# ALBERNI VALLEY LANDFILL

# 2015 OPERATIONS AND MONITORING REPORT

Submitted To: British Columbia Ministry of Environment

Prepared By: McGill & Associates Engineering Ltd. (File #2771)

On behalf of the Alberni-Clayoquot Regional District

Date: January 2017

**EXECUTIVE SUMMARY**

The Alberni-Clayoquot Regional District (ACRD) operates the Alberni Valley Landfill (AVL) under Operational Certificate MR-00524. The AVL has operated as a landfill since the 1970's and accepts solid waste generated from the City of Port Alberni, ACRD Electoral Areas within the Alberni Valley and Bamfield and First Nations Communities Tseshaht, Hupacasath, Huu-ay-aht and Uchucklesaht. This report is intended to meet the annual reporting requirements for the 2014 operating year, as required by the operational certificate and the *Landfill Criteria for Municipal Solid Waste* published by the BC Ministry of Environment (MoE) in 1993.

An estimated 18,837 tonnes of solid waste was landfilled at the AVL in 2015. Filling activities continued within the northeast expansion areas. Scale records and topographic surveys of the landfill face indicate a filling density of about 0.6 tonnes/$m^3$ is being achieved. There is an estimated landfill volume of 2,622,400 $m^3$ remaining at the AVL. Using an annual filling rate of 18,834 tonnes and a filling density of 0.55 tonnes/$m^3$ (five year average), it is estimated that the earliest the AVL will reach capacity is approximately 2090.

Expenditures for the 2015 operating year totaled about $1,854,400 and include a capital cost contribution and funds allocated for closure and post-closure requirements.

In 2015, the quarterly water quality monitoring program continued at the AVL. The results were considered satisfactory and no immediate measures were recommended. Recommendations included in the attached Piteau report, include continuing water quality monitoring, process data for leachate interception wells quarterly, report climate data, continuing to monitor water levels in the south expansion area, and installation of monitoring locations near Stevens Creek. Leachate is transported via underground pipeline to the City of Port Alberni municipal sewage lagoon for treatment. In 2015, approximately 454,915 $m^3$ of leachate was treated at the municipal sewage lagoon.

A landfill gas generation assessment was completed in March 2011. The assessment estimated that less than 1,000 tonnes of methane was generated annually at the AVL, with future projections indicating that it may produce greater than 1,000 tonnes in the 2012 operating year. The landfill gas generation model was updated with current characterization data for the 2015 operating year and indicated that the AVL may generate greater than 1,000 tonnes of methane in the 2017 calendar year. Should actual generation rates be similar to those predicted, a landfill gas management design plan must be submitted to MoE by May 1, 2019.

There were no deviations from the operating plan during 2015. Projects included continuing expansion into the northeast expansion area, installing water quality monitoring wells outside of the northeast expansion area, installing backup leachate interception wells, working towards acquiring ownership or long term tenure of the landfill property, and completing repairs on the electric perimeter fencing.

Work proposed for 2016 includes continuing to fill in the northeast expansion area, continuing to work towards acquiring ownership or long term tenure of the landfill property, updating the regional solid waste management plan, continuing to plan an expansion to the transfer station area to accommodate gypsum and woodwaste separation, improving the SCADA system and doing some upgrades to the McCoy Lake pumphouse building.

Contingency measures for power outages, accidents and leachate excursion have been discussed. The AVL is operating as designed and there are no immediate concerns with the AVL.

The Design, Operations and Closure Report estimates the financial security needed for closure and post-closure activities to be approximately $11,500,000. With over $1,720,000 in the current fund, an annual contribution of $120,000 to the closure and post-closure fund is considered appropriate at this time. As it is extremely difficult to predict costs and design practices 70 to 90 years into the future, the preliminary design and associated costs should be reviewed regularly.

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# 1. INTRODUCTION

The Alberni-Clayoquot Regional District (ACRD) operates the Alberni Valley Landfill (AVL) under the British Columbia Waste Management Act Operational Certificate Number MR-00524, issued June 29, 2004. A copy of the operational certificate is attached in Appendix A. The operational certificate provides the conditions for which the AVL is authorized to manage recyclable material and waste from the ACRD. The known areas disposing of waste at the AVL include the City of Port Alberni, ACRD Electoral Areas within the Alberni Valley and Bamfield and First Nations communities Tseshaht, Hupacasath, Huu-ay-aht and Uchucklesaht.

The AVL has operated as a landfill since the early 1970's. It is located approximately 5 km west of Port Alberni. The landfill is accessed via McCoy Lake Road, through the Tseshaht First Nation reserve land. A site location plan is attached as Figure 1. The landfill accepts various forms of solid waste including municipal solid waste, residential and commercial demolition materials (including roofing and gyproc), compost and stumps, and limited quantities of asbestos and contaminated soils. The landfill also accepts recyclables that are subsequently transferred from the landfill by Suncoast Waster Services Ltd. for recycling.

This report is intended to meet the 2015 annual reporting requirements for operations and monitoring at the AVL, as required by the operational certificate section 3.2 and the *Landfill Criteria for Municipal Solid Waste* published by BC Ministry of Environment (MoE) in 1993. Therefore, this report includes discussion of:

- Total volume and/or tonnage of waste discharged into the landfill for the year;
- Approved design volume;
- Remaining site life and capacity;
- Operational plans for the next 12 months;
- Operation and maintenance expenditures;
- Leachate, water quality and landfill gas monitoring data and interpretation;
- Amounts of leachate collected, treated and disposed;
- Any changes from approved reports, plans and specifications;
- An up to date contingency plan, noting any amendments made to the plan during the year;
- Amount of landfill gas collected and its disposition; and,
- Review of the closure plan and associated estimated costs.

## 2. SOLID WASTE QUANTIFICATION AND LANDFILL CAPACITY

A Solid Waste Management Plan (SWMP) was prepared for the ACRD by Gartner Lee Limited in 2007. The objective of the report was to update the 1996 Regional Solid Waste Management Plan to reflect the current status of solid waste operations and the current public and political direction. The SWMP outlines how the ACRD will comply with relevant regulations and operational certificates. Since the SWMP was prepared, several programs are being implemented to reduce the amount of solid waste entering the landfill. Some of these programs include a composting program and curbside recycling program.

Throughout 2015, the AVL accepted waste and charged tipping fees according to ACRD Bylaw No. R1006-4. A copy of ACRD Bylaw No. R1006-4 is attached in Appendix B. The weight of solid waste entering the landfill in 2015 is summarized in Table 1 below.

Table 1: Measured Weight of Solid Waste Entering the AVL in 2015

| Item | Weight (tonnes) |
|---|---|
| Residential Mixed Solid Waste | 8,582 |
| Commercial Mixed Solid Waste | 5,869 |
| Tires (# of tires) | 190 |
| Compost | 68 |
| Outgoing Steel | 291 |
| Incoming Cover Material | 0 |
| Asbestos | 688 |
| Special Waste | 0 |
| Roofing | 1198 |
| Gyproc | 138 |
| Mixed Construction Demolition | 2,012 |
| Service Road Cleanup | 0 |

Of the listed weights, only the mixed solid waste, asbestos, special waste, roofing, gyproc, demo materials and service road cleanup become landfilled. Any incoming cover material is used as intermediate cover and is not considered solid waste. The tires are stockpiled near the transfer station, before being removed by a recycling company. All separated recycled material (cans, glass, newspaper, cardboard, plastic and steel) is stockpiled at the transfer area near the entrance is subsequently removed by a commercial recycling company. Any asbestos received is buried in a designated section near the east expansion areas. Compost material is stockpiled onsite and removed by a private composting company.

The data for the 2015 operating year was provided by the ACRD and is based on categorized scale records. When available, the direct weight of the categorized material was used. The amount of solid waste dropped off by individuals to the landfill site was provided based on the number of bags of garbage, as this is how payment is calculated. This is different from data provided for past years, where the weight of solid waste in the transfer bins was used. In order to convert the number of bags of garbage to a representative weight, an average weight of 7.5 kg per bag was used (based on information provided in an Ergonomic Assessment study completed by the University of Ontario and the Transportation Health and Safety Association of Ontario). Where the number of bags is between four and eight, we have used the average of six bags.

The amount of material landfilled during 2015 was approximately 18,837 tonnes. Therefore, the estimated cumulative quantity of solid waste at the AVL is approximately 741,200 tonnes. A table of the estimated historic weights from 1975 to 2015 is attached included in Appendix C.

Throughout 2015, landfilling continued within the east and northeast expansion area. The filling area and other site features are shown on Figure 2. The latest topographic surveys of the landfill face were conducted on January 22, 2015 and January 21, 2016. The volume difference between these dates is approximately 31,632 $m^3$. Based on the monthly landfill reports from this period, approximately 18,000 tonnes of waste was landfilled, resulting in compacted density of 0.60 tonnes/$m^3$. Filling densities have typically ranged from 0.41 tonnes/$m^3$ in 2008 to 0.66 tonnes/$m^3$ in 2010.

Property setbacks vary throughout the site. The western limit of the site adopts the 50 m setback. On the north boundary, the setback requirement of 50 m has been relaxed to 30 m, to accommodate the existing landfill toe. The current design criteria includes 15 m setbacks on the east and south edges, finished slopes of 3H to 1V and a finished elevation of 106 m. As of January 2016 there is an estimated 2,622,400 $m^3$ available before the landfill reaches full capacity. Further detail on the proposed filling plan can be found in the *Design, Operations and Closure Report* for the Alberni Valley Landfill.

While there will likely be a population increase in future years, it is anticipated that the reduction of solid waste material will balance this, if not decrease it. Therefore, an annual filling rate of 18,834 (the average filling rate from the last five years) has been used to estimate projected annual tonnages. The filling density has varied over the past years. In order to evaluate the remaining capacity, an average (five year average) density of 0.55 tonnes/$m^3$ was used. Therefore, it is estimated that the earliest the landfill will reach capacity is in around the year 2090. It should be noted that based on annual filling rates and densities, this value can vary significantly.

## 3. OPERATION AND MAINTENANCE EXPENDITURES FOR 2015

The AVL operated as usual throughout 2015. Funds in 2015 were used to continue to investigate potential cover material sources, further development of the northeast expansion area, improvements to perimeter fencing, and design of the access road upgrades.

A summary of the 2015 expenditures are provided in Table 2 below.

Table 2: 2015 Operation and Maintenance Expenditures

| Item | Approximate Cost |
|---|---|
| Daily Operations (Staff, utilities, equipment) | $865,200 |
| Miscellaneous Operations Costs (promotional/educational materials, recycling programs) | $50,500 |
| Administration | $150,300 |
| Capital Cost Contribution | $520,600 |
| Engineering, Monitoring & Consulting Fees | $130,900 |
| Landfill Closure & Post-Closure Fund Allocation | $136,900 |
| **Total** | **$1,854,400** |

The above table does not include costs associated with the Bamfield Transfer Station, recycling depot operations and residential recycling pick up.

The 2015 expenditures for the AVL are within the original budgeted amount submitted by the ACRD.

## 4. MONITORING DATA AND INTERPRETATION

Water quality monitoring is conducted on a quarterly basis at the AVL and reported annually. Landfill gas assessments are conducted every five years as the AVL was shown to produce less than 1,000 tonnes of methane annually, however this report includes the required annual landfill gas reporting requirements. Water quality monitoring, leachate quantities and landfill gas are discussed in the sections below.

### 4.1. Leachate & Water Quality

The quarterly water quality monitoring program continued throughout 2015. Piteau Associates Engineering Ltd. prepared and submitted a report entitled "*Water Quality Monitoring Program to December 2015, Alberni Valley Landfill*", dated January, 2017. The report provides the monitoring data and interpretation of results from the surface water, groundwater and leachate samples. A summary of the results are as follows:

- Groundwater flow beneath the existing landfill is to the north, northwest and southeast while that in the bedrock beneath the Northeast Expansion Area is to the east and southeast. Groundwater flow in the south expansion area is to the east and southeast. Flow rates and quantities are low due to limited thickness of permeable sediments and low permeability of bedrock. Construction of the berm and drain in the south expansion area appear to have controlled migration of seepage west towards Heath Creek.
- Leachate discharging from the base of the existing landfill suggests that the drain water is diluted by about 2:1 or less. Current leachate indicator concentrations are considered to be typical for a landfill of this size and age. Samples from the proposed south

expansion area indicate no significant landfill effects have occurred to date, with the exception of slightly increased ammonia concentrations.

- Any potential historic leachate impacts in the southwest corner of the landfill appear to have been mitigated with the construction of the drain in the south expansion area.
- Chloride concentrations in surficial sediments on the north side of the landfill rose until it peaked in 1999 before leveling off and decreasing. Ammonia concentrations have increased in the past years, likely the result of retardation and are therefore expected to follow the chloride concentration and begin to decrease, meaning the peak leachate generation rates have already occurred.
- Since the construction of the north leachate interception trench, only very slight leachate impacts have been observed north of the leachate interception trench., despite high water levels recorded in 2015.
- Monitoring at the Northeast corner reveals a highly mineralized chemistry, but shows no indication of leachate impact. It appears the water levels do not have time to recover to static levels in between sampling sessions due to the low hydraulic conductivity of the bedrock. The water quality may be a sign of a poorly flushed flow regime or a possible connection to surface water, requiring further investigation.
- Bedrock well monitoring data indicates that no leachate impacts have occurred to the south and only very slight leachate impacts have occurred to the west, north and northeast of the present landfill footprint. Monitoring data for bedrock wells around the landfill site perimeter are well within drinking water criteria, except for iron, manganese and arsenic, which are attributed to the naturally occurring mineralogy of the bedrock in the area.
- Leachate impacts have not been detected in McCoy, Heath and Norris Creeks in 2014
- Slight leachate impacts have been detected in Stevens Creek, north of the landfill boundary. Recent water quality in Stevens Creek has met the receiving water criteria with the exception of cadmium, manganese and iron in 2014 which has slightly exceeded the freshwater aquatic life criteria. The cadmium is attributed to background sources but two additional sampling points should be added to verify that seepage beneath the berm is not the source.
- Christie Creek received discharge from the leachate lagoon until 1998 and leachate impacts have since been drastically reduced since the pipeline was commissioned. The water quality met water quality criteria with the exception of total iron, manganese and zinc. The iron and manganese criteria are based on aesthetic objectives and the zinc exceedance is likely from a background source.
- Chemistry for two leachate interception wells indicated that they were intercepting leachate and controlling the migration of leachate towards Christie Creek when

operating. However, it appears that PW-1 has been periodically in-operational and was not maintaining a low enough level to control migration.

The report provided the following monitoring program recommendations:

- Continue the quarterly monitoring program;
- Process leachate flow data annually and operational data (water levels and cumulative flows) for the leachate interception wells quarterly;
- Report climate (precipitation) data;
- Monitor water levels in the shallow piezometers in the south expansion area during sampling events;
- Piezometers at BH00-1C and BH00-2C should be replaced with multilevel completion piezometers, with 2" standpipes and data loggers. BH00-1C should be removed from the sampling program;
- The damaged MW02-1S should be repaired;
- The VOC scan and acid extractables analysis need only be completed once a year at the Aeration Lagoon Inflow and BH00-1C;
- Two additional sampling locations on Stevens Creek should be added to the quarterly sampling program; and
- Flow data from the leachate pipeline to the City of Port Alberni sewage treatment lagoon should be reviewed and reported annually.

In addition, the report recommended several design modifications and mitigative measures that include:

- The operation of the north interception trench pumps should be reviewed;
- Commission two backup for interception wells PW-1 and PW-2;
- The controls for PW-1 and PW-2 should be adjusted to increase the interception of leachate; and
- Flow monitoring should be implemented to provide weekly cumulative data.

Further detail and interpretation can be found in the water quality monitoring report, attached in Appendix D.

### 4.2. Leachate Collection System

Leachate is collected from the landfill and transported via underground pipeline to the City of Port Alberni municipal sewage lagoon. The volume of leachate received at the sewage lagoon is measured by the City of Port Alberni. The table below summarizes the monthly leachate flows throughout 2015.

Table 3: Monthly Leachate Flows for 2015

| Month | Total Volume (m3) | Average Daily Volume (m3) | Max Daily Volume (m3) | Min Daily Volume (m3) |
|---|---|---|---|---|
| January | 52,563 | 1,696 | 4,839 | 766 |
| February | 68,995 | 2,464 | 5,144 | 393 |
| March | 49,655 | 1,602 | 4,166 | 594 |
| April | 39,876 | 1,329 | 4,166 | 506 |
| May | 11,953 | 386 | 813 | - |
| June | 5,420 | 181 | 309 | 111 |
| July | 2,982 | 96 | 138 | 53 |
| August | 3,180 | 103 | 752 | - |
| September | 6,830 | 228 | 764 | 58 |
| October | 14,769 | 476 | 1,340 | 148 |
| November | 58,482 | 1,949 | 5,576 | 640 |
| December | 140,210 | 4,523 | 5,823 | 945 |
| TOTAL | 454,915 | | | |

Based on the measured flow data, approximately 454,915 $m^3$ of leachate was transported to the City of Port Alberni sewage lagoon for treatment in 2015. The monthly leachate flows for the past 8 years are plotted in the following chart.

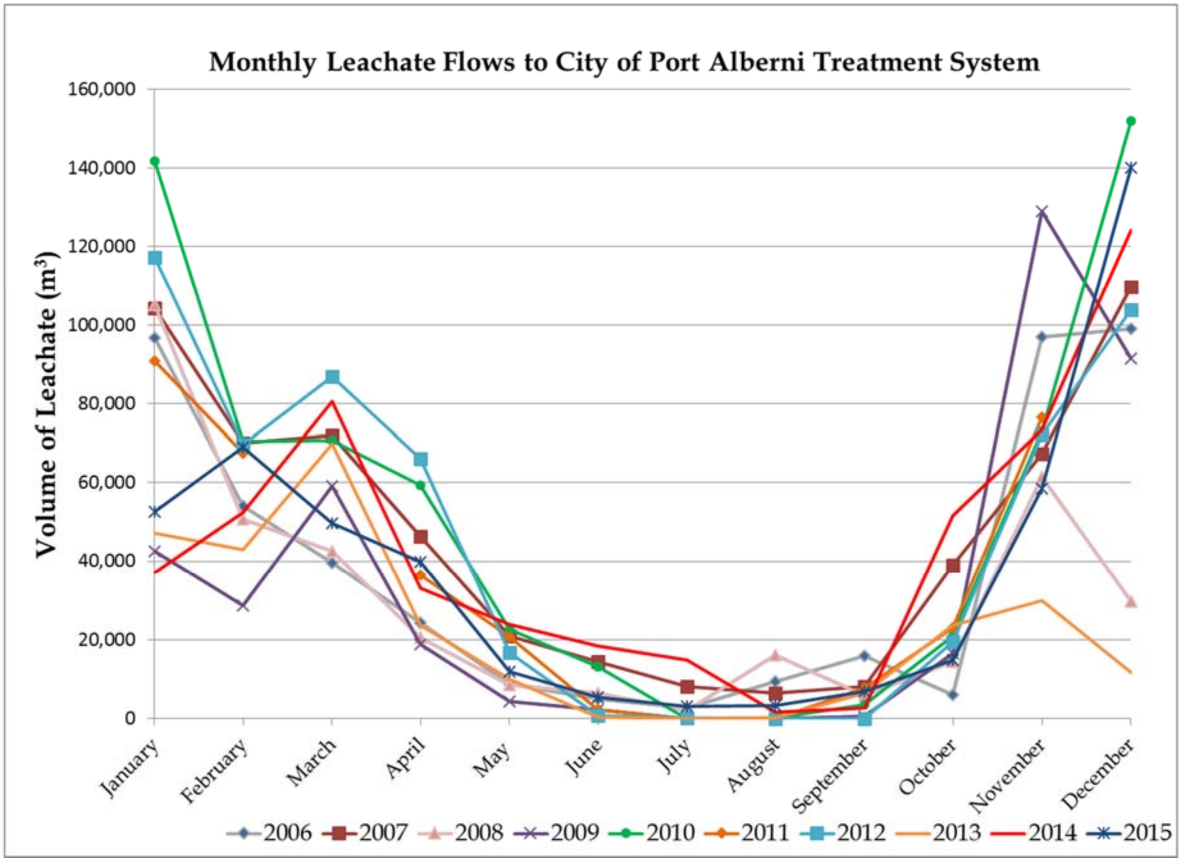



Chart 1: Monthly Leachate Volumes from 2006 to 2015

Flows follow the local precipitation patterns with increased flows during the wet winter months and lower flows during the dry summer months.

## 4.3. Landfill Gas

The following sections summarize the annual reporting requirements of the *Landfill Gas Regulation*.

### 4.3.1. Introduction

The following section has been prepared in accordance with the requirements of the British Columbia Ministry of Environment's Landfill Gas Management Regulation (Regulation), approved and ordered on December 8, 2008, and in accordance with the Landfill Gas Generation Assessment Procedure Guidance Report, as prepared for the British Columbia Ministry of Environment (MOE) by Conestoga-Rovers & Associates (CRA), dated March 2009. This section has been prepared by a qualified professional and meets the requirements of Section 4(3)(e) of the Regulation.

#### 4.3.2. Records

The following section presents the information required under Section 12(3), 13, and 14(1)(a) of the Regulation.

The Alberni-Clayoquot Regional District certifies that all records required under Section 12(3) of the British Columbia Ministry of Environment Landfill Gas Management Regulation are retained for a period of at least 10 years after they are made. Furthermore, the records will be produced for inspection or copying, upon written request from the director, in the time period specified by the director as required in Section 13 of the Regulation.

#### 4.3.3. Quantity, Source and Composition of Municipal Waste Received

The following section presents the information required under Sections 12(1)(a), 12(1)(b), 12(1)(c), 14(1)(a) and 14(2)(g) of the Regulation and as described in Section 5.1 of the Guidelines.

A breakdown of the quantity and type of solid waste entering the AVL in 2015 has been provided in Section 2. The waste composition has been categorized and a summary is provided in Appendix E. This table includes the measured waste categorization from 1995 to 2015.

As no solid waste categorization studies have been completed, the solid waste composition was based on a combination of scale records and the *British Columbia's Solid Waste Flow Report, 2006 Summary Report* prepared for MoE by BC Stats in February 2010. Further discussion on the methodology used can be found in the *Alberni Valley Landfill, Landfill Gas Generation Assessment*, prepared by McGill & Associates Engineering Ltd. in March 2011.

Using the same analysis and assumptions as the *Alberni Valley Landfill, Landfill Gas Generation Assessment,* in 2015, the AVL received:

- 7,613 tonnes (40.5%) of relatively inert material
- 5,118 tonnes (27.2%) of moderately decomposable material
- 6,105 tonnes (32.5%) of decomposable material.

A table showing the breakdown of the waste composition for 2015 has been included in Appendix E.

#### 4.3.4. Waste Diversion

The following section presents the information required under Section 14(1)(b) of the Regulation.

The SWMP prepared in 2007 estimated that the ACRD had a recycling rate of 15%. This rate was based on scale records from 2005, before a curbside recycling program was implemented. The City of Port Alberni and Beaver Creek Electoral Area now have curbside recycling programs and recycling depots are located in the City of Port Alberni and at the AVL.

There is currently no formal organics waste diversion program within the ACRD or City of Port Alberni. Backyard composting of organic waste is encouraged through distribution of backyard composters and educational material on the ACRD website.

The AVL accepts yard waste compost free of charge. The compost is stored onsite and subsequently removed by an outside contractor. The 2007 SWMP recommends several organic waste diversion programs such as establishing a yard waste depot within the City of Port Alberni, setting up a yard waste composting facility at the AVL or an alternate location, and completing a composting feasibility study. None of these programs have been implemented yet.

#### 4.3.5. Landfill Gas Generation Model Results

As found in the *Alberni Valley Landfill Gas Generation Assessment* finalized in 2011, the AVL is nearing 1,000 tonnes of methane production annually. Therefore, the *Landfill Gas Generation Estimation Tool* was used to update previous estimates of methane production. In updating the spreadsheet, the same assumptions were made as stated in the *Landfill Gas Generation Assessment Report for the Alberni Valley Landfill*, March 2011. The estimation tool spreadsheet results are attached in Appendix F and a summary of the landfill gas generation model results are presented in the table below.

Table 4: Landfill Gas Generation Model Results

| | **Year** | **Mass of Methane Generated (tonnes)** |
|---|---|---|
| Estimated Quantity of Methane Produced in year Preceding the Assessment | 2015 | 991 |
| Estimated Quantity of Methane Produced in Year of the Assessment | 2016 | 999 |
| Estimated Quantity of Methane Produced One year after the Assessment | 2017 | 1,006 |
| Estimated Quantity of Methane Produced Two Years after the Assessment | 2018 | 1,013 |
| Estimated Quantity of Methane Produced Three Years after the Assessment | 2019 | 1,020 |
| Estimated Quantity of Methane Produced Four Years after the Assessment | 2020 | 1,027 |

The model results indicate that the first year the AVL may produce greater than 1,000 tonnes of methane is in the year 2017.

Should future generation rates be similar to those projected, the annual landfill gas report for the 2017 year (submitted to MoE by May 1, 2018) may indicate that a Landfill Gas Management Design Plan be prepared and submitted to MoE by May 1, 2019.

It should be noted, however, that the landfill gas estimate process is based on the preceding 30 years from the year of evaluation. Therefore, each year, the annual tonnage disposed at the landfill is added to the overall model, and the annual tonnage from 30 years ago is removed. As the annual tonnage has remained similar from year to year, the projected date of exceedance has tended to also roll forward without being realized.

## 5. REVIEW OF OPERATING PLAN

In 2015, the landfill followed the same operating procedures as past years. Landfilling continued within east and northeast expansion area and there were no major changes to the quarterly water quality monitoring program. Notable work related to AVL operations in 2015 included:

- Continuing to work towards acquiring ownership or long term tenure of the landfill property;
- Continuing expansion into the northeast corner of the landfill, including rerouting the terminus of the leachate perimeter trench;
- Evaluating the operation of the existing leachate interception wells adjacent to the lagoon and to design and implement a backup interception system;
- Investigating future sources of cover material;
- Doing maintenance work (extending and shortening) of water quality monitoring wells;
- Expansion of the existing transfer station.
- Completing repairs on the electric bear fence;
- Updating the regional solid waste management plan; and
- Improving the current SCADA system.

In 2015 there were no major deviations from the operating plan.

## 6. 2016 OPERATIONAL PLAN

In 2016, work will continue in the northeast expansion area (Cell B). Filling operations will continue as described in the *Alberni Valley Landfill Design, Operations and Closure Report* (dated February 2012).

Plans for 2016 include:

- Continuing to develop portions of the northeast expansion area;
- Continuing to work towards acquiring ownership or long term tenure of the landfill property;
- Updating the regional solid waste management plan;
- Continuing to plan an expansion to the transfer station area to accommodate proposed gypsum and woodwaste separation initiatives;
- Improving the current SCADA system; and,
- Planning for some upgrades to the McCoy Lake Road pumphouse building (that pumps water to the landfill reservoir).

## 7. CONTINGENCY PLAN

A contingency plan has been developed to make provision for any unplanned events that may disrupt landfill operations. Various contingency measures have been discussed below.

In the event of a power outage, a backup generator is located onsite and capable of restoring power to the scale, scale shed, maintenance building, caretaker's residence and leachate pumps at the transfer bin area.

Vehicles onsite are equipped with radios that communicate with the maintenance building and the scale shed. Should there be an accident or emergency, emergency vehicles can be called from the telephone at either the maintenance building or scale shed. In addition, the AVL has been added to the Sproat Lake Fire Department service area which offers first responder services and firefighting services to onsite buildings and structures.

While monitoring wells are located to allow early identification of potential leachate problems, several contingency measures have been developed in the event that leachate excursion is found and these include:

- Drilling interception wells and installing pumps to intercept leachate flows and direct them into the leachate collection system;
- Excavating a deep sump to intercept flows destined for surface water bodies; and,
- Constructing a clay and/or bentonite berm to block groundwater flow.

A clay source is available locally and the landfill operators have the machinery available onsite for any construction needed.

## 8. CLOSURE PLAN

An *Alberni Valley Landfill Design, Operations and Closure Report* has been prepared for the AVL. The report outlines the proposed closure design for the AVL and the estimated post-closure requirements. No changes have been made to the closure design. As indicated previously the landfill is estimated to have around 70 years of remaining life before closure is required.

As per the report, the closure and post-closure costs have been estimated at approximately $11,500,000. There is currently just over $1,720,000 in the current closure and post-closure fund. In 2015, an additional $120,000 was put into the closure fund. In addition, interest was added to the fund making the total amount added to the closure fund in 2015 to be $136,877.36.

The 2016 budget indicates that an additional $120,000 will be added to the closure fund in 2016, in order to continue to build up the financial security and establish the funds needed for closure and post-closure activities. While several assumptions have been made in the preparation of the estimate (see *AVL Design, Operations and Closure Report*, 2012), it should be noted that the estimate is based on 70 to 90 years of life remaining at the AVL and current design practices. It is extremely difficult to predict costs and design practices that far into the future, therefore the closure design and associated costs should be reviewed regularly.

## 9. COMPLIANCE REVIEW

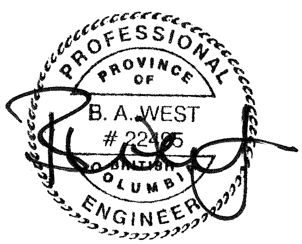
The last compliance review was completed with a Ministry of Environment representative on November 15, 2012. A compliance review was not completed during 2015.

## 10. LIMITATIONS

This document was prepared by McGill & Associates Engineering Ltd. for the Ministry of Environment, on behalf of the Alberni-Clayoquot Regional District. Its material, recommendations and conclusions represent the best material available to McGill & Associates Engineering Ltd. at the time of the report preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. McGill & Associates Engineering Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

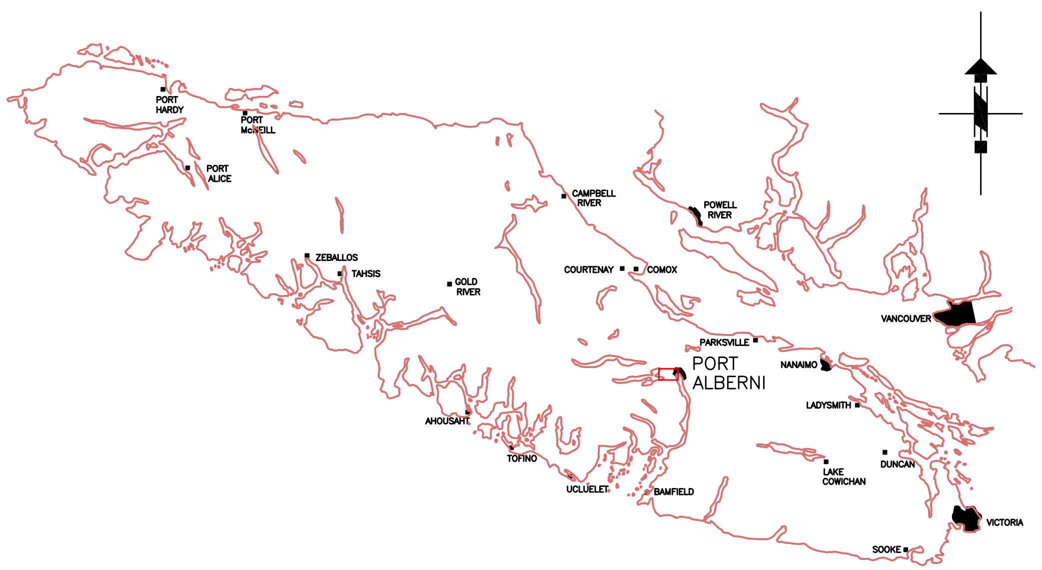
Yours truly,

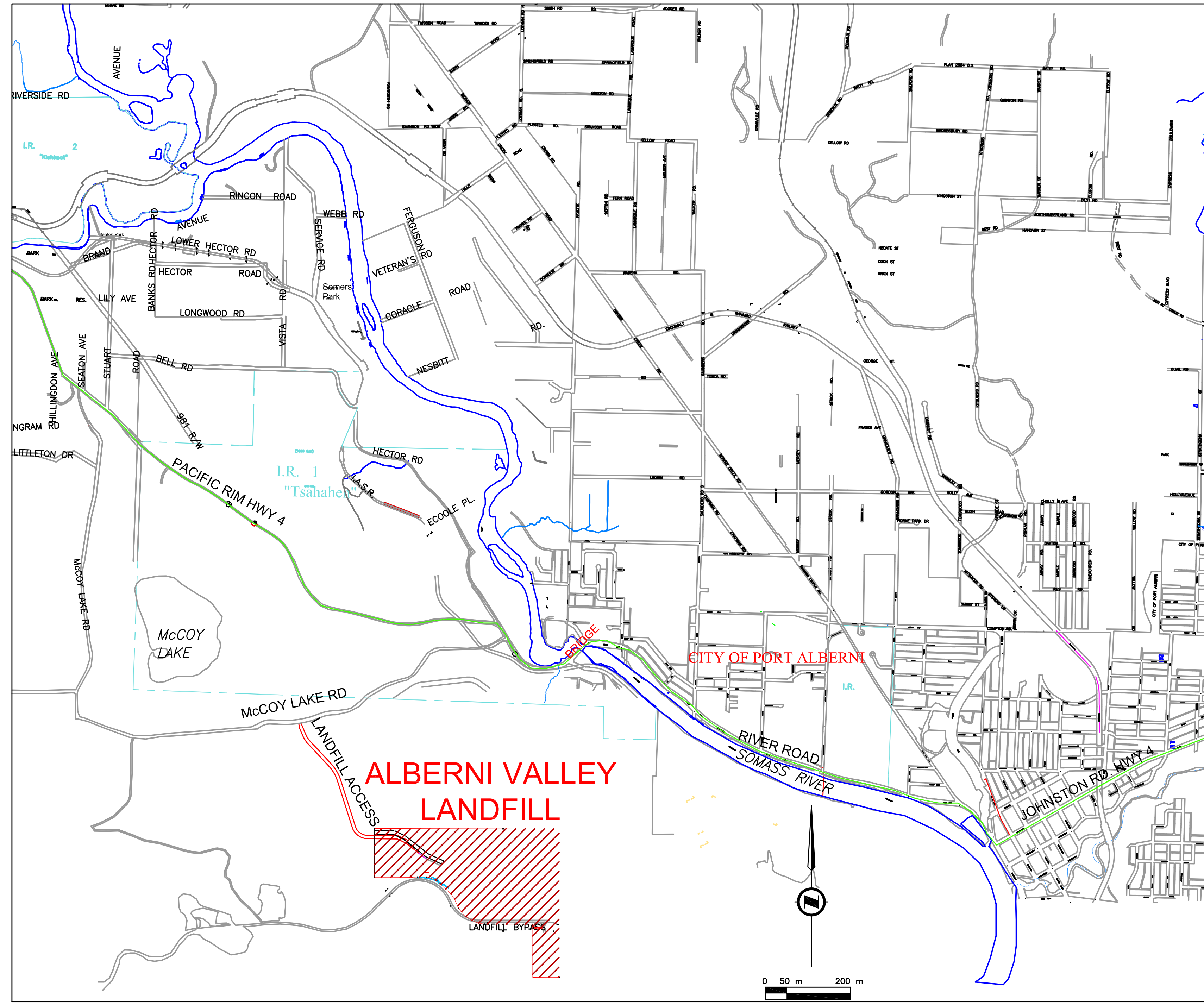
for **McGill & Associates Engineering Ltd.**




Bradley West, P. Eng.

# FIGURES



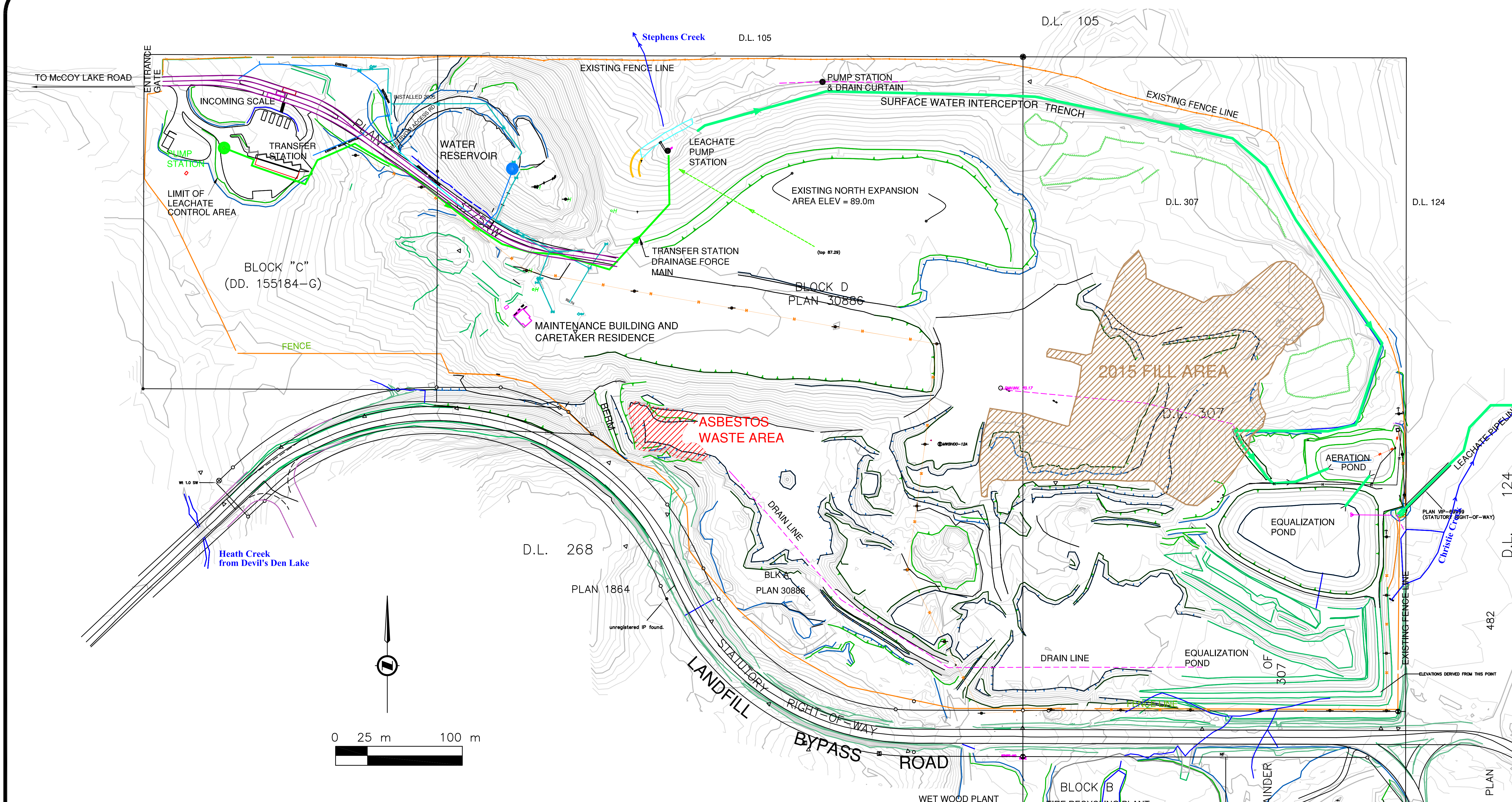

JUNE 2014

FIGURE 1

ALBERNI CLAYOQUOT REGIONAL DISTRICT

ALBERNI VALLEY LANDFILL - 2015 OPERATIONS & MONITORING REPORT

SITE LOCATION PLAN




JUNE 2014

FIGURE 2

ALBERNI CLAYOQUOT REGIONAL DISTRICT

ALBERNI VALLEY LANDFILL - 2015 OPERATIONS AND MONITORING REPORT

GENERAL SITE PLAN

S:\2771 ACRD AVL Annual Reporting\2015\Figures - pdfs in final report folder\FIGURE 2- General Site Plan.dwg Dec 16, 2016 10:06:39am

# APPENDIX A

Alberni Valley Landfill Operational Certificate MR-524

BRITISH COLUMBIA

RECEIVED JUL 02 2004

2010 VANCOUVER

File: MR-00524

Date: JUN 29 2004

**REGISTERED MAIL**

Alberni-Clayoquot Regional District
3008 Fifth Ave
Port Alberni BC V9Y 2E3

Dear Operational Certificate Holder:

Enclosed is Operational Certificate MR-00524 issued under the provisions of the *Waste Management Act*. Your attention is respectfully directed to the terms and conditions outlined in the Operational Certificate.

This Operational Certificate does not authorize entry upon, crossing over, or use for any purpose of private or Crown lands or works, unless and except as authorized by the owner of such lands or works. The responsibility for obtaining such authority rests with the Operational Certificate Holder. It is also the responsibility of the Operational Certificate Holder to ensure that all activities conducted under this authorization are carried out with regard to the rights of third parties, and comply with other applicable legislation that may be in force.

This decision may be appealed to the Environmental Appeal Board in accordance with Part 7 of the *Waste Management Act*. An appeal must be delivered within 30 days from the date that notice of this decision is given, in accordance with the practices, procedures and forms prescribed by regulation under the *Environment Management Act*. For further information, please contact the Environmental Appeal Board at 250 387 3464.

.../2

orig - agreements file
cc - Sean

Administration of this Operational Certificate will be carried out by staff from the Vancouver Island Region office. Plans, data and reports pertinent to the Operational Certificate are to be submitted to the Regional Waste Manager at Ministry of Water, Land and Air Protection, Regional Operations, Vancouver Island Region, 2080 Labieux Road, Nanaimo, British Columbia, V9T 6J9.

Yours truly,

R. Alexander
Regional Waste Manager
Vancouver Island Region

Enclosure (Copy of signed legal Operational Certificate)

cc: Environment Canada

BRITISH COLUMBIA

MINISTRY OF WATER, LAND AND AIR PROTECTION

Vancouver Island Region
Environmental Protection
2080-A Labieux Road
Nanaimo, British Columbia
V9T 6J9
Telephone: (250) 751-3100
Fax: (250) 751-3103

# OPERATIONAL CERTIFICATE

MR-00524

*Under the Provisions of the Waste Management Act*

**Regional District of Alberni-Clayoquot**

**3008 Fifth Avenue**

**Port Alberni, British Columbia**

**V9Y 2E3**

is authorised to manage recyclable material and waste from the Regional District of Alberni-Clayoquot and environs at the Alberni Valley landfill located near Port Alberni , British Columbia, subject to the conditions listed below. Contravention of any of these conditions is a violation of the *Waste Management Act* and may result in prosecution.

## 1. MANAGEMENT OF WASTE AND RECYCLABLE MATERIAL

### 1.1. Sanitary Landfill

1.1.1. This subsection applies to the discharge of waste to a sanitary landfill.

1.1.2. Waste may be discharged to the sanitary landfill shown on attached Site Plan A.

1.1.3. The characteristics of the discharge must be municipal solid waste as defined under the *Waste Management Act* and other wastes as approved in writing by the Regional Waste Manager.

1.1.4. The authorised works are a sanitary landfill, and related appurtenances approximately located as shown on attached Site Plan A.

1.1.5. The authorised works must be complete and in operation on and from the date of this operational certificate.

### 1.2. Leachate

1.2.1. This subsection applies to the management of leachate from the landfill.

1.2.2. The characteristics of the surface water and groundwater at the property boundary must not exceed concentrations set in the *British Columbia Approved Water*

R. Alexander
Regional Waste Manager

*Quality Guidelines (Criteria)* and *A Compendium of Working Water Quality Guidelines for British Columbia.* Where natural background water quality concentrations exceed the aforementioned guidelines, characteristics of the surface water and groundwater must not exceed background concentrations.

1.2.3. The authorized works are a leachate collection and conveyance system, leachate treatment works, lift station and related appurtenances approximately located as shown on Site Plan A.

1.2.4. Leachate must be collected, treated and conveyed to the City of Port Alberni sewage treatment system.

1.2.5. The authorized works must be complete and in operation on and from the date of this operational certificate.

### 1.3. Location of authorised facilities

The location of the facilities for the management of recyclable material and waste to which this operational certificate is applicable is Block D of Lot 268, Alberni Land District, approximately located as shown on attached Site Plan A. The location of the leachate treatment facility is Lot 307, Alberni Land District approximately located as shown on attached Site Plan A.

## 2. GENERAL REQUIREMENTS

### 2.1. Entrance facilities

2.1.1. The authorised facilities are signs, weigh scales, recyclable material and waste drop-off and storage facilities and related appurtenances approximately located as shown on attached Site Plan A.

2.1.2. The authorised facilities must be complete and in operation on and from the date of this operational certificate.

### 2.2. Bear-Proof Facilities

2.2.1. Bears must not access putrescible waste at the landfill facility. All putrescible waste that arrives at the landfill facility must be immediately contained within a bear-proof bin or an area enclosed by a bear-proof electric fence. Grass, leaves, weeds, branches and woodwaste are exempt from bear-proofing requirements.

2.2.2. A bear-proof electric fence must be installed around the landfill.

2.2.3. The bear-proof electric fence must be designed, constructed, operated and maintained to prevent bears from penetrating the fence.

R. Alexander.
Regional Waste Manager

2.2.4. The bear-proof electric fence must be complete and in operation on and from the date of this operational certificate.

**2.3. Qualified Professionals**

All facilities and information, including works, plans, assessments, investigations, surveys, programs and reports, must be certified by qualified professionals.

**2.4. Plans**

2.4.1. Site development, operating, leachate management, closure and post closure plans must be submitted to the Regional Waste Manager by October 31, 2004.

2.4.2. The plans must address, but not be limited to, each of the subsections in the *Landfill Criteria for Municipal Solid Waste* including performance, siting, design, operational and closure and post-closure criteria.

2.4.3. The facilities must be developed, operated and closed in accordance with the plans.

**2.5. Landfill Gas**

2.5.1. When 100,000 tonnes of waste have been discharged at the landfill, an assessment of the potential for landfill gas generation must be submitted to the Regional Waste Manager.

2.5.2. The landfill gas assessment must address, but is not limited to, subsections 4.2 and 6.4 of the *Landfill Criteria for Municipal Solid Waste* and section 6 of the *Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills.*

2.5.3. The potential for landfill gas generation is to be re-assessed at least once every 5 years after the initial assessment.

**2.6. Seismic and Fault Activity**

A report that assesses the risk from seismic and fault activity must be submitted to the Regional Waste Manager by October 31, 2004.

**2.7. Additional Facilities or Works**

The Regional Waste Manager may require investigations, surveys, and the construction of additional facilities or works including, but not limited to, additional leachate and landfill gas management facilities. The Regional Waste Manager may also amend the requirements of any of the information required by this operational certificate including plans, programs, assessments and reports.

R. Alexander
Regional Waste Manager

# 3. MONITORING AND REPORTING

## 3.1. Monitoring Program

3.1.1. A monitoring program must be developed to identify any impacts to the environment and public health from the landfill.

3.1.2. The monitoring program must address, but not be limited to, subsections 4.1, 4.2 and 7.15 of the *Landfill Criteria for Municipal Solid Waste* and the *Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills*.

3.1.3. Monitoring must be conducted in accordance with the monitoring program.

## 3.2. Annual Operating and Monitoring Report

3.2.1. An annual operating and monitoring report for the preceding 12 month period from January 1 to December 31 must be submitted to the Regional Waste Manager by May 1 of each year.

3.2.2. The report must include:

- An executive summary;
- Tonnage of each type of waste discharged to the landfill for the year;
- Remaining site life and capacity;
- Review of the preceding year of operation, plans for the next year and any new information or proposed changes relating to the facilities and plans;
- Comparison of the monitoring data with the performance criteria in section 4 of the *Landfill Criteria for Municipal Solid Waste* and the *Guidelines for Environmental Monitoring at Municipal Solid Waste Landfills*, interpretation of the monitoring data, identification and interpretation of irregularities and trends, recommendations, and any proposed changes to the monitoring program.

# 4. SITE CLOSURE

## 4.1. Closure and Post-Closure Fund

A closure and post-closure financial security trust fund must be built up over time. The closure and post-closure fund must ultimately meet or exceed the estimated closure and post-closure costs plus a reasonable contingency for any remediation that may be required.

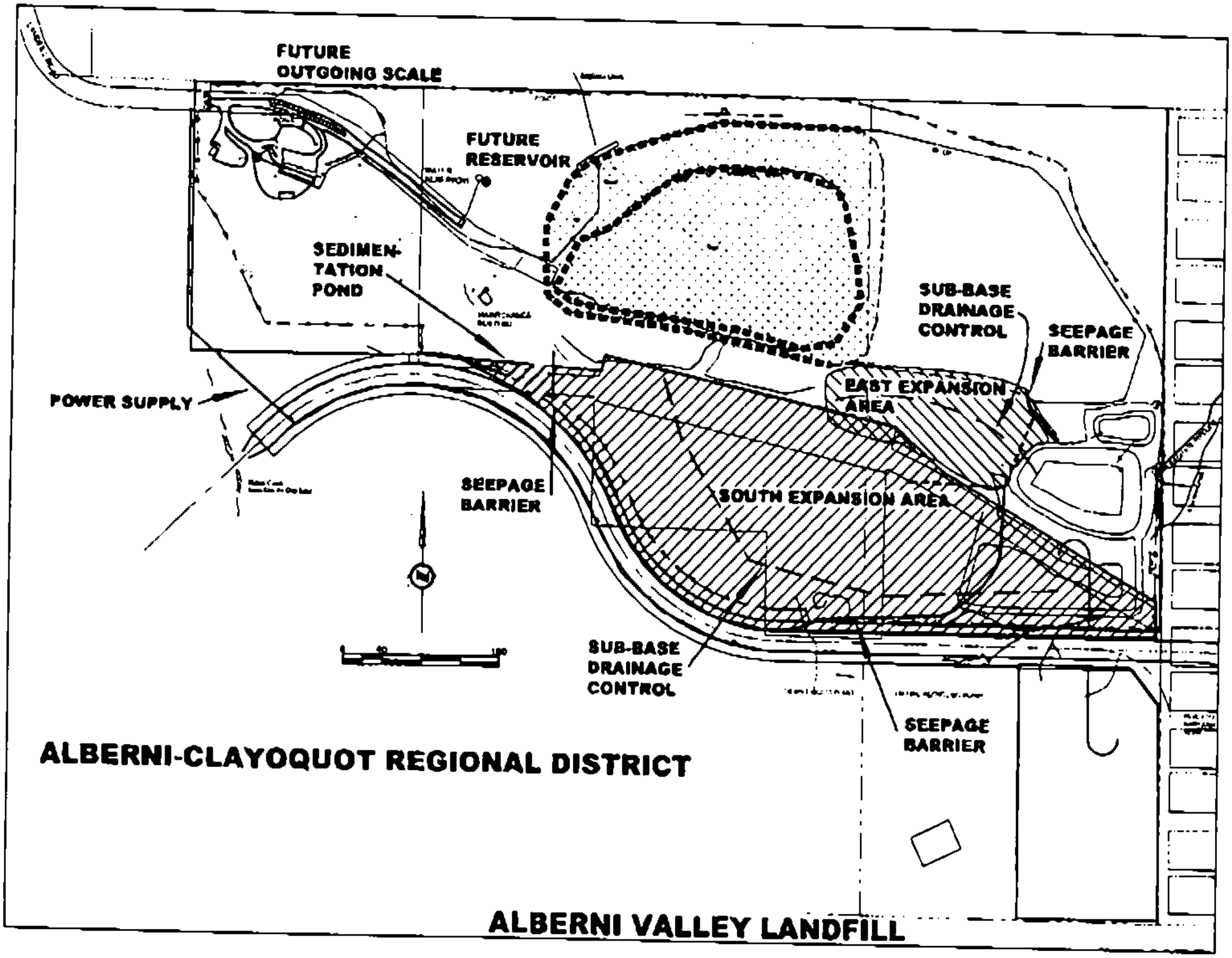
Date Issued: JUN 29 2004
Date Amended:
(most recent)

[signature]
R. Alexander.
Regional Waste Manager

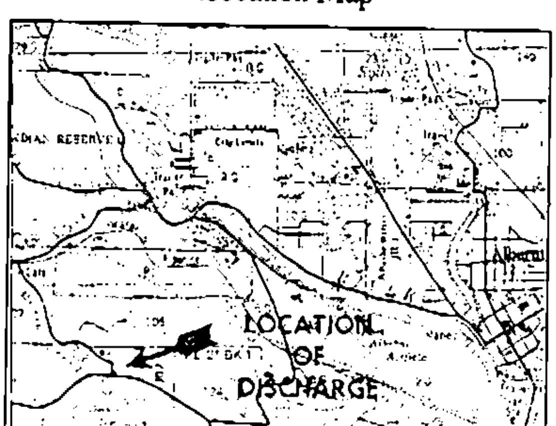
PROVINCE OF
BRITISH COLUMBIA

Environmental Protection

# SITE PLAN A




Location Map




Scale: 1:2400

OPERATIONAL CERTIFICATE: MR-00524

Date: JUN 29 2004

R.Alexander
Regional Waste Manager
Vancouver Island Region

# APPENDIX B

Alberni-Clayoquot Regional District Bylaw No. R1027 – June -4

**REGIONAL DISTRICT OF ALBERNI-CLAYOQUOT**

**BYLAW NO. R1027**

A Bylaw to Provide for
the Regulation of Solid Waste Disposal and Tipping Fees
at the Alberni Valley Landfill

**WHEREAS** by Supplementary Letters Patent, dated August 10, 1973 as amended, the Regional District of Alberni-Clayoquot was granted the function of Garbage Disposal under Division XIV of its Letters Patent;

**AND WHEREAS** the Regional District of Alberni-Clayoquot is empowered to establish a scale of charges payable for depositing Municipal Solid Waste at the Alberni Valley Landfill;

**AND WHEREAS** the Board of Directors of the Regional District of Alberni-Clayoquot deems it advisable to enact regulations pertaining to solid waste disposal and to establish a charge for depositing Municipal Solid Waste;

**NOW THEREFORE**, the Board of Directors of the Regional District of Alberni-Clayoquot in open meeting assembled enacts as follows:

**1. DEFINITIONS**

In this bylaw, unless the context otherwise requires:

1.1 **"Biomedical Waste"** means solid waste such as soiled sheets, garments and other similar solid waste. Excluded is waste material from pathology, operating rooms, laboratories and other hospital operations, which produce potentially infectious waste considered to be special waste;

1.2 **"Controlled Waste"** means certain hazardous waste, liquid waste and Municipal Solid Waste which is approved for disposal at the Alberni Valley Landfill site but which, because of its inherent nature and quantity, may require special handling and disposal techniques to avoid creating health hazards, nuisances, or environmental pollution. Controlled Waste includes, but is not limited to:

- a. Demolition wastes including:
  - i. roofing materials
  - ii. stumps, land clearing debris;
- b. Waste oils (commercial)
- c. Material containing the following:
  - i. traces of petroleum products;
  - ii. pumping from domestic septic tanks;
  - iii. catch basin and manhole material;
- d. Waste asbestos;
- e. Fish shrimp shells, animal carcasses;
- f. Steel cable;
- g. Biomedical waste

1.3 **"Corrugated Cardboard"** means recyclable waste from residential, industrial, commercial, institutional sources which includes, but is not limited to containers or materials used in containers consisting of 3 or more layers of Kraft paper material and having smooth exterior liners and a corrugated or rippled core, but excluding containers which are impregnated with blood, grease, oil, chemicals, food residue, was; or have polyethylene, foil or other non-paper liners; or are contaminated with a material which will render the corrugated cardboard not marketable;

1.4 **"Construction/Demolition Waste"** means waste produced from the construction, renovation, and demolition of buildings, bridges, wharfs, rail lines and other structures, but does not include waste containing or contaminated with asbestos, creosote, PCB treatments, paints or chemicals of any kind;

1.5 **"Environmental Management Act"** means the Environmental Management Act (British Columbia), as amended or replaced and any successor legislation and any regulations thereunder;

1.6 **"Disposal Site"** means the Alberni Valley Landfill;

1.7 **"Gypsum"** includes, but is not necessarily limited to new construction off-cuts or scraps and old wallboard that has been painted, covered in wallpaper, vinyl or ceramic tiles and is removed during renovation, but excluding wallboard from demolition sites or wallboard associated with asbestos;

1.8 **"Hazardous Waste"** means gaseous, liquid and solid waste which, because of its inherent nature and quantity, requires special disposal techniques to avoid creating health hazards, nuisances, or environmental pollution. Hazardous Wastes are toxins or poisons, corrosives, irritants, strong sensitizers, flammables, explosives, infectious waste, condemned food, etc. Flammable wastes excluding plastics, paper products and the like;

1.9 **"Ignitable"** means having the properties of:

a. flammable gas,

b. flammable liquid, or

c. flammable solids, or substances susceptible to spontaneous combustion or substances that on contact with water emit flammable gases as defined in the Special Waste Regulations of the Environmental Management Act;

1.10 **"Metal"** means recyclable ferrous and non-ferrous metallic materials which include, but are not limited to: sheet metal, siding, roofing, rebar, flashings, pipes, window frames, doors, furnaces, duct work, wire, cable, bathtubs, fencing, bicycle frames, automotive parts, machinery, appliances, garbage cans, metal furniture, tire rims and metal cans. It does not include metal that is incorporated into a product or packaging, such as a couch, that does not compose more than 50% of produce weight and that cannot be readily separated from the non-metallic components.

