent operation of this system.
6. Leachate impacts were not detected in Heath Creek in 2019, nor have they been previously. Leachate impacts were not detected in McCoy or Norris creeks when they were being sampled.
7. Slight leachate impacts have been detected in Stevens Creek, which flows over the north landfill property boundary onto Lot 105. Two additional sampling points were added in 2015,

between the toe of the berm and the original Stevens Creek sampling location, to better understand the contribution of seepage beneath the berm to the iron and cadmium exceedances recorded in Stevens Creek. Sampling results for these two additional sites indicate that some leachate is seeping under the clay berm above Stevens Creek. The general conformance of water quality to FWALC and/or GCDWQ criteria at the original Stevens Creek site indicates loading from the Landfill is low, and effects in Stevens Creek are temporal in nature. Water quality results from this site in 2019 complied with all receiving water criteria.

8. Historical leachate impacts in Christie Creek have been significant, as it received discharge from the leachate aeration lagoon up until late 1998. Following commissioning of the leachate pipeline in November 1998, the impact has been greatly reduced. In 2019, water quality complied with all receiving water quality criteria, except for pH and total iron, manganese, and zinc, which are unlikely to be associated with leachate, based on the very low chloride concentrations.

6. RECOMMENDATIONS

6.1 MONITORING PROGRAM

The monitoring program should be continued through 2020 on a quarterly basis, in accordance with Table I. Data should be reviewed quarterly and reported annually.

Sampling recommendations from the 2019 field review should be followed, including the use of dedicated bailers, calibration of the water quality meter before each sampling event for pH and electrical conductivity, rinsing the water quality meter probe with de-ionized water between samples, collection of water samples immediately after purging three well volumes where possible, and permanent retention of field notes (Piteau, 2019b).

A new dissolved copper FWALC guideline was approved in August 2019 to supersede the hardness-dependent total copper guideline. The value of the guideline is dependent on sample pH, temperature, dissolved organic carbon (DOC), humic acid content (HA), alkalinity, and major cation and anion concentrations. To facilitate the comparison of copper against the new guideline, it is recommended that the bolded parameters on Table I are included in the sampling program. For the sites where only total metals are currently monitored, a sample for dissolved copper can be collected at the same time as samples for total metals, but only analyzed when the total copper result exceeds the calculated guideline. HA has not been included since it is not yet an available laboratory test.

Samples collected from the Leachate Drain during the summer sampling event should also be analyzed for per- and polyfluoroalkyl substances (PFAS). These are a group of chemicals used to provide water repellency that have been included in the Stage 10 and 11 amendments to the BC Contaminated Sites Regulation (CSR) in 2017, and added to the GCDWQ in 2018. Sampling precautions recommended in the “Guidance for the Assessment and Remediation of Per- and Polyfluoroalkyl Substances in British Columbia” (SLR, 2019) should be followed, including analysis of field and trip blanks. If any contaminants are detected at concentrations of concern, samples should be collected again later in the year, and the monitoring program should be adjusted accordingly.

Samples from the leachate interception wells should be analyzed for the parameters in Suite 1. Including dissolved metals will further characterize leachate quality and inflow to the flow equalization lagoon since it is expected these wells will be operating in 2020. Samples need only be collected from the operating bedrock well and the operating surficial sediment well at each sampling event. If neither well is operating, one can be manually turned on and run to waste for a few minutes before collecting samples, as per current practice.

MW13-1S and MW13-2S should be sampled quarterly until a relatively stable chemistry is indicated. If another ammonia or nitrate result above background levels is recorded, a datalogger should be used to record water levels in the affected piezometer to assess the responsiveness of water levels to recharge events.

Water levels in the shallow standpipe piezometers, installed in the South Expansion Area and to the west of the cut-off berm, should be monitored when the other monitoring wells are sampled, for as long as they are accessible.

6.2 LEACHATE FLOW DATA

Flow data from the leachate drains should be processed and reported annually. Operational data (water levels and cumulative flows) for the leachate interception wells should be processed quarterly and reported annually. Flow data for the leachate pipeline to the Alberni sewage treatment lagoons should continue to be reviewed and reported annually.

6.3 MONITORING WELL REPAIRS

The standpipes at BH00-1C and BH00-2C are bent or broken off below ground and water levels in these wells are indicative of a perched water table close to the elevation of the trafficked surface where they were originally completed. These should be replaced with a multilevel piezometer. The replacement piezometers should have a 50 mm standpipe with a screen interval at the base of the waste to facilitate collection of water samples, and a multi-level vibrating wire piezometer to obtain water level measurements at two or three intermediate depths within the waste. Data loggers could be installed in the standpipe and on the vibrating wires to record seasonal water level fluctuations and responses to rainfall events.

MW02-1S was damaged in July 2015. It is recommended this monument stickup be repaired. This repair could be completed at the same time as installation of the landfill piezometers described above.

6.4 RECOMMENDED DESIGN MODIFICATIONS AND MITIGATIVE MEASURES

The two recently constructed backup leachate interception wells (PW15-1 and PW15-2) should be commissioned and the operation of PW-1 and PW-2 should be adjusted according to the recommendations in Piteau, 2017a. Water levels and pumping rates in each well should be recorded and monitored to allow for ongoing evaluation of the interception well system and periodic adjustments to the pumping controls (Piteau, 2017a).

7. LIMITATIONS

Piteau Associates Engineering Ltd. has exercised reasonable skill, care and diligence in obtaining, reviewing, analyzing and interpreting the information acquired during this study, but makes no guarantees or warranties, expressed or implied, as to the completeness of the information contained in this report. Conclusions and recommendations provided in this report are based on the information available at the time of this assessment.

In preparing the recommendations contained herein, Piteau has relied on information and interpretations provided by others. Piteau is not responsible for any errors or omissions in this information. This report is comprised of text, tables, figures and appendices, and all components must be read and interpreted in the context of the whole report. The report has been prepared for the sole use of the Alberni-Clayoquot Regional District and no representation of any kind is made to any other party.

We trust this report adequately presents and discusses the leachate sampling data collected to date. If you wish to discuss the 2019 sampling results, please contact the undersigned.

Respectfully submitted,

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TABLES

TABLE I
ALBERNI VALLEY LANDFILL 2019 MONITORING PROGRAM

Suite No.	Sites	Frequency	Analyses
1	MW94-4S, MW94-5S, MW94-6S MW98-9, MW98-10 MW02-1S when fixed , MW02-1D MW02-3S, MW02-3D, MW02-4 PW-1 or PW15-1, PW2 or PW15-2 MW13-1D	Quarterly Quarterly Annual	Field: Conductance, temperature, pH, water level Lab: Conductance, pH, TDS, chloride, sulphate, ammonia, nitrate, hardness, COD, DOC dissolved metals, alkalinity MW02-1S damaged in July 2015. MW13-1D - water level measurements collected quarterly; chemistry annually
1a	MW94-6D	Quarterly Quarterly	Field: Conductance, temperature, pH, water level Lab: Conductance, pH, TDS, chloride, sulphate, ammonia, nitrate, hardness, COD, TOC, DOC dissolved metals, alkalinity
2	MW94-4D, MW05-1S MW05-1D, <i>PW-1, PW-2</i> MW13-1S and MW13-2S	Quarterly Quarterly	Field: Conductance, temperature, pH, water level Lab: Conductance, pH, TDS, chloride, sulphate, nitrate, ammonia
3	Heath, Stevens, and Christie Creeks	Quarterly Quarterly	Field: Conductance, temperature, pH Lab: Conductance, pH, chloride, sulphate, nitrate, ammonia, hardness, COD, tot P, alkalinity total metals, DOC, dissolved Cu (analyse only if total Cu exceeds calculated guideline)
4	Leachate Drain (Aeration lagoon inflow from landfill), South Expansion Leachate Drain BH00-1C replacement (when completed)	Quarterly Quarterly Annual	Field: Conductance, temperature, pH Lab: Conductance, pH, TDS, chloride, nitrate, ammonia, hardness, sulphate, COD, TOC, tot P, total metals, alkalinity, DOC, dissolved Cu (analyse only if total Cu exceeds calculated guideline) Lab: VOC scan, acid extractables, PFAS (Standard List) for Leachate Drain only
5	BH00-1A, BH00-1C, BH00-2C, BH00-5A-S, BH00-5A-D, BH00-6A, BH00-7A, BH00-8A, MW09-1,2,3,4, and 10, MW13-2D, MW15-1S, MW15-1D, PW15-1, PW15-2	Quarterly	Field: water levels until no longer accessible

H:\Project\1005\Analysis\Chemistry\2019\[Summary Tables 2019.xlsm]Table I

- Notes: 1. **Bolded** sites and parameters to be included in monitoring program in 2020 or as noted.
2. *Italicized* sites were included in the sampling program in 2019 but should be removed for 2020.

**TABLE II
SUMMARY OF LEACHATE IMPACTS BASED ON MEAN 2019 CONCENTRATIONS**

MONITORING WELL	Easting ⁵ (X-Landfill Grid)	Northing ⁵ (Y-Landfill Grid)	Table Reference for full chemistry results	Number of samples	pH-Field	EC-Lab	Total Dissolved Solids	Chloride	Ammonia Nitrogen	Nitrate	Chemical Oxygen Demand	Total or Dissolved Hardness	Total or Dissolved Iron	Total or Dissolved Manganese	Total or Dissolved Copper
					(pH Units)	(µS/cm)	(mg/L)	(mg/L)	(mg/L-N)	(mg/L-N)	(mg/L-O)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
					7.0-10.5	-	500	250	-	10	-	-	0.3	0.05	1
FWAL GUIDELINE ²					6.5-9	-	-	150	1.84	3	-	-	0.35	2.37 (leachate)	0.002 ⁶
LEACHATE															
Leachate Drain (Lagoon Inlet)	3538	1012	B-1, 3, 4	3	7.0	969.3	490.0	66.7	20.4	0.68	106	294	10.2	6.64	0.0043
BH00-1C	3268	1148	B-2, 3, 4	0	-	-	-	-	-	-	-	-	-	-	-
South Expansion Leachate Drain	3476	838	B-4, 5	4	7.3	388.8	213.8	10.2	2.8	1.3	<14	161	0.1	2.20	0.0038
SOUTHEAST WELLS															
MW02-3S (Surficial Sediments)	3654	920	B-8	4	7.7	363	203	22.8	0.02	0.74	<14	160	<0.02	0.087	0.0036
MW02-3D (Bedrock)	3654	920	B-9	4	7.3	822	469	61.5	0.57	<0.01	24	275	<0.3	0.251	<0.0004
MW05-1S (Surficial Sediments)	3536	920	B-22	4	7.1	399	235	9.11	<0.05	<0.11	-	-	-	-	-
MW05-1D (Bedrock)	3536	920	B-22	4	6.9	796	461	33.2	0.03	0.26	-	-	-	-	-
PW-1 (Bedrock Leachate Well)	3517	975	B-23	4	6.7	966	552	41.0	0.83	<0.02	-	-	-	-	-
PW-2 (Surficial Sediment Leachate Well)	3523	987	B-23	4	6.3	3120	1582	319	79.8	<0.05	-	-	-	-	-
SOUTH AND WEST WELLS															
MW94-4S (Surficial Sediments)	2908	1061	B-10	4	9.0	257	154	8.00	0.05	0.05	<10	5	<0.01	<0.001	<0.0003
MW94-4D (Bedrock)	2908	1061	B-11	4	8.0	276	173	7.87	<0.02	0.26	-	-	-	-	-
MW02-1S (Surficial Sediments)	3384	757	B-18	0	-	-	-	-	-	-	-	-	-	-	-
MW02-1D (Background Bedrock)	3384	757	B-19	4	6.6	125	74	3.12	<0.02	0.13	<10	17	<0.02	0.007	0.0010
MW02-4 (Background Bedrock)	2521	1468	B-21	4	6.5	555	299	87.7	<0.02	<0.02	<11	137	<0.01	<0.001	<0.0006
NORTH WELLS															
MW94-5S (Bedrock)	3148	1280	B-12	4	6.9	252	143	3.34	<0.11	0.16	<10	115	0.30	0.060	0.0014
MW94-6S (Surficial Sediments)	3205	1293	B-13	4	6.3	635	313	7.18	11.0	0.03	41	254	46.1	4.64	<0.0004
MW94-6D (Bedrock)	3205	1293	B-14	4	9.3	533	344	4.54	<0.09	1.01	<19	13	1.28	<0.091	0.0046
MW98-9 (Surficial Sediments)	3211	1311	B-15	4	6.7	205	121	1.77	<0.05	0.53	<25	90	<0.02	<0.004	0.0013
MW98-10 (Surficial Sediments)	3243	1313	B-16	3	6.9	68	57	1.08	<0.02	0.42	<15	26	<0.01	0.003	<0.0005
2013 WELLS															
MW13-1D (Bedrock)	3597	1187	B-24	1	7.6	700	440	72.6	-	<0.01	109	62	2.62	0.877	0.0017
MW13-1S (Bedrock)	3595	1190	B-26	3	7.9	580	369	38.5	0.09	<0.01	-	-	-	-	-
MW13-2S (Bedrock)	3483	1272	B-26	4	7.8	355	229	5.67	<0.03	<0.09	-	-	-	-	-
CREEK SITES															
Heath Creek	2591	1560	B-27	4	7.0	65	-	4.14	<0.02	0.05	<10	26	0.13	0.005	0.0011
Stevens Creek	3077	1308	B-28	3	7.7	120	-	3.64	<0.02	0.15	<10	53	0.11	0.140	0.0008
Christie Creek U/S	3512	779	B-29	3	6.7	65	-	1.82	<0.02	0.03	<10	29	0.10	0.014	0.0019
Christie Creek D/S	3779	1084	B-29	3	7.8	101	-	2.86	0.03	<0.02	<17	47	0.72	0.135	0.0037

H:\Project\1005\Analysis\Chemistry\2019\Summary Tables 2019.xlsm\Table1

- NOTES:
1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.
 2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, June 2019. Lowest guidelines are shown.
 3. **Bolding** denotes parameters which exceed water quality criteria.
 4. "-" denotes parameter was not analysed, or a receiving water criteria was not applicable.
 5. Coordinates are given as part of the landfill coordinate system shown on Figures 2 and 3.
 6. Lowest value of superseded hardness-dependent BC FWAL total copper standard. Replaced in August 2019 by dissolved copper guideline dependent on sample pH, temperature, DOC, Humic Acid content, and major cation and anion chemistry.

**TABLE III
SUMMARY OF 2019 EXCEEDANCES OF GCDWQ AND BC FWALC**

MONITORING WELL	Table Reference for full chemistry results	Number of samples	Physical		Nutrients/ Anions		Total Metals						Dissolved Metals						Toluene			
			pH	TDS	Ammonia	Dissolved Chloride	Boron	Chromium	Iron	Manganese	Mercury	Zinc	Arsenic (1)	Boron	Cadmium	Chromium	Copper (2)	Iron		Lead	Manganese	Mercury
LEACHATE																						
Leachate Drain (Lagoon Inlet)	B-1, 3, 4	3																				
BH00-1C	B-2, 3, 4	0	No longer sampled. Replacement will be sampled once drilled.																			
South Expansion Leachate Drain	B-4, 5	4																				
SOUTHEAST WELLS																						
MW02-3S (Surficial Sediments)	B-8	4														(3)						
MW02-3D (Bedrock)	B-9	4																				
MW05-1S (Surficial Sediments)	B-22	4																				
MW05-1D (Bedrock)	B-22	4																				
PW-1 (Bedrock Leachate Well)	B-23	4																				
PW-2 (Surficial Sediment Leachate Well)	B-23	4																				
SOUTH AND WEST WELLS																						
MW94-4S (Surficial Sediments)	B-10	4											(1)									
MW94-4D (Bedrock)	B-11	4																				
MW02-1S (Surficial Sediments)	B-18	0	Damaged. Will be sampled once fixed.																			
MW02-1D (Background Bedrock)	B-19	4														(4)					(4)	
MW02-4 (Background Bedrock)	B-21	4																				
NORTH WELLS																						
MW94-5S (Bedrock)	B-12	4																				
MW94-6S (Surficial Sediments)	B-13	4											(1)									
MW94-6D (Bedrock)	B-14	4											(1)									
MW98-9 (Surficial Sediments)	B-15	4														(4)				(4)		
MW98-10 (Surficial Sediments)	B-16	3																				
2013 WELLS																						
MW13-1D (Bedrock)	B-24	1																				
MW13-1S (Bedrock)	B-26	3																				
MW13-2S (Bedrock)	B-26	4																				
CREEK SITES																						
Heath Creek	B-27	4																				
Stevens Creek	B-28	3																				
Christie Creek U/S	B-29	3																				
Christie Creek D/S	B-29	3																				

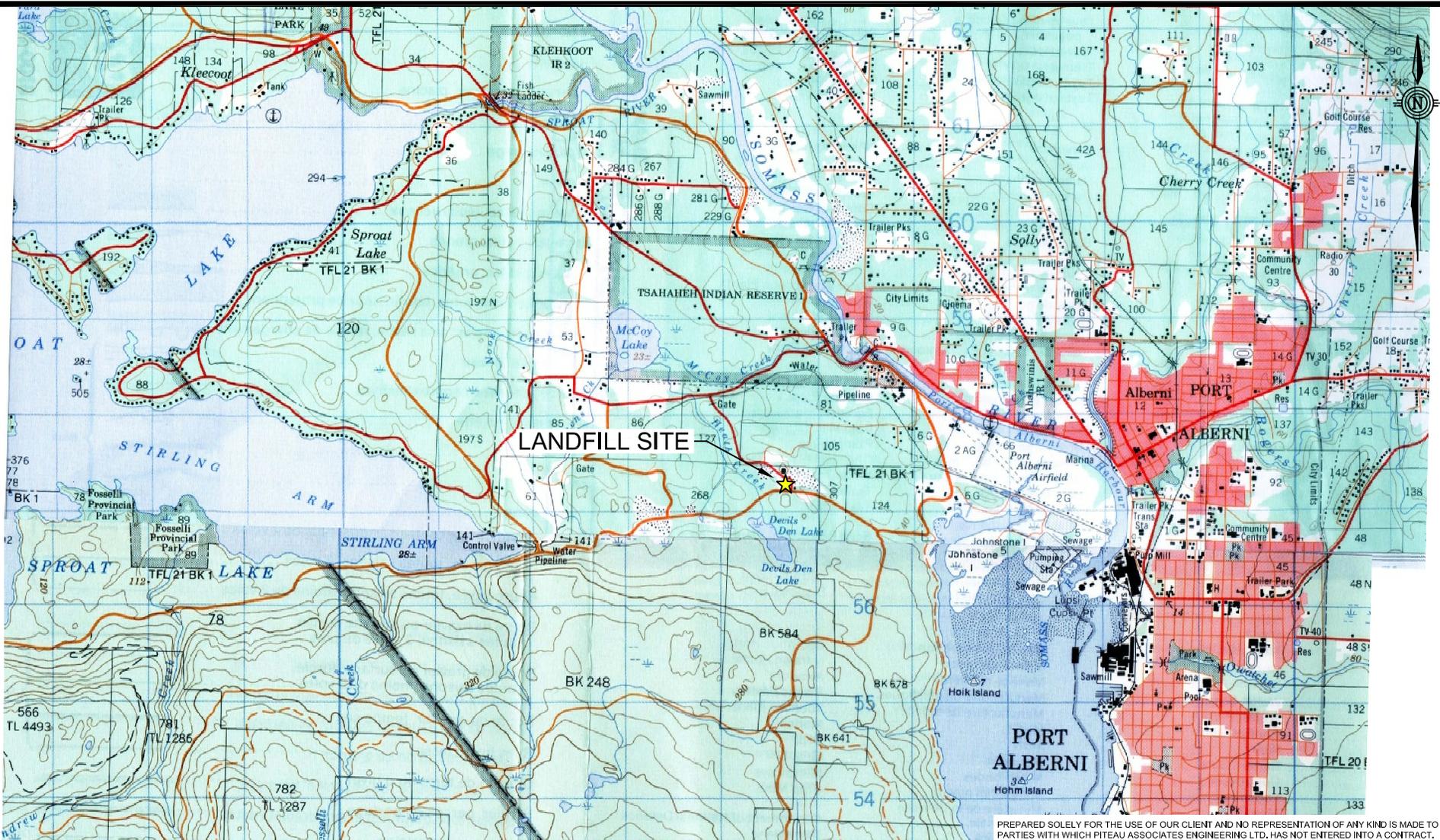
H:\Project\1005\Analysis\Chemistry\2019[Summary Tables 2019.xlsm]TableIII

NOTES:

- FWAL criterion for arsenic not considered relevant for groundwater.
- Exceedences based on an average hardness of 100 mg/L, using the superseded hardness-dependent BC FWAL total copper standard. This guideline was replaced in August 2019 by dissolved copper guideline dependent on sample pH, temperature, DOC, Humic Acid (not yet available), Alkalinity and major cation chemistry.
- Exceedance based on average hardness of 100 mg/L. With sample hardness of 640 mg/L, copper concentration does not exceed former FWAL criterion.
- January 2019 duplicate sample exceeded guideline (Table C-1)

- Blue shaded cells show sampling location has at least one exceedance of the BC FWAL for the parameter indicated
- Red shaded cells show sampling location has at least one exceedance of the GCDWQ for the parameter indicated
- Purple shaded cells show sampling location has at least one exceedance of the BC FWAL and GCDWQ for the parameter indicated
- No shading indicates all sampling results were below all guidelines
- Grey shaded cells show sampling location was not analyzed for the parameter indicated

FIGURES



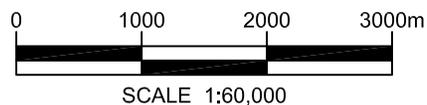
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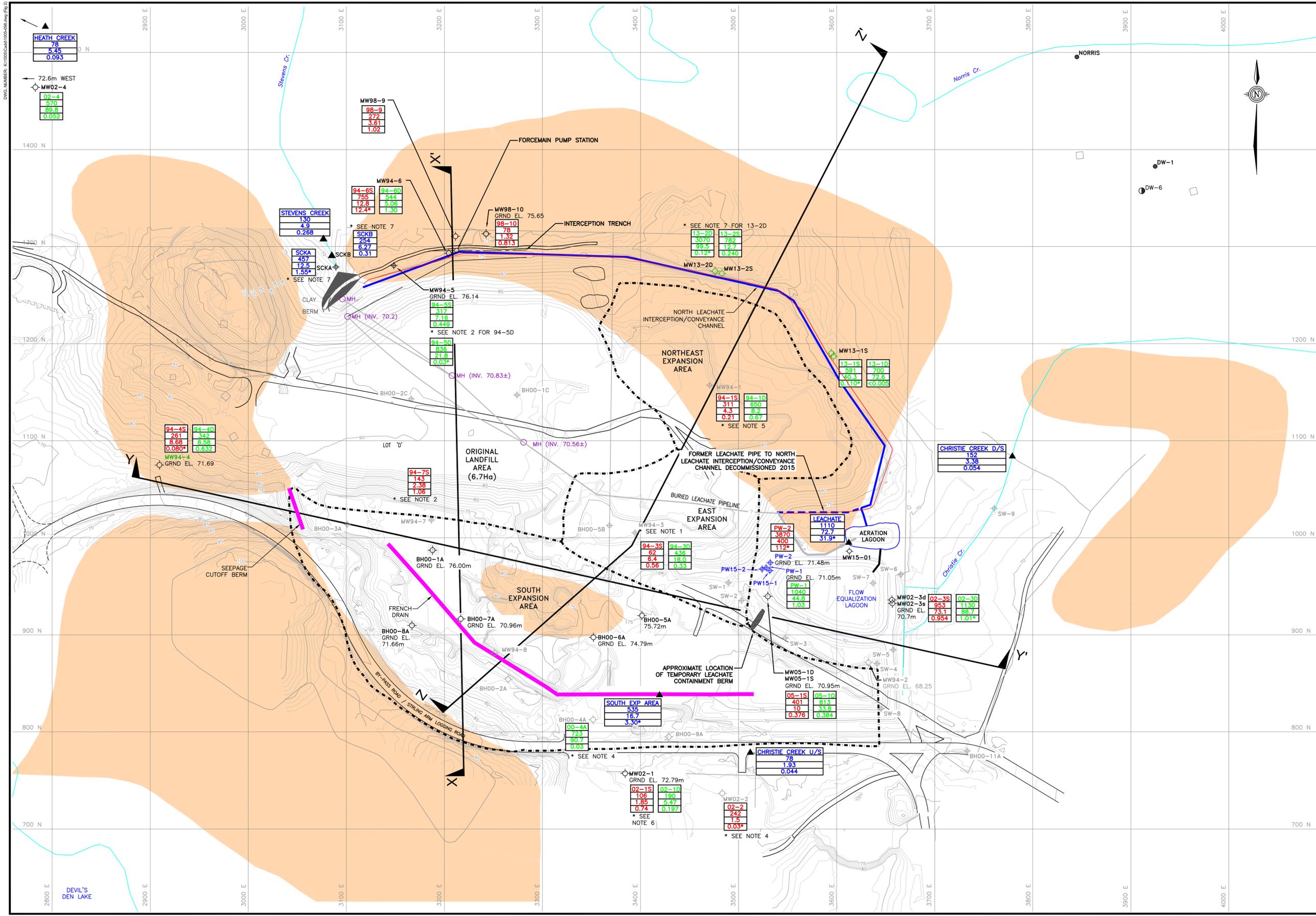
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LANDFILL LOCATION MAP

BY:	DATE:
RM/si	FEB 20
APPROVED:	FIGURE:
DJT	1



LEGEND

- MW94-2 GRND EL. 68.25: GROUNDWATER MONITORING WELL (PREFIX INDICATES DATE OF INSTALLATION)
- SW-9: SAMPLING SITES, NO LONGER MONITORED
- PW-1: INTERCEPTION WELL (CONSTRUCTED WINTER 2005/2015)
- DUG DOMESTIC WELL
- DRILLED DOMESTIC WELL
- SURFACE WATER SAMPLING SITE
- BURIED PIPE
- BEDROCK OUTCROPPING OR CLOSE TO SURFACE
- APPROXIMATE EXTENT OF LANDFILL EXPANSION AREAS
- HYDROGEOLOGICAL SECTION (FIGS. 4 AND 5)

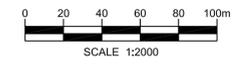
POSTED CONDUCTANCE, CHLORIDE AND NITRATE DATA. ALL DATA ARE MAXIMUM VALUES MEASURED IN 2019, UNLESS OTHERWISE STATED.

94-1S	484	5.8	0.45
-------	-----	-----	------

- CONDUCTANCE (µS/cm)
- CHLORIDE (mg/L)
- NITRATE (mg/L-N)
- * AMMONIA CONCENTRATION SHOWN WHERE IT EXCEEDS NITRATE CONCENTRATION

134 INDICATES SURFACE WATER SAMPLE
614 INDICATES SURFICIAL SEDIMENTS GROUNDWATER SAMPLE
895 INDICATES BEDROCK GROUNDWATER SAMPLE

- NOTES:**
- NOT SAMPLED SINCE 2005, RESULTS FROM 2005 SHOWN.
 - NOT SAMPLED SINCE 2008, RESULTS FROM 2008 SHOWN.
 - NOT SAMPLED SINCE 2010, RESULTS FROM 2010 SHOWN.
 - NOT SAMPLED SINCE 2011, RESULTS FROM 2011 SHOWN.
 - NOT SAMPLED SINCE 2013, RESULTS FROM 2013 SHOWN.
 - NOT SAMPLED SINCE 2015, RESULTS FROM 2015 SHOWN.
 - NOT SAMPLED SINCE 2016, RESULTS FROM 2016 SHOWN.
 - LANDFILL TOPOGRAPHY AT 1m CONTOUR INTERVAL PROVIDED BY MCGILL AND ASSOCIATES ENGINEERING LTD. ON FEBRUARY 15, 2017.
 - MAP IS PLOTTED IN LOCAL LANDFILL COORDINATES PROVIDED BY MCGILL AND ASSOCIATES ENGINEERING LTD. WELLS SURVEYED BY MCGILL AND ASSOCIATES ENGINEERING LTD.

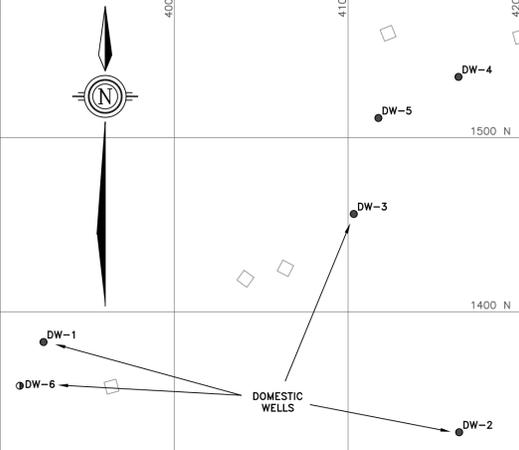
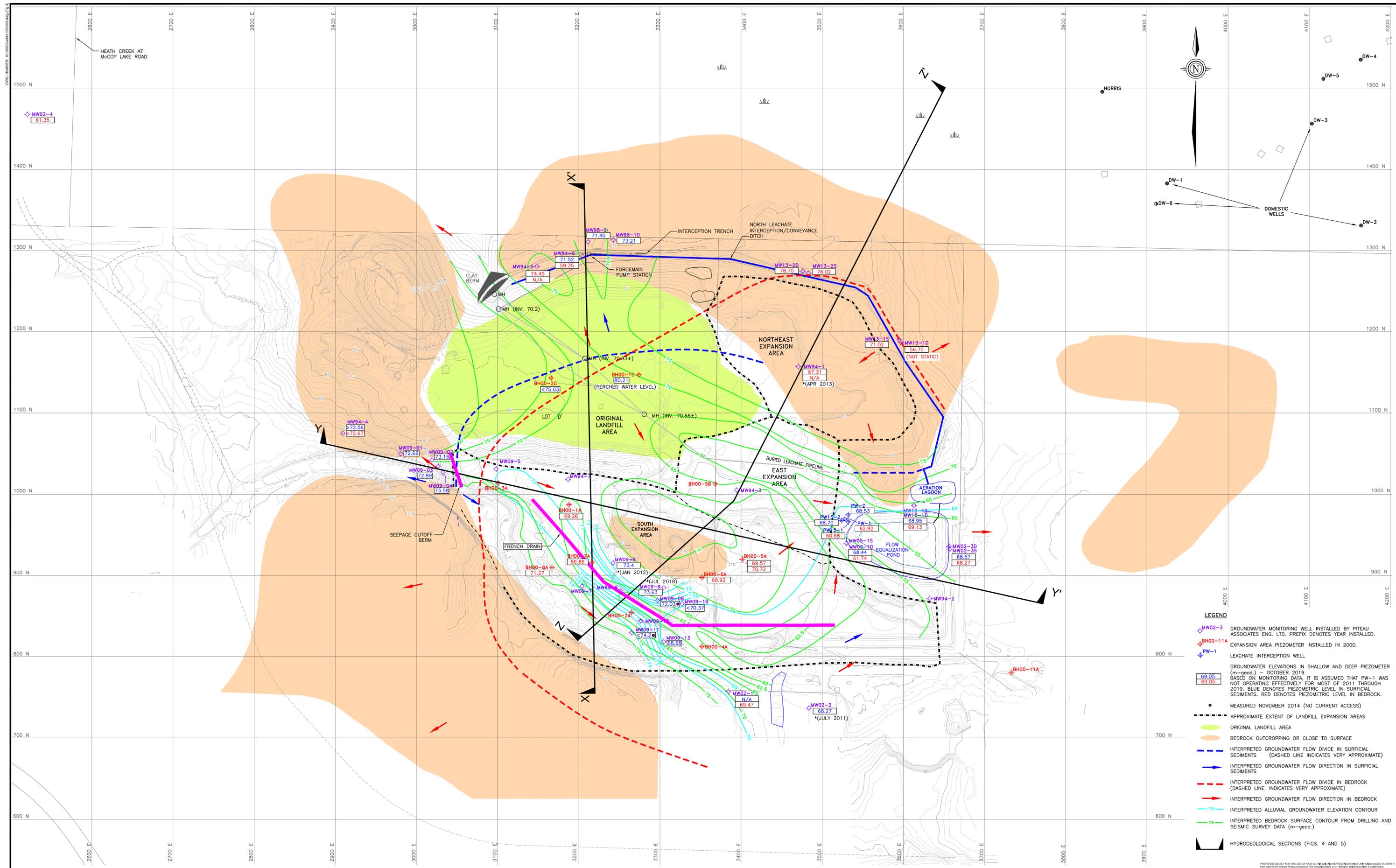


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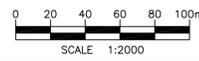
BY: RM/sl DATE: FEB 20
APPROVED: DJT FIG: 2

SITE PLAN



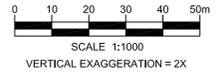
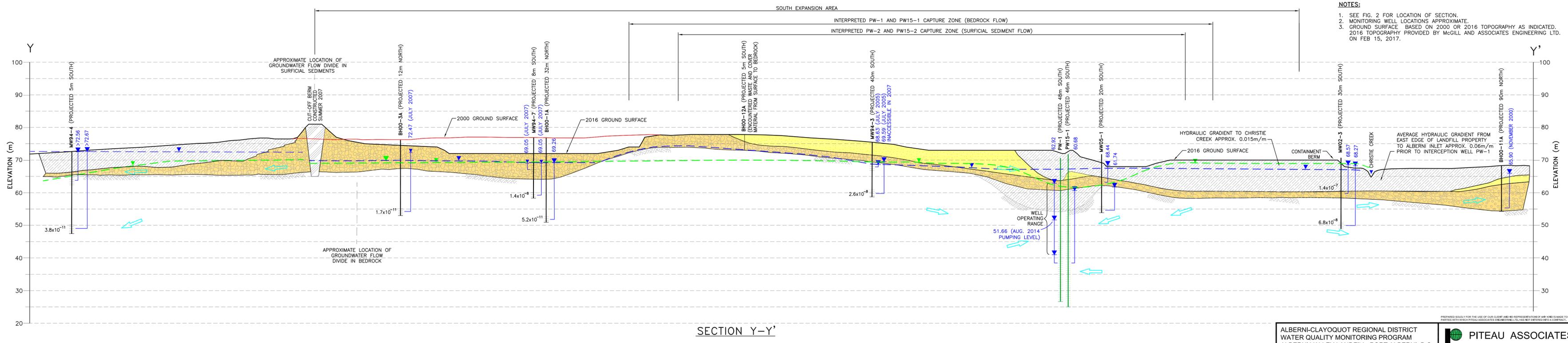
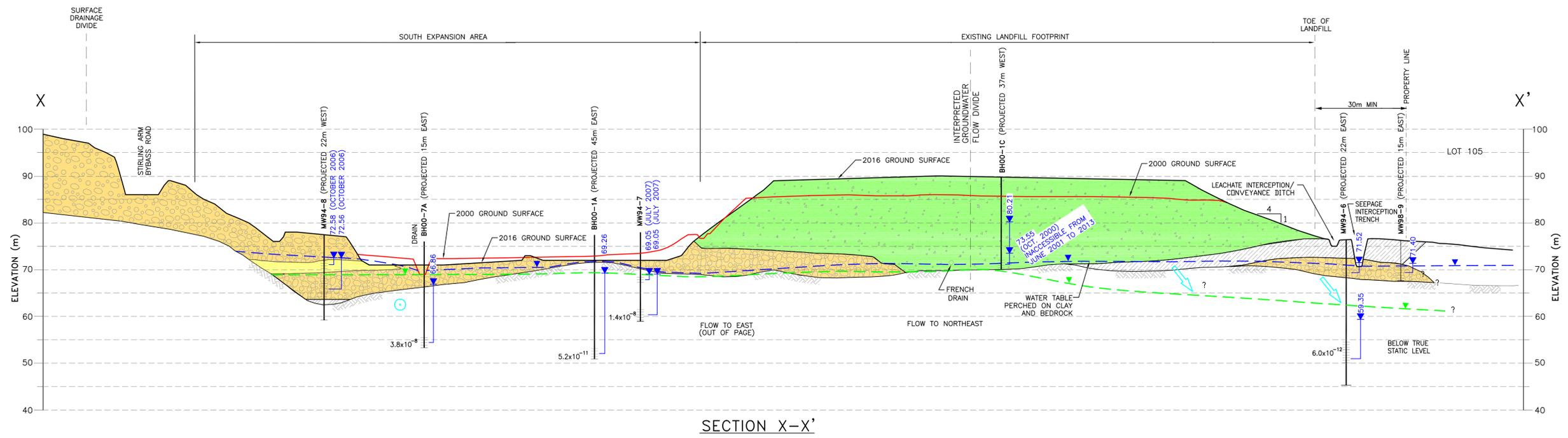
- LEGEND**
- ◇ MW02-3 GROUNDWATER MONITORING WELL INSTALLED BY PITEAU ASSOCIATES ENG. LTD. PREFIX DENOTES YEAR INSTALLED.
 - ◇ BH00-11A EXPANSION AREA PIEZOMETER INSTALLED IN 2000.
 - ◇ PW-1 LEACHATE INTERCEPTION WELL
 - 69.05 GROUNDWATER ELEVATIONS IN SHALLOW AND DEEP PIEZOMETER (m-geod.) - OCTOBER 2019. BASED ON MONITORING DATA, IT IS ASSUMED THAT PW-1 WAS NOT OPERATING EFFECTIVELY FOR MOST OF 2011 THROUGH 2019. BLUE DENOTES PIEZOMETRIC LEVEL IN SURFICIAL SEDIMENTS. RED DENOTES PIEZOMETRIC LEVEL IN BEDROCK.
 - MEASURED NOVEMBER 2014 (NO CURRENT ACCESS)
 - APPROXIMATE EXTENT OF LANDFILL EXPANSION AREAS
 - ORIGINAL LANDFILL AREA
 - BEDROCK OUTCROPPING OR CLOSE TO SURFACE
 - INTERPRETED GROUNDWATER FLOW DIVIDE IN SURFICIAL SEDIMENTS (DASHED LINE INDICATES VERY APPROXIMATE)
 - INTERPRETED GROUNDWATER FLOW DIRECTION IN SURFICIAL SEDIMENTS
 - INTERPRETED GROUNDWATER FLOW DIVIDE IN BEDROCK (DASHED LINE INDICATES VERY APPROXIMATE)
 - INTERPRETED GROUNDWATER FLOW DIRECTION IN BEDROCK
 - INTERPRETED ALLUVIAL GROUNDWATER ELEVATION CONTOUR
 - INTERPRETED BEDROCK SURFACE CONTOUR FROM DRILLING AND SEISMIC SURVEY DATA (m-geod.)
 - X HYDROGEOLOGICAL SECTIONS (FIGS. 4 AND 5)

NOTES:
 1. LANDFILL TOPOGRAPHY AT 1m CONTOUR INTERVAL PROVIDED BY MCGILL AND ASSOCIATES ENGINEERING LTD. ON FEBRUARY 15, 2017.
 2. MAP IS PLOTTED IN LOCAL LANDFILL COORDINATES, PROVIDED BY MCGILL AND ASSOCIATES.