1.11 **"Municipal Solid Waste" (MSW)** means refuse that originates from residential, commercial or institutional, demolition, land clearing or construction sources within the Regional District of Alberni-Clayoquot;

1.12 **"Person"** means an individual, a body corporate, a firm, a partnership, association or any other legal entity or an employee or agent thereof.

1.13 **"Prohibited Waste"** means a waste prohibited from disposal under Schedule 'C' attached to and forming part of this bylaw;

1.14 **"Radioactive Waste"** means waste containing a prescribed substance as defined in the Atomic Energy Control Act in sufficient quantity or concentration to require a licence for possession or use under the Act and regulations made under that Act;

1.15 **"Reactive Waste"** means waste which is;

a. explosive, oxidizing, or so unstable that it readily undergoes violent change in the presence of air or water;
b. generates toxic gases, vapours, or fumes by itself or when mixed with water; and
c. polymerizes in whole or in part by chemical action and causes damage by generating heat or increasing volume; as defined in the Special Waste Regulations of the Environmental Management Act;

1.16 **"Refuse"** means discarded or abandoned materials, substances or objects; but does not include Controlled Waste and Prohibited Waste;

1.17 **"Regional Board"** means the Board of Directors of the Regional District of Alberni-Clayoquot;

1.18 **"Regional District"** means the Regional District of Alberni-Clayoquot;

1.19 **"Special Waste"** means any chemical, compound, mixture, substance or article which is defined as such in the Special Waste Regulation of the BC Environmental Management Act.

1.20 **"Stewardship Materials"** means any waste or recyclable materials in an approved stewardship plan as defined in the Recycling Regulation of the BC Environmental Management Act;

1.21 **"Tires"** means the outer pneumatic rubber covering of wheels of passenger's vehicles, light service trucks and motorcycles with an inner diameter of less than 43 centimetres.

1.22 **"Waste Asbestos"** means a waste containing friable asbestos fibres or asbestos dust in a concentration greater than 1% by weight either at the time of manufacture, or as determined using a method specified in section 40 (1); of the BC Hazardous Waste Regulation;

1.23 **"Waste Oil"** means automotive lubricating oil, cutting oil, fuel oil, gear oil, hydraulic oil or any other refined petroleum based oil or synthetic oil where the oils are in the waste in a total concentration greater than 3% by weight and the oils through use, storage or handling have become unsuitable for their original purpose due to the presence of impurities or loss of original properties;

1.24 **"Yard and Garden Material"** means uncontaminated organic materials, substances or objects including, but not necessarily limited to, grass, lawn and hedge clippings, grass sod, flowers, leaves, vegetable stalks, shrubs and shrub tree branches less than 2" in diameter, but excluding Scotch Broom.

## 2. CONDITIONS

2.1 No person shall, in depositing Municipal Solid Waste (MSW) at the Disposal Site;

a. deposit a Prohibited Waste;
b. deposit MSW except as directed by regulations for the use of the Disposal Site;
c. unless permitted by the Regional District, deposit MSW without first having it weighted on the scales at the Disposal Site;

d. drive a vehicle anywhere on the Disposal Site except on roads provided by the Regional District for that purpose unless otherwise instructed;

e. act in a manner contrary to the posted site regulations.

2.2 Controlled Waste will not be accepted for disposal at the Disposal Site without written approval of the Regional District. This requirement may be waived, if the Regional District or its agent determines that special handling and disposal techniques are not required to dispose of the Controlled Waste. Controlled Waste for which special handling and disposal techniques are required are subject to fees as outlined in Schedule "A" attached to and forming part of this bylaw.

2.3 No person shall salvage or remove material deposited at the Disposal Site without prior written approval of the Regional District.

2.4 No person shall loiter or leave their vehicle unattended at the Disposal Site.

2.5 Persons entering the Disposal Site do so at their own risk. The Regional District accepts no liability whatsoever for damage and/or injury to persons or property at the Disposal Site.

2.6 Children under 13, and pets shall not be permitted at the Disposal Site except inside a vehicle.

2.7 No person shall deposit Municipal Solid Waste at the Disposal Site, that does not originate from within the Regional District. Any person doing so will be in contravention of this bylaw.

**3.0 CHARGES**

3.1 Every person depositing Municipal Solid Waste at the Disposal Site shall pay to the Regional District the applicable charges set out in Schedule "A" hereto.

3.2 Where a charge is not paid within the time specified in Schedule "B" , attached to and forming part of this bylaw, for its payment the person liable to pay such a charge shall:

a. In addition to such a charge pay interest thereon at a rate set out in Schedule "A" from the date the charge was due to the date of payment;

b. Not deposit any Municipal Solid Waste on or at the Disposal Site until such a charge and interest owing thereon has been paid in full.

**4. VIOLATIONS AND PENALTIES**

4.1 No persons shall do any act or suffer or permit any act or thing to be done in contravention of this Bylaw.

4.2 Every person who contravenes this bylaw, by doing any act which the bylaw forbids, or omits to do any act which the bylaw requires:

a. is guilty of an offence and is liable, on summary conviction, to a fine of not less than TWO HUNDRED ($200.00) DOLLARS and not more than TEN THOUSAND ($10,000.00) dollars for a first offence and for each subsequent offence to a fine of not less than FIVE HUNDRED ($500.00) and not more than TEN THOUSAND ($10,000.00) DOLLARS. A separate offence shall be deemed to be committed upon each day during and in which the contravention occurs or continues;

b. may be prohibited from depositing Municipal Solid Waste at the Disposal Site.

## 5. TITLE

This bylaw may be cited as the "Alberni Valley Landfill Tipping Fee and Regulation Bylaw No. R1027, 2015"

## 6. EFFECTIVE DATE

Bylaw No. R1027 "Alberni Valley Landfill Tipping Fee and Regulation" comes into effect on July 1, 2015.

## 7. REPEAL

Bylaw No. R1006, cited as the "Alberni Valley Landfill Tipping Fee and Regulation Bylaw No. R1006, 1999" is hereby rescinded as of July 1, 2015.

| | | | | |
|---|---|---|---|---|
| Read a first time this | 10th | day of | June, | 2015 |
| Read a second time this | 10th | day of | June, | 2015 |
| Read a third time this | 10th | day of | June, | 2015 |
| ADOPTED this | 10th | day of | June, | 2015 |

Certified true and correct copy **of "Alberni Valley Landfill Tipping Fee and Regulation Bylaw No. R1027, 2015"**

Russell Dyson
Chief Administrative Officer

The Corporate seal of the Regional District of Alberni-Clayoquot was hereto affixed in the presence of:

Josie Osborne
Chair

**Schedule A**
**Charges**

| | Solid Waste, excluding Controlled Waste | Tipping Fee | Other Charges |
|---|---|---|---|
| | Loads of 84 kg or greater | $95.00 per tonne | $8.00 minimum |
| | Loads under 84 kg (each garbage bag or can) | $2.00 each | $8.00 maximum |
| | Wrecked auto (each) | $100.00 each | |
| | Wrecked trucks, bus or recreational vehicle | $200.00 each | |
| | Surcharge for Solid waste containing Prohibited Recyclable Materials | $190 per tonne | |
| | Surcharge for improperly covered or secured loads | $190 per tonne | |

| | Recyclable Materials | Tipping Fee | Other Charges |
|---|---|---|---|
| | Batteries | No Charge | |
| | Corrugated Cardboard | No Charge | |
| | Fridges and Freezers | $20 each | |
| | Metal | No Charge | |
| | Stewardship Materials | No Charge | |
| | Tires | $2.00 each or $170 per tonne whichever is greater | |
| | Yard and Garden Waste (branches 2" & under) | No charge | |

| | Controlled Waste | Tipping Fee | Other Charges |
|---|---|---|---|
| | Construction/Demolition Waste | $120 per tonne | |
| | Demolition waste crushed to pieces 7 cubic centimeters or smaller | $95.00 per tonne | |
| | Stumps, land clearing debris | $120.00 per tonne | |
| | Waste oil (commercial) | $0.50 per litre | |
| | Contaminated Soils: | | |
| | Provided that the Ministry of Environment has approved of disposal of the contaminated soil, without treatment, at the Alberni Landfill | $10.00 per tonne | |
| | Provided that the Ministry of Environment has approved of the treatment and disposal of the contaminated soil at the Alberni landfill | $70.00 per tonne | Plus estimated out-of-pocket treatment costs |
| | Pumpings from domestic septic tanks | $120.00 per tonne | |
| | Catch basin and manhole material | $120.00 per tonne | |
| | Waste asbestos | $250.00 per tonne | $120.00 minimum |
| | Fish, shrimp shells, animal carcasses provided that there will be no charge for animal carcasses removed from public roadways by a public body or their contractor | $170.00 per tonne | $95.00 minimum |
| | Steel Cable | $500.00 per tonne | |
| | Biomedical waste | $132.00 per tonne | |
| | Loads containing Gypsum | $120.00 per tonne | |
| | Loads containing fish feed totes | $400.00 per tonne | $120.00 minimum |

## Schedule B
## Policies and Procedures

1. In the event that the scales provided are not operational,weight shall be estimated by the Scale Clerk employed by the Regional District of Alberni- Clayoquot.

2. All charges payable under this Bylaw shall be paid prior to the deposit of the solid waste for which the charge is made unless it is necessary to weigh the vehicle depositing solid waste loaded and empty to determine the weight of solid waste, in which case the charge shall be paid immediately after weighing the vehicle empty.

3. The person paying a charge shall obtain a receipt for such payment and shall produce such receipt for inspect ion on request of a person employed for that purpose at a disposal site as a condition of depositing solid waste at a disposal site.

4. Notwithstanding anything to the contrary in this Bylaw, persons depositing solid waste at a disposal site on a regular basis may apply to the Regional District for credit and if credit is granted to that person, then payment of the charge imposed under Schedule A shall be made and the credit extended on condition that:

    a. Payment in full shall be received by the Regional District within thirty (30) days of the last day of the month for which an invoice has been submitted. The Regional District will invoice monthly for material delivered during the preceding month. The invoice amount will be based on the total quantity of the Municipal Solid Waste delivered during the month, and the posted disposal rates in effect at the time of delivery.
    b. In order to reflect the additional administration costs associated with accounts in arrears, an overdue charge will be calculated monthly as the greater of:
        i. $2.00; or
        ii. Interest of 2% per month (effective interest rate of 26.824%) on the unpaid balance.
    c. The Regional District reserves the right to cancel the credit offered herein for late payment, non-payment or other justified cause.

## Schedule C
## Prohibited Waste

The following gaseous liquids and municipal solid wastes are not acceptable for disposal at the Disposal Site and include, but are not limited to:

i. Liquids, except as permitted herein;
ii. Ignitable wastes;
iii. Reactive wastes;
iv. Radioactive wastes;
v. Hazardous waste;
vi. Special Waste, as defined in the *Special Waste Regulation* (British Columbia) except asbestos;
vii. Medical waste
viii. Solid Waste that is on fire or smouldering
ix. Corrugated Cardboard
x. Metal
xi. Municipal Solid Waste that does not originate from within the Regional District;
xii. Stewardship Materials
xiii. Tires
xiv. Yard and Garden Waste

# APPENDIX C

Historic Weights at AVL

## APPENDIX C
## Estimated Historic Quantities at Alberni Valley Landfill

| Year[1] | Annual Weight (tonnes) | Cumulative Weight (tonnes) |
|---|---|---|
| 1975 | 18,903 | 18,903 |
| 1976 | 19,228 | 38,131 |
| 1977 | 19,460 | 57,591 |
| 1978 | 19,912 | 77,503 |
| 1979 | 19,677 | 97,180 |
| 1980 | 21,199 | 118,379 |
| 1981 | 18,713 | 137,092 |
| 1982 | 18,573 | 155,665 |
| 1983 | 18,433 | 174,098 |
| 1984 | 18,292 | 192,390 |
| 1985 | 17,869 | 210,259 |
| 1986 | 17,730 | 227,989 |
| 1987 | 17,593 | 245,582 |
| 1988 | 17,455 | 263,037 |
| 1989 | 17,317 | 280,354 |
| 1990 | 17,179 | 297,533 |
| 1991 | 17,042 | 314,575 |
| 1992 | 16,917 | 331,492 |
| 1993 | 17,062 | 348,554 |
| 1994 | 17,115 | 365,669 |
| 1995 | 19,653 | 385,322 |
| 1996 | 15,335 | 400,657 |
| 1997 | 16,694 | 417,351 |
| 1998 | 16,201 | 433,552 |
| 1999 | 15,959 | 449,511 |
| 2000 | 14,966 | 464,477 |
| 2001 | 13,462 | 477,939 |
| 2002 | 13,500 | 491,439 |
| 2003 | 14,672 | 506,111 |
| 2004 | 16,479 | 522,590 |
| 2005 | 19,198 | 541,788 |
| 2006 | 19,422 | 561,210 |
| 2007 | 22,019 | 583,229 |
| 2008 | 19,026 | 602,255 |
| 2009 | 22,878 | 625,133 |
| 2010 | 21,931 | 647,064 |
| 2011 | 18,942 | 666,006 |
| 2012 | 19,488 | 685,494 |
| 2013 | 18,155 | 703,649 |
| 2014 | 18,749 | 722,398 |
| 2015 | 18,837 | 741,234 |

**Notes:**

1. Anuual weights from 1995 to 2015 are based on scale records. Annual weights prior to 1995 are based on estimates from the *Alberni Valley Landfill Report on Landfill Gas* , prepared by Cameron Advisory Services, May 2003.

# APPENDIX D

*Water Quality Monitoring Program to December 2015*

Alberni Valley Landfill

Piteau Associates Engineering Ltd.

PITEAU ASSOCIATES
GEOTECHNICAL AND
HYDROGEOLOGICAL CONSULTANTS

SUITE 300 - 788 COPPING STREET
NORTH VANCOUVER, B.C.
CANADA - V7M 3G6
TEL: (604) 986-8551 / FAX: (604) 985-7286
www.piteau.com

# ALBERNI CLAYOQUOT REGIONAL DISTRICT

# WATER QUALITY MONITORING PROGRAM
# TO DECEMBER 2015

# ALBERNI VALLEY LANDFILL
# PORT ALBERNI, B.C.

**Prepared by**

**PITEAU ASSOCIATES ENGINEERING LTD.**

**FILE 1005-15-R1** **JANUARY 2017**

## CONTENTS

**CONTENTS** (cont'd.)

## TABLES

## FIGURES

# 1. INTRODUCTION

## 1.1 BACKGROUND

Piteau Associates Engineering Ltd. (Piteau) installed eight monitoring wells around the Alberni Valley Landfill (AVL) in November of 1994, and recommended a quarterly sampling program be implemented 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 approximately 20 years. It has been conducted on a quarterly schedule since 1998.

Two additional monitoring wells, installed in the fall of 1998 to monitor a leachate excursion towards the north boundary of the landfill property, were incorporated into the regular monitoring program at that time.

Ten monitoring wells were also constructed in the summer of 2000 as part of a hydrogeological investigation of two proposed landfill expansion areas (Piteau, 2000). One well, installed in the original landfill, was incorporated into the monitoring network at that time, and two additional wells were incorporated in 2006.

Monitoring wells were installed at four different sites in 2002 (Piteau, 2002b), as part of further hydrogeological investigations at the site. Piezometers were also installed in four diamond drillholes. Initial samples were collected from all but one of the new wells. Two of the 2002 wells were incorporated into the monitoring program after they were constructed, and the other two were added in 2006.

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

Thirteen additional shallow monitoring wells were installed in the South Expansion Area in November 2009, to measure water levels in the vicinity of 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 after they were installed are also discussed in this report. Data from the South Expansion Area Leachate Drain were included in the water quality monitoring program for the first time in 2011.

Four additional monitoring wells situated outside the north leachate interception channel, around the perimeter of the proposed Northeast Expansion Area, 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 were added to the monitoring program in 2014.

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

A compilation and assessment of the results from two leachate drains, the 18 monitoring well sites, two leachate interception wells, and six surface water monitoring sites that were sampled in 2015 are presented in this report.

## 1.2 SOURCES OF INFORMATION

Sources of information for this report include:

- Results of the hydrogeological investigation and monitoring well installation program (Piteau, 1995);
- Chemistry data for samples collected from the monitoring network since December 1994, as reported in previous monitoring reports (Piteau, 1998, 1999, 2001, 2002a, 2003, 2004, 2005, 2006, 2007b, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015);
- Chemistry data from the 2015 sampling program;
- Results of the hydrogeological investigations conducted in the proposed landfill expansion areas (Piteau, 2000 and 2002b);

- Results of the Phase 1 leachate interception well and monitoring well drilling program (Piteau, 2007a);
- Water level data from 13 shallow piezometers installed in the South Expansion Area in November 2009;
- Water level and chemistry data from the four bedrock piezometers installed in 2013 adjacent to the north leachate interception channel (Piteau, 2014); and
- Drilling and testing results of the Phase 2 leachate interception well program (Piteau, 2017).

## 1.3 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 (Fig. 1). It is situated about 5 km due west of Port Alberni, at an elevation of about 80m. Access is provided by a private road off McCoy Lake Road, or by the Stirling Arm logging road that passes along the south side of the property (Fig. 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 (Fig. 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 200mm diameter galvanized pipe was constructed through the centre of the swamp prior to landfilling (Fig. 2). A 400mm storm sewer pipe was installed above the galvanized pipe in the early 1990's, 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 80m west of the leachate aeration lagoon. In 2015, the pipeline was modified to convey discharge directly to the aeration lagoon, at the location of the surface water sampling site shown on Fig. 2.

A concrete-lined leachate interception/conveyance channel was constructed around the north perimeter of the landfill site in 1995 (Fig. 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.

All 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 1990's to convey the collected leachate to the Port Alberni sewage treatment lagoon. A flow equalization lagoon was constructed in 1996 to add 16,000 $m^3$ (3.5 million Igal) 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 a capacity of about 115 L/s (1500 Igpm). The current aeration lagoon was also constructed at this time, and the original aeration lagoon was decommissioned.

A possible leachate excursion towards the north property line was identified in monitoring data collected in 1997 and early 1998. In 1998, this area was investigated with an electromagnetic (EM) survey and two additional monitoring wells were installed in October of that year (MW98-9, MW98-10). Results of these investigations were presented 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 (Fig. 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 Fig. 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 2016). Locations of the monitoring wells are shown on Fig. 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 Fig. 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 western 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, 2016). The 2015 wells (PW15-1 and PW15-2) have not yet been put into service.

A seepage cut-off trench and berm were constructed at the northwest corner of the South Expansion Area in July 2007 (Fig. 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 about a 3m 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.

Thirteen shallow monitoring wells were installed in the South Expansion Area and on the downstream side of the cut-off trench in November 2009, to define the hydraulic gradient across the cut-off structure and the water table in the expansion area.

In 2013, two shallow and two deep monitoring wells were installed outside the north leachate interception channel, around the perimeter of the proposed Northeast Expansion Area, to provide water levels and background chemistry prior to deposition of waste in the Northeast Expansion Area.

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

## 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, identified as possible fault zones. 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 in an easterly direction, towards the head of Alberni Inlet.

### 1.4.2 Surficial Sediments

Surficial sediment cover for most of the landfill area is limited to a thin veneer over bedrock (Figs. 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:

<u>Proposed Landfill Expansion Areas</u>

The South Expansion Area (see extent on Fig. 2) is currently being used for gravel extraction. The two monitoring wells installed in this area during the 1994 drilling program, and the investigation holes drilled in 2000, encountered bedrock at depths varying between about 5m and 15m (see sections on Figs. 4 and 5). Sediments in these drillholes consisted of sand and gravel with variable silt content. A 2.4m thick layer of silt was encountered at the bottom of MW94-8. Exposures in the borrow pits in this area exhibit cross-bedding, indicating a deltaic depositional environment. Bedrock outcrops bound the sediment deposits to the south (Figs. 2, 4 and 5).

The East Expansion Area (see extent on Fig. 2) is a borrowed area 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).

<u>Bedrock Gap along Stirling Arm Logging Road</u>

MW94-4, drilled in this area, encountered clayey sediments to 6.7m depth. A thin layer of medium to coarse gravel was encountered between the base of the clay and the bedrock (see Section Y-Y' on Fig. 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.

A second well (BH00-3A) was installed near the east end of this gap during the 2000 field investigation (Piteau, 2000). This well encountered sand and gravel sediments to 8.5m depth, with a thin till lens or layer at about 6.4m depth. 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 12.6m into the bedrock.

Excavation for the seepage cut-off trench in July 2007 did not encounter the bedrock contact beneath the centre of the gulley. 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 Surge Lagoon in Christie Creek Valley

This low area appears to be a broad bedrock channel infilled with surficial sediments. The channel is at least 13m 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 (Figs. 2 and 5). The southern and eastern extents of this basin are not defined. Sediments encountered in this basin consisted of silt and clayey silt, over sand and gravel (see Section Y-Y', Fig. 4). High electrical conductivity measurements documented in an EM survey of this area during late 1994 (Piteau, 1995) are consistent with mostly clayey sediments.

Bedrock Channel at MW94-6

MW94-6 was drilled to investigate a geophysical anomaly at this location. Bedrock outcrops are present to the east and west of this location, but drilling revealed a channel approximately 7.3m deep. Sediments which have infilled the bedrock channel consist of about 4m of sandy clay over sandy gravel. A similar sediment profile was encountered in MW98-9 (see Section X-X' on Fig. 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. Data plots present monitoring data collected between 1994 and the end of 2015. Tabulated summaries are presented herein for the last four years of data. Monitoring program parameters are summarized in Table I.

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 November 2009. Monitoring wells installed in 2013 were added to the water level monitoring program in January 2014. The complete record of monitoring well elevation data is presented in this report in Tables A-1 through A-4 and Figs. A-1 to A-9 in Appendix A.

## 2.2 SAMPLING METHODS

Samples were collected from monitoring piezometers using either weighted polyethylene plastic bailers or Delrin Waterra inertial foot valve pumps on HDPE tubing. Monitoring well samples and water levels were collected by Piteau until October 1995. Monitoring was performed by McGill & Associates Engineering Ltd. (McGill) of Port Alberni from May of 1996 to January of 2006. The Alberni Clayoquot Regional District (ACRD) took over the monitoring program in January of 2006.

Only one well volume of water is removed from the bedrock wells prior to sampling. 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 down and allowed to recover for one week in advance of sampling. This procedure allows adequate time for formation water to accumulate in the wells.

A Grundfos submersible pump is used to purge monitoring wells MW02-1D, MW02-1S, MW02-3D, MW02-3S, MW02-4, MW13-1D, MW13-1S, MW13-2D, and MW13-2S. Other monitoring wells are purged using a plastic bailer or Waterra tubing with a foot valve. Leachate well samples are collected from the outlet of the 2” discharge pipe at the leachate pond, using the installed groundwater pump. 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.

In order to reduce contact by the sampler, latex gloves are worn during sampling. Samples are placed in plastic and/or glass containers provided by the laboratory for the various analytical parameters, and are stored and transported in a cooler with an ice pack. Samples for ammonia and Chemical Oxygen Demand (COD) are preserved in the field with $H_2SO_4$. Samples for total metals are preserved with $HNO_3$ in the field. Samples for dissolved metals are not preserved until after they have been filtered in the laboratory. All samples are stored in a cooler and couriered to a commercial laboratory. Since 2013, all samples have been sent to 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 of the monitoring well sites, the leachate sampling point, and the sampling locations on Christie and Stevens creeks are shown on Fig. 2. Due to the scale of the map, the sampling location on Heath Creek and the location of the well on McCoy Lake Road could not be shown. A detailed summary of each of the creek sampling points is given below.

Surface Water Samples

| | |
|---|---|
| Heath Creek | Sampled on the south side (upstream) of McCoy Lake Road. |
| Stevens Creek | Sampled approximately 50m 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 off the Stirling Arm Logging Road, east of MW94-2 and approximately 200m downstream of the flow equalization 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 discharged via a pipe to the north concrete leachate interception channel until this year. Prior to 2006, leachate samples were collected from the French drain pipe, where it discharged to the leachate conveyance ditch. After 2006, leachate samples were collected downstream of the French Drain pipe's confluence with the concrete north leachate conveyance ditch, at the inlet to the leachate aeration lagoon. In July 2015, after the French Drain pipe was rerouted, leachate samples were collected directly from the pipe where it enters the aeration lagoon.<br><br>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.

Piezometers and 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 20m 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 120m west of the original landfill. |
| MW94-5 | Approximately 60m 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 120m 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 25m north of the north leachate interception channel. |

| | |
|---|---|
| MW98-10 | Approximately 25m north of the north leachate interception channel, 30m 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 piezometer is bent or broken at a depth of 10m below ground (mbg), but samples were collected for three of four monitoring events in 2015. |
| BH00-4A | On 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 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 piezometer 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 does not require replacement if the South Expansion Area has been indefinitely deferred. |
| 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 600m WNW of original landfill footprint. Sampled quarterly since 2002. |
| PW-1 | Approximately 25m 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 30m 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 5m east of temporary leachate containment berm. Sampled quarterly starting in October 2008. |
| MW13-1 | On the north east side of the North Leachate Interception Channel. First sample collected in June 2013. Quarterly sampling began in December 2014. |
| MW13-2 | On the north side of the North Leachate Interception Channel, approximately 150m northwest of MW13-1. First sample collected in June 2013. Quarterly sampling began in December 2014. |

Piezometers 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, BH00-5A, BH00-6A, BH00-7A, BH00-8A | These wells are located in the South Expansion Area (A suffix denotes South Expansion Area) and were installed to measure hydraulic properties of the bedrock and hydraulic gradients. Water levels 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 piezometer is blocked at 3.2 mbg. |
| MW09-01 to MW09-05 | Located to the west and east side of the north containment berm, to measure hydraulic gradient across this structure. Water levels measured in November 2009 and quarterly since 2011, except for MW09-05 which was destroyed in late 2011/early 2012. |
| MW09-06 to MW09-13 | Located in South Expansion Area to determine hydraulic gradients towards the French Drain. Water levels measured in November 2009 and quarterly since 2011, except for MW09-06, MW09-07, and MW09-12, which have been inaccessible since 2012. MW09-08, MW09-09 and MW09-10 were destroyed in 2015. |

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 (Fig. 2) until 1996 are no longer monitored, at the request of the property owners.

## 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 plots on Figs. A-1 through A-9. A plan showing November 2015 groundwater levels throughout the site, with interpreted equipotentials in the South Expansion Area, in the vicinity of the French Drain, is presented as Fig. 3.

Measured water levels and interpreted piezometric surfaces on an east/west and two north/south sections through the landfill site are shown on Figs. 4 and 5. Data used for the interpretations on the sections were those collected November 20-30, 2015, or the last available winter data for piezometers that have been destroyed or are no longer accessible. Groundwater data posted on the plan on Fig. 3 are also for the water levels measured in November 2015 unless otherwise indicated.

Due to the low permeability of the rock mass, and slow response time of the piezometers, 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 (Figs. A-1 to A-5, and A-9).

As shown on Fig. A-5, BH00-1A, -3A, -4A, -6A and -8A display a declining trend between January 2001 and April 2002. 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 (Fig. 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 piezometers in the South Expansion Area displayed a dramatic drop in the summer of 2006, in response to sampling. The responsive piezometers also displayed drawdown response following the construction of a French Drain in the fall of 2006 (Fig. A-5). Elevations in MW94-7 displayed the same drop in response to the French Drain, but MW94-4S has not shown any response (Fig. A-2). A temporary 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 2015 were within the historical envelope documented since 2007.

October 2007 water levels in bedrock in the South Expansion Area were all below 71m elevation, except for BH00-5A-s which is installed in fractured bedrock, at about 72m elevation. With the exception of BH00-4A which has been sampled regularly since 2006, piezometric levels in the 2000 series piezometers in the South Expansion Area now range from about 68m to 72m. Water levels in some of the 2009 series piezometers, installed in overburden in the South Expansion Area, range from 68 to 74m, and typically fluctuate up to 2m annually (Table A-4 and Fig. A-6). A snapshot of the November 2015 water elevations (or most recent winter water elevation) in the South Expansion Area is included as Fig. 3. Piezometers exhibiting the higher heads are typically located more than 30m 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. Data for MW94-1D is often anomalous, likely reflecting a leak into the piezometer tube near the collar of this monitoring well (Piteau, 1999). The elevated head in BH00-3A in the summer of 2007 (Fig. 4 and Fig. A-5) indicates groundwater in bedrock is flowing into the South Expansion Area from beneath the ridge to the southwest. This piezometer has been inaccessible since October 2007. Data for MW05-1 have indicated an upward gradient since the summer of 2010, except for one water level in August 2014 when PW-1 was operating (Table A-3). 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 site is interpreted to be to the north, northwest, southeast and east. Groundwater flow in bedrock beneath most of the proposed 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 (Fig. 3). Groundwater flow through bedrock on the west side of the interpreted flow divide is interpreted to be in a westerly direction, and on the east side flow is interpreted to be in a southeasterly to easterly direction. 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 67.9m range that has been observed in the shallow piezometer since that time (Figs. 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. High heads in MW13-2S, along with the immediate response to precipitation recharge (Piteau, 2014), may reflect leakage from the adjacent interception ditch. The November 2014 head in MW13-2D is the highest bedrock head measured at the site (78.9m), and cannot be attributed to surface recharge in the immediate vicinity of the well. Subsequent readings in MW13-1D and MW13-2S and 2D have not recovered to heads measured in November 2014 since quarterly sampling commenced (Fig. A-9). The slow response is attributed to the low hydraulic conductivity of the rock mass.

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 attained between sampling events, are now indicated to be in the deep piezometers in MW02-3 and MW05-1D. In 2009 and 2010, the lowest bedrock heads were maintained in PW-1 and MW05-1D, due to the drawdown effect of PW-1. Between late 2010 and 2015, the PW-1 level has generally been high, and little sustained drawdown effect has been achieved, except in August 2014, when PW-1 was operating (Fig. A-7).

Groundwater flow in bedrock beneath the east edge of the landfill is currently upwards towards the surficial sediments, and easterly towards Christie Creek. The current capture zone for PW-1 is not very large, as shown by the interpreted piezometric surface for bedrock groundwater on Fig. 4. When the well was operating properly, the controlling gradient induced in the bedrock flow regime was much steeper and the well was an effective interception measure. Hydraulic gradients towards the well are currently very localized and are not very pronounced, due to what is interpreted to be a very intermittent operation schedule. Regular operation of this well is required to improve its effectiveness.

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).

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). Due to the low permeability of the bedrock, a very high component of the groundwater flow beneath the area should perch above the rock, and seep through surficial sediments. Much of the groundwater flow that seeps to depth should be intercepted by PW-1, when it is operating within the design elevation range. However, much of this flow would seep past the well when it is 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 proposed South and East Expansion areas. These sediments are very permeable and are saturated over a thickness of up to about 12m (Fig. 4). The water table in the surficial sediments in this area historically fluctuated over a range of about 1 to 2.5m each year, reaching a high in the late winter (see MW94-2S and MW94-3S on Fig. A-1; and MW94-7S on Fig. A-2). Since the French Drain was installed in the South Expansion Area in the autumn of 2009, piezometric levels have declined to slightly below El. 70m (Figs. 3 and A-5).

The most recent water levels for the 13 shallow standpipes installed in November 2009 are plotted on Fig. 3. Interpreted equipotentials exhibit a steep gradient towards the French Drain, indicating it is effectively collecting the groundwater flow from this area (Fig. 3). An easterly groundwater flow across the cut-off structure at the northwest corner of the expansion area is also indicated by the November 2015 piezometric data (Figs. 3 and 4), consistent with the interpretation reported previously (Piteau, 2011 through 2015). 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 (Figs. 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 very localized flow regime.

Most groundwater beneath the South Expansion Area is now 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 (Fig. 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. (Fig. A-5). Christie Creek, and the PW-2 leachate interception well (Fig. 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 PW-2 is operating properly, it induces a significant gradient from MW02-3S back towards MW05-1S and the well.

The past four years of water level data indicate the level at PW-2 is sometimes maintained about 2 to 3m above the El. 64.5 to 64.8m 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 (Figs. 3 and A-8). If PW-2 is not operated for prolonged periods, and is maintained at the levels measured in August 2012 or in the summer of 2013 (Fig. A-8), 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 the well was last tested in 2005 (Piteau, 2014). If this well is operated as intended, it should continue to be an effective leachate control measure.

### 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’, Fig. 4).

As indicated on Section X-X’ (Fig. 4), and the hydrographs (Figs. A-3 and A-4), piezometric levels were very high in the area 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 remedied. Water level data collected from 2002 through 2014 indicate that the interception trench has been an effective leachate control measure, except for brief intervals in the summer of 2005, winter of 2006 and January 2008. The water levels in MW98-9 did not drop in tandem with MW98-10 over the summer of 2014, but levels remained near the lower bound of the historical range since January 2008, indicating the system was functioning as intended. However, piezometric levels measured in MW98-9 and MW98-10 were very high when measured in April, July and November of 2015, potentially indicating another problem with pump operation.

### 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, completed 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 (Figs. 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 piezometers, both piezometers 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 French Drain (Fig. 2). Due to the low permeability of the landfill foundation, the majority of the leachate from the landfill naturally seeps into the two drains.

Dilution at the sampling point for the main leachate drain is minimal, probably about 2:1, so the chemistry data for these samples are considered to be characteristic 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. Both piezometers are believed to be broken at depth, BH00-1C at approximately 10 mbg and BH002-C at approximately 3 mbg, and both have displayed high water levels since being recovered. Three undiluted leachate samples were collected from BH00-1C in 2015.

Samples collected from the South Expansion Area French Drain will be representative of very dilute leachate, due to a very small area of the catchment that has been covered with waste. The chemistry of this sample is discussed in Section 4.1.3.

### 4.1.1 Inorganic Chemistry

Leachate chemistry data and water quality objective exceedances for 2015 are summarized in Tables II and III, with full reports presented in Tables B-1 through B-5, and in plots included as Figs. B-1, B-2 and B-3 in Appendix B.

The chemistry of 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).

Chloride concentrations in the leachate drain discharge have ranged between about 10 and 210 mg/L, with the two 2001 summer samples displaying the highest chloride concentrations measured to date (Fig. B-1). Recent concentrations have continued to decline from the 183 mg/L peak concentration observed in 2004. Chloride concentrations measured in 2015 averaged 86 mg/L (Table II). An anomalous chloride value of <0.05 mg/L, measured in May 2013 (Fig. B-1), is considered to be a laboratory error based on the historical record and high EC values measured for the same sample. In general, peak chloride levels are measured during the dry months of May and July. 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 recent BH00-1C chloride concentrations averaged less than half of the leachate drain discharge (Table II and Fig. 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 rising trend followed between 1998 and 2002. Although the ammonia concentration dropped down to a peak of 52.7 mg/L-N in July 2003, probably due to the antecedent drier than average weather, a rising trend persisted from 2004 through 2007 (average precipitation years), during which time ammonia concentrations displayed a peak value of 126 mg/L-N. Seasonal fluctuations similar to those of chloride are apparent in the data (Fig. B-2). The seasonal trend of greater dilution in the fall was slightly damped in 2013 and 2015, due to extended periods of dry weather in the fall. Ammonia concentrations ranged between 48 and 93 mg/L-N in 2015, all exceeding the 1.84 mg/L guideline for FWAL (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 (Fig. B-2), which is about twice the concentration sampled in the leachate drain at that time. Ammonia concentrations in the March and June 2001 samples were much lower, and are not considered to be accurate. Recent 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 this piezometer is blocked at approximately 10m depth and exhibits a perched water level, it is likely intercepting water from a relatively aerobic zone in the landfill.

Iron and manganese are the only two metals in the leachate which 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 2015 exceeded the iron and manganese FWALC for all four sampling events, with results ranging as high as 36.1 and 11.6 mg/L, respectively (Tables B-1 and III).

Copper has exceeded the FWALC, which can vary from 0.004 mg/L to 0.03 mg/L depending on the measured hardness, on four occasions. The last exceedance was a 0.007 mg/L concentration sampled in January 2005. All other monitored metal concentrations have remained below GCDWQ and FWALC, with the exception of multiple chromium and boron concentrations that have exceeded the FWALC (Table III), a single cadmium FWALC exceedance in July of 1999, and mercury concentrations that slightly exceeded the FWALC in August and December 2010, February 2011, and December of 2014 and 2015 (Tables III and B-1).

The COD of the leachate drain discharge has ranged between 20 and 160 mg/L-O since 1998, except for a very high value of 445 mg/L-O recorded for the July 2009 sample. The elevated result was 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 2015 COD concentrations ranged from 60 mg/L-O to an anomalously high 534 mg/L-O in December.

COD in the initial leachate sample from BH00-1C was much higher, at 3860 mg/L-O, 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 (Tables II and B-2).

Overall, the leachate strength appears to be relatively constant, subject to some seasonal and climatic variations. At this time, the data do 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 rate which is cause for concern.

Only two parameters have exceeded acceptable drinking water concentrations in the 23 suites of data collected from the leachate drain to date. These included a toluene concentration of 39.9 µg/L in November 1994, about 50% above the AO of 24 µg/L, and 1,4-dichlorobenzene concentrations on seven occasions, as follows: 2.0 µg/L in November 1994, 1.4 µg/L in March 1996, 1.4 µg/L in April 2002, 1.5 µg/L in April 2004, 1.7 µg/L in April 2005, 1.5 µg/L in April 2007 and 1.1 µg/L in January 2008. The latter exceeded the AO of 1 µg/L, but not the GCDWQ maximum acceptable concentration (MAC) of 5 µg/L (Table B-3). Benzene has also been detected at very low concentrations, the highest being the 3.7 µg/L result for the April 2005 sample. The MAC for benzene is 5 µg/L. It is noted that benzene, chlorobenzene, MTBE and 1,4-dichlorobenzene have been detected in most samples for the past seven years, but have not exceeded their respective MACs where these have been set. Acetone, 2-butanoe and toluene were also detected in the 2015 samples; however, none of the results exceeded guidelines. All of the results for the BH00-1C sample were non-detect.

Pentachlorophenol has only exceeded the 0.002 mg/L detection limit on one occasion, in 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 2015 detection limits were at the FWALC, and these recent non-detection results indicate that pentachlorophenol concentrations are in compliance with the objective. Two samples for phenols and extractables were collected and analyzed in 2015. While m&p cresol, bis(2-ethylhexyl)phthalate, and 2-methylnapthalene were detected at trace concentrations, no receiving water criteria are set for these parameters. For the one BH00-1C sample submitted for analysis in January 2015, all results were below the detection limits.

### 4.1.3 Inorganic Chemistry for South Expansion Area Leachate Drain

Samples for inorganic chemistry analysis have been collected from the South Expansion Area French Drain since 2011. All data are for the past four years are tabulated in Table B-5. The mean of the 2015 results for these analyses are summarized in Table II, with exceedances summarized in Table III. All 2015 results were below the receiving water criteria, with the exception of manganese (at concentrations up to twice the FWALC), ammonia (at concentrations ranging from 1.5 to 2.2 times the FWALC), and nitrate (exceeded the FWALC of 3 mg/L-N once in July 2015). 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.

## 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 (Fig. 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 display any evidence of significant leachate impact. 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 (Figs. 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. An initial chloride concentration of 6.1 mg/L was recorded in July 2002, but concentrations have since decreased, and ranged between 0.35 and 0.87 mg/L in 2015 (Table B-8). There are no indications of leachate impact in this monitoring well (Table II and Figs. B-4 and B-5).

Results for samples collected from MW05-1S have exhibited relatively low nitrate and ammonia concentrations, but elevated chloride and total dissolved solids (TDS) concentrations. The former averaged 2.08 and <0.03 mg/L-N, respectively, but chloride and TDS concentrations have ranged between 6.96 and 85.9 mg/L, and between 254 mg/L and 689 mg/L, respectively, with respective mean 2015 values of 15 and 225 mg/L. (Fig. B-4 and Tables II and B-22).

Samples from the surficial sediment interception well PW-2 over the same period exhibited chloride concentrations ranging from 24 to 155 mg/L and ammonia concentrations ranging from 2 mg/L to 56 mg/L-N, indicating this well is intercepting leachate (Table B-23). Ammonia concentrations in PW-2 for 2015 ranged from 14.7 to 16 mg/L-N. The monitoring record maximum of 56 mg/L-N measured in August 2014 was sampled after a period of no well operation, based on the water level measured at PW-2 prior to sampling. The chloride trend at MW05-1S indicates the shallow interception well is benefitting the water quality at MW05-1S (Fig. B-4).

#### 4.2.2 South Side of Landfill

Chloride concentrations in MW94-7S samples were nominally 1 mg/L up until October 1999. In 2000 they increased to 19.5 mg/L, and then decreased to about 5 mg/L in the latter half of 2002 (Fig. B-6). A steep rise was recorded during 2003, with concentrations fluctuating between 30 and 40 mg/L. These concentrations were sustained through 2004. From the start of 2005 through July of 2006, chloride concentrations declined to range 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 sampled 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 one year previous, 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 (Fig. B-7). The October 2006 increase in leachate indicator parameters is attributed to the construction of the French Drain in 2006, which will have induced leachate to flow to the south, and into the French Drain.

MW02-1S and MW02-2 are both completed in surficial sediments on the south side of the South Expansion Area (Fig. 2). Data for both of these monitoring points have exhibited baseline chemistry since sampling began in 2003 (Tables II, B-18 and B-20 and Figs. B-6 and B-7).

#### 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 (Fig. B-6). The chloride concentrations have since dropped. They averaged 7.2 mg/L in 2015 (Table II), and have been very consistent for the past seven years. Nitrate concentrations have historically remained near or below 0.05 mg/L-N (Fig. B-7 and Table B-10), and continued to do so in the 2015 samples. The absence of any nitrate or ammonia impact indicates a non-leachate source for the slightly elevated chloride concentration. Monitoring well MW94-4S is located just off of 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 (Fig. B-8). The chloride 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 recorded in 2015 ranged from 4.89 to 12.3 mg/L (Table B-13 and Fig. B-8).

As with MW94-4S and MW94-7S, there was no corresponding increase in nitrate or ammonia concentrations in the early monitoring record at MW94-6S (Fig. B-9 and Table B-13). The latter concentrations were at essentially background levels until April 1999, when ammonia concentrations began to elevate. Ammonia concentrations displayed an increasing trend from April 1999 to April 2002, when a peak concentration of 37.5 mg/L-N was reached. Ammonia concentrations dropped back to less than 4 mg/L-N in the latter part of 2002, but have ranged between 13 and 37.2 mg/L-N since that time (Table B-13 and Fig. B-9). They were approximately 13 mg/L-N throughout 2014 and 2015 with the exception of an anomalously low value of 1.7 mg/L-N in August 2014.

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 new 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 should be intercepted by the leachate interception trench, located immediately downgradient of this monitoring site (Fig. 2).

Manganese and TDS are the only parameters that have chronically exceeded AO's for drinking water in MW94-6S (Table B-13). Dissolved manganese concentrations initially exhibited an increasing trend from 1995 to a peak concentration of 25 mg/L in October 2007. They have fluctuated below 8.5 mg/L since 2012, and ranged between 5.14 and 6.94 mg/L in 2015. TDS displayed an increasing trend until 2000, when values between 1060 and 1070 mg/L were recorded. TDS concentrations declined slightly to a concentration of less than 500 mg/L in 2004. A relatively stable trend has been evident since 2005, with TDS concentrations ranging between 285 and 769 mg/L. Only one TDS exceedance has been recorded between 2012 and 2015, during which time the TDS concentrations ranged between 356 and 580 mg/L.

Iron concentrations in MW94-6S first exceeded the GCDWQ AO criterion in 2000 and have consistently exceeded the GCDWQ criterion since 2006. Concentrations vary seasonally and typically peak in winter. However, the maximum occurred in October 2006 at 55.9 mg/L. Concentrations have declined since and typically range between 1.5 and 30 mg/L. Iron concentrations ranged from 5.54 to 21 mg/L in 2015.

The only other exceedance in 2015 at MW94-6S was one chromium concentration, which was measured at the FWAL guideline of 0.001 mg/L, far below the GCDWQ MAC of 0.05 mg/L (Tables III and B-13).

Data for MW98-9 (Table B-15) are also plotted on Figs. 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, based on a large reduction in chloride concentration and generally low nitrogen concentrations. Data for 2001 displayed an increase in chloride and ammonia concentrations at MW98-9 (Figs. B-8 and B-9). The increase was attributed to the malfunction of the pumps in the interception trench. The ammonia concentrations rose to about 2.5 mg/L-N during the malfunction period, and then dropped back to 0.8 mg/L-N by October 2002. Ammonia concentrations have not exceeded the FWALC of 1.8 mg/L-N since 2006 and were less than 0.05 mg/L-N in 2014 and 2015. Chloride concentrations averaged 2.2 mg/L in 2015 (Table II), in the lower portion of the historical range. Chromium, copper and mercury concentrations have exceeded the

FWALC, but are well below the GCDWQ MAC (Tables III and B-15). As the leachate concentrations were similar or lower, the concentrations observed in MW98-9 are considered to be background. The possible malfunction of the interception trench pumps indicated by high water levels in MW98-9 does not appear to have affected water quality at this location in 2015.

Chloride, nitrate and ammonia monitoring data for MW98-10 indicate that there are no significant leachate impacts at this location. A slight increase in nitrate concentration noted in early 2000 did not recur in 2001, and chloride concentrations have not exceeded 2.5 mg/L in the past nine years (Table B-16 and Fig. B-8). Nitrate concentrations increased to 3.3 mg/L-N at the end of 2010, but varied between 0.24 and 2.48 mg/L-N in the 2015 monitoring period. Ammonia concentrations were below detection limits for the current reporting period. Similar to MW98-9 and MW94-6S, some chromium concentrations exceeded the FWALC but not the MAC. Any water quality effects associated with an apparent malfunction of the interception trench pumps are not yet apparent at this monitoring well.

## 4.3 GROUNDWATER IN BEDROCK

### 4.3 1 Background Chemistry

Chemistry data have been previously reported for seven BH2000 series wells, two MW-2002 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 2015 reporting period includes samples collected from MW02-1D and MW02-4. The latter well is located about 600m WNW from the original landfill footprint (Fig. 2). Water quality results collected from BH00-4A until access was lost in 2011 are also presented for comparison. 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 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 250m 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. A 90.7 mg/L chloride result for BH00-4A for February 2011 appears to be anomalous, and is not consistent with the historical record for this site. 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 this sampling site appear to be anomalous, and were analyzed by a new laboratory. The remainder of the results appear to be consistent with previous results (Table B-17).

Chloride concentrations of 81.5 to 102.0 mg/L were recorded in MW02-4 in 2003. Concentrations from 2004 through 2007 ranged between 64.3 and 71 mg/L. Concentrations reported for 2015 ranged from 98.1 to 111 mg/L, significantly lower than the 117 to 199 mg/L range recorded in 2010 (Table B-21). Many of the 2010 concentrations exceeded those measured in the concentrated leachate sample from the leachate drain. Sodium concentrations ranged between 40 and 66.8 mg/L over the past six years, and sulphate concentrations have varied between 10 and 40 mg/L, but are typically about 13 mg/L. 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 when the wells were sampled 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 GCDWQ AO for pH (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. With the exception of 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 and sodium concentrations are typically much lower than in MW02-4, with 2015 results averaging about 2.3 and 3.0 mg/L, respectively. Groundwater at the MW02-1D location may be better "flushed" than at the other background sites.

Metal concentrations vary significantly between samples, with iron, manganese, copper, zinc, mercury, cadmium and arsenic all exceeding receiving water criteria on more than one occasion, and sometimes at multiple sites. Iron concentrations have exceeded receiving water criteria in three of the eight 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 three times at MW02-1D. Mercury has exceeded the FWALC, but not the drinking water MAC, in three of the core holes, MW02-1D and MW02-3D (Piteau, 2002b). Copper was also detected at concentrations in excess of 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 higher concentrations than observed in the leachate. The metal occurrences 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.

Manganese concentrations have chronically exceeded the AO, but not the FWALC, at MW02-1D. Arsenic has chronically exceeded the MAC at BH00-4A. Arsenic concentrations initially exhibited a rising trend, but this is attributable to disturbances during drilling of the monitoring well. Monitoring wells often display a rising or elevated concentrations after they have been commissioned, 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 MAC of 0.01 mg/L.

No metal concentrations have exceeded receiving water criteria at MW02-4.

Based on the above, background chemistry of groundwater in the AVL area can be characterized as sodium bicarbonate-sulphate type water, 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, possibly higher near MW02-4, and 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 most recent result increased to 18 mg/L in October 2005 (Fig. B-4), reflecting the onset of waste placement in the adjacent East Expansion Area. Nitrate and ammonia concentrations remained at background levels (Fig. B-5) suggesting very minimal leachate impact to this point in time. This well was lost to the east landfill expansion in late 2005.

Only one detailed sample suite has been collected from the MW94-7D piezometers, and it did not display any indications of leachate impact at the time it was sampled in 1996 (Figs. 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

Samples from MW94-1S have exhibited nitrate concentrations as high as 5 mg/L-N in the past (July 1995), but declined before reaching a peak of 6 mg/L-N in January 2004. Nitrate concentrations displayed a range of 0.18 to 0.21 mg/L-N in 2013 (Table B-6). Chloride concentrations displayed a significant increase in 2003, trending upward throughout the year to reach 44.7 mg/L. Chloride concentrations have declined since early 2004, from an all-time peak of 55.7 mg/L in January 2004, to between 3.4 and 4.3 mg/L in the current reporting period. 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. This well was decommissioned in 2013.

Chloride concentrations in samples from MW94-1D (Table B-7) had varied up to 8.8 mg/L prior to 2003. Starting in 2003, chloride concentrations increased and displayed high variability with a peak concentration of 120 mg/L in January 2004 (Fig. B-4). Chloride concentrations decreased during 2005, and fluctuated between 3.9 and 8.2 mg/L for the last year of monitoring data in 2010.

Prior to 2003, MW94-1D nitrate concentrations were less than 2.2 mg/L-N and typically below 1.2 mg/L-N. In 2003 and 2004, nitrate concentrations reached peaks of 16 mg/L-N and 10.9 mg/L-N, respectively, exceeding the GCDWQ AO of 10 mg/L-N (Fig. B-5). Nitrate concentrations decreased considerably after 2005, with values fluctuating between <0.02 and 0.67 mg/L-N 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. Data for the four years previous to that time displayed a very consistent chloride concentration of about 13 mg/L (Fig. B-4). The nitrate concentration varied between the detection limit and about 1 mg/L-N over the same period, and was consistently above 0.75 mg/L-N since October 1998 (Fig. 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 since 2002 have indicated no significant leachate impact, with nitrate/ammonia concentrations below 0.5 mg/L-N and chloride concentrations ranging between 1.6 and 21.6 mg/L (Table B-9 and Figs. B-4 and B-5). Chloride concentrations peaked in 2012 at 21.6 mg/L, suggesting some slight leachate effects may be occurring. From 2013 through 2015, chloride concentrations dropped slightly but remained elevated above background levels, in the range of 4.17 to 18.3 mg/L. Inconsistent operation of the bedrock leachate interception well likely compromises the benefit of this mitigation measure.

Arsenic concentrations in MW94-2D varied between 0.002 to 0.019 mg/L, and exceeded 0.014 mg/L for six of ten sampling occasions between April 1998 and 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 exceed the MAC of 0.01 mg/L and are at a level that would be of concern for any domestic wells completed in bedrock in this area.

Arsenic concentrations have not exceeded 0.003 mg/L in MW02-3D. With the exception of one copper exceedance in October 2006, the only metal results for this monitoring well that exceeded AO or MACs over the past eight years are two iron concentrations and seven manganese concentrations. While iron has not exceeded its AO for the past six years, a manganese exceedance was reported for December 2015. Manganese concentrations have not exceeded the FWALC. Chromium in MW02-3D has exceeded the FWALC in October 2012 and January 2013, but has never exceeded the GCDWQ MAC. The concentrations which have exceeded the FWALC are attributed to natural background.

MW05-1D monitoring data are available from November 2008. Chloride concentrations have ranged from 11 mg/L to 64.8 mg/L, and display a general rising trend until late 2010, and a levelling trend since then (Fig. B-4). This trend suggests operation of leachate interception well PW-1 is inducing 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 (Fig. B-4). The chloride concentration from the deep piezometer measured 64.8 mg/L in July 2011, approaching the peak concentration of 85.9 mg/L measured in the shallow piezometer in April 2009. Chloride concentrations in MW05-1D then stabilized at about 55 mg/L, averaging 46.5 mg/L in 2015 (Table II). Nitrate and ammonia concentrations have ranged from below detection to an average of 0.33 mg/L-N and 0.09 mg/L-N, respectively, in 2015 (Tables II, B-23 and Fig. 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.

The leachate interception well PW-1 was first monitored in November 2008. In 2015, chloride concentrations from this well ranged from 57.9 to 71.4 mg/L, slightly lower than peak chloride levels measured in previous years (Table B-23 and Fig. B-4). Nitrate concentrations have remained at background levels, and 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 FWAL criterion of 1.8 mg/L-N (Fig. B-5). Two of four of the 2015 ammonia concentrations exceeded the FWAL criterion (Tables II, III and B-23). TDS has stabilized in the 600 to 800 mg/L range, exceeding the GCDWQ criteria for all samples collected in 2015. The elevated chloride and TDS concentrations indicate that the well is intercepting relatively deep groundwater that has been affected by leachate and has seeped down into bedrock due to the recharge gradients.

#### 4.3.4 West Side of Landfill

Monitoring data for bedrock piezometer MW94-4D displayed very similar chloride data to the shallow piezometer at this site. Chloride reached a peak concentration of 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 Fig. 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 over the past six years (Fig. B-7). Although current monitoring data indicate some very minor leachate impact at this location, 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 all show 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 (Fig. B-8). The decrease was likely due to the commissioning of the north leachate interception channel. Chloride concentrations in MW94-5S were historically elevated at the site but dropped from 21.8 to 19.8 mg/L in 2008 to a current range of 1 to 4 mg/L. Nitrate and ammonia concentrations in MW95-5S have been consistently below 0.52 mg/L-N and 0.15 mg/L-N, respectively (Table B-12). MW94-5D has not been monitored since 2008. Significant concentrations of nitrate or ammonia were not been detected in MW94-5D prior to 2008 (Fig. B-9).

Chloride concentrations in MW94-6D have been at background levels throughout the monitoring record, with the exception of the first two samples, collected in 1994 and 1995. The nitrate concentration reached 8 mg/L-N in MW94-6D in July 1995, but has not exceeded 3 mg/L-N since 2000. It averaged 1.51 mg/L-N in 2015 (Tables II and B-14 and Fig. B-9). Ammonia concentrations spiked up to about 3 mg/L-N in April 1998, followed by a ten-year fluctuation between the detection limit of 0.01 and 0.32 mg/L-N. In November 2008, the ammonia concentration reached a maximum of 7 mg/L-N. This value 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 2015 ranged from 0.14 to 0.55 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 (Fig. 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 0.02 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. Boron, copper and mercury concentrations have frequently exceeded the FWALC but have never exceeded the GCDWQ (Table III). In the past three years, some samples from MW94-6D have also exceeded the FWALC but not the GCDWQ for chromium, mercury and zinc. One of four 2015 samples exceeded the FWALC/GCDWQ AO for iron, while a different sample exceeded the GCDWQ but not the FWALC for manganese. The January 2013 sample had anomalously high concentrations of most metals, varying from two to more than 100 times greater than the other 2013 samples. The exceedances measured in January 2013 are considered erroneous.