ALBERNI-CLAYOQUOT REGIONAL DISTRICT WATER QUALITY MONITORING PROGRAM ALBERNI VALLEY LANDFILL, PORT ALBERNI, B.C.		 PITEAU ASSOCIATES <small>GEOTECHNICAL AND WATER MANAGEMENT CONSULTANTS</small>
POSTED GROUNDWATER ELEVATIONS AND INTERPRETED GROUNDWATER FLOW DIRECTIONS	BY: RM/sl APPROVED: DJT DATE: FEB 20 FIG: 3	

DWG. NUMBER: K11005/241/1005-100.dwg (REV. 4)



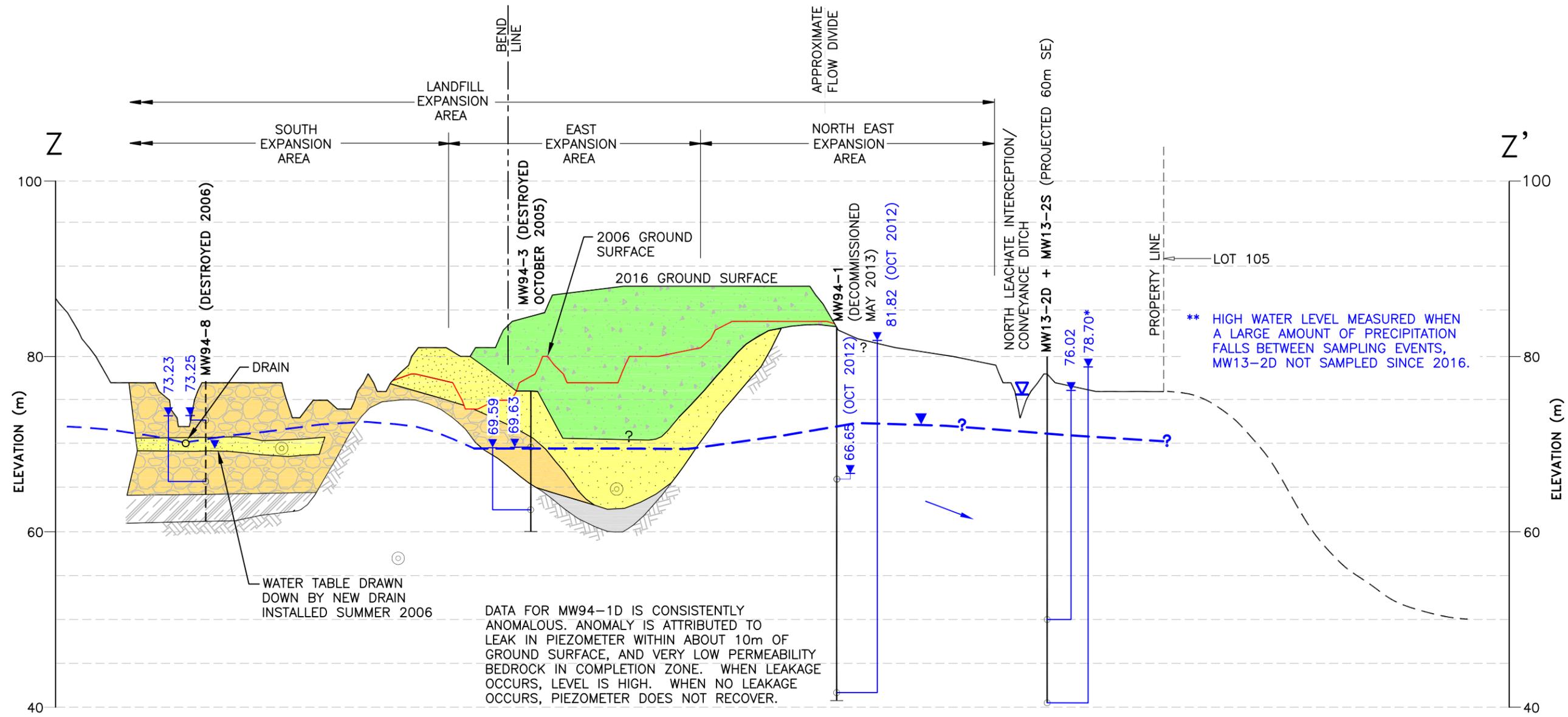
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BY:	DATE:
RM/sl	FEB 20
APPROVED:	FRG:
DJT	4

HYDROGEOLOGICAL SECTIONS X-X' AND Y-Y' THROUGH ORIGINAL LANDFILL AND SOUTH EXPANSION AREA



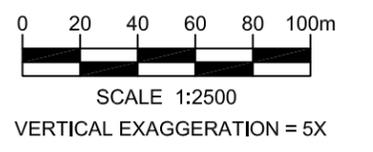
SECTION Z-Z'

NOTES:

1. SEE FIG. 2 FOR LOCATION OF SECTION.
2. MONITORING WELL LOCATIONS APPROXIMATE.
3. BOTH MONITORING WELL MW94-3 AND MW94-8 WERE DESTROYED. LAST AVAILABLE READINGS SHOWN ON SECTION. INTERPRETED WATER TABLE ELEVATION BASED ON DATA FROM OTHER MONITORING WELLS IN AREA.
4. MW94-1 WAS DECOMMISSIONED IN MAY 2013 AND WAS REPLACED WITH MW13-2.
5. GROUND SURFACE BASED ON 2006 OR 2016 TOPOGRAPHY AS INDICATED. 2016 TOPOGRAPHY PROVIDED BY MCGILL AND ASSOCIATES ENGINEERING LTD. ON FEB 15, 2017.

LEGEND

	MUNICIPAL WASTE AND COVER MATERIAL		MONITORING WELL SHOWING PIEZOMETER COMPLETION ZONES AND WATER LEVELS MEASURED AS INDICATED
	VERY DENSE SAND AND SILT WITH TRACE CLAY AND SOME GRAVEL-TILL		INTERPRETED WATER TABLE
	SILT AND CLAY SEDIMENTS (ML)		INTERPRETED GROUNDWATER FLOW DIRECTION
	SAND AND GRAVEL (GW)		FLOW OUT OF PAGE
	FINE SAND AND SILTY SAND (SP)		
	BEDROCK SURFACE		



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HYDROGEOLOGICAL SECTION Z-Z'
THROUGH ORIGINAL LANDFILL AND SOUTH EXPANSION AREA

BY:	DATE:
RM/si	FEB 20
APPROVED:	FIG:
DJT	5

APPENDIX A
WATER ELEVATION MONITORING DATA TABLES AND PLOTS

APPENDIX A - LIST OF TABLES

Table A-1	1994 and 1998 Monitoring Well Water Elevation Data
Table A-2	2000 Monitoring Well Water Elevation Data
Table A-3	2002, 2005, 2013 and 2015 Monitoring Well Water Elevation Data
Table A-4	2009 South Expansion Area Monitoring Well Elevation Data

APPENDIX A - LIST OF FIGURES

- Figure A-1 Water Level Elevations for Eastern Monitoring Wells MW94-1, MW94-2, MW94-3 and MW02-3
- Figure A-2 Water Level Elevations for Southern Monitoring Wells MW94-4 and MW94-7
- Figure A-3 Water Level Elevations for Northern Monitoring Wells MW94-5, MW94-6 and MW02-4 and Landfill Monitoring Wells BH00-1C and BH00-2C
- Figure A-4 Water Level Elevations for Northern Monitoring Wells MW98-9 and MW98-10
- Figure A-5 Water Level Elevations for Expansion Area Monitoring Wells
- Figure A-6 Water Level Elevations for 2009 Overburden Monitoring Wells in South Expansion Area
- Figure A-7 Water Level Elevations for Bedrock Leachate Interception Well Monitoring – PW-1, PW15-1, MW02-3D, MW05-1D, MW15-1D
- Figure A-8 Water Level Elevations for Surficial Sediment Interception Well Monitoring – PW-2, PW15-2, MW02-3S, MW05-1S, MW15-1S
- Figure A-9 Water Level Elevations for Northeastern Bedrock Monitoring Wells MW13-1 and MW13-2

TABLE A-1
1994 AND 1998 MONITORING WELL WATER ELEVATION DATA

ELEVATION OF WATER ¹ (m-asl)										
	MW94-1S	MW94-1D	MW94-4S	MW94-4D	MW94-5S	MW94-5D	MW94-6S	MW94-6D	MW98-9	MW98-10
Top of Casing (m-geod)	84.21	84.21	72.56	72.67	77.29	77.29	76.18	76.18	76.19	76.14
Piezo bottom (m-geod)	41.0	64.0	62.0	47.2	66.5	53.8	67.6	49.3	68.6	72.0
Completion Zone	bedrock	bedrock	bdrk/surf	bedrock	bedrock	bedrock	surficial	bedrock	surficial	surficial
MEASURED WATER ELEVATIONS (m-geod.)										
27-Jan-09	66.83	81.66	>72.56	72.67	-	-	71.61	56.96	71.49	73.00
14-Apr-09	66.64	81.70	>72.56	57.70	-	-	71.36	56.27	71.19	72.80
21-Jul-09	66.64	81.48	>72.56	49.89	-	-	70.83	57.81	70.89	72.14
7-Nov-09	65.41	50.57	>72.56	48.68	73.61	75.66	70.80	56.82	70.86	72.00
26-Jan-10	67.71	82.25	>72.56	71.46	74.66	-	72.03	57.97	72.01	73.53
6-Apr-10	66.61	82.11	>72.56	65.45	74.72	-	72.05	56.27	72.06	73.55
20-Jul-10	66.90	81.51	>72.56	65.81	72.87	-	70.76	63.54	70.86	72.13
10-Aug-10	65.73	48.70	>72.56	69.67	71.98	-	70.77	55.20	70.87	72.06
16-Nov-10	67.95	82.29	>72.56	62.09	74.57	-	71.71	59.79	71.87	73.40
6-Dec-10	66.22	82.06	>72.56	59.84	74.59	-	71.64	56.29	71.94	73.73
8-Feb-11	68.06	82.12	>72.56	65.69	74.66	plugged	72.20	58.02	72.59	73.96
9-May-11	66.86	82.04	>72.56	-	74.51	plugged	71.55	59.81	71.48	72.98
26-Jul-11	66.58	81.54	>72.56	62.66	73.32	plugged	70.80	59.04	70.88	72.05
8-Nov-11	66.52	82.15	>72.56	66.00	74.41	plugged	71.42	59.27	71.25	73.02
24-Jan-12	66.59	82.41	>72.56	68.40	74.74	plugged	72.45	58.55	73.12	74.30
8-May-12	66.81	82.11	>72.56	-	74.55	plugged	71.82	59.20	71.38	72.86
31-Jul-12	69.07	81.53	>72.56	71.80	72.82	plugged	70.82	59.51	70.80	72.14
25-Oct-12	66.65	81.82	>72.56	66.41	73.50	plugged	70.78	58.65	70.81	72.02
16-Jan-13	65.51	82.18	>72.56	61.67	74.80	plugged	72.04	57.06	72.51	73.92
15-Apr-13	67.31	82.21	>72.56	-	74.61	plugged	71.70	53.83	71.57	73.21
10-Jul-13	decommissioned	decommissioned	>72.56	69.75	73.66	plugged	71.35	52.16	71.96	72.83
13-Oct-13	decommissioned	decommissioned	>72.56	60.47	74.21	plugged	71.43	51.88	70.92	72.49
16-Jan-14	decommissioned	decommissioned	>72.56	66.84	74.63	plugged	71.90	51.82	72.07	73.69
12-May-14	decommissioned	decommissioned	>72.56	65.14	71.93	plugged	71.40	49.53	72.17	72.92
14-Aug-14	decommissioned	decommissioned	>72.56	61.18	71.36	plugged	72.15	58.43	72.13	72.12
3-Nov-14	decommissioned	decommissioned	>72.56	53.18	74.70	plugged	71.59	53.85	72.18	73.76
14-Aug-14	decommissioned	decommissioned	>72.56	61.18	71.36	plugged	72.15	58.43	72.13	72.12
3-Nov-14	decommissioned	decommissioned	>72.56	53.18	74.70	plugged	71.59	53.85	72.18	73.76
15-Jan-15	decommissioned	decommissioned	>72.56	53.67	74.88	plugged	71.78	52.94	71.55	72.88
21-Apr-15	decommissioned	decommissioned	>72.56	72.67	74.42	plugged	74.70	56.29	74.41	74.33
15-Jul-15	decommissioned	decommissioned	>72.56	50.23	-	plugged	73.13	56.33	73.11	72.99
16-Jul-15	decommissioned	decommissioned	-	-	72.57	plugged	-	-	-	-
20-Nov-15	decommissioned	decommissioned	-	-	74.71	plugged	75.00	60.45	74.88	74.76
23-Nov-15	decommissioned	decommissioned	frozen	frozen	-	plugged	-	-	-	-
25-Jan-16	decommissioned	decommissioned	>72.56	49.75	74.75	plugged	74.97	56.39	74.81	74.71
25-Apr-16	decommissioned	decommissioned	>72.56	57.07	74.08	plugged	74.19	57.98	74.11	73.84
15-Jul-16	decommissioned	decommissioned	>72.56	54.57	72.54	plugged	70.77	54.92	70.80	72.13
2-Nov-16	decommissioned	decommissioned	>72.56	62.06	75.12	plugged	72.57	55.72	73.86	74.56
18-Jan-17	decommissioned	decommissioned	>72.56	frozen	74.92	plugged	74.07	54.27	74.63	74.67
12-Apr-17	decommissioned	decommissioned	>72.56	72.67	74.84	plugged	73.80	57.62	73.95	74.39
13-Jul-17	decommissioned	decommissioned	>72.56	72.67	72.81	plugged	70.80	55.97	70.79	72.13
5-Oct-17	decommissioned	decommissioned	>72.56	72.60	70.79	plugged	70.81	55.33	70.81	72.01
18-Jan-18	decommissioned	decommissioned	>72.56	72.67	75.07	plugged	72.17	58.34	73.74	74.49
20-Apr-18	decommissioned	decommissioned	72.56	72.61	74.59	plugged	72.03	59.16	71.87	73.38
20-Jul-18	decommissioned	decommissioned	>72.56	62.30	72.62	plugged	70.81	59.34	70.80	72.14
18-Oct-18	decommissioned	decommissioned	>72.56	60.03	73.92	plugged	71.00	56.41	70.91	72.24
4-Jan-19	decommissioned	decommissioned	-	-	-	plugged	73.84	57.62	74.21	74.51
25-Jan-19	decommissioned	decommissioned	>72.56	56.35	74.84	plugged	-	-	-	-
10-Apr-19	decommissioned	decommissioned	>72.56	61.49	74.79	plugged	71.81	58.66	72.45	73.94
18-Jul-19	decommissioned	decommissioned	>72.56	67.20	72.13	plugged	70.75	59.00	72.79	72.09
28-Oct-19	decommissioned	decommissioned	>72.56	>72.665	74.45	plugged	71.52	59.35	71.40	73.21

H:\Project\1005\Analysis\Water_Elevations\2019\Tables-2019.xlsx\Tab A-1 MW94-98

NOTES:

- The locations and elevations of monitoring wells were surveyed by McGill & Associates Engineering Ltd. of Port Alberni. Only data for last ten years shown. Wells not monitored in last ten years not included.
- Italicized values indicate non-static water elevations in slow responding monitoring wells.

TABLE A-2
2000 MONITORING WELL WATER ELEVATION DATA

ELEVATION OF WATER ¹ (m-asl)										
	BH00-1A	BH00-1C	BH00-2A	BH00-2C	BH00-4A	BH00-5A-S	BH00-5A-D	BH00-6A	BH00-7A	BH00-8A
Ground Elevation (m-geod.) ¹	71.65	89.24	75.05	89.90	75.21	75.72	75.72	74.79	70.96	71.66
Top of Casing (m-geod)	72.38	89.90	75.94	89.29	75.96	76.72	76.72	75.64	71.58	72.40
Piezo bottom (m-geod)	51.00	72.27	49.30	75.03	48.71	69.02	62.92	60.49	53.51	59.29
Completion Zone	bedrock	surficial	bedrock	surficial	bedrock	bdrik-frac	bedrock	bedrock	bedrock	bedrock
MEASURED WATER ELEVATIONS (m-geod.)										
27-Jan-09	-	-	69.42	-	52.37	70.65	69.68	69.18	-	71.06
14-Apr-09	-	-	69.52	87.43	51.87	70.85	69.84	69.52	-	71.11
21-Jul-09	-	-	69.59	-	52.83	69.48	69.88	69.45	-	71.10
7-Nov-09	-	-	69.57	87.36	51.89	69.46	69.87	69.06	-	71.04
26-Jan-10	-	-	69.78	87.53	54.03	71.70	70.09	69.58	-	71.17
6-Apr-10	-	-	69.82	87.52	51.65	71.84	70.17	69.74	-	71.20
14-Apr-10	-	-	-	-	-	-	-	-	-	-
20-Jul-10	-	-	69.81	87.41	-	69.46	70.20	69.60	-	71.21
10-Aug-10	-	-	-	-	-	-	-	-	-	-
16-Nov-10	-	-	69.77	87.49	54.61	71.12	70.26	70.05	-	71.18
6-Dec-10	-	-	-	-	-	-	-	-	-	-
8-Feb-11	-	-	69.87	87.57	51.71	71.60	70.43	70.75	-	71.55
9-May-11	-	-	-	-	inaccessible	70.68	70.60	70.96	-	71.57
26-Jul-11	-	-	-	-	inaccessible	69.73	-	70.64	-	71.51
8-Nov-11	-	-	69.89	87.57	inaccessible	73.84	-	70.29	-	71.38
24-Jan-12	-	-	-	87.59	inaccessible	71.06	70.64	70.59	-	71.40
8-May-12	-	-	-	87.61	inaccessible	70.32	70.75	70.89	-	71.43
31-Jul-12	-	-	-	87.52	inaccessible	69.36	70.71	70.49	-	-
25-Oct-12	-	-	-	87.44	inaccessible	70.07	70.68	70.04	-	-
16-Jan-13	-	-	-	87.62	inaccessible	70.50	70.76	70.60	-	-
15-Apr-13	-	-	-	87.59	inaccessible	69.88	70.81	70.78	-	-
10-Jul-13	-	-	-	-	inaccessible	69.36	70.79	70.64	-	-
13-Oct-13	69.26	-	70.04	88.17	inaccessible	69.52	70.81	70.37	-	-
16-Jan-14	69.33	87.40	-	81.27	inaccessible	70.54	70.77	70.55	69.45	71.51
12-May-14	69.52	87.40	70.30	83.43	inaccessible	70.43	70.86	70.81	69.48	71.57
14-Aug-14	69.11	81.16	inaccessible	88.04	inaccessible	69.32	70.66	68.67	65.70	71.26
3-Nov-14	69.11	82.98	inaccessible	87.93	inaccessible	70.49	70.76	69.09	69.20	71.38
15-Jan-15	69.59	-	inaccessible	86.05	inaccessible	69.89	70.70	70.24	69.64	71.51
21-Apr-15	69.57	80.87	inaccessible	86.16	inaccessible	A-2	70.78	70.62	69.64	71.51
15-Jul-15	69.32	-	inaccessible	dry	inaccessible	69.34	70.73	70.27	68.52	71.74
16-Jul-15	-	80.38	inaccessible	-	inaccessible	-	-	-	-	-
22-Oct-15	-	-	inaccessible	-	inaccessible	-	-	-	-	71.74
23-Nov-15	69.31	81.10	inaccessible	86.94	inaccessible	69.60	70.72	70.23	69.45	71.69
20-Jan-16	-	80.55	inaccessible	-	inaccessible	-	-	-	-	-
28-Jan-16	69.63	-	inaccessible	86.97	inaccessible	71.74	70.78	70.65	0.00	72.40
28-Apr-16	69.64	-	inaccessible	80.04	inaccessible	70.83	74.07	68.31	69.35	72.31
11-Jul-16	69.38	80.08	inaccessible	87.14	inaccessible	69.33	70.78	70.44	68.88	71.87
31-Oct-16	69.31	81.18	inaccessible	87.00	inaccessible	70.98	70.77	70.32	70.07	71.61
16-Jan-17	69.60	80.04	inaccessible	87.08	inaccessible	69.72	70.84	70.78	69.56	frozen
6-Apr-17	69.73	80.44	inaccessible	87.13	inaccessible	71.64	70.90	70.94	70.17	71.67
13-Jul-17	69.43	80.34	inaccessible	dry	inaccessible	69.35	70.87	70.58	69.00	71.47
2-Oct-17	69.21	81.92	inaccessible	86.66	inaccessible	69.30	70.81	70.12	68.62	71.24
15-Jan-18	69.56	82.39	inaccessible	86.79	inaccessible	70.75	70.86	73.05	69.90	71.41
18-Apr-18	69.61	80.12	inaccessible	87.31	inaccessible	70.38	70.90	71.87	69.70	71.31
23-Jul-18	69.41	80.28	inaccessible	86.66	inaccessible	69.33	70.84	70.76	68.88	71.21
4-Oct-18	69.29	80.07	inaccessible	dry	inaccessible	69.68	70.81	70.11	69.33	71.19
1-Jan-19	69.80	80.18	inaccessible	86.88	inaccessible	71.22	70.86	70.77	70.12	71.43
9-Apr-19	69.65	80.17	inaccessible	86.65	inaccessible	70.75	70.86	70.55	69.54	71.41
16-Jul-19	69.39	80.72	inaccessible	dry	inaccessible	69.31	70.80	69.82	68.38	71.25
28-Oct-19	69.26	80.21	inaccessible	dry	inaccessible	69.57	70.72	68.92	66.86	71.27

NOTES:

- The locations and elevations of monitoring wells were surveyed by McGill & Associates Engineering Ltd. of Port Alberni. Only data for last ten years shown. Wells not monitored in last ten years not included.
- Italicized values indicate non-static water elevations in slow responding monitoring wells.

H:\Project\1005\Analysis\Water_Elevations\2019\Tables-2019.xlsx\Tab A-2 BH00

TABLE A-3
2002, 2005, 2013, AND 2015 MONITORING WELL WATER ELEVATION DATA

	ELEVATION OF WATER ¹ (m-asl)																		
	MW02-1D	MW02-1S	MW02-2	MW02-3D	MW02-3S	MW02-4	MW05-1D	MW05-1S	PW-1	PW-2	MW13-1D	MW13-1S	MW13-2D	MW13-2S	PW15-1	PW15-2	MW15-1D	MW15-1S	
Ground Elevation (m-geod.) ¹	77.29	77.56	72.63	70.72	70.65	67.15	70.82	70.82	71.52	71.48	73.11	73.00	78.97	78.50	70.69	71.28	70.87	70.87	
Top of Casing (m-geod)	78.34	78.67	73.71	70.72	70.65	68.24	71.51	71.51	72.01	72.06	74.10	73.96	79.87	79.04	71.87	72.00	71.87	71.87	
Piezo bottom (m-geod)	19.07	65.82	61.05	48.85	58.52	28.99	39.40	59.80	44.81	9.90	37.91	47.90	38.77	48.30	24.99	59.68	46.41	64.21	
Completion Zone	bedrock	surfacial	surfacial	bedrock	surfacial	bedrock	bdk frac	surfacial	bdk frac	surfacial	bedrock	bedrock	bedrock	bedrock	bedrock	surfacial	bedrock	surfacial	
	MEASURED WATER ELEVATIONS (m-geod.)																		
27-Jan-09	68.43	69.49	68.97	67.98	68.38	60.99	59.38	67.77	49.05	65.12	-	-	-	-	-	-	-	-	
14-Apr-09	69.38	69.39	69.07	68.79	67.55	61.31	68.97	67.95	68.93	67.81	-	-	-	-	-	-	-	-	
21-Jul-09	68.77	68.78	68.19	66.72	66.75	64.86	59.16	66.60	60.71	66.62	-	-	-	-	-	-	-	-	
7-Nov-09	68.59	68.61	67.48	66.18	66.32	59.84	61.85	66.27	51.11	66.20	-	-	-	-	-	-	-	-	
26-Jan-10	70.04	72.97	69.33	68.59	68.69	62.14	59.71	68.56	52.30	65.05	-	-	-	-	-	-	-	-	
6-Apr-10	69.98	69.97	69.24	67.92	68.54	62.09	61.37	68.09	55.84	65.03	-	-	-	-	-	-	-	-	
14-Apr-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
20-Jul-10	69.10	68.93	68.30	67.09	67.15	63.74	66.84	66.88	55.40	66.72	-	-	-	-	-	-	-	-	
10-Aug-10	68.79	68.79	68.06	67.77	67.64	63.46	66.11	69.55	67.80	69.35	64.97	-	-	-	-	-	-	-	
16-Nov-10	69.96	69.83	69.07	69.32	69.16	66.11	69.55	67.80	69.35	64.97	-	-	-	-	-	-	-	-	
6-Dec-10	69.92	69.91	69.16	69.40	69.27	65.17	-	-	-	-	-	-	-	-	-	-	-	-	
8-Feb-11	69.84	69.79	69.30	69.31	68.97	66.04	69.87	68.13	69.65	65.12	-	-	-	-	-	-	-	-	
9-May-11	69.44	69.45	68.91	69.02	68.60	61.74	70.13	67.88	69.26	67.48	-	-	-	-	-	-	-	-	
26-Jul-11	68.32	68.35	68.27	67.85	67.64	63.68	67.84	67.05	68.40	67.07	-	-	-	-	-	-	-	-	
8-Nov-11	69.44	69.43	vandalized	68.92	68.45	65.33	69.01	67.56	68.97	67.40	-	-	-	-	-	-	-	-	
24-Jan-12	69.84	69.79	damaged	69.49	69.03	61.94	70.00	68.47	69.80	65.56	-	-	-	-	-	-	-	-	
8-May-12	69.44	69.45	damaged	68.87	68.29	61.23	69.54	67.95	69.46	67.70	-	-	-	-	-	-	-	-	
31-Jul-12	68.32	68.35	damaged	67.77	67.64	63.68	67.84	67.05	68.37	67.07	-	-	-	-	-	-	-	-	
25-Oct-12	69.44	69.43	damaged	67.53	67.21	64.21	68.01	66.63	67.97	65.07	-	-	-	-	-	-	-	-	
16-Jan-13	70.24	70.22	damaged	69.32	68.95	47.91	69.64	67.84	69.32	65.87	-	-	-	-	-	-	-	-	
15-Apr-13	69.51	69.50	damaged	69.22	68.75	61.54	69.71	68.56	69.55	68.59	-	-	-	-	-	-	-	-	
10-Jul-13	68.31	68.31	damaged	68.07	67.75	60.22	68.63	67.22	68.45	67.20	-	-	-	-	-	-	-	-	
13-Oct-13	68.67	68.71	damaged	68.80	68.62	61.10	69.12	67.76	69.00	67.22	-	-	-	-	-	-	-	-	
16-Jan-14	69.74	69.74	damaged	69.16	68.87	62.04	69.40	67.91	69.28	67.68	68.34	69.50	70.57	77.54	-	-	-	-	
12-May-14	69.44	69.47	damaged	68.72	68.45	60.92	69.16	68.56	68.68	67.48	68.28	69.40	74.37	74.14	-	-	-	-	
14-Aug-14	69.00	68.96	damaged	65.91	66.53	59.72	55.97	65.92	51.62	65.84	69.74	74.37	74.14	-	-	-	-	-	
9-Nov-14	69.65	69.43	damaged	69.18	70.07	62.21	68.88	68.55	-	-	69.99	69.89	78.85	74.39	-	-	-	-	
15-Jan-15	69.44	69.47	damaged	69.32	69.25	61.92	69.61	68.11	69.45	66.19	61.99	70.66	78.77	63.84	-	-	-	-	
21-Apr-15	69.40	69.40	damaged	68.96	68.82	61.12	68.69	68.59	69.56	68.60	62.20	70.67	78.57	57.97	-	-	-	-	
16-Jul-15	68.47	damaged	damaged	67.90	67.79	59.47	68.08	66.24	-	-	58.56	69.82	56.61	56.61	-	-	-	-	
29-Jul-15	-	damaged	damaged	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
22-Oct-15	-	damaged	damaged	-	-	-	-	-	68.33	65.76	-	-	-	-	-	-	-	-	
20-Nov-15	70.07	damaged	damaged	-	-	61.92	69.53	-	-	-	63.34	71.17	62.27	58.58	-	-	68.92	68.94	
23-Nov-15	-	damaged	damaged	69.00	68.91	-	67.56	-	-	-	-	-	-	-	-	-	-	-	
30-Nov-15	-	damaged	damaged	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
20-Jan-16	70.16	damaged	damaged	69.56	69.41	61.62	70.17	69.21	-	-	55.23	71.39	58.70	55.27	-	-	-	-	
25-Jan-16	-	damaged	damaged	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
28-Jan-16	-	damaged	damaged	-	-	-	-	-	70.41	69.55	-	-	-	-	-	-	-	-	
21-Apr-16	-	damaged	damaged	68.98	68.87	60.76	69.52	68.40	-	-	59.60	70.94	60.67	72.43	-	-	-	-	
25-Apr-16	-	damaged	damaged	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
28-Apr-16	69.64	damaged	damaged	-	-	-	-	-	69.32	68.32	-	-	-	-	69.05	69.39	69.65	68.38	
11-Jul-16	-	damaged	damaged	-	-	-	-	-	-	-	-	-	-	-	68.52	67.84	68.74	68.52	
15-Jul-16	69.04	damaged	damaged	68.23	68.15	61.63	67.86	68.75	68.63	65.36	56.94	70.02	58.89	54.37	-	-	-	-	
31-Oct-16	-	damaged	damaged	-	-	-	-	-	69.98	69.16	-	-	-	-	-	-	69.99	69.34	
2-Nov-16	-	damaged	damaged	69.79	69.69	-	68.69	-	-	-	-	-	-	-	-	-	-	-	
4-Nov-16	70.99	damaged	damaged	-	-	66.14	70.21	-	-	-	59.90	71.42	78.72	60.19	-	-	-	-	
16-Jan-17	-	damaged	damaged	-	-	-	-	-	69.58	68.57	54.03	71.14	78.20	53.35	69.59	68.77	69.67	frozen	
18-Jan-17	-	damaged	damaged	-	-	-	-	69.30	-	-	-	-	-	-	-	-	-	-	
19-Jan-17	70.24	damaged	damaged	69.52	69.37	66.01	70.14	-	-	-	-	-	-	-	-	-	-	-	
6-Apr-17	-	damaged	damaged	-	-	-	-	-	70.19	69.23	63.17	71.29	78.85	62.45	70.21	69.45	70.05	69.89	
12-Apr-17	-	damaged	damaged	-	-	-	-	69.09	-	-	-	-	-	-	-	-	-	-	
13-Apr-17	77.02	damaged	damaged	69.25	69.05	61.48	63.56	-	-	-	-	-	-	-	-	-	-	-	
10-Jul-17	68.64	damaged	damaged	68.47	68.31	59.60	69.00	-	68.85	68.08	68.16	70.60	-	69.19	-	-	-	-	
13-Jul-17	-	damaged	damaged	-	-	-	-	68.04	-	-	-	-	-	-	68.87	68.29	69.00	68.83	
2-Oct-17	-	damaged	damaged	-	-	-	-	-	-	-	-	-	-	-	68.37	67.87	68.49	68.17	
4-Oct-17	68.90	damaged	damaged	67.85	67.72	59.24	68.44	67.64	68.36	67.67	-	-	-	-	-	-	-	-	
5-Oct-17	-	damaged	damaged	-	-	-	-	-	-	-	68.47	69.91	75.83	52.88	-	-	-	-	
15-Jan-18	-	damaged	damaged	-	-	-	-	-	-	-	-	-	-	-	69.85	69.09	70.07	69.79	
18-Jan-18	71.02	damaged	damaged	69.73	69.61	61.67	70.55	69.58	69.89	68.93	70.97	71.18	77.87	77.77	-	-	-	-	
17-Apr-18	70.31	damaged	damaged	69.28	69.29	61.34	69.96	69.82	68.80	68.80	71.10	-	77.71	-	-	-	-	-	
18-Apr-18	-	damaged	damaged	-	-	-	-	-	-	-	-	-	-	-	69.77	69.03	69.96	69.60	
20-Apr-18	-	damaged	damaged	-	-	-	-	68.83	-	-	-	-	-	-	-	-	-	-	
19-Jul-18	-	damaged	damaged	-	-	63.46	-	-	-	-	-	71.04	70.31	not sampled	75.13	-	-	-	
20-Jul-18	69.03	damaged	damaged	68.22	68.11	-	68.73	67.83	68.70	67.92	-	-	-	-	-	-	-	-	
23-Jul-18	-	damaged	damaged	-	-	-	-	-	69.18	68.41	-	-	-	-	-	-	-	-	
4-Oct-18	-	damaged	damaged	-	-	-	-	-	-	-	-	-	-	-	68.70	68.11	68.82	68.62	
17-Oct-18	70.52	damaged	damaged	-	-	60.41	69.23	68.27	-	-	-	-	-	69.18	68.61	69.70	69.53	-	
18-Oct-18	-	damaged	damaged																

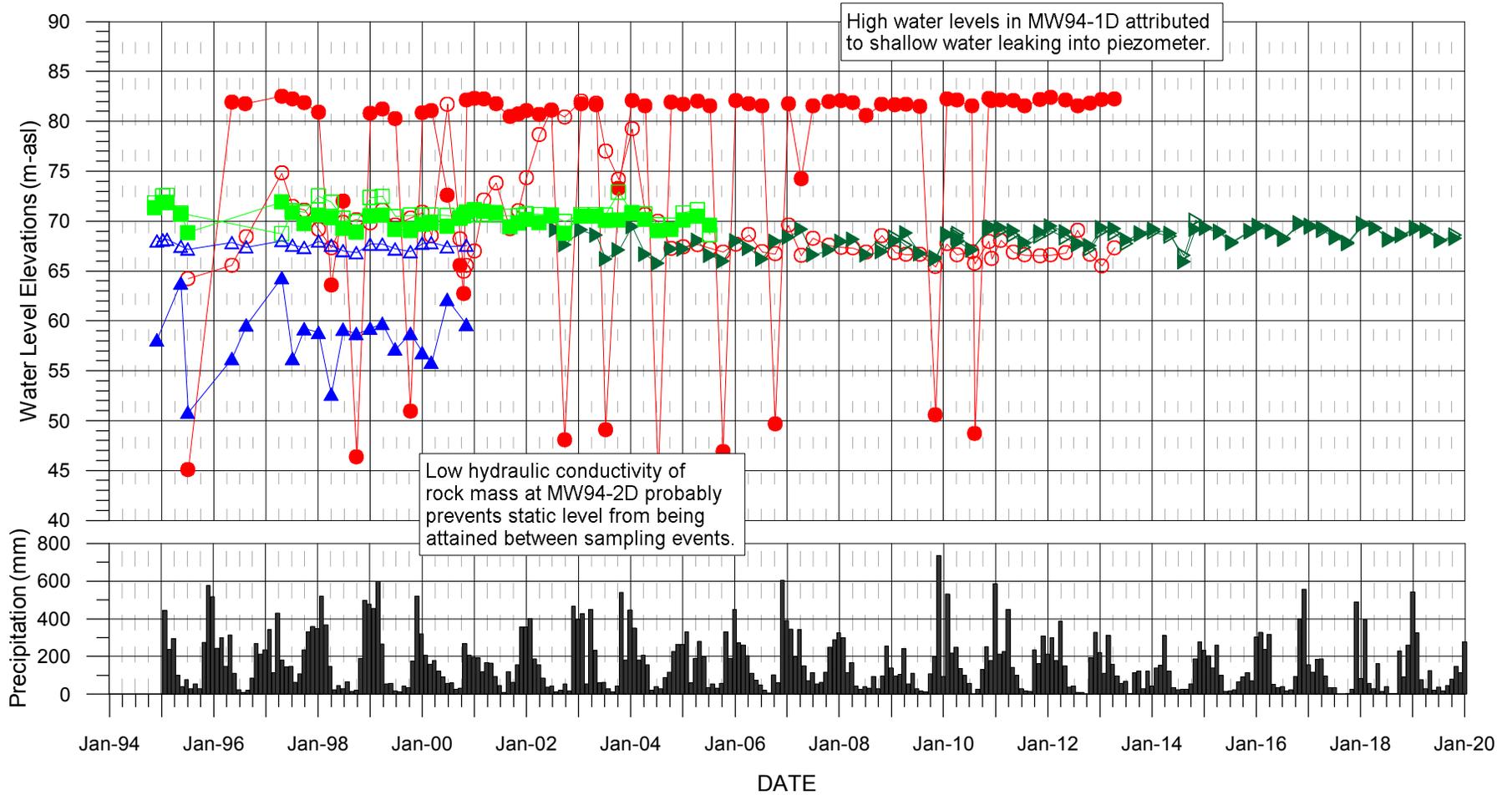
TABLE A-4
2009 SOUTH EXPANSION AREA MONITORING WELL ELEVATION DATA

	MW09-01	MW09-02	MW09-03	MW09-04	MW09-05	MW09-06	MW09-07	MW09-08	MW09-09	MW09-10	MW09-11	MW09-12	MW09-13
Ground Elev.	73.38	73.99	74.61	75.52	71.41	77.50	76.43	77.99	77.38	71.75	77.47	77.16	78.18
Top PVC Elev.	74.29	74.91	75.48	76.24	72.29	78.39	77.31	78.86	78.15	72.81	78.17	77.86	78.86
Stickup	0.91	0.92	0.88	0.72	0.88	0.89	0.88	0.87	0.77	1.05	0.70	0.70	0.69
Depth (m)	1.98	3.66	13.72	5.18	4.11	3.96	4.42	6.4	3.66	2.44	3.25	8.38	11.58
Date	Water Elevation (m-geod)												
10-Nov-09	-	-	-	-	68.74	73.50	74.36	-	-	69.93	75.27	69.59	69.39
24-Nov-09	72.09	73.72	-	74.29	71.21	73.49	73.94	72.00	-	70.69	75.61	73.57	70.71
10-Jan-11	72.09	73.37	72.94	73.92	70.29	73.40	73.31	72.03	73.57	69.47	74.12	69.54	69.16
4-May-11	72.08	73.24	72.53	73.67	69.81	-	72.93	71.97	-	-	74.17	69.51	68.97
20-Jun-11	72.02	72.61	71.40	72.99	69.24	73.39	72.01	71.83	-	-	73.87	68.80	68.75
26-Oct-11	72.08	73.26	72.34	73.66	69.69	73.39	72.91	72.02	-	-	74.16	69.53	68.95
22-Jan-12	72.09	73.41	72.85	73.97	destroyed	73.39	73.21	72.03	<73.6	69.57	74.73	69.55	69.20
16-Jun-12	72.12	73.39	72.96	A-4	destroyed	destroyed	72.72	71.98	<73.6	<69.1	<74.2	69.48	68.96
30-Jul-12	71.51	72.17	71.57	72.33	destroyed	destroyed	71.97	71.82	<73.6	<69.1	<74.2	68.81	68.76
18-Oct-12	72.14	73.64	71.21	73.36	destroyed	destroyed	inaccessible	72.01	<73.6	69.28	<74.2	inaccessible	68.80
16-Jan-13	72.10	73.31	73.01	73.72	destroyed	destroyed	inaccessible	72.01	-	-	<74.2	inaccessible	69.01
15-Apr-13	72.09	73.10	72.82	73.47	destroyed	destroyed	inaccessible	72.01	-	-	<74.2	inaccessible	68.92
10-Jul-13	72.04	72.65	68.91	72.91	destroyed	destroyed	inaccessible	71.82	-	-	<74.2	inaccessible	68.77
13-Oct-13	72.06	73.05	72.42	73.49	destroyed	destroyed	inaccessible	72.00	-	-	<74.2	inaccessible	68.91
16-Jan-14	72.10	73.25	72.82	73.80	destroyed	destroyed	inaccessible	72.02	<73.7	69.29	<74.2	inaccessible	69.07
1-May-14	72.10	73.25	73.01	73.75	destroyed	destroyed	inaccessible	72.01	<73.7	<69.1	<74.2	inaccessible	69.02
1-Aug-14	<72.1	71.37	71.20	71.68	destroyed	destroyed	inaccessible	71.53	<73.7	<69.1	<74.2	inaccessible	68.71
3-Nov-14	72.10	73.45	72.14	73.93	destroyed	destroyed	inaccessible	72.03	<73.7	69.85	<74.2	inaccessible	68.89
16-Jan-15	72.12	73.28	73.04	73.68	inaccessible	inaccessible	inaccessible	71.90	dry	<69.1	dry	inaccessible	68.96
22-Apr-15	72.09	73.09	72.78	73.53	inaccessible	inaccessible	inaccessible	71.98	73.57	69.13	74.14	inaccessible	68.92
15-Jul-15	dry	71.64	71.38	71.92	inaccessible	inaccessible	inaccessible	71.64	dry	<69.1	74.14	inaccessible	68.72
30-Nov-15	72.09	73.11	72.82	73.55	inaccessible	inaccessible	inaccessible	inaccessible	inaccessible	<69.1	inaccessible	inaccessible	68.93
28-Jan-16	72.05	73.58	73.26	74.31	inaccessible	inaccessible	inaccessible	inaccessible	<74.5	69.52	74.13	inaccessible	69.20
28-Apr-16	72.07	72.86	72.40	73.22	inaccessible	inaccessible	inaccessible	71.92	<74.5	<69.1	removed	inaccessible	68.84
11-Jul-16	71.76	72.21	71.52	72.44	inaccessible	inaccessible	inaccessible	removed	<74.5	<69.1	removed	inaccessible	68.73
31-Oct-16	72.12	73.40	73.21	74.00	inaccessible	inaccessible	inaccessible	removed	73.61	69.37	removed	inaccessible	69.15
16-Jan-17	72.09	73.08	72.62	73.50	inaccessible	inaccessible	inaccessible	removed	73.63	<69.1	removed	inaccessible	68.91
6-Apr-17	72.12	73.50	73.34	74.19	inaccessible	inaccessible	inaccessible	removed	73.64	69.56	removed	inaccessible	69.18
13-Jul-17	71.73	72.18	71.54	72.38	inaccessible	inaccessible	inaccessible	removed	73.64	dry	removed	inaccessible	68.75
2-Oct-17	71.40	70.94	70.71	71.29	inaccessible	inaccessible	inaccessible	removed	73.63	69.14	removed	inaccessible	68.68
15-Jan-18	73.09	73.27	73.01	73.93	inaccessible	inaccessible	inaccessible	removed	73.66	69.37	removed	inaccessible	69.14
18-Apr-18	72.12	72.96	72.61	73.30	inaccessible	inaccessible	inaccessible	removed	73.62	dry	removed	inaccessible	68.98
23-Jul-18	71.79	72.30	71.61	72.48	inaccessible	inaccessible	inaccessible	removed	73.63	69.13	removed	inaccessible	68.74
4-Oct-18	72.76	73.24	72.69	73.60	inaccessible	inaccessible	inaccessible	removed	removed	dry	removed	inaccessible	removed
1-Jan-19	72.85	73.35	73.46	74.04	inaccessible	inaccessible	inaccessible	removed	removed	69.71	removed	inaccessible	removed
9-Apr-19	72.70	73.29	72.54	73.84	inaccessible	inaccessible	inaccessible	removed	removed	69.52	removed	inaccessible	removed
16-Jul-19	71.34	71.88	71.26	72.04	inaccessible	inaccessible	inaccessible	removed	removed	dry	removed	inaccessible	removed
28-Oct-19	72.66	73.16	72.89	73.58	inaccessible	inaccessible	inaccessible	removed	removed	dry	removed	inaccessible	removed

H:\Project\1005\Analysis\Water_Elevations\2019\Tables-2019.xlsx]Table A-4 2009

NOTES:

1. The locations and elevations of monitoring wells were surveyed by McGill & Associates Engineering Ltd. of Port Alberni.
2. Italicized values indicate non-static water elevations in slow responding monitoring wells.