### 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 sampled up to two times in 2013 upon completion, and were added to the quarterly monitoring program in December 2014. Samples collected to date are indicative of a sodium sulphate type chemistry with a very high total dissolved solids concentration and a high EC (Tables II, B-24 and B-25).

Groundwater in MW13-1D/S is highly mineralized groundwater. Combined with a high COD (197 to 800 mg/L), this is indicative of a groundwater flow regime that receives very little recharge and is poorly flushed. Concentrations of most parameters peaked in the water sample collected in December 2014 or January 2015, and have since decreased slightly. It is likely these wells are very close to the groundwater flow divide interpreted on Fig. 3. Groundwater in MW13-2D/S has shown a large overall decrease in parameter concentrations indicating that these sampling sites receive moderate recharge. As the high EC and chloride levels are not accompanied by elevated nitrate and ammonia concentrations, and as the wells are located over 150m from the original landfill footprint in a direction that is currently interpreted to be perpendicular to the groundwater flow gradient, the highly mineralized groundwater is attributed to background quality.

Exceedances of the FWAL and/or GCDWQ criteria in the 2015 samples have been noted for TDS, sulphate, arsenic, chromium, lithium, manganese and uranium at one or more of the monitoring wells (Table III). 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 to the west of the landfill, opposite to the interpreted principal direction of subsurface leachate migration (Fig. 3). There have been no indications of leachate impact to Heath Creek (Table B-26). Prior to 2005, chloride concentrations had remained below 7 mg/L, except for one 7.5 mg/L result in May 1997 and a 9.8 mg/L result in September 2001 (Fig. B-12). The chloride concentration jumped to 91 mg/L in August 2010 but dropped back to 3.5 mg/L in the subsequent sample collected in December. The August 2010 value appears to be an anomaly, as all other results since January 2005 ranged between 1.4 and 7.7 mg/L. As the conductance is considered too low for a chloride concentration of 91 mg/L, the August chloride concentration is not considered valid. Chloride concentrations for 2015 ranged from 1.93 to 2.8 mg/L and were within the historic range. The slightly elevated winter results are likely due to road salt.

Nitrate and ammonia concentrations have not exceeded 0.3 mg/L-N in Heath Creek since the start of monitoring record, and ammonia concentrations are typically less than 0.15 mg/L-N (Table B-26 and Fig. B-13).

Total iron concentrations have exceeded the GCDWQ AO of 0.3 mg/L on nine occasions in the monitoring record, with the maximum of 3.25 mg/L occurring in November 2001. The last exceedance occurred in December of 2014 at 2.17 mg/L. The FWAL criterion of 1 mg/L has only been exceeded twice, on the two occasions above. Total manganese concentrations have exceeded the GCDWQ AO guideline of 0.05 mg/L on five occasions in the sampling record. The last exceedance occurred in December 2014. The elevated concentrations of iron and manganese in the December 2014 sample correspond with elevated phosphorus and are likely due to sediment in the sample. Other than the December 2014 results, iron and manganese concentrations have been in compliance with all FWALC and GCDWQ guidelines since April 2007 (Table B-26). The total zinc concentration measured in May 2013 of 0.013 mg/L 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 2015 were below FWALC and GCDWQ (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 (Fig. 2). The water quality in this creek has displayed some slight leachate impacts on occasion, and in 2015, two additional sampling points were added between the toe of the berm and the original Stevens Creek sampling site, to assess whether the seepage beneath the berm accounts for the leachate impact in Stevens Creek. SCKA is a hand-dug piezometer installed to 0.9m depth at the toe of the berm, and SCKB is a pond where groundwater discharges, midway between SCKA and the original Stevens Creek site (Fig. 2). These new sites were sampled in April and December 2015, but were dry for the July sampling session (Table B-27).

Chloride concentrations in Stevens Creek have ranged up to 55.7 mg/L. The highest chloride concentration to date was sampled on October 7, 2002 (Fig. B-12). Chloride data for 2015 ranged from 3.32 mg/L in January to 4.76 mg/L in July (Table B-27). Chloride concentrations measured at SCKA and SCKB averaged 14.2 and 3.8 mg/L, respectively (Table II). Concentrations at the former site were consistently greater than the original sampling site, while concentrations at the latter were similar to the original Stevens Creek site.

Nitrate concentrations fluctuated between 0.043 and 0.471 mg/L-N at the Stevens Creek sampling site in 2015. The October 2005 result of 4.58 mg/L-N is the highest nitrate concentration recorded to date (Fig. B-13). Elevated nitrate and chloride concentrations at that time were likely due to the drier than average 2004/2005 winter, but may have also been due to a partial malfunction of the leachate lift station located upstream of the clay berm at the top end of Stevens Creek. Nitrate concentrations in 2015 at SCKA and SCKB were slightly elevated compared to the Stevens Creek sampling site, and ranged from 0.589 to 1.5 mg/L-N, and 0.27 to 0.665 mg/L-N, respectively. Nitrate concentrations have not exceeded the FWALC (3 mg/L-N) since the autumns of 2005 and 2008.

The highest ammonia concentration in the monitoring record was 1.8 mg/L-N, sampled in the winter of 1993 (Fig. B-13). Ammonia concentrations remained below 0.01 mg/L-N in 2015. As with nitrate, ammonia concentrations in SCKA and SCKB were slightly elevated, with measured concentrations up to 0.75 and 0.17 mg/L-N, respectively. The water quality in Stevens Creek complied with applicable receiving water criteria for nutrients throughout 2015.

Of the five total metals analyzed for in Stevens Creek, cadmium, manganese, iron, and zinc all exceeded FWALC in July 2015 (Tables III and B-27). All five total metals FWALC were exceeded for the December 2015 SCKA sample, and iron and zinc were exceeded in the April sample. Each site also had one instance of manganese exceeding the GCDWQ AO but not the FWALC in 2015. The SCKA results were collected from a standpipe piezometer, and are not filtered, so may be elevated due to sample turbidity. SCKB results were all below applicable FWAL criteria, and metal concentrations were typically similar to and sometimes lower than the original Stevens Creek sample, suggesting natural background variability. Guidelines for cadmium (revised February 2015) and manganese are hardness dependent. A hardness of 50 mg/L was used, based on the approximate average hardness of 2015 samples.

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. Two detectable results are noted for 2015 samples, with concentrations of 20 and 45 mg/L-O, measured in January and July, respectively. Results from SCKA and SCKB are only available for the April and December, 2015, when Stevens Creek results were non-detect. Maximum COD concentrations at SCKA and SCKB were 118 and 30 mg/L-O, respectively (Table B-27). The elevated value in SCKA may be due to turbidity associated with collecting the sample from a standpipe.

Preliminary 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 original at the original Stevens Creek sampling site. 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 the SCKA sample. SCKA and SCKB were both dry for the July sampling session when many of the metals exceedances were reported for Stevens Creek, so the exceedances could not be directly correlated with data at the upstream locations, and could be attributed to either deep leachate seepage or natural background.

### 4.4.4 Norris Creek

Norris Creek was sampled between November 1994 and May 1997. Sampling of this creek was terminated at this time, as access to the property was no longer available. Leachate indicator parameters were all present at 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 concentrations coincided, and were sampled 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. Over the sampled period 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 (Figs. 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 (Fig. 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 upstream sample from September 13, 2001 displayed an ammonia concentration of 2.4 mg/L-N, indicating a source upstream of the landfill. Downstream ammonia concentrations were relatively low in 2015, ranging from 0.012 mg/L-N in December to 0.29 mg/L-N in January. Upstream sample ammonia concentrations ranged from <0.01 to 0.02 mg/L-N (Table B-28). Ammonia concentrations last exceeded FWALC in July 2009 during drier than usual conditions.

Nitrate concentrations have ranged between <0.05 and 0.43 mg/L-N for both the upstream and downstream sampling results during 2008 through 2015, and do not indicate any landfill effects (Table B-28).

Downstream chloride concentrations in Christie Creek are typically very similar to the upstream results, and have not exceeded 2.8 mg/L in the past seven years (Table B-28). Upstream concentrations have not exceeded 2.4 mg/L over the same period.

COD concentrations over the period of record have varied from <20 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 site, 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. COD concentrations for 2015 ranged from <10 mg/L-O to 20 mg/L-O for both sites. COD should continue to be monitored closely at both locations.

The manganese FWAL criterion has only been exceeded during the dry summer months at the downstream site, while the lower GCDWQ criterion has been exceeded on a chronic basis. Manganese concentrations at the upstream sampling site often exceed the FWAL criterion. While no summer sampling data are available for the upstream site for comparison, the downstream samples often have higher concentrations of manganese. 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 FWAL criterion.

Iron concentrations at the downstream Christie Creek sampling site frequently exceed GCDWQ and FWAL criteria. Iron concentrations at the upstream sampling site have exceeded GCDWQ or FWAL criteria for about one third of the sampling events since late 2005. Recent recorded iron exceedances at the upstream site were in December 2010, February 2011, January 2012, October 2013, December 2014 and December 2015, with concentrations of 0.722, 0.867, 0.576, 0.354, 0.376, and 0.34 mg/L respectively. The concentrations at the downstream site were 1.01, 0.213, 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 slightly exceeded the FWALC of 0.0075 mg/L on many occasions over the monitoring record. These exceedances are attributed to background chemistry, as the upstream results typically exceed the downstream results. Upstream zinc concentrations have exceeded the FWALC for all sampling events since 2009 (Table B-28).

A cadmium concentration of 0.00025 mg/L was recorded at the downstream sampling site in December 2015, exceeding the hardness-dependent cadmium FWAL criterion of 0.00009 mg/L. As all other cadmium results at both sampling sites were at or below the 0.00001 mg/L detection limit since cadmium was first measured in 2013, this result is considered anomalous.

## 4.5 DOMESTIC WELLS

Seven wells, all located on the east end of Lot 105 (Fig. 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 that services 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 a near pristine character.

# 5. SUMMARY

1. Groundwater flow beneath the original landfill is principally to the north/northwest and south/southeast. Groundwater beneath the South and East Expansion areas is interpreted to flow principally to the east and southeast. Groundwater flow in bedrock beneath the Northeast Expansion Area is interpreted to be to the southeast and south, due to an interpreted flow divide near MW13-1 and MW13-2. Flow 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. In the past, groundwater beneath the extreme southwest corner of the original landfill footprint may have flowed in a westerly direction towards Heath Creek, but this would have represented a very small component of the total groundwater flow beneath the site. Construction of the French Drain in the South Expansion Area and the seepage cut-off wall/berm across the trough of surficial sediments that underlies the southwest corner of the landfill appears to have controlled the migration of seepage towards Heath Creek.

2. Monitoring data for the leachate that discharges from the drain through the base of the AVL display a declining trend in leachate strength from 1995 to 1997, a slightly increasing trend to 2001, and a relatively level trend for the past 14 years. Ammonia and chloride concentrations have recently varied over the 3.4 to 93 mg/L-N, and 20.9 to 132 mg/L ranges, respectively. COD has ranged between 40 and 534 mg/L-O over the past four years. The concentration of leachate indicators for these samples suggests that the leachate drain water is diluted by about 2:1 or less, as compared to four samples (collected in 2001) of undiluted leachate from BH00-1C, constructed within the landfill footprint. Current leachate indicator concentrations are considered to be 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 to date, with the exception of slightly elevated ammonia concentrations (2.5 to 9.7 mg/L-N).

3. Significant leachate impacts have only been detected in four of the 11 monitoring wells completed in surficial sediments. These impacts have been temporal in nature, and the most significant impact was addressed by the north interception trench commissioned in late 1999. Field measurements of seeps near the flow equalization lagoon during 1998 and 1999

delineated a possible surface or near surface migration path for leachate to flow eastwards towards Christie Creek. A small containment berm constructed adjacent to the south side of the flow equalization lagoon in late 1999 effectively cut off this pathway. Construction of the east perimeter containment embankment in 2001 addressed this problem in a more permanent manner.

4. Chloride concentrations at MW94-4S, completed in surficial sediments on the west side of the landfill, peaked at about 30 mg/L in late 1997. This concentration has since declined to an average of less than 8 mg/L. Nitrate and TDS concentrations have remained very low at this site throughout the monitoring record, indicating that landfill leachate may not be the source of the chloride. Notwithstanding the chloride source, any leachate impacts that may have occurred at this location are not considered to be significant, and appear to have been mitigated with the French Drain and seepage cut-off wall/berm constructed in the South Expansion Area in 2006 and 2007, respectively.

5. Chloride and ammonia concentrations in MW94-6S, completed in a localized surficial sediment deposit on the north side of the landfill, displayed a rising trend until 1999. The chloride trend peaked at 113 mg/L in April 1999, and fluctuated before leveling off in 2002. Concentrations again peaked in 2005 but have declined since. Chloride concentrations from 2012 to 2015 ranged from 4.89 to 17 mg/L. Ammonia concentrations remained below 0.22 mg/L-N until April 1999, and then increased to the 25 to 37 mg/L-N range until approximately 2007, when they began dropping to the current 13 mg/L-N level. It is likely that the lag in ammonia concentrations, relative to the peak chloride concentrations, is the result of retardation along the groundwater flow path. The ammonia concentration trend should continue to follow the chloride trend, which suggests that peak leachate generation rates from this portion of the landfill have already occurred. Most of the groundwater flow past this location should report to the leachate interception trench commissioned in late 1999.

6. Chloride and nitrogen concentrations at MW98-9, located north of the leachate interception trench, have decreased since 1999, likely due to the interception trench commissioned late that year. Recent data for chloride at this site indicate concentrations at or only slightly above background. Recent ammonia concentrations mirror the chloride trend. Although high water levels measured in 2015 indicate a possible problem with the leachate interception trench, the

2015 water quality results indicate only a very slight leachate impact at this location. Cadmium concentrations are well below the GCDWQ MAC, but sometimes exceed the FWALC (updated February 2015). These concentrations exceed those sampled in the leachate, and are attributed to a natural source.

7. Initial water level and water quality results from background monitoring wells in the northeast corner of the property, adjacent to the north leachate interception ditch, indicate highly mineralized chemistry. Relatively high water levels in MW13-1, and chloride, sulphate, EC and TDS levels above those measured in the leachate samples, indicate a poorly flushed flow regime. Based on the 2014 water levels at MW13-2S, it appears this shallow bedrock piezometer may have a connection with the leachate interception ditch, but chemistry results collected to date show an absence of nitrate or ammonia. Static water levels measured in MW13-2D are higher than those of any local surface water recharge sources but may be indicative of a connection to surface and local precipitation recharge, as both MW13-2 completions show an immediate response to precipitation recharge. Water levels measured in these wells in 2015 after quarterly sampling began were much lower than those measured in 2014. It appears the water levels do not have time to recover to static water levels in between sampling sessions due to the low hydraulic conductivity of the rock mass. More data are required at these locations to provide a better understanding of the groundwater flow regime.

8. Chloride concentrations in MW05-1S have ranged from 85 mg/L when this monitoring well was incorporated into the monitoring program in November 2008, to about 15 mg/L in 2015. These concentrations indicate some leachate effect at this location, but the declining trend is attributed to the beneficial effect of the shallow leachate interception well that was commissioned in late 2007. Ammonia and nitrate data do not exhibit any significant leachate effects to this point in time.

9. Monitoring data for the bedrock monitoring wells and pumping well sampled in 2015 indicate no leachate impacts have occurred to the south, and only very slight leachate impacts have occurred to the west, north, northeast and east of the present landfill footprint. Maximum nitrate and chloride concentrations in bedrock wells during the year were less than

2.12 mg/L-N (MW94-6D) and 192 mg/L, respectively. The 192 mg/L chloride result was for MW13-1D and is not attributed to leachate. All monitoring data for bedrock wells indicate groundwater quality around the landfill site perimeter is well within drinking water criteria, with the exception of iron, manganese and arsenic concentrations. The former two often exceed their respective AOs in natural groundwater. Arsenic is only elevated above the 0.01 mg/L MAC for drinking water in MW94-6D, BH00-4A, and MW13-1D. This elevated concentration is naturally occurring, and is attributed to the mineralogy of the bedrock in the area (Piteau, 2001). Cadmium concentrations in MW02-1D have on occasion exceeded the FWALC (updated February 2015), but are attributed to a natural source.

The 6.1 mg/L-N nitrate concentration recorded for MW94-5S in October 2005 is the highest bedrock concentration recorded for this landfill site to date. It was still below the drinking water objective, and concentrations at this site have since dropped below 0.8 mg/L-N. As noted above, the maximum nitrate concentration sampled from bedrock in 2015 was 2.12 mg/L-N, measured in MW94-6D. The maximum 2015 ammonia concentration in bedrock was 6.4 mg/L-N, measured in PW-1. The 2015 results indicate there is no significant nitrogen loading leaching from the landfill along bedrock flow paths, although chloride concentrations of about 50 mg/L in MW05-1D indicate some leachate is reaching this monitoring well.

10. Leachate impacts were not detected in Heath Creek in 2015, nor have they been previously. Leachate impacts were not detected in McCoy or Norris creeks when they were being sampled.

11. A slight leachate impact has been detected in Stevens Creek, which flows over the north landfill property boundary onto Lot 105. The highest chloride concentration in the Stevens Creek monitoring record is the 55.7 mg/L concentration measured in October 2002. Chloride concentrations averaged 4 mg/L in 2015. Ammonia concentrations recorded in 2015 were non-detect, and nitrate concentrations varied between 0.043 and 0.471 mg/L-N in 2015, averaging 0.24 mg/L-N. A 4.58 mg/L-N result, measured in October 2005, is the highest nitrate concentration observed to date. Nitrate concentrations last exceeded the FWALC (3.0 mg/L-N) in November 2008. Water quality in Stevens Creek for the past four years has consistently met receiving water criteria, with the exception of two zinc, two cadmium, three iron and seven manganese exceedances of the FWAL and/or GCDWQ criteria. Total

cadmium was added to the sampling suite in July 2013 and two of the nine samples collected since then have exceeded the recently updated dissolved cadmium guideline. Two additional sampling points were added in 2015 between the toe of the berm and the original Stevens Creek sampling location, to verify that seepage beneath the berm is not the source of the iron and cadmium exceedances in previous years. Initial sampling results indicate that some leachate is seeping under the clay berm above Stevens Creek, but that at least some of the metal concentrations measured at the original Stevens Creek sampling site can be attributed to natural background. More sampling results are needed to fully differentiate the leachate effect from background.

12. Historical leachate impacts in Christie Creek have been significant, as it received discharge from the leachate aeration lagoon up until late 1998. Since the leachate pipeline was commissioned in November 1998, the impact of leachate on Christie Creek has been drastically reduced. Maximum concentrations of ammonia and chloride measured in samples collected in 2015 were 0.29 mg/L-N and 1.59 mg/L, respectively, compared to average values of about 10 mg/L-N and 40 mg/L prior to 1999. Christie Creek water quality complied with all receiving water quality criteria for which analyses were performed in 2015, with the exception of total iron, which has chronically exceeded the drinking water AO and FWALC, manganese, which often exceeds the drinking water AO, and occasionally exceeds the FWALC, zinc, which chronically exceeds the FWALC, and cadmium, which exceeded the FWALC criteria for the first time in December 2015 in the downstream sample only. The upstream zinc concentration typically exceeds the downstream concentration, indicating a background source. The very low chloride concentration (<2 mg/L) also indicates that the exceedance of the metals criteria is unlikely to be associated with leachate. Elevated COD values up to about 160 mg/L-O were observed in the winters of 2008 and 2010, but not since.

13. Two leachate interception wells, PW-1 and PW-2, located adjacent to the East Expansion Area, were commissioned in late 2007. Monitoring started in November 2008. Chemistry results measured to date indicate that these wells are intercepting leachate. Available groundwater elevation information indicates they control the migration of leachate towards Christie Creek when they are operating properly.

PW-2 did not appear to be maintaining a low enough level to provide sustained hydraulic control over leachate in surficial sediments for about half of the monitoring events since 2009. A hydraulic gradient towards PW-2 was observed for most 2015 monitoring events; however, observed water levels were consistently above the design pumping level in the winter months. PW-1, the bedrock well, also appears to have been non-operational in early 2009, late 2010 and for most of 2011 through 2015, with the exception of the August 2014 visit. PW-1 will have had minimal effect during most of 2011 to 2015.

Rising chloride concentrations in MW02-3D since early 2010 (12 mg/L in December 2015) may reflect leachate migration in bedrock that is not being intercepted by PW-1, due to the intermittent operation of this well.

Pumping tests conducted in May 2013 at the two interception wells indicated no decline in well performance since they were originally tested in 2005 (Piteau, 2014). The observed leachate effects are therefore attributed to the intermittent operation of the wells.

# 6. RECOMMENDATIONS

## 6.1 MONITORING PROGRAM RECOMMENDATIONS

The monitoring program should be continued through 2016 on a quarterly basis, as per Table I. Data should be reviewed and reported annually.

Flow data from the leachate drains should be processed and reported annually, and operational data (water levels and cumulative flows) for the leachate interception wells should be processed quarterly and reported annually. Climate (precipitation data) should also be reported.

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.

The piezometers at BH00-1C and BH00-2C are bent or broken at 10 and 3 mbg, respectively, and water levels at this location are indicative of a perched water table close to the elevation of the trafficked surface where they were originally completed. These landfill piezometers should be decommissioned and replaced with a single multilevel completion piezometer. The replacement piezometers should have a 2" standpipe completed at the base of the waste to facilitate collection of water samples, and a multi-level vibrating wire piezometer installation to obtain water level measurements at two or three depths within the waste. Data loggers could be installed in the piezometer and on the vibrating wires to measure and record water level response to rainfall and seasonal fluctuations. In the meantime, BH00-1C should be removed from the monitoring program, as samples from this well are not considered representative of undiluted leachate chemistry.

MW02-1S was damaged in July 2015. It is recommended this monument stickup be repaired. This repair could be completed by the drilling company when they are onsite to install the landfill piezometer described above.

The VOC scan and acid extractables laboratory analyses need only be completed once per year for the Aeration Lagoon Inflow and the BH00-1C replacement (Suite 4), as per Table I. If possible, this scan should be completed in the summer sampling session.

When sufficient water is available for sampling, the two additional sampling locations on Stevens Creek between the toe of the berm and the original Stevens Creek sampling site should be included in the quarterly sampling program, for a total of three locations on Stevens Creek. It would be beneficial to attempt to collect a lower turbidity sample from SCKA. A low-flow peristaltic pump is recommended for sampling SCKA to limit the disturbance to the adjacent sediments. Once a total of four sample suites have been collected and the results have been reviewed, the sample locations and frequency will be revisited.

Flow data for the leachate pipeline to the Alberni sewage treatment lagoons should be reviewed and reported annually.

## 6.2 RECOMMENDED DESIGN MODIFICATIONS AND MITIGATIVE MEASURES

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

The operation of the pump for the interception trench system to the north of the original landfill area should be reviewed, based on the high water levels measured in MW98-9 in April, July and December of 2015.

Flow monitoring should be implemented to provide data to calculate weekly cumulative flows from all wells. This will provide a measure for evaluating the wells' performance over time. .

# 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 McGill & Associates Engineering Ltd., 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 2015 sampling results, please contact us.

Respectfully submitted,

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# 8. REFERENCES

Associated Engineering Services Ltd., 1973. Design Drawings for the Regional District of Alberni-Clayoquot Sanitary Landfill. 10 drawings.

Health Canada, 2014. Guidelines for Canadian Drinking Water Quality—Summary Table. Water and Air Quality Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario.

Piteau Associates Engineering Ltd., 1995. “Phase I Hydrogeological and Geotechnical Assessment-Alberni Valley Landfill.” Unpublished report prepared for the Alberni-Clayoquot Regional District, March, 31pp.

Piteau Associates Engineering Ltd., 1998. “Water Quality Monitoring Program to Spring 1998-Alberni Valley Landfill, Port Alberni, B.C.” Report prepared for the Alberni-Clayoquot Regional District, July, 24p.

Piteau Associates Engineering Ltd., 1999. “Water Quality Monitoring Program to Summer 1999-Alberni Valley Landfill, Port Alberni, B.C.” Report prepared for the Alberni-Clayoquot Regional District, November, 25p.

Piteau Associates Engineering Ltd., 2000. “Preliminary Report for Geotechnical Investigation and Assessment of Expansion Areas.” Report prepared for the Alberni-Clayoquot Regional District and McGill & Associates Engineering Ltd., October, 33p.

Piteau Associates Engineering Ltd., 2001. “Water Quality Monitoring Program to December 2000 - Alberni Valley Landfill, Port Alberni, B.C.” Report prepared for the Alberni-Clayoquot Regional District, January, 32p.

Piteau Associates Engineering Ltd., 2002a. “Water Quality Monitoring Program to December 2001 - Alberni Valley Landfill, Port Alberni, B.C.” Report prepared for the Alberni-Clayoquot Regional District, January, 31p.

Piteau Associates Engineering Ltd., 2002b. “Geotechnical Investigation and Assessment of Expansion Areas.” Report prepared for the Alberni-Clayoquot Regional District and McGill & Associates Engineering Ltd., December, 40p.

Piteau Associates Engineering Ltd., 2003. “Water Quality Monitoring Program to December 2002 - Alberni Valley Landfill, Port Alberni, B.C.” Report prepared for the Alberni-Clayoquot Regional District, January, 32p.

Piteau Associates Engineering Ltd., 2004. “Water Quality Monitoring Program to December 2003-Alberni Valley Landfill, Port Alberni, B.C.” Report prepared for the Alberni-Clayoquot Regional District, January, 33p.

Piteau Associates Engineering Ltd., 2005. “Water Quality Monitoring Program to December 2004 - Alberni Valley Landfill, Port Alberni, B.C.” Report prepared for the Alberni-Clayoquot Regional District, April, 36p.

**REFERENCES** (cont'd.)

Piteau Associates Engineering Ltd., 2006. "Water Quality Monitoring Program to December 2005 - Alberni Valley Landfill, Port Alberni, B.C." Report prepared for the Alberni-Clayoquot Regional District, February, 35p.

Piteau Associates Engineering Ltd., 2007a. "Phase 1 Leachate Interception Well and Monitoring Well Drilling Program - Alberni Valley Landfill, Port Alberni, B.C." Report prepared for the Alberni-Clayoquot Regional District, October, 16p.

Piteau Associates Engineering Ltd., 2007b. "Water Quality Monitoring Program to December 2006 - Alberni Valley Landfill, Port Alberni, B.C." Report prepared for the Alberni-Clayoquot Regional District, October, 41p.

Piteau Associates Engineering Ltd., 2008. "Water Quality Monitoring Program to December 2007 - Alberni Valley Landfill, Port Alberni, B.C." Report prepared for the Alberni-Clayoquot Regional District, October, 43p.

Piteau Associates Engineering Ltd., 2009. "Water Quality Monitoring Program to December 2008 - Alberni Valley Landfill, Port Alberni, B.C." Report prepared for the Alberni-Clayoquot Regional District, September, 43p.

Piteau Associates Engineering Ltd., 2010. "Water Quality Monitoring Program to December 2009 - Alberni Valley Landfill, Port Alberni, B.C." Report prepared for the Alberni-Clayoquot Regional District, November, 45p.

Piteau Associates Engineering Ltd., 2011. "Water Quality Monitoring Program to December 2010 - Alberni Valley Landfill, Port Alberni, B.C." Report prepared for the Alberni-Clayoquot Regional District, September, 45p.

Piteau Associates Engineering Ltd., 2012. "Water Quality Monitoring Program to December 2011 - Alberni Valley Landfill, Port Alberni, B.C." Report prepared for the Alberni-Clayoquot Regional District, September, 48p.

Piteau Associates Engineering Ltd., 2013. "Water Quality Monitoring Program to December 2012 - Alberni Valley Landfill, Port Alberni, B.C." Report prepared for the Alberni-Clayoquot Regional District, September, 50p.

Piteau Associates Engineering Ltd., 2014. "Water Quality Monitoring Program to December 2013 - Alberni Valley Landfill, Port Alberni, B.C." Report prepared for the Alberni-Clayoquot Regional District, August, 51p.

Piteau Associates Engineering Ltd., 2015. "Water Quality Monitoring Program to December 2014 - Alberni Valley Landfill, Port Alberni, B.C." Report prepared for the Alberni-Clayoquot Regional District, August, 57p.

Piteau Associates Engineering Ltd., 2017. "Phase 2 Leachate Interception Well and Monitoring Well Drilling and Testing Program - Alberni Valley Landfill, Port Alberni, B.C." Report prepared for the Alberni-Clayoquot Regional District and McGill & Associates Engineering Ltd., January, 19p.

# TABLES

## TABLE I
## ALBERNI VALLEY LANDFILL 2015 MONITORING PROGRAM

| Suite No. | Sites | Frequency | Analyses |
|---|---|---|---|
| 1 | MW94-4S, MW94-5S, MW94-6S<br>MW98-9, MW98-10<br>MW02-1S, MW02-1D<br>MW02-3S<br>MW02-3D, MW02-4<br>MW13-1D, MW13-2D<br>*South Expansion Leachate Drain* | Quarterly<br>Quarterly | Field: Conductance, temperature, pH, water level<br>Lab: Conductance, pH, TDS, chloride, sulphate, ammonia, nitrate, **hardness,** COD, dissolved metals, **ion balance, bicarbonate**<br><br>MW02-1S damaged in July 2015. |
| 1a | MW94-6D | Quarterly<br>Quarterly | Field: Conductance, temperature, pH, water level<br>Lab: Conductance, pH, TDS, chloride, sulphate, ammonia, nitrate, **hardness,** COD, TOC, dissolved metals, **ion balance, bicarbonate** |
| 2 | MW94-4D, MW05-1S<br>MW05-1D, PW-1, PW-2<br>MW13-1S, MW13-2S | Quarterly<br>Quarterly | Field: Conductance, temperature, pH, water level<br>Lab: Conductance, pH, TDS, chloride, sulphate, nitrate, ammonia |
| 3 | Heath, Stevens,<br>and Christie Creeks<br>SCKA, SCKB (two samples) | Quarterly<br>Quarterly | Field: Conductance, temperature, pH<br>Lab: Conductance, pH, chloride, **sulphate,** nitrate, ammonia, hardness, COD, tot P, total:Cd, Cr, Fe, Mn, Zn |
| 4 | Aeration lagoon inflow<br>(leachate from landfill), **South Expansion Leachate Drain**<br>*BH00-1C* , **BH00-1C replacement (when completed)** | Quarterly<br>Quarterly<br><br>Annual | Field: Conductance, temperature, pH<br>Lab: Conductance, pH, TDS, chloride, nitrate, ammonia, **hardness,** COD, TOC, tot P, total metals**, ion balance, bicarbonate**<br>Lab: VOC scan, acid extractables (twice in 2015 for leachate drain, once for BH00-1C) |
| 5 | BH00-1A, **BH00-1C**, BH00-2A,<br>BH00-2C, BH00-5A-S, BH00-5A-D,<br>BH00-6A, BH00-7A, BH00-8A,<br>MW09-1,2,3,4,8,9,10,11, and 13<br>**MW15-1S, MW15-1D,**<br>**PW15-1, PW15-2** | Quarterly | Field: water levels until no longer accessible<br><br>BH00-2A, MW09-8, MW09-9 and MW09-11 no longer accessible. |

H:\Project\1005\Analysis\Chemistry\2015\[Summary Tables.xlsx]Table I - 2015

Notes: 1. **Bolded** sites and parameters were not part of the 2015 suite but should be included in the 2016 monitoring program.
2. *Italicized* sites and parameters were part of the 2015 monitoring program but should be removed for 2016.

# TABLE II
## SUMMARY OF LEACHATE IMPACTS BASED ON MEAN 2015 CONCENTRATIONS

| MONITORING WELL | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (mg/L) | (µS/cm) | (mg/L) | (mg/L) | (mg/L-N) | (mg/L-N) | (mg/L-O) | (mg/L) | (mg/L) | (mg/L) |
| GCDWQ [1] | | | 6.5-8.5 | - | 500 | 250 | - | 10 | - | - | 0.3 | 0.05 |
| FWAL GUIDELINE [2] | | | 6.5-9 | - | - | 150 | 1.84 | 3 | - | - | 1 (total) | 2.47 (leachate) |
| **LEACHATE** | | | | | | | | | | | | |
| Lagoon Inlet | B-1, 3, 4 | 4 | 6.9 | 1653 | **771** | 86.2 | **65.3** | <0.2 | 191 | 449 | **32** | **4.89** |
| BH00-1C | B-2, 3, 4 | 3 | 7.2 | 709 | 434 | 29.4 | **3.7** | **25.1** | 146 | 248 | **130** | **2.32** |
| South Expansion Leachate Drain | B-5 | 4 | 6.9 | 464 | 250 | 12.5 | **3.5** | 1.6 | <15 | 187 | <0.01 | **2.37** |
| **SOUTHEAST WELLS** | | | | | | | | | | | | |
| MW02-3S (Surficial Sediments) | B-8 | 4 | 7.6 | 127 | 64 | 0.5 | <0.02 | 0.54 | <14 | 59 | <0.01 | 0.002 |
| MW02-3D (Bedrock) | B-9 | 4 | 7.7 | 299 | 157 | 10.0 | <0.29 | <0.08 | <13 | 83 | <0.053 | <0.039 |
| MW05-1S (Surficial Sediments) | B-22 | 4 | 7.2 | 383 | 225 | 15.0 | <0.03 | 2.08 | - | - | - | - |
| MW05-1D (Bedrock) | B-22 | 4 | 7.1 | 791 | **518** | 46.5 | 0.09 | 0.33 | - | - | - | - |
| PW-1 (Bedrock Leachate Well) | B-23 | 4 | 6.8 | 1163 | **671** | 66.0 | **2.9** | <0.01 | - | - | - | - |
| PW-2 (Surficial Sediment Leachate Well) | B-23 | 4 | 6.7 | 905 | 469 | 36.5 | **15.7** | <0.01 | - | - | - | - |
| **SOUTH AND WEST WELLS** | | | | | | | | | | | | |
| MW94-4S (Surficial Sediments) | B-10 | 4 | 9.2 | 260 | 155 | 7.2 | 0.05 | 0.04 | <11 | 4 | <0.01 | <0.001 |
| MW94-4D (Bedrock) | B-11 | 4 | 8.4 | 366 | 227 | 6.2 | <0.01 | 0.51 | - | - | - | - |
| MW02-1S (Surficial Sediments) | B-18 | 2 | 6.5 | 97 | 43 | 1.5 | <0.01 | 0.61 | <10 | 39 | <0.01 | <0.003 |
| MW02-1D (Background Bedrock) | B-19 | 4 | 7.0 | 79 | 52 | 1.4 | <0.01 | 0.50 | <10 | 33 | <0.01 | 0.022 |
| MW02-4 (Background Bedrock) | B-21 | 4 | 7.3 | 628 | 342 | 105.0 | <0.02 | 0.05 | <10 | 165 | <0.01 | <0.001 |
| **NORTH WELLS** | | | | | | | | | | | | |
| MW94-5S (Bedrock) | B-12 | 4 | 6.9 | 246 | 139 | 1.2 | <0.03 | 0.30 | <10 | 123.5 | <0.015 | 0.01 |
| MW94-6S (Surficial Sediments) | B-13 | 4 | 6.4 | 736 | 391 | 8.5 | **13.1** | <0.14 | 45 | 290 | **11.2** | **6.0** |
| MW94-6D (Bedrock) | B-14 | 4 | 8.7 | 629 | 366 | 3.7 | **0.4** | 1.51 | 50 | 8 | 0.26 | 0.02 |
| MW98-9 (Surficial Sediments) | B-15 | 4 | 6.4 | 194 | 123 | 2.2 | <0.02 | 0.28 | <10 | 90 | <0.01 | <0.012 |
| MW98-10 (Surficial Sediments) | B-16 | 4 | 6.6 | 69 | 65 | 0.7 | <0.01 | 1.00 | <15 | 23 | <0.01 | <0.003 |
| **2013 WELLS** | | | | | | | | | | | | |
| MW13-1D (Bedrock) | B-24 | 4 | 8.1 | 2388 | **1758** | 102.8 | <0.02 | <0.01 | 427 | 162 | 0.07 | **1.13** |
| MW13-1S (Bedrock) | B-24 | 4 | 7.9 | 1678 | **1200** | 43.3 | <0.08 | <0.01 | - | - | - | - |
| MW13-2D (Bedrock) | B-25 | 4 | 8.7 | 881 | **640** | 26.3 | <0.01 | <0.06 | 119 | 74 | <0.027 | **0.13** |
| MW13-2S (Bedrock) | B-25 | 4 | 7.6 | 2198 | **1635** | 56.8 | <0.01 | <0.01 | - | - | - | - |
| **CREEK SITES** | | | | | | | | | | | | |
| Heath Creek | B-26 | 4 | 7.3 | 57.5 | - | 2.3 | <0.01 | 0.16 | <10 | 23 | 0.15 | 0.01 |
| SCKA (Piezometer at Base of Clay Berm) | B-27 | 2 | - | 418.5 | - | 14.2 | 0.59 | 1.04 | 89 | 250 | **38.4** | **1.73** |
| SCKB (Pond above Stevens Creek Site) | B-27 | 2 | - | 131.0 | - | 3.8 | 0.10 | 0.47 | <20 | 66 | 0.11 | **0.13** |
| Stevens Creek | B-27 | 4 | 6.8 | 137.8 | - | 4.0 | <0.01 | 0.24 | <21 | 58 | **0.35** | **0.51** |
| Christie Creek U/S | B-28 | 3 | 8.7 | 57.0 | - | 1.0 | <0.01 | 0.12 | <14 | 25 | 0.21 | **0.07** |
| Christie Creek D/S | B-28 | 3 | 8.6 | 64.3 | - | 1.3 | 0.11 | 0.11 | <13 | 29 | **0.98** | **0.11** |

H:\Project\1005\Analysis\Chemistry\2015\[Summary Tables.xlsx]TableII

NOTES:
1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, October 2014). 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"). 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. Total hardness, iron and manganese measured for surface water samples, while dissolved harness, iron and manganese reported for groundwater samples.

# TABLE III
## SUMMARY OF 2015 EXCEEDANCES OF GCDWQ AND BC FWAL

| MONITORING WELL | Table Reference for full chemistry results | Number of samples | Physical: pH | Physical: Total Dissolved Solids | Nutrients/Anions: Nitrate | Nutrients/Anions: Ammonia | Nutrients/Anions: Dissolved Sulphate | Total Metals: Arsenic | Total Metals: Boron | Total Metals: Cadmium | Total Metals: Chromium | Total Metals: Copper | Total Metals: Iron | Total Metals: Lead | Total Metals: Manganese | Total Metals: Mercury | Total Metals: Zinc | Dissolved Metals (2): Arsenic | Dissolved Metals (2): Boron | Dissolved Metals (2): Chromium | Dissolved Metals (2): Copper | Dissolved Metals (2): Iron | Dissolved Metals (2): Lead | Dissolved Metals (2): Manganese | Dissolved Metals (2): Mercury | Dissolved Metals (2): Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **LEACHATE** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lagoon Inlet | B-1, B-3, B-4 | 4 | | Red | | Blue | | | Blue | | Blue | | Purple | | Purple | Blue | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey |
| BH00-1C | B-2, B-3, B-4 | 3 | Purple | Red | Purple | Blue | | Blue (2) | | Blue | Blue | Blue | Purple | Purple | Purple | Purple | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey |
| South Expansion Leachate Drain | B-5 | 4 | | | Blue | Blue | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | | | | | | | Purple | | |
| **SOUTHEAST WELLS** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MW02-3S (Surficial Sediments) | B-8 | 4 | | | | | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | | | | | | | | | |
| MW02-3D (Bedrock) | B-9 | 4 | | | | | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | | | | | | | Red | | |
| MW05-1S (Surficial Sediments) | B-22 | 4 | | | | | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey |
| MW05-1D (Bedrock) | B-22 | 4 | | Red | | | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey |
| PW-1 (Bedrock Leachate Well) | B-23 | 4 | | Red | | Blue | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey |
| PW-2 (Surficial Sediment Leachate Well) | B-23 | 4 | | Red | | Blue | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey |
| **SOUTH AND WEST WELLS** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MW94-4S (Surficial Sediments) | B-10 | 4 | Purple | | | | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Blue | Blue | Blue | Blue | | Purple | | Blue | Blue |
| MW94-4D (Bedrock) | B-11 | 4 | Purple | | | | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey |
| MW02-1S (Surficial Sediments) | B-18 | 2 | Purple | | | | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | | | | | | | | | |
| MW02-1D (Background Bedrock) | B-19 | 4 | Purple | | | | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | | | | Blue | | | | | Blue |
| MW02-4 (Background Bedrock) | B-21 | 4 | | | | | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | | | | | | | | | |
| **NORTH WELLS** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MW94-5S (Bedrock) | B-12 | 4 | | | | | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | | | | | | | | | |
| MW94-6S (Surficial Sediments) | B-13 | 4 | Purple | | | Blue | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | | | Blue | | Purple | | Purple | | |
| MW94-6D (Bedrock) | B-14 | 4 | Purple | | | | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Purple | Blue | Blue | Blue | Purple | | Red | Blue | |
| MW98-9 (Surficial Sediments) | B-15 | 4 | Purple | | | | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | | | Blue | Blue | | | | Blue | |
| MW98-10 (Surficial Sediments) | B-16 | 4 | Purple | | | | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | | | Blue | | | | | | |
| **2013 WELLS** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MW13-1D (Bedrock) - Note 1 | B-24 | 4 | | Red | | | Purple | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Purple | | | | | | Red | | |
| MW13-1S (Bedrock) | B-24 | 4 | | Red | | | Purple | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey |
| MW13-2D (Bedrock) - Note 1 | B-25 | 4 | | Red | | | Purple | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Blue | | Blue | | | | Red | | |
| MW13-2S (Bedrock) | B-25 | 4 | | Red | | | Purple | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey |
| **CREEK SITES** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Heath Creek | B-26 | 4 | | Grey | | | Grey | Grey | Grey | | | Grey | | Grey | | Grey | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey |
| SCKA (Piezometer at Base of Clay Berm) | B-27 | 2 | | Grey | | | Grey | Grey | Grey | Blue | Blue | Grey | Purple | Grey | Purple | Grey | Blue | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey |
| SCKB (Pond above Stevens Creek Site) | B-27 | 2 | | Grey | | | Grey | Grey | Grey | | | Grey | | Grey | Red | Grey | | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey |
| Stevens Creek | B-27 | 4 | | Grey | | | Grey | Grey | Grey | Blue | | Grey | Purple | Grey | Purple | Grey | Blue | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey |
| Christie Creek U/S | B-28 | 3 | Purple | Grey | | | Grey | Grey | Grey | | | Grey | Red | Grey | Red | Grey | Blue | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey |
| Christie Creek D/S | B-28 | 3 | Purple | Grey | | | Grey | Grey | Grey | Blue | | Grey | Purple | Grey | Red | Grey | Blue | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey | Grey |

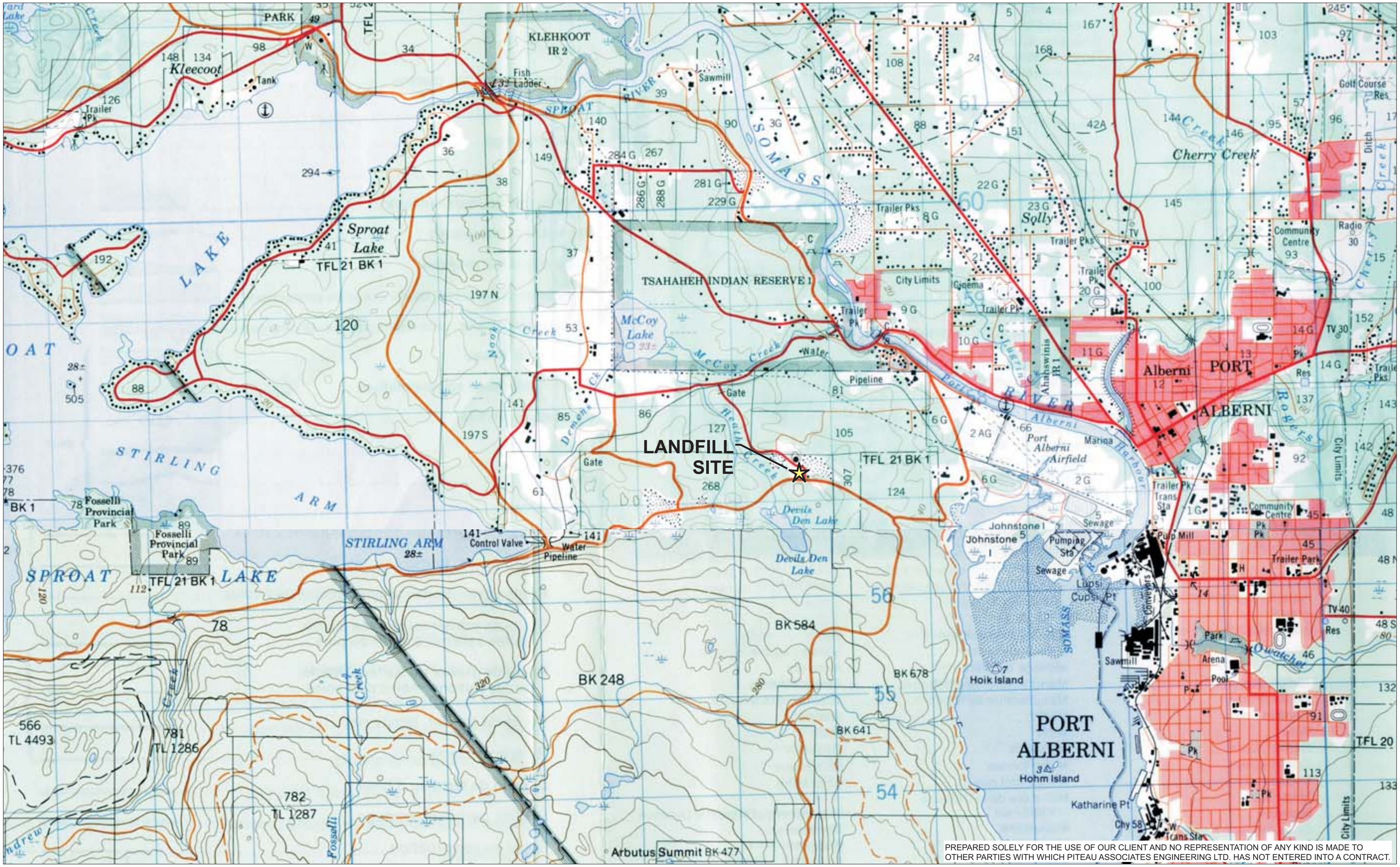
H:\Project\1005\Analysis\Chemistry\2015\[Summary Tables.xlsx]TableIII TableIII

NOTES:
1. MW13-1D and MW13-2D also have exceedances of dissolved sodium, and lithium, and uranium (1D only) not associated with the landfill.
2. FWAL Criteria for metals not considered relevant for groundwater

- Blue shaded cells show sampling location has at least one exceedance of the BC FWAL for the parameter indicated (Metals criteria not considered relevant for groundwater)
- 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
- Grey shaded cells show sampling location was not analyzed for the parameter indicated
- No shading indicates all sampling results were below the FWAL guideline

# FIGURES

DWG. NUMBER: 1005-005.CDR




PREPARED SOLELY FOR THE USE OF OUR CLIENT AND NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH PITEAU ASSOCIATES ENGINEERING LTD. HAS NOT ENTERED INTO A CONTRACT.

ALBERNI-CLAYOQUOT REGIONAL DISTRICT

PITEAU ASSOCIATES

GEOTECHNICAL AND HYDROGEOLOGICAL CONSULTANTS

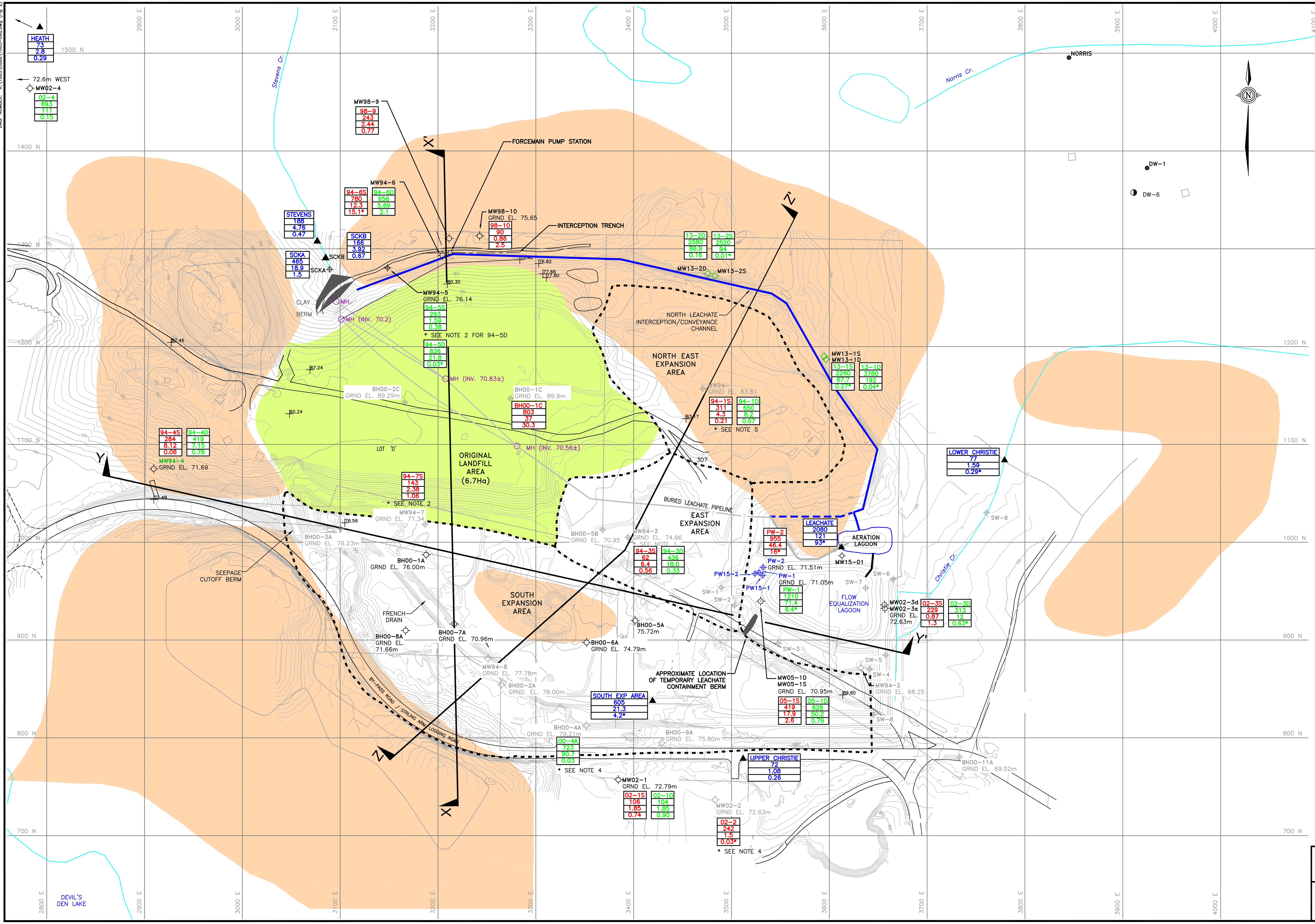
0 1000 2000 3000m

SCALE 1:60000

WATER QUALITY
MONITORING PROGRAM
ALBERNI VALLEY LANDFILL
PORT ALBERNI, B.C.

LANDFILL
LOCATION PLAN

| BY: | DATE: |
|---|---|
| ATH/sl | APR 16 |
| APPROVED: | FIG: |
| ATH | 1 |




DWG. NUMBER: K:\1005\Cadd\1005-092.dwg (Fig 2)

## 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 2005/2006)
- DUG DOMESTIC WELL
- DRILLED DOMESTIC WELL
- SURFACE WATER SAMPLING SITE
- SURFACE FLOW CHANNEL
- BURIED PIPE
- BEDROCK OUTCROPPING OR CLOSE TO SURFACE
- APPROXIMATE EXTENT OF LANDFILL EXPANSION AREAS
- Y — Y' HYDROGEOLOGICAL SECTION (FIGS. 4 AND 5)

POSTED CONDUCTANCE, CHLORIDE AND NITRATE DATA. ALL DATA ARE MAXIMUM VALUES MEASURED IN 2015, UNLESS OTHERWISE STATED.

| 94-1S | |
|---|---|
| 484 | CONDUCTANCE ($\mu$S/cm) |
| 5.8 | CHLORIDE (mg/L) |
| 0.45 | 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:

1. NOT SAMPLED SINCE 2005, RESULTS FROM 2005 SHOWN.
2. NOT SAMPLED SINCE 2008, RESULTS FROM 2008 SHOWN.
3. NOT SAMPLED SINCE 2010, RESULTS FROM 2010 SHOWN.
4. NOT SAMPLED SINCE 2011, RESULTS FROM 2011 SHOWN.
5. NOT SAMPLED SINCE 2013, RESULTS FROM 2013 SHOWN.

0 20 40 60 80 100m
SCALE 1:2000



ALBERNI-CLAYOQUOT REGIONAL DISTRICT

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WATER QUALITY MONITORING PROGRAM
ALBERNI VALLEY LANDFILL
PORT ALBERNI, B.C.

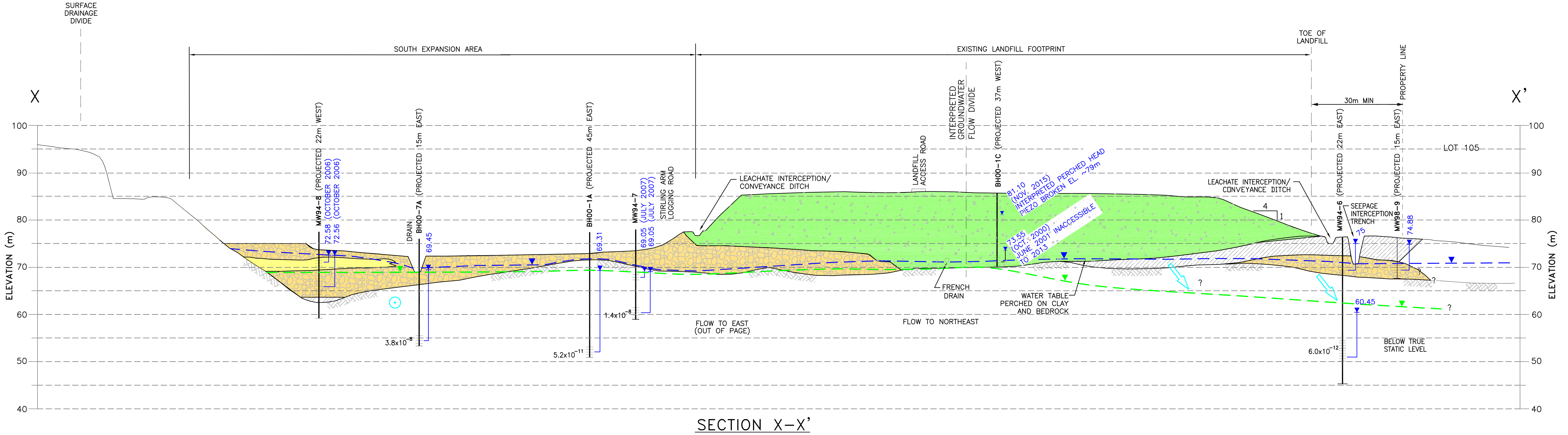
SITE PLAN

BY: JM/sl
DATE: APR 16
APPROVED: ATH
FIG: 2


**NOTE:**
GRID IS RELATIVE TO McGILL & ASSOCIATES ENGINEERING LTD. DATUM



| | | | |
|---|---|---|---|
| ALBERNI-CLAYOQUOT REGIONAL DISTRICT | | PITEAU ASSOCIATES GEOTECHNICAL AND HYDROGEOLOGICAL CONSULTANTS | |
| WATER QUALITY MONITORING PROGRAM ALBERNI VALLEY LANDFILL PORT ALBERNI, B.C. | POSTED GROUNDWATER ELEVATIONS AND INTERPRETED GROUNDWATER FLOW DIRECTIONS | BY: CM/sl APPROVED: ATH | DATE: APR 16 FIG: 3 |





**LEGEND**

- MUNICIPAL WASTE
- SILT AND CLAY SEDIMENTS (ML)
- SAND AND GRAVEL (GW)
- FINE SAND AND SILTY SAND (SP)
- VERY DENSE SAND AND SILT TILL – SOME GRAVEL (SM)
- BEDROCK SURFACE
- BH or MW (1.4x10⁻⁷, 6.8x10⁻⁸): MONITORING WELLS SHOWING PIEZOMETER COMPLETION ZONES AND WATER LEVELS MEASURED NOVEMBER 2015, UNLESS OTHERWISE NOTED. (SEE LOGS IN PITEAU, 2000 AND PITEAU 2006) NUMBERS POSTED BESIDE SCREENS ARE HYDRAULIC CONDUCTIVITY VALUES (m/s) DETERMINED FROM RISING HEAD TEST.
- PW-1: LEACHATE INTERCEPTION WELL
- INTERPRETED WATER TABLE IN SURFICIAL SEDIMENTS
- INTERPRETED 2015 PIEZOMETRIC LEVEL IN BEDROCK
- INTERPRETED PIEZOMETRIC LEVEL IN BEDROCK WITH OPTIMUM EFFECTS OF PW–1 (ASSUMES PW–1 PUMPING, WHICH WAS SELDOM IN 2015).
- INTERPRETED GROUNDWATER FLOW DIRECTION (IF IN PLANE OF SECTION)
- INTERPRETED GROUNDWATER FLOW DIRECTION IS OUT OF PAGE

**NOTES:**

1. SEE FIG. 2 FOR LOCATION OF SECTION.
2. GROUND SURFACE BASED ON 2000 TOPOGRAPHY.

0 10 20 30 40 50m
SCALE 1:1000
VERTICAL EXAGGERATION = 2X



ALBERNI-CLAYOQUOT REGIONAL DISTRICT

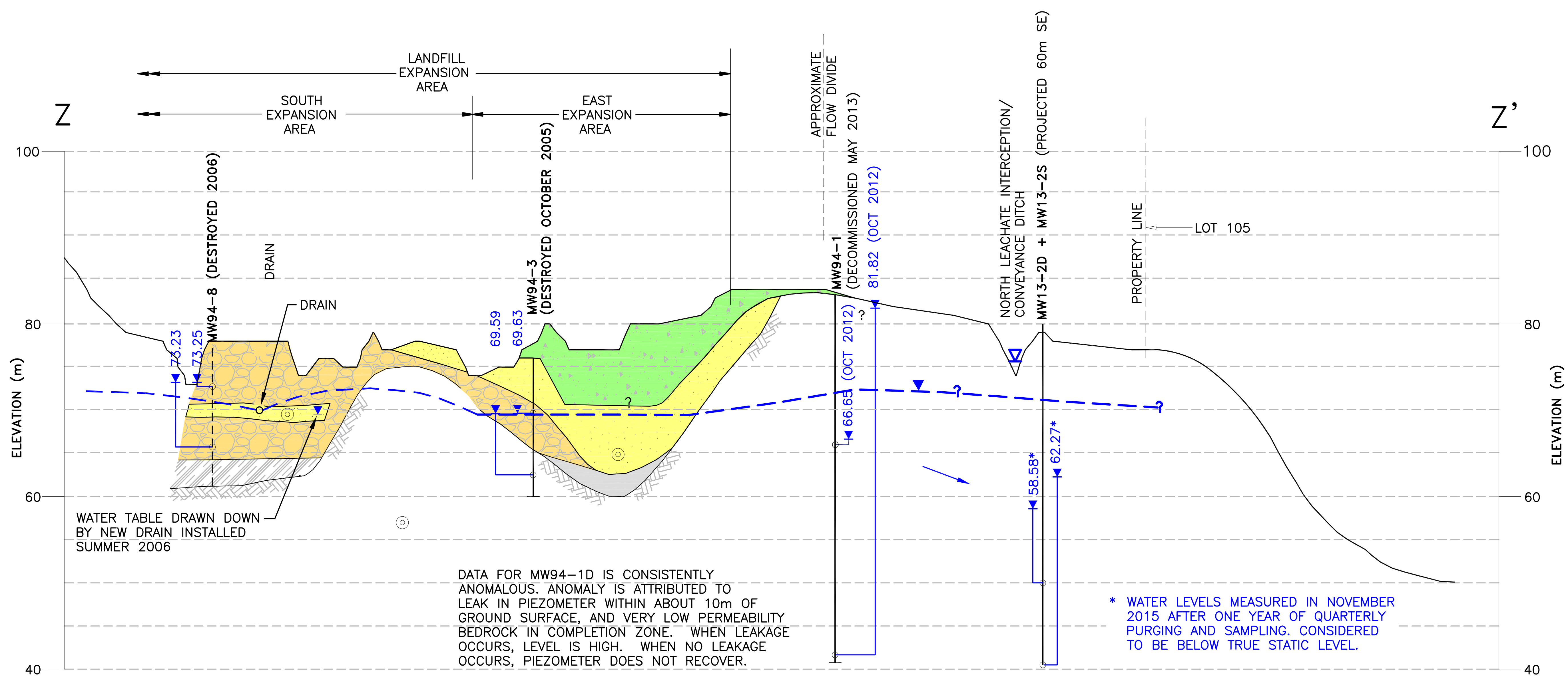
PITEAU ASSOCIATES
GEOTECHNICAL AND HYDROGEOLOGICAL CONSULTANTS

WATER QUALITY MONITORING PROGRAM
ALBERNI VALLEY LANDFILL
PORT ALBERNI, B.C.

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

| BY: | DATE: |
|---|---|
| CM/sl | APR 16 |
| APPROVED: ATH | FIG: 4 |

DWG. NUMBER: K:\1005\Cadd\1005-082.dwg (Fig 5)




## SECTION Z–Z'

## LEGEND

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

## NOTES:

1. SEE FIG. 2 FOR LOCATION OF SECTION.
2. 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.
3. MW94–1 WAS DECOMMISSIONED IN MAY 2013 AND WAS REPLACED WITH MW13–2.
4. GROUND SURFACE BASED ON 2006 TOPOGRAPHY.

0 20 40 60 80 100m

SCALE 1:2500

VERTICAL EXAGGERATION = 5X



| | | | |
|---|---|---|---|
| ALBERNI-CLAYOQUOT REGIONAL DISTRICT | | PITEAU ASSOCIATES<br>GEOTECHNICAL AND HYDROGEOLOGICAL CONSULTANTS | |
| WATER QUALITY<br>MONITORING PROGRAM<br>ALBERNI VALLEY LANDFILL<br>PORT ALBERNI, B.C. | HYDROGEOLOGICAL SECTION Z-Z'<br>THROUGH EXISTING LANDFILL AND<br>SOUTH EXPANSION AREA | BY: CM/sl<br>APPROVED: ATH | DATE: APR 16<br>FIG: 5 |

# APPENDIX A

# WATER ELEVATION MONITORING DATA TABLES AND PLOTS

## APPENDIX A

## LIST OF TABLES



## LIST OF FIGURES

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

| | ELEVATION OF WATER[1] (m-asl) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MW94-1S | MW94-1D | MW94-2S | MW94-2D | MW94-3S | MW94-3D | MW94-4S | MW94-4D | MW94-5S | MW94-5D | MW94-6S | MW94-6D | MW94-7S | MW94-7D | MW98-9 | MW98-10 |
| Top of Casing (m-geod) | 84.21 | 84.21 | 68.53 | 68.53 | 75.43 | 75.43 | 72.56 | 72.67 | 77.29 | 77.29 | 76.18 | 76.18 | 78.48 | 78.48 | 76.19 | 76.14 |
| Piezo bottom (m-geod) | 41.0 | 64.0 | 55.5 | 48.8 | 68.5 | 60.0 | 62.0 | 47.2 | 66.5 | 53.8 | 67.6 | 49.3 | 66.4 | 58.5 | 68.6 | 72.0 |
| Completion Zone | bedrock | bedrock | surficial | bedrock | surficial | bedrock | bdrk/surf | bedrock | bedrock | bedrock | surficial | bedrock | surficial | bedrock | surficial | surficial |
| MEASURED WATER ELEVATIONS (m-geod.) | | | | | | | | | | | | | | | | |
| 07-Jan-05 | 67.42 | 81.69 | buried | buried | 70.84 | 70.13 | >72.56 | frozen | 74.29 | 72.58 | 71.02 | *56.33* | 74.92 | 74.93 | 70.88 | 72.72 |
| 15-Apr-05 | 67.63 | 82.02 | buried | buried | 71.16 | 70.52 | >72.56 | *61.55* | 74.61 | 73.15 | 74.70 | *58.26* | 77.00 | 75.52 | 74.73 | 74.71 |
| 11-Jul-05 | 67.25 | 81.52 | buried | buried | 68.63 | 69.59 | >72.56 | *49.76* | 73.35 | 72.02 | 73.72 | *58.06* | 73.94 | 73.73 | 73.64 | 72.06 |
| 11-Oct-05 | 66.88 | *46.88* | buried | buried | inaccessible | inaccessible | >72.56 | *55.12* | 72.97 | 71.44 | 72.67 | *57.24* | 72.61 | 72.61 | 72.61 | 72.22 |
| 09-Jan-06 | 67.67 | 82.07 | buried | buried | inaccessible | inaccessible | >72.56 | *52.87* | 74.49 | 73.25 | 75.12 | *58.25* | 76.06 | 76.06 | 75.10 | 74.59 |
| 10-Apr-06 | 68.62 | 81.74 | buried | buried | inaccessible | inaccessible | >72.56 | *65.47* | 74.51 | 72.92 | 74.51 | *58.81* | 74.99 | 74.99 | 74.35 | 74.24 |
| 12-Jul-06 | 66.90 | 81.51 | buried | buried | inaccessible | inaccessible | >72.56 | *49.59* | 72.48 | 71.22 | 73.05 | *58.59* | 73.30 | 72.48 | 73.07 | 72.92 |
| 10-Oct-06 | 66.71 | *49.64* | buried | buried | inaccessible | inaccessible | >72.56 | *49.69* | 73.20 | 71.87 | 72.92 | *57.44* | 69.01 | 69.04 | 72.94 | 72.82 |
| 11-Jan-07 | 69.57 | 81.73 | buried | buried | inaccessible | inaccessible | >72.56 | *67.19* | 73.25 | 74.72 | 71.76 | *59.80* | 70.48 | 70.53 | 72.59 | 74.08 |
| 10-Apr-07 | - | - | buried | buried | inaccessible | inaccessible | >72.56 | - | 74.51 | 72.63 | 71.42 | *53.34* | 69.10 | - | 71.02 | 72.94 |
| 11-Apr-07 | 66.53 | *74.23* | buried | buried | inaccessible | inaccessible | >72.56 | *61.30* | - | - | - | - | - | - | - | - |
| 03-Jul-07 | 68.26 | 81.52 | buried | buried | inaccessible | inaccessible | >72.56 | *65.07* | 73.90 | 72.41 | 70.88 | *58.99* | 69.05 | 69.05 | 70.92 | 72.16 |
| 23-Oct-07 | 67.55 | 81.96 | buried | buried | inaccessible | inaccessible | >72.56 | *59.08* | 74.66 | 73.10 | 71.56 | *57.60* | 69.16 | 69.19 | 72.19 | 73.88 |
| 15-Jan-08 | 67.37 | 82.06 | buried | buried | inaccessible | inaccessible | >72.56 | *51.89* | 74.86 | 73.29 | 75.08 | *57.44* | 70.18 | 70.22 | 75.00 | 74.55 |
| 09-Apr-08 | 67.28 | 81.84 | buried | buried | inaccessible | inaccessible | >72.56 | *60.41* | 74.59 | 72.81 | 71.44 | *57.03* | - | - | 71.21 | 72.95 |
| 08-Jul-08 | 66.86 | 80.59 | buried | buried | inaccessible | inaccessible | >72.56 | *53.97* | 72.67 | 71.23 | 70.84 | *57.24* | - | - | 70.85 | 72.14 |
| 27-Oct-08 | 68.53 | 81.67 | buried | buried | inaccessible | inaccessible | >72.56 | *49.86* | 74.21 | 72.59 | 71.21 | *57.66* | destroyed | destroyed | 71.06 | 72.67 |
| 27-Jan-09 | 66.83 | 81.66 | buried | buried | inaccessible | inaccessible | >72.56 | 72.67 | - | - | 71.61 | *56.96* | - | - | 71.49 | 73.00 |
| 14-Apr-09 | 66.64 | 81.70 | buried | buried | inaccessible | inaccessible | >72.56 | *57.70* | - | - | 71.36 | *56.27* | - | - | 71.19 | 72.80 |
| 21-Jul-09 | 66.64 | 81.48 | buried | buried | inaccessible | inaccessible | >72.56 | *49.89* | - | - | 70.83 | *57.81* | - | - | 70.89 | 72.14 |
| 07-Nov-09 | 65.41 | *50.57* | buried | buried | inaccessible | inaccessible | >72.56 | *48.68* | 73.61 | 75.66 | 70.80 | *56.82* | - | - | 70.86 | 72.00 |
| 26-Jan-10 | 67.71 | 82.25 | buried | buried | inaccessible | inaccessible | >72.56 | 71.46 | 74.66 | - | 72.03 | *57.97* | - | - | 72.01 | 73.53 |
| 06-Apr-10 | 66.61 | 82.11 | buried | buried | inaccessible | inaccessible | >72.56 | *65.45* | 74.72 | - | 72.05 | *56.27* | - | - | 72.06 | 73.55 |
| 20-Jul-10 | 66.90 | 81.51 | buried | buried | inaccessible | inaccessible | >72.56 | *65.81* | 72.87 | - | 70.76 | *63.54* | - | - | 70.86 | 72.13 |
| 10-Aug-10 | 65.73 | *48.70* | buried | buried | inaccessible | inaccessible | >72.56 | *69.67* | 71.98 | - | 70.77 | *55.20* | - | - | 70.87 | 72.06 |
| 16-Nov-10 | 67.95 | 82.29 | buried | buried | inaccessible | inaccessible | >72.56 | *62.09* | 74.57 | - | 71.71 | *59.79* | - | - | 71.87 | 73.40 |
| 06-Dec-10 | 66.22 | 82.06 | buried | buried | inaccessible | inaccessible | >72.56 | *59.84* | 74.59 | - | 71.64 | *56.29* | - | - | 71.94 | 73.73 |
| 08-Feb-11 | 68.06 | 82.12 | buried | buried | inaccessible | inaccessible | >72.56 | *65.69* | 74.66 | plugged | 72.20 | *58.02* | inaccessible | inaccessible | 72.59 | 73.96 |
| 09-May-11 | 66.86 | 82.04 | buried | buried | inaccessible | inaccessible | >72.56 | - | 74.51 | plugged | 71.55 | *59.81* | inaccessible | inaccessible | 71.48 | 72.98 |
| 26-Jul-11 | 66.58 | 81.54 | buried | buried | inaccessible | inaccessible | >72.56 | *62.66* | 73.32 | plugged | 70.80 | *59.04* | inaccessible | inaccessible | 70.88 | 72.05 |
| 08-Nov-11 | 66.52 | 82.15 | buried | buried | inaccessible | inaccessible | >72.56 | *66.00* | 74.41 | plugged | 71.42 | *59.27* | inaccessible | inaccessible | 71.25 | 73.02 |
| 24-Jan-12 | 66.59 | 82.41 | buried | buried | inaccessible | inaccessible | >72.56 | *68.40* | 74.74 | plugged | 72.45 | *58.55* | inaccessible | inaccessible | 73.12 | 74.30 |
| 08-May-12 | 66.81 | 82.11 | buried | buried | inaccessible | inaccessible | >72.56 | - | 74.55 | plugged | 71.62 | *59.20* | inaccessible | inaccessible | 71.38 | 72.86 |
| 31-Jul-12 | 69.07 | 81.53 | buried | buried | inaccessible | inaccessible | >72.56 | 71.80 | 72.82 | plugged | 70.82 | *59.51* | inaccessible | inaccessible | 70.80 | 72.14 |
| 25-Oct-12 | 66.65 | 81.82 | buried | buried | inaccessible | inaccessible | >72.56 | *66.41* | 73.50 | plugged | 70.78 | *58.65* | inaccessible | inaccessible | 70.81 | 72.02 |
| 16-Jan-13 | 65.51 | 82.18 | buried | buried | inaccessible | inaccessible | >72.56 | *61.67* | 74.80 | plugged | 72.04 | *57.06* | inaccessible | inaccessible | 72.51 | 73.92 |
| 15-Apr-13 | 67.31 | 82.21 | buried | buried | inaccessible | inaccessible | >72.56 | - | 74.61 | plugged | 71.70 | *53.83* | inaccessible | inaccessible | 71.57 | 73.21 |
| 10-Jul-13 | decommissioned | decommissioned | buried | buried | inaccessible | inaccessible | >72.56 | *69.75* | 73.66 | plugged | 71.35 | *52.16* | inaccessible | inaccessible | 71.96 | 72.83 |
| 13-Oct-13 | - | - | buried | buried | inaccessible | inaccessible | >72.56 | *60.47* | 74.21 | plugged | 71.43 | *51.88* | inaccessible | inaccessible | 70.92 | 72.49 |
| 16-Jan-14 | - | - | buried | buried | inaccessible | inaccessible | >72.56 | *66.84* | 74.63 | plugged | 71.90 | *51.82* | inaccessible | inaccessible | 72.07 | 73.69 |
| 12-May-14 | - | - | buried | buried | inaccessible | inaccessible | >72.56 | *65.14* | 71.93 | plugged | 71.40 | *49.53* | inaccessible | inaccessible | 72.17 | 72.92 |
| 14-Aug-14 | - | - | buried | buried | inaccessible | inaccessible | >72.56 | *61.18* | 71.36 | plugged | 72.15 | *58.43* | inaccessible | inaccessible | 72.13 | 72.12 |
| 03-Nov-14 | - | - | buried | buried | inaccessible | inaccessible | >72.56 | *53.18* | 74.70 | plugged | 71.59 | *53.85* | inaccessible | inaccessible | 72.18 | 73.76 |
| 14-Aug-14 | - | - | buried | buried | inaccessible | inaccessible | >72.56 | *61.18* | 71.36 | plugged | 72.15 | *58.43* | inaccessible | inaccessible | 72.13 | 72.12 |
| 03-Nov-14 | - | - | buried | buried | inaccessible | inaccessible | >72.56 | *53.18* | 74.70 | plugged | 71.59 | *53.85* | inaccessible | inaccessible | 72.18 | 73.76 |
| 15-Jan-15 | - | - | buried | buried | inaccessible | inaccessible | >72.56 | *53.67* | 70.46 | - | 71.78 | *52.94* | inaccessible | inaccessible | 71.55 | 72.88 |
| 21-Apr-15 | - | - | buried | buried | inaccessible | inaccessible | >72.56 | 72.67 | 74.42 | plugged | 74.70 | *56.29* | inaccessible | inaccessible | 74.41 | 74.33 |
| 15-Jul-15 | - | - | buried | buried | inaccessible | inaccessible | >72.56 | *50.23* | - | - | 73.13 | *56.33* | inaccessible | inaccessible | 73.11 | 72.99 |
| 16-Jul-15 | - | - | buried | buried | inaccessible | inaccessible | - | - | 72.57 | - | - | - | inaccessible | inaccessible | - | - |
| 20-Nov-15 | - | - | buried | buried | inaccessible | inaccessible | - | - | 74.71 | - | 75.00 | *60.45* | inaccessible | inaccessible | 74.88 | 74.76 |
| 23-Nov-15 | - | - | buried | buried | inaccessible | inaccessible | frozen | frozen | - | - | - | - | inaccessible | inaccessible | - | - |

NOTES:

H:\Project\1005\Analysis\Water_Elevations\2015\[Tables-2015.xlsx]Tab A-1 MW94-98

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.

# TABLE A-2
# 2000 MONITORING WELL WATER ELEVATION DATA

| ELEVATION OF WATER[1] (m-asl) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BH00-1A | BH00-1C | BH00-2A | BH00-2C | BH00-3A | BH00-4A | BH00-5A-S | BH00-5A-D | BH00-5B | BH00-6A | BH00-7A | BH00-8A |
| Ground Elevation (m-geod.) [1] | 71.65 | 89.24 | 75.05 | 89.90 | 71.07 | 75.21 | 75.72 | 75.72 | 70.95 | 74.79 | 70.96 | 71.66 |
| Top of Casing (m-geod) | 72.38 | 89.90 | 75.94 | 89.29 | 72.52 | 75.96 | 76.72 | 76.72 | 72.00 | 75.64 | 71.58 | 72.40 |
| Piezo bottom (m-geod) | 51.00 | 72.27 | 49.30 | 75.03 | 53.63 | 48.71 | 69.02 | 62.92 | 55.15 | 60.49 | 53.51 | 59.29 |
| Completion Zone | bedrock | surficial | bedrock | surficial | bedrock | bedrock | bdrk-frac | bedrock | bedrock | bedrock | bedrock | bedrock |
| MEASURED WATER ELEVATIONS (m-geod.) | | | | | | | | | | | | |
| 07-Jan-05 | 74.22 | - | 73.68 | - | 77.23 | 71.65 | 71.82 | 71.18 | - | 72.65 | 71.30 | 74.57 |
| 15-Apr-05 | 74.71 | - | 73.91 | - | 77.23 | 71.94 | 72.21 | 71.37 | - | - | 71.89 | 71.77 |
| 11-Jul-05 | 74.53 | - | 73.99 | - | 77.23 | 71.96 | 71.55 | 71.44 | 69.63 | 72.45 | 70.82 | 75.02 |
| 11-Oct-05 | 73.46 | - | 73.70 | - | 77.23 | 71.87 | 71.11 | 71.42 | 69.10 | 71.78 | 69.99 | 74.69 |
| 09-Jan-06 | 74.49 | - | 73.83 | - | 77.23 | 71.94 | 73.17 | 71.54 | 71.11 | 72.54 | 72.29 | 74.77 |
| 10-Apr-06 | 74.95 | - | 74.02 | - | 77.23 | 71.99 | 71.97 | 71.66 | 70.37 | 72.68 | 71.62 | 74.57 |
| 12-Jul-06 | 74.25 | - | 73.97 | - | 77.23 | 72.04 | 71.02 | 71.65 | 69.43 | 72.15 | 70.48 | 75.01 |
| 10-Oct-06 | *67.16* | - | *61.63* | - | *63.92* | *55.17* | *69.43* | *67.52* | *69.01* | *71.04* | *69.99* | *66.58* |
| 11-Jan-07 | *64.88* | - | *64.76* | *87.02* | *67.86* | *56.17* | *68.72* | *68.77* | - | *72.53* | - | *68.52* |
| 11-Apr-07 | - | - | - | - | - | *50.31* | - | - | - | - | - | - |
| 03-Jul-07 | 65.10 | - | 67.52 | 87.42 | 72.47 | *53.20* | 69.92 | 68.86 | inaccessible | 71.58 | inaccessible | 70.26 |
| 23-Oct-07 | 64.84 | - | 68.15 | 87.43 | 72.61 | *52.70* | 71.28 | 69.00 | inaccessible | 69.94 | - | 70.57 |
| 15-Jan-08 | 65.40 | - | 68.66 | 87.47 | - | *51.82* | 72.83 | 69.26 | inaccessible | 69.87 | - | 70.89 |
| 09-Apr-08 | inaccessible | - | 69.00 | 87.45 | inaccessible | *52.00* | 70.74 | 69.48 | inaccessible | 70.01 | - | 71.04 |
| 08-Jul-08 | inaccessible | - | 69.19 | - | inaccessible | *52.37* | 69.47 | 69.52 | inaccessible | 69.37 | - | 71.06 |
| 27-Oct-08 | - | - | 69.28 | 87.24 | - | *53.61* | 70.26 | 69.55 | inaccessible | 68.89 | - | 70.98 |
| 27-Jan-09 | - | - | 69.42 | - | - | *52.37* | 70.65 | 69.68 | inaccessible | 69.18 | - | 71.06 |
| 14-Apr-09 | - | - | 69.52 | 87.43 | - | *51.87* | 70.85 | 69.84 | inaccessible | 69.52 | - | 71.11 |
| 21-Jul-09 | - | - | 69.59 | - | - | *52.83* | 69.48 | 69.88 | inaccessible | 69.45 | - | 71.10 |
| 07-Nov-09 | - | - | 69.57 | 87.36 | - | *51.89* | 69.46 | 69.87 | inaccessible | 69.06 | - | 71.04 |
| 26-Jan-10 | - | - | 69.78 | 87.53 | - | *54.03* | 71.70 | 70.09 | inaccessible | 69.58 | - | 71.17 |
| 06-Apr-10 | - | - | 69.82 | 87.52 | - | *51.65* | 71.84 | 70.17 | inaccessible | 69.74 | - | 71.20 |
| 14-Apr-10 | - | - | - | - | - | - | - | - | inaccessible | - | - | - |
| 20-Jul-10 | - | - | 69.81 | 87.41 | - | - | 69.46 | 70.20 | inaccessible | 69.60 | - | 71.21 |
| 10-Aug-10 | - | - | - | - | - | - | - | - | inaccessible | - | - | - |
| 16-Nov-10 | - | - | 69.77 | 87.49 | - | *54.61* | 71.12 | 70.26 | inaccessible | 70.05 | - | 71.18 |
| 06-Dec-10 | - | - | - | - | - | - | - | - | inaccessible | - | - | - |
| 08-Feb-11 | - | - | 69.87 | 87.57 | - | *51.71* | 71.60 | 70.43 | inaccessible | 70.75 | - | 71.55 |
| 09-May-11 | - | - | - | - | - | - | 70.68 | 70.60 | inaccessible | 70.96 | - | 71.57 |
| 26-Jul-11 | - | - | - | - | - | - | 69.73 | - | inaccessible | 70.64 | - | 71.51 |
| 08-Nov-11 | - | - | 69.89 | 87.57 | - | - | 73.84 | - | inaccessible | 70.29 | - | 71.38 |
| 24-Jan-12 | - | - | - | 87.59 | - | - | 71.06 | 70.64 | inaccessible | 70.59 | - | 71.40 |
| 08-May-12 | - | - | - | 87.61 | - | - | 70.32 | 70.75 | inaccessible | 70.89 | - | 71.43 |
| 31-Jul-12 | - | - | - | 87.52 | - | - | 69.36 | 70.71 | inaccessible | 70.49 | - | - |
| 25-Oct-12 | - | - | - | 87.44 | - | - | 70.07 | 70.68 | inaccessible | 70.04 | - | - |
| 16-Jan-13 | - | - | - | 87.62 | - | - | 70.50 | 70.76 | inaccessible | 70.60 | - | - |
| 15-Apr-13 | - | - | - | 87.59 | - | - | 69.88 | 70.81 | inaccessible | 70.78 | - | - |
| 10-Jul-13 | - | - | - | - | - | - | 69.36 | 70.79 | inaccessible | 70.64 | - | - |
| 13-Oct-13 | 69.26 | - | 70.04 | 88.17 | - | - | 69.52 | 70.81 | inaccessible | 70.37 | - | - |
| 16-Jan-14 | 69.33 | 87.40 | - | 81.27 | - | - | 70.54 | 70.77 | inaccessible | 70.55 | 69.45 | 71.51 |
| 12-May-14 | 69.52 | 87.40 | 70.30 | 83.43 | - | - | 70.43 | 70.86 | inaccessible | 70.81 | 69.48 | 71.57 |
| 14-Aug-14 | 69.11 | 81.16 | - | 88.04 | - | - | 69.32 | 70.66 | inaccessible | 68.67 | 65.70 | 71.26 |
| 03-Nov-14 | 69.11 | 82.98 | - | 87.93 | - | - | 70.49 | 70.76 | inaccessible | 69.09 | 69.20 | 71.38 |
| 15-Jan-15 | 69.59 | - | - | 86.05 | - | - | 69.89 | 70.70 | - | 70.24 | 69.64 | 71.51 |
| 21-Apr-15 | 69.57 | 80.87 | - | 86.16 | - | - | 69.71 | 70.78 | - | 70.62 | 69.64 | 71.51 |
| 15-Jul-15 | 69.32 | - | - | dry | - | - | 69.34 | 70.73 | - | 70.27 | 68.52 | 71.74 |
| 16-Jul-15 | - | 80.38 | - | - | - | - | - | - | - | - | - | - |
| 22-Oct-15 | - | - | - | - | - | - | - | - | - | - | - | 71.74 |
| 20-Nov-15 | - | - | - | - | - | - | - | - | - | - | - | - |
| 23-Nov-15 | 69.31 | 81.10 | - | 86.94 | - | - | 69.60 | 70.72 | - | 70.23 | 69.45 | 71.69 |

NOTES:

H:\Project\1005\Analysis\Water_Elevations\2015\[Tables-2015.xlsx]Tab A-2 BH00

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.

# TABLE A-3
# 2002, 2005, AND 2013 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 |
| Ground Elevation (m-geod.)[1] | 77.29 | 77.56 | 72.63 | 70.80 | 70.71 | 67.15 | 70.95 | 70.95 | 71.05 | 71.51 | 73.11 | 73.00 | 78.97 | 78.50 |
| Top of Casing (m-geod) | 78.34 | 78.67 | 73.71 | 70.78 | 70.70 | 68.24 | 71.55 | 71.55 | 72.05 | 72.11 | 74.10 | 73.96 | 79.87 | 79.04 |
| 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 |
| Completion Zone | bedrock | surficial | surficial | bedrock | surficial | bedrock | bdrk-frac | surficial | bdrk-frac | surficial | bedrock | bedrock | bedrock | bedrock |
| MEASURED WATER ELEVATIONS (m-geod.) | | | | | | | | | | | | | | |
| 07-Jan-05 | 71.57 | 71.75 | 69.21 | 67.25 | 68.70 | 61.70 | - | - | - | - | - | - | - | - |
| 15-Apr-05 | 71.84 | 71.98 | 69.51 | 68.09 | 69.17 | 61.71 | - | - | - | - | - | - | - | - |
| 11-Jul-05 | 71.61 | 71.47 | 68.85 | 66.61 | 67.95 | 60.15 | - | - | - | - | - | - | - | - |
| 11-Oct-05 | 71.08 | 71.00 | 68.33 | 66.03 | 67.60 | 59.56 | - | - | - | - | - | - | - | - |
| 09-Jan-06 | 72.00 | 71.96 | 69.88 | 68.07 | 69.52 | 62.06 | - | - | - | - | - | - | - | - |
| 10-Apr-06 | 71.65 | 71.62 | 69.36 | 67.32 | 68.70 | 60.90 | - | - | - | - | - | - | - | - |
| 12-Jul-06 | 71.61 | 71.25 | 68.67 | 66.26 | 67.58 | 59.77 | - | - | - | - | - | - | - | - |
| 10-Oct-06 | 68.91 | 68.88 | 68.01 | 68.01 | 67.48 | 59.54 | - | - | - | - | - | - | - | - |
| 11-Jan-07 | 70.94 | 70.95 | 69.80 | 68.42 | 69.89 | 61.78 | - | - | - | - | - | - | - | - |
| 11-Apr-07 | 69.42 | 69.40 | 69.08 | 69.20 | 69.03 | 64.52 | - | - | - | - | - | - | - | - |
| 03-Jul-07 | 69.17 | 69.20 | 68.71 | 66.66 | 68.04 | 60.17 | - | - | - | - | - | - | - | - |
| 23-Oct-07 | 69.79 | 69.80 | 69.09 | 67.14 | 68.80 | 62.10 | - | - | - | - | - | - | - | - |
| 15-Jan-08 | 70.62 | 70.59 | 69.67 | 67.97 | 69.44 | 65.90 | - | - | - | - | - | - | - | - |
| 09-Apr-08 | 69.49 | 69.49 | 69.13 | 68.21 | 68.30 | 64.81 | - | - | - | - | - | - | - | - |
| 08-Jul-08 | 68.80 | 68.81 | 68.18 | 66.67 | 67.04 | 63.07 | - | - | - | - | - | - | - | - |
| 27-Oct-08 | 69.09 | 69.12 | 68.33 | 66.98 | 67.28 | 64.22 | 60.14 | 66.80 | 56.38 | 66.73 | - | - | - | - |
| 27-Jan-09 | 68.43 | 69.49 | 68.97 | 68.04 | 68.43 | 60.99 | 59.42 | 67.81 | 49.09 | 65.17 | - | - | - | - |
| 14-Apr-09 | 69.38 | 69.39 | 69.07 | 68.84 | 67.60 | 61.31 | 69.01 | 67.99 | 68.97 | 67.86 | - | - | - | - |
| 21-Jul-09 | 68.77 | 68.78 | 68.19 | 66.78 | 66.80 | 64.86 | 59.20 | 66.64 | 60.75 | 66.67 | - | - | - | - |
| 07-Nov-09 | 68.59 | 68.61 | 67.46 | 66.24 | 66.37 | 59.84 | 61.89 | 66.31 | 51.15 | 66.25 | - | - | - | - |
| 26-Jan-10 | 70.04 | 72.97 | 69.33 | 68.65 | 68.74 | 62.14 | 59.75 | 68.60 | 52.34 | 65.10 | - | - | - | - |
| 06-Apr-10 | 69.98 | 69.97 | 69.24 | 68.39 | 68.59 | 62.09 | 61.41 | 68.13 | 55.88 | 65.08 | - | - | - | - |
| 14-Apr-10 | - | - | - | 67.98 | 68.77 | - | - | - | - | - | - | - | - | - |
| 20-Jul-10 | 69.10 | 68.93 | 68.30 | 67.15 | 67.20 | 63.74 | 66.88 | 66.92 | 55.44 | 66.77 | - | - | - | - |
| 10-Aug-10 | 68.79 | 68.79 | 68.06 | - | - | 63.46 | - | - | - | - | - | - | - | - |
| 16-Nov-10 | 69.96 | 69.83 | 69.07 | 69.38 | 69.21 | 66.11 | 69.59 | 67.84 | 69.39 | 65.02 | - | - | - | - |
| 06-Dec-10 | 69.92 | 69.91 | 69.16 | 69.46 | 69.32 | 65.17 | - | - | - | - | - | - | - | - |
| 08-Feb-11 | 69.84 | 69.79 | 69.30 | 69.37 | 69.02 | 66.04 | 69.91 | 68.17 | 69.69 | 65.17 | - | - | - | - |
| 09-May-11 | 69.44 | 69.45 | 68.91 | 69.08 | 68.65 | 61.74 | 70.17 | 67.92 | 69.30 | 67.51 | - | - | - | - |
| 26-Jul-11 | 68.92 | 68.85 | 68.27 | 67.91 | 67.42 | 63.83 | 68.58 | 67.09 | 68.44 | 67.12 | - | - | - | - |
| 08-Nov-11 | 69.44 | 69.43 | vandalized | 68.98 | 68.50 | 65.33 | 69.05 | 67.60 | 69.01 | 67.45 | - | - | - | - |
| 24-Jan-12 | 69.84 | 69.79 | - | 69.55 | 69.08 | 61.94 | 70.04 | 68.51 | 69.84 | 65.61 | - | - | - | - |
| 08-May-12 | 69.44 | 69.45 | - | 68.93 | 68.34 | 61.23 | 69.58 | 67.99 | 69.50 | 67.75 | - | - | - | - |
| 31-Jul-12 | 68.92 | 68.85 | - | 67.83 | 67.69 | 63.68 | 68.50 | 67.09 | 66.69 | 68.42 | - | - | - | - |
| 25-Oct-12 | 69.44 | 69.43 | - | 67.59 | 67.26 | 64.21 | 68.05 | 66.67 | 68.01 | 65.12 | - | - | - | - |
| 16-Jan-13 | 70.24 | 70.22 | - | 69.38 | 69.00 | 47.91 | 69.68 | 67.88 | 69.36 | 65.92 | - | - | - | - |
| 15-Apr-13 | 69.51 | 69.50 | - | 69.28 | 68.80 | 61.54 | 69.75 | 68.60 | 69.59 | 68.64 | - | - | - | - |
| 10-Jul-13 | 68.81 | 68.83 | - | 68.13 | 67.80 | 60.22 | 68.67 | 67.26 | 68.49 | 67.25 | - | - | - | - |
| 13-Oct-13 | 68.67 | 68.71 | - | 68.86 | 68.67 | 61.10 | 69.16 | 67.80 | 69.04 | 67.27 | - | - | - | - |
| 16-Jan-14 | 69.74 | 69.74 | - | 69.22 | 68.92 | 62.04 | 69.44 | 67.95 | 69.32 | 67.73 | 68.34 | 69.50 | 70.57 | 77.54 |
| 12-May-14 | 69.44 | 69.47 | - | 68.78 | 68.50 | 60.92 | 69.20 | 68.60 | 68.72 | 67.53 | 68.28 | 69.40 | 74.37 | 74.14 |
| 14-Aug-14 | 69.00 | 68.96 | - | 65.97 | 66.58 | 59.72 | 56.01 | 65.96 | 51.66 | 65.89 | 69.95 | 69.74 | 74.37 | 74.14 |
| 03-Nov-14 | 69.66 | 69.43 | - | 69.24 | 70.12 | 62.21 | 68.92 | 68.39 | - | - | 69.99 | 69.89 | 78.85 | 74.39 |
| 15-Jan-15 | 69.44 | 67.47 | - | 69.38 | 69.30 | 61.92 | 69.65 | 68.15 | 69.49 | 66.24 | *61.99* | 70.66 | 78.77 | *63.84* |
| 21-Apr-15 | 69.40 | 69.40 | - | 69.02 | 68.87 | 61.12 | 68.73 | 68.63 | 69.60 | 68.65 | *62.20* | 70.67 | 78.57 | *57.97* |
| 16-Jul-15 | 69.47 | damaged | - | 67.96 | 67.84 | 59.47 | 68.12 | 66.28 | - | - | *58.56* | 69.82 | *56.61* | *56.61* |
| 29-Jul-15 | - | - | - | - | - | - | - | - | 67.89 | 65.18 | - | - | - | - |
| 22-Oct-15 | - | - | - | - | - | - | - | - | 68.37 | 65.81 | - | - | - | - |
| 20-Nov-15 | 70.07 | - | - | - | - | 61.92 | 69.57 | - | - | - | *63.34* | 71.17 | *62.27* | *58.58* |
| 23-Nov-15 | - | - | - | 69.06 | 68.96 | - | - | 67.60 | - | - | - | - | - | - |

H:\Project\1005\Analysis\Water_Elevations\2015\[Tables-2015.xlsx]Tab A-3 MW02,05,13

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.

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

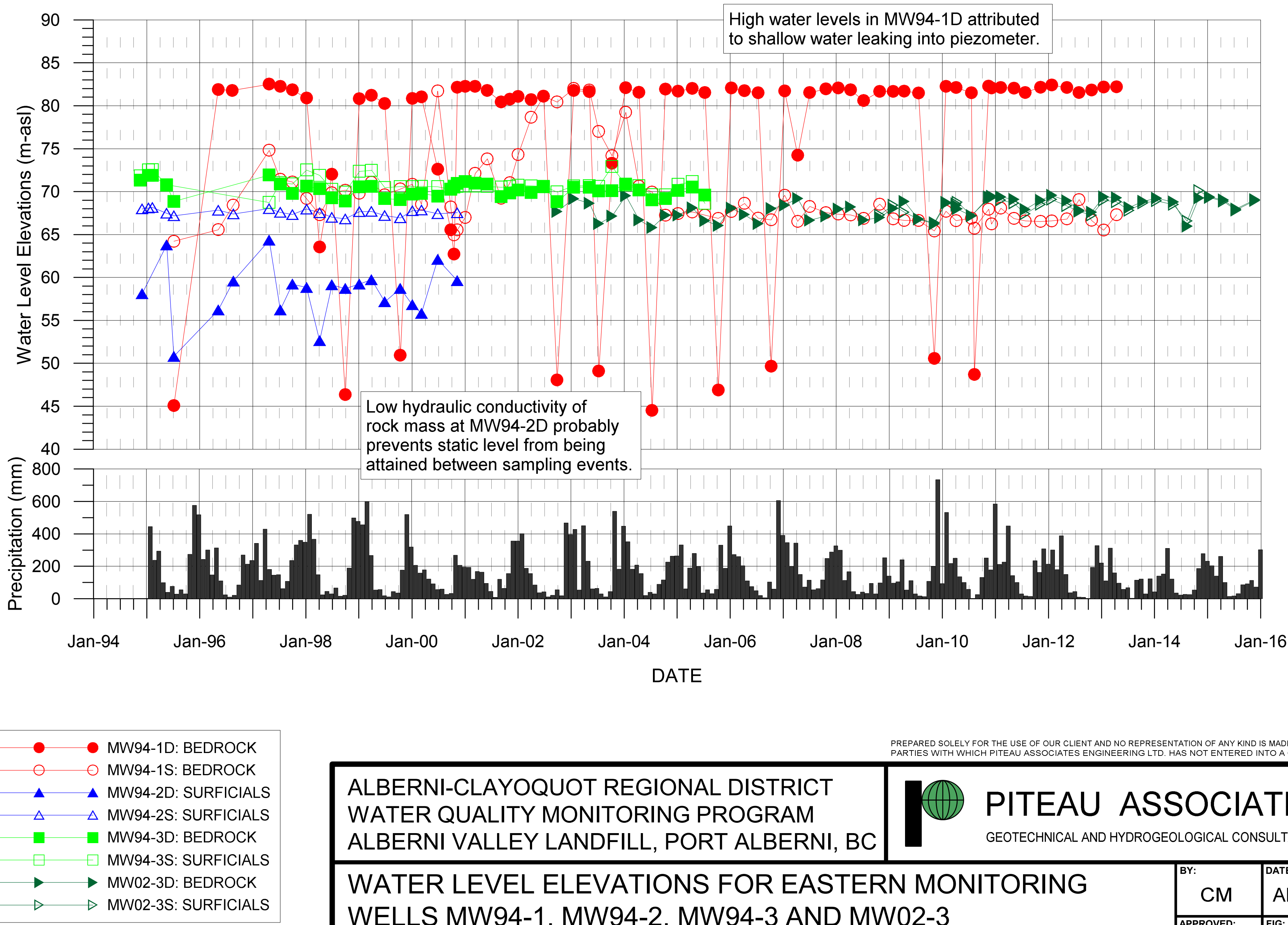
| | MW09-01 | MW09-02 | MW09-03 | MW09-04 | MW09-05 | MW09-06 | MW09-07 | MW09-08 | MW09-09 | MW09-10 | MW09-11 | MW09-12 | MW09-13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Elev. | 73.38 | 73.99 | 74.61 | 75.52 | 71.41 | 77.50 | 76.43 | 77.99 | 77.38 | 71.75 | 77.47 | 77.16 | 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 | 73.71 | 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 | - | 68.72 |
| 30-Nov-15 | 72.09 | 73.11 | 72.82 | 73.55 | inaccessible | inaccessible | inaccessible | inaccessible | inaccessible | <69.1 | inaccessible | inaccessible | 68.93 |

NOTES:

H:\Project\1005\Analysis\Water_Elevations\2015\[Tables-2015.xlsx]Table A-4 2009

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.



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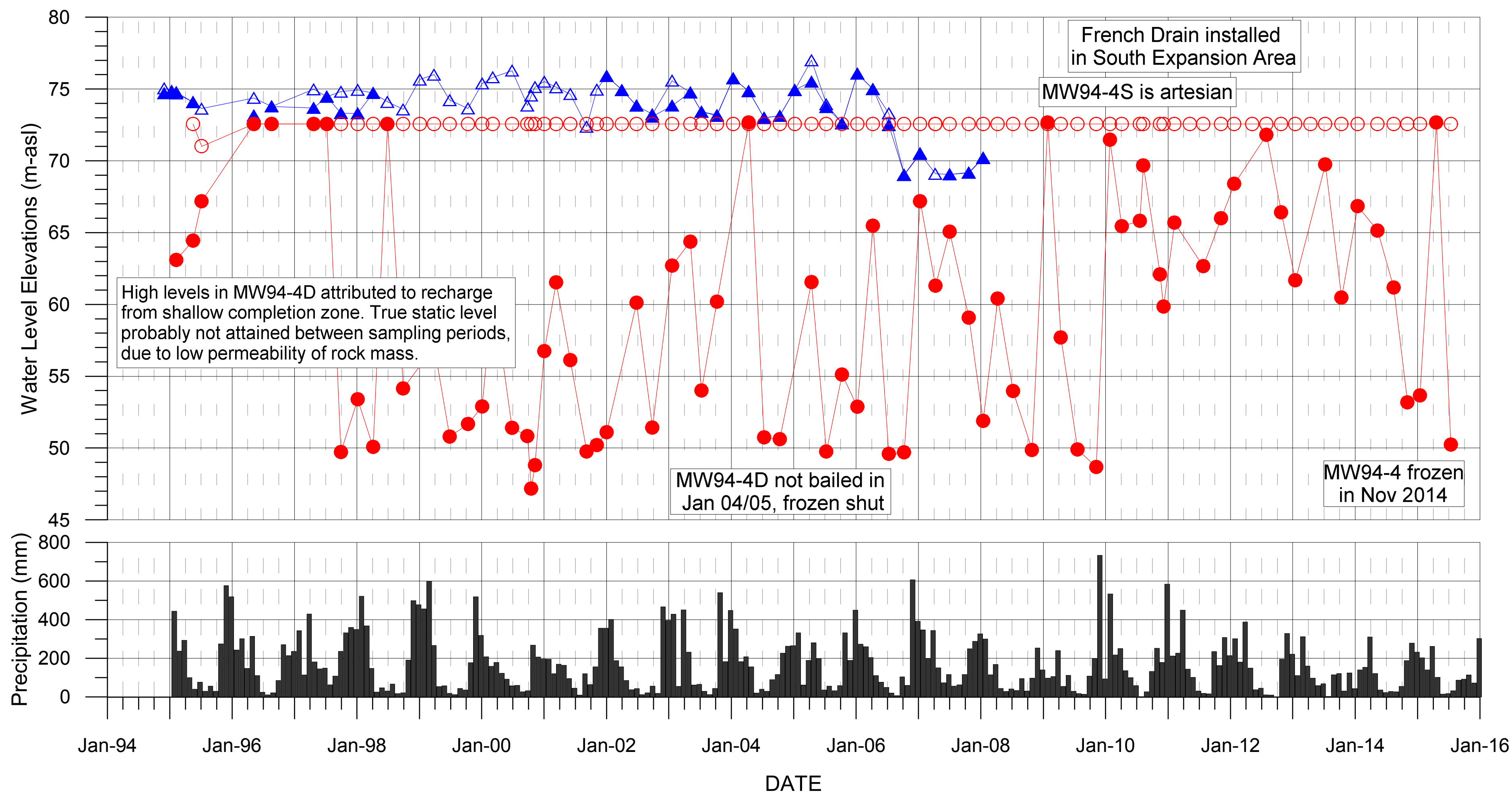
# WATER LEVEL ELEVATIONS FOR EASTERN MONITORING WELLS MW94-1, MW94-2, MW94-3 AND MW02-3

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: | FIG: |
| ATH | A-1 |

H:\Project\1005\Analysis\Water_Elevations\2015\2-WL4-7D.grf



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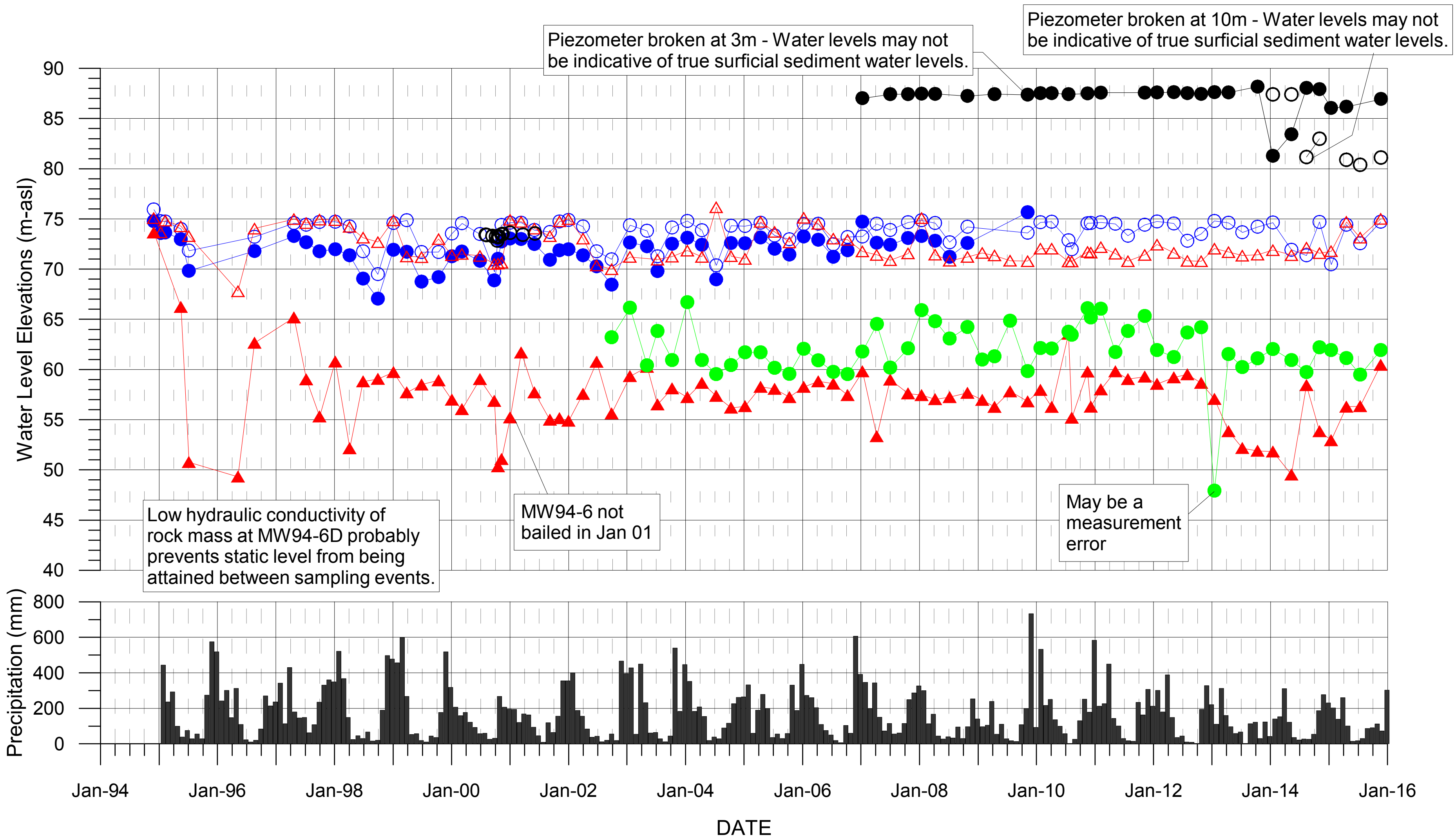
WATER LEVEL ELEVATIONS FOR SOUTHERN MONITORING WELLS MW94-4 AND MW94-7

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: | FIG: |
| ATH | A-2 |

H:\Project\1005\Analysis\Water_Elevations\2015\3-WL5-6D.grf




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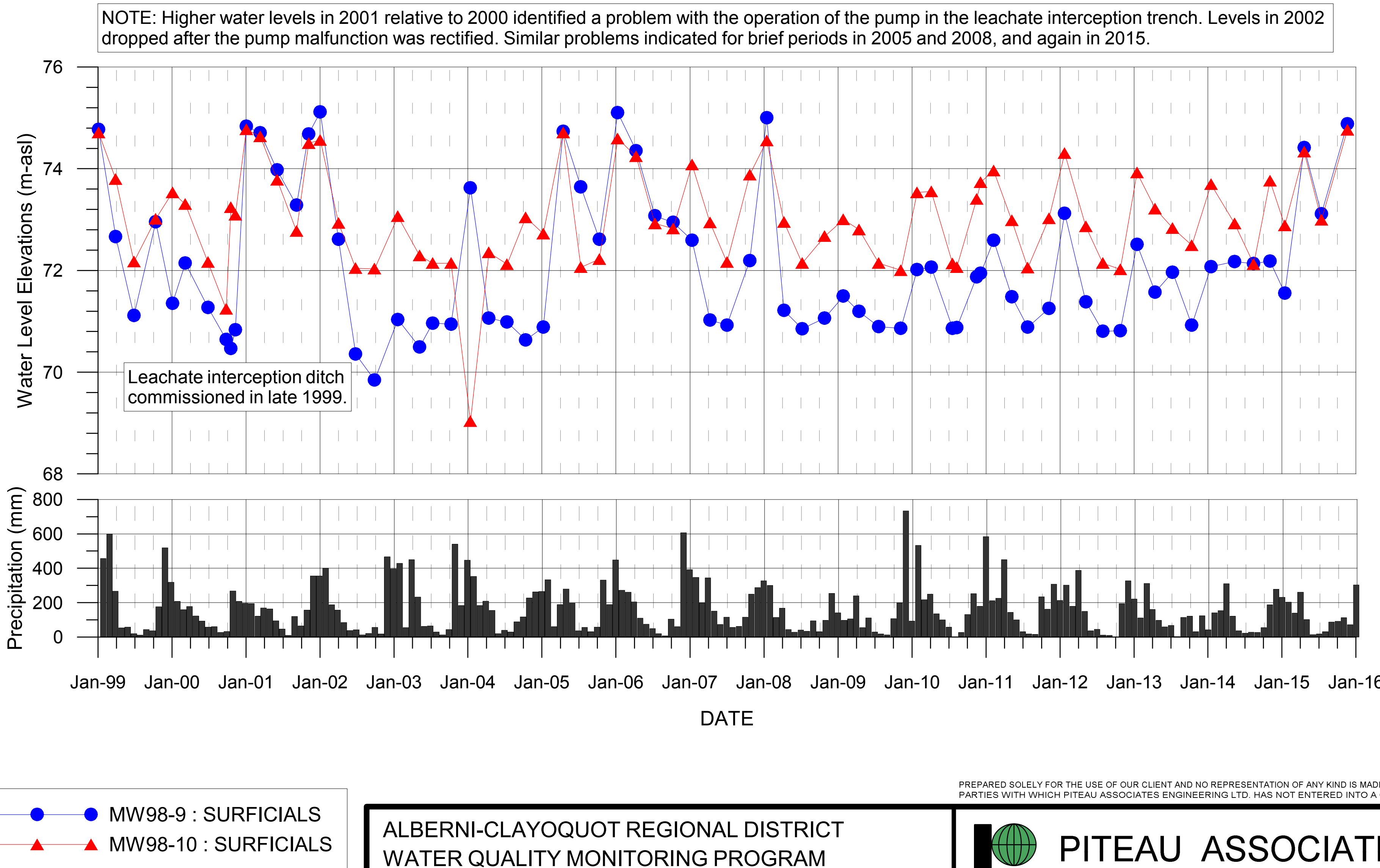
# WATER LEVEL ELEVATIONS FOR NORTHERN MONITORING WELLS MW94-5, MW94-6 AND MW02-4 AND LANDFILL MONITORING WELLS BH00-1C AND BH00-2C