- MW94-1D: BEDROCK
- MW94-1S: BEDROCK
- ▲—▲ MW94-2D: SURFICIALS
- △—△ MW94-2S: SURFICIALS
- MW94-3D: BEDROCK
- MW94-3S: SURFICIALS
- ▶—▶ MW02-3D: BEDROCK
- ▷—▷ MW02-3S: SURFICIALS

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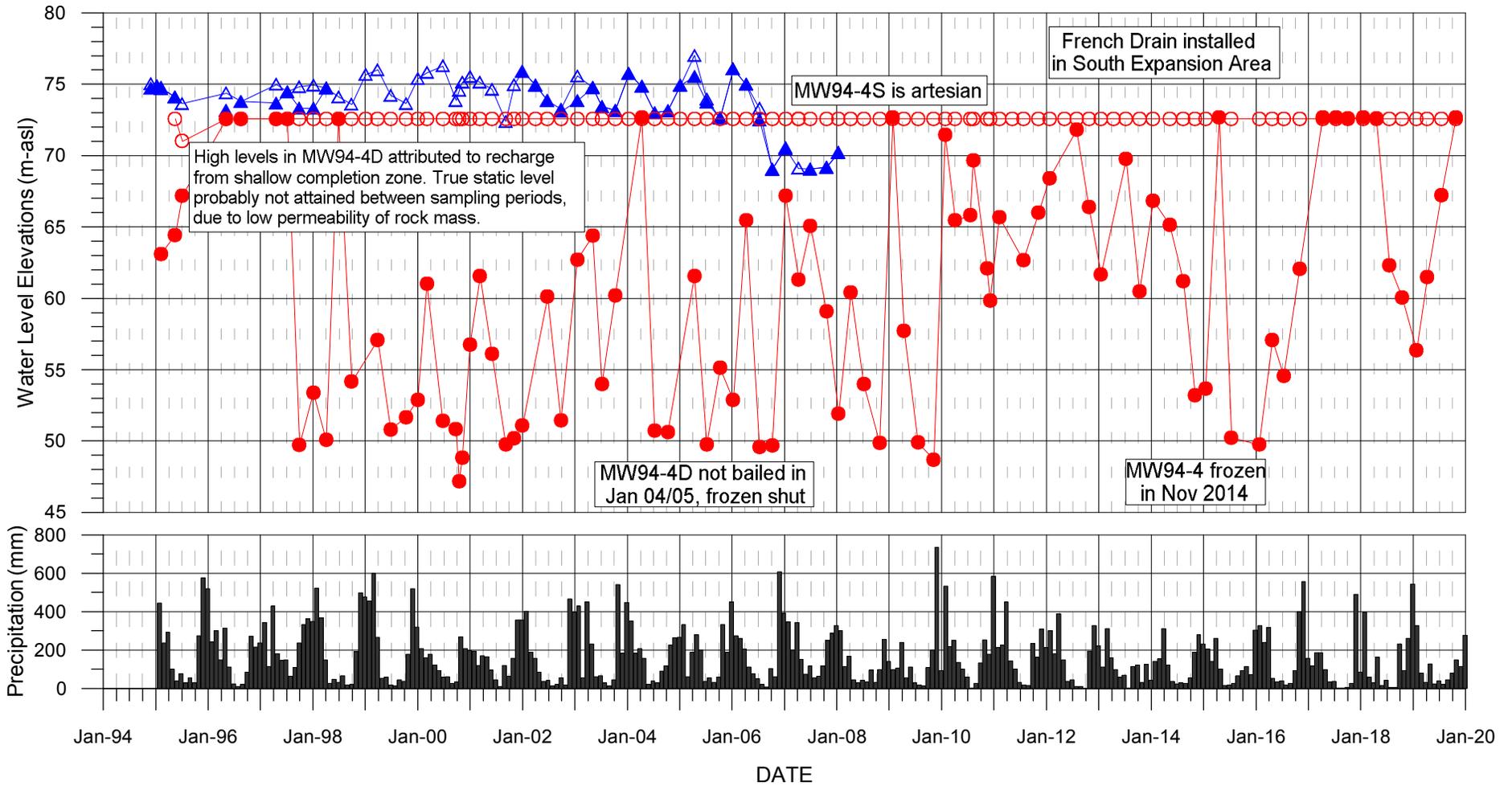
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WATER LEVEL ELEVATIONS FOR EASTERN MONITORING
 WELLS MW94-1, MW94-2, MW94-3 AND MW02-3

BY:	SC	DATE:	FEB 20
APPROVED:	JM	FIG:	A-1



- MW94-4D: BEDROCK
- MW94-4S: BEDROCK/SURFICIALS
- ▲—▲ MW94-7D: BEDROCK
- △—△ MW94-7S: SURFICIALS

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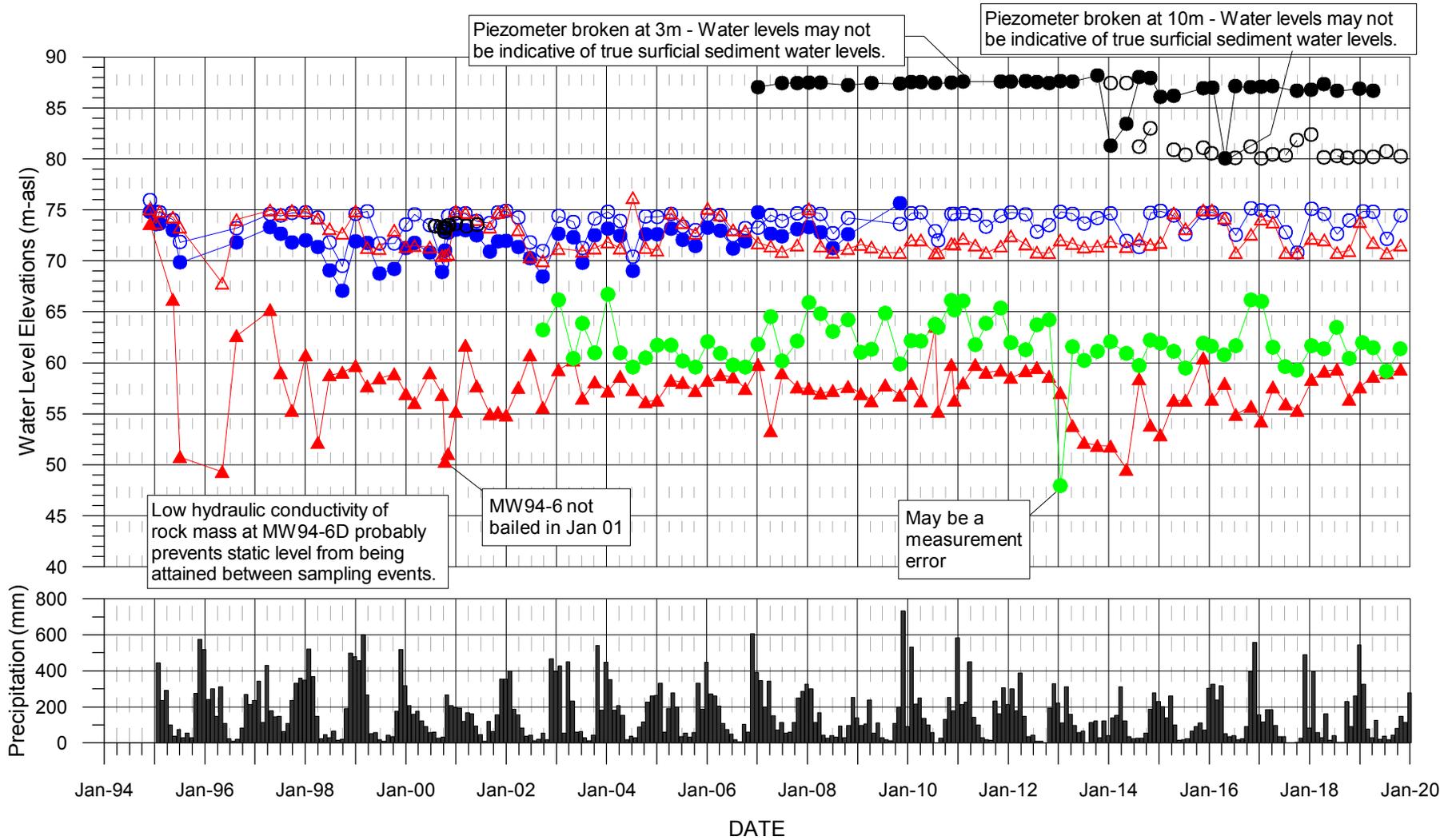


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**WATER LEVEL ELEVATIONS FOR SOUTHERN MONITORING
 WELLS MW94-4 AND MW94-7**

BY:	DATE:
SC	FEB 20
APPROVED:	FIG:
JM	A-2



- MW94-5D: BEDROCK
- MW94-5S: BEDROCK
- ▲ MW94-6D: BEDROCK
- △ MW94-6S: SURFICIAL
- MW02-4: BEDROCK
- BH00-1C: SURFICIAL
- BH00-2C: SURFICIAL

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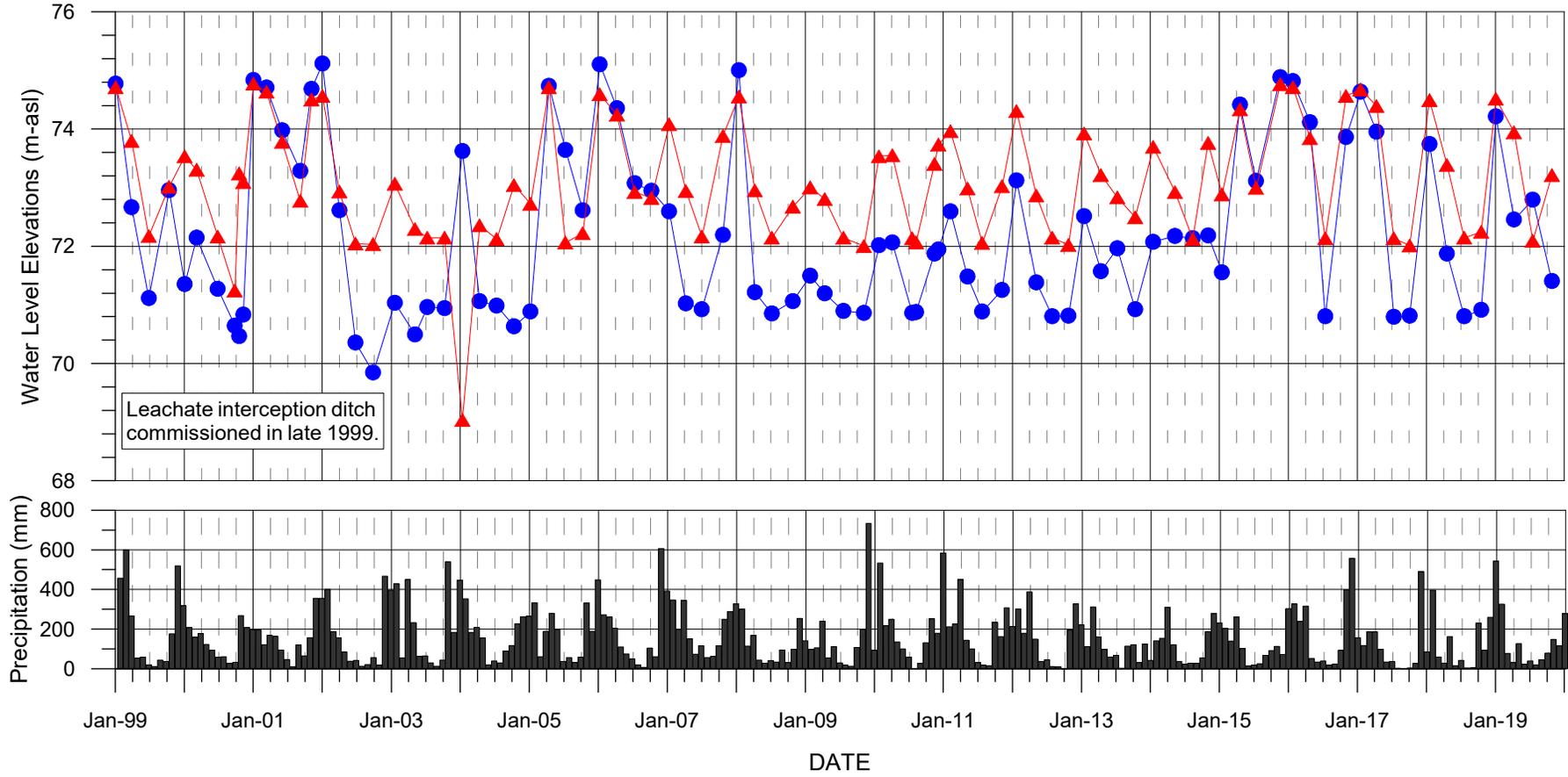
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**WATER LEVEL ELEVATIONS FOR NORTHERN MONITORING
 WELLS MW94-5, MW94-6 AND MW02-4 AND LANDFILL
 MONITORING WELLS BH00-1C AND BH00-2C**

BY:	DATE:
SC	FEB 20
APPROVED:	FIG:
JM	A-3

NOTE: Higher water levels in 2001 relative to 2000 identified a problem with the operation of the pump in the leachate interception trench. Levels in 2002 dropped after the pump malfunction was rectified. Similar problems indicated for brief periods in 2005, 2006, 2008, 2015-2016, 2017 and 2019.



●—● MW98-9 : SURFICIALS
 ▲—▲ MW98-10 : SURFICIALS

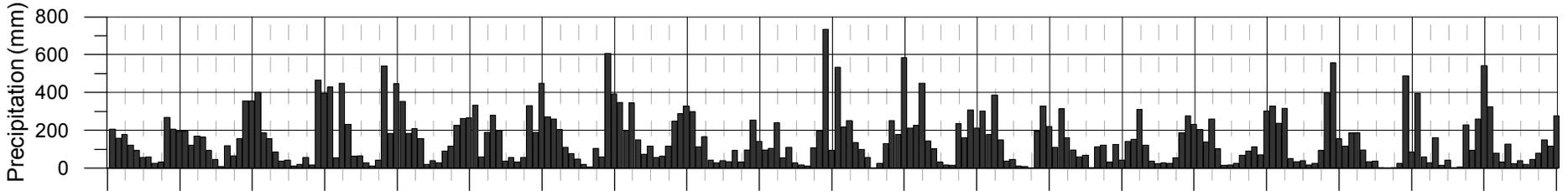
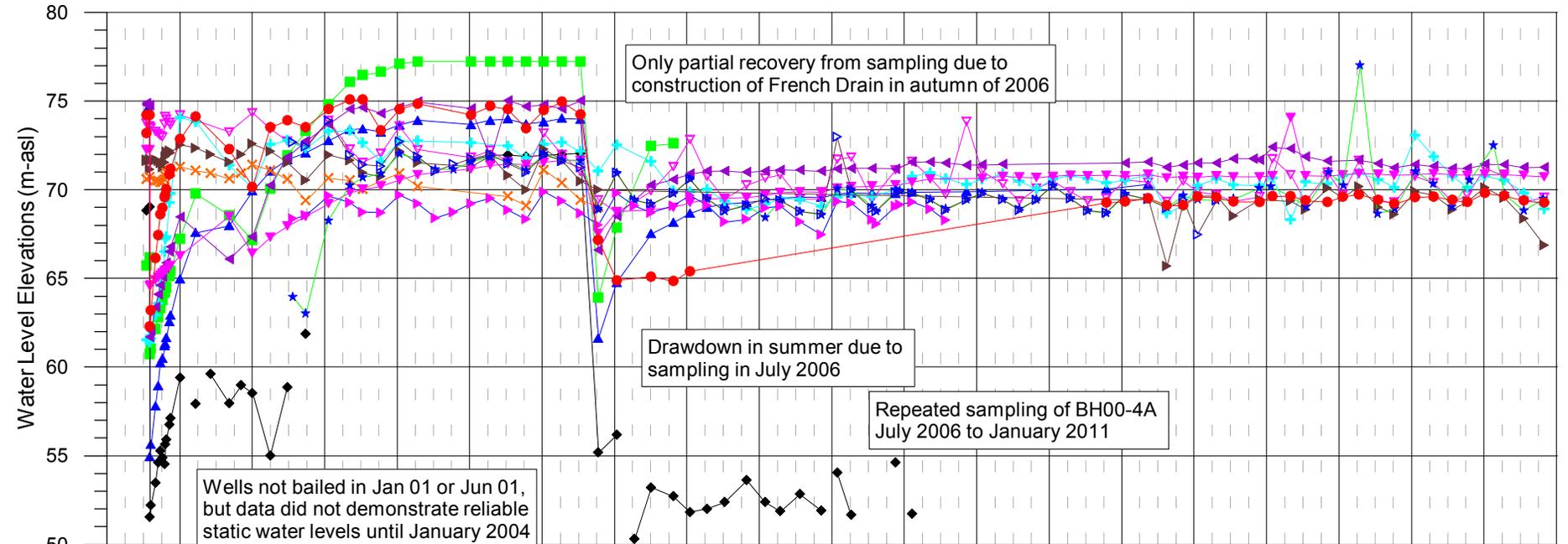
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WATER LEVEL ELEVATIONS FOR NORTHERN MONITORING
 WELLS MW98-9 AND MW98-10

BY:	DATE:
SC	FEB 20
APPROVED:	FIG:
JM	A-4



Jan-00 Jan-01 Jan-02 Jan-03 Jan-04 Jan-05 Jan-06 Jan-07 Jan-08 Jan-09 Jan-10 Jan-11 Jan-12 Jan-13 Jan-14 Jan-15 Jan-16 Jan-17 Jan-18 Jan-19 Jan-20

DATE

- BH00-1A
- ▲ BH00-2A
- BH00-3A
- ◆ BH00-4A
- ▼ BH00-5As
- ▽ BH00-5Ad
- ◆ BH00-6A
- ▶ BH00-7A
- ◀ BH00-8A
- × BH00-5B
- ★ MV02-1D
- ▶ MV02-1S
- ◀ MV02-2

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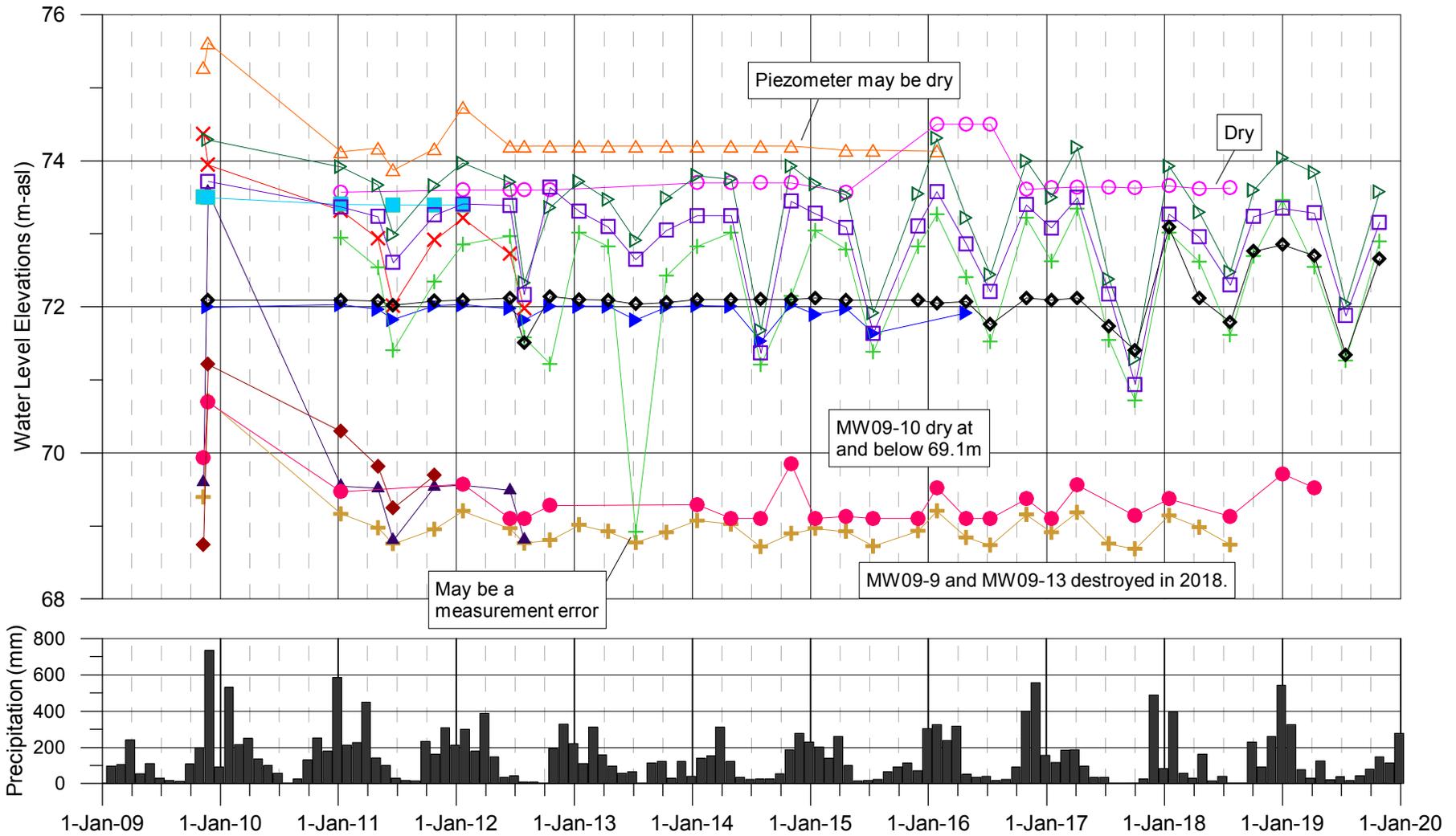
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**WATER LEVEL ELEVATIONS FOR EXPANSION
 AREA MONITORING WELLS**

BY:	SC	DATE:	FEB 20
APPROVED:	JM	FIG:	A-5



- ◆ MW09-01 ▶ MW09-08
- ◻ MW09-02 ○ MW09-09
- + MW09-03 ● MW09-10
- ▵ MW09-04 ▲ MW09-11
- ◆ MW09-05 ▼ MW09-12
- ◻ MW09-06 + MW09-13
- × MW09-07

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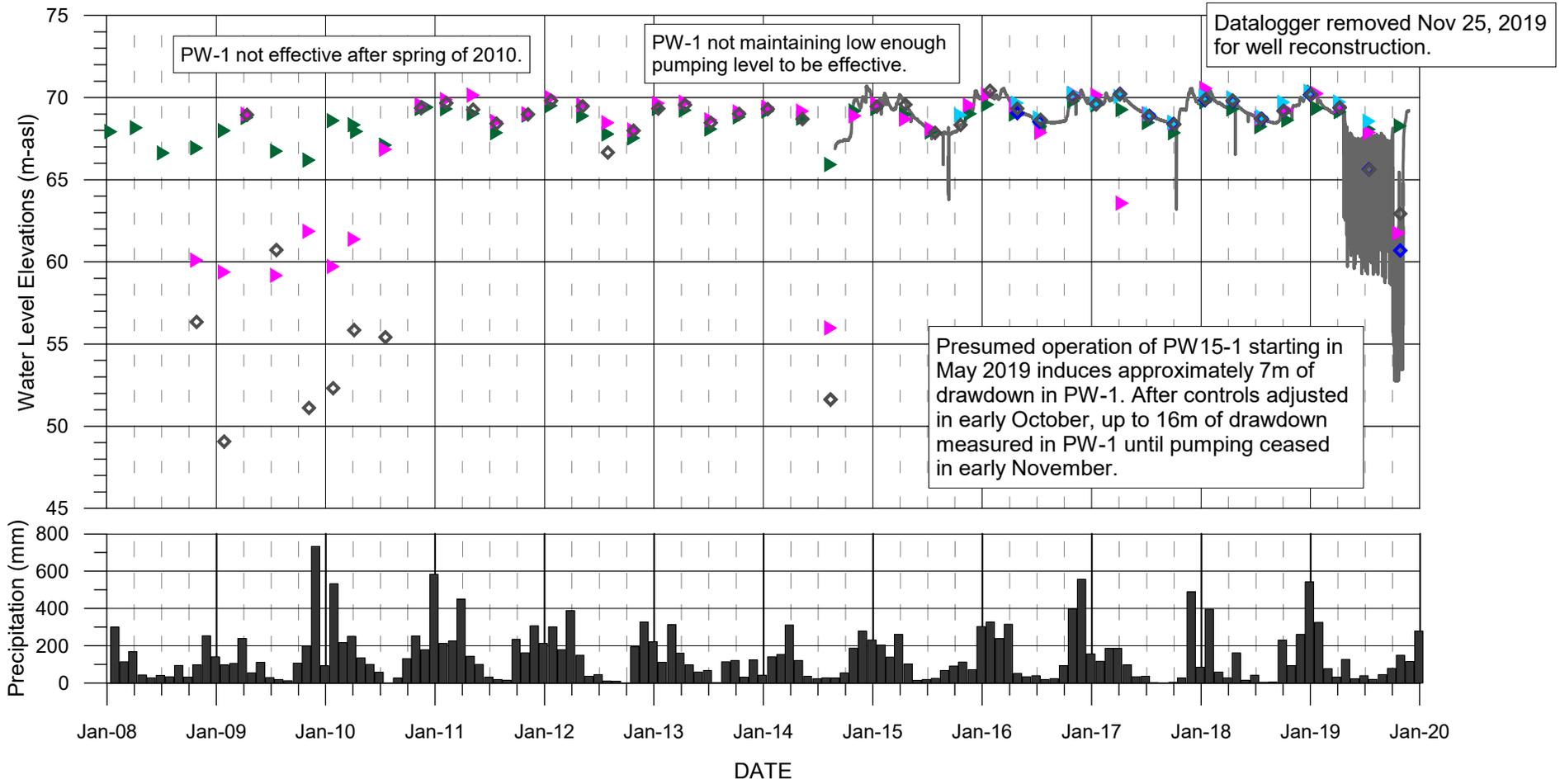
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**WATER LEVEL ELEVATIONS FOR 2009 OVERBURDEN
 MONITORING WELLS IN SOUTH EXPANSION AREA**

BY:	DATE:
SC	FEB 20
APPROVED:	FIG:
JM	A-6



- ◆ PW-15-1: BEDROCK
- ▼ MW02-3D: BEDROCK
- ▲ MW05-1D: BEDROCK
- ▲ MW15-1D: BEDROCK
- ◇ PW-1: BEDROCK
- PW-1 DATA LOGGER

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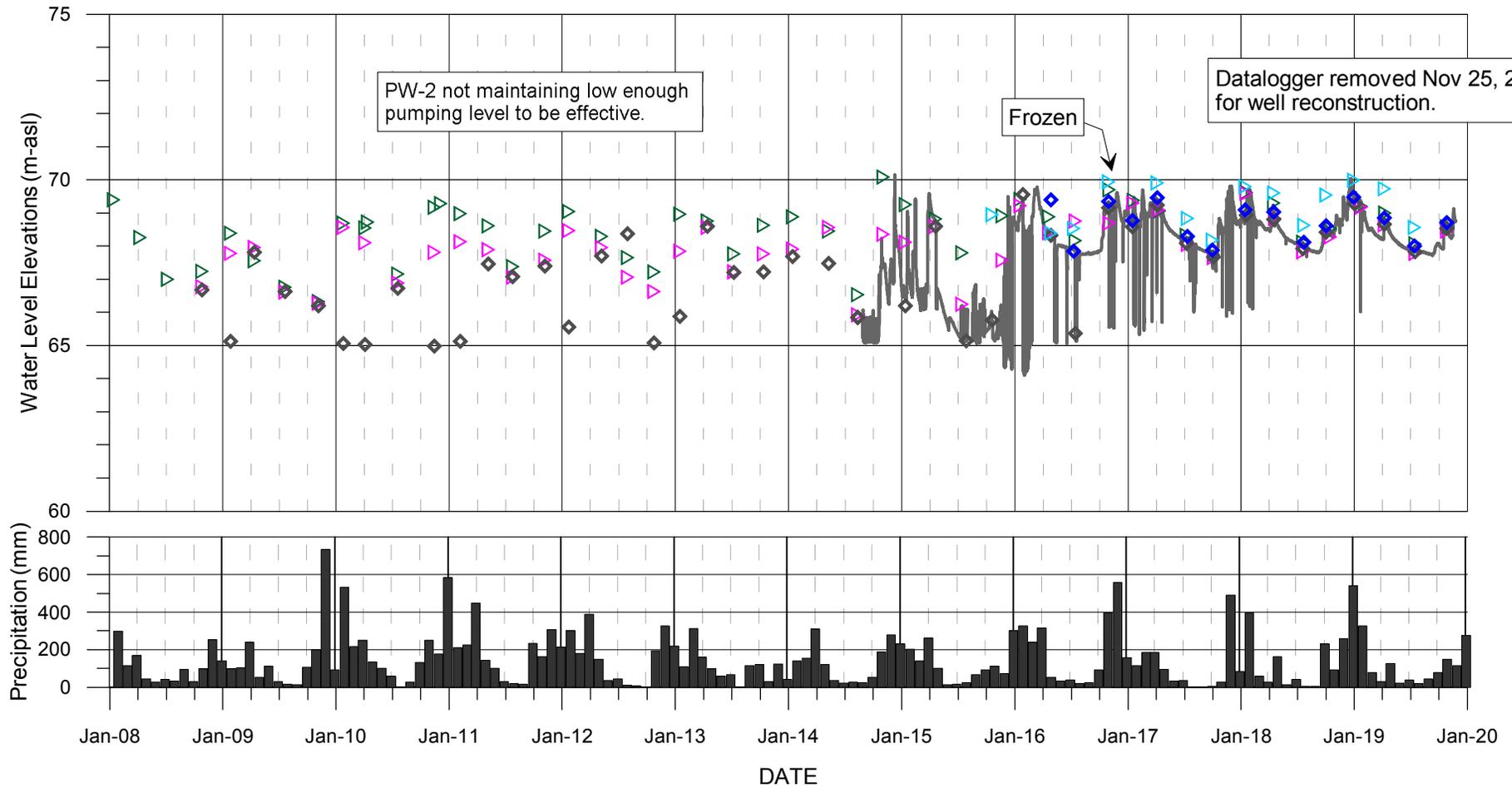
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**WATER LEVEL ELEVATIONS FOR BEDROCK
 LEACHATE INTERCEPTION WELL MONITORING
 PW-1, PW15-1, MW02-3D, MW05-1D, MW15-1D**

BY:	DATE:
SC	FEB 20
APPROVED:	FIG:
JM	A-7



- ◆ PW15-2 : SURFICIALS
- ▼ MW02-3S: SURFICIALS
- ▼ MW05-1S: SURFICIALS
- ▼ MW15-1S : SURFICIALS
- ◆ PW-2 : SURFICIALS
- PW-2 DATA LOGGER

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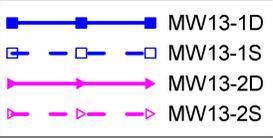
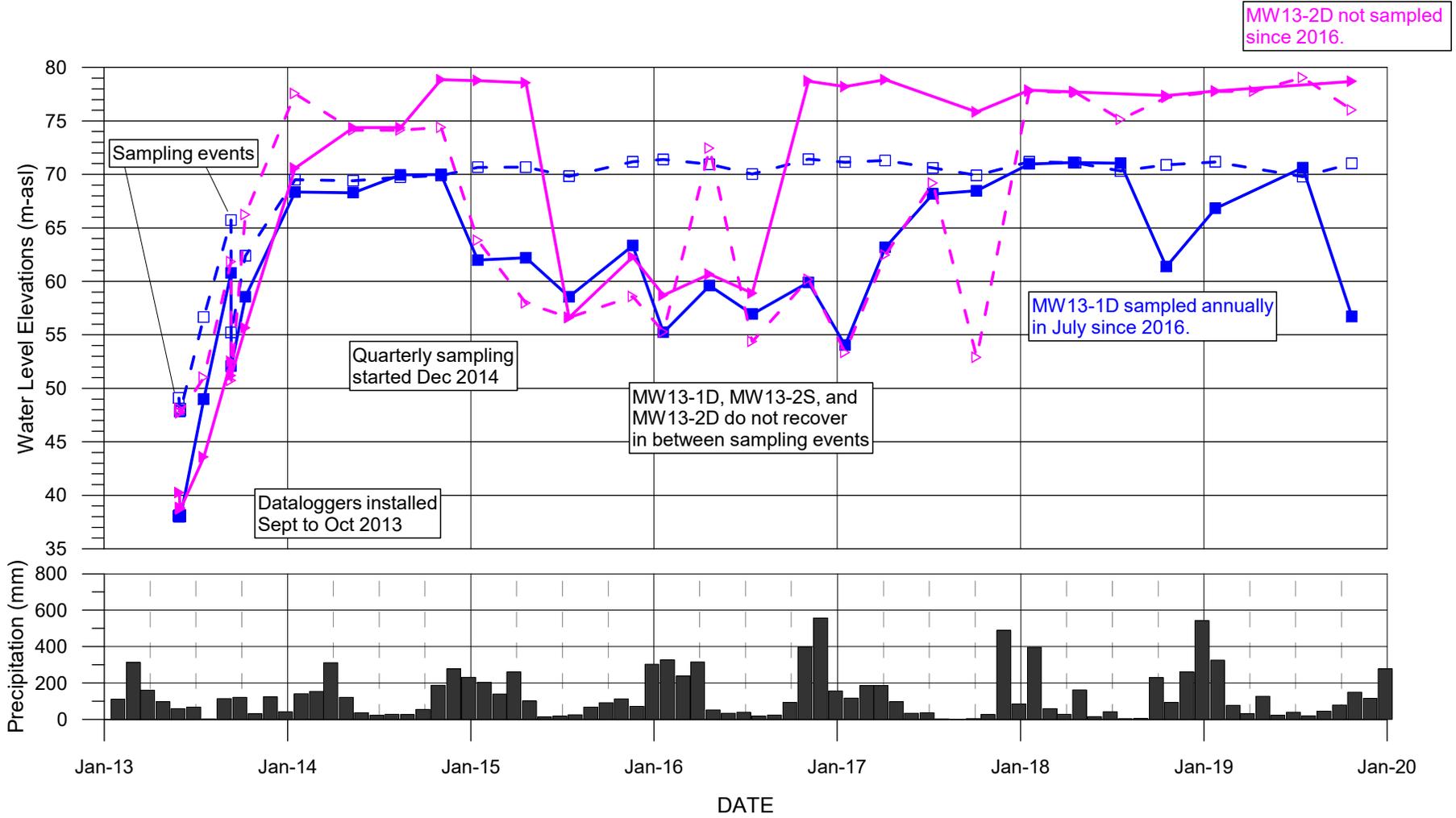
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WATER LEVEL ELEVATIONS FOR SURFICIAL
 SEDIMENT INTERCEPTION WELL MONITORING
 PW-2, PW15-2, MW02-3S, MW05-1S, MW15-1S

BY:	SC	DATE:	FEB 20
APPROVED:	JM	FIG:	A-8



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**WATER LEVEL ELEVATIONS FOR NORTHEASTERN
 BEDROCK MONITORING WELLS MW13-1 AND MW13-2**

BY:	SC	DATE:	FEB 20
APPROVED:	JM	FIG:	A-9

APPENDIX B
CHEMISTRY MONITORING DATA TABLES AND PLOTS

APPENDIX B - LIST OF TABLES

Table B-1	Summary of Inorganic Chemistry Data for Leachate Drain – 2016 to 2019
Table B-2	Summary of Inorganic Chemistry Data for BH00-1C – 2000, 2001 and 2015
Table B-3	Summary of Leachate Volatile Organic Analyses – 2010 to 2019
Table B-4	Summary of Leachate Phenol and Acid Extractable Analyses – 2010 to 2019
Table B-5	Summary of Inorganic Chemistry Data for South Expansion Area Leachate Drain – 2016 to 2019
Table B-6	Summary of Inorganic Chemistry Data for MW94-1S – 2011 to 2013
Table B-7	Summary of Inorganic Chemistry Data for MW94-1D – 2009 to 2010
Table B-8	Summary of Inorganic Chemistry Data for MW02-3S – 2016 to 2019
Table B-9	Summary of Inorganic Chemistry Data for MW02-3D – 2016 to 2019
Table B-10	Summary of Inorganic Chemistry Data for MW94-4S – 2016 to 2019
Table B-11	Summary of Inorganic Chemistry Data for MW94-4D – 2016 to 2019
Table B-12	Summary of Inorganic Chemistry Data for MW94-5S – 2016 to 2019
Table B-13	Summary of Inorganic Chemistry Data for MW94-6S – 2016 to 2019
Table B-14	Summary of Inorganic Chemistry Data for MW94-6D – 2016 to 2019
Table B-15	Summary of Inorganic Chemistry Data for MW98-9 – 2016 to 2019
Table B-16	Summary of Inorganic Chemistry Data for MW98-10 – 2016 to 2019
Table B-17	Summary of Inorganic Chemistry Data for BH00-4A – 2009 to 2011
Table B-18	Summary of Inorganic Chemistry Data for MW02-1S – 2013 to 2015
Table B-19	Summary of Inorganic Chemistry Data for MW02-1D – 2016 to 2019
Table B-20	Summary of Inorganic Chemistry Data for MW02-2 – 2009 to 2011
Table B-21	Summary of Inorganic Chemistry Data for MW02-4 – 2016 to 2019
Table B-22	Summary of Inorganic Chemistry Data for MW05-1 – 2016 to 2019
Table B-23	Summary of Inorganic Chemistry Data for PW-1 and PW-2 – 2016 to 2019
Table B-24	Summary of Inorganic Chemistry Data for MW13-1D – 2015 to 2019
Table B-25	Summary of Inorganic Chemistry Data for MW13-2D – 2013 to 2016

APPENDIX B - LIST OF TABLES Continued

Table B-26	Summary of Inorganic Chemistry Data for MW13-1S and MW13-2S – 2016 to 2019
Table B-27	Summary of Inorganic Chemistry Data for Heath Creek – 2016 to 2019
Table B-28	Summary of Inorganic Chemistry Data for Stevens Creek – 2016 to 2019 and SCKA and SCK B - 2015 to 2016
Table B-29	Summary of Inorganic Chemistry Data for Christie Creek – 2016 to 2019

APPENDIX B - LIST OF FIGURES

- Figure B-1 Chloride Concentration Time-Series Plot for Leachate
- Figure B-2 Ammonia Concentration Time-Series Plot for Leachate
- Figure B-3 COD Concentration Time-Series Plot for Leachate
- Figure B-4 Chloride Concentration Time-Series Plot for Southeast Wells MW94-1, MW94-2, MW94-3, MW02-3, MW05-1, PW-1, and PW-2
- Figure B-5 Nitrogen or Ammonia Concentration Time-Series Plot for Southeast Wells MW94-1, MW94-2, MW94-3, MW02-3, MW05-1, PW-1, and PW-2
- Figure B-6 Chloride Concentration Time-Series Plot for South and West Wells MW94-4, MW94-7, MW02-1S and MW02-2
- Figure B-7 Nitrogen Concentration Time-Series Plot for South and West Wells MW94-4, MW94-7, MW02-1S and MW02-2
- Figure B-8 Chloride Concentration Time-Series Plot for North Wells MW94-5, MW94-6, MW98-9 and MW98-10 and Background Wells BH00-4A and MW02-4
- Figure B-9 Nitrogen Concentration Time-Series Plot for North Wells MW94-5, MW94-6, MW98-9 and MW98-10 and Background Wells BH00-4A and MW02-4
- Figure B-10 Chloride Concentration Time-Series Plot for MW13-1S, MW13-1D, MW13-2S, and MW13-2D
- Figure B-11 Nitrogen Concentration Time-Series Plot for MW13-1S, MW13-1D, MW13-2S, and MW13-2D
- Figure B-12 Chloride Concentration Time-Series Plot for Creek Sampling Sites
- Figure B-13 Nitrogen Concentration Time-Series Plot for Creek Sampling Sites
- Figure B-14 Electrical Conductance Time-Series Plot for Creek Sampling Sites

TABLE B-1
SUMMARY OF INORGANIC CHEMISTRY DATA FOR LEACHATE DRAIN
2016 to 2019

SAMPLE DATE	units	RECEIVING WATER CRITERIA		27-Jan-16	10-May-16	26-Jul-16	08-Nov-16	24-Jan-17	21-Apr-17	20-Jul-17	12-Oct-17	30-Jan-18	25-Apr-18	30-Jul-18	31-Oct-18	30-Jan-19	17-Apr-19	25-Jul-19	31-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS																			
pH - Field	pH	7.0 - 10.5	6.5 - 9.0	-	7.03	5.97	7.02	7.21	6.99	7.51	7.24	6.73	6.33		6.95	6.63	7.27		7.23
pH - Lab	pH	7.0 - 10.5	6.5 - 9.0	7.21	7.05	7.31	6.96	7.14	7.11	7.72	7.83	7.33	7.1		7.61	7.6	7.68		7.87
EC - Field	µS/cm	-	-	-	1841	1848	1861	1879	1914	1690	1528	1618	1585	dry	731	767	684	dry	585
EC - Lab	µS/cm	-	-	218	2250	2220	2390	2550	2300	2020	2040	2100	1980		1050	1110	902		896
Total Hardness (CaCO ₃)	mg/L	-	-	80	542	531	631	612	598	511	497	493	471		305	320	288		275
Total Dissolved Solids	mg/L	500	-	160	942	1080	1180	1150	1010	858	870	888	805		545	540	440		490
Temperature - Field	°C	-	-	-	15.84	17.11	14.27	11.95	13.58	15.3	12.89	12.15	14.8		11.82	9.34	13.94		8.22
DISSOLVED ANIONS																			
Alkalinity	mg/L CaCO ₃	-	-	-	1080	1020	1030	1180	1143	948	985	993	930		403	480	363		353
Chloride	mg/L	250	150	9.67	108	106	130	136	124	99.4	102	105	83.8		73.1	65.6	61.9		72.7
Sulphate	mg/L	500	429	-	0.8	0.7	12.1	1.1	1.2	0.8	1.3	3.6	1		6.1	2	4.7		4.8
CATIONS																			
Calcium	mg/L	-	-	25.1	161	159	183	178	173	152	148	141	139		93	100	89.1		84.9
Magnesium	mg/L	-	-	4.15	34.1	32.5	42.2	40.6	40.2	32	30.9	34.1	30.2		17.6	17	16		15.3
Potassium	mg/L	-	-	3.1	60.6	56.3	70.9	69.8	66.6	53.6	51.4	52.2	48.7		19.6	23.1	16.6		10.9
Sodium	mg/L	200	-	9	117	110	145	145	133	105	101	112	93.3		53	60.1	56.1		56.1
TOTAL METALS																			
Arsenic	mg/L	0.010	0.005	0.0007	0.0008	0.0009	0.0026	0.0018	0.0016	0.0006	0.0008	0.0025	0.001		0.0013	0.0021	0.0015		0.0024
Barium	mg/L	1.0	1.0	0.029	0.204	0.245	0.258	0.302	0.262	0.245	0.208	0.335	0.214		0.105	0.0971	0.0787		0.0763
Boron	mg/L	5.0	1.2	0.103	1.73	1.74	1.76	1.9	1.92	1.69	1.73	1.46	1.55		0.419	0.539	0.352		0.315
Cadmium	mg/L	0.005	0.00059	0.00007	<0.00001	0.00001	0.00011	0.00005	<0.00001	<0.00001	0.00002	<0.00001	<0.00001		0.00005	0.00002	0.00004		0.00002
Chromium	mg/L	0.05	0.001	0.0032	0.0015	0.0014	0.0103	0.004	0.0025	0.0016	0.0013	0.0039	0.0016		0.0027	0.0035	0.0023		0.0013
Cobalt	mg/L	-	0.05	0.0019	0.00143	0.00129	0.00532	0.00246	0.00167	0.00133	0.00121	0.00293	0.00112		0.00309	0.00479	0.00345		0.00402
Copper	mg/L	1	0.016	0.0144	0.0006	0.0006	0.0041	0.002	<0.0005	0.0007	0.0009	0.0039	0.0005		0.0052	0.002	0.004		0.0069
Iron	mg/L	0.3	1	5.1	27.5	25.6	42.2	40.2	38.3	37.8	25.9	61.1	35.8		6.68	17.3	7.36		6.01
Lead	mg/L	0.005	0.022	0.00018	<0.00005	<0.00005	0.00198	0.0001	0.00007	<0.00005	0.00006	0.00021	<0.00005		0.00017	0.00005	0.0002		0.00013
Manganese	mg/L	0.02	2.37	0.968	2.3	2.21	6.63	4.26	3.47	2.22	2.12	3.29	2.49		5.55	6.44	5.68		7.79
Mercury	µg/L	1	0.02	0.01	<0.01	0.02	0.02	<0.01	<0.01	0.01	<0.01	0.02	<0.01		-	-	0.02		0.03
Vanadium	µg/L	-	-	0.005	0.002	0.002	0.01	0.005	0.004	0.003	0.002	0.009	0.003		0.002	0.002	0.002		0.002
Zinc	mg/L	5	0.24	0.023	<0.005	<0.005	0.201	0.01	<0.005	0.007	<0.005	0.011	<0.005		0.02	0.015	0.009		0.013
NUTRIENTS																			
Nitrate	mg/L as N	10	3	0.095	<0.005	0.1	<0.005	0.08	0.11	<0.005	0.06	0.27	0.29		1.01	0.06	1.27		0.698
Ammonia Nitrogen	mg/L as N	-	1.8	1.68	102	106	116	122	107	100	97.7	79.1	89.3		23.5	31.9	15.6		13.8
Total Phosphorus	mg/L as P	-	-	0.07	0.065	0.035	0.503	0.246	0.119	0.057	0.04	0.31	0.082		0.088	0.104	0.057		0.035
POLLUTANT TESTS																			
Chemical Oxygen Demand	mg/L as O	-	-	143	118	108	614	200	150	111	95	131	98		219	141	99		79
Total Organic Carbon	mg/L as O	-	-	41	33.3	30.1	193	73	46	31.6	30.4	47	34.8		69.2	53	36.7		22.4

H:\Project1005\Analysis\Chemistry\2019\Tables_B-1 to B-9.xlsx\Table B-1 LeachateDrain

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 400 mg/L.

TABLE B-2
SUMMARY OF INORGANIC CHEMISTRY DATA FOR BH00-1C
2000, 2001 and 2015

SAMPLE DATE LAB NAME	units	RECEIVING WATER CRITERIA		03-Aug-00	08-Jan-01	30-Mar-01	18-Jun-01	29-Jan-15	08-May-15	03-Dec-15
		GCDWQ ¹	AQUATIC LIFE ²	CANTEST	CANTEST	CANTEST	CANTEST	AGAT	AGAT	AGAT
PHYSICAL TESTS										
pH - Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	-	6.45	7.03	7.39	-
pH - Lab	pH	7.0 - 10.5	6.5 - 9.0	7	6.65	6.6	6.66	6.46	6.94	7.78
EC - Field	µS/cm	-	-	-	-	-	1797	626	614	-
EC - Lab	µS/cm	-	-	2920	2590	2500	2460	681	643	803
Total Hardness (CaCO ₃)	mg/L	-	-	-	-	-	-	218	228	297
Total Dissolved Solids	mg/L	500	-	-	984	987	1060	383	408	510
Temperature - Field	°C	-	-	-	-	-	18.1	12.77	16.45	-
DISSOLVED ANIONS										
Alkalinity	mg/L CaCO ₃	-	-	-	-	-	-	-	-	-
Chloride	mg/L	250	150	221	131	125	154	27.2	23.9	37
Sulphate	mg/L	500	429	65	32.2	33.2	29.6	-	-	-
METALS										
Arsenic	mg/L	0.010	0.005	<u>Dissolved</u> 0.004	<u>Dissolved</u> 0.004	<u>Dissolved</u> 0.006	<u>Dissolved</u> 0.002	<u>Total</u> 0.0059	<u>Total</u> 0.0025	<u>Total</u> 0.0027
Boron	mg/L	5	1.2	<0.0002	<0.0002	<0.0002	<0.0002	0.933	0.825	1.08
Cadmium	mg/L	0.005	0.00042	<0.0002	<0.0002	<0.0002	<0.0002	0.00039	0.00011	<0.00001
Chromium	mg/L	0.05	0.001	<0.01	0.001	<0.001	0.002	0.0219	0.0076	0.0079
Copper	mg/L	1	0.010	<0.01	<0.001	0.001	<0.001	0.0322	0.0122	0.0159
Iron	mg/L	0.3	1	0.12	17.3	0.83	5.02	258	63.6	69
Lead	mg/L	0.005	0.014	<0.01	<0.001	<0.001	<0.001	0.0241	0.00622	0.00882
Manganese	mg/L	0.02	1.71	6.71	5.52	4.28	4.77	4.43	1.27	1.26
Mercury	µg/L	1	0.02	<0.05	<0.02	<0.02	<0.02	0.02	0.02	0.04
Zinc	mg/L	5	0.13	<0.005	<0.005	0.005	<0.005	0.086	0.03	0.045
NUTRIENTS										
Nitrate	mg/L as N	10	3	<0.005	<0.1	<0.25	<0.25	18.6	26.3	30.3
Ammonia Nitrogen	mg/L as N	-	1.8	123	143	0.22	0.2	11	0.03	0.03
Total Phosphorus	mg/L as P	-	-	4.26	-	-	-	2.26	0.572	-
POLLUTANT TESTS										
Chemical Oxygen Demand	mg/L as O	-	-	3860	323	508	433	240	70	129
Total Organic Carbon	mg/L as O	-	-	143	-	-	-	13.2	38.4	18.3

NOTES:

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-1 to B-9.xlsx]Table B-2 BH00-1C

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 250 mg/L.

PITEAU ASSOCIATES

Geotechnical and Water Management Consultants

TABLE B-5
SUMMARY OF INORGANIC CHEMISTRY DATA FOR SOUTH EXPANSION AREA LEACHATE DRAIN
2016 to 2019

SAMPLE DATE LAB NAME	units	RECEIVING WATER CRITERIA		27-Jan-16	10-May-16	27-Jul-16	09-Nov-16	23-Jan-17	20-Apr-17	19-Jul-17	11-Oct-17	30-Jan-18	25-Apr-18	30-Jul-18	31-Oct-18	30-Jan-19	17-Apr-19	24-Jul-19	31-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	N/A	AGAT	AGAT	N/A	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	Not	6.93	6.04	Not	7.28	7.4	7.26	6.43	7.89	6.7	6.96	7.42	7.13	7.55	-	7.12
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	Sampled	6.93	7.04	Sampled	6.95	7.57	7.43	7.57	6.97	7.01	6.88	7.05	7.1	7.03	7.42	7.11
EC-Field	µS/cm	-	-	(Flooded)	346	481	(Flooded)	197	222	415	519	68	251	443	262	233	223	-	234
EC-Lab	µS/cm	-	-		487	639		317	318	554	666	128	363	544	360	359	333	535	328
Total Hardness (CaCO ₃)	mg/L	-	-		214	268		125	131	192	292	45	151	243	138	147	145	229	122
Total Dissolved Solids	mg/L	500	-		278	345		198	155	288	388	65	190	298	200	198	190	292	175
Temperature-Field	°C	-	-		10.93	14.12		7.03	9.42	13.96	14	5.83	10.73	15.49	13.27	8.23	9.63	-	11.88
DISSOLVED ANIONS																			
Alkalinity	mg/L CaCO ₃	-	-		222	281		139	143	255	309	48	164	238	154	158	144	245	145
Chloride	mg/L	250	150		12.1	20.1		7.01	6.16	15.7	25.7	2.32	8.38	15.7	8.87	6.81	8.33	16.7	9.02
Sulphate	mg/L	500	429		16.9	18		11.7	13.6	12.9	15.7	9.3	12.1	15.3	8.5	16.7	9.1	13	6.7
CATIONS																			
Calcium	mg/L	-	-		70	87.3		40.8	42.5	62.5	93.3	14.3	49.3	78.7	44.8	48.2	47.5	74.5	39.6
Magnesium	mg/L	-	-		9.4	12.1		5.52	6.08	8.79	14.4	2.28	6.83	11.4	6.33	6.39	6.48	10.5	5.51
Potassium	mg/L	-	-		4.1	5.1		2.9	3.49	4	6.1	1.7	3.7	5.3	3.9	3.7	3.2	4.8	3.2
Sodium	mg/L	200	-		13.8	18.6		8.2	8.95	13.4	21	3.3	10.3	16.2	10.9	9.2	9.3	15.5	10
TOTAL METALS																			
Arsenic	mg/L	0.010	0.005		<0.0001	0.0002		<0.0001	0.0001	0.0002	0.0002	0.0002	0.0001	<0.0001	0.0001	0.0002	0.0002	0.0003	0.0001
Barium	mg/L	1	1		0.0359	0.0425		0.0209	0.0219	0.0376	0.0527	0.0077	0.0265	0.0407	0.0233	0.0243	0.0222	0.0352	0.0173
Boron	mg/L	5	1.2		0.246	0.338		0.159	0.164	0.257	0.37	0.077	0.152	0.261	0.191	0.181	0.148	0.242	0.149
Cadmium	mg/L	0.005	0.00035		0.00008	0.00008		0.00005	0.00004	0.00006	0.00008	0.00001	0.00005	0.00007	0.00005	0.00004	0.00004	0.00005	0.00004
Chromium	mg/L	0.05	0.001		<0.0005	<0.0005		<0.0005	<0.0005	<0.0005	<0.0005	0.0008	<0.0005	<0.0005	<0.0005	0.0014	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	-	0.05		0.00137	0.00149		0.00059	0.0008	0.00158	0.00181	0.0003	0.00147	0.00191	0.00085	0.00077	0.00132	0.00158	0.00103
Copper	mg/L	1	0.008		0.0031	0.0045		0.0022	0.0025	0.0033	0.0052	0.0035	0.0025	0.0043	0.0028	0.0025	0.0021	0.0054	0.0053
Iron	mg/L	0.3	1.00		0.02	<0.01		<0.01	0.05	0.02	0.02	0.35	0.08	0.04	0.04	0.06	0.09	0.04	0.03
Lead	mg/L	0.005	0.011		<0.00005	<0.00005		<0.00005	0.0001	<0.00005	<0.00005	0.0001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Manganese	mg/L	0.02	1.49		3.08	3.88		1.38	1.81	2.89	4.84	0.222	2.23	3.72	1.99	1.79	1.93	3.29	1.78
Mercury	µg/L	1	0.02		<0.01	0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	-	-	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-		<0.001	<0.001		<0.001	<0.001	0.001	0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	mg/L	5	0.09		<0.005	<0.005		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
NUTRIENTS																			
Nitrate	mg/L as N	10	3		0.619	1.28		1.01	0.722	1.41	3.3	0.561	0.664	1.62	1.43	0.708	0.928	2.23	1.53
Ammonia Nitrogen	mg/L as N	-	1.8		4.5	4.43		2.46	3.1	4.6	4.1	0.59	3.32	3.66	3.1	3.3	2.45	3.15	2.32
Total Phosphorus	mg/L	-	-		0.006	0.009		0.005	0.008	0.007	0.011	0.019	<0.005	0.01	0.009	0.008	<0.005	<0.005	<0.005
POLLUTANT TESTS																			
Chemical Oxygen Demand	mg/L as O	-	-		<10	26		<10	<10	<10	<10	<10	<10	24	14	<10	14	20	<10
Total Organic Carbon	mg/L as O	-	-		3.8	5.1		2.9	3.7	4.8	5.3	2.7	4.1	4.5	5.8	6.1	6.5	4.6	2.7

H:\Project1005\Analysis\Chemistry\2019\Tables_B-1 to B-9.xlsx|Table B-5 SouthExpArea

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 200 mg/L.

TABLE B-6
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW94-1S
2011 to 2013

SAMPLE DATE LAB NAME	units	RECEIVING WATER CRITERIA		08-Feb-11	09-May-11	26-Jul-11	08-Nov-11	24-Jan-12	08-May-12	31-Jul-12	25-Oct-12	17-Jan-13	09-May-13
		GCDWQ ¹	AQUATIC LIFE ²	NORTH ISLAND									
PHYSICAL TESTS													
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	10.82	9.51	8.88	8.79	8.2	8.4	8.25	8.2	9.94	7.27
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	9.2	7.7	8.8	8.6	9.67	8.2	8.03	8.22	8.3	8.3
EC-Field	µS/cm	-	-	777	493	182	154	325	344	302	315	288	277
EC-Lab	µS/cm	-	-	809	497	389	335	301	308	292	292	311	302
Total Hardness (CaCO ₃)	mg/L	-	-	26	15	17	20	26	30	31	29	41	38
Total Dissolved Solids	mg/L	500	-	448	302	254	236	196	208	230	222	186	200
Temperature-Field	°C	-	-	10.38	11.68	11.59	10.47	8.87	11.41	12.27	10.38	9.28	11.44
DISSOLVED ANIONS													
Chloride	mg/L	250	150	<2	3.9	4.2	3.3	3.6	4.7	6.4	5.2	4.3	3.43
Sulphate	mg/L	500	128	31	32	32	29.9	33.9	42.2	35.2	15.5	33.9	30
DISSOLVED CATIONS													
Calcium	mg/L	-	-	8	4.6	5.2	6.1	8.2	9.1	9.7	9.02	12.5	11.8
Magnesium	mg/L	-	-	1.4	0.9	1	1.2	1.4	1.8	1.7	1.63	2.3	2.06
Potassium	mg/L	-	-	0.9	0.6	0.6	0.5	0.5	0.6	0.5	0.6	0.5	0.6
Sodium	mg/L	200	-	188	104	84.2	59.2	64.2	62.5	59.7	57.4	50.5	54.4
DISSOLVED METALS													
Arsenic	mg/L	0.010	0.005	0.0183	0.0174	0.0135	0.0106	0.0091	0.0076	0.0091	0.0088	0.0062	0.0078
Barium	mg/L	1	1	0.007	0.004	0.005	0.006	0.008	0.007	0.007	0.008	0.009	0.009
Boron	mg/L	5	1.2	0.286	0.348	0.338	0.366	0.346	0.32	0.325	0.373	0.454	0.363
Cadmium	mg/L	0.005	0.00009	0.00004	0.00003	0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	0.00001
Chromium	mg/L	0.05	0.001	0.0017	0.0012	0.001	<0.0004	0.001	0.0009	0.001	0.0015	0.0015	0.001
Cobalt	mg/L	-	0.05	0.00006	0.00004	0.00006	<0.0004	0.00016	0.00012	0.00007	0.00014	<0.00002	<0.00002
Copper	mg/L	1	0.001	0.0017	0.002	0.003	<0.001	0.002	0.001	0.001	0.001	0.001	0.001
Iron	mg/L	0.3	0.35	<0.005	<0.005	0.027	0.03	0.024	0.022	0.022	0.008	0.008	<0.005
Lead	mg/L	0.005	0.004	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Manganese	mg/L	0.02	0.74	<0.001	<0.001	<0.001	0.012	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury	µg/L	1	0.02	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1
Vanadium	mg/L	-	-	0.015	0.0128	0.0084	0.006	0.0052	0.0045	0.0048	0.00396	0.0038	0.00393
Zinc	mg/L	5	0.0075	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
NUTRIENTS													
Nitrate	mg/L as N	10	3	0.5	0.4	0.5	0.39	0.3	0.43	0.28	0.18	0.21	0.18
Ammonia Nitrogen	mg/L as N	-	1.8	<0.01	<0.01	0.05	0.15	<0.01	0.02	0.05	0.06	<0.01	0.01
POLLUTANT TESTS													
Chemical Oxygen Demand	mg/L as O	-	-	30	20	40	30	50	20	20	53	14	32

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-1 to B-9.xlsx\Table B-6 MW94-1S

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 30 mg/L.

3. MW94-1S was decommissioned in May 2013.

PITEAU ASSOCIATES

Geotechnical and Water Management Consultants

TABLE B-7
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW94-1D
2009 to 2010

SAMPLE DATE	units	RECEIVING WATER CRITERIA		04-Feb-09	22-Apr-09	27-Jul-09	10-Nov-09	08-Feb-10	14-Apr-10	10-Aug-10	06-Dec-10
		GCDWQ ¹	AQUATIC LIFE ²	CANTEST	CANTEST	CANTEST	CANTEST	CANTEST	MAXXAM	MAXXAM	NORTH ISLAND
PHYSICAL TESTS											
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	7.87	7.28	7.18	7.45	7.46	7.75	8.7	7.61
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	7.78	7.76	7.85	8.01	7.93	8.2	8.45	7.7
EC-Field	µS/cm	-	-	334	245	285	510	423	336	620	508
EC-Lab	µS/cm	-	-	367	261	317	572	403	350	650	532
Total Dissolved Solids	mg/L	500	-	228	126	182	336	233	180	500	314
Temperature-Field	°C	-	-	8.41	11.22	11.13	12.71	10.17	10.08	11.17	10.92
DISSOLVED ANIONS											
Chloride	mg/L	250	150	7.43	1.06	2.34	12.6	7.63	3.9	4.7	8.2
Sulphate	mg/L	500	128	-	-	-	-	14.5	11	44	16
NUTRIENTS											
Nitrate	mg/L as N	10	3	0.24	<0.05	0.12	0.4	<0.05	<0.02	0.67	0.3
Ammonia Nitrogen	mg/L as N	-	1.8	<0.01	0.02	<0.01	0.02	<0.01	<0.01	0.045	0.03
Nitrate and Nitrite	mg/L as N	-	-	-	-	-	-	-	<0.02	0.67	-

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-1 to B-9.xlsx]Table B-7 MW94-1D

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

- GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.
- Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.
 Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.
 Aquatic life guideline for sulphate is based on total hardness, which varies between samples. Guidelines shown are based on average hardness of less than 30 mg/L.
- Sample analyzed past recommended holding time for nitrate sample collected on 10-Aug-10.
- MW94-1D was decommissioned in May 2013.

TABLE B-8
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW02-3S
2016 to 2019

SAMPLE DATE	units	RECEIVING WATER CRITERIA		28-Jan-16	10-May-16	27-Jul-16	09-Nov-16	23-Jan-17	20-Apr-17	19-Jul-17	11-Oct-17	29-Jan-18	25-Apr-18	30-Jul-18	31-Oct-18	30-Jan-19	17-Apr-19	24-Jul-19	31-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	7.91	6.28	7.9	7.53	7.8611	7.53	7.22	7.54	7.76	6.69	7.89	7.68	7.80	-	7.53
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	7.41	7.33	7.44	7.48	7.41	7.8	7.54	7.61	7.57	7.58	7.49	7.69	7.59	7.6	7.64	7.64
EC-Field	µS/cm	-	-	-	128	395	83	93	110	192	279	89	250	997	133	94	158	-	133
EC-Lab	µS/cm	-	-	89	172	591	102	132	141	200	427	129	360	1290	169	128	223	953	147
Dissolved Hardness (CaCO ₃)	mg/L	-	-	84	126	124	112	60.1	68.7	89	256	57.8	172	640	74.8	55.4	101	413	71
Total Dissolved Solids	mg/L	500	-	38	105	328	50	78	62	95	248	70	200	772	95	48	120	560	82
Temperature-Field	°C	-	-	-	12.04	15.73	13.65	9.56	9.52	14.43	13.02	9.13	9.79	13.1	14.45	9.75	10.37	-	14.38
DISSOLVED ANIONS																			
Alkalinity	mg/L CaCO ₃	-	-	-	81	250	49	61	73	89	191	64	173	555	72	58	90	409	67
Chloride	mg/L	250	150	0.4	2.23	31.5	0.51	1.52	0.46	3.01	20.9	1.13	15.4	101	2.73	4.97	11	73.1	2.2
Sulphate	mg/L	500	309	0.5	1.3	5.5	1.3	1.2	0.7	2.3	2.7	0.9	2.2	9.1	2.8	1	2.4	10.9	2.5
DISSOLVED CATIONS																			
Calcium	mg/L	-	-	15.2	26.9	84	15.6	20.7	23.8	30.2	73.1	20	52.8	176	25.6	19	32.2	116	24
Magnesium	mg/L	-	-	1.2	2.79	19	1.34	2.04	2.25	3.31	17.9	1.91	9.69	48.6	2.65	1.94	5.09	29.9	2.7
Potassium	mg/L	-	-	0.11	0.36	1.39	0.13	0.09	0.147	0.37	0.68	0.09	0.34	1.32	0.15	0.09	0.2	0.97	0.18
Sodium	mg/L	200	-	0.96	2.17	8.2	1.21	1.26	1.48	2.49	9.12	1.32	7.86	32.3	2.88	2.21	4.82	27.5	4.08
ION BALANCE																			
Ion Balance	%	-	-	10	6	0	9	8	5	10	-19	10	4	-1	2	11	-1	-10	-6
DISSOLVED METALS																			
Arsenic	mg/L	0.010	0.005	<0.0001	0.0001	0.0014	0.0001	<0.0001	<0.0001	0.0003	0.0007	0.0001	0.0009	0.0082	0.0003	0.0002	0.0006	0.0025	0.0003
Barium	mg/L	1	1	0.0226	0.025	0.0358	0.0124	0.0128	0.0173	0.0202	0.0401	0.009	0.0192	0.0694	0.0035	0.0026	0.0062	0.0472	0.0084
Boron	mg/L	5	1.2	0.018	0.037	0.168	0.032	0.022	0.026	0.037	0.143	0.026	0.111	0.404	0.066	0.046	0.064	0.333	0.066
Cadmium	mg/L	0.005	0.00029	0.00007	<0.00001	0.00002	<0.00001	0.0012	0.00004	0.00034	0.00048	0.00002	<0.00001	0.00006	<0.00001	0.00003	0.00021	0.00006	<0.00001
Chromium	mg/L	0.05	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	-	0.05	<0.00005	<0.00005	0.00009	<0.00005	<0.00005	<0.00005	<0.00005	0.00031	<0.00005	0.00009	0.00726	<0.00005	0.00008	0.00418	0.00008	0.00008
Copper	mg/L	1	0.006	0.0012	0.0021	0.0019	0.0015	0.0027	0.0015	0.003	0.0035	0.0012	0.0033	0.0042³	0.0022	0.0021	0.0027	0.0074⁴	0.0023
Iron	mg/L	0.3	0.35	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.02	0.18	<0.01	<0.01	<0.01	0.03	0.01
Lead	mg/L	0.005	0.009	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Manganese	mg/L	0.02	1.27	<0.001	<0.001	0.051	0.012	0.01	<0.01	0.002	0.105	0.002	0.002	0.525	0.003	0.008	0.01	0.317	0.011
Mercury	µg/L	1	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-	0.0011	0.0008	0.001	0.0016	0.0005	0.0012	0.0013	0.0012	0.0008	0.001	<0.0005	0.0014	0.0011	0.001	0.0007	0.0014
Zinc	mg/L	5	0.0525	0.006	0.005	0.009	0.002	0.01	0.006	0.015	0.019	0.013	0.007	0.006	<0.002	<0.002	<0.002	0.004	<0.002
NUTRIENTS																			
Nitrate	mg/L as N	10	3	0.263	1	1.9	0.286	1.02	0.426	2.77	2.49	0.321	0.239	0.016	1.2	0.442	0.954	0.76	0.818
Ammonia Nitrogen	mg/L as N	-	1.8	<0.01	0.06	1.36	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	<0.01	0.02	<0.01	0.02	0.02	0.01	0.04
POLLUTANT TESTS																			
Chemical Oxygen Demand	mg/L as O	-	-	<10	<10	41	<10	<10	<10	<10	<10	<10	<10	35	<10	<10	<10	25	<10

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-1 to B-9.xlsx|Table B-8 MW02-3S

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 150 mg/L.

3. Exceedance based on average hardness of 150 mg/L. With sample hardness of 640 mg/L, copper concentration does not exceed FWAL criterion.

4. Exceedance based on average hardness of 150 mg/L. With sample hardness of 410 mg/L, copper concentration does not exceed FWAL criterion.

TABLE B-9
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW02-3D
2016 to 2019

SAMPLE DATE LAB NAME	units	RECEIVING WATER CRITERIA		28-Jan-16	10-May-16	27-Jul-16	09-Nov-16	23-Jan-17	20-Apr-17	19-Jul-17	11-Oct-17	29-Jan-18	25-Apr-18	30-Jul-18	31-Oct-18	30-Jan-19	17-Apr-19	24-Jul-19	31-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	7.44	6.28	7.96	7.62	7.48	7.2	6.87	7.01	7.46	6.92	7.28	7.09	7.68	-	7.02
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	7.91	7.74	7.6	7.99	7.77	8.17	7.89	7.92	7.88	7.75	7.58	7.78	7.84	7.83	7.79	7.72
EC-Field	µS/cm	-	-	-	390	380	477	413	419	460	494	350	387	442	420	425	411	-	864
EC-Lab	µS/cm	-	-	420	541	-	639	629	594	626	682	534	560	546	538	619	589	948	1130
Dissolved Hardness (CaCO ₃)	mg/L	-	-	75	59	69	65	229	234	221	252	165	177	165	165	169	170	330	429
Total Dissolved Solids	mg/L	500	-	222	318	275	351	368	318	335	410	300	312	305	318	348	338	520	670
Temperature-Field	°C	-	-	-	12.44	14.53	14.06	9.08	9.62	12.81	12	9.02	10.17	11.64	14.97	10.34	11.16	-	13.51
DISSOLVED ANIONS																			
Alkalinity	mg/L CaCO ₃	-	-	-	240	220	277	279	275	281	312	238	247	229	222	253	243	399	461
Chloride	mg/L	250	150	27.6	31.2	27.6	42.7	36.8	34.3	35.6	44.1	31.1	34	33.4	34.1	46.3	37.4	73.4	88.7
Sulphate	mg/L	500	309	5.6	7.1	7	4.3	5.6	6.5	6.6	6.3	6.9	8.5	8.2	8.9	8.5	10.1	17.1	21.4
DISSOLVED CATIONS																			
Calcium	mg/L	-	-	38.6	56.4	50.4	55.4	68.5	69.8	65.4	74.1	49.7	53.1	49.1	48.8	50.6	51.7	97.5	130
Magnesium	mg/L	-	-	7.37	11.3	10	11	14.1	14.5	14.1	16.3	10	10.9	10.3	10.4	10.3	9.92	20.9	25.4
Potassium	mg/L	-	-	0.81	0.85	0.86	1.08	0.84	0.976	0.88	0.95	0.76	0.87	0.94	0.96	0.87	0.92	1.47	1.42
Sodium	mg/L	200	-	44.1	37.4	42.3	70.1	43.1	47	43.8	46.5	49.2	51.7	52.3	51.4	62	60.8	75.7	83.7
ION BALANCE																			
Ion Balance	%	-	-	5	7	2	1	4	-2	6	7	6	4	2	1	7	1	-5	-1
DISSOLVED METALS																			
Arsenic	mg/L	0.010	0.005	0.0009	0.0009	0.0011	0.0015	0.0003	0.0007	0.0008	0.0009	0.001	0.0009	0.0014	0.0014	0.0012	0.0005	0.0012	0.0006
Barium	mg/L	1	1	0.0338	0.0435	0.0398	0.0537	0.0663	0.0499	0.0516	0.0571	0.0498	0.0635	0.0532	0.0415	0.0483	0.0423	0.0866	0.0999
Boron	mg/L	5	1.2	0.324	0.351	0.33	0.368	0.386	0.444	0.453	0.441	0.492	0.477	0.434	0.47	0.494	0.482	0.606	0.635
Cadmium	mg/L	0.005	0.00029	0.00003	0.00006	<0.00001	<0.00001	0.00029	0.00005	0.00004	0.00001	0.00002	0.00001	<0.00001	<0.00001	0.00002	0.00002	<0.00001	<0.00001
Chromium	mg/L	0.05	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0008	<0.0005
Cobalt	mg/L	-	0.05	0.00008	0.00044	0.00025	0.00055	0.00046	0.00053	0.00046	0.00066	0.0007	0.00416	0.0041	0.00173	0.00133	0.00079	0.00215	0.00253
Copper	mg/L	1	0.006	0.0013	0.0019	<0.0002	0.0006	0.0037	0.004	0.0007	0.0006	0.002	0.0025	<0.0002	<0.0002	0.0005	0.0004	<0.0002	0.0004
Iron	mg/L	0.3	0.35	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.44	0.21	0.16	<0.01	0.56	0.46
Lead	mg/L	0.01	0.009	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Manganese	mg/L	0.02	1.27	<0.001	0.193	0.095	0.222	0.098	0.146	0.079	0.133	0.165	0.271	0.241	0.178	0.199	0.16	0.334	0.31
Mercury	µg/L	1	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-	0.0009	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Zinc	mg/L	5	0.0525	0.005	0.008	0.003	0.003	0.013	0.006	0.005	0.005	0.005	0.019	<0.002	<0.002	0.002	<0.002	<0.002	<0.002
NUTRIENTS																			
Nitrate	mg/L as N	10	3	0.071	0.042	0.019	0.012	0.006	0.006	0.054	0.07	<0.005	0.008	0.008	0.015	<0.005	<0.005	0.012	0.011
Ammonia Nitrogen	mg/L as N	-	1.8	0.01	0.07	0.23	0.08	0.03	<0.01	<0.01	0.32	0.04	0.14	0.22	0.14	0.11	0.37	1.01	0.77
POLLUTANT TESTS																			
Chemical Oxygen Demand	mg/L as O	-	-	17	<10	66	<10	<10	<10	<10	<10	<10	<10	14	27	14	15	30	35

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-1 to B-9.xlsx|Table B-9 MW02-3D

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Lowest guideline of maximum acceptable concentration or aesthetic objective is shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 150 mg/L.

TABLE B-10
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW94-4S
2016 to 2019

SAMPLE DATE LAB NAME	units	RECEIVING WATER CRITERIA		27-Jan-16	10-May-16	26-Jul-16	08-Nov-16	18-Jan-17	21-Apr-17	20-Jul-17	12-Oct-17	29-Jan-18	26-Apr-18	01-Aug-18	31-Oct-18	30-Jan-19	17-Apr-19	25-Jul-19	30-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT		AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	10.11	7.3	8.29	Frozen	10.02	8.85	7.94	8.03	7.38	8.02	7.16	9.14	9.17	-	8.6
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	9.23	9.18	9.14	8.41		9.03	8.57	9.06	9.26	9.19	8.95	9.19	9.22	9.28	9.24	9.38
EC-Field	µS/cm	-	-	-	212	199	264		163	190	175	153	180	337	173	157	166	-	162
EC-Lab	µS/cm	-	-	261	261	255	351		253	249	252	251	256	254	259	256	261	254	256
Dissolved Hardness (CaCO ₃)	mg/L	-	-	<5	<5	<5	<5		4.13	3.8	3.6	3.2	3.7	3.7	6.7	3.8	3.6	10.4	3.8
Total Dissolved Solids	mg/L	500	-	142	158	178	235		155	140	172	155	142	178	168	162	158	145	152
Temperature-Field	°C	-	-	-	12.08	15.74	9.55		7.56	13.7	9.87	6.24	11.73	16.19	10.32	6	8.15	-	8.44
DISSOLVED ANIONS																			
Alkalinity	mg/L CaCO ₃	-	-	-	115	110	127		117	120	114	114	115	109	113	115	115	117	114
Chloride	mg/L	250	150	7.06	7.2	7.63	5.51		7.03	7.48	8.61	7.47	7.32	8.6	9.21	7.66	7.88	8.68	7.77
Sulphate	mg/L	500	128	5.9	6.5	6	36.9		5.8	5.8	6.5	5.4	6.1	5.9	5.7	5.9	6.1	6.1	6.2
DISSOLVED CATIONS																			
Calcium	mg/L	-	-	1.6	1.51	1.42	2.81		1.56	1.44	1.36	1.3	1.41	1.4	2.37	1.42	1.44	3.55	1.44
Magnesium	mg/L	-	-	0.06	0.06	0.05	0.49		0.058	0.05	0.05	<0.05	0.05	0.06	0.2	0.05	<0.05	0.37	0.05
Potassium	mg/L	-	-	0.42	0.35	0.33	0.48		0.375	0.33	0.3	0.29	0.35	0.43	0.39	0.33	0.44	0.44	0.35
Sodium	mg/L	200	-	58.4	57.1	54.2	74.2		60	55.8	55.1	52.3	55.5	55.6	52.6	55.6	57.2	57.2	55.6
ION BALANCE																			
Ion Balance	%	-	-	5	3	4	3		-1	8	7	10	6	2	8	6	3	0	5
DISSOLVED METALS																			
Arsenic	mg/L	0.010	0.005	0.0057	0.0528	0.0048	0.055		0.0042	0.0039	0.0052	0.0054	0.0052	0.0052	0.005	0.0054	0.0051	0.0048	0.0049
Barium	mg/L	1	1	0.003	0.0022	0.0039	0.005		0.0038	0.003	0.0039	0.0036	0.0038	0.0027	0.0038	0.0035	0.0025	0.0042	0.0035
Boron	mg/L	5	1.2	1.69	2.78	1.41	2.71		1.58	1.53	1.43	1.49	1.55	1.55	1.44	1.51	1.56	1.38	1.52
Cadmium	mg/L	0.005	0.00009	<0.00001	<0.00001	<0.00001	0.00002		<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Chromium	mg/L	0.05	0.001	<0.0005	0.0006	<0.0005	0.0011		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	-	0.05	<0.00005	<0.00005	<0.00005	0.00099		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Copper	mg/L	1	0.002	0.0003	0.0025	<0.0002	0.0038		0.0002	0.0002	0.002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	<0.0002	<0.0002	0.0005
Iron	mg/L	0.3	0.35	0.02	<0.01	<0.01	0.78		<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	
Lead	mg/L	0.005	0.004	<0.00005	<0.00005	<0.00005	0.0004		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	
Manganese	mg/L	0.02	0.737	<0.001	0.001	<0.001	0.019		<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.001	
Mercury	µg/L	1	0.02	<0.01	<0.01	0.01	0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	
Vanadium	mg/L	-	-	0.0008	0.0278	0.0007	0.0296		0.0007	0.0007	0.001	0.0008	0.0007	0.0009	<0.0005	0.0006	0.0008	0.0005	
Zinc	mg/L	5	0.0075	<0.002	<0.002	<0.002	0.004		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	
NUTRIENTS																			
Nitrate	mg/L as N	10	3	0.022	0.038	0.028	0.517		0.013	0.025	0.098	0.034	0.045	0.03	0.049	0.042	0.04	0.028	0.076
Ammonia Nitrogen	mg/L as N	-	1.8	0.09	0.04	0.07	<0.01		0.06	0.02	<0.01	<0.01	0.02	0.06	<0.01	0.04	0.01	0.05	0.08
POLLUTANT TESTS																			
Chemical Oxygen Demand	mg/L as O	-	-	<10	<10	<10	<10		<10	22	<10	<10	<10	<10	<10	<10	<10	<10	<10

H:\Project1005\Analysis\Chemistry\2019\Tables_B-10 to B-18.xlsx|Table B-10 MW94-4S

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of less than 30 mg/L.