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: | FIG: |
| ATH | A-3 |

H:\Project\1005\Analysis\Water_Elevations\2015\4-WL98.grf



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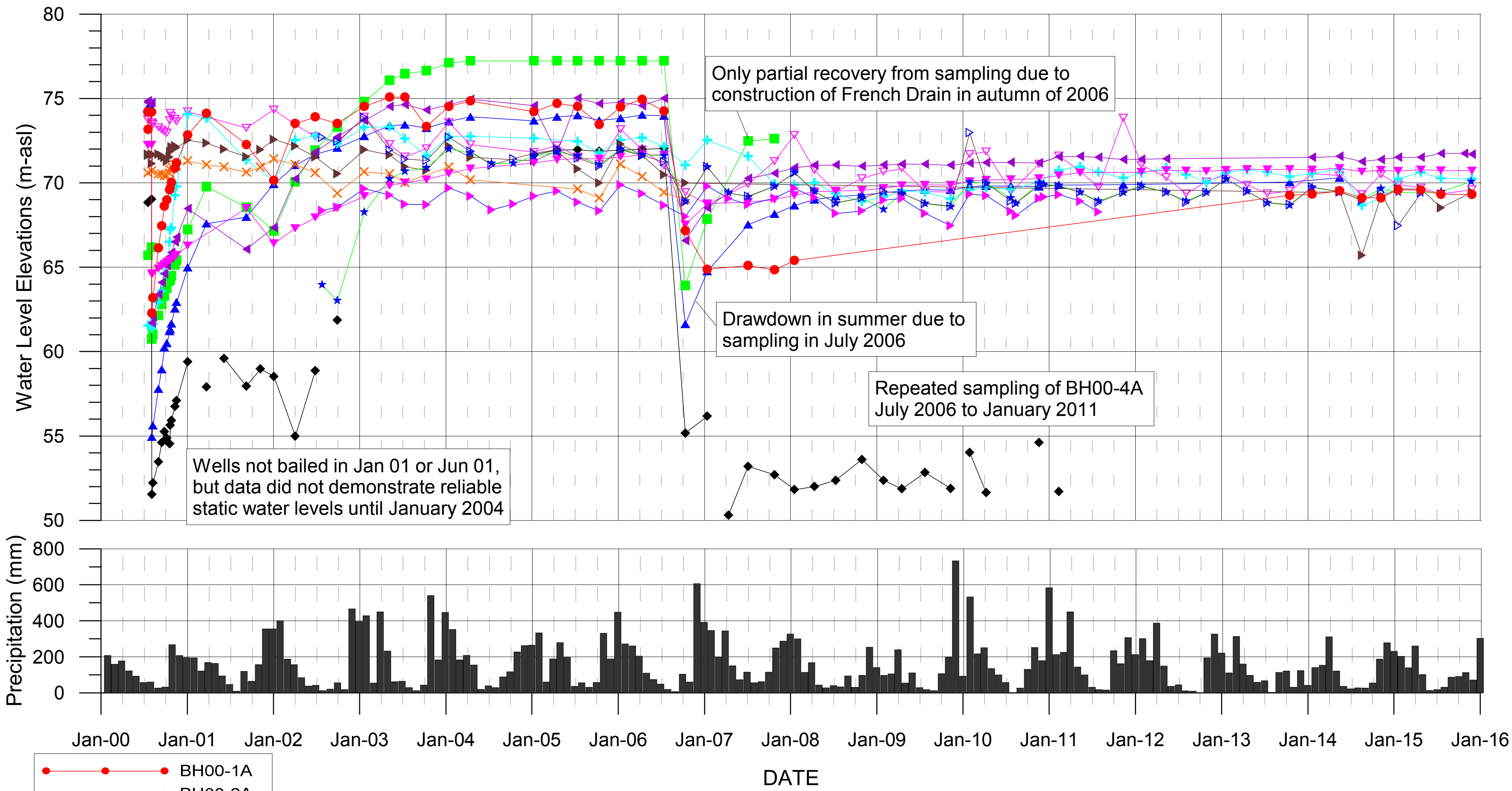
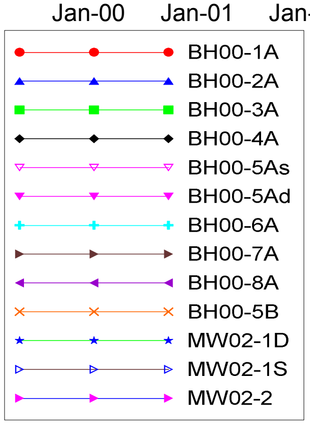
WATER LEVEL ELEVATIONS FOR NORTHERN MONITORING WELLS MW98-9 AND MW98-10

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: | FIG: |
| ATH | A-4 |

H:\Project\1005\Analysis\Water_Elevations\20155-WL00.grf



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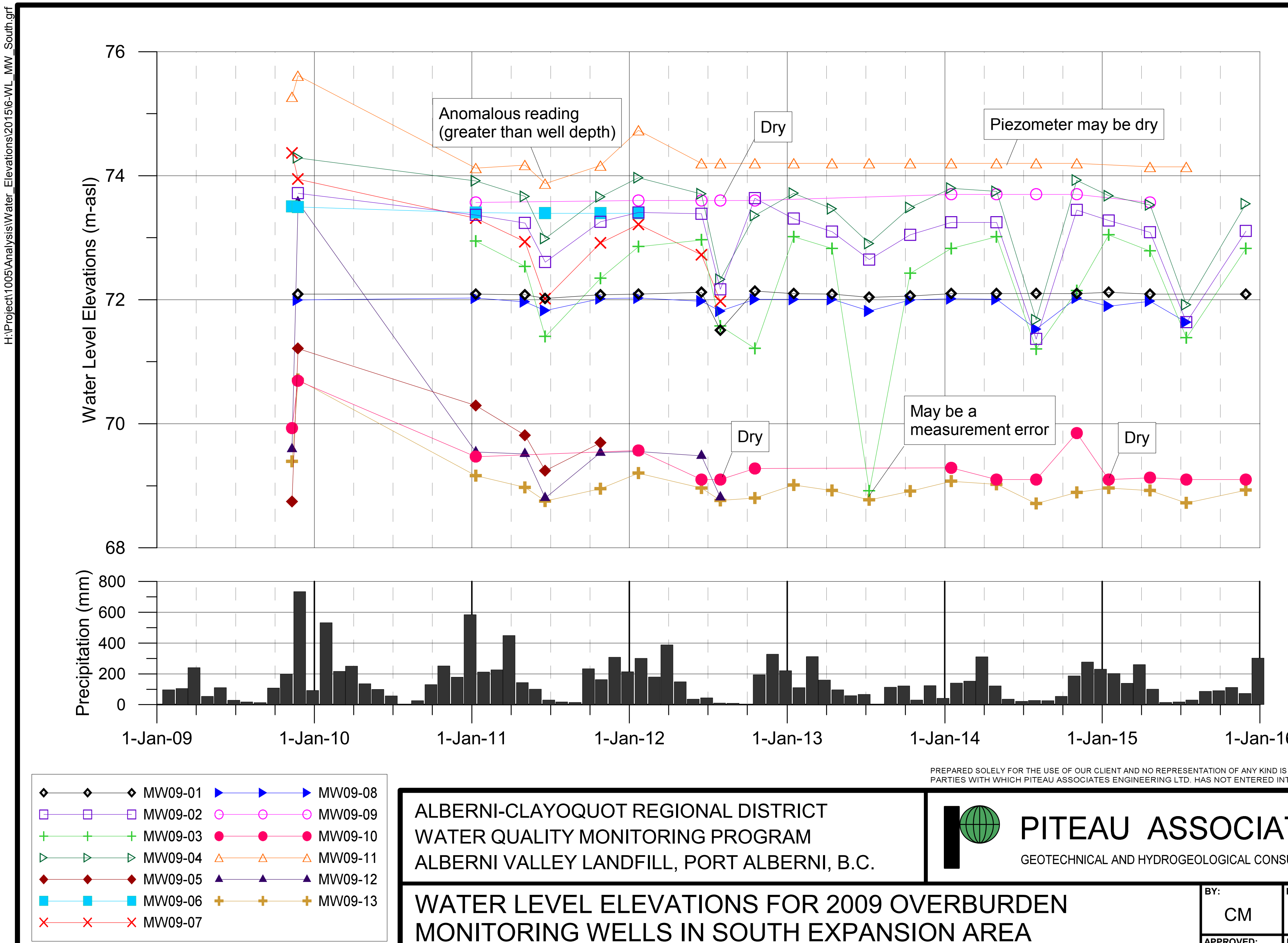
# WATER LEVEL ELEVATIONS FOR EXPANSION AREA MONITORING WELLS

| BY: CM | DATE: APR 16 |
| --- | --- |
| APPROVED: ATH | FIG: A-5 |



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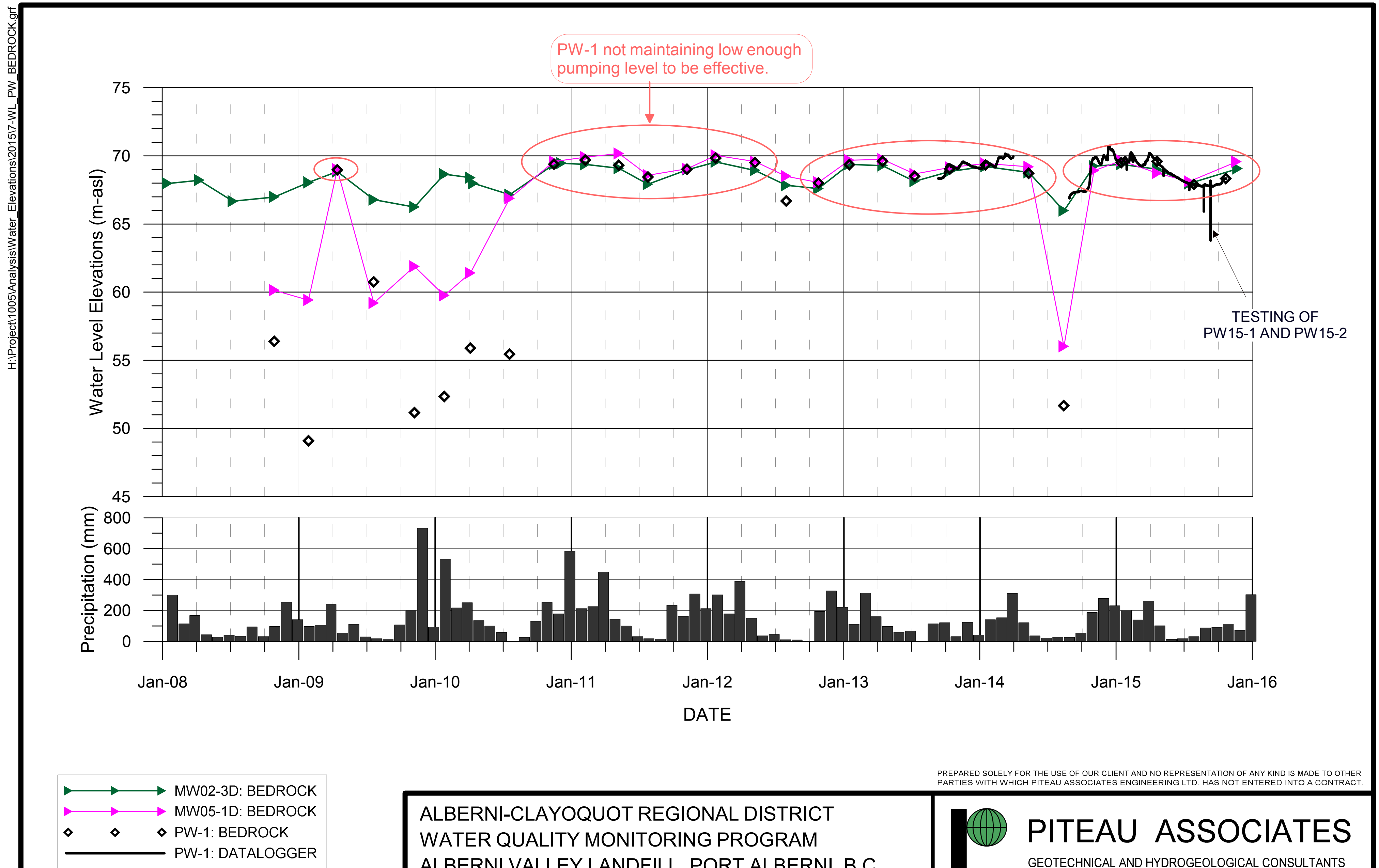
# WATER LEVEL ELEVATIONS FOR 2009 OVERBURDEN MONITORING WELLS IN SOUTH EXPANSION AREA

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: | FIG: |
| ATH | A-6 |

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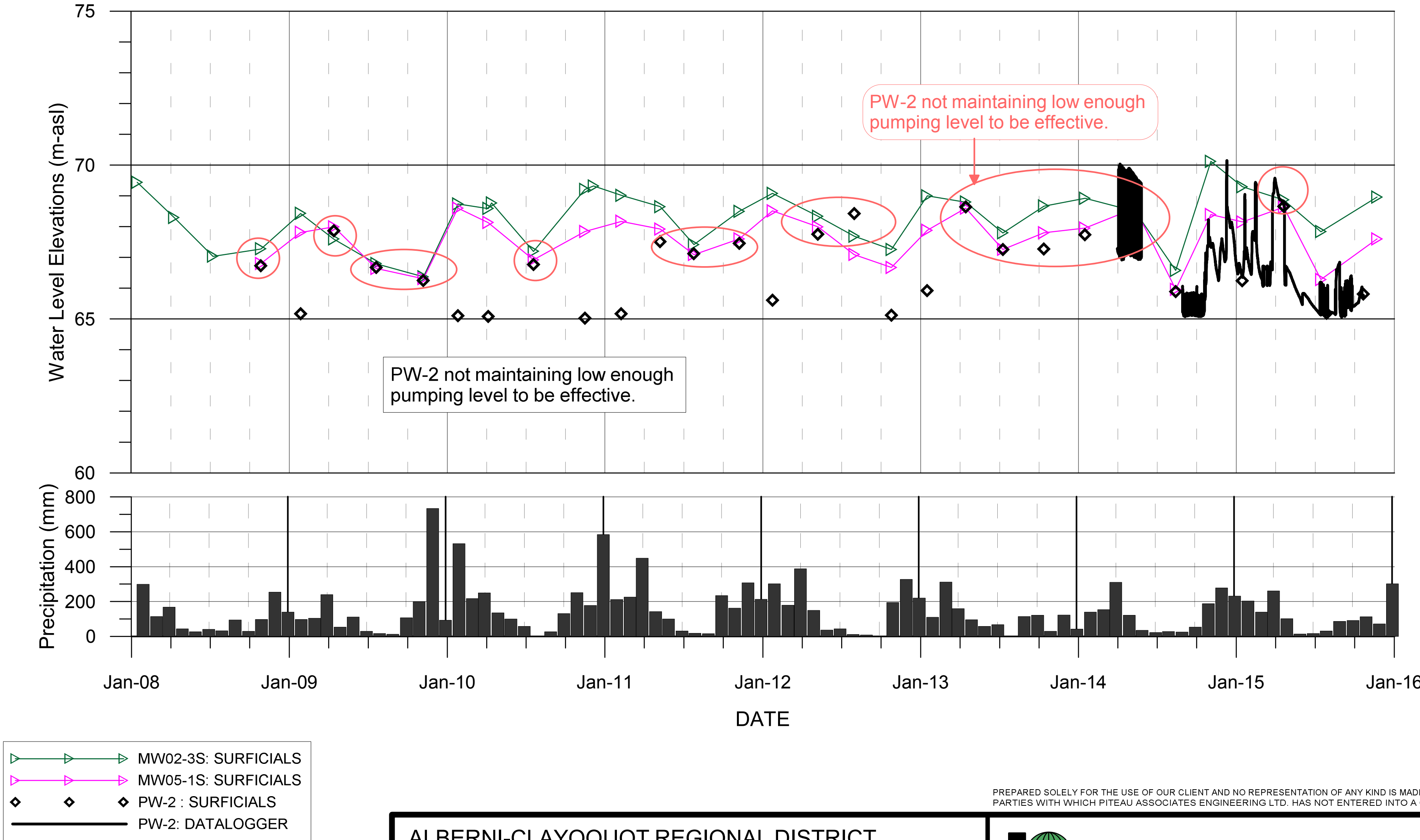
WATER LEVEL ELEVATIONS FOR BEDROCK
LEACHATE INTERCEPTION WELL MONITORING
PW-1, MW02-3D, MW05-1D

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: ATH | FIG: A-7 |



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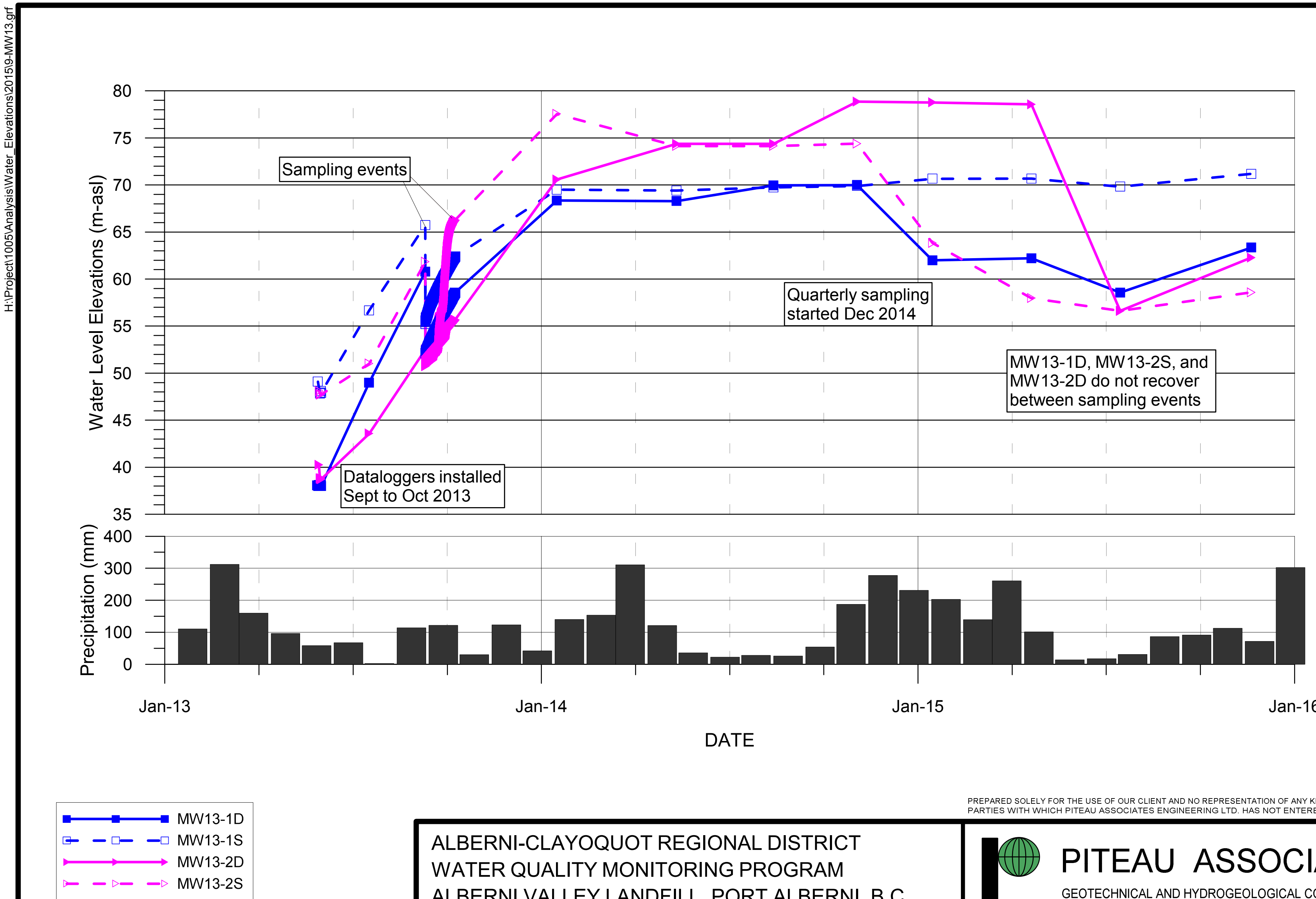
# WATER LEVEL ELEVATIONS FOR SURFICIAL SEDIMENT INTERCEPTION WELL MONITORING PW-2, MW02-3S, MW05-1S

| | |
|---|---|
| BY: CM | DATE: APR 16 |
| APPROVED: ATH | FIG: A-8 |

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

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: | FIG: |
| ATH | A-9 |

# APPENDIX B

# CHEMISTRY MONITORING DATA TABLES AND PLOTS

## APPENDIX B

## LIST OF TABLES

## LIST OF FIGURES

# TABLE B-1
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR LEACHATE DRAIN
# 2012 to 2015

| SAMPLE DATE | units | RECEIVING WATER CRITERIA | | 24-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 16-Jan-13 | 07-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 | 29-Jul-15 | 03-Dec-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | | |
| pH - Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 6.9 | 7.2 | 7.2 | 7.3 | 6.63 | 7.49 | 7.51 | - | 7.36 | 7.27 | - | 6.95 | 7.09 | 6.93 | 6.65 | - |
| pH - Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.55 | 7.23 | 7.65 | 7.02 | 7.4 | 7.2 | 7.4 | 7.3 | 7.16 | 7.27 | 7.3 | 6.57 | 7.02 | 7.31 | 7.1 | 7.36 |
| EC - Field | µS/cm | - | - | 543 | 1845 | 2170 | 770 | 1450 | 2152 | 2025 | - | 1393 | 1868 | - | 397 | 1287 | 1377 | 2081 | - |
| EC - Lab | µS/cm | - | - | 523 | 1684 | 2038 | 729 | 138 | 2210 | 2040 | 1828 | 1540 | 2160 | 2420 | 403 | 1340 | 1400 | 2080 | 1790 |
| Total Hardness ($CaCO_3$) | mg/L | - | - | 170 | 450 | 570 | 232 | 390 | 556 | 500 | 450 | 428 | 493 | 629 | 122 | 353 | 391 | 501 | 550 |
| Total Dissolved Solids | mg/L | 500 | - | 222 | **808** | **954** | 366 | **664** | **982** | **904** | **796** | **620** | **933** | **1000** | 206 | **600** | **632** | **890** | **962** |
| Temperature - Field | °C | - | - | 5.48 | 15.27 | 16.63 | 11.17 | 9.32 | 16.67 | 24.28 | - | 6.01 | 18.41 | - | 10.08 | 11.07 | 14.38 | 15.77 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | | |
| Bicarbonate | mg/L | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1040 | - |
| Chloride | mg/L | 250 | 150 | 25.3 | 88 | 119 | 36.4 | 71 | <0.05 | 104 | 90 | 75.4 | 116 | 132 | 20.9 | 58.7 | 57.2 | 108 | 121 |
| **TOTAL METALS** | | | | | | | | | | | | | | | | | | | |
| Arsenic | mg/L | 0.010 | 0.005 | 0.0003 | 0.0011 | 0.0009 | 0.00144 | 0.00122 | 0.00088 | 0.0012 | 0.0011 | 0.001 | 0.0008 | 0.0009 | 0.0007 | 0.0012 | 0.0007 | 0.0003 | 0.002 |
| Boron | mg/L | 5.0 | 1.2 | - | - | - | - | - | - | - | - | 1.15 | **1.85** | **2.01** | 0.246 | 0.942 | 0.934 | **1.46** | **1.42** |
| Cadmium | mg/L | 0.005 | 0.00061 | 0.00003 | 0.00001 | <0.00001 | 0.00005 | 0.00002 | 0.00002 | 0.00002 | <0.00001 | 0.00001 | 0.00003 | 0.00001 | 0.00005 | 0.00001 | <0.00001 | <0.00001 | 0.0002 |
| Chromium | mg/L | 0.05 | 0.001 | 0.0008 | **0.0015** | **0.0016** | **0.0017** | **0.0015** | **0.0016** | **0.0016** | **0.0016** | **0.0013** | **0.0014** | **0.0016** | **0.0025** | **0.0014** | **0.0011** | **0.0014** | **0.0043** |
| Copper | mg/L | 1 | 0.017 | 0.002 | <0.001 | <0.001 | 0.0047 | 0.0029 | 0.0008 | 0.001 | <0.001 | 0.0017 | 0.0005 | <0.0005 | 0.0095 | 0.0009 | 0.0006 | <0.0005 | 0.0075 |
| Iron | mg/L | 0.3 | 1 | **12.7** | **16.2** | **12.2** | **42.8** | **25.8** | **26.4** | **17.2** | **20.9** | **30.9** | **16.2** | **70.5** | **4.26** | **24.8** | **33** | **36.1** | **35.4** |
| Lead | mg/L | 0.01 | 0.023 | 0.0001 | <0.0001 | <0.0001 | 0.0007 | 0.0002 | <0.0001 | <0.0001 | <0.0001 | 0.00004 | <0.00005 | <0.00005 | 0.00035 | 0.00005 | 0.00005 | <0.00005 | 0.00048 |
| Manganese | mg/L | 0.05 | 2.47 | **0.858** | **2.74** | **2.36** | **1.75** | **2.49** | **2.6** | **2.11** | **2.73** | **3.26** | **2.04** | **2.49** | **1.51** | **2.88** | **2.75** | **2.34** | **11.6** |
| Mercury | µg/L | 1 | 0.02 | <0.01 | <0.01 | <0.01 | <0.01 | <0.1 | <0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | **0.03** | <0.01 | <0.01 | 0.01 | **0.04** |
| Zinc | mg/L | 5 | 0.26 | 0.005 | 0.003 | 0.002 | 0.0147 | 0.0059 | 0.0123 | 0.002 | 0.003 | <0.005 | <0.005 | <0.005 | 0.023 | <0.005 | <0.005 | <0.005 | 0.047 |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | 0.71 | 0.09 | 0.83 | 1.22 | 0.22 | 0.21 | 0.48 | 0.09 | 0.294 | 0.12 | 0.446 | 0.146 | <0.005 | 0.556 | 0.115 | <0.005 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | **14.1** | **77** | **93** | **24.6** | **68.7** | **72.7** | **86.6** | **80** | **54** | **88** | **3.4** | **9** | **48** | **50** | **93** | **70** |
| Total Phosphorus | mg/L as P | - | - | 0.029 | 0.047 | 0.043 | 0.024 | 0.052 | 0.045 | 0.04 | 0.051 | 0.09 | 0.049 | 0.024 | 0.093 | 0.065 | - | 0.045 | - |
| **POLLUTANT TESTS** | | | | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | 40 | 110 | 120 | 62 | 73 | 118 | 96 | 81 | 78 | 90 | 110 | 150 | 70 | 60 | 101 | 534 |
| Total Organic Carbon | mg/L as O | - | - | 8.5 | 27.4 | 33.7 | 10 | 22.6 | 33.8 | 30.7 | 26.4 | 21.2 | 30.1 | 35 | 47.7 | 17.1 | 111 | 31 | 178 |

H:\Project\1005\Analysis\Chemistry\2015\[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, October 2014). 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"). Accessed June 2015.
   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 400 mg/L.
3. Anomalous chloride value measured in laboratory for 7-May-13 sample assumed to be erroneous.

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

| SAMPLE DATE | 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | CANTEST | CANTEST | CANTEST | CANTEST | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | |
| pH - Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | **-** | **-** | **-** | **6.45** | 7.03 | 7.39 | **-** |
| pH - Lab | pH | 6.5 - 8.5 | 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** | | | | | | | | | | |
| Chloride | mg/L | 250 | 150 | **221** | 131 | 125 | **154** | 27.2 | 23.9 | 37 |
| **METALS** | | | | Dissolved | Dissolved | Dissolved | Dissolved | Total | Total | Total |
| Arsenic | mg/L | 0.010 | 0.005 | 0.004 | 0.004 | **0.006** | 0.002 | **0.0059** | 0.0025 | 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 | 0.00038 | <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 | 0.009 | <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 | 0.01 | 0.012 | <0.01 | <0.001 | <0.001 | <0.001 | **0.0241** | 0.00622 | 0.00882 |
| Manganese | mg/L | 0.05 | 1.60 | **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 | 0.11 | <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 |

H:\Project\1005\Analysis\Chemistry\2015\[Tables_B-1 to B-9.xlsx]Table B-2 BH00-1C

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, October 2014). 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"). Accessed June 2015.
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 225 mg/L.

# TABLE B-3
# SUMMARY OF LEACHATE VOLATILE ORGANIC ANALYSES

| | RECEIVING WATER CRITERIA | | Leachate Drain | | | | | | | | | | | | | | | | | | | | | BH00-1C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE DATE | | | 28-Apr-05 | 18-Apr-06 | 10-Apr-07 | 23-Jan-08 | 16-Apr-08 | 23-Jul-08 | 04-Nov-08 | 03-Feb-09 | 23-Apr-09 | 28-Jul-09 | 12-Nov-09 | 08-Feb-10 | 06-Dec-10 | 08-Feb-11 | 24-Jan-12 | 24-Oct-13 | 05-Feb-14 | 21-May-14 | 21-Aug-14 | 12-Dec-14 | 28-Jan-15 | 07-May-15 | 29-Jan-15 |
| LAB NAME | GCDWQ[1] | AQUATIC LIFE[2] | CANTEST | CANTEST | CANTEST | CANTEST | CANTEST | CANTEST | CANTEST | CANTEST | CANTEST | CANTEST | CANTEST | CANTEST | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| **VOLATILE ORGANIC COMPOUNDS** | | | | | | | | | | | | | | | | | | | | | | | | | |
| Acetone | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 14 | 14 | 18 | 199 | 32 | <10 | <10 |
| Benzene | 5 | 40 | 3.7 | 1.4 | 1.9 | 2.5 | 1 | 0.5 | <0.1 | 0.6 | 0.7 | 0.7 | 0.6 | 1 | 1 | 0.5 | 0.4 | 0.5 | 0.6 | 0.9 | 0.8 | <0.5 | 0.6 | <0.5 | <0.5 |
| Bromobenzene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - | - |
| Bromochloromethane | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - | - |
| Bromodichloromethane | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.5 | <0.5 | <0.5 | <0.1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Bromoform | - | - | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.1 | <0.1 | <0.1 | <0.1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Bromomethane | - | - | <0.8 | <0.8 | <0.8 | <0.8 | <0.8 | <0.8 | <0.8 | <0.8 | <0.8 | <0.8 | <0.8 | <0.8 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| n-Butylbenzene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - | - |
| 2-Butanone | - | - | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | - | - | - | - | <10 | <10 | <10 | 258 | 27 | <10 | <10 |
| sec-Butylbenzene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - | - |
| tert-Butylbenzene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - | - |
| Carbon Tetrachloride | 5 | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Chlorobenzene | - | - | 7.3 | 3.5 | 6 | 5.3 | <0.1 | 1.6 | <0.1 | 1.2 | 1.5 | 2.1 | 1.4 | 2.7 | 2.3 | 1.6 | 1.5 | 1.9 | 2 | 2 | 3 | <1 | 2 | 1 | <1 |
| Chloroethane | - | - | <0.4 | <0.4 | <0.4 | 0.9 | 0.6 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Chloroform | - | - | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 | <0.3 | <0.5 | <0.5 | <0.5 | <0.1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Chloromethane | - | - | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 2-Chlorotoluene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - | - |
| 4-Chlorotoluene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - | - |
| Dibromochloromethane | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.5 | <0.5 | <0.5 | <0.1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 1,2-Dibromo-3-Chloropropane | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - | - |
| 1,2-Dibromoethane | - | - | <0.1 | <0.1 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | - | <0.3 | <0.3 | <0.3 | - | - | - |
| Dibromomethane | - | - | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.1 | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - | - |
| Dichloromethane | - | - | <6 | <6 | <6 | <6 | <6 | <6 | <6 | <6 | <6 | <6 | <6 | <6 | <0.1 | <10 | <10 | <10 | <1 | <1 | <1 | 1 | <1 | <1 | <1 |
| Dichlorodifluoromethane | - | - | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <1 | <1 | <1 | <1 | - | - | - | - | - | - | - |
| 1,2-Dichlorobenzene | 200 | 3 | 0.2 | <0.1 | 0.2 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <1 | <1 | <1 | <1 | <1 | <0.5 | <1 |
| 1,3-Dichlorobenzene | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| 1,4-Dichlorobenzene | 5 | 1 | **1.7** | 0.7 | **1.5** | **1.1** | <0.1 | 0.4 | <0.1 | 0.3 | 0.4 | 0.5 | <0.1 | 0.7 | 0.7 | 0.8 | 0.4 | 0.4 | 0.6 | 0.7 | 0.9 | <0.5 | 0.7 | 0.6 | <0.5 |
| 1,1-Dichloroethane | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 1,2-Dichloroethane | 5 | - | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.5 | <0.5 | <0.5 | <0.5 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 1,1-Dichloroethene | 14 | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.5 | <0.5 | <0.5 | <0.5 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| cis-1,2-Dichloroethene | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| trans-1,2-Dichloroethene | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 1,2-Dichloropropane | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 1,3-Dichloropropane | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - | - |
| 2,2-Dichloropropane | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <1 | <1 | <1 | - | - | - | - | - | - | - |
| 1,1-Dichloropropene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - | - |
| cis-1,3-Dichloropropene | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| trans-1,3-Dichloropropene | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Ethylbenzene | 140 | 1.6 | 0.2 | <0.1 | <0.1 | 0.7 | **2.3** | <0.1 | <0.1 | <0.1 | <0.1 | 0.8 | 0.3 | 0.2 | 0.6 | <0.1 | <0.1 | <0.1 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Hexachlorobutadiene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | - | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 |
| 2-Hexanone | - | - | <5 | <5 | <20 | <20 | <20 | <20 | <20 | <20 | <20 | <20 | <20 | <20 | - | - | - | - | - | - | - | - | - | - | - |
| p-Isopropyltoluene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - | - |
| Methyl t-Butyl Ether | 20 | 440 | - | - | - | - | - | - | - | - | - | - | - | - | - | 1.7 | 0.4 | 0.6 | 1 | 1 | 1 | <1 | <1 | <1 | <1 |
| Naphthalene | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | 0.6 | <0.5 | - | <0.3 | <0.2 | <0.3 | <0.3 | <0.3 | <0.3 |
| iso-Propylbenzene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | 0.2 | 0.1 | - | - | - | - | - | - | - |
| n-Propylbenzene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - | - |
| 4-Methyl-2-pentanone | - | - | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | <2 | - | - | - | - | <10 | <10 | <10 | <10 | <10 | <10 | <10 |
| Styrene | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | 0.7 | <0.1 | <0.1 | <0.1 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| 1,1,2,2-Tetrachloroethane | - | - | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.1 | <0.1 | <0.1 | <0.1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 1,1,1,2-Tetrachloroethane | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Tetrachloroethene | 5 | 111 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.5 | <0.5 | <0.5 | <0.5 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Toluene | 60 | 24 | <0.1 | 1.9 | 2 | 12 | 2.8 | <0.1 | <0.1 | <0.1 | <0.1 | 3.1 | 1.8 | 0.8 | 0.1 | <0.1 | <0.1 | <0.1 | <0.5 | <0.5 | <0.5 | 8.5 | 0.8 | <0.5 | <0.5 |
| 1,2,3-Trichlorobenzene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - | - |
| 1,2,4-Trichlorobenzene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 1,1,1-Trichloroethane | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 1,1,2-Trichloroethane | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Trichloroethene | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.5 | <0.5 | <0.5 | <0.5 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| Trichlorofluoromethane | - | - | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.1 | <0.1 | <0.1 | <0.1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| 1,2,3-Trichloropropane | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - | - |
| 1,2,4-Trimethylbenzene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - | - |
| 1,3,5-Trimethylbenzene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - | - |
| Vinyl Chloride | 2 | - | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.5 | <0.5 | <0.5 | <0.5 | <1 | <1 | <1 | <1 | <1 | <1 | <1 |
| m&p-Xylene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Xylenes | 90 | 20 | 1.4 | 0.3 | 0.7 | 2.1 | 0.4 | <0.1 | <0.1 | 0.2 | <0.1 | 3.9 | 0.7 | 0.5 | 1.3 | <0.1 | <0.1 | <0.1 | - | <1 | <1 | <1 | - | - | - |

H:\Project\1005\Analysis\Chemistry\2015\[Tables_B-1 to B-9.xlsx]Table B-3 LeachateOrganic

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, October 2014). 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"). Accessed June 2015.

# TABLE B-4
# SUMMARY OF LEACHATE PHENOL AND ACID EXTRACTABLE ANALYSES

| | | | | Leachate Drain | | | | | | | | | | | | | | | | | BH00-1C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE DATE | RECEIVING WATER CRITERIA | | | 19-Oct-05 | 18-Apr-06 | 10-Apr-07 | 04-Nov-08 | 03-Feb-09 | 23-Apr-09 | 28-Jul-09 | 12-Nov-09 | 08-Feb-10 | 14-Apr-10 | 08-Feb-11 | 24-Jan-12 | 21-May-14 | 21-Aug-14 | 12-Dec-14 | 28-Jan-15 | 07-May-15 | 29-Jan-15 |
| LAB NAME | GCDWQ[1] MAC | GCDWQ[1] AO | AQUATIC LIFE[2] | CANTEST | CANTEST | CANTEST | CANTEST | CANTEST | CANTEST | CANTEST | CANTEST | CANTEST | MAXXAM | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| **ACID EXTRACTABLES** | | | | | | | | | | | | | | | | | | | | | |
| 4-Chloro-3-methylphenol | 5 | - | - | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <1 | <0.7 | - | - | - | - | - | - | - | - |
| m-Cresol | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | - | - | - | - | - | - |
| o-Cresol (2-methylphenol) | - | - | - | <2 | <2 | <2 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | - | - | <0.5 | <0.5 | - | - | - | - | - | - |
| p-Cresol (4-methylphenol) | - | - | - | <3 | <3 | <3 | 2.9 | <0.5 | <0.5 | <0.5 | 6.3 | - | - | <0.5 | <0.5 | - | - | - | - | - | - |
| m&p Cresol | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | 10 | 3.5 | <0.5 | <0.5 |
| 2,4-Dimethylphenol | - | - | - | <2 | <2 | <2 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <3 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | - | - | - |
| 4,6-Dinitro-o-cresol | - | - | - | <10 | <10 | <10 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | - | - | - | - | - | - | - | - | - | - |
| 2,4-Dinitrophenol | - | - | - | <10 | <10 | <10 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.7 | <0.5 | <0.5 | <10 | <10 | <10 | - | - | - |
| 2-Nitrophenol | - | - | - | <2 | <2 | <2 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <10 | <10 | - | - | - | - | - | - |
| 4-Nitrophenol | - | - | - | <2 | <2 | <2 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | - | - | - | - | - | - |
| Phenol | - | - | 50 | <1 | <1 | <1 | <0.5 | <0.5 | <0.5 | <0.5 | 1.4 | <0.5 | - | <2 | <2 | <1 | <1 | 7.8 | - | - | - |
| **BASE/NEUTRAL EXTRACTABLES** | | | | | | | | | | | | | | | | | | | | | |
| Acenaphthene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.31 | 0.37 | <0.3 | <0.3 | <0.3 | <0.3 |
| Acenaphthylene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.31 | <0.2 | <0.31 | <0.31 | <0.31 | <0.31 |
| Anthracene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.3 | <0.1 | <0.3 | <0.3 | <0.3 | <0.3 |
| Benzo(a)anthracene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| Benzo(b)fluoranthene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.2 | <0.1 | <0.2 | <0.2 | <0.2 | <0.2 |
| Benzo(k)fluoranthene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.2 | <0.1 | <0.2 | <0.2 | <0.2 | <0.2 |
| Benzo(g,h,i)perylene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| Benzo(a)pyrene | 0.01 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.09 | <0.01 | <0.09 | <0.09 | <0.09 | <0.09 |
| Bis(2-chloroethyl)ether | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Bis(2-chloroisopropyl)ether | 50 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Bis(2-Ethylhexyl)phthalate | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | 0.88 | <0.5 | 2.9 | <0.5 | <0.5 |
| 1,1-Biphenyl | 200 | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| p-Chloroaniline | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <1 | <1 | <1 | <1 | <1 | <1 |
| Chrysene | 5 | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | <0.27 | <0.1 | <0.27 | <0.27 | <0.27 | <0.27 |
| Dibenz(a,h)anthracene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.2 | <0.2 | <0.2 | - | - | - |
| 3,3'-dichlorobenzidine | 5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Diethyl phthalate | 14 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | 0.92 | <0.5 | <0.5 | <0.5 |
| Dimethyl phthalate | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| 2,4-Dinitrotoluene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| 2,6-Dinitrotoluene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | <0.5 | - | - | - |
| Fluoranthene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.27 | <0.2 | <0.27 | <0.27 | <0.27 | <0.27 |
| Fluorene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.31 | 0.31 | <0.31 | <0.31 | <0.31 | <0.31 |
| Hexachlorobenzene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Hexachlorobutadiene | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 |
| Hexachloroethane | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Indeno(1,2,3-cd)pyrene | 140 | - | 1.6 | - | - | - | - | - | - | - | - | - | - | - | - | <0.27 | <0.2 | <0.27 | <0.27 | <0.27 | <0.27 |
| Naphthalene | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | 0.6 | <0.3 | <0.2 | <0.3 | <0.3 | <0.3 | <0.3 |
| 2-Methylnaphthalene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.82 | <0.5 | <0.5 | <0.5 | 0.71 | <0.5 |
| Phenanthrene | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.32 | 0.15 | <0.32 | <0.32 | <0.32 | <0.32 |
| Pyrene | 20 | - | 440 | - | - | - | - | - | - | - | - | - | - | - | - | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 1,2,4-Trichlorobenzene | - | - | 1 | - | - | - | - | - | - | - | - | - | - | <0.1 | <0.1 | <1 | <1 | <1 | <1 | <1 | <1 |
| **CHLORINATED PHENOLS** | | | | | | | | | | | | | | | | | | | | | |
| 2-Chlorophenol | - | 0.1 | 11 | <1 | <1 | <1 | <1 | <1 | - | <1 | <1 | <1 | <0.8 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | - | - | - |
| 3-Chlorophenol | - | 0.1 | 9.3 | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | - | - | - | - | - | - |
| 4-Chlorophenol | - | 0.1 | 4.8 | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | - | - | - | - | - | - |
| 2,3-Dichlorophenol | - | 0.3 | 3.1 | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | - | - | - | - | - | - |
| 2,4-Dichlorophenol | 900 | 0.3 | 1.6 | <1 | <2 | <2 | <1 | <1 | - | <1 | <1 | <1 | - | <0.5 | <0.5 | <0.3 | <0.3 | <0.3 | - | - | - |
| 2,5-Dichlorophenol | - | 0.3 | 1.4 | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | - | - | - | - | - | - |
| 2,6-Dichlorophenol | - | 0.3 | 5.5 | - | - | - | - | - | - | - | - | - | <0.7 | <0.5 | - | - | - | - | - | - | - |
| 3,4-Dichlorophenol | - | 0.3 | 1.6 | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | - | - | - | - | - | - |
| 2,3,4-Trichlorophenol | - | 2 | 1.3 | - | - | - | - | - | - | - | - | - | <0.7 | <0.5 | <0.5 | - | - | - | - | - | - |
| 2,3,5-Trichlorophenol | - | 2 | 1.3 | - | - | - | - | - | - | - | - | - | <0.7 | <0.5 | <0.5 | - | - | - | - | - | - |
| 2,3,6-Trichlorophenol | - | 2 | 4.4 | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | - | - | - | - | - | - |
| 2,4,5-Trichlorophenol | - | 2 | 1.2 | <1 | <1 | <1 | <1 | <1 | - | <1 | <1 | <1 | <0.7 | <0.5 | <0.5 | - | - | - | - | - | - |
| 2,4,6-Trichlorophenol | 5 | 2 | 3.2 | <1 | <1 | <1 | <1 | <1 | - | <1 | <1 | <1 | <0.7 | <0.5 | <0.5 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 3,4,5-Trichlorophenol | - | 2 | 0.5 | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | - | - | - | - | - | - |
| 2,3,4,5-Tetrachlorophenol | - | 1 | 1.0 | - | - | - | - | - | - | - | - | - | <0.7 | <0.5 | <0.5 | - | - | - | - | - | - |
| 2,3,4,6-Tetrachlorophenol | 100 | 1 | 2.9 | - | - | - | - | - | - | - | - | - | <0.7 | <0.5 | - | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| 2,3,5,6-Tetrachlorophenol | - | 1 | 1.3 | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | - | - | - | - | - | - |
| Pentachlorophenol | 60 | 30 | 0.5 | <2 | <2 | <2 | <2 | <2 | - | <2 | <2 | <2 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Total Chlorinated Phenols | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.5 | <0.5 | - | - | - | - | - | - |

H:\Project\1005\Analysis\Chemistry\2015\[Tables_B-1 to B-9.xlsx]Table B-4 LeachatePhenol

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, October 2014). 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"). Accessed June 2015.

# TABLE B-5
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR SOUTH EXPANSION AREA FRENCH DRAIN
# 2012 to 2015

| SAMPLE DATE | units | RECEIVING WATER CRITERIA | | 24-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 17-Jan-13 | 09-May-13 | 16-Jul-13 | 24-Oct-13 | 05-Feb-14 | 22-May-14 | 21-Aug-14 | 29-Jan-15 | 08-May-15 | 30-Jul-15 | 03-Dec-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 6.65 | 7 | 6.8 | 6.6 | 7.16 | 7.47 | 7.15 | - | 7.26 | 7.03 | - | 7.45 | 6.63 | 6.68 | - |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.23 | 7.69 | 8.24 | 6.65 | 6.7 | 6.7 | 6.6 | 6.5 | 6.89 | 6.93 | 7.06 | 6.66 | 6.89 | 7.18 | 7.7 |
| EC-Field | µS/cm | - | - | 309 | 481 | 609 | 441 | 362 | 446 | 465 | - | 389 | 389 | - | 380 | 425 | 592 | - |
| EC-Lab | µS/cm | - | - | 268 | 429 | 557 | 421 | 387 | 472 | 491 | 444 | 455 | 455 | 596 | 401 | 435 | 605 | 413 |
| Total Hardness ($CaCO_3$) | mg/L | - | - | 120 | 191 | 239 | 173 | 165 | 193 | 192 | 160 | 193 | 189 | 273 | 158 | 171 | 265 | 154 |
| Total Dissolved Solids | mg/L | 500 | - | 152 | 252 | 350 | 236 | 204 | 266 | 270 | 232 | 233 | 278 | 335 | 190 | 228 | 363 | 220 |
| Temperature-Field | °C | - | - | 6.15 | 8.82 | 13.49 | 12.42 | 7.3 | 9.39 | 10.99 | - | 9.24 | 10.46 | - | 9.22 | 16.74 | 14.08 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | |
| Chloride | mg/L | 250 | 150 | 8.4 | 13.3 | 22.2 | 16.4 | 8.5 | 24.3 | 16.2 | 13.6 | 11.9 | 13 | 23.2 | 9.33 | 9.5 | 21.3 | 9.72 |
| Sulphate | mg/L | 500 | 100 | 7.8 | 31.8 | 25.6 | 10.7 | 26.7 | 33 | 15.5 | 10 | 16.2 | 15.6 | 18.6 | 25.5 | 17.7 | 20.8 | 15.1 |
| **DISSOLVED CATIONS** | | | | | | | | | | | | | | | | | | |
| Calcium | mg/L | - | - | 38.3 | 62.9 | 78.3 | 56.5 | 54.4 | 62.9 | 62.5 | 51.2 | 62.9 | 61 | 89.5 | 51.3 | 55.4 | 85.5 | 49.4 |
| Magnesium | mg/L | - | - | 5.5 | 8.4 | 10.5 | 7.85 | 7.16 | 8.72 | 8.7 | 7.77 | 8.81 | 8.86 | 12 | 7.23 | 7.87 | 12.5 | 7.33 |
| Potassium | mg/L | - | - | 2.9 | 3.2 | 3.9 | 3.5 | 4 | 3.9 | 3.6 | 3.3 | - | - | - | - | - | - | - |
| Sodium | mg/L | 200 | - | 10.3 | 13.8 | 19.4 | 16.7 | 12 | 15.6 | 16.7 | 16.7 | 16.8 | 14.3 | 21.9 | 11.5 | 13.8 | 21.4 | 17.5 |
| **DISSOLVED METALS** | | | | | | | | | | | | | | | | | | |
| Arsenic | mg/L | 0.010 | 0.005 | <0.0002 | <0.0002 | <0.0002 | 0.0002 | <0.0002 | <0.0002 | <0.0002 | 0.0003 | 0.0001 | <0.0001 | <0.0001 | <0.0001 | 0.0001 | 0.0001 | 0.0001 |
| Barium | mg/L | 1 | 1 | 0.022 | 0.036 | 0.042 | 0.033 | 0.03 | 0.035 | 0.036 | 0.033 | 0.0323 | 0.031 | 0.0397 | 0.0297 | 0.0294 | 0.0422 | 0.027 |
| Boron | mg/L | 5 | 1.2 | 0.159 | 0.205 | 0.264 | 0.242 | 0.197 | 0.236 | 0.222 | 0.247 | 0.224 | 0.226 | 0.239 | 0.194 | 0.275 | 0.326 | 0.205 |
| Cadmium | mg/L | 0.005 | 0.00035 | 0.00004 | 0.00005 | 0.00002 | 0.00007 | 0.00013 | 0.00006 | 0.00006 | 0.00006 | 0.00007 | 0.00006 | 0.00002 | 0.00004 | 0.00006 | 0.00007 | 0.00004 |
| Chromium | mg/L | 0.05 | 0.001 | 0.0007 | 0.0006 | **0.0028** | **0.0032** | **0.0021** | **0.0014** | **0.005** | 0.0006 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Cobalt | mg/L | - | 0.05 | 0.00058 | 0.0039 | 0.00165 | 0.00165 | 0.00137 | 0.00092 | 0.00108 | 0.00083 | 0.00066 | 0.00067 | 0.00082 | 0.00121 | 0.00109 | 0.00093 | 0.00068 |
| Copper | mg/L | 1 | 0.008 | 0.003 | 0.003 | 0.004 | 0.003 | 0.003 | 0.004 | 0.003 | 0.004 | 0.0033 | 0.003 | 0.0047 | 0.0023 | 0.0028 | 0.0042 | 0.003 |
| Iron | mg/L | 0.3 | 0.35 | <0.005 | 0.018 | 0.012 | 0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Lead | mg/L | 0.01 | 0.011 | <0.001 | <0.001 | <0.001 | <0.001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.00001 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| Manganese | mg/L | 0.05 | 1.49 | **1.98** | **7.32** | **8.38** | **5.21** | **2.97** | **3.18** | **3.65** | **2.8** | **2.47** | **2.05** | **2.83** | **2.21** | **2.25** | **3.03** | **1.97** |
| Mercury | µg/L | 1 | 0.02 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Vanadium | mg/L | - | - | 0.0007 | 0.0005 | 0.0016 | 0.00149 | 0.0013 | 0.00115 | 0.00093 | 0.0009 | 0.0008 | 0.0007 | 0.0008 | 0.0005 | 0.0006 | 0.0009 | 0.0007 |
| Zinc | mg/L | 5 | 0.09 | <0.01 | <0.01 | <0.01 | <0.01 | 0.001 | 0.002 | 0.001 | <0.001 | 0.001 | <0.002 | 0.035 | <0.002 | <0.002 | <0.002 | <0.002 |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | 1.08 | 0.34 | 1.14 | 1.12 | 0.63 | 1.08 | 1.14 | 0.86 | 0.877 | 0.822 | **4.86** | 0.646 | 0.976 | **3.32** | 1.47 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | **3.53** | **4.2** | **4.42** | **4.07** | **3.08** | **4.66** | **2.94** | **2.54** | **3.2** | **2.2** | **9.7** | **2.86** | **3.4** | **3.51** | **4.17** |
| **POLLUTANT TESTS** | | | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | 20 | 20 | 40 | 14 | 17 | 19 | 23 | 15 | 18 | <10 | 20 | 20 | 18 | <10 | <10 |

H:\Project\1005\Analysis\Chemistry\2015\[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, October 2014). 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"). Accessed June 2015.
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 200 mg/L.

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

| SAMPLE DATE | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND |
| **PHYSICAL TESTS** | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 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 | 6.5 - 8.5 | 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 | 100 | 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 | 0.4 | <0.005 | <0.005 | 0.027 | 0.03 | 0.024 | 0.022 | 0.022 | 0.008 | 0.008 | <0.005 |
| Lead | mg/L | 0.01 | 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 | 0.05 | 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\2015\[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, October 2014). 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. Assumes hardness averages less than 30 mg/L. Available: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#approved. Guidelines for the Protection of Fresh-Water Aquatic Life ("FWAL"). Accessed June 2015.
3. MW94-1S was decommissioned in May 2013.

## 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | CANTEST | CANTEST | CANTEST | CANTEST | CANTEST | MAXXAM | MAXXAM | NORTH ISLAND |
| **PHYSICAL TESTS** | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.87 | 7.28 | 7.18 | 7.45 | 7.46 | 7.75 | **8.7** | 7.61 |
| pH-Lab | pH | 6.5 - 8.5 | 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 | 100 | - | - | - | - | 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\2015\[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.
1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, October 2014). 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"). Accessed June 2015.
3. Sample analyzed past recommended holding time for nitrate sample collected on 10-Aug-10.
4. MW94-1D was decomissioned in May 2013.

# TABLE B-8
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW02-3S
# 2012 to 2015

| SAMPLE DATE | units | RECEIVING WATER CRITERIA | | 24-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 17-Jan-13 | 09-May-13 | 16-Jul-13 | 24-Oct-13 | 05-Feb-14 | 22-May-14 | 21-Aug-14 | 12-Dec-14 | 29-Jan-15 | 08-May-15 | 30-Jul-15 | 03-Dec-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.53 | 7.4 | 8 | 7.5 | 8.6 | 7.7 | 7.68 | - | 7.91 | 7.91 | - | 7.64 | 8.23 | 7.36 | 7.35 | - |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 8.77 | 7.91 | 8.58 | 7.54 | 7.7 | 7.7 | 7.9 | 7.6 | 7.82 | 7.9 | 7.54 | 6.52 | 7 | 7.54 | 6.94 | 7.63 |
| EC-Field | µS/cm | - | - | 138.7 | 241 | 269 | 169 | 147 | 228 | 251 | - | 205 | 243 | - | 65 | 120 | 207 | 78 | - |
| EC-Lab | µS/cm | - | - | 125 | 224 | 250 | 161 | 153 | 248 | 266 | 244 | 238 | 277 | 307 | 65 | 125 | 229 | 65 | 87 |
| Dissolved Hardness ($CaCO_3$) | mg/L | | | 71 | 121 | 130 | 83 | 84 | 126 | 124 | 112 | 122 | 136 | 151 | 30.1 | 59.2 | 108 | 28.1 | 40.9 |
| Total Dissolved Solids | mg/L | 500 | - | 56 | 122 | 148 | 90 | 82 | 148 | 160 | 130 | 123 | 185 | 168 | 35 | 63 | 105 | 48 | 38 |
| Temperature-Field | ℃ | - | - | 9.55 | 10.31 | 11.58 | 11.36 | 10.29 | 11.29 | 11.78 | - | 9.84 | 10.82 | - | 9.91 | 10.55 | 11.61 | 14.89 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | | |
| Alkalinity | mg/L | - | - | 71 | 121 | 130 | 83 | - | - | - | - | - | - | - | - | - | - | - | - |
| Bicarbonate | mg/L | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 29 | - |
| Chloride | mg/L | 250 | 150 | 3 | 2.1 | 2.7 | 0.4 | 1 | 2.11 | 2.8 | 2.6 | 3.46 | 3.3 | 4.66 | 1.4 | 0.59 | 0.37 | 0.87 | 0.35 |
| Sulphate | mg/L | 500 | 309 | 0.8 | 1 | 8.1 | 1.4 | 1 | 6.1 | 7.3 | 3.8 | 4.6 | 4.9 | 7.7 | <0.5 | 0.6 | 2.3 | 1.1 | 0.8 |
| **DISSOLVED CATIONS** | | | | | | | | | | | | | | | | | | | |
| Calcium | mg/L | - | - | 25.1 | 42.1 | 38.5 | 29 | 29.1 | 39.3 | 37.3 | 35.5 | 38.1 | 42.8 | 45 | 10.8 | 20.8 | 38 | 9.47 | 14.4 |
| Magnesium | mg/L | - | - | 2 | 3.9 | 7.8 | 2.67 | 2.86 | 6.68 | 7.63 | 5.62 | 6.62 | 7.13 | 9.26 | 0.759 | 1.77 | 3.3 | 1.09 | 1.2 |
| Potassium | mg/L | - | - | <0.1 | 0.1 | 0.5 | 0.2 | <0.1 | 0.4 | 0.4 | 0.3 | - | - | - | - | - | - | - | - |
| Sodium | mg/L | 200 | - | 1.1 | 2.5 | 4.7 | 2.5 | 1.5 | 4.2 | 5.5 | 3.9 | 4.36 | 4.8 | 5.72 | 1.18 | 2.14 | 1.99 | 1.26 | 1.4 |
| **DISSOLVED METALS** | | | | | | | | | | | | | | | | | | | |
| Arsenic | mg/L | 0.010 | 0.005 | <0.0002 | 0.0004 | 0.003 | 0.0004 | 0.0003 | 0.0011 | 0.0027 | 0.0011 | 0.0016 | 0.0011 | 0.0024 | <0.0001 | <0.0001 | 0.0002 | 0.0003 | <0.0001 |
| Barium | mg/L | 1 | 1 | 0.004 | 0.007 | 0.008 | 0.005 | 0.003 | 0.007 | 0.009 | 0.008 | 0.00629 | 0.0079 | 0.0095 | 0.0032 | 0.004 | 0.0056 | 0.0068 | 0.0079 |
| Boron | mg/L | 5 | 1.2 | 0.016 | 0.022 | 0.098 | 0.046 | 0.021 | 0.082 | 0.09 | 0.081 | 0.083 | 0.087 | 0.088 | 0.017 | 0.026 | 0.039 | 0.021 | 0.017 |
| Cadmium | mg/L | 0.005 | 0.00021 | <0.00001 | <0.00001 | <0.00001 | 0.00001 | 0.00001 | <0.00001 | <0.00001 | 0.00002 | <0.00001 | 0.00002 | <0.00001 | <0.00001 | 0.00033 | <0.00001 | <0.00001 | <0.00001 |
| Chromium | mg/L | 0.05 | 0.001 | 0.0005 | 0.0004 | 0.0008 | 0.0014 | 0.0009 | 0.0006 | <0.0004 | <0.0004 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Cobalt | mg/L | - | 0.05 | <0.00002 | 0.00005 | 0.00007 | 0.00007 | 0.00004 | <0.00002 | 0.00008 | 0.00004 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | 0.00034 | <0.00005 | <0.00005 | <0.00005 |
| Copper | mg/L | 1 | 0.004 | 0.001 | 0.002 | <0.001 | 0.004 | <0.001 | 0.001 | <0.001 | 0.001 | 0.0009 | 0.0012 | 0.0008 | 0.0019 | 0.0035 | 0.002 | 0.0027 | 0.0015 |
| Iron | mg/L | 0.3 | 0.4 | <0.005 | <0.005 | <0.005 | 0.016 | <0.005 | <0.005 | <0.005 | <0.005 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Lead | mg/L | 0.01 | 0.006 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.00001 | <0.00005 | <0.00005 | <0.00005 | 0.00035 | <0.00005 | <0.00005 | <0.00005 |
| Manganese | mg/L | 0.05 | 1.05 | <0.001 | 0.002 | 0.068 | <0.001 | 0.001 | <0.001 | 0.0011 | <0.001 | <0.001 | <0.001 | 0.029 | 0.001 | 0.001 | <0.001 | 0.004 | 0.001 |
| Mercury | µg/L | 1 | 0.02 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.1 | <0.01 | <0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Vanadium | mg/L | - | - | 0.001 | 0.0012 | 0.0014 | 0.00188 | 0.00115 | 0.0017 | 0.00095 | 0.00144 | 0.0011 | 0.0011 | 0.0006 | 0.0012 | 0.001 | 0.001 | 0.0008 | 0.0011 |
| Zinc | mg/L | 5 | 0.0150 | 0.004 | 0.005 | 0.005 | 0.004 | <0.001 | 0.002 | 0.001 | 0.002 | <0.001 | <0.002 | 0.003 | 0.005 | 0.004 | 0.004 | 0.012 | <0.002 |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | <0.05 | 0.68 | <0.05 | 0.1 | <0.05 | 0.1 | <0.05 | 0.1 | 0.062 | 0.152 | 0.166 | 0.056 | 0.306 | 0.339 | 1.25 | 0.251 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | <0.01 | <0.01 | 0.04 | <0.01 | 0.14 | <0.01 | 0.03 | <0.02 | <0.01 | <0.01 | 0.11 | <0.01 | <0.01 | <0.01 | 0.02 | 0.02 |
| **POLLUTANT TESTS** | | | | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | <10 | <10 | 20 | <10 | 12 | 17 | <10 | 22 | 60 | 10 | 10 | 20 | 10 | <10 | 24 | <10 |

H:\Project\1005\Analysis\Chemistry\2015\[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, October 2014). 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"). Accessed June 2015.
   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 100 mg/L.