TABLE B-11
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW94-4D
2016 to 2019

SAMPLE DATE LAB NAME	units	RECEIVING WATER CRITERIA		27-Jan-16	10-May-16	26-Jul-16	08-Nov-16	18-Jan-17	21-Apr-17	20-Jul-17	12-Oct-17	29-Jan-18	26-Apr-18	01-Aug-18	31-Oct-18	30-Jan-19	17-Apr-19	25-Jul-19	30-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT		AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	9.7	6.72	9.08	Frozen	9.45	8.11	7.63	7.83	7.28	8.67	7.07	8	8.52	-	7.57
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	8.42	8.31	8.83	9.36		8.63	8.03	8.61	8.27	8.37	8.28	8.3	8.31	8.14	8.12	8.26
EC-Field	µS/cm	-	-	-	251	178	229		165	194	177	155	157	250	232	320	266	-	167
EC-Lab	µS/cm	-	-	411	372	258	258		253	250	253	246	261	350	333	342	267	247	247
Total Dissolved Solids	mg/L	500	-	225	242	162	158		168	145	115	145	162	228	222	210	175	150	155
Temperature-Field	°C	-	-	-	10.17	10.42	9.64		9.07	14.41	9.09	5.77	10.43	10.1	9.16	8.7	9.41	-	9.39
DISSOLVED ANIONS																			
Chloride	mg/L	250	150.00	5.36	6.08	7.65	6.74		7.28	7.3	7.54	7.73	7.32	7.32	7.55	6.42	8.05	8.58	8.41
Sulphate	mg/L	500	128	63.1	47.5	8.2	5.4		6	5.6	6	5.5	9.1	39.8	28.1	34.4	11.4	6.2	6.1
NUTRIENTS																			
Nitrate	mg/L as N	10	3	0.792	0.604	0.097	0.026		0.078	0.079	0.131	0.084	0.107	0.457	0.528	0.632	0.156	0.165	0.097
Ammonia Nitrogen	mg/L as N	-	2	<0.01	<0.01	<0.01	0.09		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	0.01	<0.01	0.04

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-10 to B-18.xlsx|Table B-11 MW94-4D

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guideline for sulphate is based on total hardness, which varies between samples. Guidelines shown are based on average hardness of less than 30 mg/L.

TABLE B-12
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW94-5S
2016 to 2019

SAMPLE DATE LAB NAME	units	RECEIVING WATER CRITERIA		27-Jan-16	05-May-16	26-Jul-16	08-Nov-16	24-Jan-17	21-Apr-17	13-Jul-17	11-Oct-17	29-Jan-18	25-Apr-18	01-Aug-18	31-Oct-18	29-Jan-19	16-Apr-19	24-Jul-19	31-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	7.18	5.73	6.7	7.66	7.51	7.36	7.17	7.41	8.04	8.94	8.35	6.57	6.9	-	7.34
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	7.2	7.18	7.09	7.21	7.24	7.82	7.38	7.38	7.48	7.08	7.17	7.21	7.42	7.43	7.31	7.3
EC-Field	µS/cm	-	-	-	165	236	513	167	128	180	242	125	137	201	390	144	128	-	231
EC-Lab	µS/cm	-	-	254	221	307	291	233	200	243	326	195	189	247	275	201	216	275	317
Dissolved Hardness (CaCO ₃)	mg/L	-	-	127	124	122	130	108	89	114	166	87.6	90.6	145	130	97.8	105	94.5	162
Total Dissolved Solids	mg/L	500	-	128	125	158	185	140	110	152	195	110	110	118	170	98	135	158	182
Temperature-Field	°C	-	-	-	11.5	12.99	12.57	8.9	8.8	13.39	12.64	8.29	10.78	13.91	13.56	9.43	9.43	-	11.59
DISSOLVED ANIONS																			
Alkalinity	mg/L CaCO ₃	-	-	-	107	136	141	115	95	117	157	91	92	110	125	100	101	127	153
Chloride	mg/L	250	150	0.97	0.6	5.51	1.36	0.82	0.51	2.72	3.94	1.33	0.74	2.82	1.96	0.95	1.84	7.16	3.42
Sulphate	mg/L	500	309	8	5.7	8.6	9.8	7	5.3	6.1	10.3	7.8	6.4	9.2	9.8	6.3	6.9	8.6	11.5
DISSOLVED CATIONS																			
Calcium	mg/L	-	-	41.1	32.8	48.1	46.1	34.8	28.5	36.5	53.1	28.2	29.2	47.2	41.9	31.6	29.7	30.4	52.8
Magnesium	mg/L	-	-	5.88	4.95	7.23	6.77	5.11	4.33	5.49	8.05	4.18	4.3	6.48	6.2	4.58	7.45	4.51	7.38
Potassium	mg/L	-	-	0.63	0.39	0.43	0.26	0.31	0.352	0.35	0.4	0.27	0.3	1.62	0.27	0.24	0.34	0.52	0.32
Sodium	mg/L	200	-	4.09	2.9	4.04	4.35	3.42	2.82	3.2	4.62	2.83	2.56	4.68	3.27	2.89	2.98	25.8	4.31
ION BALANCE																			
Ion Balance	%	-	-	3	4	-1	1	6	6	6	0	7	4	-25	1	4	-1	2	-1
DISSOLVED METALS																			
Arsenic	mg/L	0.010	0.005	0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	0.0002	0.0001	0.0001	0.0001	0.0007	0.0001	0.0001	<0.0001	0.0017	0.0002
Barium	mg/L	1	1	0.0171	0.0135	0.0175	0.018	0.0157	0.0149	0.0189	0.0389	0.0133	0.013	0.011	0.0146	0.0113	0.0062	0.0194	0.0193
Boron	mg/L	5	1.2	0.313	0.277	0.25	0.429	0.287	0.244	0.259	0.277	0.281	0.273	0.33	0.401	0.285	0.231	0.427	0.418
Cadmium	mg/L	0.005	0.00029	0.00002	<0.00001	0.00001	0.00003	0.0002	0.00005	0.00004	0.00004	0.00004	0.00003	<0.00001	0.00002	0.00001	0.00004	0.00006	0.00005
Chromium	mg/L	0.05	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	-	0.05	<0.00005	<0.00005	<0.00005	<0.00005	0.00008	<0.00005	<0.00005	0.00009	<0.00005	<0.00005	0.00074	<0.00005	0.0002	0.00019	0.00025	<0.00005
Copper	mg/L	1	0.006	0.0014	0.0009	0.0007	0.0007	0.0014	0.0006	0.0008	0.0012	0.0015	0.0005	0.0002	0.0006	0.0008	0.0013	0.0016	0.002
Iron	mg/L	0.3	0.35	0.12	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	0.02	0.03	0.1	8.06	0.01	0.73	0.12	0.31	0.02
Lead	mg/L	0.005	0.009	<0.00005	<0.00005	<0.00005	<0.00005	0.00011	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.0011	<0.00005
Manganese	mg/L	0.02	1.265	0.023	0.002	0.02	0.004	0.006	0.003	0.011	0.029	0.001	0.001	1.09	0.004	0.115	0.09	0.029	0.006
Mercury	µg/L	1	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0006	0.0015	<0.0005
Zinc	mg/L	5	0.053	0.035	0.017	0.011	0.029	0.033	0.029	0.014	0.002	0.042	0.021	0.006	0.024	0.01	<0.002	0.006	0.008
NUTRIENTS																			
Nitrate	mg/L as N	10	3	0.057	0.032	1.52	0.142	0.065	0.028	0.407	0.628	0.164	0.085	0.613	0.129	0.058	0.038	0.449	0.078
Ammonia Nitrogen	mg/L as N	-	1.8	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.3	<0.01	<0.01	<0.01	<0.01	0.03	0.37	<0.01	0.04
POLLUTANT TESTS																			
Chemical Oxygen Demand	mg/L as O	-	-	22	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-10 to B-18.xlsx|Table B-12 MW94-5S

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 150 mg/L.

TABLE B-13
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW94-6S
2016 to 2019

SAMPLE DATE LAB NAME	units	RECEIVING WATER CRITERIA		27-Jan-16	05-May-16	26-Jul-16	08-Nov-16	24-Jan-17	21-Apr-17	13-Jul-17	11-Oct-17	29-Jan-18	26-Apr-18	01-Aug-18	31-Oct-18	29-Jan-19	16-Apr-19	24-Jul-19	30-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT										
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	6.99	5.66	7.2	6.77	7.39	7.18	7.42	7.11	7.56	8.77	8.07	6.06	6.72	-	6.18
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	6.71	6.63	6.74	6.75	6.59	7.01	7.02	6.8	6.84	6.6	6.75	6.67	6.73	6.81	6.81	6.7
EC-Field	µS/cm	-	-	-	523	712	499	167	445	661	633	429	526	705	590	375	514	-	551
EC-Lab	µS/cm	-	-	692	653	861	612	686	568	821	808	535	639	809	726	453	664	755	669
Dissolved Hardness (CaCO ₃)	mg/L	-	-	375	371	412	307	291	285	321	309	194	237	336	251	173	245	337	260
Total Dissolved Solids	mg/L	500	-	335	330	455	368	372	300	432	420	312	282	438	388	220	330	380	322
Temperature-Field	°C	-	-	-	10.81	12.03	10.38	8.96	8.32	11.23	11.41	9.42	11.84	12.96	12	9.17	9.04	-	12.21
DISSOLVED ANIONS																			
Alkalinity	mg/L CaCO ₃	-	-	-	335	436	315	354	293	441	438	265	336	427	370	228	339	392	343
Chloride	mg/L	250	150	7.18	5.86	8.24	5.51	6.38	4.75	7.31	7.68	5.06	5.82	7.71	8.55	3.6	6.75	12.8	5.57
Sulphate	mg/L	500	429	<0.5	<0.5	<0.5	0.6	0.7	<0.5	0.5	0.6	1.7	1.4	<0.5	1.9	<0.5	3.4	<0.5	2.4
DISSOLVED CATIONS																			
Calcium	mg/L	-	-	84.3	76.9	123	70.8	79.3	71.7	111	111	64.2	78	113	82.7	57.1	82.2	110	86.5
Magnesium	mg/L	-	-	11.7	11	15.2	10.1	10.9	10.4	13.5	13.2	8.28	10.2	13	10.8	7.33	9.64	15.1	10.8
Potassium	mg/L	-	-	10.2	8.3	10.5	8.42	8.04	7.66	9.13	8.78	7.39	7.91	8.92	8.42	6.57	7.3	7.95	8.3
Sodium	mg/L	200	-	14.3	11	15.8	11	13.7	9.34	12.6	14.9	10.8	10.6	15	11.7	9.06	13.1	13.2	10.8
ION BALANCE																			
Ion Balance	%	-	-	3	-5	7	23	22	16	18	17	26	22	13	25	14	20	-8	17
DISSOLVED METALS																			
Arsenic	mg/L	0.010	0.005	0.0013	0.0028	0.0009	0.001	0.0023	0.0004	0.0004	0.0006	0.0023	0.001	0.006	0.0012	0.0062	0.0059	0.0064	0.0073
Barium	mg/L	1	1	0.029	0.0299	0.0295	0.028	0.0295	0.0194	0.0209	0.0377	0.0223	0.021	0.0428	0.0245	0.0266	0.0297	0.0454	0.0357
Boron	mg/L	5	1.2	0.431	0.311	0.438	0.372	0.366	0.264	0.345	0.369	0.322	0.268	0.391	0.389	0.265	0.312	0.323	0.363
Cadmium	mg/L	0.005	0.000	<0.00001	<0.00001	0.00009	0.00005	<0.00001	<0.00001	0.00013	0.00009	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	0.00008	<0.00001
Chromium	mg/L	0.05	0.001	0.0008	0.0008	<0.0005	0.0006	0.0007	<0.0005	<0.0005	<0.0005	0.0007	0.0005	0.0006	0.0007	0.0009	0.0009	0.0007	0.001
Cobalt	mg/L	-	0.05	0.00653	0.00681	0.0056	0.00567	0.00597	0.00549	0.00507	0.00452	0.00477	0.00477	0.00386	0.0039	0.00359	0.00439	0.00322	0.00331
Copper	mg/L	1	0.012	0.0006	<0.0002	<0.0002	0.0003	<0.0002	<0.0002	0.0011	0.0005	<0.0002	0.0006	0.0015	<0.0002	0.0006	<0.0002	<0.0002	0.0005
Iron	mg/L	0.3	0.35	19.2	31.4	6.56	14.1	29.1	8.15	<0.01	8.34	24	21.9	55.5	25.6	34.5	49.3	48.2	52.2
Lead	mg/L	0.005	0.016	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00006	<0.00005	0.00006	<0.00005	0.0001	<0.00005	<0.00005
Manganese	mg/L	0.02	1.925	5.02	5.04	5.82	4.86	5.2	4.98	5.89	5.35	3.52	5.03	5.98	4.94	3.45	4.97	4.94	5.18
Mercury	µg/L	1	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0018	<0.0005	0.0021	0.0022	0.0016	0.0022	
Zinc	mg/L	5	0.165	<0.002	<0.002	0.002	0.004	0.004	0.003	0.004	0.005	0.003	<0.002	0.005	<0.002	0.005	0.002	0.004	<0.002
NUTRIENTS																			
Nitrate	mg/L as N	10	3	<0.005	<0.005	<0.005	0.901	<0.005	0.011	<0.005	<0.005	0.008	0.022	0.014	0.034	0.028	0.014	0.018	0.05
Ammonia Nitrogen	mg/L as N	-	1.8	10.7	10.7	14.2	12.5	10.2	8.77	12.3	12.8	9.7	11.5	12.5	13.8	8.79	10.4	12.4	12.3
POLLUTANT TESTS																			
Chemical Oxygen Demand	mg/L as O	-	-	34	53	72	22	35	37	<10	<10	30	45	<10	40	29	39	49	48

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-10 to B-18.xlsx|Table B-13 MW94-6S

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 300 mg/L.

TABLE B-14
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW94-6D
2016 to 2019

SAMPLE DATE	units	RECEIVING WATER CRITERIA		27-Jan-16	05-May-16	26-Jul-16	08-Nov-16	24-Jan-17	21-Apr-17	13-Jul-17	11-Oct-17	29-Jan-18	26-Apr-18	01-Aug-18	31-Oct-18	29-Jan-19	16-Apr-19	24-Jul-19	30-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT												
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	9.58	7.07	10.06	10.19	9.72	8.68	6.93	7.14	7.61	8.35	8.53	9.34	9.38	-	9.15
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	8.81	9.13	9.41	9.43	9.37	9.53	9.56	9.5	9.37	9.38	9.3	9.39	9.41	9.47	9.41	9.62
EC-Field	µS/cm	-	-	-	414	429	399	344	359	372	368	338	354	375	203	338	346	-	3751
EC-Lab	µS/cm	-	-	704	631	632	611	530	558	561	543	525	530	539	533	518	541	530	544
Dissolved Hardness (CaCO ₃)	mg/L	-	-	<5	<5	<5	<5	2.2	<5	<7	5	2.1	2.3	3.1	3.6	9.5	1.2	39.6	2.8
Total Dissolved Solids	mg/L	500	-	400	396	330	422	480	350	267	275	267	300	380	360	290	362	382	340
Temperature-Field	°C	-	-	-	10.64	12.64	10.54	8.88	9.69	11.1	10.76	9.53	10.93	11.23	10.31	9.63	10.13	-	12.25
DISSOLVED ANIONS																			
Alkalinity	mg/L CaCO ₃	-	-	-	257	252	242	223	229	236	232	226	231	232	230	222	228	233	238
Chloride	mg/L	250	150	3.74	3.34	3.22	3.5	3.07	3.24	3.4	3.73	3.53	4.05	3.95	4.09	4.22	4.44	4.43	5.06
Sulphate	mg/L	500	128	60.8	62.7	61.2	51.9	36.8	44.9	44.2	42.2	35.9	33	31.6	31	32.4	31.5	30	29.1
DISSOLVED CATIONS																			
Calcium	mg/L	-	-	1.9	1.08	1.59	1.24	0.77	1.04	1.24	1.58	0.75	0.82	1.1	1.27	2.48	0.48	10.8	0.82
Magnesium	mg/L	-	-	<0.5	0.08	0.1	0.22	0.07	0.078	0.08	0.16	0.06	0.07	0.08	0.1	0.8	<0.05	3.06	0.18
Potassium	mg/L	-	-	1.4	0.76	0.65	0.63	0.6	0.658	0.54	0.51	0.69	0.65	0.52	0.61	0.69	0.56	1.18	0.53
Sodium	mg/L	200	-	163	135	130	123	118	128	126	121	118	122	120	106	121	118	141	118
ION BALANCE																			
Ion Balance	%	-	-	5	10	12	11	4	1	5	7	5	3	4	14	-2	5	27	6
DISSOLVED METALS																			
Arsenic	mg/L	0.010	0.005	0.0164	0.0259	0.0328	0.031	0.0246	0.0228	0.0288	0.0282	0.0291	0.0238	0.0232	0.0215	0.0212	0.0221	0.0215	0.0169
Barium	mg/L	1	1	0.0029	0.0024	<0.0002	0.005	0.0015	0.0021	0.0017	0.002	0.0095	0.0019	0.0017	0.0018	0.0234	0.0008	0.0686	0.0032
Boron	mg/L	5	1.2	2.36	2.59	2.59	2.48	2.34	2.55	2.57	2.52	2.35	2.34	2.45	2.39	2.32	2.37	2.36	2.18
Cadmium	mg/L	0.005	0.00009	0.00005	0.00002	0.00001	0.00001	0.00001	0.00001	<0.00001	<0.00001	0.00003	<0.00001	<0.00001	<0.00001	0.00007	<0.00001	0.00028	0.00002
Chromium	mg/L	0.05	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	-	0.05	0.00011	0.00011	0.00009	0.00012	0.00006	0.00009	0.00007	0.00007	0.00005	0.00006	0.00005	<0.00005	0.00089	<0.00005	0.00318	0.00012
Copper	mg/L	1	0.002	0.0034	0.0046	0.004	0.0052	0.0044	0.0044	0.0039	0.0037	0.0036	0.0029	0.0031	0.0024	0.0046	0.0019	0.0087	0.0033
Iron	mg/L	0.3	0.35	0.6	0.06	0.05	0.36	0.04	0.052	0.02	0.03	0.02	0.04	0.17	0.05	1.49	0.02	3.37	0.25
Lead	mg/L	0.005	0.004	0.00063	0.00062	0.00053	0.00075	0.00032	0.0005	0.00033	0.00036	0.00027	0.00031	0.00029	0.00036	0.00619	0.00016	0.0272	0.00112
Manganese	mg/L	0.02	0.74	<0.01	0.004	0.002	0.004	0.001	0.001	<0.001	0.001	<0.001	0.001	<0.001	0.001	0.062	<0.001	0.293	0.009
Mercury	µg/L	1	0.02	<0.1	0.01	0.03	0.07	0.03	0.02	0.01	0.02	0.02	0.02	0.02	-	-	<0.01	<0.01	0.01
Vanadium	mg/L	-	-	0.0046	0.0102	0.0158	0.0164	0.0125	0.0146	0.0142	0.0136	0.0137	0.0139	0.0125	0.0121	0.0121	0.0113	0.012	0.0073
Zinc	mg/L	5	0.0075	<0.002	<0.002	0.003	0.005	<0.002	<0.002	<0.002	0.056	<0.002	<0.002	<0.002	<0.002	0.022	<0.002	0.107	0.005
NUTRIENTS																			
Nitrate	mg/L as N	10	3	1.37	1.16	1.07	1.17	1.03	1.2	1.03	1.21	0.994	1.01	0.922	0.859	1.3	1.11	0.978	0.662
Ammonia Nitrogen	mg/L as N	-	1.8	0.41	0.41	0.25	0.18	0.01	0.05	<0.01	0.5	<0.01	0.78	0.02	0.19	<0.01	<0.1	0.16	0.1
POLLUTANT TESTS																			
Chemical Oxygen Demand	mg/L as O	-	-	91	323	264	195	33	49	<10	<10	20	18	<10	<10	<10	42	14	<10
Total Organic Carbon	mg/L as O	-	-	25.6	<5	5	1.8	10.7	19.6	2.1	3.7	4.6	5.3	2.3	14.6	7.5	5.2	4.4	4.6

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-10 to B-18.xlsx|Table B-14 MW94-6D

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of less than 30 mg/L.

TABLE B-15
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW98-9
2016 to 2019

SAMPLE DATE	units	RECEIVING WATER CRITERIA		27-Jan-16	05-May-16	26-Jul-16	08-Nov-16	24-Jan-17	21-Apr-17	13-Jul-17	05-Oct-17	29-Jan-18	26-Apr-18	01-Aug-18	31-Oct-18	29-Jan-19	16-Apr-19	24-Jul-19	30-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	7.16	6.24	6.88	7.47	8.37	6.92	7.06	8.48	8.31	9.13	8.66	6.2	7.2	-	6.78
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	7.11	7.16	7.11	6.85	6.82	7.32	7.53	7.33	6.96	7.36	7.14	6.81	6.88	7.57	7.34	7.46
EC-Field	µS/cm	-	-	-	252	485	85	72	77	235	250	48	148	207	93	55	43	-	185
EC-Lab	µS/cm	-	-	333	363	634	104	107	125	328	354	71	218	286	129	74	216	272	257
Dissolved Hardness (CaCO ₃)	mg/L	-	-	37	49	144	142	46	84	178	156	28.4	58	96.1	55.3	31.5	106	101	122
Total Dissolved Solids	mg/L	500	-	165	210	352	75	72	88	190	182	50	115	166	96	45	145	152	140
Temperature-Field	°C	-	-	-	11.46	13.88	13.93	8.5	8.27	11.53	12.01	8.56	9.97	12.19	12.25	9.4	8.49	-	12.29
DISSOLVED ANIONS																			
Alkalinity	mg/L CaCO ₃	-	-	-	184	328	46	50	62	170	185	34	113	145	61	34	109	138	126
Chloride	mg/L	250	150	2.99	2.53	6.86	1.13	1.04	0.86	3.37	4.81	0.95	1.13	3.58	1.12	0.73	1.03	3.61	1.69
Sulphate	mg/L	500	309	2.5	2.6	2.5	1	1	1	3.2	2.9	0.9	1.9	2.9	1.7	0.7	2.2	3.5	3.7
DISSOLVED CATIONS																			
Calcium	mg/L	-	-	43.3	41.1	87.2	10.7	11.7	13.8	41.4	39.3	6.94	26.5	26.4	13.7	8.03	27.2	27.3	30.8
Magnesium	mg/L	-	-	14.2	14.5	23	3.41	3.85	5.71	11	9.67	2.7	10.1	7.33	5.12	2.77	9.33	7.96	10.9
Potassium	mg/L	-	-	0.35	0.35	1.55	0.12	0.16	0.174	0.49	0.36	0.07	0.24	0.39	0.26	0.11	0.21	0.36	0.33
Sodium	mg/L	200	-	7.68	6.45	19.5	3.59	3.4	3.35	13.2	12.4	2.53	3.79	12.1	3.34	3.04	3.85	7.06	4.79
ION BALANCE																			
Ion Balance	%	-	-	0	9	-3	1	1	1	1	16	9	3	20	5	-4	1	-21	2
DISSOLVED METALS																			
Arsenic	mg/L	0.010	0.005	0.0015	0.0017	0.0005	0.0003	0.0003	0.0004	0.0006	0.0004	0.0002	0.0022	0.0007	0.0009	0.0003	0.0017	0.0007	0.0018
Barium	mg/L	1	1	0.0118	0.0119	0.0516	0.005	0.0038	0.004	0.0207	0.0282	0.002	0.005	0.0108	0.0041	0.0022	0.0048	0.0079	0.0083
Boron	mg/L	5	1.2	0.084	0.074	0.315	0.016	0.014	0.009	0.186	0.169	0.005	0.009	0.172	0.02	0.008	0.01	0.073	0.036
Cadmium	mg/L	0.005	0.00021	0.00002	0.00004	0.00037	0.00003	0.00004	<0.00001	0.00015	0.00011	<0.00001	<0.00001	0.00002	<0.00001	<0.00001	<0.00001	0.00002	<0.00001
Chromium	mg/L	0.05	0.001	0.0007	<0.0005	<0.0005	0.0012	0.0013	0.0012	<0.0005	<0.0005	0.0014	0.001	<0.0005	0.0012	0.0011	0.001	0.0005	0.0009
Cobalt	mg/L	-	0.05	0.00005	0.00008	0.00148	<0.00005	<0.00005	<0.00005	0.00037	0.00058	<0.00005	<0.00005	0.00014	<0.00005	<0.00005	<0.00005	0.00014	<0.00005
Copper	mg/L	1	0.004	0.0015	0.0022	0.0023	0.0007	0.0024	0.0006	0.0014	0.0019	<0.0002	0.0004	0.0002	0.0004	0.0013	0.0005	0.0004	0.0031
Iron	mg/L	0.3	0.35	0.05	<0.01	<0.01	<0.01	<0.01	0.187	<0.01	<0.01	<0.01	0.03	0.06	0.01	0.02	<0.01	0.02	0.01
Lead	mg/L	0.005	0.006	<0.00005	<0.00005	0.00012	<0.00005	<0.00005	0.00017	0.00006	0.0001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00015
Manganese	mg/L	0.02	1.05	0.009	0.059	2.56	0.003	<0.001	0.004	0.797	0.62	<0.001	<0.001	0.303	<0.001	0.002	<0.001	0.011	0.001
Mercury	µg/L	1	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-	0.0027	0.0027	0.0011	0.0009	0.0008	0.002	0.001	<0.0005	0.001	0.0033	0.0006	0.002	0.0008	0.0027	0.0012	0.0028
Zinc	mg/L	5	0.0150	0.002	0.003	0.003	0.005	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.004
NUTRIENTS																			
Nitrate	mg/L as N	10	3	1.15	1.12	1.27	0.174	0.196	0.46	0.202	0.198	0.254	0.816	0.17	0.504	0.217	0.753	0.129	1.02
Ammonia Nitrogen	mg/L as N	-	1.8	<0.01	0.25	0.53	0.02	<0.01	<0.01	0.15	0.2	<0.01	0.05	0.07	0.01	<0.01	0.08	0.02	0.07
POLLUTANT TESTS																			
Chemical Oxygen Demand	mg/L as O	-	-	20	19	211	<10	36	<10	<10	<10	<10	<10	<10	<10	<10	51	28	<10

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-10 to B-18.xlsx Table B-15 MW98-9

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 100 mg/L.

TABLE B-16
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW98-10
2016 to 2019

SAMPLE DATE LAB NAME	units	RECEIVING WATER CRITERIA		27-Jan-16	05-May-16	26-Jul-16	08-Nov-16	24-Jan-17	21-Apr-17	18-Jul-17	11-Oct-17	29-Jan-18	26-Apr-18	30-Jul-18	31-Oct-18	29-Jan-19	16-Apr-19	24-Jul-19	30-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	7.24		6.53	8.16	9.4			8.77	8.49		8.93	6.8	6.91		6.95
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	6.45	6.46		6.37	6.51	6.51			6.56	6.54		6.38	6.67	6.83		6.8
EC-Field	µS/cm	-	-	-	60	dry	52	43	33	dry	dry	28	49	dry	64	40	131	dry	62
EC-Lab	µS/cm	-	-	67	72		71	68	43			42	67		64	52	73		78
Dissolved Hardness (CaCO ₃)	mg/L	-	-	22	26		21	22	12.9			11	12.9		17.3	19.2	26.9		32.3
Total Dissolved Solids	mg/L	500	-	32	68		48	60	25			30	45		62	22	72		78
Temperature-Field	°C	-	-	-	10.56		12.67	6.88	7.91			7.06	9.45		12.47	8.23	9.3		12.63
DISSOLVED ANIONS																			
Alkalinity	mg/L CaCO ₃	-	-	-	30		22	28	11			13	29		14	24	33		33
Chloride	mg/L	250	150	1.14	0.95		1.19	0.94	0.76			1.02	0.88		0.63	0.73	1.32		1.18
Sulphate	mg/L	500	128	2	2.3		1.7	2.1	1.8			2	2.3		1.6	2	2.1		2.1
DISSOLVED CATIONS																			
Calcium	mg/L	-	-	5.89	6.8		5.53	5.96	3.53			3	6.18		4.77	5.36	7.38		9.06
Magnesium	mg/L	-	-	1.65	2.01		1.61	1.72	0.982			0.85	1.92		1.3	1.41	2.05		2.36
Potassium	mg/L	-	-	0.08	<0.05		0.07	<0.05	0.08			<0.05	0.07		0.17	0.05	0.09		0.11
Sodium	mg/L	200	-	5.16	4.79		5.09	4.3	3.36			2.78	4.18		4.44	4.78	4.96		7
ION BALANCE																			
Ion Balance	%	-	-	-4	-4		10	10	-17			8	3		4	-5	0		-20
DISSOLVED METALS																			
Arsenic	mg/L	0.010	0.005	0.0001	<0.0001		<0.0001	<0.0001	<0.0001			<0.0001	<0.0001		0.0001	0.0001	<0.0001		0.0003
Barium	mg/L	1	1	0.0013	0.0009		0.003	0.0006	0.0012			0.0009	0.0007		0.002	0.0012	0.0005		0.0018
Boron	mg/L	5	1.2	0.022	0.023		0.024	0.021	0.017			0.017	0.016		0.025	0.027	0.02		0.048
Cadmium	mg/L	0.005	0.00009	0.00002	<0.00001		0.00007	0.00002	<0.00001			0.00001	0.00001		0.00001	0.00001	<0.00001		<0.00001
Chromium	mg/L	0.05	0.001	0.0011	0.001		0.0009	0.0011	<0.0005			0.0006	0.0011		0.0008	0.0009	0.0014		0.002
Cobalt	mg/L	-	0.05	<0.00005	<0.00005		<0.00005	<0.00005	<0.00005			<0.00005	<0.00005		<0.00005	<0.00005	<0.00005		<0.00005
Copper	mg/L	1	0.002	0.0004	0.0003		0.0024	0.0006	0.0008			0.0005	0.0005		0.0002	0.0008	<0.0002		0.0006
Iron	mg/L	0.3	0.35	0.03	<0.01		<0.01	<0.01	<0.01			<0.01	0.01		<0.01	0.02	<0.01		<0.01
Lead	mg/L	0.005	0.004	<0.00005	<0.00005		<0.00005	<0.00005	<0.00005			<0.00005	<0.00005		<0.00005	<0.00005	<0.00005		<0.00005
Manganese	mg/L	0.02	0.74	<0.001	0.001		0.002	<0.001	<0.001			<0.001	0.002		0.002	0.002	0.001		0.006
Mercury	µg/L	1	0.02	<0.01	<0.01		0.03	<0.01	<0.01			<0.01	<0.01		-	-	<0.01		<0.01
Vanadium	mg/L	-	-	0.0016	0.0019		0.0015	0.0015	0.0008			0.0011	0.0023		0.0014	0.0015	0.0021		0.0027
Zinc	mg/L	5	0.01	<0.002	<0.002		0.003	0.002	<0.002			0.002	0.01		<0.002	0.002	<0.002		0.002
NUTRIENTS																			
Nitrate	mg/L as N	10	3	0.752	0.17		2.72	0.838	0.929			0.543	0.188		3.23	0.271	0.18		0.813
Ammonia Nitrogen	mg/L as N	-	1.8	0.03	<0.01		0.01	<0.01	<0.01			<0.01	<0.01		<0.01	<0.01	<0.01		0.05
POLLUTANT TESTS																			
Chemical Oxygen Demand	mg/L as O	-	-	24	25		<10	<10	<10			<10	<10		<10	<10	25		<10

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-10 to B-18.xlsx|Table B-16 MW98-10

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 30 mg/L.

TABLE B-17
SUMMARY OF INORGANIC CHEMISTRY DATA FOR BH00-4A
2009 to 2011

SAMPLE DATE	units	RECEIVING WATER CRITERIA		04-Feb-09	22-Apr-09	27-Jul-09	12-Nov-09	25-Feb-10	13-Apr-10	11-Aug-10	06-Dec-10	08-Feb-11
		GCDWQ ¹	AQUATIC LIFE ²	CANTEST	CANTEST	CANTEST	CANTEST	CANTEST	MAXXAM	MAXXAM	NORTH ISLAND	NORTH ISLAND
PHYSICAL TESTS												
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	9.17	9.15	8.27	8.38	8.71	8.62	10.03	8.5	9.04
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	9.02	9.01	8.98	8.99	9	8.9	8.9	9.1	9.2
EC-Field	µS/cm	-	-	641	682	696	654	748	679	698	775	688
EC-Lab	µS/cm	-	-	709	740	785	732	703	703	745	157	723
Total Hardness (CaCO ₃)	mg/L	-	-	11	8.6	8.7	7.8	7.6	6.9	8.8	8	7
Total Dissolved Solids	mg/L	500	-	485	472	490	478	466	380	440	556	406
Temperature-Field	°C	-	-	7.56	9.55	12.25	8.15	8.53	9.02	10.3	8.12	8.79
DISSOLVED ANIONS												
Chloride	mg/L	250	150	5.03	4.51	4.86	4.76	4.99	4.9	4.9	6.4	90.7
Sulphate	mg/L	500	128	177	190	210	181	188	170	180	1.4	2.4
DISSOLVED CATIONS												
Calcium	mg/L	-	-	3.6	2.91	2.89	2.63	2.55	2.27	2.98	2.8	2.5
Magnesium	mg/L	-	-	0.41	0.33	0.35	0.31	0.31	0.3	0.33	0.3	0.2
Potassium	mg/L	-	-	0.9	0.75	0.71	0.6	0.68	0.64	0.79	0.7	0.6
Sodium	mg/L	200	-	184	156	166	176	177	136	162	160	148
DISSOLVED METALS												
Arsenic	mg/L	0.010	0.005	0.026	0.02	0.023	0.022	0.031	0.0284	0.0328	0.0273	0.0266
Barium	mg/L	1	1	0.009	0.0071	0.0073	0.0059	0.0043	0.007	0.006	0.006	0.005
Boron	mg/L	5	1.2	2.39	1.83	2.57	1.84	1.84	1.98	1.87	2.086	1.855
Cadmium	mg/L	0.005	0.00009	<0.0002	<0.00004	<0.00004	0.00007	0.00003	0.00003	0.00026	0.00014	0.00009
Chromium	mg/L	0.05	0.001	<0.001	0.0006	0.0006	0.0006	0.0006	<0.001	<0.001	0.0008	0.0006
Cobalt	mg/L	-	0.05	<0.001	<0.0002	<0.0002	0.0001	<0.0001	<0.0005	<0.0005	0.00007	0.00007
Copper	mg/L	1	0.002	0.003	0.0036	0.0032	0.0029	0.0029	0.003	0.003	0.002	0.002
Iron	mg/L	0.3	0.35	0.05	0.08	0.08	0.16	0.13	0.336	0.171	0.032	0.026
Lead	mg/L	0.005	0.004	<0.001	<0.0002	<0.0002	0.00029	0.00023	0.0005	0.0008	0.0002	0.0001
Manganese	mg/L	0.02	0.74	0.004	0.0035	0.01	0.0029	0.0024	0.004	0.003	<0.001	<0.001
Mercury	µg/L	1	0.02	<20	<20	<20	<20	<0.02	<0.2	0.04	<0.01	0.01
Vanadium	mg/L	-	-	0.021	0.018	0.019	0.02	0.028	0.027	0.029	0.0265	0.0272
Zinc	mg/L	5	0.0075	<0.005	0.001	0.001	0.001	0.002	<0.005	0.006	0.002	<0.001
NUTRIENTS												
Nitrate	mg/L as N	10	3	0.72	0.71	0.96	0.87	0.88	0.68	0.77	0.8	<0.1
Ammonia Nitrogen	mg/L as N	-	1.8	0.02	0.04	0.02	0.02	0.02	0.03	0.023	0.02	0.05
POLLUTANT TESTS												
Chemical Oxygen Demand	mg/L as O	-	-	40	29	<20	60	40	<10	36	40	20

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-10 to B-18.xlsx\Table B-17 BH00-4A

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples.

Guidelines shown are based on average hardness of less than 30 mg/L.

3. BH00-4A has been inaccessible since February 2011.

4. Lab conductance results in the 06-Dec-10 and 08-Feb-11, and chloride results in the 08-Feb-11 analyses are suspect.

PITEAU ASSOCIATES

Geotechnical and Water Management Consultants

TABLE B-18
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW02-1S
2013 to 2015

SAMPLE DATE LAB NAME	units	RECEIVING WATER CRITERIA		17-Jan-13	09-May-13	16-Jul-13	24-Oct-13	05-Feb-14	21-May-14	21-Aug-14	12-Dec-14	28-Jan-15	07-May-15	
		GCDWQ ¹	AQUATIC LIFE ²	NORTH ISLAND	AGAT	AGAT								
PHYSICAL TESTS														
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	7.19	7.12	7.14	-	6.72	6.71	-	6.96	6.53	6.52	Damaged since Jul-15
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	6.3	6.2	6.3	6.3	6.34	6.55	6.36	5.73	5.96	6.51	
EC-Field	µS/cm	-	-	64	64	75	-	7.6	77	-	40	103	86	
EC-Lab	µS/cm	-	-	73.3	75	74	80	88	91	95	44	106	87	
Dissolved Hardness (CaCO ₃)	mg/L	-	-	31	30	36	29	32	33	30	31	40.8	36.5	
Total Dissolved Solids	mg/L	500	-	40	60	40	48	40	115	49	28	63	23	
Temperature-Field	°C	-	-	7.49	8.69	8.83	-	8.36	8.94	-	9.39	8.5	9.36	
DISSOLVED ANIONS														
Chloride	mg/L	250	150	1.7	1.16	1.1	1.3	1.56	1.43	1.41	1.73	1.85	1.08	
Sulphate	mg/L	500	128	1.5	1.6	1.6	1.8	1.9	2	2	1.7	2.3	2.3	
DISSOLVED CATIONS														
Calcium	mg/L	-	-	9.46	9.78	8.78	8.99	12.2	11.1	7.61	4.44	12	10.6	
Magnesium	mg/L	-	-	2.07	2.14	1.95	2.09	2.56	2.48	1.99	1.14	2.62	2.43	
Potassium	mg/L	-	-	0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	
Sodium	mg/L	200	-	2.1	2.4	2.3	2.4	2.79	2.54	2.7	2.1	3.46	2.49	
DISSOLVED METALS														
Arsenic	mg/L	0.010	0.005	<0.0002	<0.0002	<0.0002	<0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	
Barium	mg/L	1	1	0.002	0.002	0.001	0.001	0.00141	0.0017	0.0018	0.0044	0.0026	0.0024	
Boron	mg/L	5	1.2	0.038	0.022	0.012	0.014	0.017	0.014	0.012	0.014	0.022	0.016	
Cadmium	mg/L	0.005	0.00009	0.00003	0.00002	0.00001	0.00002	0.00001	0.00002	0.00002	0.00004	<0.00001	<0.00001	
Chromium	mg/L	0.05	0.001	0.0006	0.0004	<0.0004	<0.0004	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	
Cobalt	mg/L	-	0.05	<0.00002	0.00008	0.00004	<0.00002	<0.00005	<0.00005	<0.00005	0.0533	0.00006	0.00016	
Copper	mg/L	1	0.002	<0.001	<0.001	<0.001	<0.001	<0.0002	0.0002	0.0005	0.0006	0.0003	0.0004	
Iron	mg/L	0.3	0.35	<0.005	<0.005	<0.005	0.014	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Lead	mg/L	0.005	0.004	<0.0001	<0.0001	<0.0001	<0.0001	<0.00001	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	
Manganese	mg/L	0.02	0.737	0.017	0.0076	0.0141	0.006	0.003	0.002	<0.001	0.012	0.002	0.003	
Mercury	µg/L	1	0.02	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Vanadium	mg/L	-	-	0.00046	0.00053	0.00058	0.00046	0.0004	<0.0005	<0.0005	<0.0005	0.0006	0.0006	
Zinc	mg/L	5	0.0075	0.008	0.004	0.001	<0.001	0.001	0.002	0.003	0.005	0.006	0.002	
NUTRIENTS														
Nitrate	mg/L as N	10	3	0.11	0.06	0.07	0.19	0.236	0.482	0.309	0.068	0.475	0.735	
Ammonia Nitrogen	mg/L as N	-	1.8	0.11	<0.01	0.03	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
POLLUTANT TESTS														
Chemical Oxygen Demand	mg/L as O	-	-	<10	16	<10	28	<10	<10	<10	<10	10	<10	

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NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples.

Guidelines shown are based on average hardness of 30 mg/L.

TABLE B-19
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW02-1D
2016 to 2019

SAMPLE DATE	units	RECEIVING WATER CRITERIA		27-Jan-16	10-May-16	26-Jul-16	08-Nov-16	24-Jan-17	21-Apr-17	20-Jul-17	12-Oct-17	29-Jan-18	25-Apr-18	30-Jul-18	31-Oct-18	29-Jan-19	16-Apr-19	25-Jul-19	30-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	7.16	6.35	6.16	7.25	7.56	8.77	8.93	8.2	6.97	8.56	8.61	6.04	6.78	-	6.95
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	6.16	6.72	6.94	6.17	6.77	7.43	7.3	7.48	6.94	6.77	7.53	7.58	6.47	6.85	7.62	7.65
EC-Field	µS/cm	-	-	-	100	100	33	76	71	113	146	82	70	173	110	32	83	-	121
EC-Lab	µS/cm	-	-	23	125	149	33	116	117	139	192	125	101	216	177	32	114	162	190
Dissolved Hardness (CaCO ₃)	mg/L	-	-	8.5	42.1	34.7	10.5	32.6	31.3	29.8	18.2	23.8	28	12	15	10.3	30.2	23.6	4.2
Total Dissolved Solids	mg/L	500	-	18	82	78	28	95	60	88	103	70	65	106	130	20	68	98	108
Temperature-Field	°C	-	-	-	9.56	11.27	11.45	7.71	7.71	9.75	8.33	7.05	10.03	11.07	8.75	8.11	8.75	-	7.74
DISSOLVED ANIONS																			
Alkalinity	mg/L CaCO ₃	-	-	-	49	67	11	53	54	72	95	57	47	102	84	12	53	78	88
Chloride	mg/L	250	150	1.26	1.19	1.65	2.04	1.54	1.41	1.37	3.55	1.94	1.55	4.31	3.42	1.8	2.07	3.15	5.47
Sulphate	mg/L	500	218	0.8	7.8	4.7	0.8	2.7	3.2	3	4.4	2.5	2.3	4.4	3.7	0.9	2.5	3.4	4.4
DISSOLVED CATIONS																			
Calcium	mg/L	-	-	2.15	12.3	10.1	2.61	9.51	9.04	8.62	5.26	6.86	8.08	3.47	4.41	2.64	8.98	6.93	1.21
Magnesium	mg/L	-	-	0.75	2.77	2.29	0.96	2.15	2.13	2	1.22	1.63	1.89	0.8	0.97	0.9	1.89	1.53	0.28
Potassium	mg/L	-	-	0.17	0.21	0.3	0.16	0.17	0.184	0.19	0.25	0.16	0.14	0.37	0.43	0.21	0.4	0.3	0.09
Sodium	mg/L	200	-	1.04	7.71	18.5	1.31	10.8	12.8	18.6	36	12.9	10.9	47.3	36.7	1.98	13.6	27.4	36.5
ION BALANCE																			
Ion Balance	%	-	-	5	3	1	8	6	2	10	9	18	1	-2	-2	4	-2	-4	17
DISSOLVED METALS																			
Arsenic	mg/L	0.010	0.005	<0.0001	0.0001	0.0005	<0.0001	0.0005	0.0005	0.0008	0.0024	0.0009	0.0005	0.0049	0.0037	0.0001	0.0006	0.0011	0.0025
Barium	mg/L	1	1	0.0018	0.0042	0.0142	0.0027	0.0082	0.0084	0.0089	0.01	0.015	0.0095	0.0088	0.0063	0.0031	0.0056	0.0055	0.0059
Boron	mg/L	5	1.2	0.009	0.02	0.552	0.01	0.226	0.283	0.366	0.997	0.288	0.177	1.59	0.977	0.022	0.238	0.758	1.23
Cadmium	mg/L	0.005	0.00011	<0.00001	0.00002	0.00003	0.00006	0.00018	0.00006	0.00011	0.00001	0.00006	0.00002	<0.00001	<0.00001	0.00002	0.0001	0.00002	0.00002
Chromium	mg/L	0.05	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	-	0.05	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00008	<0.00005	<0.00005	<0.00005
Copper	mg/L	1	0.002	0.0009	0.0004	<0.0002	0.0012	0.0012	0.0005	0.0006	0.0009	0.0005	0.0005	0.0003	0.0017	0.0017	0.0003	0.0012	0.0006
Iron	mg/L	0.3	0.35	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	<0.01	<0.01
Lead	mg/L	0.005	0.004	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.00042	<0.00005	0.00005	<0.00005
Manganese	mg/L	0.02	0.78	0.04	0.02	0.098	0.005	0.049	0.05	0.034	0.005	0.041	0.027	0.037	0.039	0.008	0.009	0.007	0.004
Mercury	µg/L	1	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-	<0.0005	<0.0005	0.0008	<0.0005	<0.0005	0.0007	0.0009	0.002	0.0008	0.0007	0.0031	0.0022	<0.0005	0.0007	0.0012	0.0025
Zinc	mg/L	5	0.0075	0.005	0.004	0.004	0.005	0.006	0.007	0.005	0.002	0.011	0.007	<0.002	0.004	0.006	0.004	0.002	<0.002
NUTRIENTS																			
Nitrate	mg/L as N	10	3.0	<0.005	0.573	0.418	0.009	0.455	0.362	0.326	0.273	0.345	0.23	0.152	0.289	0.021	0.144	0.165	0.197
Ammonia Nitrogen	mg/L as N	-	1.8	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	<0.01	<0.01	0.04
POLLUTANT TESTS																			
Chemical Oxygen Demand	mg/L as O	-	-	15	<10	<10	<10	<10	<10	24	<10	<10	<10	<10	16	<10	<10	<10	<10

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-19 to B-29.xlsx|Table B-19 MW02-1D

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 40 mg/L.

TABLE B-20
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW02-2
2009 to 2011

SAMPLE DATE LAB NAME	units	RECEIVING WATER CRITERIA		04-Feb-09	22-Apr-09	27-Jul-09	10-Nov-09	08-Feb-10	14-Apr-10	10-Aug-10	06-Dec-10	08-Feb-11	09-May-11	26-Jul-11
		GCDWQ ¹	AQUATIC LIFE ²	CANTEST	CANTEST	CANTEST	CANTEST	CANTEST	MAXXAM	MAXXAM	NORTH ISLAND	NORTH ISLAND	NORTH ISLAND	NORTH ISLAND
PHYSICAL TESTS														
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	6.56	7.3	6.98	6.77	6.9	7.28	8.1	6.78	7.49	7.43	7.93
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	7.33	7.96	7.32	7.34	7.66	7.9	7.57	6.9	6.9	7.7	7.8
EC-Field	µS/cm	-	-	154	221	152	127	172	184	174	167	176	235	110
EC-Lab	µS/cm	-	-	172	235	169	166	176	196	171	173.6	191.4	242	237
Total Hardness (CaCO ₃)	mg/L	-	-	-	-	72.5	-	-	92.2	84.1	-	-	-	-
Total Dissolved Solids	mg/L	500	-	135	111	103	111	109	110	96	120	124	134	148
Temperature-Field	°C	-	-	9.69	10.54	11.65	11.2	10.52	10.71	11.74	11.16	10.63	10.86	11.34
DISSOLVED ANIONS														
Chloride	mg/L	250	150	1.49	1.53	1.39	1.47	1.4	1	1	<2	1.5	<2	<2
Sulphate	mg/L	500	218	0.71	1.09	0.61	<0.5	0.63	<0.5	<0.5	<2	0.45	2	<2
DISSOLVED CATIONS														
Calcium	mg/L	-	-	29.9	37.3	21.8	22.7	27.2	28.5	25.4	23	28.1	36.9	38.6
Magnesium	mg/L	-	-	5.56	6.01	4.39	4.41	4.44	5.09	5.02	4.7	5.5	5.7	6.2
Potassium	mg/L	-	-	0.3	0.2	0.19	0.2	0.19	0.19	0.2	0.2	0.2	0.2	0.2
Sodium	mg/L	200	-	3.91	2.72	3.95	4.01	3.23	3.12	3.5	3.5	3.6	2.9	2.6
DISSOLVED METALS														
Arsenic	mg/L	0.010	0.005	<0.001	0.0003	0.0003	0.0002	<0.0002	<0.0001	<0.0001	<0.0002	<0.0002	<0.0002	0.0002
Barium	mg/L	1	1	0.002	0.002	0.0022	0.0021	0.002	0.002	0.002	0.002	0.002	0.002	0.002
Boron	mg/L	5	1.2	<0.05	0.03	0.03	0.018	0.027	<0.05	<0.05	0.02	0.018	0.04	0.03
Cadmium	mg/L	0.005	0.000179	<0.0002	<0.00004	0.00013	0.00002	0.00003	<0.1	0.00004	0.00003	0.00002	0.00008	0.00003
Chromium	mg/L	0.05	<0.001	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.001	<0.001	<0.0004	<0.0004	0.0369	<0.0004
Cobalt	mg/L	-	0.05	<0.001	<0.0002	0.0005	0.0004	0.0004	<0.0005	<0.0005	0.00056	0.0003	0.00007	0.00006
Copper	mg/L	1	0.003	<0.001	0.0003	0.0008	0.0001	0.0003	0.0004	<0.0002	<0.001	<0.001	<0.001	<0.001
Iron	mg/L	0.3	0.35	<0.01	<0.01	<0.05	<0.01	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Lead	mg/L	0.005	0.006	<0.001	<0.0002	<0.0002	<0.00005	<0.00005	<0.0002	<0.0002	<0.0001	<0.0001	<0.0001	<0.0001
Manganese	mg/L	0.02	0.96	0.26	0.029	0.19	0.208	0.155	0.145	0.154	0.187	0.184	0.024	0.024
Mercury	µg/L	1	0.02	<20	<20	<20	<20	<0.02	<0.02	<0.02	<0.01	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-	-	-	-	-	<0.0001	<0.005	<0.005	0.0001	0.0001	0.0012	0.0012
Zinc	mg/L	5	0.0075	<0.005	<0.001	0.003	0.003	0.002	<0.005	<0.005	0.002	0.003	0.003	0.002
NUTRIENTS														
Nitrate	mg/L as N	10	3.0	<0.05	<0.05	<0.05	<0.05	<0.05	<0.02	<0.02	<0.1	<0.01	<0.1	<0.1
Ammonia Nitrogen	mg/L as N	-	1.8	<0.01	<0.01	0.02	0.03	<0.01	0.01	<0.05	0.02	<0.01	<0.01	0.03
POLLUTANT TESTS														
Chemical Oxygen Demand	mg/L as O	-	-	<20	<20	<20	<20	25	12	20	<10	20	<10	<10

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-19 to B-29.xlsx|Table B-20 MW02-2

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq_wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate and zinc are based on total hardness, which varies between samples.

Guidelines shown are based on average hardness of 80 mg/L.

3. Ammonia Reportable Detection Limit (RDL) raised for 10-Aug-10 sample due to interference from sample matrix.

4. Well vandalized after July 2011 sampling event.

TABLE B-21
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW02-4
2016 to 2019

SAMPLE DATE	units	RECEIVING WATER CRITERIA		27-Jan-16	10-May-16	26-Jul-16	08-Nov-16	24-Jan-17	21-Apr-17	20-Jul-17	12-Oct-17	30-Jan-18	25-Apr-18	30-Jul-18	31-Oct-18	29-Jan-19	16-Apr-19	25-Jul-19	30-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	7.16	6.03	7.64	8.29	8.44	7.26	7.73	7.81	8.91	8.36	8.35	6.37	6.9	-	6.36
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	7.44	7.39	7.53	7.7	7.63	7.95	8.07	7.61	7.42	7.42	7.09	7.53	7.7	7.4	7.66	7.54
EC-Field	µS/cm	-	-	-	391	443	363	346	341	337	398	408	414	404	390	369	372	-	349
EC-Lab	µS/cm	-	-	602	601	542	524	514	508	500	504	577	579	565	569	554	570	542	554
Dissolved Hardness (CaCO ₃)	mg/L	-	-	185	144	135	128	127	122	115	126	171	169	144	150	136	143	137	132
Total Dissolved Solids	mg/L	500	-	330	350	330	322	332	285	262	288	318	348	338	335	295	320	272	310
Temperature-Field	°C	-	-	-	9.3	12.23	9.97	7.26	8.38	9.96	9.43	7.99	9.21	11.58	9.55	8.15	8.93	-	8.27
DISSOLVED ANIONS																			
Alkalinity	mg/L CaCO ₃	-	-	-	158	143	140	144	150	156	149	127	127	127	134	131	131	132	120
Chloride	mg/L	250	150	95	87.2	76	67.2	62.8	65.8	64.5	64.1	101	95.9	92.3	88.4	89.8	87.5	84.5	88.8
Sulphate	mg/L	500	309	15.2	13.8	14.6	13.3	14.3	14.6	14	15.5	13.4	14	14	14.3	13	13.1	13.2	14.9
DISSOLVED CATIONS																			
Calcium	mg/L	-	-	61	47.1	44.1	41.4	41.3	39.7	37.4	40.8	56.2	55.4	47.1	49.5	44.7	47.4	45.2	43.6
Magnesium	mg/L	-	-	7.93	6.31	5.99	5.96	5.68	5.58	5.16	5.76	7.45	7.38	6.36	6.43	5.96	5.96	5.97	5.64
Potassium	mg/L	-	-	0.76	0.95	1.08	0.94	0.94	0.877	0.93	0.89	0.55	0.51	0.77	0.79	0.91	0.99	0.87	0.87
Sodium	mg/L	200	-	47.7	64.1	54.5	53	53.5	51.5	56.5	51.2	40.2	40.4	47.3	44.9	54.3	54.3	55.4	58.3
ION BALANCE																			
Ion Balance	%	-	-	2	4	4	2	1	9	9	7	9	7	9	9	6	2	-2	0
DISSOLVED METALS																			
Arsenic	mg/L	0.010	0.005	0.0009	0.0003	0.0023	0.0033	0.0015	0.0009	0.0013	0.0012	0.0008	0.0007	0.001	0.0012	0.0015	0.0011	0.0008	0.0033
Barium	mg/L	1	1	0.0349	0.0432	0.0305	0.0294	0.0296	0.031	0.0266	0.0319	0.0317	0.0252	0.023	0.0256	0.028	0.0274	0.0279	0.0219
Boron	mg/L	5	1.2	0.53	0.67	0.696	0.6	0.599	0.637	0.68	0.694	0.476	0.474	0.581	0.559	0.579	0.588	0.632	0.621
Cadmium	mg/L	0.005	0.00030	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	0.00001	0.00002
Chromium	mg/L	0.05	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	mg/L	-	0.05	<0.00005	<0.00005	<0.00005	0.0002	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Copper	mg/L	1	0.006	0.0004	0.0004	<0.0002	0.0042	0.0011	<0.0002	0.0002	0.0012	0.0006	0.0002	0.0004	0.0006	0.0009	<0.0002	<0.0002	0.0009
Iron	mg/L	0.3	0.35	0.03	<0.01	<0.01	0.56	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Lead	mg/L	0.01	0.009	<0.00005	<0.00005	<0.00005	0.0005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Manganese	mg/L	0.02	1.3	<0.001	0.001	<0.001	0.053	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	0.002	<0.001	<0.001	0.002	<0.001
Mercury	µg/L	1	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	-	-	<0.01	<0.01	<0.01
Vanadium	mg/L	-	-	0.0006	<0.0005	0.0012	0.002	<0.0005	0.0005	0.0009	0.0006	0.0007	0.0005	0.0006	0.0005	0.001	0.0008	0.0006	0.0018
Zinc	mg/L	5	0.06	0.002	<0.002	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	0.002	0.003	0.004	0.003	0.009	0.008	0.006	0.003
NUTRIENTS																			
Nitrate	mg/L as N	10	3.0	0.039	<0.005	0.048	0.008	0.026	0.02	<0.005	<0.005	0.033	0.029	<0.005	<0.005	0.008	<0.005	<0.005	0.052
Ammonia Nitrogen	mg/L as N	-	1.8	0.02	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04
POLLUTANT TESTS																			
Chemical Oxygen Demand	mg/L as O	-	-	13	<10	<10	<10	<10	<10	23	<10	<10	<10	19	15	<10	<10	14	<10

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-19 to B-29.xlsx\Table B-21 MW02-4

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 160 mg/L.

TABLE B-22
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW05-1
2016 to 2019

LOCATION	units	RECEIVING WATER CRITERIA		MW05-1S	MW05-1S	MW05-1S	MW05-1S	MW05-1S	MW05-1S	MW05-1S	MW05-1S	MW05-1S	MW05-1S	MW05-1S	MW05-1S	MW05-1S	MW05-1S	MW05-1S	
				28-Jan-16	10-May-16	27-Jul-16	08-Nov-16	23-Jan-17	20-Apr-17	19-Jul-17	11-Oct-17	30-Jan-18	25-Apr-18	30-Jul-18	31-Oct-18	30-Jan-19	17-Apr-19	24-Jul-19	31-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	6.65	6.13	7.09	7.34	7.24	7.52	7.2	7.44	7.45	7.16	7.37	6.77	7.19	-	7.19
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	7.22	7.05	6.98	7.2	7.14	7.64	7.35	6.97	7.22	7.04	6.92	7.13	7.27	7.1	7.39	7.16
EC-Field	µS/cm	-	-	-	300	675	311	559	325	347	341	328	298	314	302	272	274	-	279
EC-Lab	µS/cm	-	-	439	435	427	423	443	458	460	470	428	397	415	430	392	400	401	401
Total Dissolved Solids	mg/L	500	-	240	265	252	248	292	250	260	262	245	235	245	230	238	238	228	245
Temperature-Field	°C	-	-	-	11.25	14.63	11.63	9.05	10.95	11.88	11.79	10.44	10.73	12.61	12.09	10.34	11.05	-	10.85
DISSOLVED ANIONS																			
Chloride	mg/L	250	150	14.7	16.2	17.7	16	15.5	15.5	15.7	16.5	11.3	10.6	11.6	11.7	10	8.76	9.59	8.07
Sulphate	mg/L	500	128	15.6	19.6	20.2	21.6	21.3	21.4	21.5	24.1	20.3	20.9	21	20.6	18.7	19	19.3	19
NUTRIENTS																			
Nitrate	mg/L as N	10	3	6.8	4	2.05	0.716	1.17	2.7	2.37	1.15	0.31	0.402	0.132	0.027	0.376	0.033	0.015	<0.005
Ammonia Nitrogen	mg/L as N	-	1.8	0.08	0.05	0.09	<0.01	0.04	<0.01	<0.01	0.1	0.11	<0.01	<0.01	<0.01	<0.01	0.09	0.03	0.06

LOCATION	units	RECEIVING WATER CRITERIA		MW05-1D	MW05-1D	MW05-1D	MW05-1D	MW05-1D	MW05-1D	MW05-1D	MW05-1D	MW05-1D	MW05-1D	MW05-1D	MW05-1D	MW05-1D	MW05-1D	MW05-1D	MW05-1D
				28-Jan-16	10-May-16	27-Jul-16	08-Nov-16	23-Jan-17	20-Apr-17	19-Jul-17	11-Oct-17	30-Jan-18	25-Apr-18	30-Jul-18	31-Oct-18	30-Jan-19	17-Apr-19	24-Jul-19	31-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	6.83	6.18	7.36	7.25	7.15	7.39	7.1	7.26	7.25	6.94	7.27	6.48	7.06	-	7.21
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	7.7	7.4	7.42	7.76	7.81	8.13	7.85	7.64	7.69	7.69	7.34	7.62	7.8	7.74	7.93	7.86
EC-Field	µS/cm	-	-	-	612	320	630	297	573	620	637	605	601	687	390	513	525	-	54
EC-Lab	µS/cm	-	-	832	886	885	829	848	783	817	845	915	865	907	536	782	787	813	802
Total Dissolved Solids	mg/L	500	-	450	518	485	475	510	448	452	488	510	482	518	305	458	442	462	482
Temperature-Field	°C	-	-	-	11.04	13.33	13.88	9.94	9.92	14.37	13.64	8.94	10.51	14.17	14.02	9.52	10.29	-	10.69
DISSOLVED ANIONS																			
Chloride	mg/L	250	150	45.3	45.7	44.2	40.9	42.7	41.8	39.8	44.1	38.8	37.7	38.5	22.5	33.7	32.6	33.8	32.7
Sulphate	mg/L	500	128	8.1	8.5	8.6	7.9	8.6	8.4	8.1	9.3	9	10.2	10.6	6.2	9.5	9.8	10.5	10.6
NUTRIENTS																			
Nitrate	mg/L as N	10	3.0	0.261	<0.005	<0.005	0.27	0.11	0.291	0.056	0.202	<0.005	0.1	0.023	0.183	0.098	0.182	0.367	0.384
Ammonia Nitrogen	mg/L as N	-	1.8	0.08	0.04	0.41	0.02	0.03	0.03	0.4	0.18	0.03	<0.01	0.13	0.03	0.01	0.04	0.04	0.04

H:\Project1005\Analysis\Chemistry\2019\Tables_B-19 to B-29.xlsx|Table B-22 MW05-1

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guideline for sulphate is based on total hardness, which varies between samples. Guidelines shown are based on hardness of less than 30 mg/L.

TABLE B-23
SUMMARY OF INORGANIC CHEMISTRY DATA FOR PW-1 AND PW-2
2016 to 2019

LOCATION	units	RECEIVING WATER CRITERIA		PW-1	PW-1	PW-1	PW-1	PW-1	PW-1	PW-1	PW-1	PW-1	PW-1	PW-1	PW-1	PW-1	PW-1	PW-1	
				28-Jan-16	10-May-16	27-Jul-16	09-Nov-16	28-Jan-16	20-Apr-17	10-Jul-17	04-Oct-17	30-Jan-18	25-Apr-18	30-Jul-18	31-Oct-18	30-Jan-19	17-Apr-19	24-Jul-19	31-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²		AGAT	AGAT													
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	Not	7.26	5.93	7.05	6.89	6.91	7.07	6.39	7.1	7.93	7.04	7.01	6.23	6.97	-	6.92
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	Sampled	7.14	6.97	7.39	7.26	7.83	7.51	7.46	7.4	7.31	7.14	7.25	7.36	7.26	7.62	7.53
EC-Field	µS/cm	-	-		878	900	769	765	784	809	764	742	778	834	758	676	708	-	569
EC-Lab	µS/cm	-	-		1250	1290	1110	1200	1090	1150	1110	1110	1080	1090	1080	1040	1040	934	848
Total Dissolved Solids	mg/L	500	-		730	738	662	708	630	638	648	632	618	610	622	602	592	522	490
Temperature-Field	°C	-	-		11.55	11.79	10.96	9.28	10.51	11.85	11.1	9.71	11.02	14.48	10.84	9.94	10.38	-	10.67
DISSOLVED ANIONS																			
Chloride	mg/L	250	150.00		57.2	67.1	50.7	53.4	50.5	49.4	50.9	45.9	42.5	42.2	41.1	38.6	36.7	44.8	44
Sulphate	mg/L	500	309		9.4	8.9	10.9	10.4	7.4	9.6	7.5	9.9	10.8	6.9	5.9	11.2	10.6	10.4	11.1
NUTRIENTS																			
Nitrate	mg/L as N	10	3		0.087	0.15	<0.005	<0.005	0.08	0.012	0.13	<0.005	0.022	0.044	0.021	0.06	0.029	<0.005	<0.005
Ammonia Nitrogen	mg/L as N	-	1.8		1.8	1.59	0.8	1.02	0.98	0.11	1.07	1.13	1.14	1.19	1.29	1.03	1.0	0.61	0.7

LOCATION	units	RECEIVING WATER CRITERIA		PW-2															
				28-Jan-16	10-May-16	27-Jul-16	09-Nov-16	23-Jan-17	20-Apr-17	10-Jul-17	04-Oct-17	30-Jan-18	25-Apr-18	30-Jul-18	31-Oct-18	30-Jan-19	17-Apr-19	24-Jul-19	31-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT															
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	6.57	5.85	6.73	6.81	6.76	6.62	6	6.86	7.59	6.57	6.48	6.01	6.51	-	6.41
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	6.97	6.55	6.82	6.85	6.74	6.73	6.97	6.76	6.84	6.67	6.64	6.66	6.75	6.78	6.84	6.8
EC-Field	µS/cm	-	-		1243	1239	826	747	1143	1675	1727	850	1232	2511	2382	1087	2777	-	2653
EC-Lab	µS/cm	-	-	1040	1950	1520	1090	959	1380	2140	2130	1150	1500	3230	3200	1490	3870	3680	3440
Total Dissolved Solids	mg/L	500	-	532	1070	812	590	558	800	1150	1130	660	822	1750	1720	798	1920	1890	1720
Temperature-Field	°C	-	-		11.83	12.7	12.85	10.25	10.47	12.22	12.27	9.15	10.81	13.04	13.12	10.22	11.2	-	12.68
DISSOLVED ANIONS																			
Chloride	mg/L	250	150	43.4	166	97.4	59.6	56.9	128	229	219	77.5	118	356	361	120	400	395	361
Sulphate	mg/L	500	309	3.3	2.4	3.5	13.3	10.4	4.9	2.4	0.8	16	11.5	<0.5	0.7	6.2	0.7	<0.5	0.7
NUTRIENTS																			
Nitrate	mg/L as N	10	3.0	0.051	<0.005	0.06	<0.005	<0.005	<0.005	<0.005	0.1	<0.005	<0.005	0.033	0.056	0.03	<0.005	0.14	<0.005
Ammonia Nitrogen	mg/L as N	-	1.8	10.2	24.9	25.7	18.4	13.5	14.8	34.2	45	13.7	30.4	59.3	82.8	26.8	84.9	95.5	112

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-19 to B-29.xlsx|Table B-23 PW1-2

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guideline for sulphate is based on total hardness, which varies between samples. Guidelines shown are based on hardness of 150 mg/L, conservatively based on MW02-3S and MW02-3D

TABLE B-24
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW13-1D
2015 to 2019

SAMPLE DATE	units	RECEIVING WATER CRITERIA		29-Jan-15	08-May-15	30-Jul-15	03-Dec-15	28-Jan-16	10-May-16	27-Jul-16	09-Nov-16	20-Jul-17	30-Jul-18	25-Jul-19	31-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT	AGAT							
PHYSICAL TESTS															
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	8.73	7.59	7.88	-	-	8.43	6.51	7.57	7.85	7.82		7.62
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	7.93	7.87	7.73	8.04	7.79	7.66	7.53	7.6	7.84	7.59		7.79
EC-Field	µS/cm	-	-	3524	2597	1722	-	-	591	732	713	650	664	dry	456
EC-Lab	µS/cm	-	-	3780	2660	1820	1290	1200	953	1030	1010	928	958		700
Dissolved Hardness (CaCO ₃)	mg/L	-	-	307	163	107	70.1	74.7	60.7	108	116	96.2	85.7		66.1
Total Dissolved Solids	mg/L	500	-	2880	1980	1300	872	770	605	648	662	588	612		440
Temperature-Field	°C	-	-	9.15	9.72	11.25	-	-	11.55	11.68	9.82	11.1	10.7		8.59
DISSOLVED ANIONS															
Alkalinity	mg/L CaCO ₃	-	-	-	-	-	-	-	343	284	273	301	383		228
Chloride	mg/L	250	150	192	91.6	65.3	62.4	59.7	63.8	64.6	68.2	77.3	74.9		72.6
Sulphate	mg/L	500	309	1060	780	431	258	179	64.2	145	130	67.9	8.7		18.5
DISSOLVED CATIONS															
Calcium	mg/L	-	-	106	56.2	36.4	23	25	20.3	36.1	39.3	32.9	29		22.4
Magnesium	mg/L	-	-	10.2	5.48	3.81	3.08	2.97	2.44	4.22	4.3	3.42	3.22		2.46
Sodium	mg/L	200	-	1020	627	412	295	283	204	204	187	172	180		125
ION BALANCE															
Ion Balance	%	-	-	-	-	-	-	-8	-2	-5	-4	2	4		3
DISSOLVED METALS															
Aluminum	mg/L	0.1	0.05	0.02	0.013	0.009	0.004	0.004	0.002	0.004	<0.002	0.003	0.007		<0.002
Antimony	mg/L	0.006	0.02	0.0014	0.0014	0.001	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002		<0.0002
Arsenic	mg/L	0.010	0.005	0.0442	0.0303	0.0269	0.0115	0.0096	0.0073	0.0028	0.0014	0.0024	0.0039		0.004
Barium	mg/L	1	1	0.108	0.058	0.0497	0.0385	0.0414	0.0439	0.0833	0.095	0.0692	0.0825		0.0672
Boron	mg/L	5	1.2	0.384	0.442	0.314	0.264	0.319	0.289	0.251	0.291	0.252	0.299		0.241
Cadmium	mg/L	0.005	0.00021	0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001		<0.00001
Chromium	mg/L	0.05	0.001	0.0009	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005		<0.0005
Cobalt	mg/L	-	0.05	0.00189	0.00118	0.00053	0.00054	0.00042	0.00019	0.00114	0.00071	0.00011	0.00009		0.0001
Copper	mg/L	1	0.00	0.0005	<0.0002	<0.0002	0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	<0.0002		0.0005
Iron	mg/L	0.3	0.35	0.153	0.092	0.03	0.02	0.02	0.01	0.06	0.07	0.04	0.1		1.04
Lead	mg/L	0.005	0.006	0.00022	0.00009	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005		<0.00005
Manganese	mg/L	0.02	1.045	1.65	1.02	0.843	1	0.966	1.05	2.72	3.56	2.38	1.85		0.857
Mercury	µg/L	1	0.02	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01		<0.01
Molybdenum	mg/L	-	2	0.00832	0.0053	0.00396	0.0072	0.00599	0.00169	0.0114	0.0182	0.00036	0.00028		0.00414
Nickel	mg/L	-	0.15	0.01	0.0061	0.0036	0.0021	0.0021	0.0014	0.0022	0.0025	0.0014	0.0013		0.0021
Selenium	mg/L	0.01	-	0.0007	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0007		<0.0005
Thallium	mg/L	-	0.0003	0.00002	<0.00001	0.00002	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001		<0.00001
Titanium	mg/L	-	2	0.007	0.0035	0.003	0.0014	0.0015	0.0019	0.0012	0.0013	0.002	0.0022		0.0024
Uranium	mg/L	0.02	0.033	0.061	0.0322	0.0185	0.0129	0.0124	0.00724	0.0283	0.0226	0.00516	0.00392		0.00343
Zinc	mg/L	5	0.015	0.004	<0.002	<0.002	<0.002	0.004	<0.002	<0.002	<0.002	0.005	<0.002		<0.002
NUTRIENTS															
Nitrate	mg/L as N	10	3.0	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	0.007		<0.005
Ammonia Nitrogen	mg/L as N	-	1.80	0.04	0.01	<0.01	<0.01	0.02	0.005	0.01	0.04	<0.01	0.19		-
POLLUTANT TESTS															
Chemical Oxygen Demand	mg/L as O	-	-	800	470	242	197	151	114	106	113	126	156		109
Total Organic Carbon	mg/L as O	-	-	-	-	-	-	40.4	-	30	-	-	-		-

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-19 to B-29.xlsx\Table B-24 MW13-1D

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 100 mg/L.

TABLE B-25
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW13-2D
2013 to 2016

SAMPLE DATE	units	RECEIVING WATER CRITERIA		01-Jun-13	10-Sep-13	12-Dec-14	29-Jan-15	08-May-15	30-Jul-15	03-Dec-15	28-Jan-16	10-May-16	27-Jul-16	09-Nov-16
		GCDWQ ¹	AQUATIC LIFE ²	ALS	ALS	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS														
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	-	10.39	9.74	8.91	7.58	-	-	8.15	6.3	8.96
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	8	7.65	9.28	8.78	8.97	7.75	8.16	8.01	7.98	7.93	8
EC-Field	µS/cm	-	-	-	-	170	161	228	572	-	-	1722	1422	78
EC-Lab	µS/cm	-	-	370	5810	186	130	207	608	2580	3070	2540	2050	96
Dissolved Hardness (CaCO ₃)	mg/L	-	-	-	-	13.5	26.8	18.3	44.8	205	202	130	109	25.3
Total Dissolved Solids	mg/L	500	-	258	4180	96	70	88	403	2000	2260	1890	1460	58
Temperature-Field	°C	-	-	-	-	9.27	9.27	10.35	12.85	-	-	10.58	10.97	10.91
DISSOLVED ANIONS														
Alkalinity	mg/L CaCO ₃	-	-	94.4	350	-	-	-	-	-	-	663	541	47
Chloride	mg/L	250	150	14.8	307	0.61	0.85	2.85	14.5	86.9	99.5	74.1	56.1	0.55
Sulphate	mg/L	500	429	64.5	2370	9.3	8.6	24.7	146	857	881	587	438	2.3
DISSOLVED CATIONS														
Calcium	mg/L	-	-	37.5	168	5.11	10.2	6.85	16.2	70.1	68.9	43.5	37.4	8.77
Magnesium	mg/L	-	-	16.2	17.1	0.178	0.32	0.283	1.05	7.33	7.39	5.1	3.76	0.82
Sodium	mg/L	200	-	-	1120	33.6	14.1	33.7	118	692	680	593	426	7.74
ION BALANCE														
Ion Balance	%	-	-	-	-	-	-	-	-	-	4	-4	3	9
DISSOLVED METALS														
Aluminum	mg/L	0.1	0.05	-	0.021	0.156	0.122	0.016	0.026	0.009	0.014	0.01	0.007	0.026
Antimony	mg/L	0.006	0.02	-	<0.0005	0.0006	<0.0002	0.0005	0.002	0.0007	0.0005	0.0003	0.0005	0.0003
Arsenic	mg/L	0.01	0.005	-	0.0072	0.0025	0.0007	<0.0001	0.0016	0.0096	0.0244	0.0258	0.0237	0.0005
Barium	mg/L	1	1	-	0.087	0.0037	0.0074	0.0005	0.0105	0.0428	0.06	0.0413	0.0307	0.0082
Boron	mg/L	5	1.2	-	0.53	0.027	0.013	0.002	0.075	0.386	0.606	0.692	0.644	0.01
Cadmium	mg/L	0.005	0.00042	-	<0.00025	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001
Chromium	mg/L	0.05	0.001	-	<0.0025	<0.0005	<0.0005	<0.0005	<0.0005	0.0014	0.0018	0.0009	<0.0005	<0.0005
Cobalt	mg/L	-	0.05	-	0.00649	0.00009	0.00005	<0.00005	0.00012	0.00051	0.00049	0.00034	0.0003	<0.00005
Copper	mg/L	1	0.01	-	<0.0025	0.0018	0.0009	<0.0002	0.0009	0.0006	0.0003	0.0003	0.0008	0.0008
Iron	mg/L	0.3	0.35	-	4.58	0.014	<0.01	0.017	0.04	0.04	0.1	0.17	0.02	<0.01
Lead	mg/L	0.005	0.014	-	<0.001	0.00012	0.00007	<0.00005	0.00011	<0.00005	0.00008	<0.00005	<0.00005	<0.00005
Manganese	mg/L	0.02	1.705	-	7.31	0.001	0.006	0.001	0.091	0.418	0.847	0.878	0.659	0.015
Mercury	µg/L	1	0.02	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
Molybdenum	mg/L	-	2	-	0.0351	0.00074	0.00028	0.00025	0.00545	0.00708	0.00401	0.00183	0.00418	0.00053
Nickel	mg/L	-	0.15	-	0.0071	<0.0002	<0.0002	<0.0002	0.0029	0.0049	0.0054	0.0026	0.0029	<0.0002
Selenium	mg/L	0.01	-	-	<0.005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Thallium	mg/L	-	0.0003	-	<0.0005	<0.00001	<0.00001	<0.00001	<0.00001	0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	mg/L	-	2	-	<0.05	0.0012	0.0007	<0.0005	0.0007	0.0023	0.0044	0.0056	0.0029	<0.0005
Uranium	mg/L	0.02	0.033	-	0.0542	0.00033	0.00025	0.00008	0.00262	0.0104	0.0156	0.0161	0.0117	0.00027
Zinc	mg/L	5	0.128	-	<0.01	<0.002	<0.002	<0.002	0.005	0.006	<0.002	<0.002	0.003	<0.002
NUTRIENTS														
Nitrate	mg/L as N	10	3.0	0.358	<0.25	0.045	0.068	0.164	<0.005	<0.005	<0.005	<0.005	<0.005	0.02
Ammonia Nitrogen	mg/L as N	-	1.80	0.0308	0.0142	0.01	<0.01	<0.01	<0.01	<0.01	0.12	0.11	0.01	<0.01
POLLUTANT TESTS														
Chemical Oxygen Demand	mg/L as O	-	-	-	1280	<10	10	25	77	363	424	329	275	<10
Total Organic Carbon	mg/L as O	-	-	-	-	-	-	-	-	-	132	-	86.2	-

#REF!

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 250 mg/L.

TABLE B-26
SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW13-1S AND MW13-2S
2016 to 2019

LOCATION	units	RECEIVING WATER CRITERIA		MW13-1S	MW13-1S	MW13-1S	MW13-1S	MW13-1S	MW13-1S	MW13-1S	MW13-1S	MW13-1S	MW13-1S	
				28-Jan-16	10-May-16	27-Jul-16	09-Nov-16	20-Jul-17	26-Apr-18	30-Jul-18	30-Jan-19	17-Apr-19	25-Jul-19	31-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS														
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	8.24	6.22	8.67	7.94	7.53	803	8.32		-	7.55
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	8.02	7.98	8.08	8.31	7.9	7.97	7.9	8.29	Inaccessible	8.13	8.25
EC-Field	µS/cm	-	-	-	572	411	584	471	439	444	397		-	418
EC-Lab	µS/cm	-	-	1200	849	580	770	649	643	602	591		565	584
Total Dissolved Solids	mg/L	500	-	828	558	352	518	398	405	390	368		348	390
Temperature-Field	°C	-	-	-	10.56	11.76	11.08	12.44	10.55	12.49	9.72		-	12.82
DISSOLVED ANIONS														
Chloride	mg/L	250	150	31.1	26.2	23.7	30.7	29	31.5	35.6	37.5		37.8	40.3
Sulphate	mg/L	500	218	247	125	62.1	85.5	63.7	51.5	35.3	28.6		25.3	23
NUTRIENTS														
Nitrate	mg/L as N	10	3	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005	<0.005
Ammonia Nitrogen	mg/L as N	-	1.8	<0.01	<0.01	0.04	0.07	<0.1	0.13	0.09	0.07		0.11	0.08

LOCATION	units	RECEIVING WATER CRITERIA		MW13-2S	MW13-2S	MW13-2S	MW13-2S	MW13-2S	MW13-2S	MW13-2S	MW13-2S	MW13-2S	MW13-2S	MW13-2S
				28-Jan-16	10-May-16	27-Jul-16	09-Nov-16	20-Jul-17	26-Apr-18	30-Jul-18	30-Jan-19	17-Apr-19	25-Jul-19	31-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS														
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	7.94	6.35	7.5	8.34	8.15	8.51	7.95	7.68	-	7.71
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	8.01	7.7	7.69	7.48	8.01	7.23	7.05	7.74	7.64	7.75	7.57
EC-Field	µS/cm	-	-	-	484	846	880	622	77	97	99	160	-	191
EC-Lab	µS/cm	-	-	3070	697	1230	1300	867	105	118	137	224	782	275
Total Dissolved Solids	mg/L	500	-	2260	472	848	922	568	58	50	72	132	552	158
Temperature-Field	°C	-	-	-	10.83	10.87	9.87	11.28	10.26	12.03	9.87	10.86	-	9.28
DISSOLVED ANIONS														
Chloride	mg/L	250	150	99.5	11.4	20.3	13.9	10.4	1.77	1.71	1.4	4.1	12.7	4.48
Sulphate	mg/L	500	218	881	64.5	241	390	183	1.9	2.3	1.9	26.1	133	36.8
NUTRIENTS														
Nitrate	mg/L as N	10	3.0	<0.005	<0.005	<0.005	<0.005	<0.005	0.14	0.154	0.24	0.106	<0.005	<0.005
Ammonia Nitrogen	mg/L as N	-	1.8	0.12	0.02	0.11	0.13	1.7	<0.01	<0.01	<0.01	<0.01	0.03	0.05

NOTES: H:\Project\1005\Analysis\Chemistry\2019\Tables_B-19 to B-29.xlsx\Table B-26 MW13-1S-2S

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guideline for sulphate is based on total hardness, which varies between samples. Guidelines shown are based on hardness of 60 mg/L.