# TABLE B-9
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW02-3D
# 2012 to 2015

| SAMPLE DATE | units | RECEIVING WATER CRITERIA | | 24-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 17-Jan-13 | 09-May-13 | 16-Jul-13 | 24-Oct-13 | 05-Feb-14 | 22-May-14 | 21-Aug-14 | 12-Dec-14 | 29-Jan-15 | 08-May-15 | 30-Jul-15 | 03-Dec-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.92 | 8.1 | 7.8 | 7.9 | 8.53 | 7.77 | 7.78 | - | 7.88 | 8.02 | - | 7.24 | 8.15 | 7.65 | 7.19 | - |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 8.72 | 8.06 | 8.56 | 7.92 | 8 | 7.9 | 7.4 | 7.9 | 7.98 | 8.02 | 7.61 | 7.17 | 7.5 | 7.82 | 7.77 | 8.03 |
| EC-Field | µS/cm | - | - | 269 | 297 | 310 | 345 | 289 | 261 | 299 | 311 | 251 | 279 | - | 261 | 269 | 279 | 282 | - |
| EC-Lab | µS/cm | - | - | 240 | 258 | 283 | 318 | 292 | 280 | 315 | 311 | 293 | 331 | 299 | 286 | 292 | 294 | 296 | 313 |
| Dissolved Hardness ($CaCO_3$) | mg/L | | | 70 | 79 | 78 | 101 | 75 | 59 | 69 | 65 | 68.3 | 82 | 119 | 94.3 | 89.2 | 75.1 | 79.3 | 89.2 |
| Total Dissolved Solids | mg/L | 500 | - | 142 | 138 | 178 | 192 | 176 | 180 | 268 | 176 | 163 | 233 | 153 | 178 | 153 | 148 | 158 | 168 |
| Temperature-Field | °C | - | - | 8.98 | 9.95 | 11.65 | 13.23 | 10.27 | 10.77 | 12.2 | - | 8.31 | 11.18 | - | 11.22 | 10.38 | 11.37 | 14.6 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | | |
| Alkalinity | mg/L | - | - | 70 | 79 | 78 | 101 | - | - | - | - | - | - | - | - | - | - | - | - |
| Bicarbonate | mg/L | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 143 | - |
| Chloride | mg/L | 250 | 150 | 6.7 | 14.4 | 16 | 21.6 | 11.5 | 9.66 | 14.1 | 14.4 | 12.8 | 18.3 | 4.17 | 5.54 | 8.34 | 9.3 | 10.3 | 12 |
| Sulphate | mg/L | 500 | 309 | 5.8 | 6.9 | 7.1 | 6.6 | 6 | 6.4 | 7.2 | 7 | 6.9 | 1.4 | 4.7 | 5.8 | 6.3 | 6.4 | 5.9 | 6 |
| **DISSOLVED CATIONS** | | | | | | | | | | | | | | | | | | | |
| Calcium | mg/L | - | - | 22 | 24.6 | 24.4 | 31.3 | 23.7 | 18.3 | 21.6 | 20 | 21.4 | 25.7 | 35.8 | 28.7 | 27.4 | 22.8 | 24 | 26.7 |
| Magnesium | mg/L | - | - | 3.7 | 4.3 | 4.2 | 5.47 | 3.89 | 3.12 | 3.64 | 3.64 | 3.6 | 4.33 | 7.13 | 5.49 | 5.05 | 4.4 | 4.7 | 5.46 |
| Potassium | mg/L | - | - | 0.6 | 0.6 | 0.8 | 0.7 | 0.7 | 0.7 | 0.9 | 0.7 | - | - | - | - | - | - | - | - |
| Sodium | mg/L | 200 | - | 33.2 | 33 | 33.6 | 36.6 | 39.7 | 39.9 | 41.9 | 39.7 | 40.2 | 51.4 | 16.5 | 32 | 32.9 | 34.3 | 34.9 | 37.4 |
| **DISSOLVED METALS** | | | | | | | | | | | | | | | | | | | |
| Arsenic | mg/L | 0.010 | 0.005 | 0.0014 | 0.0011 | 0.0012 | 0.0012 | 0.0014 | 0.0017 | 0.0011 | 0.0013 | 0.0017 | 0.0009 | 0.001 | 0.0013 | 0.001 | 0.0015 | 0.0013 | 0.0011 |
| Barium | mg/L | 1 | 1 | 0.012 | 0.013 | 0.015 | 0.019 | 0.014 | 0.011 | 0.013 | 0.016 | 0.0128 | 0.0171 | 0.014 | 0.0136 | 0.0158 | 0.0133 | 0.0141 | 0.0206 |
| Boron | mg/L | 5 | 1.2 | 0.212 | 0.246 | 0.296 | 0.374 | 0.284 | 0.26 | 0.312 | 0.322 | 0.298 | 0.349 | 0.11 | 0.198 | 0.239 | 0.306 | 0.259 | 0.226 |
| Cadmium | mg/L | 0.005 | 0.00021 | 0.00008 | 0.00001 | <0.00001 | 0.00015 | 0.00002 | <0.00001 | 0.00001 | <0.00001 | 0.00002 | 0.00003 | <0.00001 | 0.00001 | <0.00001 | <0.00001 | <0.00001 | 0.00003 |
| Chromium | mg/L | 0.05 | 0.001 | 0.0006 | <0.004 | 0.0008 | **0.0019** | **0.0013** | 0.0007 | <0.0004 | <0.0004 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Cobalt | mg/L | - | 0.05 | 0.00007 | 0.00019 | 0.00026 | 0.00058 | 0.00098 | 0.00009 | 0.00018 | 0.0003 | 0.00009 | 0.00029 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | 0.00005 | 0.00025 |
| Copper | mg/L | 1 | 0.004 | <0.001 | 0.001 | 0.002 | <0.001 | <0.001 | 0.001 | <0.001 | <0.001 | 0.0009 | 0.0018 | 0.001 | 0.0008 | 0.0007 | 0.0007 | 0.001 | 0.0035 |
| Iron | mg/L | 0.3 | 0.350 | 0.006 | 0.01 | 0.017 | 0.006 | <0.005 | <0.005 | <0.005 | <0.005 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.18 |
| Lead | mg/L | 0.01 | 0.006 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.00001 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | 0.00163 | 0.00014 |
| Manganese | mg/L | 0.05 | 1.05 | <0.001 | <0.001 | <0.001 | 0.0271 | <0.001 | <0.001 | 0.0012 | 0.041 | <0.001 | 0.029 | <0.001 | <0.001 | <0.001 | 0.045 | 0.016 | **0.095** |
| Mercury | µg/L | 1 | 0.02 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.1 | <0.01 | <0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Vanadium | mg/L | - | - | 0.0011 | 0.0008 | 0.0009 | 0.00094 | 0.00121 | 0.00125 | 0.00081 | 0.0005 | 0.0008 | 0.0009 | 0.0007 | 0.001 | 0.0007 | 0.0007 | 0.0008 | 0.0006 |
| Zinc | mg/L | 5 | 0.0150 | 0.004 | 0.004 | 0.004 | 0.004 | 0.002 | 0.003 | 0.005 | 0.002 | 0.005 | 0.004 | 0.004 | 0.008 | 0.012 | 0.006 | 0.005 | 0.011 |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | 0.19 | <0.05 | 0.08 | <0.05 | 0.08 | 0.19 | <0.05 | <0.05 | <0.005 | 0.013 | 0.389 | 0.147 | 0.129 | <0.005 | 0.165 | 0.012 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | <0.01 | 0.03 | 0.11 | 0.01 | 0.18 | <0.01 | 0.93 | 0.15 | <0.01 | 0.02 | 0.09 | <0.01 | <0.01 | <0.01 | 0.63 | 0.49 |
| **POLLUTANT TESTS** | | | | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | 10 | 40 | 20 | <10 | <10 | <10 | 11 | 16 | <10 | <10 | <10 | 20 | 20 | 12 | <10 | <10 |

H:\Project\1005\Analysis\Chemistry\2015\[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, October 2014). 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"). Accessed June 2015.
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 100 mg/L.

# TABLE B-10
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW94-4S
# 2012 to 2015

| SAMPLE DATE | units | RECEIVING WATER CRITERIA | | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 16-Jan-13 | 07-May-13 | 16-Jul-13 | 23-Oct-13 | 05-Feb-14 | 21-May-14 | 21-Aug-14 | 12-Dec-14 | 28-Jan-15 | 07-May-15 | 29-Jul-15 | 03-Dec-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 9.6 | **9.7** | **9.2** | **10.49** | 7.54 | 8.22 | **-** | **10.26** | **9.58** | **-** | **10.01** | **9.83** | **9.03** | **8.64** | **-** |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 9.94 | **8.98** | **9.18** | **9.6** | **9.5** | **9.4** | **9.6** | **9.35** | **9.31** | **9.12** | **9.11** | **8.62** | **9.06** | **9.33** | **9.1** |
| EC-Field | µS/cm | - | - | 266 | 256 | 258 | 245 | 232 | 245 | - | 221 | 216 | - | 235 | 238 | 240 | 240 | - |
| EC-Lab | µS/cm | - | - | 240 | 236 | 241 | 258 | 261 | 260 | 256 | 262 | 259 | 270 | 258 | 284 | 256 | 253 | 248 |
| ORP | mV | - | - | 36.9 | 17.4 | 50.5 | -19.1 | 126 | -18.2 | - | 134.5 | -120.4 | - | -115 | - | - | - | - |
| Dissolved Hardness ($CaCO_3$) | mg/L | | | <5 | <5 | <5 | <5 | <5 | <5 | <5 | 2.47 | 4 | 3.83 | 3.87 | 3.32 | 3.66 | 3.8 | 3.4 |
| Total Dissolved Solids | mg/L | 500 | - | 158 | 200 | 180 | 158 | 176 | 156 | 164 | 153 | 208 | 150 | 170 | 155 | 170 | 148 | 148 |
| Temperature-Field | °C | - | - | 8.7 | 13.67 | 9.46 | 6.44 | 11.12 | 13.79 | - | 5.1 | 11.31 | - | 10.21 | 7.8 | 9.14 | 12.69 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | |
| Bicarbonate | mg/L | | | - | - | - | - | - | - | - | - | - | - | - | - | - | 67 | - |
| Chloride | mg/L | 250 | - | 8.2 | 8.1 | 8.6 | 7.3 | 7.06 | 7.5 | 7.5 | 7.51 | 7.52 | 8.57 | 7.11 | 7.25 | 6.36 | 8.12 | 7.26 |
| Sulphate | mg/L | 500 | 100 | 6.7 | 7.8 | 7.4 | 6.3 | 5.9 | 7 | 6.2 | 6.2 | 6.1 | 7.5 | 6.5 | 5.5 | 5.4 | 6.3 | 6.2 |
| **DISSOLVED CATIONS** | | | | | | | | | | | | | | | | | | |
| Calcium | mg/L | - | - | 1.5 | 1.5 | 1.4 | 1.61 | 1.44 | 1.34 | 1.34 | 0.988 | 1.48 | 1.4 | 1.43 | 1.33 | 1.38 | 1.42 | 1.28 |
| Magnesium | mg/L | - | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.05 | 0.074 | 0.08 | 0.073 | <0.05 | 0.053 | 0.05 | 0.05 |
| Potassium | mg/L | - | - | 0.4 | 0.4 | 0.5 | 0.3 | 0.3 | 0.3 | 0.3 | - | - | - | - | - | - | - | - |
| Sodium | mg/L | 200 | - | 54.2 | 58.9 | 56.7 | 53.4 | 58.8 | 56 | 56.7 | 55.6 | 71 | 63.4 | 65.8 | 60.2 | 57.5 | 56.7 | 59.4 |
| **DISSOLVED METALS** | | | | | | | | | | | | | | | | | | |
| Arsenic | mg/L | 0.010 | 0.005 | **0.0051** | **0.0054** | **0.0055** | **0.0054** | **0.0058** | **0.0055** | **0.0055** | **0.0096** | **0.0052** | 0.0045 | **0.0058** | **0.0053** | **0.0052** | **0.0053** | **0.0055** |
| Barium | mg/L | 1 | 1 | 0.003 | 0.004 | 0.003 | 0.004 | 0.003 | 0.003 | 0.003 | 0.00082 | 0.0037 | 0.0034 | 0.0033 | 0.0037 | 0.0027 | 0.0049 | 0.003 |
| Boron | mg/L | 5 | 1.2 | **1.606** | **1.54** | **1.526** | **1.88** | **1.58** | **1.389** | **1.58** | **1.25** | **1.61** | **1.23** | **1.81** | **1.53** | **1.51** | **1.48** | **1.51** |
| 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 | 0.00002 | <0.00001 | 0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Chromium | mg/L | 0.05 | 0.001 | <0.0004 | 0.0006 | 0.0006 | 0.0007 | 0.0004 | <0.0004 | <0.0004 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | **0.0015** | <0.0005 | <0.0005 |
| Cobalt | mg/L | - | 0.05 | <0.00002 | 0.00005 | <0.00002 | 0.00025 | <0.00002 | <0.00002 | <0.00002 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| Copper | mg/L | 1 | 0.002 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.0002 | 0.0002 | 0.0005 | 0.0004 | 0.0016 | **0.0046** | <0.0002 | **0.128** |
| Iron | mg/L | 0.3 | 0.4 | 0.026 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 | <0.01 | <0.01 |
| Lead | mg/L | 0.01 | 0.004 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.00001 | <0.00005 | 0.00005 | <0.00005 | <0.00005 | 0.0002 | <0.00005 | **0.0241** |
| Manganese | mg/L | 0.05 | 0.737 | <0.001 | <0.001 | <0.001 | 0.0023 | <0.001 | <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 | <0.01 | <0.01 | **0.02** |
| Vanadium | mg/L | - | - | 0.0008 | 0.0008 | 0.00105 | 0.00086 | 0.0009 | 0.00076 | 0.00075 | 0.0008 | 0.0007 | 0.0008 | 0.0009 | 0.0007 | 0.0007 | 0.0006 | 0.0012 |
| Zinc | mg/L | 5 | 0.0075 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.002 | <0.002 | <0.002 | <0.002 | 0.005 | <0.002 | **0.074** |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | <0.05 | 0.06 | 0.11 | <0.05 | 0.05 | 0.09 | <0.05 | 0.012 | 0.018 | 0.069 | 0.046 | 0.04 | 0.021 | 0.058 | 0.048 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | 0.08 | 0.08 | 0.11 | <0.01 | 0.05 | 0.06 | 0.05 | 0.05 | 0.09 | 0.02 | 0.02 | 0.05 | 0.05 | 0.03 | 0.06 |
| **POLLUTANT TESTS** | | | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | 10 | <10 | <10 | <10 | <10 | <10 | 13 | <10 | <10 | <10 | 20 | 10 | 12 | <10 | <10 |

H:\Project\1005\Analysis\Chemistry\2015\[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, October 2014). 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"). Accessed June 2015.
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 less than 30 mg/L.

# TABLE B-11
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW94-4D
# 2012 to 2015

| SAMPLE DATE | units | RECEIVING WATER CRITERIA | | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 16-Jan-13 | 07-May-13 | 16-Jul-13 | 23-Oct-13 | 05-Feb-14 | 21-May-14 | 21-Aug-14 | 12-Dec-14 | 28-Jan-15 | 07-May-15 | 29-Jul-15 | 03-Dec-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | **8.8** | **9.2** | 8.2 | **10.62** | 7.68 | 7.97 | **-** | **9.8** | **8.6** | **-** | **9.32** | **9.3** | 7.9 | 8.14 | **-** |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | **9.48** | 8.49 | 8.31 | **9.6** | **9.6** | **9.4** | **8.8** | **8.84** | 8.47 | 8.06 | 8.3 | 7.91 | 8.09 | 8.45 | 8.33 |
| EC-Field | µS/cm | - | - | 259 | 297 | 413 | 238 | 240 | 215 | - | 222 | 198 | - | 404 | 374 | 259 | 363 | - |
| EC-Lab | µS/cm | - | - | 238 | 255 | 384 | 260 | 265 | 283 | 385 | 262 | 235 | 467 | 434 | 419 | 262 | 372 | 410 |
| ORP | mV | - | - | 51.2 | 29.9 | 85.6 | -20.7 | 114.6 | -2.6 | - | 136.4 | -94.7 | - | -88.1 | - | - | - | - |
| Total Dissolved Solids | mg/L | 500 | - | 132 | 228 | 292 | 166 | 180 | 170 | 250 | 153 | 200 | 270 | 277 | 260 | 179 | 233 | 235 |
| Temperature-Field | °C | - | - | 8.55 | 9.76 | 8.87 | 8.19 | 10.95 | 9.55 | - | 8.06 | 9.7 | - | 9.28 | 8.72 | 9.31 | 11.33 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | |
| Bicarbonate | mg/L | | | - | - | - | - | - | - | - | - | - | - | - | - | - | 134 | - |
| Chloride | mg/L | 250 | - | 8.1 | 8.1 | 7.3 | 7.4 | 6.7 | 7.5 | 6.6 | 7.63 | 6.44 | 5.7 | 5 | 5.37 | 7.15 | 6.29 | 6.01 |
| Sulphate | mg/L | 500 | 100 | 6.7 | 24.6 | 58 | 6.7 | 5.7 | 15.2 | 49.1 | 11.3 | 15.1 | 69.6 | 66.4 | 58.3 | 10.2 | 49.1 | 62.8 |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | 0.09 | 0.26 | 0.85 | <0.05 | 0.05 | 0.14 | 0.7 | 0.113 | 0.178 | 0.879 | 0.633 | 0.576 | 0.14 | 0.558 | 0.779 |
| Ammonia Nitrogen | mg/L as N | - | 2 | <0.01 | 0.08 | 0.06 | 0.09 | <0.01 | <0.01 | <0.02 | 0.02 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.02 |

H:\Project\1005\Analysis\Chemistry\2015\[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, October 2014). 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"). Accessed June 2015.

# TABLE B-12
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW94-5S
# 2012 to 2015

| SAMPLE DATE | units | RECEIVING WATER CRITERIA | | 24-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 16-Jan-13 | 07-May-13 | 16-Jul-13 | 23-Oct-13 | 05-Feb-14 | 21-May-14 | 20-Aug-14 | 12-Dec-14 | 28-Jan-15 | 07-May-15 | 29-Jul-15 | 03-Dec-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.3 | 7.5 | 7.2 | 6.8 | **8.83** | 6.98 | 7.23 | - | 7.52 | 7.08 | - | 7.8 | 6.99 | 6.79 | 6.77 | - |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | **8.53** | 6.55 | 7.8 | 6.91 | 7 | 7.3 | 7.1 | 7 | 7.43 | 7.34 | 7.07 | 6.82 | 6.92 | 7.15 | 7.42 | 7.79 |
| EC-Field | µS/cm | - | - | 313 | 257 | 280 | 326 | 229 | 240 | 252 | - | 267 | 86 | - | 316 | 207 | 180 | 284 | - |
| EC-Lab | µS/cm | - | - | 283 | 226 | 262 | 308 | 245 | 247 | 263 | 285 | 288 | 141 | 335 | 380 | 226 | 185 | 279 | 293 |
| ORP | mV | - | - | 55.3 | 223.6 | -1.7 | 75.2 | 125.2 | -28.3 | 52.6 | - | 1 | -33.1 | - | -47.2 | - | - | - | - |
| Dissolved Hardness ($CaCO_3$) | mg/L | | | 159 | 120 | 144 | 156 | 127 | 124 | 122 | 130 | 145 | 58.5 | 167 | 193 | 106 | 100 | 139 | 149 |
| Total Dissolved Solids | mg/L | 500 | - | 168 | 130 | 198 | 212 | 136 | 148 | 138 | 164 | 150 | 85 | 160 | 218 | 113 | 120 | 153 | 168 |
| Temperature-Field | °C | - | - | 8.2 | 10.22 | 15.33 | 13.58 | 8.87 | 10.51 | 12.52 | - | 9.12 | 10.97 | - | 12.27 | 9.92 | 11.57 | 15.07 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | | |
| Bicarbonate | mg/L | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 150 | - |
| Chloride | mg/L | 250 | - | 1.2 | 0.9 | 1.68 | 3.8 | 1.4 | 1.18 | 0.9 | 1.3 | 1.39 | 1.49 | 3.67 | 3.64 | 1.27 | 0.62 | 1.21 | 1.59 |
| Sulphate | mg/L | 500 | 100 | 10.8 | 8.2 | 8.3 | 13.8 | 10 | 9.8 | 8.6 | 9.3 | 9.9 | 3.1 | 9.4 | 15.1 | 7.1 | 4.6 | 8.2 | 10.7 |
| **DISSOLVED CATIONS** | | | | | | | | | | | | | | | | | | | |
| Calcium | mg/L | - | - | 51.4 | 39.8 | 46.4 | 50.2 | 41.1 | 40.2 | 39.4 | 41 | 46.6 | 19.1 | 54.8 | 63.6 | 34.8 | 32.2 | 44.9 | 47.8 |
| Magnesium | mg/L | - | - | 7.4 | 5.8 | 6.8 | 7.47 | 6.01 | 5.75 | 5.84 | 6.63 | 7.05 | 2.63 | 7.41 | 8.28 | 4.72 | 4.77 | 6.49 | 7.15 |
| Potassium | mg/L | - | - | 0.4 | 0.4 | 0.4 | 0.5 | 0.3 | 0.4 | 0.3 | 0.4 | - | - | - | - | - | - | - | - |
| Sodium | mg/L | 200 | - | 5.5 | 4.3 | 5.4 | 5.4 | 4 | 4.8 | 4.4 | 4.3 | 5.81 | 4.48 | 5.64 | 6.68 | 4.79 | 3.5 | 3.94 | 5.98 |
| **DISSOLVED METALS** | | | | | | | | | | | | | | | | | | | |
| Arsenic | mg/L | 0.010 | 0.005 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | **0.1027** | <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 | 0.023 | 0.018 | 0.02 | 0.021 | 0.018 | 0.098 | 0.017 | 0.019 | 0.0211 | 0.0122 | 0.0245 | 0.0269 | 0.0157 | 0.0132 | 0.0139 | 0.0194 |
| Boron | mg/L | 5 | 1.2 | 0.311 | 0.256 | 0.28 | 0.272 | 0.346 | 0.45 | 0.246 | 0.303 | 0.318 | 0.113 | 0.238 | 0.339 | 0.251 | 0.272 | 0.373 | 0.286 |
| Cadmium | mg/L | 0.005 | 0.00029 | 0.00009 | 0.00005 | 0.00001 | 0.00004 | 0.00006 | **0.103** | 0.00002 | 0.00006 | 0.00002 | 0.00005 | <0.00001 | 0.00005 | <0.00001 | 0.00002 | 0.00001 | 0.00003 |
| Chromium | mg/L | 0.05 | 0.001 | 0.0008 | <0.004 | **0.001** | **0.0017** | 0.0009 | **0.0984** | **0.0088** | 0.0005 | <0.0005 | <0.0005 | <0.0005 | **0.0028** | <0.0005 | **0.005** | <0.0005 | <0.0005 |
| Cobalt | mg/L | - | 0.05 | 0.00003 | 0.00005 | 0.00005 | 0.00015 | 0.00078 | **0.093** | 0.0001 | 0.00005 | <0.00005 | <0.00005 | <0.00005 | 0.00007 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| Copper | mg/L | 1 | 0.006 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | **0.093** | <0.001 | <0.001 | 0.0005 | 0.0018 | 0.0009 | 0.0024 | 0.0006 | 0.0008 | 0.0006 | 0.0009 |
| Iron | mg/L | 0.3 | 0.35 | <0.005 | <0.005 | 0.006 | <0.005 | 0.012 | 0.005 | <0.005 | 0.014 | <0.01 | <0.01 | <0.01 | 0.02 | <0.01 | 0.019 | 0.01 | 0.02 |
| Lead | mg/L | 0.01 | 0.009 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | **0.108** | <0.0001 | <0.0001 | <0.00001 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | 0.0001 |
| Manganese | mg/L | 0.05 | 1.265 | 0.002 | 0.003 | <0.001 | 0.0154 | 0.0434 | <0.001 | 0.0011 | 0.007 | 0.005 | 0.011 | <0.001 | 0.002 | 0.005 | 0.004 | 0.02 | 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 | <0.01 |
| Vanadium | mg/L | - | - | 0.0003 | 0.0002 | 0.0004 | 0.00053 | 0.00034 | 0.09602 | 0.0003 | 0.00027 | 0.0002 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Zinc | mg/L | 5 | 0.053 | 0.039 | 0.028 | 0.018 | 0.015 | 0.03 | **0.097** | 0.016 | 0.021 | 0.012 | 0.029 | 0.023 | 0.019 | 0.026 | 0.024 | 0.012 | 0.034 |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | 0.21 | 0.06 | 0.23 | 0.75 | 0.17 | 0.13 | 0.12 | 0.31 | 0.311 | 0.364 | 0.518 | 1.01 | 0.33 | 0.18 | 0.317 | 0.379 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | <0.01 | 0.02 | 0.04 | <0.01 | 0.11 | <0.01 | 0.03 | <0.02 | <0.01 | 0.04 | <0.01 | <0.01 | 0.02 | 0.02 | <0.01 | 0.07 |
| **POLLUTANT TESTS** | | | | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | <10 | 30 | <10 | <10 | <10 | 16 | <10 | 27 | <10 | <10 | <10 | 10 | 10 | <10 | <10 | <10 |

H:\Project\1005\Analysis\Chemistry\2015\[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, October 2014). 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"). Accessed June 2015.
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 150 mg/L.

# TABLE B-13
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW94-6S
# 2012 to 2015

| SAMPLE DATE | units | RECEIVING WATER CRITERIA | | 24-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 16-Jan-13 | 07-May-13 | 16-Jul-13 | 23-Oct-13 | 05-Feb-14 | 21-May-14 | 20-Aug-14 | 12-Dec-14 | 28-Jan-15 | 07-May-15 | 29-Jul-15 | 03-Dec-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 6.5 | 6.6 | 6.5 | **6.2** | 7.17 | 6.86 | 8.03 | **-** | 6.77 | **6.48** | **-** | **6.23** | 6.71 | **6.17** | **6.42** | **-** |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 6.87 | 7.71 | 7.85 | **6.36** | **6.4** | **6.4** | **6.4** | **6.3** | 6.53 | 6.65 | 6.56 | **6.35** | **6.36** | 6.7 | 6.75 | 7.12 |
| EC-Field | µS/cm | - | - | 964 | 993 | 1039 | 867 | 793 | 816 | 961 | - | 829 | 813 | - | 789 | 773 | 716 | 894 | - |
| EC-Lab | µS/cm | - | - | 986 | 949 | 1078 | 908 | 758 | 775 | 866 | 914 | 937 | 819 | 985 | 763 | 710 | 678 | 775 | 780 |
| ORP | mV | - | - | -54.9 | -52.6 | -70.3 | 10.1 | -35.9 | -25.4 | -41.2 | - | -24.2 | -58.1 | - | -39.2 | - | - | - | - |
| Dissolved Hardness ($CaCO_3$) | mg/L | | | 375 | 371 | 412 | 307 | 291 | 285 | 321 | 309 | 369 | 332 | 453 | 300 | 264 | 250 | 325 | 322 |
| Total Dissolved Solids | mg/L | 500 | - | 476 | 480 | **580** | 466 | 356 | 382 | 442 | 452 | 493 | 433 | 450 | 403 | 365 | 360 | 415 | 422 |
| Temperature-Field | °C | - | - | 8.93 | 8.56 | 10.24 | 10.96 | 9.34 | 9.68 | 10.61 | - | 9.29 | 10.47 | - | 10.94 | 9.86 | 10.13 | 12.76 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | | |
| Bicarbonate | mg/L | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 431 | - |
| Chloride | mg/L | 250 | - | 17 | 16.7 | 15.1 | 11.4 | 11.1 | 14.6 | 15.4 | 12 | 14.5 | 11 | 13 | 8.81 | 7.19 | 4.89 | 12.3 | 9.46 |
| Sulphate | mg/L | 500 | 100 | <0.5 | 1.4 | <0.5 | 2.8 | 0.5 | 1.5 | <0.5 | 0.7 | 1.5 | 0.9 | 0.5 | <0.5 | 1.1 | <0.5 | 0.5 | <0.5 |
| **DISSOLVED CATIONS** | | | | | | | | | | | | | | | | | | | |
| Calcium | mg/L | - | - | 121 | 120 | 134 | 99.4 | 95.1 | 93.4 | 105 | 100 | 120 | 109 | 152 | 99.2 | 87.1 | 81.8 | 106 | 104 |
| Magnesium | mg/L | - | - | 17.8 | 17.6 | 18.8 | 14.4 | 12.9 | 12.6 | 14.6 | 14.2 | 16.8 | 14.5 | 17.9 | 12.7 | 11.3 | 11 | 14.6 | 15.1 |
| Potassium | mg/L | - | - | 13.6 | 12.2 | 15.1 | 12.4 | 11.2 | 11.9 | 11.7 | 12 | - | - | - | - | - | - | - | - |
| Sodium | mg/L | 200 | - | 23.9 | 22.3 | 26.4 | 24.3 | 15.8 | 17.9 | 19.8 | 19.8 | 21 | 18.7 | 22 | 17 | 19.3 | 13.1 | 16.1 | 19.6 |
| **DISSOLVED METALS** | | | | | | | | | | | | | | | | | | | |
| Arsenic | mg/L | 0.010 | 0.005 | 0.0004 | 0.0005 | 0.0005 | 0.0006 | 0.0004 | <0.0002 | 0.0005 | 0.0007 | 0.0015 | 0.0005 | 0.0001 | 0.0007 | 0.0005 | 0.0011 | 0.0008 | 0.0009 |
| Barium | mg/L | 1 | 1 | 0.026 | 0.025 | 0.025 | 0.028 | 0.023 | <0.001 | 0.028 | 0.039 | 0.0364 | 0.0206 | 0.023 | 0.0275 | 0.0278 | 0.0301 | 0.0298 | 0.0274 |
| Boron | mg/L | 5 | 1.2 | 0.695 | 0.591 | 0.632 | 0.66 | 0.589 | 0.02 | 0.48 | 0.636 | 0.586 | 0.456 | 0.475 | 0.523 | 0.527 | 0.367 | 0.434 | 0.467 |
| Cadmium | mg/L | 0.005 | 0.001 | 0.00004 | <0.00001 | <0.00001 | 0.00002 | 0.00002 | <0.00001 | 0.00002 | 0.00006 | 0.00003 | 0.00006 | 0.00001 | 0.00002 | 0.00011 | <0.00001 | 0.00009 | 0.00005 |
| Chromium | mg/L | 0.05 | 0.001 | **0.0046** | **0.0024** | **0.0076** | **0.0099** | **0.0062** | <0.0004 | **0.0036** | **0.0044** | 0.0005 | 0.0005 | <0.0005 | 0.0006 | 0.0008 | **0.001** | 0.0006 | 0.0007 |
| Cobalt | mg/L | - | 0.05 | 0.00816 | 0.00841 | 0.00741 | 0.00795 | 0.00602 | 0.00005 | 0.00814 | 0.00822 | 0.00745 | 0.00726 | 0.00753 | 0.0061 | 0.00539 | 0.00589 | 0.00786 | 0.00827 |
| Copper | mg/L | 1 | 0.016 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 0.0008 | 0.0004 | 0.0008 | <0.0002 | 0.0005 | 0.0002 | 0.0005 | 0.0003 |
| Iron | mg/L | 0.3 | 0.35 | **3.77** | **4.79** | 0.019 | **1.58** | **1.5** | **6.03** | 0.008 | **10.8** | <0.01 | **4.92** | <0.01 | **16.6** | **5.54** | **21** | **10.9** | **7.22** |
| Lead | mg/L | 0.01 | 0.022 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | 0.00022 | <0.00005 | 0.00015 | <0.00005 | 0.00017 | <0.00005 | <0.00005 | <0.00005 |
| Manganese | mg/L | 0.05 | 2.365 | **8.45** | **8.11** | **8** | **6.37** | **5.76** | **5.98** | **7.07** | **6.87** | **7.45** | **6.31** | **7.81** | **6.06** | **5.15** | **5.14** | **6.63** | **6.94** |
| 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 | <0.01 |
| Vanadium | mg/L | - | - | 0.0015 | 0.0008 | 0.0021 | 0.00287 | 0.00184 | <0.0001 | 0.00106 | 0.00142 | 0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.0008 |
| Zinc | mg/L | 5 | 0.240 | 0.002 | <0.001 | <0.001 | 0.003 | 0.002 | <0.001 | 0.002 | 0.003 | 0.005 | <0.002 | 0.002 | 0.003 | 0.004 | <0.002 | 0.003 | 0.005 |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | 0.12 | <0.05 | <0.05 | <0.05 | <0.05 | 0.05 | <0.05 | <0.05 | 0.293 | 0.23 | 0.84 | 0.331 | <0.005 | 0.555 | 0.008 | <0.005 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | **18.6** | **19** | **19.7** | **18.9** | **14.9** | **14.9** | **16.6** | **15.9** | **13.6** | **14.3** | 1.7 | **13** | **13** | **12.6** | **11.5** | **15.1** |
| **POLLUTANT TESTS** | | | | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | 90 | 80 | 60 | 67 | 80 | 85 | 53 | 69 | 57 | 50 | 30 | 60 | 50 | 40 | 48 | 40 |

H:\Project\1005\Analysis\Chemistry\2015\[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, October 2014). 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"). Accessed June 2015.
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 400 mg/L.

# TABLE B-14
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW94-6D
# 2012 to 2015

| SAMPLE DATE | units | RECEIVING WATER CRITERIA | | 24-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 16-Jan-13 | 07-May-13 | 16-Jul-13 | 23-Oct-13 | 05-Feb-14 | 21-May-14 | 20-Aug-14 | 12-Dec-14 | 28-Jan-15 | 07-May-15 | 29-Jul-15 | 03-Dec-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | **9.41** | **9.7** | **9.8** | **9.3** | **10.51** | 7.43 | 7.66 | **-** | **9.89** | **9.91** | **-** | **8.68** | **9.07** | **9.08** | 7.84 | **-** |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | **10.66** | **10.54** | 8.17 | **9.09** | **9.4** | **9.4** | **9.4** | **9.5** | **9.13** | **9.13** | **9.2** | **8.91** | **8.84** | **9.16** | 8.35 | 8.45 |
| EC-Field | µS/cm | - | - | 641 | 590 | 584 | 648 | 570 | 594 | 611 | - | 564 | 522 | - | 568 | 563 | 528 | 596 | - |
| EC-Lab | µS/cm | - | - | 584 | 520 | 531 | 554 | 632 | 696 | 696 | 721 | 681 | 619 | 600 | 603 | 641 | 586 | 631 | 656 |
| ORP | mV | - | - | -114 | 117.5 | 33.4 | 100.3 | 28 | 216.8 | 111.4 | - | 94.6 | -99 | - | -81 | - | - | - | - |
| Dissolved Hardness ($CaCO_3$) | mg/L | | | <5 | <5 | <5 | <5 | 351 | <5 | <7 | 5 | 3.37 | 2.95 | 3.44 | 2.37 | 7.41 | 3.77 | 15 | 4.9 |
| Total Dissolved Solids | mg/L | 500 | - | **690** | **1100** | **1130** | **1190** | 486 | 498 | 472 | 488 | 415 | **1250** | **1340** | 360 | 450 | 314 | 420 | 278 |
| Temperature-Field | °C | - | - | 9.45 | 10.59 | 10.56 | 9.84 | 9.19 | 10.54 | 10.86 | - | 8.97 | 10.79 | - | 10.1 | 9.56 | 10.66 | 12.13 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | | |
| Bicarbonate | mg/L | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 305 | - |
| Chloride | mg/L | 250 | - | 2 | 2 | 2.1 | 3 | 2.76 | 1.87 | 4 | 1.84 | 2.1 | 2.39 | 2.65 | 2.38 | 2.38 | 2.23 | 5.69 | 4.33 |
| Sulphate | mg/L | 500 | 100 | 43.3 | 40 | 45 | 49 | 51.6 | 73.9 | 80 | 92.8 | 87.1 | 61.1 | 58.3 | 65.9 | 71.1 | 57.4 | 34.5 | 40.9 |
| **DISSOLVED CATIONS** | | | | | | | | | | | | | | | | | | | |
| Calcium | mg/L | - | - | 0.7 | 0.5 | 0.8 | 0.75 | 44.8 | 0.93 | <1 | 1.56 | 1.35 | 0.969 | 1.23 | 0.791 | 2.28 | 1.35 | 4.85 | 1.67 |
| Magnesium | mg/L | - | - | <0.1 | <0.1 | 0.2 | <0.1 | 58.1 | 0.17 | <1 | 0.27 | <0.25 | 0.13 | 0.09 | 0.095 | 0.416 | 0.097 | 0.69 | 0.17 |
| Potassium | mg/L | - | - | 0.6 | 0.6 | 0.6 | 0.8 | 5.4 | 0.9 | <1 | 0.7 | - | - | - | - | - | - | - | - |
| Sodium | mg/L | 200 | - | 147 | 130 | 132 | 148 | 170 | 160 | 146 | 152 | 165 | 143 | 136 | 135 | 148 | 129 | 152 | 170 |
| **DISSOLVED METALS** | | | | | | | | | | | | | | | | | | | |
| Arsenic | mg/L | 0.010 | 0.005 | **0.0186** | **0.017** | **0.0185** | **0.0196** | **0.0279** | **0.0243** | **0.0285** | **0.0291** | **0.0286** | **0.0238** | **0.0271** | **0.0256** | **0.0238** | **0.0231** | **0.0071** | **0.0093** |
| Barium | mg/L | 1 | 1 | 0.002 | 0.001 | 0.002 | 0.002 | 0.27 | 0.003 | <0.01 | 0.004 | 0.00431 | 0.0067 | 0.0021 | 0.0016 | 0.0047 | 0.0026 | 0.0148 | 0.0036 |
| Boron | mg/L | 5 | 1.2 | **2.076** | **2.072** | **2.161** | **2.519** | **2.96** | **3.393** | **3.09** | **4.13** | **3.74** | **2.57** | **2.27** | **2.85** | **3.27** | **2.74** | **2.08** | **1.92** |
| Cadmium | mg/L | 0.005 | 0.00009 | 0.00002 | 0.00002 | 0.00002 | 0.00004 | **0.0012** | 0.00007 | <0.0001 | 0.00007 | 0.00005 | **0.00013** | 0.00002 | <0.00001 | <0.00001 | 0.0000 | 0.00002 | 0.00003 |
| Chromium | mg/L | 0.05 | 0.00 | 0.0009 | <0.0004 | 0.0004 | **0.0016** | **0.0028** | 0.0008 | <0.004 | <0.0004 | 0.0007 | <0.0005 | <0.0005 | 0.0007 | <0.0005 | 0.0007 | <0.0005 | 0.0008 |
| Cobalt | mg/L | - | 0.05 | 0.00007 | 0.00008 | 0.00011 | 0.00028 | 0.00933 | 0.00034 | 0.00037 | 0.00027 | 0.00018 | 0.00049 | 0.00008 | 0.00011 | 0.00019 | 0.00009 | 0.00029 | 0.00012 |
| Copper | mg/L | 1 | 0.002 | **0.005** | **0.003** | **0.004** | **0.006** | **0.008** | **0.02** | **0.02** | **0.021** | **0.0093** | **0.0124** | **0.0083** | **0.0048** | **0.0068** | **0.0031** | **0.0032** | **0.004** |
| Iron | mg/L | 0.3 | 0.35 | 0.062 | 0.143 | 0.104 | 0.08 | **156** | **0.383** | **0.627** | **0.426** | 0.128 | 0.082 | 0.041 | 0.096 | **0.68** | 0.061 | 0.22 | 0.09 |
| Lead | mg/L | 0.01 | 0.004 | 0.0007 | 0.0009 | 0.0005 | 0.0009 | **0.0948** | 0.0033 | 0.0039 | 0.0038 | 0.00196 | 0.0029 | 0.00074 | 0.0008 | 0.00115 | 0.00063 | 0.0005 | 0.00063 |
| Manganese | mg/L | 0.05 | 0.74 | <0.001 | <0.001 | <0.001 | 0.0022 | **1.72** | 0.0075 | 0.011 | 0.013 | 0.007 | <0.001 | <0.001 | 0.004 | 0.011 | 0.004 | **0.075** | 0.006 |
| Mercury | µg/L | 1 | 0.02 | 0.01 | **0.02** | <0.01 | **0.02** | **0.19** | **0.11** | **0.08** | <0.1 | **0.05** | <0.01 | **0.02** | 0.01 | **0.02** | **0.03** | **0.04** | **0.1** |
| Vanadium | mg/L | - | - | 0.0082 | 0.0048 | 0.0064 | 0.00704 | 0.01217 | 0.00742 | 0.00755 | 0.0123 | 0.0101 | 0.0085 | 0.0115 | 0.0087 | 0.0091 | 0.0097 | 0.0028 | 0.0028 |
| Zinc | mg/L | 5 | 0.0075 | 0.001 | 0.002 | **0.012** | 0.001 | **0.3** | 0.004 | <0.01 | 0.005 | **0.012** | **0.015** | 0.005 | 0.002 | 0.002 | 0.004 | <0.002 | 0.003 |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | <0.5 | 0.6 | 0.71 | 0.9 | 0.85 | 1.02 | 0.7 | 0.44 | 1.64 | 1.27 | 1.51 | 1.03 | 1.33 | 0.773 | 1.83 | 2.12 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | 0.1 | <0.01 | <0.01 | 0.23 | **2.12** | 1.04 | **2.69** | **2.78** | 0.3 | 0.68 | 0.44 | 0.76 | 0.52 | 0.35 | 0.55 | 0.14 |
| **POLLUTANT TESTS** | | | | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | 50 | 20 | 20 | 19 | 53 | 137 | 569 | 892 | 81 | 50 | 10 | 60 | 120 | 30 | 14 | 35 |
| Total Organic Carbon | mg/L as O | - | - | 12 | 3.5 | 3.4 | 1.9 | 2 | 26.7 | 200 | 187 | 18 | 5.7 | - | <5 | - | 25.7 | 7.6 | 9 |

H:\Project\1005\Analysis\Chemistry\2015\[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, October 2014). 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"). Accessed June 2015.
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 less than 30 mg/L.

# TABLE B-15
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW98-9
# 2012 to 2015

| SAMPLE DATE | units | RECEIVING WATER CRITERIA | | 24-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 16-Jan-13 | 07-May-13 | 16-Jul-13 | 23-Oct-13 | 05-Feb-14 | 21-May-14 | 20-Aug-14 | 12-Dec-14 | 28-Jan-15 | 07-May-15 | 29-Jul-15 | 03-Dec-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 6.6 | 7.1 | 6.5 | **6.3** | 7.4 | 6.89 | 6.94 | **-** | 7.79 | 6.97 | **-** | 6.77 | **6.21** | **6.16** | 6.79 | **-** |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.65 | 8.36 | 7.72 | **6.4** | 6.5 | 7.3 | **6.4** | 6.7 | 6.97 | 7.18 | 6.59 | 6.67 | **6.04** | 6.92 | 7.42 | 7.76 |
| EC-Field | µS/cm | - | - | 86.6 | 113 | 308 | 314 | 90 | 170 | 365 | - | 208 | 185 | - | 74 | 64 | 208 | 244 | - |
| EC-Lab | µS/cm | - | - | 79 | 101 | 283 | 290 | 103 | 181 | 388 | 371 | 240 | 222 | 309 | 84 | 69 | 226 | 243 | 237 |
| ORP | mV | - | - | 251.5 | 172.3 | 84.2 | 220 | 192.8 | 259.4 | 154 | - | 109.6 | -74.6 | - | -15.2 | - | - | - | - |
| Dissolved Hardness ($CaCO_3$) | mg/L | | | 37 | 49 | 144 | 142 | 46 | 84 | 178 | 156 | 119 | 99 | 144 | 34 | 27.8 | 98.4 | 115 | 119 |
| Total Dissolved Solids | mg/L | 500 | - | 54 | 124 | 246 | 216 | 98 | 150 | 216 | 212 | 133 | 145 | 173 | 61 | 53 | 150 | 155 | 135 |
| Temperature-Field | °C | - | - | 8.54 | 8.53 | 10.12 | 9.6 | 8.92 | 9.71 | 10.01 | - | 8.31 | 9.46 | - | 10.23 | 9.34 | 11.15 | 13.61 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | | |
| Bicarbonate | mg/L | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 134 | - |
| Chloride | mg/L | 250 | - | 2 | 2.1 | 10 | 9.5 | 2.4 | 2.47 | 9.1 | 6.52 | 2.61 | 2.64 | 11.5 | 1.79 | 1.41 | 2.44 | 2.41 | 2.35 |
| Sulphate | mg/L | 500 | 309 | 0.7 | 1.3 | <5 | 3.6 | 1 | 2.8 | 4.4 | 4.3 | 3.2 | 3 | 3.3 | 0.9 | 0.6 | 2.5 | 3.7 | 3.2 |
| **DISSOLVED CATIONS** | | | | | | | | | | | | | | | | | | | |
| Calcium | mg/L | - | - | 9.9 | 13 | 41 | 41.9 | 12.1 | 22.6 | 47.5 | 42.8 | 31.6 | 26.7 | 39 | 8.88 | 7.21 | 25.2 | 29.7 | 29.9 |
| Magnesium | mg/L | - | - | 3 | 4.2 | 10 | 9.19 | 3.91 | 6.74 | 14.4 | 12.1 | 9.79 | 7.84 | 11.3 | 2.88 | 2.37 | 8.62 | 9.9 | 10.8 |
| Potassium | mg/L | - | - | <0.1 | 0.2 | 0.4 | 0.4 | 0.1 | 0.2 | 0.3 | 0.6 | - | - | - | - | - | - | - | - |
| Sodium | mg/L | 200 | - | 3.3 | 3.2 | 8.9 | 8.4 | 3.1 | 5.7 | 10.2 | 12.5 | 7.27 | 7.37 | 6.27 | 3.64 | 3.45 | 4.19 | 4.43 | 5.4 |
| **DISSOLVED METALS** | | | | | | | | | | | | | | | | | | | |
| Arsenic | mg/L | 0.010 | 0.005 | <0.0002 | 0.0009 | 0.0006 | 0.0004 | 0.0004 | 0.0011 | 0.0008 | 0.0006 | 0.0025 | 0.001 | 0.0002 | 0.0002 | 0.0003 | 0.0013 | 0.0015 | 0.0017 |
| Barium | mg/L | 1 | 1 | 0.002 | 0.004 | 0.016 | 0.028 | 0.004 | 0.006 | 0.014 | 0.02 | 0.00832 | 0.0075 | 0.0106 | 0.002 | 0.0027 | 0.0077 | 0.0073 | 0.0079 |
| Boron | mg/L | 5 | 1.2 | 0.02 | 0.022 | 0.135 | 0.138 | 0.019 | 0.066 | 0.118 | 0.235 | 0.094 | 0.099 | 0.046 | 0.01 | 0.01 | 0.026 | 0.033 | 0.026 |
| Cadmium | mg/L | 0.005 | 0.00021 | **0.00034** | 0.00001 | 0.00015 | **0.00023** | <0.00001 | 0.00002 | 0.00006 | **0.00023** | 0.00004 | 0.00005 | 0.00005 | 0.00007 | 0.0002 | 0.00007 | 0.00002 | 0.00001 |
| Chromium | mg/L | 0.05 | 0.001 | **0.0018** | 0.0008 | **0.001** | **0.0026** | **0.0013** | **0.001** | 0.0005 | <0.0004 | <0.0005 | <0.0005 | <0.0005 | **0.0014** | **0.0015** | <0.0005 | <0.0005 | 0.0007 |
| Cobalt | mg/L | - | 0.05 | <0.00002 | 0.00004 | 0.0001 | 0.00023 | <0.00002 | 0.00005 | 0.00013 | 0.00062 | 0.00008 | 0.00007 | <0.00005 | <0.00005 | 0.00022 | <0.00005 | <0.00005 | <0.00005 |
| Copper | mg/L | 1 | 0.004 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 0.001 | 0.0004 | 0.0006 | 0.0007 | 0.0007 | **0.0097** | 0.0008 | 0.0005 | 0.0005 |
| Iron | mg/L | 0.3 | 0.35 | <0.005 | 0.027 | <0.005 | <0.005 | 0.071 | <0.005 | <0.005 | <0.005 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Lead | mg/L | 0.01 | 0.006 | <0.0001 | 0.0001 | <0.0001 | <0.0001 | <0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.00002 | 0.00049 | <0.00005 | <0.00005 | 0.00027 | 0.0001 | <0.00005 | <0.00005 |
| Manganese | mg/L | 0.05 | 1.05 | <0.001 | <0.001 | **0.199** | 0.0273 | 0.0026 | <0.001 | **0.0511** | **1.04** | **0.113** | **0.113** | 0.004 | 0.004 | <0.001 | 0.041 | 0.002 | 0.003 |
| 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 | **0.02** | <0.01 | <0.01 | <0.01 |
| Vanadium | mg/L | - | - | 0.0008 | 0.0011 | 0.001 | 0.00102 | 0.00095 | 0.0015 | 0.00125 | 0.00094 | 0.0022 | 0.0012 | 0.001 | 0.0006 | 0.0007 | 0.002 | 0.0021 | 0.0033 |
| Zinc | mg/L | 5 | 0.0150 | 0.002 | <0.01 | <0.01 | 0.002 | 0.001 | <0.001 | 0.002 | 0.002 | <0.001 | <0.002 | <0.002 | <0.002 | <0.002 | 0.003 | <0.002 | 0.005 |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | <0.05 | <0.05 | <0.1 | 0.29 | <0.05 | 0.13 | <0.05 | 0.08 | 0.027 | 0.046 | 0.104 | 0.033 | 0.013 | 0.238 | 0.09 | 0.767 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | <0.01 | <0.01 | 0.06 | 0.06 | 0.1 | 0.01 | 0.04 | 0.98 | 0.02 | 0.04 | <0.01 | 0.01 | <0.01 | 0.01 | <0.01 | 0.03 |
| **POLLUTANT TESTS** | | | | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | 10 | 100 | 70 | 40 | 68 | 94 | 40 | 87 | 35 | 10 | 10 | 10 | 10 | <10 | <10 | <10 |

H:\Project\1005\Analysis\Chemistry\2015\[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, October 2014). 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"). Accessed June 2015.
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 100 mg/L.