TABLE B-27
SUMMARY OF INORGANIC CHEMISTRY DATA FOR HEATH CREEK
2016 to 2019

SAMPLE DATE LAB NAME	units	RECEIVING WATER CRITERIA		28-Jan-16	10-May-16	27-Jul-16	08-Nov-16	23-Jan-17	20-Apr-17	20-Jul-17	11-Oct-17	30-Jan-18	25-Apr-18	30-Jul-18	31-Oct-18	29-Jan-19	17-Apr-19	24-Jul-19	30-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	8.84	6.91	7.41	7.24	9.51	7.88	7.76	8.25	8.18	8.72	8.29	6.61	7.2	-	7.21
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	6.99	7.09	6.99	6.92	6.89	7.19	7.74	7.26	6.78	7.06	6.88	7.22	7.08	7.3	7.91	7.43
EC-Field	µS/cm	-	-	-	166	60	217	72	81	49	103	25	108	84	67	210	43	-	115
EC-Lab	µS/cm	-	-	35	58	73	40	53	51	66	71	32	70	71	68	48	61	73	78
Total Hardness (CaCO ₃)	mg/L	-	-	13	24	29	16	17	18.9	26	30	12	22	31	28	18	25	30	29
Temperature-Field	°C	-	-	-	10.54	16.71	11.61	5.09	9.95	14.88	9.79	5.32	10.75	17.94	10.44	6.58	8.9	-	5.37
DISSOLVED ANIONS																			
Chloride	mg/L	250	150	1.41	1.93	1.87	1.24	5.44	2.82	1.97	2.2	1.95	6.68	2.13	3.07	3.47	5.11	2.51	5.45
Sulphate	mg/L	500	128	-	-	-	1.8	0.8	0.8	0.8	0.7	0.6	0.9	0.7	0.7	0.8	0.9	0.7	0.7
TOTAL METALS																			
Cadmium	mg/L	0.005	0.00009	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Chromium	mg/L	0.05	0.001	0.0008	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	<0.0005	<0.0005	<0.0005	0.002	<0.0005	<0.0005	<0.0005
Iron	mg/L	0.3	1.0	0.37	0.06	0.06	0.21	0.09	0.145	0.03	0.03	0.2	0.11	0.04	0.31	0.15	0.13	0.06	0.19
Manganese	mg/L	0.02	0.74	0.012	0.005	0.008	0.01	0.004	0.006	0.003	0.004	0.008	0.005	0.006	0.012	0.004	0.004	0.008	0.004
Zinc	mg/L	5	0.0075	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
NUTRIENTS																			
Nitrate	mg/L as N	10	3.0	0.095	0.136	0.197	0.054	0.081	0.028	0.13	0.058	0.036	0.042	0.207	0.046	0.058	0.026	0.093	0.04
Ammonia Nitrogen	mg/L as N	-	1.8	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04
Total Phosphorus	mg/L as P	-	-	<0.005	<0.005	0.006	0.009	<0.005	0.006	0.006	0.006	0.009	0.005	0.008	0.011	0.007	<0.005	0.006	<0.005
POLLUTANT TESTS																			
Chemical Oxygen Demand	mg/L as O	-	-	16	<10	<10	<10	<10	<10	18	<10	<10	<10	<10	17	<10	<10	11	<10

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-19 to B-29.xlsx|Table B-27 HeathCrk

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper (former guideline), lead, manganese, sulphate, and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 30 mg/L.

TABLE B-28
SUMMARY OF INORGANIC CHEMISTRY DATA FOR STEVENS CREEK - 2016 TO 2019
AND SCK A AND SCK B - 2015 TO 2016

SAMPLE DATE	units	RECEIVING WATER CRITERIA		27-Jan-16	05-May-16	03-Dec-15	08-Nov-16	24-Jan-17	21-Apr-17	19-Jul-17	11-Oct-17	29-Jan-18	26-Apr-18	30-Jul-18	31-Oct-18	29-Jan-19	16-Apr-19	24-Jul-19	30-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	7.21		7.4	8.53	7.75	7.25		7.88	7.87		8.7	7.49	7.47		8.08
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	7.11	7.28		6.94	7.1	7.34	7.24		7.1	7.25		7.28	7.25	7.5		7.3
EC-Field	µS/cm	-	-	-	109	dry	42	67	62	312	dry	40	108	dry	85	68	86	dry	85
EC-Lab	µS/cm	-	-	85	140		66	105	98	156		69	131		107	100	129		130
Total Hardness (CaCO ₃)	mg/L	-	-	-	60		29	44	40.3	67		29	56		45	44	59		55
Temperature-Field	°C	-	-	-	10.05		11.5	4.93	7.89	15.1		6.27	9.27		10.29	6.57	8		6.66
DISSOLVED ANIONS																			
Chloride	mg/L	250	150	1.57	3.64		1.63	2.64	2.54	3.28		1.92	3.75		3.9	2.63	3.4		4.9
Sulphate	mg/L	500	218	-	-		0.9	1	0.9	1.4		0.8	1		1	1	1		1.2
TOTAL METALS																			
Cadmium	mg/L	0.005	0.00013	<0.00001	<0.00001		<0.00001	<0.00001	<0.00001	0.00003		<0.00001	<0.00001		<0.00001	<0.00001	<0.00001		<0.00001
Chromium	mg/L	0.05	0.001	<0.0005	<0.0005		<0.0005	<0.0005	<0.0005	0.0026		<0.0005	<0.0005		<0.0005	<0.0005	<0.0005		<0.0005
Iron	mg/L	0.3	1.0	0.12	<0.01		0.04	<0.01	<0.01	2.64		0.02	0.18		0.03	0.03	0.08		0.21
Manganese	mg/L	0.02	0.83	0.115	0.014		0.026	0.015	0.02	2.9		0.009	0.293		0.038	0.01	0.108		0.303
Zinc	mg/L	5	0.0075	0.006	<0.005		<0.005	<0.005	<0.005	0.036		<0.005	<0.005		<0.005	<0.005	<0.005		<0.005
NUTRIENTS																			
Nitrate	mg/L as N	10	3.0	0.266	0.048		0.176	0.356	0.227	0.03		0.305	0.146		0.316	0.268	0.098		0.096
Ammonia Nitrogen	mg/L as N	-	1.8	0.02	<0.01		<0.01	<0.01	<0.01	<0.01		<0.01	<0.01		<0.01	<0.01	<0.01		0.04
Total Phosphorus	mg/L as P	-	-	0.005	0.005		0.007	<0.005	<0.005	0.091		0.01	0.01		0.007	0.006	0.007		0.011
POLLUTANT TESTS																			
Chemical Oxygen Demand	mg/L as O	-	-	26	17		<10	<10	<10	<10		<10	<10		<10	<10	<10		<10

LOCATION	units	RECEIVING WATER CRITERIA		SCK A						SCK B									
		GCDWQ ¹	AQUATIC LIFE ²	23-Apr-15	29-Jul-15	03-Dec-15	27-Jan-16	05-May-16	26-Jul-16	08-Nov-16	23-Apr-15	29-Jul-15	03-Dec-15	27-Jan-16	05-May-16	26-Jul-16	08-Nov-16		
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-		-	-	6.43		6.62	-	-	-	7.03		8.02			
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	6.77		7.13	6.98	6.69		6.78	6.62	7.07	6.85	7.02		6.88			
EC-Field	µS/cm	-	-	-	dry	-	-	388	dry	219	-	-	-	188	dry	58			
EC-Lab	µS/cm	-	-	465		372	347	457		293	166	96	82	254		91			
Total Hardness (CaCO ₃)	mV	-	-	224		276	-	201		138	81.4	50	-	105		40			
Temperature-Field	°C	-	-	-		-	-	11.44		12.46	-	-	-	14.07		11.96			
DISSOLVED ANIONS																			
Chloride	mg/L	250	150	18.9		9.47	4.62	12.5		3.08	3.92		3.63	1.38	6.27		1.54		
Sulphate	mg/L	500	218	-		-	-	-		4.1	-		-	-	-		0.8		
TOTAL METALS																			
Cadmium	mg/L	0.005	0.00013	0.00011		0.00107	0.00099	0.00002		0.00005	<0.00001		<0.00001	<0.00001	<0.00001		<0.00001		<0.00001
Chromium	mg/L	0.05	0.001	0.0078		0.0601	0.048	0.0021		<0.0005	<0.0005		<0.0005	<0.0005	<0.0005		<0.0005		<0.0005
Iron	mg/L	0.3	1.0	7.26		69.6	55.7	1.37		0.73	0.198		0.03	0.13	0.41		0.04		0.04
Manganese	mg/L	0.02	0.83	0.725		2.74	1.98	3.91		1.42	0.049		0.046	1.14	0.026		0.026		0.026
Zinc	mg/L	5	0.0075	0.01		0.076	0.066	<0.005		<0.005	<0.005		<0.005	<0.005	<0.005		<0.005		<0.005
NUTRIENTS																			
Nitrate	mg/L as N	10	3.0	1.5		0.589	1.19	0.24		0.072	0.27		0.665	0.31	0.181		0.279		
Ammonia Nitrogen	mg/L as N	-	1.8	0.42		0.75	0.55	1.55		0.8	0.17		0.02	0.04	0.22		<0.01		
Total Phosphorus	mg/L as P	-	-	0.139		0.391	0.498	0.006		0.013	0.041		0.007	0.011	0.012		0.007		
POLLUTANT TESTS																			
Chemical Oxygen Demand	mg/L as O	-	-	60		118	93	12		<10	30		<10	26	27		<10		

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-19 to B-29.xlsx|Table B-28 StevensCk

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq_wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), copper, lead, manganese and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 50 mg/L.

TABLE B-29
SUMMARY OF INORGANIC CHEMISTRY DATA FOR CHRISTIE CREEK
2016 to 2019

DOWNSTREAM SAMPLING SITE

SAMPLE DATE LAB NAME	units	RECEIVING WATER CRITERIA		28-Jan-16	10-May-16	27-Jul-16	09-Nov-16	23-Jan-17	20-Apr-17	19-Jul-17	11-Oct-17	30-Jan-18	25-Apr-18	30-Jul-18	31-Oct-18	29-Jan-19	17-Apr-19	24-Jul-19	30-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT		AGAT	AGAT	AGAT			AGAT	AGAT		AGAT	AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-	8.36		8.23	7.68	8.02			7.72	8.17		7.91		7.96	-	7.56
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	6.7	7.05		6.85	6.74	7.43			6.74	7.04		6.95		7.05	7.72	7.05
EC-Field	µS/cm	-	-	-	83	dry	33	46	45	dry	dry	33	75	dry	51	inaccessible	54	-	52
EC-Lab	µS/cm	-	-	40	106		48	59	55			43	72		73		68	152	82
Total Hardness (CaCO ₃)	mg/L	-	-	16	47		20	22	25.5			14	32		31		33	73	36
Temperature-Field	°C	-	-	-	11.8		11.88	4.57	9.08			5.66	9.22		9.97		9.11	-	5.42
DISSOLVED ANIONS																			
Chloride	mg/L	250	150	0.74	1.99		1.28	0.95	0.92			1.24	1.61		2.38		2.49	3.38	2.71
Sulphate	mg/L	500	128	-	-		1.8	1.3	1			1	0.9		1.7		0.9	<0.5	2.3
TOTAL METALS																			
Cadmium	mg/L	0.005	0.00009	0.00002	0.00005		<0.00001	0.00001	<0.00001			<0.00001	<0.00001		<0.00001		0.00004	<0.00001	0.00002
Chromium	mg/L	0.05	0.001	0.0008	0.0008		0.0005	0.0006	0.0016			0.0007	0.0006		0.0006		<0.0005	<0.0005	0.0007
Iron	mg/L	0.3	1.0	0.42	2.36		0.25	0.36	0.839			0.32	0.87		0.48		0.67	0.77	0.73
Manganese	mg/L	0.02	0.74	0.018	1.03		0.021	0.04	0.052			0.014	0.102		0.047		0.078	0.25	0.077
Zinc	mg/L	5	0.0075	0.029	0.015		0.031	0.018	0.022			0.029	0.017		0.019		0.013	<0.005	0.016
NUTRIENTS																			
Nitrate	mg/L as N	10	3.0	0.127	0.068		0.046	0.094	0.047			0.088	0.006		0.086		<0.005	0.054	<0.005
Ammonia Nitrogen	mg/L as N	-	1.8	0.01	0.15		<0.01	0.02	<0.01			<0.01	<0.01		0.02		0.02	0.03	0.04
Total Phosphorus	mg/L as P	-	-	<0.005	0.023		0.012	0.012	0.014			0.012	0.011		0.015		0.009	0.018	0.015
POLLUTANT TESTS																			
Chemical Oxygen Demand	mg/L as O	-	-	29	<10		<10	<10	<10			<10	<10		19		<10	31	<10

UPSTREAM SAMPLING SITE

SAMPLE DATE LAB NAME	units	RECEIVING WATER CRITERIA		28-Jan-16	10-May-16	26-Jul-16	09-Nov-16	23-Jan-17	21-Apr-17	19-Jul-17	11-Oct-17	30-Jan-18	25-Apr-18	30-Jul-18	31-Oct-18	29-Jan-19	17-Apr-19	24-Jul-19	30-Oct-19
		GCDWQ ¹	AQUATIC LIFE ²	AGAT	AGAT		AGAT	AGAT					AGAT	AGAT		AGAT	AGAT	AGAT	AGAT
PHYSICAL TESTS																			
pH-Field	pH	7.0 - 10.5	6.5 - 9.0	-			6.35	7.26	7.91			9	7.35		8.81	6.1	7.16		6.8
pH-Lab	pH	7.0 - 10.5	6.5 - 9.0	6.74			6.76	6.73	7.19			6.61	6.91		6.86	6.99	7.09		7.01
EC-Field	µS/cm	-	-	-	dry	dry	43	35	38	dry	dry	24	48	dry	51	36	78	dry	50
EC-Lab	µS/cm	-	-	39			48	52	56			36	63		70	53	64		78
Total Hardness (CaCO ₃)	mg/L	-	-	17			20	22	25.8			14	29		30	23	30		33
Temperature-Field	°C	-	-	-			12.21	4.18	9.45			5.52	12.51		10.39	6.09	9.42		6.35
DISSOLVED ANIONS																			
Chloride	mg/L	250	150	0.78			1.06	0.82	0.67			1.15	1.17		1.83	1.74	1.93		1.79
Sulphate	mg/L	500	128	-			1.7	1.4	1.2			1.2	1.1		1.6	1.3	1.1		2.9
TOTAL METALS																			
Cadmium	mg/L	0.005	0.00009	<0.00001			<0.00001	<0.00001	<0.00001			<0.00001	<0.00001		<0.00001	<0.00001	<0.00001		<0.00001
Chromium	mg/L	0.05	0.001	0.0005			<0.0005	<0.0005	<0.0005			0.0007	<0.0005		<0.0005	<0.0005	<0.0005		<0.0005
Iron	mg/L	0.3	1.0	0.25			0.12	0.11	0.224			0.26	0.07		0.14	0.14	0.09		0.06
Manganese	mg/L	0.02	0.74	0.018			0.009	0.007	0.017			0.01	0.009		0.008	0.011	0.026		0.005
Zinc	mg/L	5	0.0075	0.043			0.045	0.023	0.027			0.043	0.025		0.034	0.025	0.023		0.032
NUTRIENTS																			
Nitrate	mg/L as N	10	3.0	0.115			0.045	0.117	0.06			0.11	0.011		0.116	0.044	0.007		0.044
Ammonia Nitrogen	mg/L as N	-	1.8	<0.01			<0.01	<0.01	<0.01			<0.01	<0.01		<0.01	<0.01	<0.01		0.04
Total Phosphorus	mg/L as P	-	-	<0.005			0.009	0.006	0.008			0.011	<0.005		0.008	0.007	<0.005		<0.005
POLLUTANT TESTS																			
Chemical Oxygen Demand	mg/L as O	-	-	23			<10	<10	<10			<10	<10		13	<10	<10		<10

H:\Project\1005\Analysis\Chemistry\2019\Tables_B-19 to B-29.xlsx\Table B-29 ChristieCrk

NOTES:

Bold denotes parameters which exceed relevant water quality criteria. FWAL criterion for arsenic not considered relevant for groundwater.

"-" denotes parameter was not analysed, or a receiving water criteria was not applicable.

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, June 2019). Maximum acceptable concentration or aesthetic objectives shown.

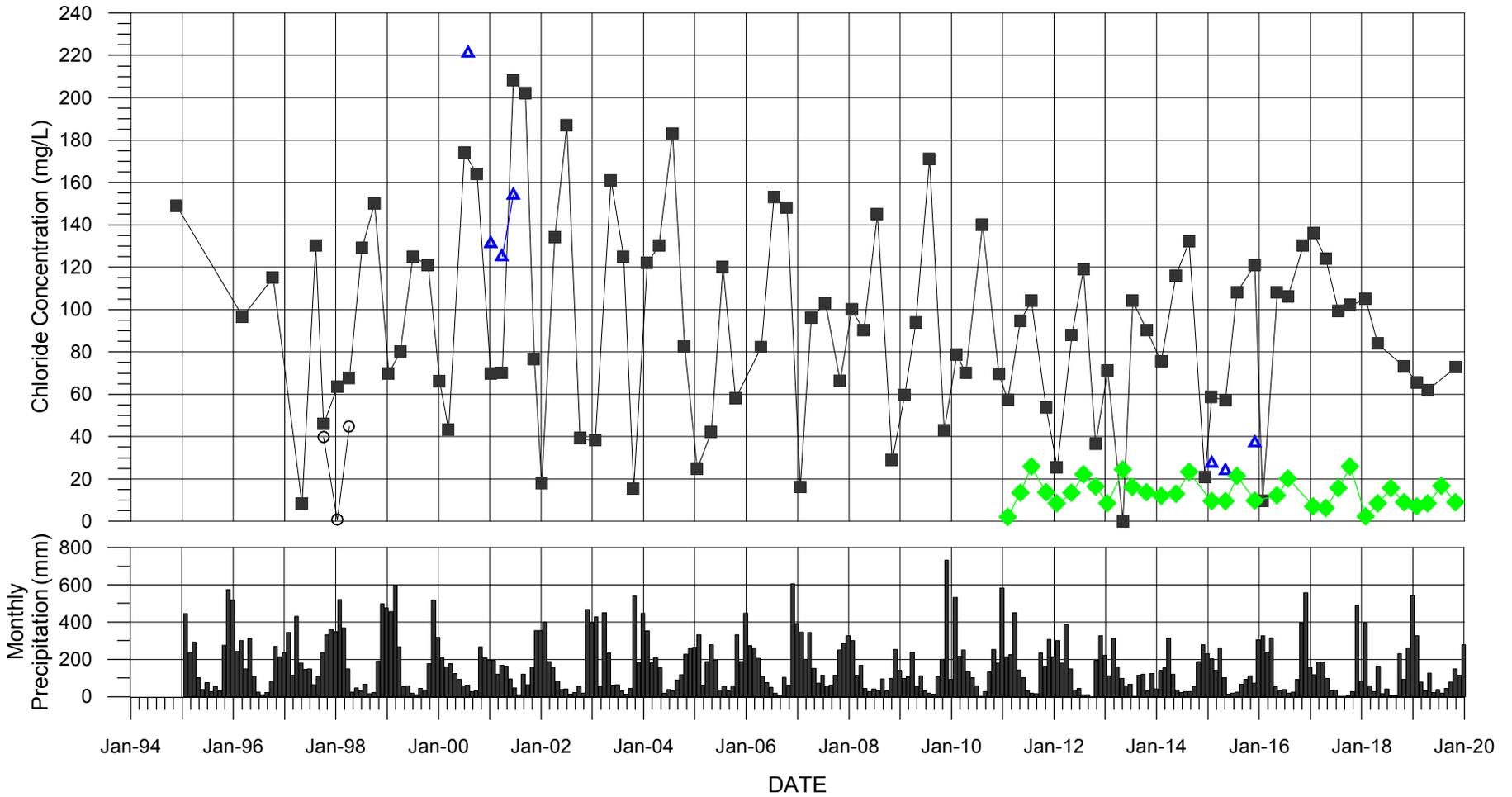
2. Approved and Working Water Quality Guidelines, Science and Information Branch, Environmental Protection Division, BC Ministry of Environment.

Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). BC MOE, August 2019.

Aquatic life guidelines for cadmium (dissolved), manganese, sulphate, and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 30 mg/L.

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Geotechnical and Water Management Consultants



- Leachate Drain
- Surge Lagoon Outlet
- ▲—▲—▲ BH00-1C (Landfill Well)
- ◆—◆—◆ South Expansion Leachate Drain

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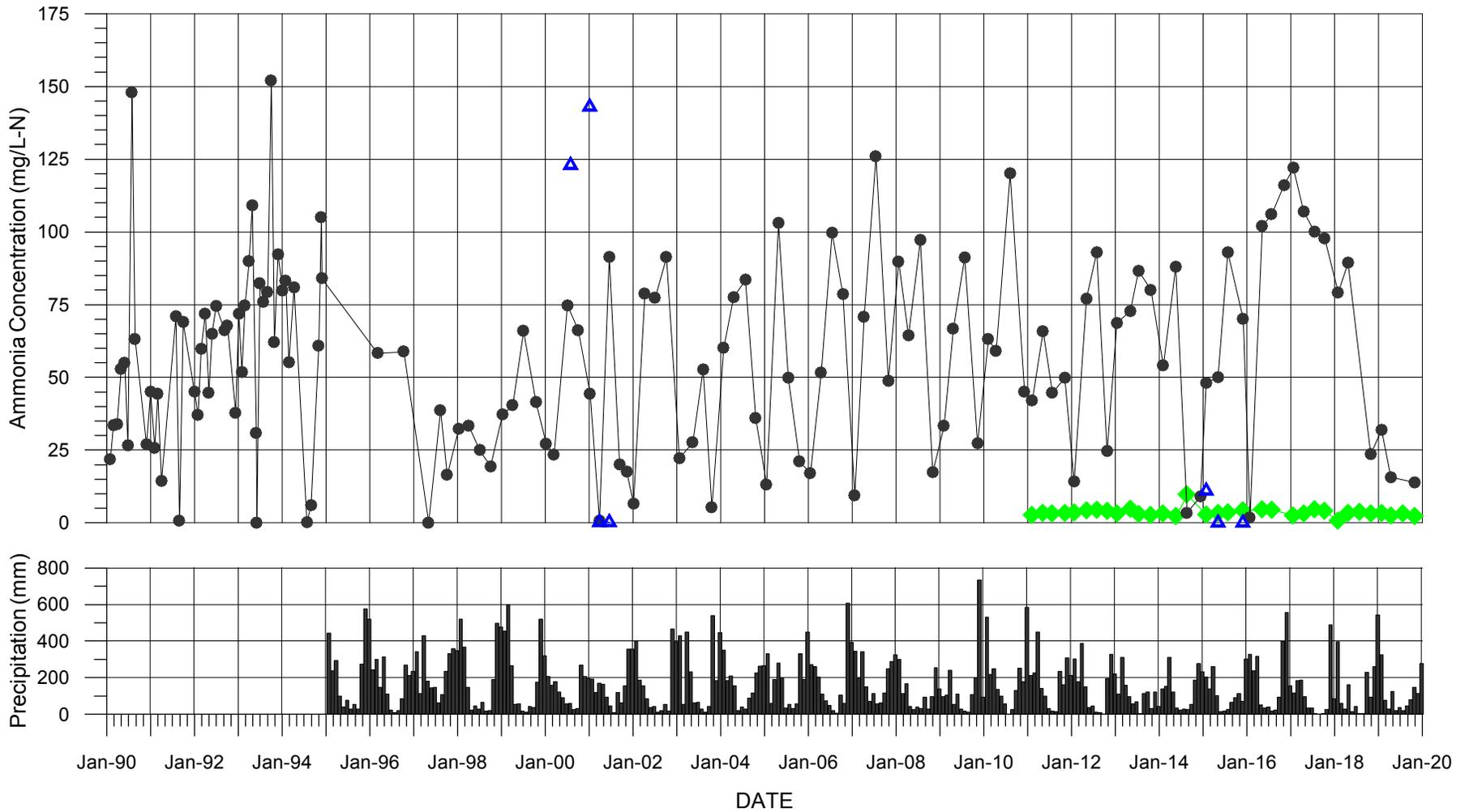
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**CHLORIDE CONCENTRATION TIME-SERIES PLOT
 FOR LEACHATE**

BY:	DATE:
SC	FEB 20
APPROVED:	FIG:
JM	B-1



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- — ● Leachate Inlet
- ▲ — ▲ BH00-1C
- ◆ — ◆ South Expansion Leachate Drain

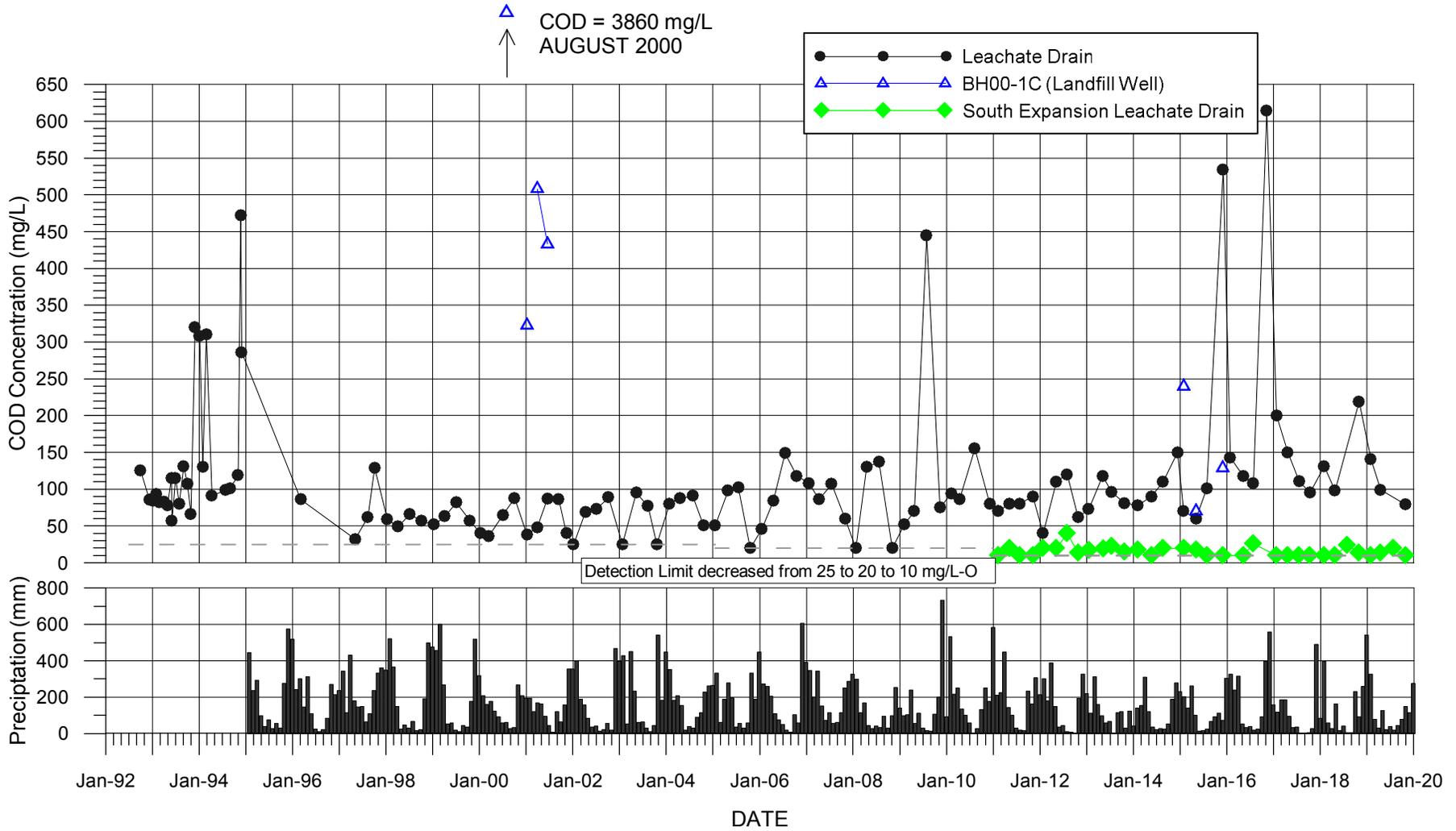
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**AMMONIA CONCENTRATION TIME-SERIES PLOT
 FOR LEACHATE**

BY:	DATE:
SC	FEB 20
APPROVED:	FIG:
JM	B-2



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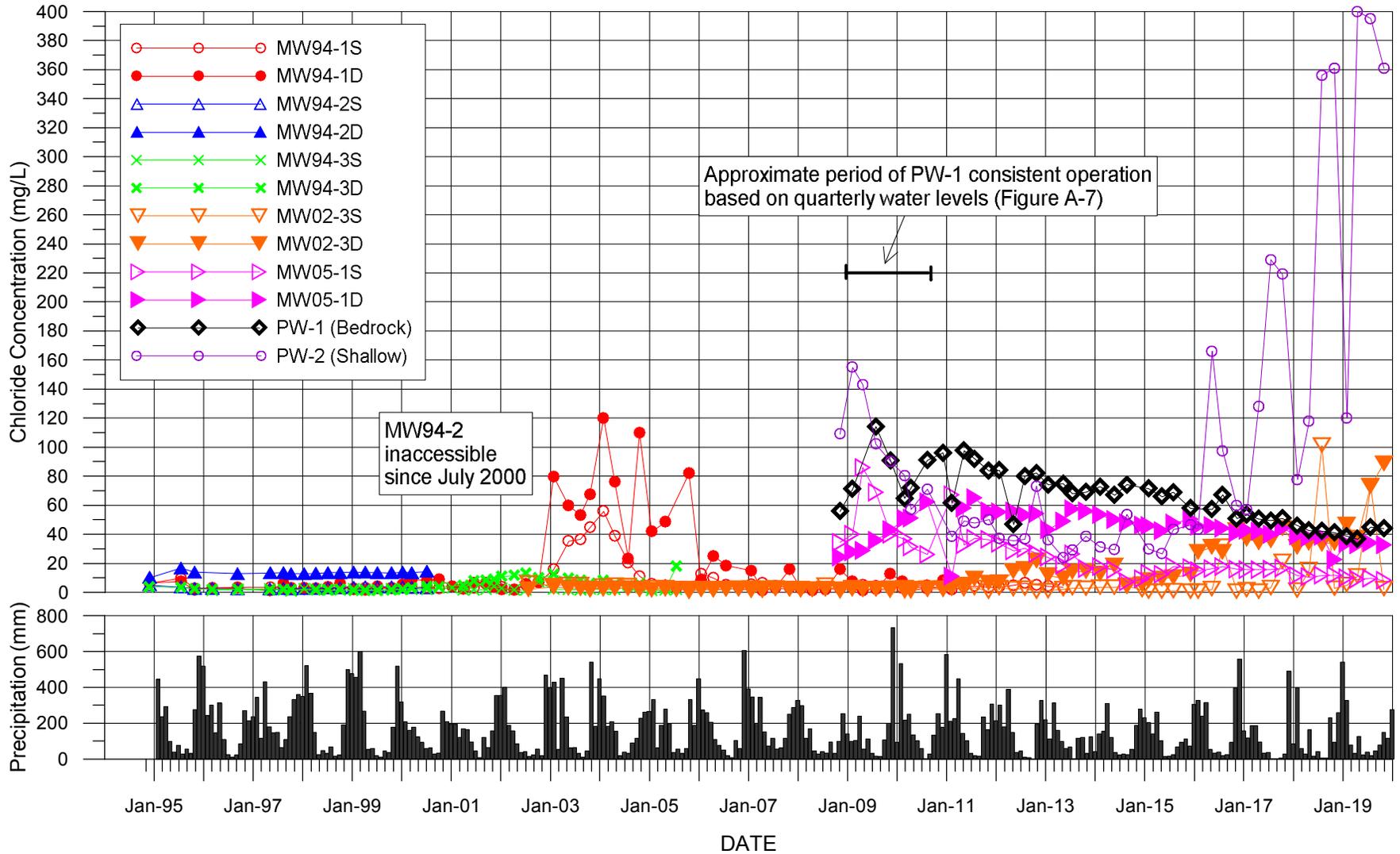
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**COD CONCENTRATION TIME-SERIES PLOT
 FOR LEACHATE**

BY:	SC	DATE:	FEB 20
APPROVED:	JM	FIG:	B-3



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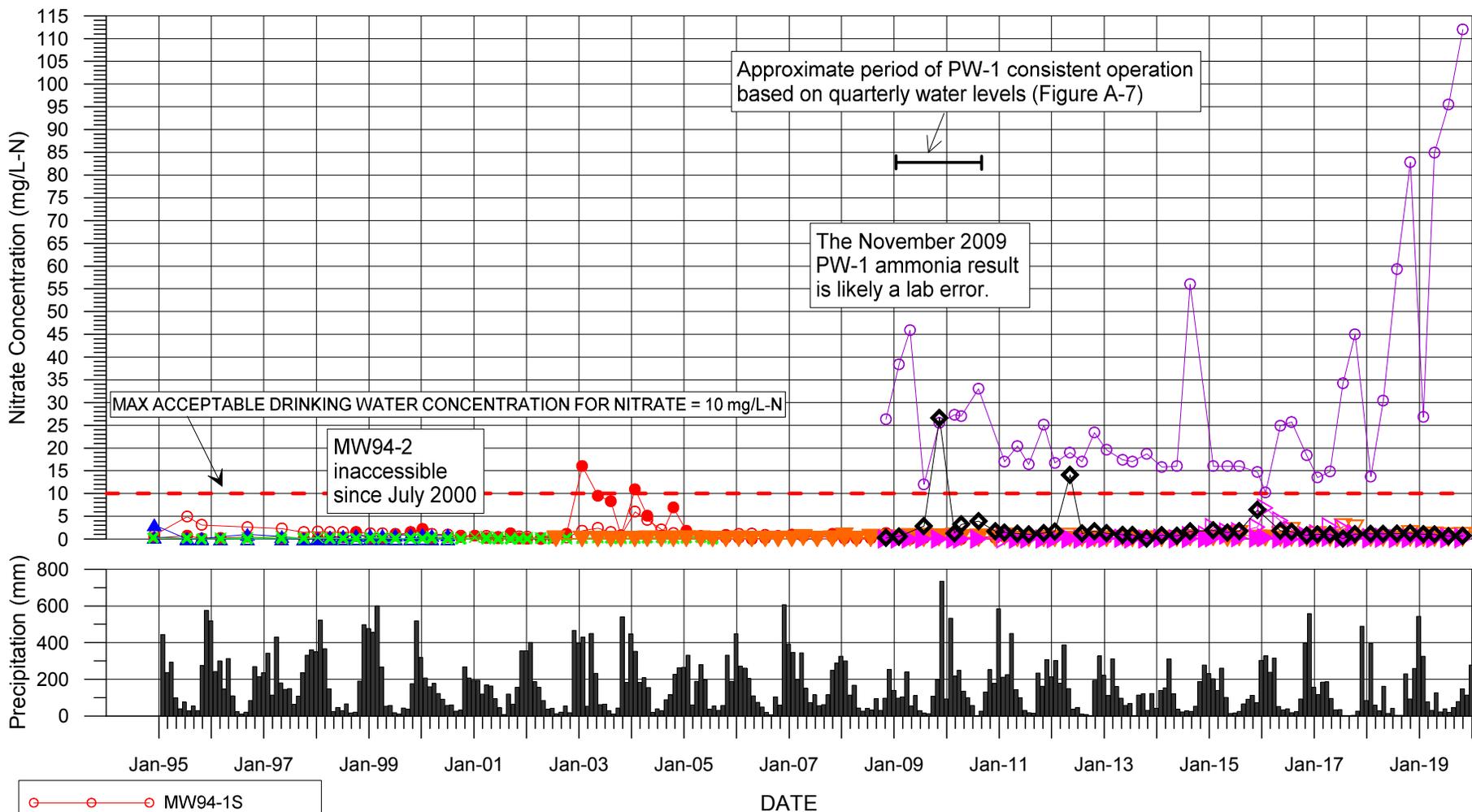
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CHLORIDE CONCENTRATION TIME-SERIES PLOT FOR
 SOUTHEAST WELLS MW94-1, MW94-2, MW94-3, MW02-3,
 MW05-1, PW-1, AND PW-2

BY:	SC	DATE:	FEB 20
APPROVED:	JM	FIG:	B-4



- MW94-1S
- MW94-1D
- △ MW94-2S
- ▲ MW94-2D
- × MW94-3S
- × MW94-3D
- ▽ MW02-3S
- ▽ MW02-3D
- ▽ MW05-1S
- ▽ MW05-1D
- ◆ PW-1 (AMMONIA)
- PW-2 (AMMONIA)

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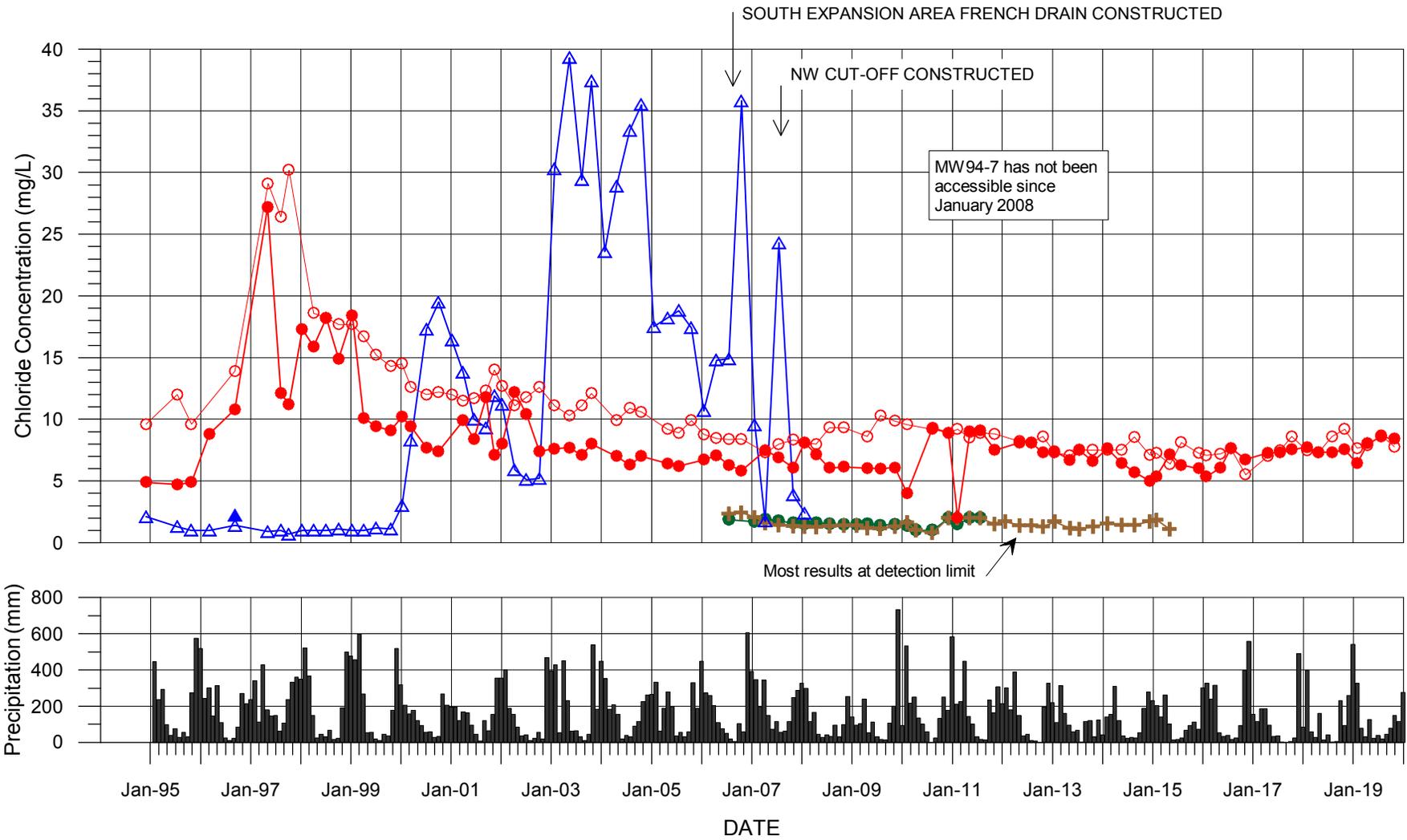
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**NITROGEN CONCENTRATION TIME-SERIES PLOT
 FOR SOUTHEAST WELLS MW94-1, MW94-2, MW94-3, MW02-3,
 MW05-1, PW-1, AND PW-2**

BY:	SC	DATE:	FEB 20
APPROVED:	JM	FIG:	B-5



- MW94-4S
- MW94-4D
- △—△—△ MW94-7S
- ▲—▲—▲ MW94-7D
- +—+—+ MW02-1S
- MW02-2

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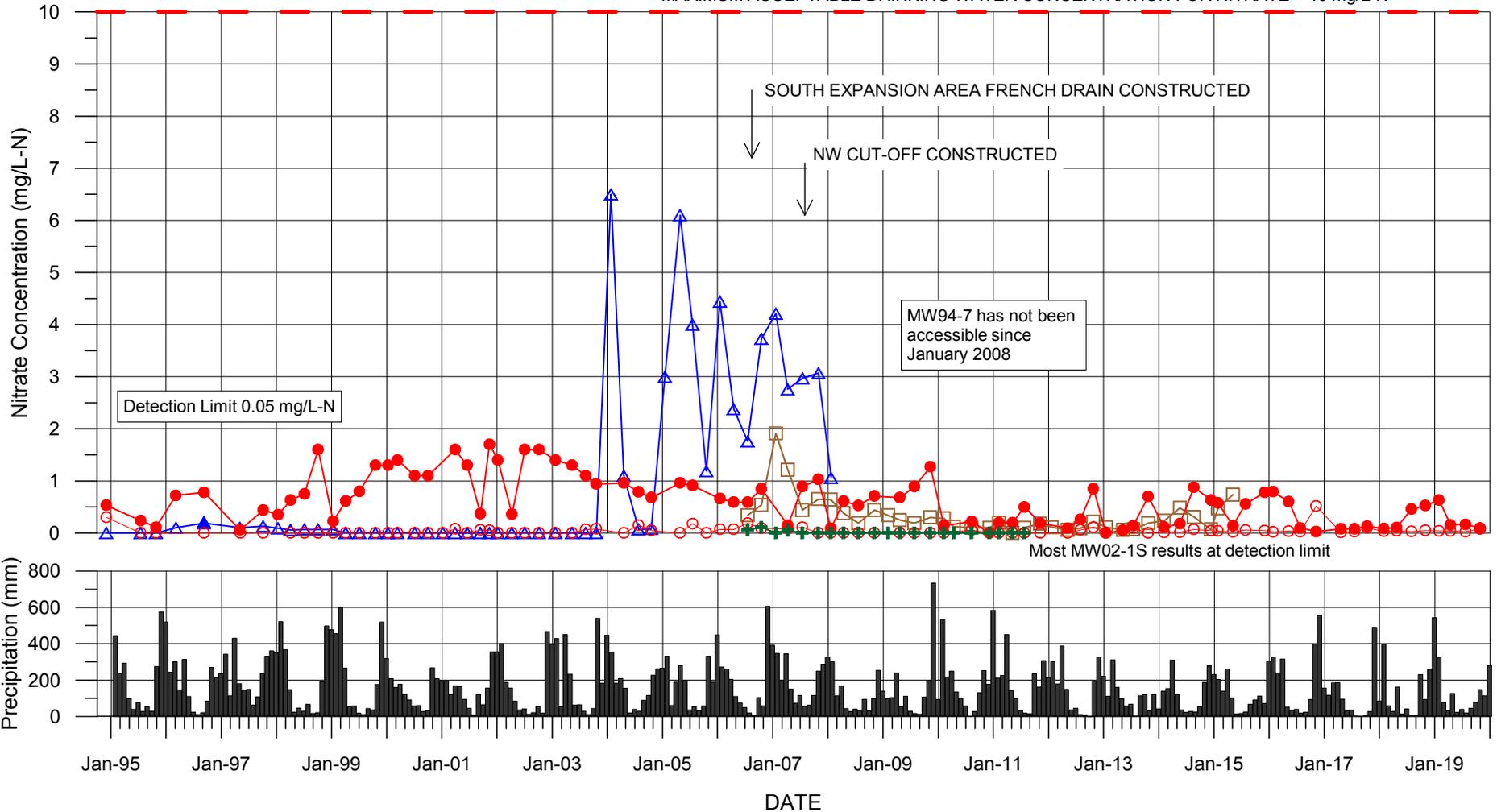
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**CHLORIDE CONCENTRATION TIME-SERIES PLOT FOR
 SOUTH AND WEST WELLS MW94-4, MW94-7, MW02-1S
 AND MW02-2**

BY:	SC	DATE:	FEB 20
APPROVED:	JM	FIG:	B-6

MAXIMUM ACCEPTABLE DRINKING WATER CONCENTRATION FOR NITRATE = 10 mg/L-N



- MW94-4S
- MW94-4D
- △—△—△ MW94-7S
- ▲—▲—▲ MW94-7D
- MW02-1S
- +—+—+ MW02-2

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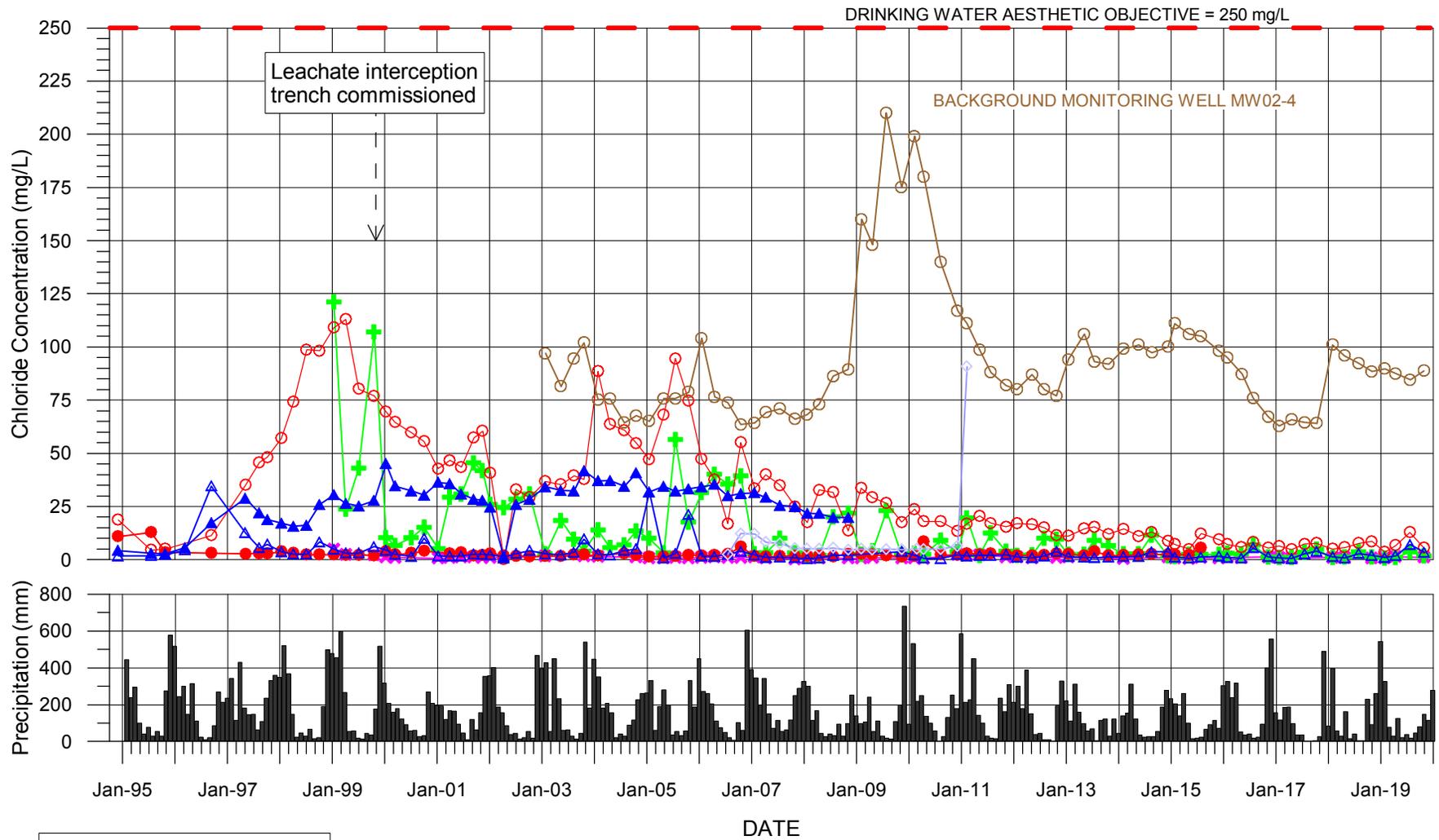
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**NITROGEN CONCENTRATION TIME-SERIES PLOT FOR
 SOUTH AND WEST WELLS MW94-4, MW94-7, MW02-1S
 AND MW02-2**

BY:	DATE:
SC	FEB 20
APPROVED:	FIG:
JM	B-7



- ▲ MW94-5S
- MW94-5D
- MW94-6S
- MW94-6D
- + MW98-9
- × MW98-10
- ◇ BH00-4A
- MW02-4

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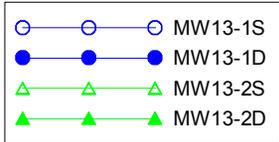
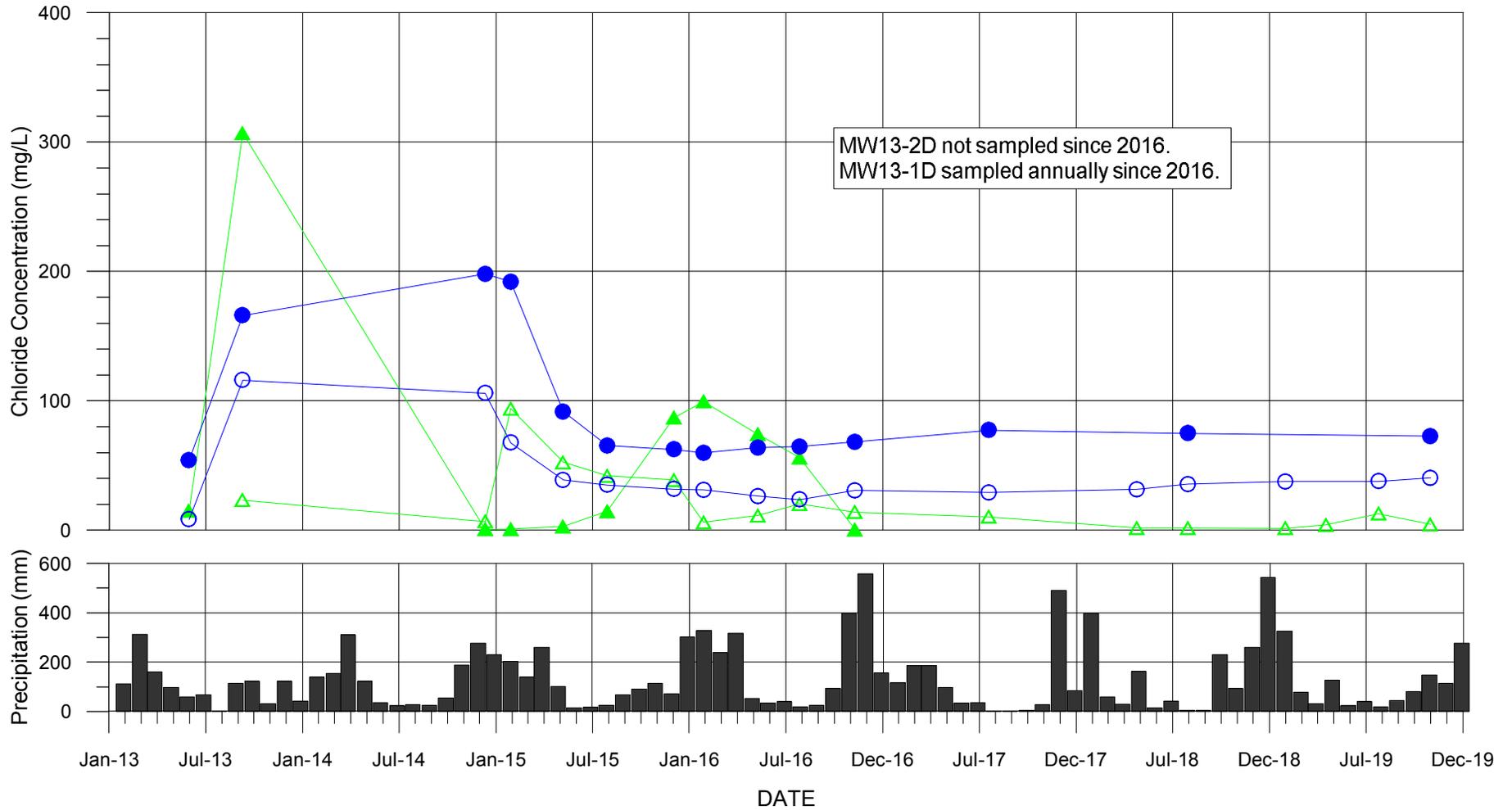
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CHLORIDE CONCENTRATION TIME-SERIES PLOT FOR
 NORTH WELLS MW94-5, MW94-6, MW98-9 AND MW98-10
 AND BACKGROUND WELLS BH00-4A AND MW02-4

BY:	SC	DATE:	FEB 20
APPROVED:	JM	FIG:	B-8



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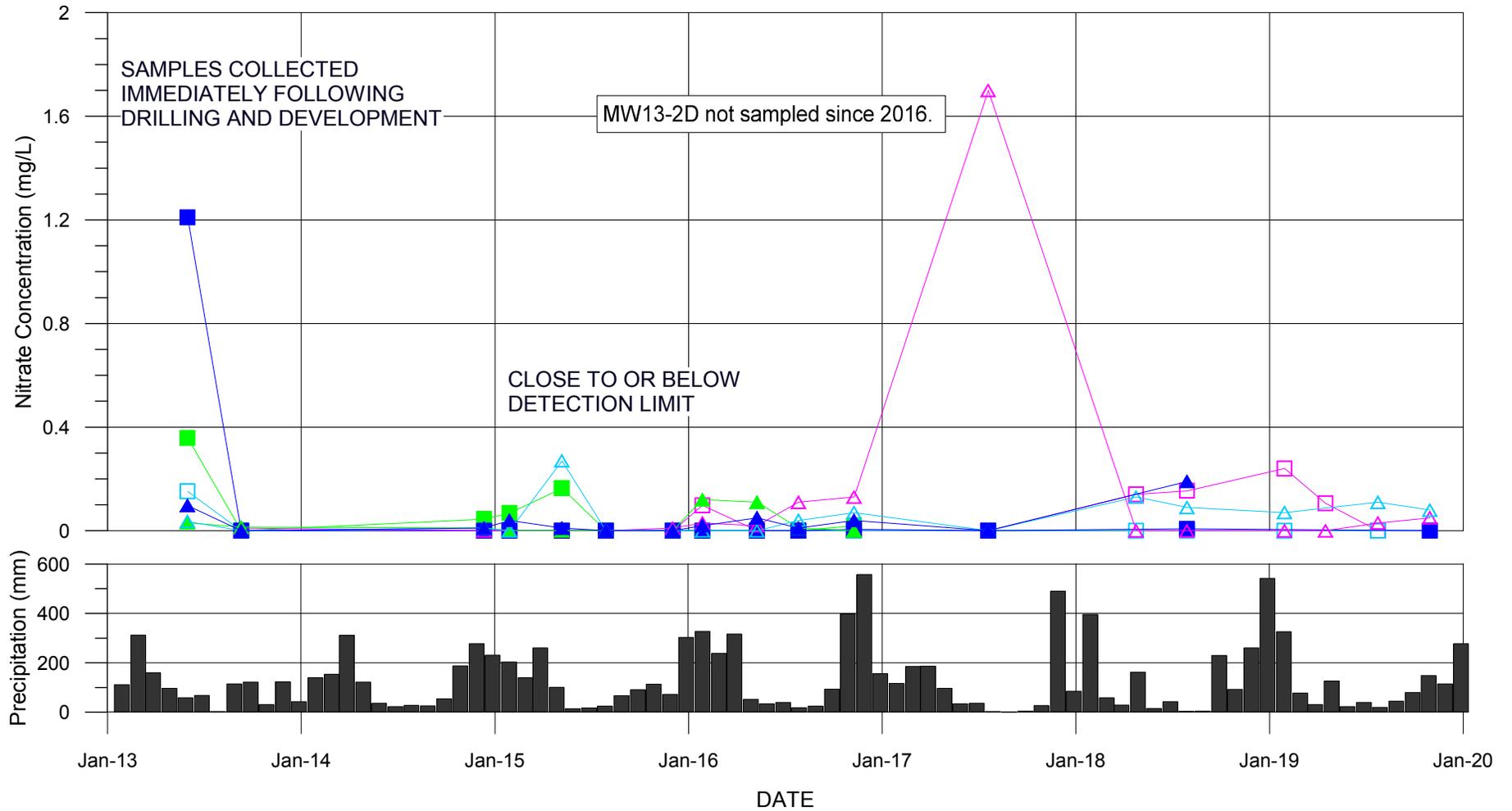
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CHLORIDE CONCENTRATION TIME-SERIES PLOT FOR
MW13-1S, MW13-1D, MW13-2S AND MW13-2D

BY:	SC	DATE:	FEB 20
APPROVED:	JM	FIG:	B-10



- MW13-1S (Nitrate)
- △ MW13-1S (Ammonia)
- MW13-1D (Nitrate)
- ▲ MW13-1D (Ammonia)
- MW13-2S (Nitrate)
- △ MW13-2S (Ammonia)
- MW13-2D (Nitrate)
- ▲ MW13-2D (Ammonia)

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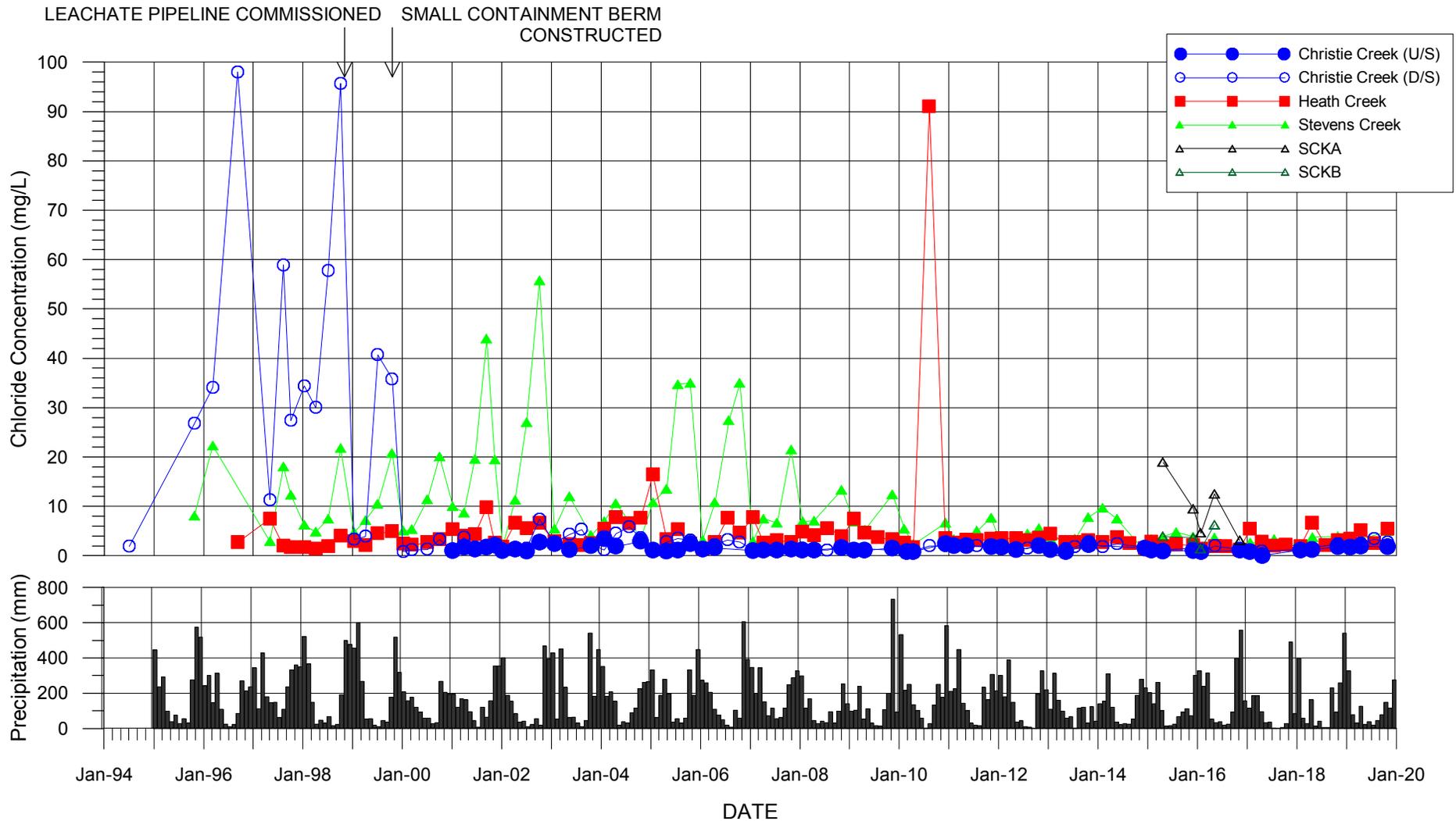
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**NITROGEN CONCENTRATION TIME-SERIES PLOT FOR
 MW13-1S, MW13-1D, MW13-2S AND MW13-2D**

BY:	SC	DATE:	FEB 20
APPROVED:	JM	FIG:	B-11



NOTE:
 Christie Creek chloride concentrations dropped from a level indicative of severe leachate impact (approaching 100 mg/L), to less than 5 mg/L, and are now below background concentrations observed in Heath Creek. Values typically increase in summer, during a period of lower dilution, but are expected to stay well below previous levels.

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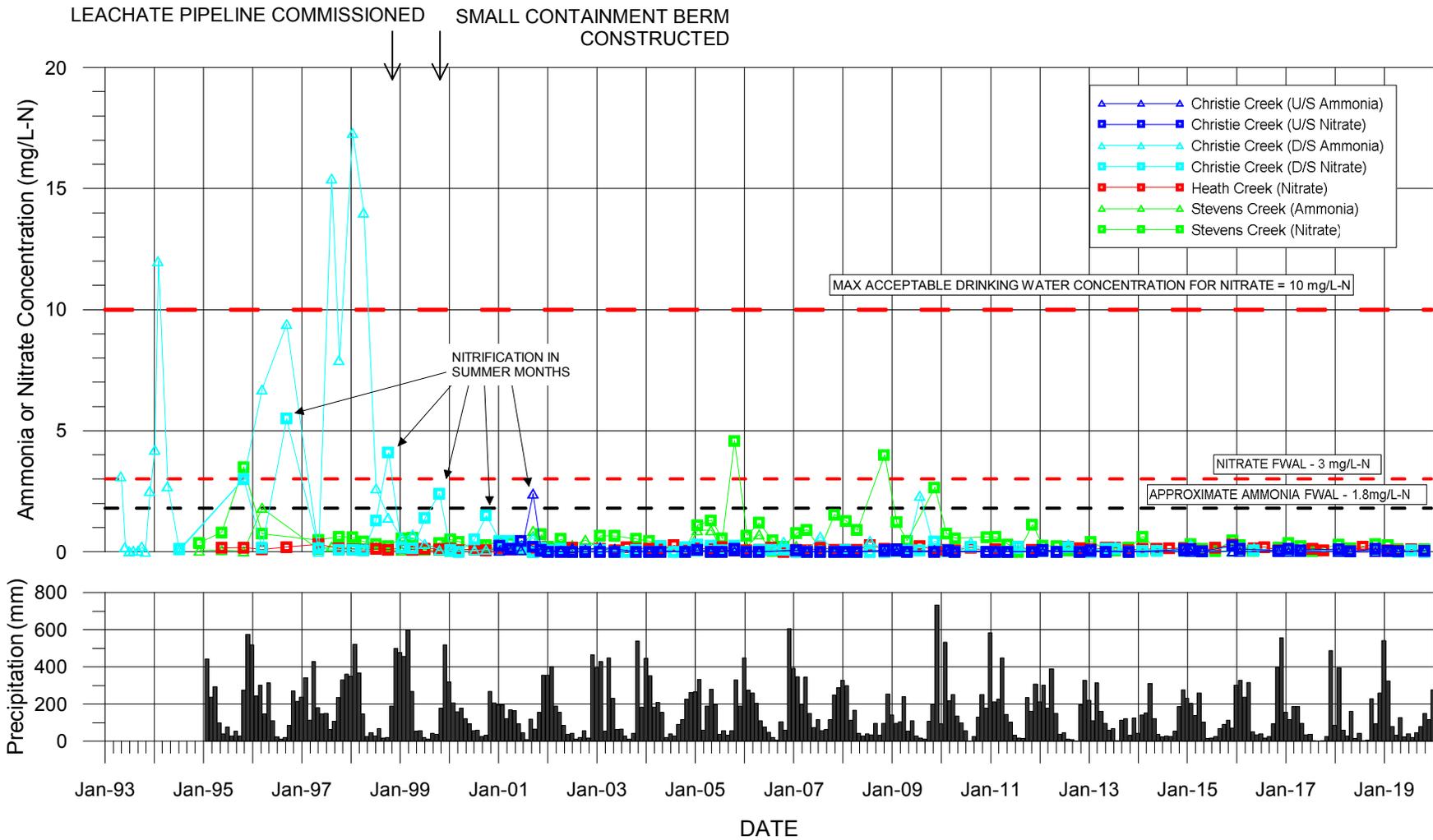
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CHLORIDE CONCENTRATION TIME-SERIES PLOT FOR CREEK SAMPLING SITES

BY:	SC	DATE:	FEB 20
APPROVED:	JM	FIG:	B-12



Notes:
 Winter ammonia concentrations in Christie Creek in years previous to 1999 ranged from about 6 to 17 mg/L-N, generally exceeding the aquatic life criteria of about 1.8 mg/L-N (temperature dependent). Since 2002 concentrations have stayed below 0.07 mg/L-N, well below the aquatic life criteria, with the exception of one summer occasion in 2009.

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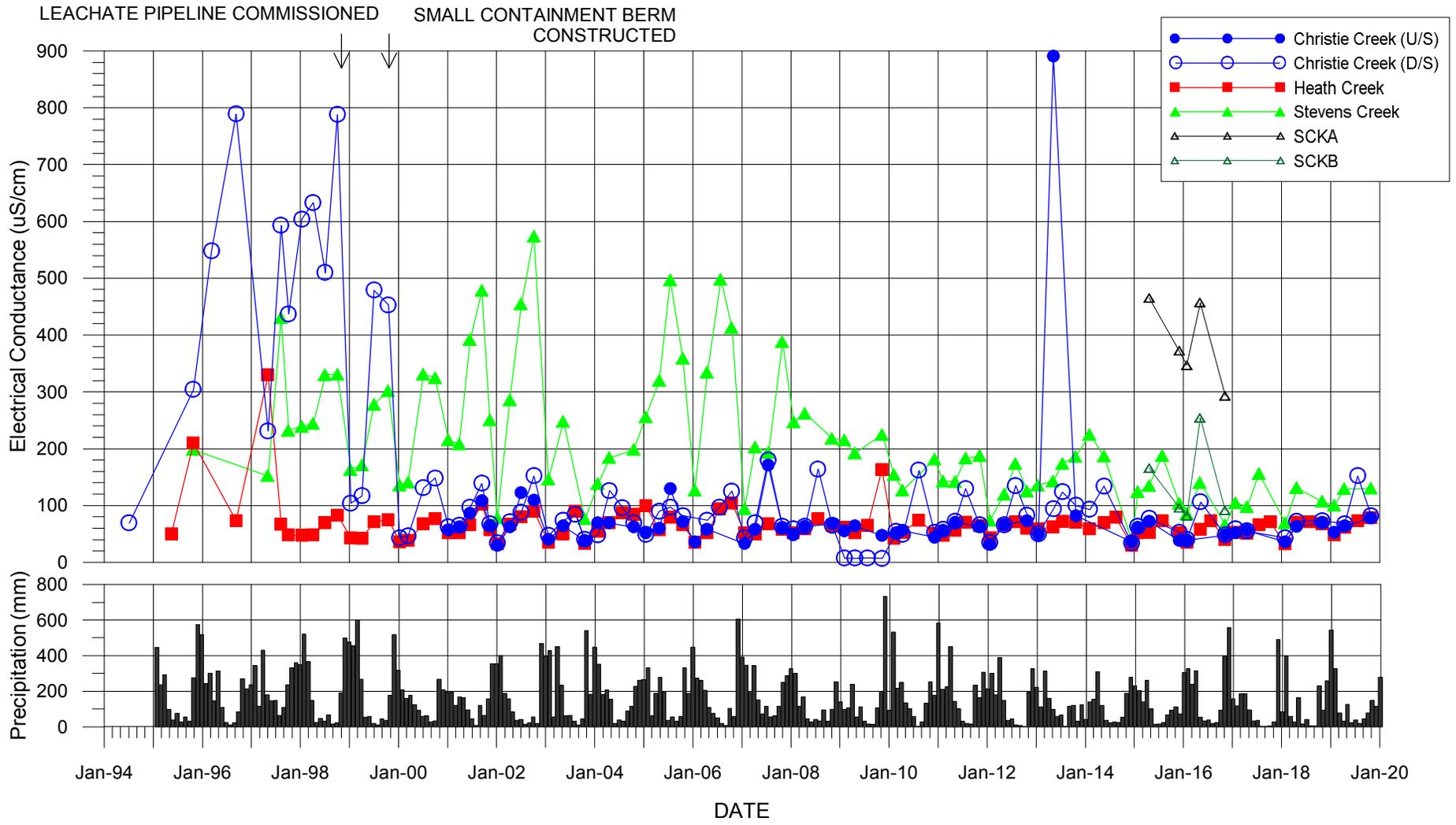
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NITROGEN CONCENTRATION TIME-SERIES PLOT FOR CREEK SAMPLING SITES

BY:	SC	DATE:	FEB 20
APPROVED:	JM	FIG:	B-13



Notes:
 Winter conductance measurements in Christie Creek approach background measured in Heath Creek, after the pipeline was commissioned.

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ELECTRICAL CONDUCTANCE TIME-SERIES PLOT FOR
 CREEK SAMPLING SITES

BY:	SC	DATE:	FEB 20
APPROVED:	JM	FIG:	B-14

APPENDIX C
MONITORING DATA TABLES FOR 2018 DUPLICATE SAMPLES

APPENDIX C - LIST OF TABLES

Table C-1	Summary of Duplicate Sample Results for Suite 1 Analyses – 2019
Table C-2	Summary of Duplicate Sample Results for Suite 2 Analyses – 2019
Table C-3	Summary of Duplicate Sample Results for Suite 3 Analyses – 2019
Table C-4	Summary of Duplicate Sample Results for Suite 4 Analyses – 2019

TABLE C-1 SUMMARY OF DUPLICATE SAMPLE RESULTS FOR SUITE 1 ANALYSES - 2019

SAMPLE DATE SAMPLE TYPE LAB NAME	UNITS	MW02-1D			MW98-9			MW94-4S				
		29-Jan-19 PR AGAT	29-Jan-19 DUP AGAT	RPD	16-Apr-19 PR AGAT	16-Apr-19 DUP AGAT	RPD	30-Oct-19 PR AGAT	31-Oct-19 DUP AGAT	RPD		
PHYSICAL TESTS												
pH-Lab	pH	6.47	6.39	1	7.57	7.57	0	9.38	9.37	0		
EC-Lab	µS/cm	32	32	0	216	222	3	256	254	1		
Dissolved Hardness (CaCO ₃)	mg/L	10.3	14	30	106	106	0	3.8	3.9	3		
Total Dissolved Solids	mg/L	20	<5	>120	145	145	0	152	165	8		
DISSOLVED ANIONS												
Alkalinity	mg/L CaCO ₃	12	10	18	109	110	1	114	115	1		
Chloride	mg/L	1.8	1.79	1	1.03	1.05	2	7.77	7.78	0		
Sulphate	mg/L	0.9	0.9	0	2.2	2.1	5	6.2	6.1	2		
DISSOLVED METALS												
Arsenic	mg/L	0.0001	0.0002	67	0.0017	0.0011	43	0.0049	0.005	2		
Barium	mg/L	0.0031	0.0053	52	0.0048	0.0055	14	0.0035	0.0034	3		
Boron	mg/L	0.022	0.063	96	0.01	0.011	10	1.52	1.53	1		
Cadmium	mg/L	0.00002	0.00006	100	<0.00001	<0.00001	-	<0.00001	<0.00001	-		
Chromium	mg/L	<0.0005	<0.0005	-	0.001	<0.0005	>67	<0.0005	<0.0005	-		
Cobalt	mg/L	0.00008	0.00016	67	<0.00005	0.00023	>129	<0.00005	<0.00005	-		
Copper	mg/L	0.0017	0.0035	69	0.0005	<0.0002	>86	0.0005	0.0008	46		
Iron	mg/L	0.04	0.16	120	<0.01	1.82	>198	<0.01	<0.01	-		
Lead	mg/L	0.00042	0.00105	86	<0.00005	<0.00005	-	<0.00005	<0.00005	-		
Manganese	mg/L	0.008	0.018	77	<0.001	0.239	>198	<0.001	<0.001	-		
Mercury	µg/L	-	-	-	<0.01	<0.01	-	<0.01	<0.01	-		
Vanadium	mg/L	<0.0005	0.0006	>18	0.0027	0.0016	51	0.0009	0.0008	12		
Zinc	mg/L	0.006	0.011	59	<0.002	<0.002	-	<0.002	<0.002	-		
NUTRIENTS												
Nitrate	mg/L as N	0.021	0.02	5	0.753	1.02	30	0.076	0.077	1		
Ammonia Nitrogen	mg/L as N	<0.01	<0.01	-	0.08	0.02	120	0.08	0.04	67		
POLLUTANT TESTS												
Chemical Oxygen Demand	mg/L as O	<10	<10	-	51	70	31	<10	<10	-		
RPD Average				>52	RPD Average				>52	RPD Average		10
RPD Min				0	RPD Min				0	RPD Min		0
RPD Max				>120	RPD Max				>198	RPD Max		67

H:\Project\1005\Analysis\Chemistry\2019\QAQC.xlsm|Table C-1

NOTES:

"-" denotes the parameter was not analyzed or that both the PR and DUP have values below the detection limit, and no RPD has been calculated.

bold values indicate RPD > 65

PR = primary sample

DUP = duplicate sample

RPD = relative percent difference

">" denotes that one of the samples had a value below the detection limit. The RPD shown is a conservative value based on the detection limit.

TABLE C-2 SUMMARY OF DUPLICATE SAMPLE RESULTS FOR SUITE 2 ANALYSES - 2019

SAMPLE DATE SAMPLE TYPE LAB NAME	UNITS	MW13-1S			MW94-4D			MW05-1D		
		30-Jan-19 PR AGAT	30-Jan-19 DUP AGAT	RPD	25-Jul-19 PR AGAT	25-Jul-19 DUP AGAT	RPD	31-Oct-19 PR AGAT	31-Oct-19 DUP AGAT	RPD
PHYSICAL TESTS										
pH-Lab	pH	8.29	8.21	1	8.12	8.16	0	7.86	7.95	1
EC-Lab	µS/cm	591	590	0	247	250	1	802	798	1
Total Dissolved Solids	mg/L	368	392	6	150	152	1	482	432	11
DISSOLVED ANIONS										
Chloride	mg/L	37.5	37.6	0	8.58	8.34	3	32.7	32.6	0
Sulphate	mg/L	28.6	28.3	1	6.2	6.7	8	10.6	10.5	1
NUTRIENTS										
Nitrate	mg/L as N	<0.005	<0.005	-	0.165	0.145	13	0.384	0.383	0
Ammonia Nitrogen	mg/L as N	0.07	0.1	35	<0.01	<0.01	-	0.04	0.04	0
RPD Average				7			4			2
RPD Min				0			0			0
RPD Max				35			13			11

H:\Project\1005\Analysis\Chemistry\2019\QAQC.xlsm]Table C-2

NOTES:

"-" denotes the parameter was not analyzed or that both the PR and DUP have values below the detection limit, and no RPD has been calculated.

PR = primary sample

DUP = duplicate sample

RPD = relative percent difference

">" denotes that one of the samples had a value below the detection limit. The RPD shown is a conservative value based on the detection limit.

TABLE C-3 SUMMARY OF DUPLICATE SAMPLE RESULTS FOR SUITE 3 ANALYSES - 2019

SAMPLE DATE SAMPLE TYPE LAB NAME	UNITS	Christie Creek U/S			Heath Creek		
		17-Apr-19 PR AGAT	17-Apr-19 DUP AGAT	RPD	30-Oct-19 PR AGAT	30-Oct-19 DUP AGAT	RPD
PHYSICAL TESTS							
pH-Lab	pH	7.09	7.07	0	7.43	7.28	2
EC-Lab	µS/cm	64	65	2	78	75	4
Total Hardness (CaCO ₃)	mg/L	30	30	0	29	28	4
DISSOLVED ANIONS							
Chloride	mg/L	1.93	1.89	2	5.45	5.42	1
Sulphate	mg/L	1.1	1	10	0.7	0.7	0
TOTAL METALS							
Cadmium	mg/L	<0.00001	<0.00001	-	<0.00001	<0.00001	-
Chromium	mg/L	<0.0005	<0.0005	-	<0.0005	<0.0005	-
Iron	mg/L	0.09	0.09	0	0.19	0.19	0
Manganese	mg/L	0.026	0.028	7	0.004	0.004	0
Zinc	mg/L	0.023	0.022	4	<0.005	<0.005	-
NUTRIENTS							
Nitrate	mg/L as N	0.007	0.007	0	0.04	0.038	5
Ammonia Nitrogen	mg/L as N	<0.01	0.02	>67	0.04	0.04	0
Total Phosphorus	mg/L	<0.005	<0.005	-	<0.005	<0.005	-
POLLUTANT TESTS							
Chemical Oxygen Demand	mg/L as O	<10	<10	-	<10	<10	-
RPD Average				>9	2		
RPD Min				0	0		
RPD Max				>67	5		

H:\Project\1005\Analysis\Chemistry\2019\QAQC.xlsm]Table C-3

NOTES:

"-" denotes the parameter was not analyzed or that both the PR and DUP have values below the detection limit, and no RPD has been calculated.

PR = primary sample

DUP = duplicate sample

RPD = relative percent difference

">" denotes that one of the samples had a value below the detection limit. The RPD shown is a conservative value based on the detection limit.

TABLE C-4 SUMMARY OF DUPLICATE SAMPLE RESULTS FOR SUITE 4 ANALYSES - 2019

		South Expansion Leachate Drain		
SAMPLE DATE	UNITS	17-Apr-19	17-Apr-19	RPD
SAMPLE TYPE		PR	DUP	
LAB NAME		AGAT	AGAT	
PHYSICAL TESTS				
pH-Lab	pH	7.03	7.2	2
EC-Lab	µS/cm	333	333	0
Total Hardness (CaCO ₃)	mg/L	145	141	3
Total Dissolved Solids	mg/L	190	198	4
DISSOLVED ANIONS				
Alkalinity	mg/L CaCO ₃	144	146	1
Chloride	mg/L	8.33	8.1	3
Sulphate	mg/L	9.1	9.2	1
TOTAL METALS				
Arsenic	mg/L	0.0002	0.0002	0
Boron	mg/L	0.148	0.144	3
Cadmium	mg/L	0.00004	0.00004	0
Chromium	mg/L	<0.0005	<0.0005	-
Copper	mg/L	0.0021	0.0032	42
Iron	mg/L	0.09	0.09	0
Lead	mg/L	<0.00005	<0.00005	-
Manganese	mg/L	1.93	1.92	1
Mercury	ug/L	<0.01	<0.01	-
Zinc	mg/L	<0.005	<0.005	-
NUTRIENTS				
Nitrate	mg/L as N	0.928	0.943	2
Ammonia Nitrogen	mg/L as N	2.45	2.61	6
Total Phosphorus	mg/L	<0.005	<0.005	-
POLLUTANT TESTS				
Chemical Oxygen Demand	mg/L as O	14	15	7
Total Organic Carbon	mg/L as O	6.5	3	74
RPD Average				9
RPD Min				0
RPD Max				74

H:\Project\1005\Analysis\Chemistry\2019\QAQC.xlsm]Table C-4

NOTES:

"-" denotes the parameter was not analyzed or that both the PR and DUP have values below the detection limit, and no RPD has been calculated.

bold values indicate RPD > 65

PR = primary sample

DUP = duplicate sample

RPD = relative percent difference

">" denotes that one of the samples had a value below the detection limit. The RPD shown is a conservative value based on the detection limit.

PITEAU ASSOCIATES

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