# TABLE B-16
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW98-10
# 2012 to 2015

| SAMPLE DATE | units | RECEIVING WATER CRITERIA | | 24-Jan-12 | 08-May-12 | 25-Oct-12 | 16-Jan-13 | 05-Feb-14 | 12-Dec-14 | 28-Jan-15 | 07-May-15 | 29-Jul-15 | 03-Dec-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 6.5 | 6.7 | **6.2** | 7.54 | 7.69 | 7.45 | 6.61 | **6.48** | 6.77 | **-** |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.44 | 8.26 | **6.4** | **6.3** | 6.54 | 6.53 | **5.96** | **6.36** | 6.96 | 6.9 |
| EC-Field | µS/cm | - | - | 66.8 | 87 | 98 | 55 | 71 | 76 | 61 | 43 | 89 | - |
| EC-Lab | µS/cm | - | - | 61 | 77 | 90 | 62 | 81 | 70 | 63 | 42 | 90 | 81 |
| ORP | mV | - | - | 253.1 | 183.5 | 216 | 181.5 | 123.3 | -12.8 | - | - | - | - |
| Dissolved Hardness ($CaCO_3$) | mg/L | | | 22 | 26 | 26 | 21 | 33.8 | 21.7 | 20.7 | 12.5 | 35.3 | 25.3 |
| Total Dissolved Solids | mg/L | 500 | - | 50 | 114 | 118 | 50 | 55 | 48 | 55 | 68 | 80 | 55 |
| Temperature-Field | °C | - | - | 7.42 | 8.1 | 10.74 | 7.47 | 8.43 | 9.41 | 8.45 | 10.6 | 13.35 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | |
| Bicarbonate | mg/L | | | - | - | - | - | - | - | - | - | 43 | - |
| Chloride | mg/L | 250 | - | 1.1 | 0.8 | 1 | 1.1 | 0.47 | 1.09 | 0.75 | 0.46 | 0.86 | 0.81 |
| Sulphate | mg/L | 500 | 100 | 2.2 | 6.5 | 6.1 | 2.6 | 2.5 | 2.2 | 2.2 | 2.1 | 2.8 | 1.9 |
| **DISSOLVED CATIONS** | | | | | | | | | | | | | |
| Calcium | mg/L | - | - | 6.2 | 7.1 | 7.32 | 5.75 | 9.38 | 5.97 | 5.67 | 3.47 | 9.56 | 6.72 |
| Magnesium | mg/L | - | - | 1.7 | 2 | 1.97 | 1.67 | 2.52 | 1.64 | 1.58 | 0.936 | 2.77 | 2.06 |
| Potassium | mg/L | - | - | <0.1 | 0.1 | 0.2 | <0.1 | - | - | - | - | - | - |
| Sodium | mg/L | 200 | - | 4.4 | 6.4 | 7.7 | 3.7 | 5.17 | 5.42 | 4.84 | 4.11 | 5.1 | 6.2 |
| **DISSOLVED METALS** | | | | | | | | | | | | | |
| Arsenic | mg/L | 0.010 | 0.005 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | 0.0003 | <0.0001 | <0.0001 | 0.0001 | 0.0001 | 0.0001 |
| Barium | mg/L | 1 | 1 | <0.001 | 0.003 | 0.003 | <0.001 | 0.00083 | 0.0011 | 0.0008 | 0.0015 | 0.0007 | 0.0013 |
| Boron | mg/L | 5 | 1.2 | 0.031 | 0.027 | 0.048 | 0.034 | 0.033 | 0.029 | 0.026 | 0.024 | 0.035 | 0.025 |
| Cadmium | mg/L | 0.005 | 0.00009 | **0.00012** | **0.00018** | 0.00008 | **0.00020** | 0.00007 | 0.00005 | 0.00002 | 0.00001 | 0.00002 | 0.00002 |
| Chromium | mg/L | 0.05 | 0.001 | **0.0012** | <0.0004 | **0.0018** | **0.0015** | **0.0011** | **0.0011** | **0.0017** | 0.0008 | **0.0016** | **0.0014** |
| Cobalt | mg/L | - | 0.05 | <0.00002 | 0.00011 | 0.00015 | <0.00002 | <0.00005 | 0.00006 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| Copper | mg/L | 1 | 0.002 | <0.001 | <0.001 | <0.001 | <0.001 | 0.0006 | 0.0006 | 0.0005 | 0.0006 | 0.0006 | 0.0003 |
| Iron | mg/L | 0.3 | 0.35 | <0.005 | <0.005 | 0.006 | <0.005 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Lead | mg/L | 0.01 | 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 | 0.05 | 0.74 | <0.001 | 0.032 | 0.0015 | 0.0016 | 0.009 | 0.004 | 0.003 | 0.001 | 0.003 | 0.003 |
| 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 |
| Vanadium | mg/L | - | - | 0.0018 | 0.0001 | 0.00152 | 0.00216 | 0.0018 | 0.0019 | 0.0018 | 0.0013 | 0.0031 | 0.0019 |
| Zinc | mg/L | 5 | 0.01 | 0.002 | 0.002 | 0.004 | 0.002 | 0.002 | 0.003 | <0.002 | <0.002 | <0.002 | <0.002 |
| **NUTRIENTS** | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | 1.27 | 0.26 | 0.81 | 0.42 | 0.25 | 1.32 | 0.582 | 0.715 | 0.24 | 2.48 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | <0.01 | 0.07 | 0.08 | <0.01 | 0.02 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| **POLLUTANT TESTS** | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | 20 | 30 | 46 | 28 | 24 | 20 | 20 | <10 | 20 | <10 |

H:\Project\1005\Analysis\Chemistry\2015\[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, October 2014). 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"). Accessed June 2015.
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 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | CANTEST | CANTEST | CANTEST | CANTEST | CANTEST | MAXXAM | MAXXAM | NORTH ISLAND | NORTH ISLAND |
| **PHYSICAL TESTS** | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 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 | 6.5 - 8.5 | 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 |
| ORP | mV | - | - | 9.17 | 9.15 | 8.27 | 8.38 | -53.9 | -25.4 | -66.8 | -49.9 | 96.7 |
| 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 | - | 5.03 | 4.51 | 4.86 | 4.76 | 4.99 | 4.9 | 4.9 | 6.4 | 90.7 |
| Sulphate | mg/L | 500 | 100 | **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 | 0.01 | 0.004 | <0.001 | <0.0002 | <0.0002 | 0.00029 | 0.00023 | 0.0005 | 0.0008 | 0.0002 | 0.0001 |
| Manganese | mg/L | 0.05 | 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\2015\[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, October 2014). 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"). Accessed June 2015.
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 less than 30 mg/L.
3. BH00-4A has been inaccessible since Feburary 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.

# TABLE B-18
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW02-1S
# 2012 to 2015

| SAMPLE DATE | units | RECEIVING WATER CRITERIA | | 24-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | **6.3** | 7 | **6.18** | **6.3** | 7.19 | 7.12 | 7.14 | **-** | 6.72 | 6.71 | **-** | 6.96 | 6.53 | 6.52 |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.62 | 8.3 | 8.49 | **6.33** | **6.3** | **6.2** | **6.3** | **6.3** | **6.34** | 6.55 | **6.36** | **5.73** | **5.96** | 6.51 |
| EC-Field | µS/cm | - | - | 75.6 | 74 | 77 | 75 | 64 | 64 | 75 | - | 7.6 | 77 | - | 40 | 103 | 86 |
| EC-Lab | µS/cm | - | - | 61 | 70 | 84 | 65 | 73.3 | 75 | 74 | 80 | 88 | 91 | 95 | 44 | 106 | 87 |
| ORP | mV | - | - | 118.4 | 170.1 | 90.8 | 196.6 | - | - | - | - | 175.1 | -23.6 | - | 4.1 | - | - |
| Dissolved Hardness ($CaCO_3$) | mg/L | | | 31 | 30 | 36 | 29 | 32 | 33 | 30 | 31 | 41 | 37.9 | 27.2 | 15.8 | 40.8 | 36.5 |
| Total Dissolved Solids | mg/L | 500 | - | 34 | 30 | 78 | 62 | 40 | 60 | 40 | 48 | 40 | 115 | 49 | 28 | 63 | 23 |
| Temperature-Field | °C | - | - | 6.87 | 8.12 | 9.35 | 7.78 | 7.49 | 8.69 | 8.83 | - | 8.36 | 8.94 | - | 9.39 | 8.5 | 9.36 |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | |
| Chloride | mg/L | 250 | - | 1.7 | 1.4 | 1.4 | 1.3 | 1.7 | 1.16 | 1.1 | 1.3 | 1.56 | 1.43 | 1.41 | 1.73 | 1.85 | 1.08 |
| Sulphate | mg/L | 500 | 100 | 2.1 | 1.6 | 2 | 1.5 | 1.5 | 1.6 | 1.6 | 1.8 | 1.9 | 2 | 2 | 1.7 | 2.3 | 2.3 |
| **DISSOLVED CATIONS** | | | | | | | | | | | | | | | | | |
| Calcium | mg/L | - | - | 9.1 | 8.9 | 10.5 | 8.44 | 9.46 | 9.78 | 8.78 | 8.99 | 12.2 | 11.1 | 7.61 | 4.44 | 12 | 10.6 |
| Magnesium | mg/L | - | - | 2 | 2 | 2.3 | 1.87 | 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 | 0.2 | 0.1 | <0.1 | <0.1 | <0.1 | - | - | - | - | - | - |
| Sodium | mg/L | 200 | - | 2.1 | 2 | 2.5 | 2.2 | 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 | <0.0003 | <0.0004 | <0.0005 | <0.0006 | <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 | 0.002 | 0.002 | 0.001 | 0.001 | 0.00141 | 0.0017 | 0.0018 | 0.0044 | 0.0026 | 0.0024 |
| Boron | mg/L | 5 | 1.2 | 0.019 | 0.012 | 0.013 | 0.027 | 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 | 0.00007 | 0.00004 | <0.00001 | <0.00001 | 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 | <0.0005 | <0.0006 | 0.0004 | 0.0006 | 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 | 0.00015 | 0.00008 | 0.00005 | 0.00004 | <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 | <0.001 | <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 | <0.005 | <0.005 | <0.005 | <0.005 | 0.014 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Lead | mg/L | 0.01 | 0.004 | 0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.00001 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| Manganese | mg/L | 0.05 | 0.737 | 0.041 | 0.023 | 0.024 | 0.006 | 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 | <0.01 | <0.01 | <0.01 | <0.01 | <0.1 | <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 | 0.0006 | 0.00057 | 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 | 0.006 | 0.003 | <0.001 | 0.001 | **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 | 0.09 | 0.22 | 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 | <0.01 | 0.02 | <0.01 | <0.01 | 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 | 10 | 20 | 20 | <10 | 16 | <10 | 28 | <10 | <10 | <10 | <10 | 10 | <10 |

H:\Project\1005\Analysis\Chemistry\2015\[Tables_B-10 to B-18.xlsx]Table B-18 MW02-1S

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, October 2014). 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"). Accessed June 2015.
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 30 mg/L.

# TABLE B-19
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW02-1D
# 2012 to 2015

| SAMPLE DATE | units | RECEIVING WATER CRITERIA GCDWQ[1] | AQUATIC LIFE[2] | 24-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 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 | 29-Jul-15 | 03-Dec-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | | | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 6.6 | 6.9 | 6.5 | 6.5 | 7.68 | 7.23 | 7.31 | - | 7.33 | 7.57 | - | 7.24 | 6.56 | 7.27 | 7.22 | - |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 8.1 | **8.73** | 8.09 | 6.56 | 6.5 | 6.6 | 6.5 | 6.6 | 6.62 | 6.88 | 6.63 | **5.84** | **5.89** | 6.79 | 7.09 | 6.78 |
| EC-Field | µS/cm | - | - | 83.2 | 86 | 98 | 96 | 59 | 82 | 83 | - | 11.6 | 103 | - | 39 | 57 | 108 | 104 | - |
| EC-Lab | µS/cm | - | - | 77 | 83 | 99 | 89 | 64 | 97 | 96 | 94 | 92 | 115 | 115 | 44 | 64 | 104 | 103 | 45 |
| ORP | mV | - | - | 85.8 | 123.6 | 103.5 | 165.5 | - | - | - | - | 168.2 | -46 | - | 3.8 | - | - | - | - |
| Dissolved Hardness ($CaCO_3$) | mg/L | | | 34 | 39 | 47 | 37 | 25 | 41 | 39 | 35 | 37.6 | 43 | 44 | 15.7 | 24.3 | 45.4 | 45.6 | 16.2 |
| Total Dissolved Solids | mg/L | 500 | - | 42 | 52 | 82 | 72 | 34 | 64 | 52 | 52 | 50 | 120 | 75 | 23 | 33 | 85 | 70 | 18 |
| Temperature-Field | °C | - | - | 7.14 | 8.04 | 8.54 | 7.86 | 7.46 | 10.15 | 9.62 | - | 9.77 | 9.22 | - | 9.49 | 8.52 | 10.33 | 11.32 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | | |
| Bicarbonate | mg/L | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 48 | - |
| Chloride | mg/L | 250 | - | 1.8 | 1.5 | 1.5 | 1.3 | 1.7 | 1.21 | 1.2 | 1.4 | 1.65 | 1.53 | 1.54 | 1.56 | 1.48 | 1.14 | 1.16 | 1.85 |
| Sulphate | mg/L | 500 | 100 | 2.5 | 3.1 | 3.3 | 3.1 | 1.7 | 2.5 | 3.1 | 3.1 | 2.2 | 3.5 | 3.6 | 1.5 | 1.5 | 3.1 | 3.5 | 1.2 |
| **DISSOLVED CATIONS** | | | | | | | | | | | | | | | | | | | |
| Calcium | mg/L | - | - | 10 | 11.4 | 13.9 | 10.8 | 7.31 | 12.1 | 11.6 | 10.2 | 11.1 | 12.6 | 12.8 | 4.3 | 7.03 | 13.2 | 13.3 | 4.43 |
| Magnesium | mg/L | - | - | 2.2 | 2.6 | 3 | 2.4 | 1.64 | 2.66 | 2.55 | 2.41 | 2.39 | 2.81 | 2.93 | 1.2 | 1.63 | 3.01 | 3 | 1.25 |
| Potassium | mg/L | - | - | <0.1 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | - | - | - | - | - | - | - | - |
| Sodium | mg/L | 200 | - | 3 | 3.3 | 3.9 | 3.4 | 2.2 | 3.7 | 3.6 | 3.3 | 5.42 | 6.67 | 4.7 | 2.01 | 2.78 | 3.54 | 3.68 | 1.98 |
| **DISSOLVED METALS** | | | | | | | | | | | | | | | | | | | |
| Arsenic | mg/L | 0.010 | 0.005 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | 0.0003 | 0.0002 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| Barium | mg/L | 1 | 1 | 0.003 | 0.002 | 0.002 | 0.002 | 0.002 | 0.003 | 0.002 | 0.003 | 0.00298 | 0.0034 | 0.0028 | 0.002 | 0.0021 | 0.0018 | 0.0023 | 0.0026 |
| Boron | mg/L | 5 | 1.2 | 0.015 | 0.01 | 0.009 | 0.023 | 0.026 | 0.02 | 0.012 | 0.012 | 0.071 | 0.091 | 0.017 | 0.012 | 0.013 | 0.015 | 0.017 | 0.014 |
| Cadmium | mg/L | 0.005 | 0.00011 | **0.00015** | 0.00004 | 0.00007 | 0.00003 | 0.00005 | 0.00004 | 0.00006 | 0.00003 | 0.00002 | 0.00003 | 0.00003 | 0.00003 | 0.00001 | 0.00001 | 0.00001 | 0.00001 |
| Chromium | mg/L | 0.05 | 0.020 | <0.0004 | <0.0004 | <0.0004 | 0.0004 | 0.0004 | 0.0004 | <0.0004 | <0.0004 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Cobalt | mg/L | - | 0.05 | 0.00002 | 0.00003 | 0.00005 | 0.00019 | <0.00002 | <0.00002 | 0.00003 | <0.00002 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| Copper | mg/L | 1 | 0.002 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 0.0003 | 0.0005 | 0.0004 | 0.0016 | **0.002** | 0.001 | 0.0005 | 0.0011 |
| Iron | mg/L | 0.3 | 0.35 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | 0.006 | <0.005 | <0.005 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Lead | mg/L | 0.01 | 0.004 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.00001 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| Manganese | mg/L | 0.05 | 0.78 | **0.113** | **0.105** | **0.132** | **0.122** | **0.0702** | **0.0808** | **0.107** | **0.074** | 0.036 | **0.062** | 0.04 | 0.016 | 0.022 | 0.031 | 0.022 | 0.011 |
| Mercury | µg/L | 1 | 0.02 | <0.01 | <0.01 | **0.02** | <0.01 | <0.01 | <0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Vanadium | mg/L | - | - | 0.0004 | 0.0004 | 0.0005 | 0.00049 | 0.00029 | 0.00056 | 0.00048 | 0.0004 | 0.0003 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.0005 | <0.0005 | <0.0005 |
| Zinc | mg/L | 5 | 0.0075 | **0.01** | 0.005 | 0.006 | 0.004 | **0.01** | 0.006 | 0.006 | 0.003 | 0.003 | 0.004 | 0.004 | 0.004 | 0.004 | 0.005 | **0.009** | 0.003 |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | 0.13 | 0.1 | 0.06 | 0.13 | 0.11 | 0.12 | 0.08 | 0.15 | 0.254 | 0.582 | 0.443 | 0.118 | 0.398 | 0.895 | 0.584 | 0.126 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | <0.01 | 0.02 | 0.04 | 0.08 | 0.1 | <0.01 | 0.03 | <0.02 | <0.01 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| **POLLUTANT TESTS** | | | | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | <10 | 70 | <10 | 11 | <10 | 18 | 11 | 18 | <10 | <10 | <10 | 10 | 10 | <10 | <10 | <10 |

H:\Project\1005\Analysis\Chemistry\2015\[Tables_B-19 to B-28.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, October 2014). 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"). Accessed June 2015.
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 40 mg/L.

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

| 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 | 08-Feb-11 | 09-May-11 | 26-Jul-11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | 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 | 6.5 - 8.5 | 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 | 6.5 - 8.5 | 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 | - | 1.49 | 1.53 | 1.39 | 1.47 | 1.4 | 1 | 1 | <2 | 1.5 | <2 | <2 |
| Sulphate | mg/L | 500 | 100 | 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 | 0.0200 | <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 | 0.01 | 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 | 0.05 | 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 | <0.05 | <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\2015\[Tables_B-19 to B-28.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, October 2014). 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"). Accessed June 2015.
   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 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
# 2012 to 2015

| SAMPLE DATE | units | RECEIVING WATER CRITERIA | | 23-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 16-Jan-13 | 07-May-13 | 16-Jul-13 | 23-Oct-13 | 05-Feb-14 | 21-May-14 | 21-Aug-14 | 12-Dec-14 | 28-Jan-15 | 07-May-15 | 29-Jul-15 | 03-Dec-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.6 | 7.6 | 7.4 | 7.2 | 8.01 | 6.93 | 7.02 | - | 7.1 | 7.03 | - | 6.65 | 7.95 | 6.61 | 7.21 | - |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.03 | 6.88 | 8.02 | 7.05 | 7.5 | 7.8 | 7.4 | 7.3 | 7.45 | 7.52 | 7.3 | 6.75 | 7.06 | 7.52 | 7.8 | 7.75 |
| EC-Field | µS/cm | - | - | 557 | 569 | 563 | 577 | 575 | 588 | 574 | - | 543 | 516 | - | 557 | 591 | 606 | 603 | - |
| EC-Lab | µS/cm | - | - | 500 | 503 | 516 | 546 | 605 | 603 | 601 | 580 | 593 | 611 | 624 | 614 | 693 | 622 | 609 | 588 |
| ORP | mV | - | - | 180.2 | 200.6 | 61 | 178 | 157.8 | 289.6 | 145.8 | - | 203.5 | -80.1 | - | -29.4 | - | - | - | - |
| Dissolved Hardness ($CaCO_3$) | mg/L | | | 148 | 128 | 163 | 156 | 177 | 178 | 157 | 145 | 169 | 168 | 170 | 176 | 167 | 167 | 170 | 156 |
| Total Dissolved Solids | mg/L | 500 | - | 290 | 292 | 350 | 336 | 332 | 374 | 344 | 324 | 320 | 375 | 270 | 363 | 385 | 338 | 335 | 310 |
| Temperature-Field | °C | - | - | 7.63 | 8.92 | 9.48 | 8.7 | 7.87 | 9.05 | 9.51 | - | 7.35 | 9.34 | - | 9.31 | 8.75 | 9.55 | 11.52 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | | |
| Bicarbonate | mg/L | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 149 | - |
| Chloride | mg/L | 250 | - | 80 | 87 | 80 | 77 | 94 | 106 | 93 | 92 | 99.1 | 101 | 97.3 | 100 | 111 | 106 | 105 | 98.1 |
| Sulphate | mg/L | 500 | 309 | 12.2 | 12.9 | 13.6 | 13.8 | 13.2 | 11.8 | 13.3 | 13.3 | 14.3 | 15.1 | 15 | 14.1 | 13.9 | 13.7 | 13.9 | 14.4 |
| **DISSOLVED CATIONS** | | | | | | | | | | | | | | | | | | | |
| Calcium | mg/L | - | - | 49.4 | 42.4 | 54.1 | 51.7 | 58.8 | 59.1 | 52 | 47.4 | 55.4 | 55.6 | 56.5 | 58.5 | 54.6 | 54.2 | 55.5 | 50.3 |
| Magnesium | mg/L | - | - | 6.1 | 5.4 | 6.9 | 6.61 | 7.43 | 7.37 | 6.68 | 6.54 | 7.42 | 7.14 | 7.11 | 7.33 | 7.52 | 7.57 | 7.69 | 7.37 |
| Potassium | mg/L | - | - | 0.9 | 0.8 | 1 | 1.1 | 0.9 | 0.9 | 1 | 1 | - | - | - | - | - | - | - | - |
| Sodium | mg/L | 200 | - | 55.4 | 49.3 | 51.4 | 51.5 | 50.9 | 52.9 | 53.6 | 53.5 | 53 | 66.8 | 57.8 | 60.3 | 55 | 55.3 | 54.6 | 57.6 |
| **DISSOLVED METALS** | | | | | | | | | | | | | | | | | | | |
| Arsenic | mg/L | 0.010 | 0.005 | 0.0018 | 0.0014 | 0.0016 | 0.0016 | 0.0015 | 0.0011 | 0.0015 | 0.0015 | 0.0016 | 0.0009 | 0.0011 | 0.0009 | 0.001 | 0.0007 | 0.0011 | 0.0008 |
| Barium | mg/L | 1 | 1 | 0.029 | 0.029 | 0.034 | 0.034 | 0.038 | 0.039 | 0.039 | 0.04 | 0.0486 | 0.038 | 0.0374 | 0.0358 | 0.0412 | 0.0405 | 0.0403 | 0.0368 |
| Boron | mg/L | 5 | 1.2 | 0.593 | 0.571 | 0.596 | 0.591 | 0.737 | 0.556 | 0.547 | 0.643 | 0.656 | 0.617 | 0.505 | 0.635 | 0.619 | 0.623 | 0.644 | 0.607 |
| 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 | 0.00002 | 0.00002 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Chromium | mg/L | 0.05 | 0.02 | 0.0007 | 0.0005 | 0.0013 | 0.0014 | 0.0011 | 0.0008 | <0.0004 | <0.0004 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| Cobalt | mg/L | - | 0.05 | <0.02 | 0.00005 | 0.00006 | 0.00024 | <0.00002 | 0.00003 | 0.0001 | 0.00004 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| Copper | mg/L | 1 | 0.006 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 0.0002 | 0.0004 | 0.0009 | 0.0004 | 0.0003 | 0.0012 | 0.0003 | 0.0002 |
| Iron | mg/L | 0.3 | 0.35 | 0.017 | 0.017 | 0.015 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Lead | mg/L | 0.01 | 0.009 | <0.0001 | 0.0004 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.00001 | 0.00009 | 0.00041 | <0.00005 | <0.00005 | <0.00005 | <0.00005 | <0.00005 |
| Manganese | mg/L | 0.05 | 1.3 | <0.001 | <0.001 | <0.001 | <0.001 | 0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 0.002 |
| Mercury | µg/L | 1 | 0.02 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.1 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Vanadium | mg/L | - | - | 0.0014 | 0.001 | 0.0011 | 0.00119 | 0.00109 | 0.00096 | 0.00087 | 0.0007 | 0.0008 | 0.0006 | 0.0007 | 0.0006 | 0.0006 | <0.0005 | 0.0006 | 0.0006 |
| Zinc | mg/L | 5 | 0.06 | <0.001 | 0.001 | <0.001 | 0.001 | <0.001 | 0.001 | 0.002 | 0.001 | <0.001 | 0.004 | 0.002 | <0.002 | 0.002 | <0.002 | 0.002 | <0.002 |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | <0.05 | <0.05 | <0.05 | <0.05 | 0.06 | 0.05 | 0.05 | <0.05 | 0.072 | 0.062 | 0.068 | 0.024 | 0.033 | 0.154 | 0.013 | <0.005 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | <0.01 | <0.01 | 0.02 | <0.01 | <0.01 | <0.01 | 0.03 | <0.02 | <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 | - | - | 10 | 20 | <10 | 35 | 15 | 17 | <10 | 48 | <10 | <10 | <10 | 10 | 10 | 10 | <10 | <10 |

H:\Project\1005\Analysis\Chemistry\2015\[Tables_B-19 to B-28.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, October 2014). 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"). Accessed June 2015.
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 160 mg/L.

# TABLE B-22
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW05-1
# 2012 to 2015

| LOCATION | | 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 | MW05-1S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE DATE | units | | | 24-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 17-Jan-13 | 09-May-13 | 16-Jul-13 | 24-Oct-13 | 05-Feb-14 | 22-May-14 | 21-Aug-14 | 12-Dec-14 | 29-Jan-15 | 08-May-15 | 30-Jul-15 | 03-Dec-15 |
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.1 | 6.7 | 6.9 | 7 | 7.36 | 7.52 | 7.35 | - | 7.4 | 7.35 | - | 7.08 | 7.9 | 6.78 | 7.05 | - |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.48 | 7.67 | 8.52 | 6.87 | 6.8 | 6.8 | 6.8 | 6.8 | 7 | 7.26 | 6.99 | 6.81 | 6.86 | 7 | 7.41 | 7.58 |
| EC-Field | µS/cm | - | - | 7.65 | 544 | 639 | 571 | 582 | 459 | 510 | - | 362 | 374 | - | 252 | 345 | 367 | 424 | - |
| EC-Lab | µS/cm | - | - | 686 | 517 | 580 | 537 | 614 | 492 | 533 | 456 | 429 | 431 | 235 | 274 | 367 | 383 | 419 | 364 |
| Total Dissolved Solids | mg/L | 500 | - | 418 | 332 | 360 | 338 | 348 | 294 | 314 | 254 | 230 | 258 | 140 | 168 | 228 | 213 | 230 | 228 |
| Temperature-Field | °C | - | - | 9.34 | 9.8 | 11.37 | 10.62 | 9.69 | 10.5 | 10.62 | - | 9.46 | 10.14 | - | 10.21 | 9.74 | 11.53 | 12.5 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | | |
| Chloride | mg/L | 250 | - | 33.5 | 28.5 | 30.1 | 26.7 | 24.1 | 18.7 | 26.3 | 16.3 | 17.4 | 15.4 | 6.96 | 9.09 | 13 | 12.4 | 17.9 | 16.8 |
| Sulphate | mg/L | 500 | 100 | 28.7 | 22 | 18 | 18.2 | 14.4 | 18.8 | 18.7 | 19 | 18.6 | 22.4 | 14.2 | 15.5 | 16.8 | 17.2 | 16.7 | 15.7 |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | <0.05 | <0.05 | <0.05 | <0.05 | 0.09 | 0.17 | <0.05 | <0.05 | 0.153 | 0.066 | 0.776 | 0.937 | 2.52 | 1.56 | 1.63 | 2.61 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | <0.01 | <0.01 | <0.01 | 0.03 | <0.01 | <0.01 | <0.01 | 0.04 | <0.01 | <0.01 | <0.01 | <0.01 | 0.02 | <0.01 | <0.01 | 0.09 |

| LOCATION | | 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE DATE | units | | | 24-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 17-Jan-13 | 09-May-13 | 16-Jul-13 | 24-Oct-13 | 05-Feb-14 | 22-May-14 | 21-Aug-14 | 12-Dec-14 | 29-Jan-15 | 08-May-15 | 30-Jul-15 | 03-Dec-15 |
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.6 | 7.6 | 7.3 | 7.5 | 7.98 | 7.61 | 7.32 | - | 7.39 | 7.53 | - | 7.05 | 7.54 | 6.8 | 6.82 | - |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.92 | 7.64 | 8.35 | 7.25 | 7.4 | 7.3 | 7.2 | 7.2 | 7.66 | 7.67 | 7.42 | 7.17 | 7.39 | 7.44 | 7.76 | 8 |
| EC-Field | µS/cm | - | - | 952 | 917 | 923 | 923 | 639 | 760 | 851 | - | 706 | 696 | - | 720 | 717 | 734 | 779 | - |
| EC-Lab | µS/cm | - | - | 868 | 839 | 849 | 872 | 672 | 799 | 895 | 856 | 839 | 821 | 814 | 782 | 763 | 758 | 814 | 828 |
| Total Dissolved Solids | mg/L | 500 | - | **536** | **536** | **534** | **530** | 380 | 464 | 464 | **504** | 443 | 490 | 425 | 428 | 425 | **660** | 460 | **525** |
| Temperature-Field | °C | - | - | 7.65 | 9.12 | 11.95 | 12.26 | 9.38 | 9.63 | 11.65 | - | 9.17 | 10.18 | - | 10.51 | 9.6 | 10.45 | 13.9 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | | |
| Chloride | mg/L | 250 | - | 55 | 56 | 53 | 54 | 43 | 48.9 | 57.3 | 55.8 | 53.4 | 49.8 | 47.9 | 46.2 | 45.7 | 42.4 | 47.6 | 50.2 |
| Sulphate | mg/L | 500 | 100 | 3.8 | 4.8 | 5 | 4.1 | 2.7 | 4.6 | 5.3 | 4.7 | 5.2 | 5.8 | 7.5 | 7.1 | 7.6 | 8.4 | 12.9 | 8.8 |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | 0.26 | 0.14 | <0.05 | <0.05 | 0.13 | 0.14 | <0.05 | <0.05 | 0.217 | <0.005 | 0.023 | 0.102 | 0.18 | 0.794 | 0.199 | 0.16 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | <0.01 | 0.01 | 0.19 | 0.2 | 0.12 | 0.02 | 0.04 | <0.02 | 0.02 | 0.02 | 0.06 | <0.01 | 0.23 | 0.04 | 0.08 | 0.01 |

H:\Project\1005\Analysis\Chemistry\2015\[Tables_B-19 to B-28.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, October 2014). 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"). Accessed June 2015.

# TABLE B-23
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR PW-1 AND PW-2
# 2012 to 2015

| 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE DATE | | | | 24-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 17-Jan-13 | 09-May-13 | 16-Jul-13 | 24-Oct-13 | 05-Feb-14 | 22-May-14 | 21-Aug-14 | 29-Jan-15 | 08-May-15 | 30-Jul-15 | 03-Dec-15 |
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7 | 6.9 | 6.9 | 6.8 | 6.33 | 7.44 | 7.67 | - | 7.03 | 6.96 | - | 7.24 | 6.56 | 6.72 | - |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.29 | 7.12 | 8.01 | 6.79 | 6.8 | 6.8 | 6.8 | 6.8 | 7.05 | 7.23 | 7.1 | 6.95 | 7.13 | 7.52 | 7.87 |
| EC-Field | µS/cm | - | - | 1434 | 1114 | 1399 | 1385 | 1201 | 1243 | 1203 | - | 1096 | 1029 | - | 1127 | 1120 | 1188 | - |
| EC-Lab | µS/cm | - | - | 1312 | 1044 | 1292 | 1320 | 1246 | 1275 | 1254 | 1279 | 1260 | 1220 | 1190 | 1180 | 1200 | 1210 | 1060 |
| Total Dissolved Solids | mg/L | 500 | - | **824** | **604** | **816** | **838** | **796** | **762** | **816** | **762** | **705** | **725** | **660** | **673** | **678** | **703** | **630** |
| Temperature-Field | °C | - | - | 10.01 | 9.89 | 12.84 | 10.7 | 10.22 | 10.89 | 11.46 | - | 9.86 | 11.14 | - | 10.19 | 11.37 | 11.23 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | |
| Chloride | mg/L | 250 | - | 84 | 46.7 | 80 | 82 | 74 | 74.7 | 68 | 69 | 72.7 | 66.9 | 74 | 71.4 | 65.8 | 68.8 | 57.9 |
| Sulphate | mg/L | 500 | 100 | 2.4 | 8.8 | 4.2 | 3.4 | 3.5 | 2.7 | 3.7 | 3.5 | 3.7 | 4.6 | 8.7 | 3.8 | 4.5 | 6.9 | 10.1 |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | 0.01 | <0.05 | <0.05 | 0.143 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | 1.64 | **14.1** | 1.22 | 1.69 | 1.26 | 0.91 | 0.9 | 0.1 | 0.84 | 0.7 | 1.67 | **1.9** | 1.42 | 1.76 | **6.4** |

| LOCATION | units | RECEIVING WATER CRITERIA | | PW-2 | PW-2 | PW-2 | PW-2 | PW-2 | PW-2 | PW-2 | PW-2 | PW-2 | PW-2 | PW-2 | PW-2 | PW-2 | PW-2 | PW-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE DATE | | | | 24-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 17-Jan-13 | 09-May-13 | 16-Jul-13 | 24-Oct-13 | 05-Feb-14 | 22-May-14 | 21-Aug-14 | 29-Jan-15 | 08-May-15 | 30-Jul-15 | 03-Dec-15 |
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 6.7 | 6.8 | 6.6 | 6.7 | 6.21 | 7.39 | 8.34 | - | 6.83 | 6.79 | - | 6.96 | 6.53 | 6.6 | - |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.23 | 7.21 | 7.95 | 6.66 | 6.6 | 6.5 | 6.5 | 6.5 | 6.75 | 6.8 | 6.72 | 6.57 | 6.81 | 7.02 | 7.1 |
| EC-Field | µS/cm | - | - | 1061 | 1073 | 1035 | 1443 | 1171 | 940 | 930 | - | 890 | 802 | - | 954 | 812 | 974 | - |
| EC-Lab | µS/cm | - | - | 1011 | 1005 | 999 | 1414 | 971 | 928 | 922 | 1099 | 1020 | 880 | 1190 | 943 | 807 | 955 | 913 |
| Total Dissolved Solids | mg/L | 500 | - | **528** | **538** | **550** | **766** | **588** | 480 | 488 | **574** | **518** | 485 | **594** | 470 | 388 | 488 | **530** |
| Temperature-Field | °C | - | - | 10.29 | 9.82 | 11.68 | 11.55 | 11.31 | 10.54 | 11.5 | - | 9.51 | 10.54 | - | 11.59 | 12.43 | 12.91 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | |
| Chloride | mg/L | 250 | - | 37 | 35.6 | 36.6 | 73 | 36.1 | 24 | 28.9 | 38.5 | 31.2 | 29.4 | 53.6 | 29.8 | 26.5 | 43.2 | 46.4 |
| Sulphate | mg/L | 500 | 100 | 18.9 | 10.5 | 6.8 | 7.9 | 16.2 | 14.3 | 13.5 | 13.5 | 16.3 | 14 | 8.3 | 11.9 | 11.9 | 9.8 | 10.3 |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | <0.05 | <0.05 | <0.05 | 0.07 | <0.05 | <0.01 | <0.05 | <0.05 | 0.266 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | **16.7** | **19** | **17** | **23.4** | **19.6** | **17.4** | **17** | **18.7** | **15.8** | **16** | **56** | **16** | **16** | **16** | **14.7** |

H:\Project\1005\Analysis\Chemistry\2015\[Tables_B-19 to B-28.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, October 2014). 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"). Accessed June 2015.

# TABLE B-24
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW13-1D AND MW13-1S
# 2013 to 2015

| LOCATION | units | RECEIVING WATER CRITERIA | | MW13-1D | | | | | | | MW13-1S | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE DATE | | | | 01-Jun-13 | 10-Sep-13 | 12-Dec-14 | 29-Jan-15 | 08-May-15 | 30-Jul-15 | 03-Dec-15 | 01-Jun-13 | 10-Sep-13 | 12-Dec-14 | 29-Jan-15 | 08-May-15 | 30-Jul-15 | 03-Dec-15 |
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | ALS | ALS | AGAT | AGAT | AGAT | AGAT | AGAT | ALS | ALS | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | - | - | 8.28 | 8.73 | 7.59 | 7.88 | - | - | - | 8.19 | 8.24 | 7.62 | 7.83 | - |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.92 | 7.8 | 8.13 | 7.93 | 7.87 | 7.73 | 8.04 | 8.41 | 8 | 7.85 | 7.67 | 7.8 | 7.91 | 8.15 |
| EC-Field | µS/cm | - | - | - | - | 3466 | 3524 | 2597 | 1722 | - | - | - | 2444 | 2189 | 1586 | 1450 | - |
| EC-Lab | µS/cm | - | - | 1320 | 3130 | 3650 | 3780 | 2660 | 1820 | 1290 | 327 | 1980 | 2610 | 2260 | 1660 | 1510 | 1280 |
| Dissolved Hardness ($CaCO_3$) | mg/L | | | 611 | 314 | 277 | 307 | 163 | 107 | 70.1 | 45.9 | 140 | - | - | - | - | - |
| Total Dissolved Solids | mg/L | 500 | - | **1020** | **2440** | **2770** | **2880** | **1980** | **1300** | **872** | 237 | **1590** | **1940** | **1670** | **1140** | **1110** | **878** |
| Temperature-Field | °C | - | - | - | - | 9.47 | 9.15 | 9.72 | 11.25 | - | - | - | 10.46 | 9.48 | 10.55 | 12.68 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | |
| Bicarbonate | mg/L | | | - | - | - | - | - | 432 | - | - | - | - | - | - | - | - |
| Chloride | mg/L | 250 | - | 54.2 | 166 | 198 | 192 | 91.6 | 65.3 | 62.4 | 8.31 | 116 | 106 | 67.7 | 38.8 | 34.9 | 31.7 |
| Sulphate | mg/L | 500 | 429 | **557** | **1220** | **915** | **1060** | **780** | **431** | 258 | 28.7 | **643** | **744** | **700** | **480** | 397 | 302 |
| **DISSOLVED CATIONS** | | | | | | | | | | | | | | | | | |
| Calcium | mg/L | - | - | 186 | 106 | 95.2 | 106 | 56.2 | 36.4 | 23 | 11.7 | 49 | - | - | - | - | - |
| Magnesium | mg/L | - | - | 35.6 | 12.1 | 9.64 | 10.2 | 5.48 | 3.81 | 3.08 | 4.06 | 4.29 | - | - | - | - | - |
| Sodium | mg/L | 200 | - | - | **555** | **904** | **1020** | **627** | **412** | **295** | - | **386** | - | - | - | - | - |
| **DISSOLVED METALS** | | | | | | | | | | | | | | | | | |
| Aluminum | mg/L | 0.1 | 0.05 | - | 0.014 | 0.019 | 0.02 | 0.013 | 0.009 | 0.004 | - | 0.024 | - | - | - | - | - |
| Antimony | mg/L | 0.006 | 0.02 | - | <0.0005 | 0.0008 | 0.0014 | 0.0014 | 0.001 | 0.0002 | - | <0.0005 | - | - | - | - | - |
| Arsenic | mg/L | 0.01 | 0.01 | - | 0.0032 | **0.074** | **0.0442** | **0.0303** | **0.0269** | **0.0115** | - | 0.0029 | - | - | - | - | - |
| Barium | mg/L | 1 | 1 | - | 0.121 | 0.092 | 0.108 | 0.058 | 0.0497 | 0.0385 | - | 0.04 | - | - | - | - | - |
| Boron | mg/L | 5 | 1.2 | - | 0.25 | 0.331 | 0.384 | 0.442 | 0.314 | 0.264 | - | 0.38 | - | - | - | - | - |
| Cadmium | mg/L | 0.005 | 0.00042 | - | 0.00012 | <0.00001 | 0.00001 | <0.00001 | <0.00001 | <0.00001 | - | <0.0001 | - | - | - | - | - |
| Chromium | mg/L | 0.05 | 0.001 | - | <0.001 | 0.0005 | 0.0009 | <0.0005 | <0.0005 | <0.0005 | - | <0.001 | - | - | - | - | - |
| Cobalt | mg/L | - | 0.05 | - | 0.00674 | 0.00041 | 0.00189 | 0.00118 | 0.00053 | 0.00054 | - | 0.0015 | - | - | - | - | - |
| Copper | mg/L | 1 | 0.01 | - | 0.0038 | <0.0002 | 0.0005 | <0.0002 | <0.0002 | 0.0002 | - | 0.0024 | - | - | - | - | - |
| Iron | mg/L | 0.3 | 0.35 | - | **0.588** | 0.049 | 0.153 | 0.092 | 0.03 | 0.02 | - | 0.043 | - | - | - | - | - |
| Lead | mg/L | 0.01 | 0.014 | - | <0.001 | 0.00014 | 0.00022 | 0.00009 | <0.00005 | <0.00005 | - | <0.001 | - | - | - | - | - |
| Lithium | mg/L | - | 0.014 | - | <0.05 | **0.0386** | **0.0638** | **0.0626** | **0.0419** | **0.0325** | - | <0.05 | - | - | - | - | - |
| Manganese | mg/L | 0.05 | 1.705 | - | **3.26** | **1.53** | **1.65** | **1.02** | **0.843** | **1** | - | **0.489** | - | - | - | - | - |
| Mercury | µg/L | 1 | 0.02 | - | - | <0.01 | 0.01 | <0.01 | <0.01 | <0.01 | - | - | - | - | - | - | - |
| Molybdenum | mg/L | - | 2 | - | 0.0255 | 0.00252 | 0.00832 | 0.0053 | 0.00396 | 0.0072 | - | 0.023 | - | - | - | - | - |
| Nickel | mg/L | - | 0.15 | - | 0.0103 | 0.005 | 0.01 | 0.0061 | 0.0036 | 0.0021 | - | 0.0067 | - | - | - | - | - |
| Selenium | mg/L | 0.01 | - | - | <0.002 | 0.0045 | 0.0007 | <0.0005 | <0.0005 | <0.0005 | - | <0.002 | - | - | - | - | - |
| Silver | mg/L | - | - | - | <0.00005 | <0.00002 | 0.00011 | 0.00018 | <0.00002 | <0.00002 | - | <0.00005 | - | - | - | - | - |
| Thallium | mg/L | - | 0.0003 | - | <0.0002 | <0.00001 | 0.00002 | <0.00001 | <0.00001 | 0.00002 | - | <0.0002 | - | - | - | - | - |
| Titanium | mg/L | - | 2 | - | - | - | - | - | 0.003 | 0.0014 | - | - | - | - | - | - | - |
| Uranium | mg/L | 0.02 | 0.033 | - | **0.044** | **0.0254** | **0.061** | **0.0322** | 0.0185 | 0.0129 | - | **0.0387** | - | - | - | - | - |
| Vanadium | mg/L | - | - | - | <0.03 | 0.0096 | 0.0076 | 0.0037 | 0.0029 | 0.0014 | - | <0.03 | - | - | - | - | - |
| Zinc | mg/L | 5 | 0.128 | - | 0.012 | <0.002 | 0.004 | <0.002 | <0.002 | <0.002 | - | 0.0073 | - | - | - | - | - |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3.00 | 1.21 | <0.1 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | 0.152 | <0.1 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| Ammonia Nitrogen | mg/L as N | - | 1.80 | 0.0972 | <0.005 | 0.01 | 0.04 | 0.01 | <0.01 | <0.01 | 0.036 | <0.005 | 0.01 | <0.01 | 0.27 | <0.01 | <0.01 |
| **POLLUTANT TESTS** | | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | - | 700 | 770 | 800 | 470 | 242 | 197 | - | 491 | - | - | - | - | - |

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, October 2014). 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"). Accessed June 2015.
Aquatic life guidelines for sulphate, cadmium (dissolved), copper, lead, manganese and zinc are based on total hardness, which varies between samples. Guidelines shown are based on average hardness of 250 mg/L.

# TABLE B-25
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR MW13-2D AND MW13-2S
# 2013 to 2015

| LOCATION | | RECEIVING WATER CRITERIA | | MW13-2D | | | | | | | MW13-2S | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SAMPLE DATE | units | | | 01-Jun-13 | 10-Sep-13 | 12-Dec-14 | 29-Jan-15 | 08-May-15 | 30-Jul-15 | 03-Dec-15 | 10-Sep-13 | 12-Dec-14 | 29-Jan-15 | 08-May-15 | 30-Jul-15 | 03-Dec-15 |
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | ALS | ALS | AGAT | AGAT | AGAT | AGAT | AGAT | ALS | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | - | - | 10.39 | 9.74 | 8.91 | 7.58 | - | - | 8.99 | 7.9 | 7.35 | 7.48 | - |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 8 | 7.65 | 9.28 | 8.78 | 8.97 | 7.75 | 8.16 | 7.94 | 7.63 | 7.57 | 7.48 | 7.91 | 8.07 |
| EC-Field | µS/cm | - | - | - | - | 170 | 161 | 228 | 572 | - | - | 387 | 2366 | 2436 | 2007 | - |
| EC-Lab | µS/cm | - | - | 370 | 5810 | 186 | 130 | 207 | 608 | 2580 | 904 | 423 | 2520 | 2510 | 2110 | 1650 |
| Dissolved Hardness ($CaCO_3$) | mg/L | | | 160 | 489 | 13.5 | 26.8 | 18.3 | 44.8 | 205 | 67.5 | - | - | - | - | - |
| Total Dissolved Solids | mg/L | 500 | - | 258 | **4180** | 96 | 70 | 88 | 403 | **2000** | **641** | 250 | **1870** | **1860** | **1610** | **1200** |
| Temperature-Field | °C | - | - | - | - | 9.27 | 9.27 | 10.35 | 12.85 | - | - | 9.75 | 9.62 | 10.36 | 11.45 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | |
| Bicarbonate | mg/L | | | - | - | - | - | - | 132 | - | - | - | - | - | - | - |
| Chloride | mg/L | 250 | - | 14.8 | **307** | 0.61 | 0.85 | 2.85 | 14.5 | 86.9 | 23.2 | 6.71 | 94 | 52.5 | 42 | 38.7 |
| Sulphate | mg/L | 500 | 429 | 64.5 | **2370** | 9.3 | 8.6 | 24.7 | 146 | **857** | 221 | 73 | **748** | **498** | 29.4 | 230 |
| **DISSOLVED CATIONS** | | | | | | | | | | | | | | | | |
| Calcium | mg/L | - | - | 37.5 | 168 | 5.11 | 10.2 | 6.85 | 16.2 | 70.1 | 24.2 | - | - | - | - | - |
| Magnesium | mg/L | - | - | 16.2 | 17.1 | 0.178 | 0.32 | 0.283 | 1.05 | 7.33 | 1.73 | - | - | - | - | - |
| Sodium | mg/L | 200 | - | - | **1120** | 33.6 | 14.1 | 33.7 | 118 | **692** | 121 | - | - | - | - | - |
| **DISSOLVED METALS** | | | | | | | | | | | | | | | | |
| Aluminum | mg/L | 0.1 | 0.05 | - | 0.021 | **0.156** | **0.122** | 0.016 | 0.026 | 0.009 | **0.067** | - | - | - | - | - |
| Antimony | mg/L | 0.006 | 0.02 | - | <0.0005 | 0.0006 | <0.0002 | 0.0005 | 0.002 | 0.0007 | 0.0052 | - | - | - | - | - |
| Arsenic | mg/L | 0.01 | 0.01 | - | **0.0072** | 0.0025 | 0.0007 | <0.0001 | 0.0016 | **0.0096** | **0.016** | - | - | - | - | - |
| Barium | mg/L | 1 | 1 | - | 0.087 | 0.0037 | 0.0074 | 0.0005 | 0.0105 | 0.0428 | 0.024 | - | - | - | - | - |
| Boron | mg/L | 5 | 1.2 | - | 0.53 | 0.027 | 0.013 | 0.002 | 0.075 | 0.386 | 0.24 | - | - | - | - | - |
| Cadmium | mg/L | 0.005 | 0.00042 | - | <0.00025 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00005 | - | - | - | - | - |
| Chromium | mg/L | 0.05 | 0.001 | - | <0.0025 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | **0.0014** | **0.0109** | - | - | - | - | - |
| Cobalt | mg/L | - | 0.05 | - | 0.00649 | 0.00009 | 0.00005 | <0.00005 | 0.00012 | 0.00051 | <0.0005 | - | - | - | - | - |
| Copper | mg/L | 1 | 0.01 | - | <0.0025 | 0.0018 | 0.0009 | <0.0002 | 0.0009 | 0.0006 | 0.0085 | - | - | - | - | - |
| Iron | mg/L | 0.3 | 0.35 | - | **4.58** | 0.014 | <0.01 | 0.017 | 0.04 | 0.04 | 0.04 | - | - | - | - | - |
| Lead | mg/L | 0.01 | 0.014 | - | <0.001 | 0.00012 | 0.00007 | <0.00005 | 0.00011 | <0.00005 | <0.001 | - | - | - | - | - |
| Lithium | mg/L | - | 0.014 | - | **0.063** | 0.0006 | 0.0008 | <0.0005 | 0.0084 | **0.0339** | <0.05 | - | - | - | - | - |
| Manganese | mg/L | 0.05 | 1.705 | - | **7.31** | 0.001 | 0.006 | 0.001 | **0.091** | **0.418** | 0.039 | - | - | - | - | - |
| Mercury | µg/L | 1 | 0.02 | - | - | <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 | 0.0154 | - | - | - | - | - |
| Nickel | mg/L | - | 0.15 | - | 0.0071 | <0.0002 | <0.0002 | <0.0002 | 0.0029 | 0.0049 | <0.005 | - | - | - | - | - |
| Selenium | mg/L | 0.01 | - | - | <0.005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | 0.0017 | - | - | - | - | - |
| Silver | mg/L | - | - | - | <0.00005 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00005 | - | - | - | - | - |
| Thallium | mg/L | - | 0.0003 | - | <0.0005 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | 0.00001 | <0.0002 | - | - | - | - | - |
| Titanium | mg/L | - | 2 | - | - | - | - | - | 0.0007 | 0.0023 | - | - | - | - | - | - |
| Uranium | mg/L | 0.02 | 0.033 | - | **0.0542** | 0.00033 | 0.00025 | 0.00008 | 0.00262 | 0.0104 | 0.00916 | - | - | - | - | - |
| Vanadium | mg/L | - | - | - | <0.06 | 0.0159 | 0.0042 | <0.0005 | 0.0019 | 0.0053 | <0.03 | - | - | - | - | - |
| Zinc | mg/L | 5 | 0.128 | - | <0.01 | <0.002 | <0.002 | <0.002 | 0.005 | 0.006 | 0.0052 | - | - | - | - | - |
| **NUTRIENTS** | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3.00 | 0.358 | <0.25 | 0.045 | 0.068 | 0.164 | <0.005 | <0.005 | <0.05 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| Ammonia Nitrogen | mg/L as N | - | 1.80 | 0.0308 | 0.0142 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.0106 | <0.01 | <0.01 | <0.01 | <0.01 | 0.01 |
| **POLLUTANT TESTS** | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | - | 1280 | <10 | 10 | 25 | 77 | 363 | 43 | - | - | - | - | - |

H:\Project\1005\Analysis\Chemistry\2015\[Tables_B-19 to B-28.xlsx]Table B-25 MW13-2

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, October 2014). 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"). Accessed June 2015.
Aquatic life guidelines for sulphate, cadmium (dissolved), copper, lead, manganese 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 HEATH CREEK
# 2012 to 2015

| SAMPLE DATE | units | RECEIVING WATER CRITERIA | | 23-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 16-Jan-13 | 07-May-13 | 16-Jul-13 | 23-Oct-13 | 05-Feb-14 | 21-May-14 | 20-Aug-14 | 12-Dec-14 | 28-Jan-15 | 23-Apr-15 | 30-Jul-15 | 03-Dec-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.4 | 7.7 | 7.5 | 7.6 | 7.85 | 6.93 | 6.85 | - | 7.67 | 7.17 | - | **9.33** | 6.82 | - | 7.79 | - |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 6.98 | **10.26** | **8.76** | 7.67 | 7.4 | 7.3 | 7.5 | 7.5 | 7.29 | 7.4 | 6.84 | 6.53 | 6.67 | 7.22 | 7.27 | 7.39 |
| EC-Field | µS/cm | - | - | 49.1 | 56 | 70 | 69 | 54 | 58 | 72 | - | 1.76 | 61 | - | 32 | 57 | - | 73 | - |
| EC-Lab | µS/cm | - | - | 43 | 66 | 71 | 60 | 59 | 62 | 72 | 70 | 59 | 69 | 79 | 30 | 52 | 53 | 73 | 52 |
| Total Hardness (CaCO3) | mg/L | - | - | - | - | - | - | - | - | - | - | - | - | - | 14.7 | 20.4 | 21 | 29.8 | 22 |
| ORP | mV | - | - | 180.2 | 103.1 | 43 | 74.1 | 128.9 | 271 | 129 | - | 208.2 | -72.8 | - | -33.4 | - | - | - | - |
| Temperature-Field | °C | - | - | 3.18 | 12.08 | 14.63 | 8.4 | 3.61 | 12.52 | 14.02 | - | 1.01 | 13.11 | - | 8.72 | 7.26 | - | 18.91 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | | |
| Chloride | mg/L | 250 | - | 3.5 | 3.5 | 3.1 | 3.6 | 4.4 | 2.71 | 2.7 | 3.1 | 2.76 | 3.72 | 2.56 | 1.47 | 2.8 | 1.93 | 2.31 | 2.1 |
| **TOTAL METALS** | | | | | | | | | | | | | | | | | | | |
| Cadmium | mg/L | 0.005 | 0.00009 | - | - | - | - | - | - | <0.00001 | <0.00001 | 0.00001 | <0.00001 | <0.00001 | 0.00002 | <0.00001 | 0.00002 | <0.00001 | <0.00001 |
| Chromium | mg/L | 0.05 | 0.02 | 0.0005 | <0.0004 | <0.0004 | <0.0005 | <0.0005 | <0.005 | 0.0005 | <0.0004 | <0.0005 | <0.0005 | <0.0005 | 0.0032 | <0.0005 | 0.001 | <0.0005 | <0.0005 |
| Iron | mg/L | 0.3 | 1.0 | 0.199 | 0.095 | 0.022 | 0.169 | 0.093 | 0.163 | 0.095 | 0.153 | 0.188 | 0.103 | 0.053 | **2.17** | 0.16 | 0.115 | 0.04 | 0.28 |
| Manganese | mg/L | 0.05 | 0.74 | 0.005 | 0.006 | <0.005 | 0.006 | 0.0033 | <0.01 | 0.0069 | <0.005 | 0.003 | 0.005 | 0.009 | **0.104** | 0.005 | 0.005 | 0.009 | 0.007 |
| Zinc | mg/L | 5 | 0.0075 | 0.002 | 0.001 | <0.001 | 0.0007 | 0.001 | **0.013** | <0.001 | - | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | 0.06 | <0.05 | 0.22 | 0.14 | 0.1 | 0.16 | 0.17 | 0.06 | 0.114 | 0.116 | 0.14 | 0.154 | 0.116 | 0.047 | 0.173 | 0.291 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | <0.01 | <0.01 | 0.06 | <0.01 | <0.01 | <0.01 | 0.02 | <0.02 | <0.01 | <0.01 | 0.02 | 0.04 | <0.01 | <0.01 | <0.01 | 0.01 |
| Total Phosphorus | mg/L as P | - | - | 0.009 | 0.007 | <0.003 | 0.005 | <0.003 | 0.022 | 0.003 | 0.003 | <0.005 | <0.005 | <0.005 | 0.039 | 0.005 | <0.005 | <0.005 | 0.005 |
| **POLLUTANT TESTS** | | | | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | 10 | 20 | <10 | 27 | 11 | 10 | <10 | 28 | <10 | <10 | <10 | 30 | 10 | <10 | <10 | <10 |

H:\Project\1005\Analysis\Chemistry\2015\[Tables_B-19 to B-28.xlsx]Table B-26 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, October 2014). 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"). Accessed June 2015.
   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 30 mg/L.

# TABLE B-27
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR STEVENS CREEK
# 2012 to 2015

| SAMPLE DATE | units | RECEIVING WATER CRITERIA | | 23-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 16-Jan-13 | 07-May-13 | 16-Jul-13 | 23-Oct-13 | 05-Feb-14 | 21-May-14 | 12-Dec-14 | 28-Jan-15 | 23-Apr-15 | 29-Jul-15 | 03-Dec-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.1 | 7.4 | 7 | 7.8 | 8.14 | 6.99 | 7.34 | - | **8.58** | 7.1 | 6.77 | 7.25 | - | **6.36** | - |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | **8.72** | **8.7** | 7.96 | 6.78 | 7.2 | 7.1 | 7.4 | 7.4 | 7.48 | 7.53 | 6.54 | 6.88 | 7.28 | 7.23 | 7.45 |
| EC-Field | µS/cm | - | - | 79.7 | 134 | 184 | 144 | 134 | 128 | 168 | - | 218 | 157 | 38 | 118 | - | 185 | - |
| EC-Lab | µS/cm | - | - | 74 | 120 | 174 | 125 | 136 | 143 | 174 | 186 | 225 | 187 | 40 | 124 | 135 | 188 | 104 |
| Total Hardness (CaCO3) | mg/L | - | - | - | - | - | - | - | - | - | - | - | - | 16.3 | 53.2 | 59.2 | 74.5 | 46 |
| ORP | mV | - | - | 224.8 | 147.2 | 34.6 | 175.1 | 153.3 | 251.6 | 19.2 | - | 191.1 | -59.1 | 13.8 | - | - | - | - |
| Temperature-Field | °C | - | - | 5.6 | 8.79 | 13.25 | 7.66 | 4.91 | 10.46 | 14.48 | - | 1.58 | 12.09 | 9.28 | 10.1 | - | 15.53 | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | |
| Chloride | mg/L | 250 | - | 2 | 2.6 | 4.4 | 5.5 | 3.5 | 3.22 | 3.4 | 7.8 | 9.7 | 7.45 | 0.96 | 3.32 | 3.87 | 4.76 | 3.86 |
| **TOTAL METALS** | | | | | | | | | | | | | | | | | | |
| Cadmium | mg/L | 0.005 | 0.00013 | - | - | - | - | - | - | 0.00002 | **0.0011** | <0.00001 | <0.00001 | 0.00002 | <0.00001 | <0.00001 | **0.00026** | <0.00001 |
| Chromium | mg/L | 0.05 | 0.02 | <0.0004 | <0.0004 | <0.0004 | <0.0005 | <0.0005 | <0.0005 | 0.0017 | 0.0005 | <0.0005 | <0.0005 | 0.0007 | <0.0005 | <0.0005 | 0.0012 | <0.0005 |
| Iron | mg/L | 0.3 | 1.0 | 0.014 | 0.01 | 0.236 | 0.007 | 0.023 | 0.026 | **0.436** | **0.475** | 0.174 | 0.02 | 0.168 | 0.136 | 0.151 | **1.02** | 0.11 |
| Manganese | mg/L | 0.05 | 0.83 | 0.02 | 0.012 | **2.16** | 0.005 | **0.0528** | 0.0156 | **0.329** | **0.663** | **0.279** | 0.025 | 0.043 | 0.035 | **0.304** | **1.65** | 0.049 |
| Zinc | mg/L | 5 | 0.0075 | 0.003 | 0.001 | **0.009** | 0.0016 | 0.0022 | 0.0015 | 0.004 | - | 0.006 | <0.005 | <0.005 | <0.005 | <0.005 | **0.05** | <0.005 |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | 0.25 | 0.24 | 0.05 | 0.14 | 0.41 | 0.08 | 0.05 | 0.17 | 0.63 | 0.078 | 0.173 | 0.321 | 0.126 | 0.043 | 0.471 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | <0.01 | <0.01 | 0.05 | 0.04 | 0.1 | <0.01 | 0.03 | <0.02 | <0.01 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| Total Phosphorus | mg/L as P | - | - | 0.012 | 0.005 | 0.013 | <0.003 | <0.003 | 0.006 | 0.019 | <0.003 | 0.005 | <0.005 | 0.009 | <0.005 | 0.011 | 0.021 | - |
| **POLLUTANT TESTS** | | | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | <10 | <10 | 10 | <10 | 10 | 17 | <10 | 26 | <10 | <10 | 20 | 20 | <10 | 45 | <10 |

| LOCATION | units | RECEIVING WATER CRITERIA | | SCK A | | | SCK B | | |
|---|---|---|---|---|---|---|---|---|---|
| SAMPLE DATE | | | | 23-Apr-15 | 29-Jul-15 | 03-Dec-15 | 23-Apr-15 | 29-Jul-15 | 03-Dec-15 |
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | AGAT | | AGAT | AGAT | | AGAT |
| **PHYSICAL TESTS** | | | | | dry | | | dry | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | - | | - | - | | - |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 6.77 | | 7.13 | 6.62 | | 7.07 |
| EC-Field | µS/cm | - | - | - | | - | - | | - |
| EC-Lab | µS/cm | - | - | 465 | | 372 | 166 | | 96 |
| Total Hardness ($CaCO_3$) | mV | - | - | 224 | | 276 | 81.4 | | 50 |
| Temperature-Field | °C | - | - | - | | - | - | | - |
| **DISSOLVED ANIONS** | | | | | | | | | |
| Chloride | mg/L | 250 | - | 18.9 | | 9.47 | 3.92 | | 3.63 |
| **TOTAL METALS** | | | | | | | | | |
| Cadmium | mg/L | 0.005 | 0.00013 | 0.00011 | | **0.00107** | <0.00001 | | <0.00001 |
| Chromium | mg/L | 0.05 | 0.02 | 0.0078 | | **0.0601** | <0.0005 | | <0.0005 |
| Iron | mg/L | 0.3 | 1.0 | **7.26** | | **69.6** | 0.198 | | 0.03 |
| Manganese | mg/L | 0.05 | 0.83 | **0.725** | | **2.74** | **0.214** | | 0.049 |
| Zinc | mg/L | 5 | 0.0075 | **0.01** | | **0.076** | <0.005 | | <0.005 |
| **NUTRIENTS** | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | 1.5 | | 0.589 | 0.27 | | 0.665 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | 0.42 | | 0.75 | 0.17 | | 0.02 |
| Total Phosphorus | mg/L as P | - | - | 0.139 | | 0.391 | 0.041 | | 0.007 |
| **POLLUTANT TESTS** | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | 60 | | 118 | 30 | | <10 |

H:\Project\1005\Analysis\Chemistry\2015\[Tables_B-19 to B-28.xlsx]Table B-27 StevensCrk

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, October 2014). 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"). Accessed June 2015.
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-28
# SUMMARY OF INORGANIC CHEMISTRY DATA FOR CHRISTIE CREEK
# 2012 to 2015

DOWNSTREAM SAMPLING SITE

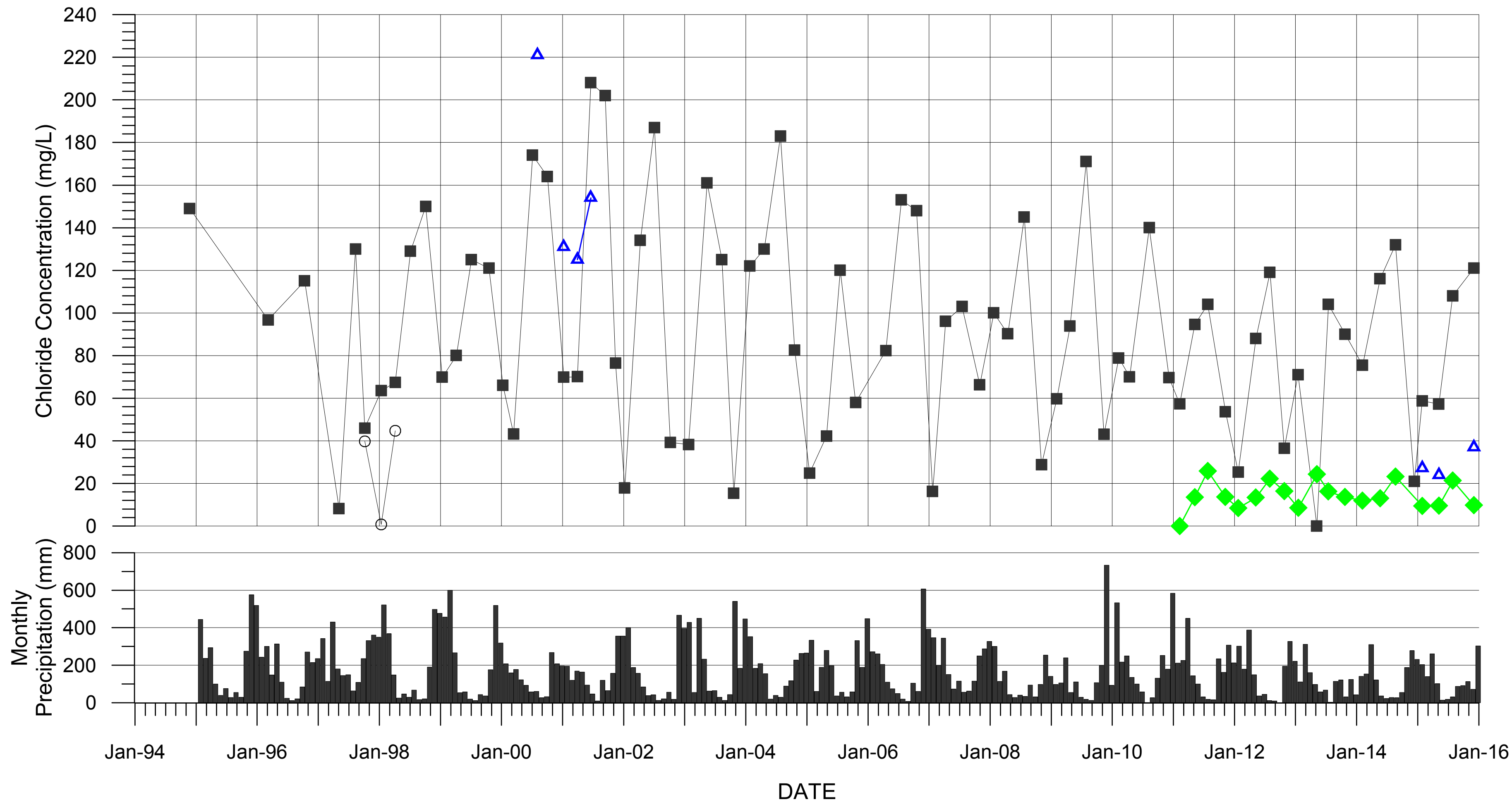
| SAMPLE DATE | units | RECEIVING WATER CRITERIA | | 24-Jan-12 | 08-May-12 | 31-Jul-12 | 25-Oct-12 | 17-Jan-13 | 09-May-13 | 16-Jul-13 | 24-Oct-13 | 05-Feb-14 | 22-May-14 | 12-Dec-14 | 29-Jan-15 | 23-Apr-15 | 30-Jul-15 | 03-Dec-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | AGAT | AGAT | | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | | | | | dry | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7 | 7.3 | 7.2 | 6.7 | 8.17 | 7.68 | 7.72 | - | 8.08 | 8.14 | 7.38 | **8.57** | - | | - |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | **8.81** | 8.09 | **9.15** | 7.01 | 6.7 | 6.9 | 7.1 | 6.8 | 6.87 | 7.26 | **6.4** | **6.44** | 7.01 | | 7.19 |
| EC-Field | µS/cm | - | - | 41.3 | 73 | 138 | 76 | 47 | 91 | 130 | - | 91 | 108 | 32 | 63 | - | | - |
| EC-Lab | µS/cm | - | - | 35 | 66 | 135 | 83 | 50 | 94 | 124 | 100 | 93 | 134 | 34 | 63 | 77 | | 53 |
| Total Hardness ($CaCO_3$) | mg/L | - | - | - | - | - | - | - | - | - | - | - | - | 14.8 | 28 | 34.5 | | 24 |
| ORP | mV | - | - | 75.8 | 59.2 | 0.8 | 87 | 83.9 | 275 | 43.2 | - | 20.3 | -58.1 | -33.1 | - | - | | - |
| Temperature-Field | °C | - | - | 2.34 | 9.41 | 13.99 | 7.23 | 2.99 | 12.49 | 15.19 | - | 1.63 | 13.23 | 9.39 | 6.81 | - | | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | | | | | |
| Chloride | mg/L | 250 | - | 2 | 1.3 | 1.5 | 2.2 | 1.3 | 1.36 | 1.8 | 2.8 | 1.84 | 2.4 | 1.72 | 1.22 | 1.16 | | 1.59 |
| **TOTAL METALS** | | | | | | | | | | | | | | | | | | |
| Cadmium | mg/L | 0.005 | 0.00009 | - | - | - | - | - | - | <0.00001 | <0.00001 | <0.00001 | 0.00002 | <0.00001 | 0.00001 | <0.00001 | | **0.00025** |
| Chromium | mg/L | 0.05 | 0.02 | 0.0014 | <0.0004 | 0.0005 | <0.0005 | 0.0006 | <0.005 | 0.0013 | 0.0005 | 0.0012 | <0.0005 | 0.0009 | 0.0007 | 0.0007 | | 0.0007 |
| Iron | mg/L | 0.3 | 1.0 | **1.05** | **1.35** | **2.92** | **0.331** | **0.687** | **2.2** | **2.73** | **1.43** | **2.14** | **2.66** | **0.548** | **0.932** | **1.59** | | **0.43** |
| Manganese | mg/L | 0.05 | 0.74 | 0.046 | **0.212** | **2.34** | 0.0268 | **0.0905** | **0.508** | **2.6** | **0.358** | **0.432** | **0.85** | 0.02 | **0.112** | **0.175** | | 0.028 |
| Zinc | mg/L | 5 | 0.0075 | **0.018** | **0.009** | **0.01** | 0.0059 | **0.016** | **0.021** | 0.007 | - | **0.016** | **0.016** | **0.026** | **0.016** | **0.016** | | **0.02** |
| **NUTRIENTS** | | | | | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | 0.06 | <0.05 | 0.19 | <0.05 | <0.05 | 0.12 | 0.12 | <0.05 | 0.039 | 0.037 | 0.102 | 0.084 | 0.014 | | 0.224 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | <0.01 | 0.04 | 0.29 | <0.01 | 0.11 | 0.04 | 0.21 | 0.03 | 0.06 | 0.08 | <0.01 | 0.29 | 0.02 | | 0.02 |
| Total Phosphorus | mg/L as P | - | - | 0.021 | 0.014 | 0.019 | <0.05 | 0.008 | 0.016 | 0.022 | 0.004 | 0.022 | 0.019 | 0.01 | 0.015 | 0.02 | | 0.012 |
| **POLLUTANT TESTS** | | | | | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | 20 | 20 | 40 | 17 | 12 | 16 | 16 | 20 | 16 | 10 | 20 | 20 | 10 | | <10 |

UPSTREAM SAMPLING SITE

| SAMPLE DATE | units | RECEIVING WATER CRITERIA | | 24-Jan-12 | 08-May-12 | 25-Oct-12 | 17-Jan-13 | 09-May-13 | 24-Oct-13 | 12-Dec-14 | 29-Jan-15 | 23-Apr-15 | 30-Jul-15 | 03-Dec-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LAB NAME | | GCDWQ[1] | AQUATIC LIFE[2] | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | NORTH ISLAND | AGAT | AGAT | AGAT | | AGAT |
| **PHYSICAL TESTS** | | | | | | | | | | | | | dry | |
| pH-Field | pH | 6.5 - 8.5 | 6.5 - 9.0 | 6.8 | 7.6 | 6.7 | 7.59 | 7.89 | - | **8.84** | **8.74** | - | | - |
| pH-Lab | pH | 6.5 - 8.5 | 6.5 - 9.0 | 7.81 | **8.53** | 6.82 | 6.8 | 7 | 6.9 | **6.33** | **6.4** | 7 | | 6.96 |
| EC-Field | µS/cm | - | - | 38.9 | 68 | 79 | 59 | 83 | - | 40 | 78 | - | | - |
| EC-Lab | µS/cm | - | - | 31 | 66 | 73 | 49 | 891 | 82 | 36 | 61 | 72 | | 38 |
| Total Hardness ($CaCO_3$) | mg/L | - | - | - | - | - | - | - | - | 14.8 | 27.4 | 30.9 | | 17 |
| ORP | mV | - | - | 117.4 | 93.6 | 112.2 | 127.3 | 264 | - | -13.6 | - | - | | - |
| Temperature-Field | °C | - | - | 3.05 | 10.42 | 9.75 | 4.08 | 11.81 | - | 9.49 | 7.62 | - | | - |
| **DISSOLVED ANIONS** | | | | | | | | | | | | | | |
| Chloride | mg/L | 250 | - | 1.7 | 1.2 | 2 | 1.2 | 0.83 | 2.2 | 1.53 | 1.08 | 0.95 | | 1.04 |
| **TOTAL METALS** | | | | | | | | | | | | | | |
| Cadmium | mg/L | 0.005 | 0.00009 | - | - | - | - | - | - | <0.00001 | <0.00001 | <0.00001 | | 0.00001 |
| Chromium | mg/L | 0.05 | 0.02 | 0.0009 | <0.0004 | <0.0005 | <0.0005 | <0.005 | 0.0006 | 0.001 | <0.0005 | <0.0005 | | 0.0007 |
| Iron | mg/L | 0.3 | 1.0 | **0.576** | 0.11 | 0.032 | 0.175 | 0.262 | **0.354** | **0.376** | 0.163 | 0.117 | | **0.34** |
| Manganese | mg/L | 0.05 | 0.74 | 0.038 | **0.077** | 0.002 | 0.008 | **0.302** | 0.0382 | 0.019 | 0.025 | **0.158** | | 0.023 |
| Zinc | mg/L | 5 | 0.0075 | **0.028** | **0.021** | **0.019** | **0.018** | **0.049** | - | **0.037** | **0.022** | **0.027** | | **0.035** |
| **NUTRIENTS** | | | | | | | | | | | | | | |
| Nitrate | mg/L as N | 10 | 3 | 0.08 | <0.05 | <0.05 | 0.05 | <0.01 | <0.05 | 0.099 | 0.099 | 0.012 | | 0.255 |
| Ammonia Nitrogen | mg/L as N | - | 1.8 | <0.01 | 0.02 | <0.01 | <0.01 | 0.02 | <0.02 | 0.01 | <0.01 | <0.01 | | 0.02 |
| Total Phosphorus | mg/L as P | - | - | 0.018 | 0.004 | <0.05 | <0.003 | 0.008 | <0.003 | 0.026 | 0.006 | <0.005 | | 0.014 |
| **POLLUTANT TESTS** | | | | | | | | | | | | | | |
| Chemical Oxygen Demand | mg/L as O | - | - | 20 | 30 | 12 | 17 | 18 | 37 | 20 | 20 | <10 | | 11 |

H:\Project\1005\Analysis\Chemistry\2015\[Tables_B-19 to B-28.xlsx]Table B-28 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, October 2014). 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"). Accessed June 2015.
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 30 mg/L.
4. May 2013 EC-Lab considered erroneous.



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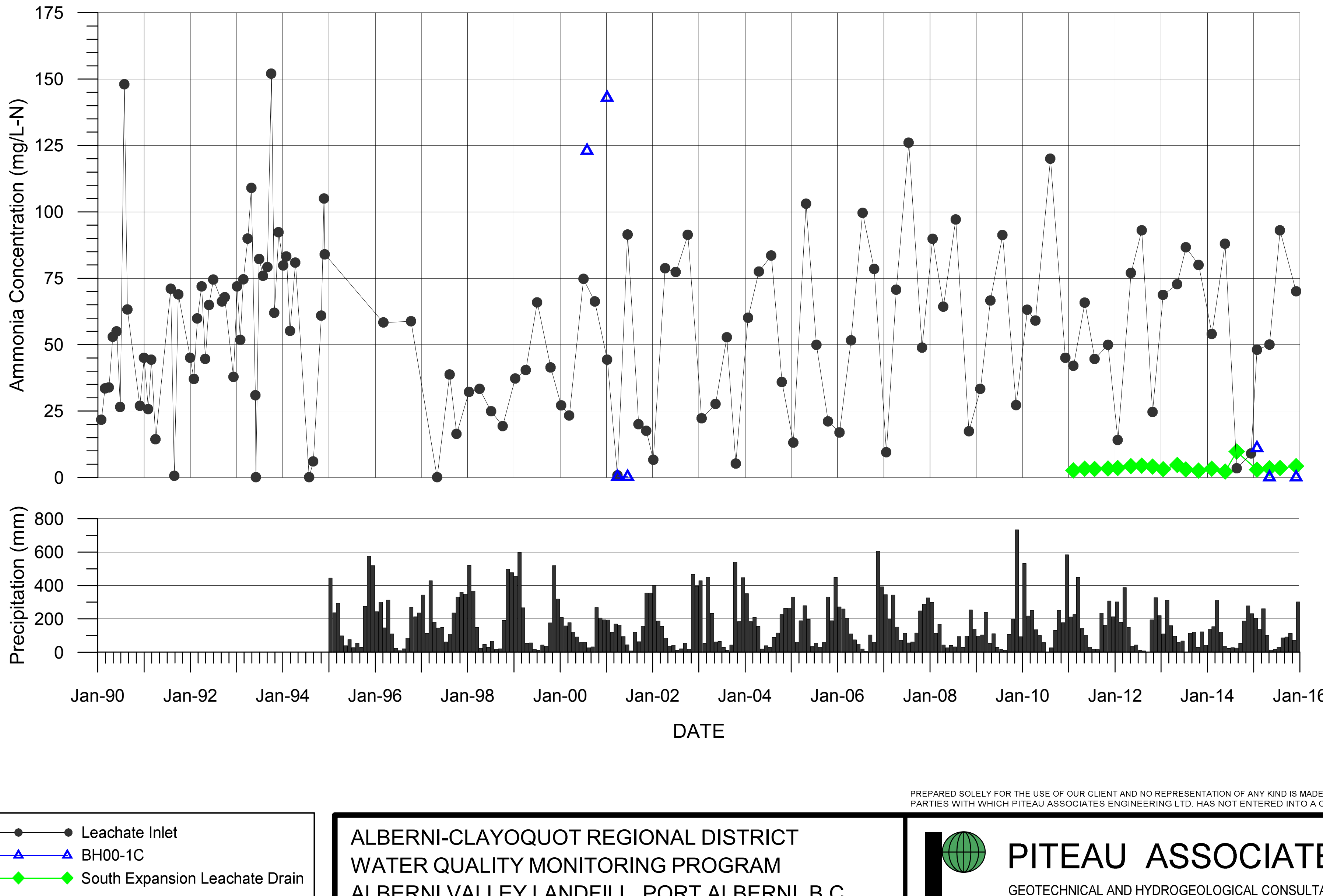
# CHLORIDE CONCENTRATION TIME-SERIES PLOT FOR LEACHATE

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: | FIG: |
| ATH | B-1 |



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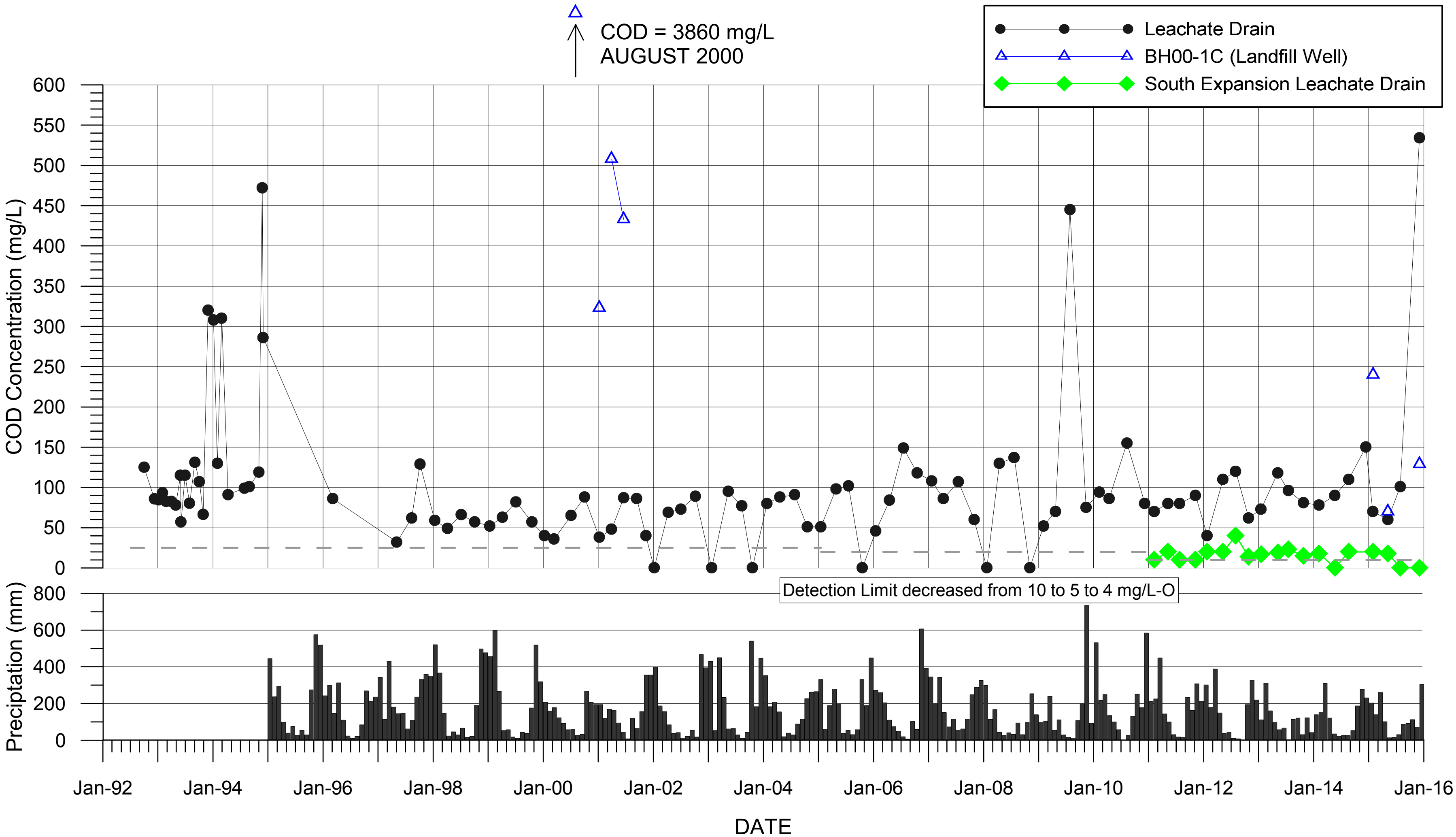
# AMMONIA CONCENTRATION TIME-SERIES PLOT FOR LEACHATE

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: | FIG: |
| ATH | B-2 |



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# COD CONCENTRATION TIME-SERIES PLOT FOR LEACHATE

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: | FIG: |
| ATH | B-3 |

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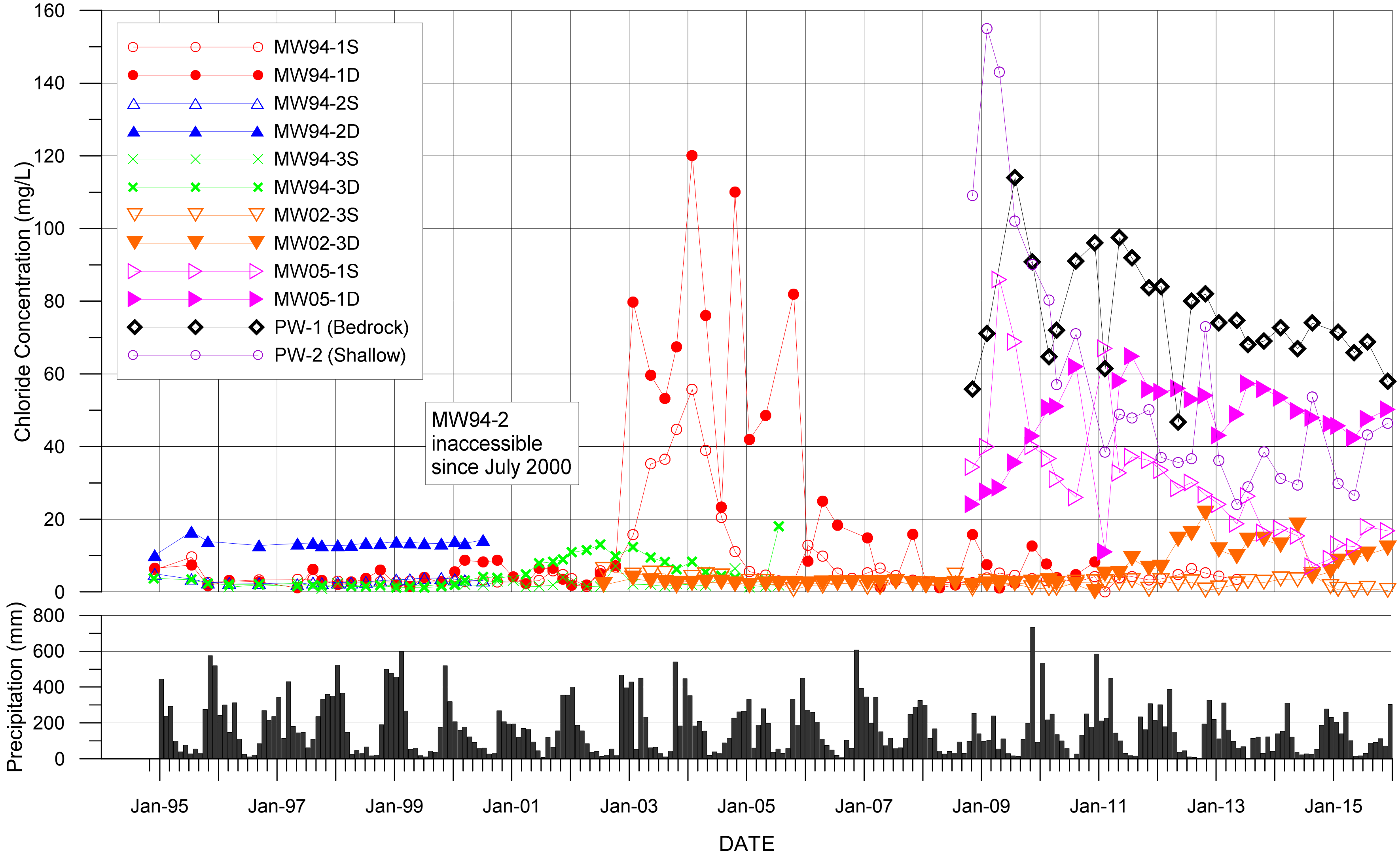




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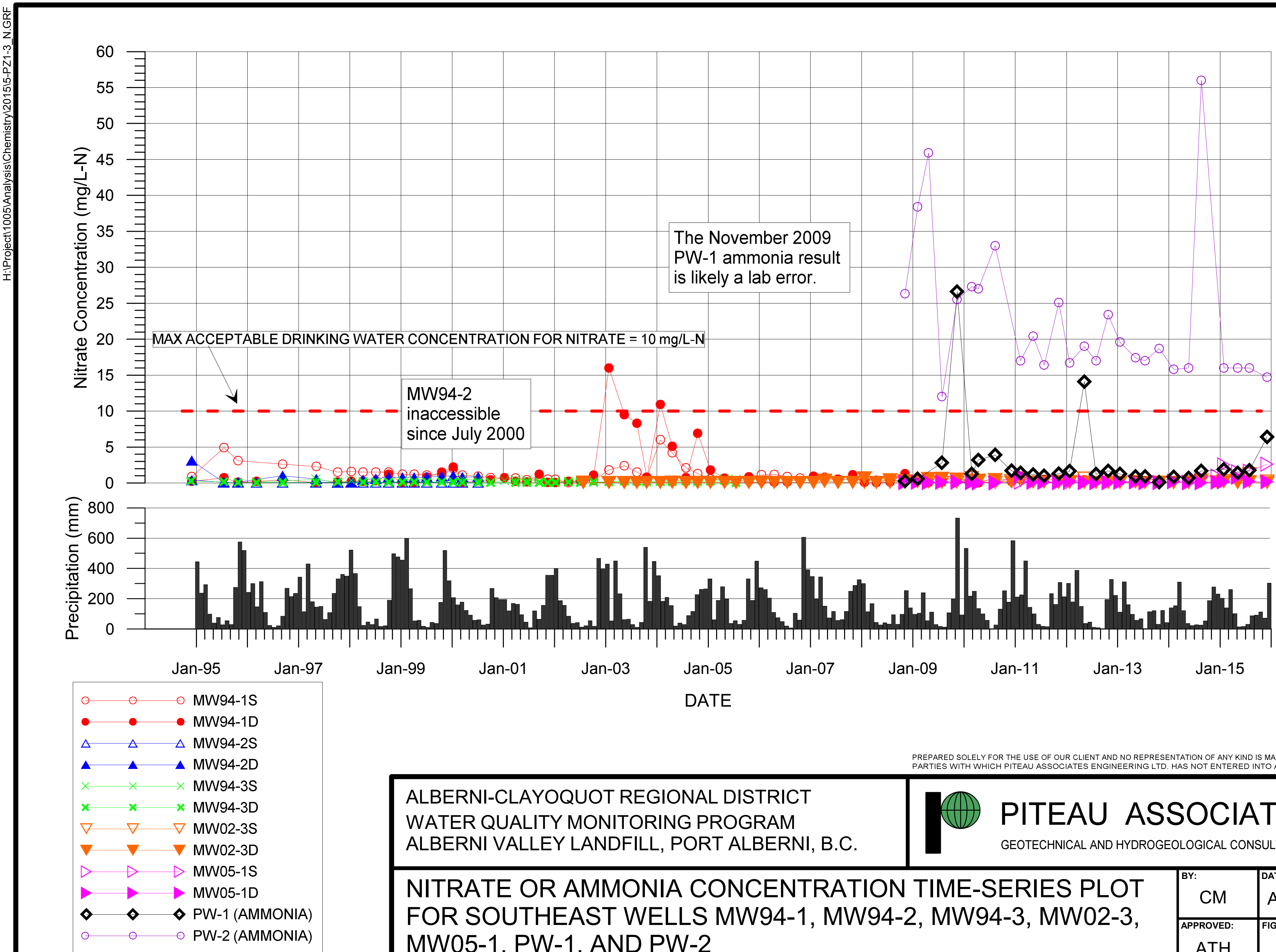
# CHLORIDE CONCENTRATION TIME-SERIES PLOT FOR SOUTHEAST WELLS MW94-1, MW94-2, MW94-3, MW02-3, MW05-1, PW-1, AND PW-2

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: | FIG: |
| ATH | B-4 |



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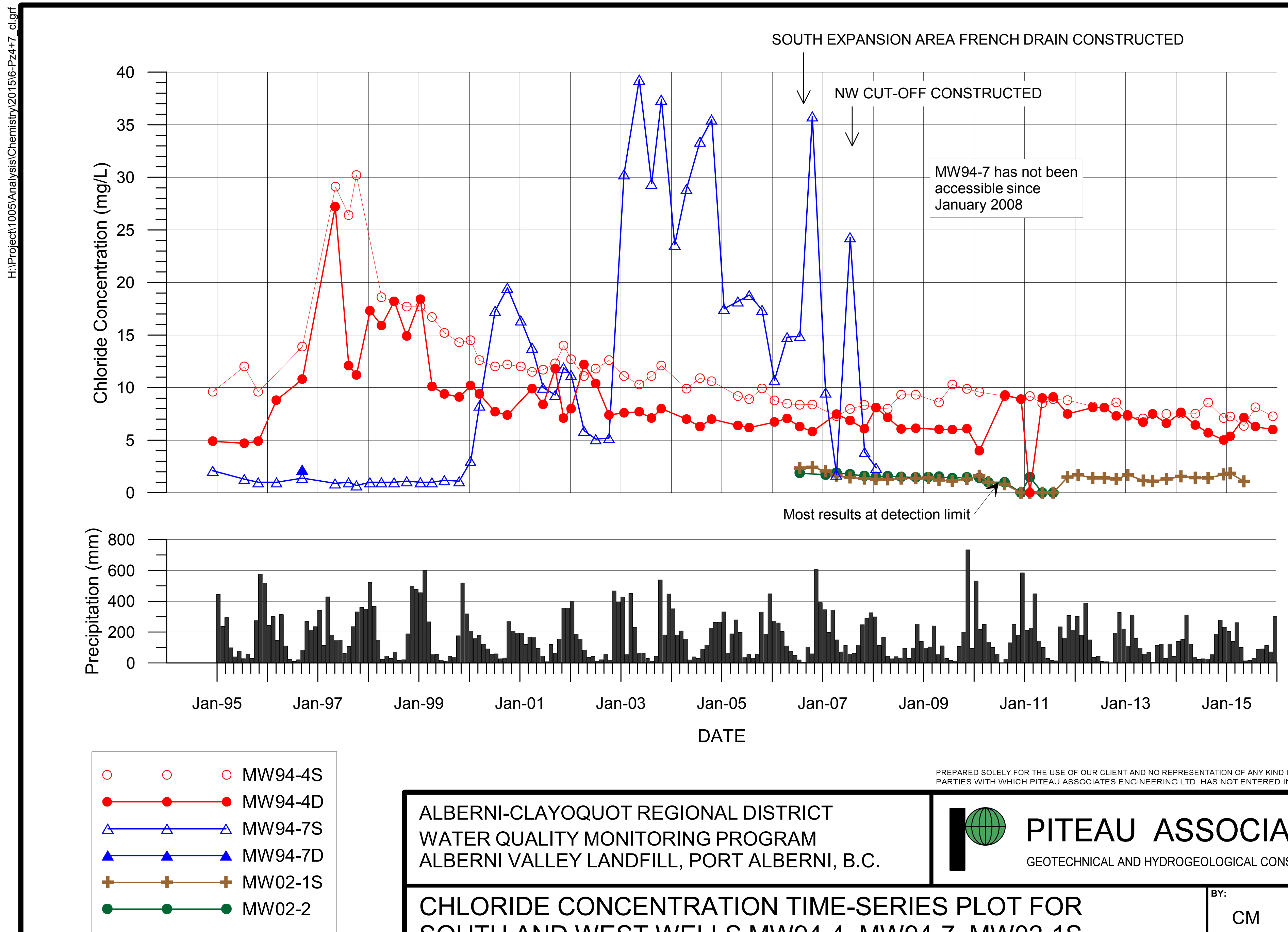
NITRATE OR AMMONIA CONCENTRATION TIME-SERIES PLOT FOR SOUTHEAST WELLS MW94-1, MW94-2, MW94-3, MW02-3, MW05-1, PW-1, AND PW-2

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: | FIG: |
| ATH | B-5 |



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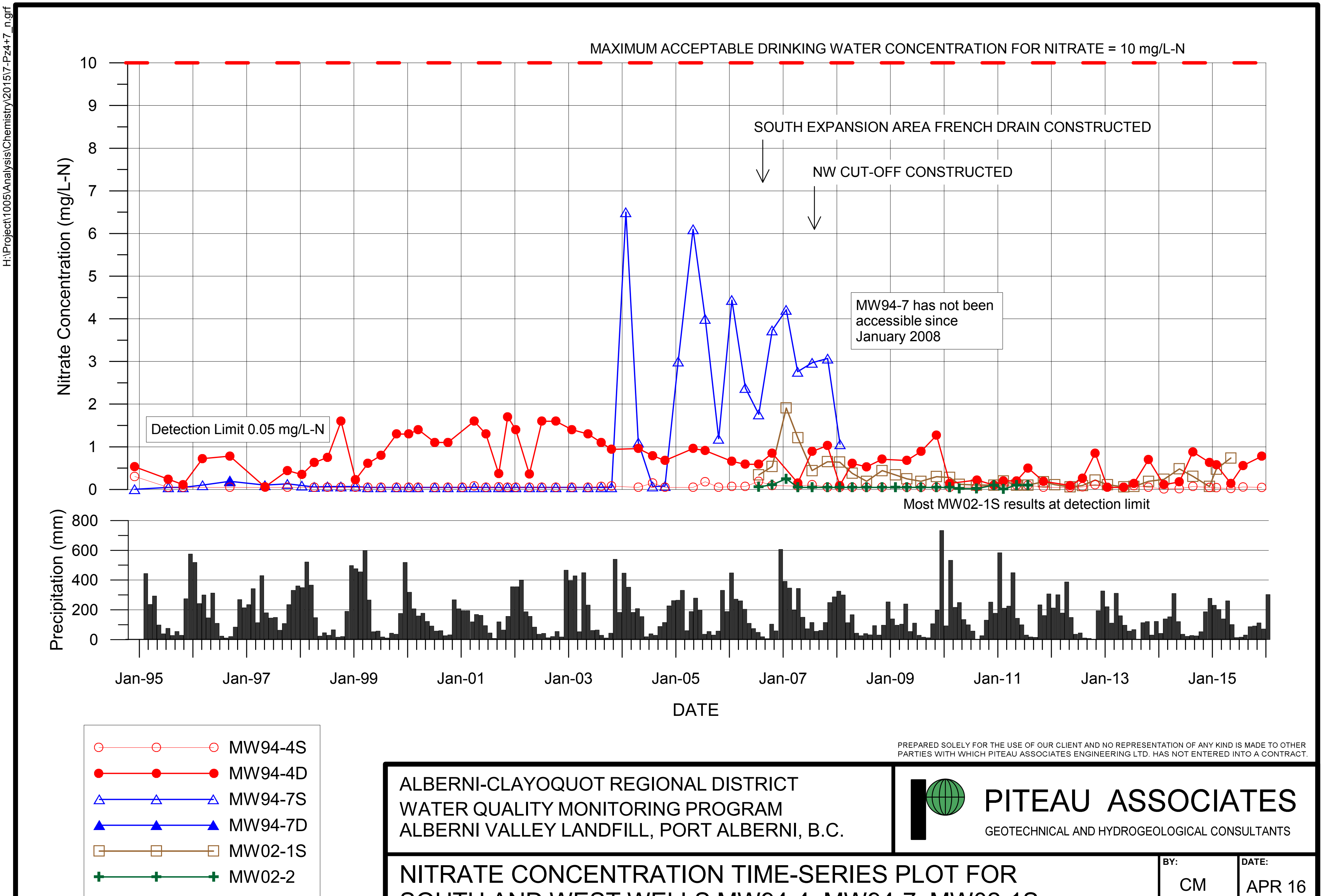
CHLORIDE CONCENTRATION TIME-SERIES PLOT FOR SOUTH AND WEST WELLS MW94-4, MW94-7, MW02-1S AND MW02-2

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: ATH | FIG: B-6 |



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

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: | FIG: |
| ATH | B-7 |

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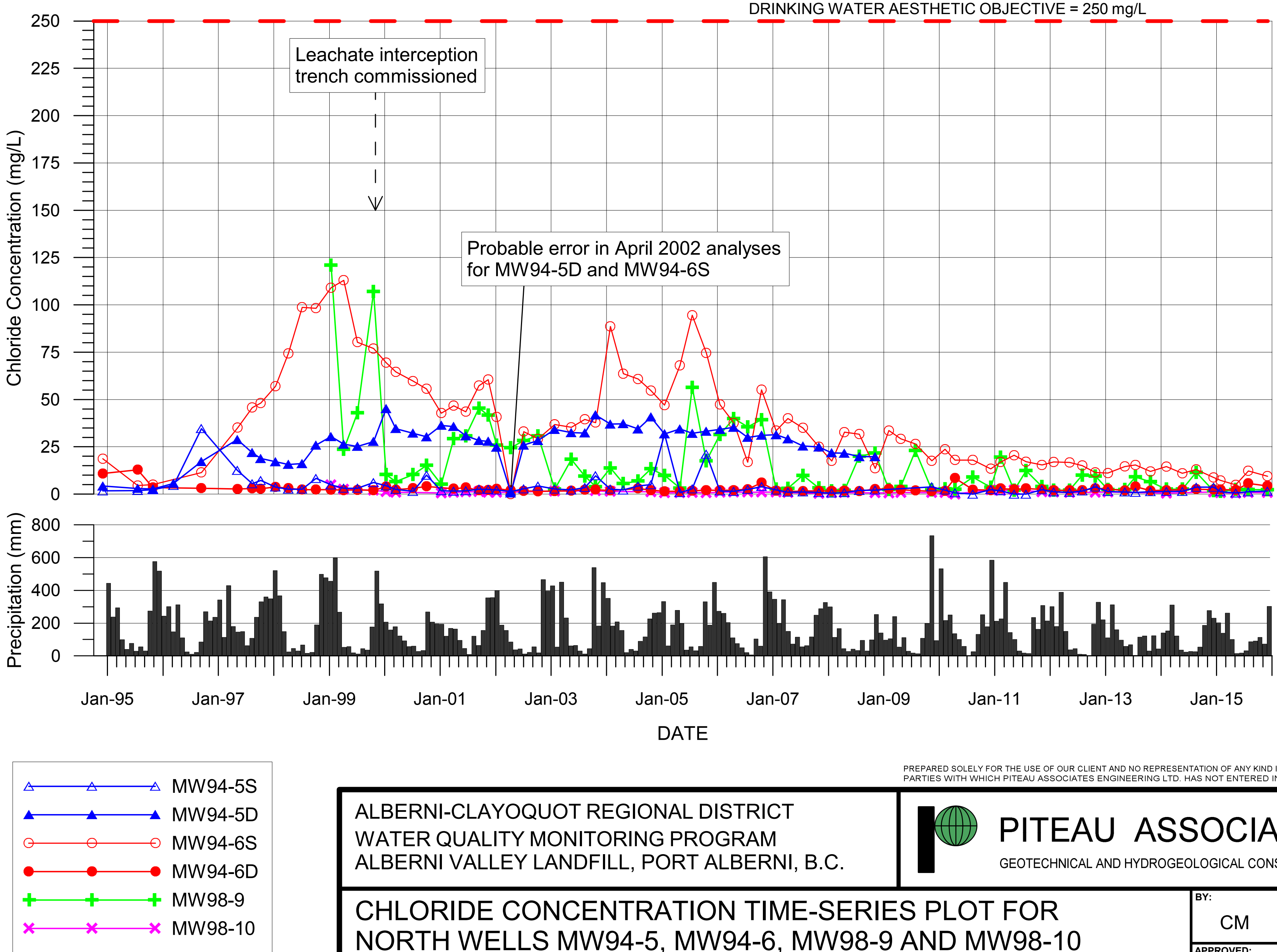




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CHLORIDE CONCENTRATION TIME-SERIES PLOT FOR
NORTH WELLS MW94-5, MW94-6, MW98-9 AND MW98-10

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: | FIG: |
| ATH | B-8 |

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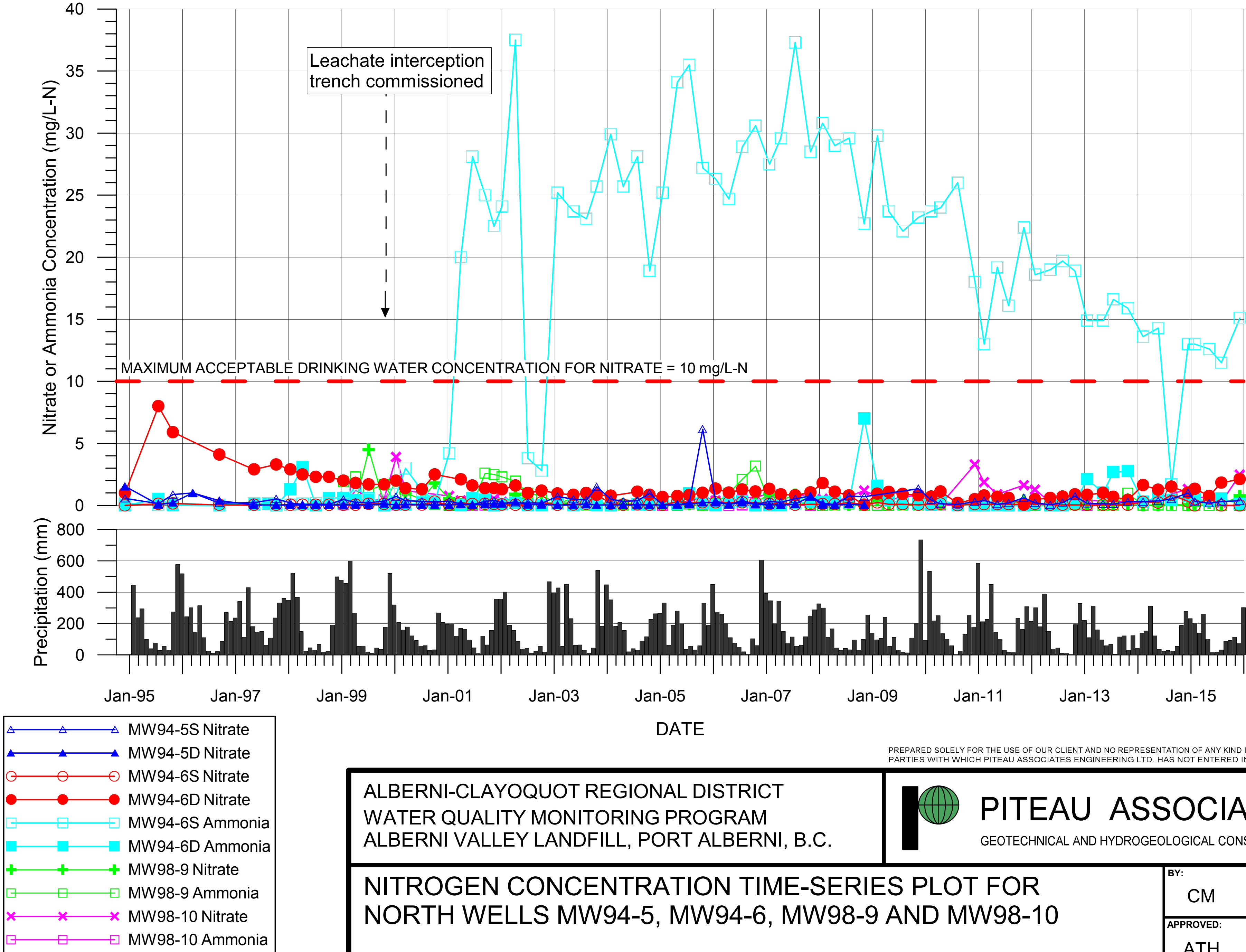




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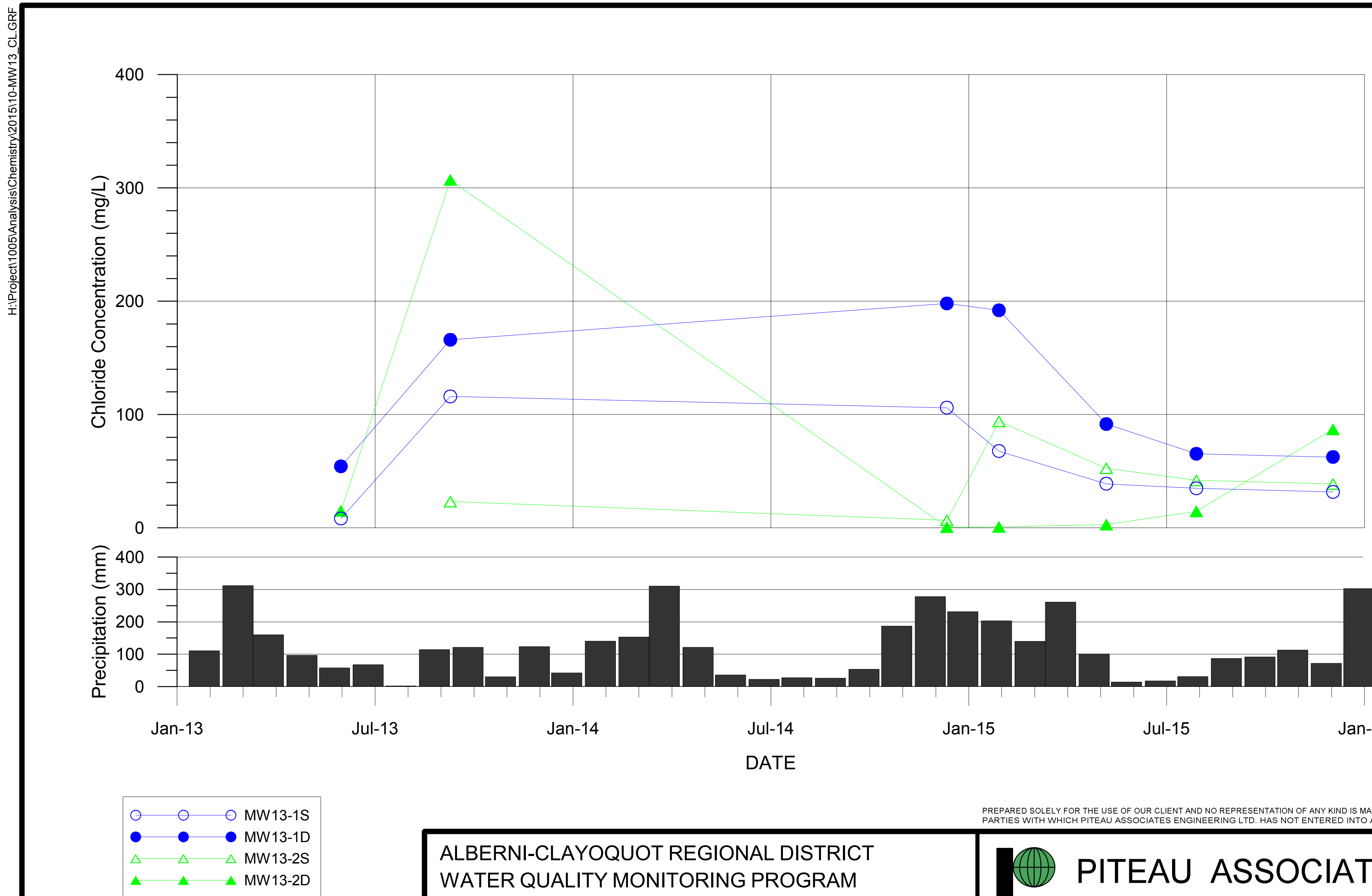
NITROGEN CONCENTRATION TIME-SERIES PLOT FOR NORTH WELLS MW94-5, MW94-6, MW98-9 AND MW98-10

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: | FIG: |
| ATH | B-9 |



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

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: | FIG: |
| ATH | B-10 |

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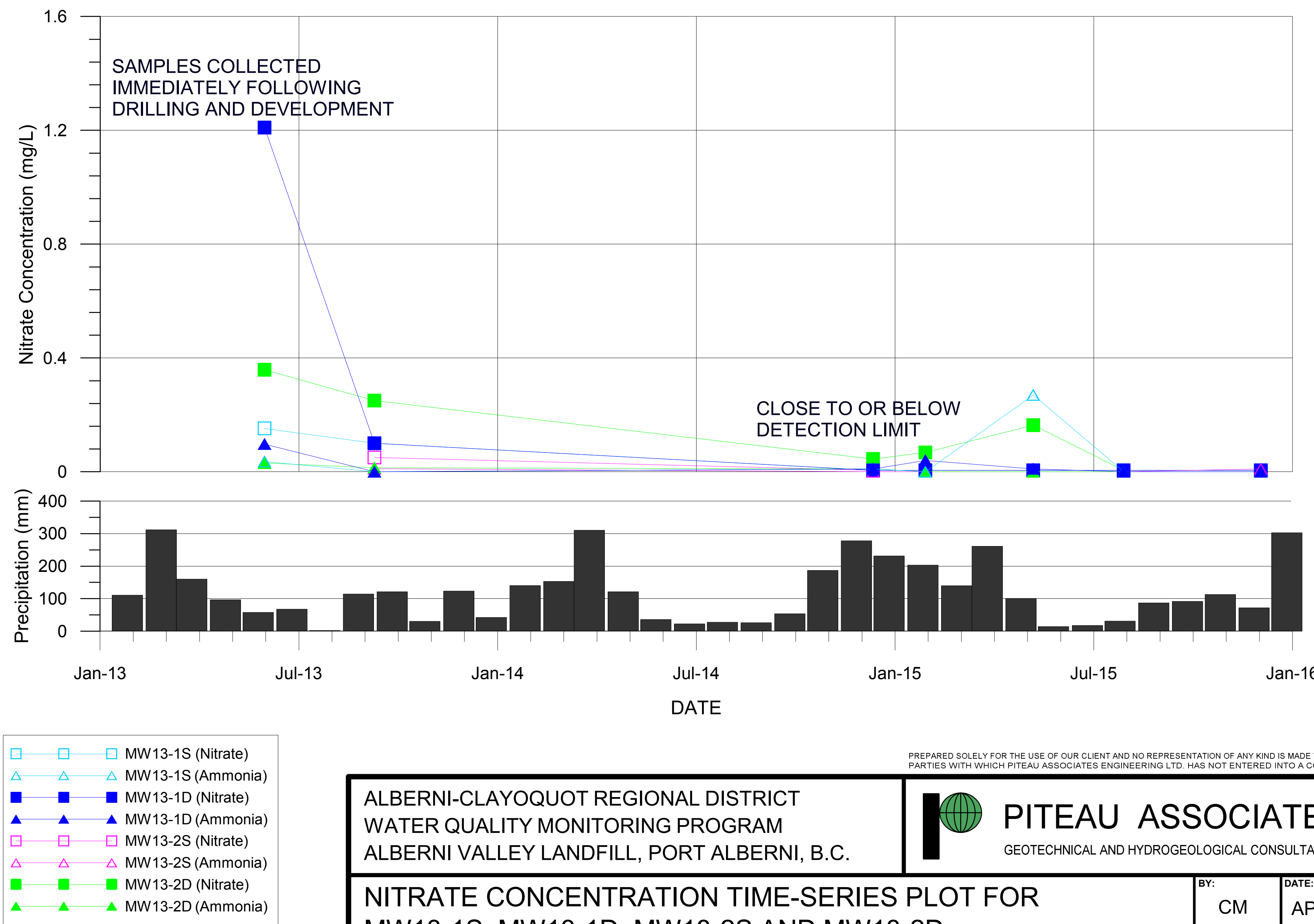




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NITRATE CONCENTRATION TIME-SERIES PLOT FOR
MW13-1S, MW13-1D, MW13-2S AND MW13-2D

BY: CM
DATE: APR 16
APPROVED: ATH
FIG: B-11

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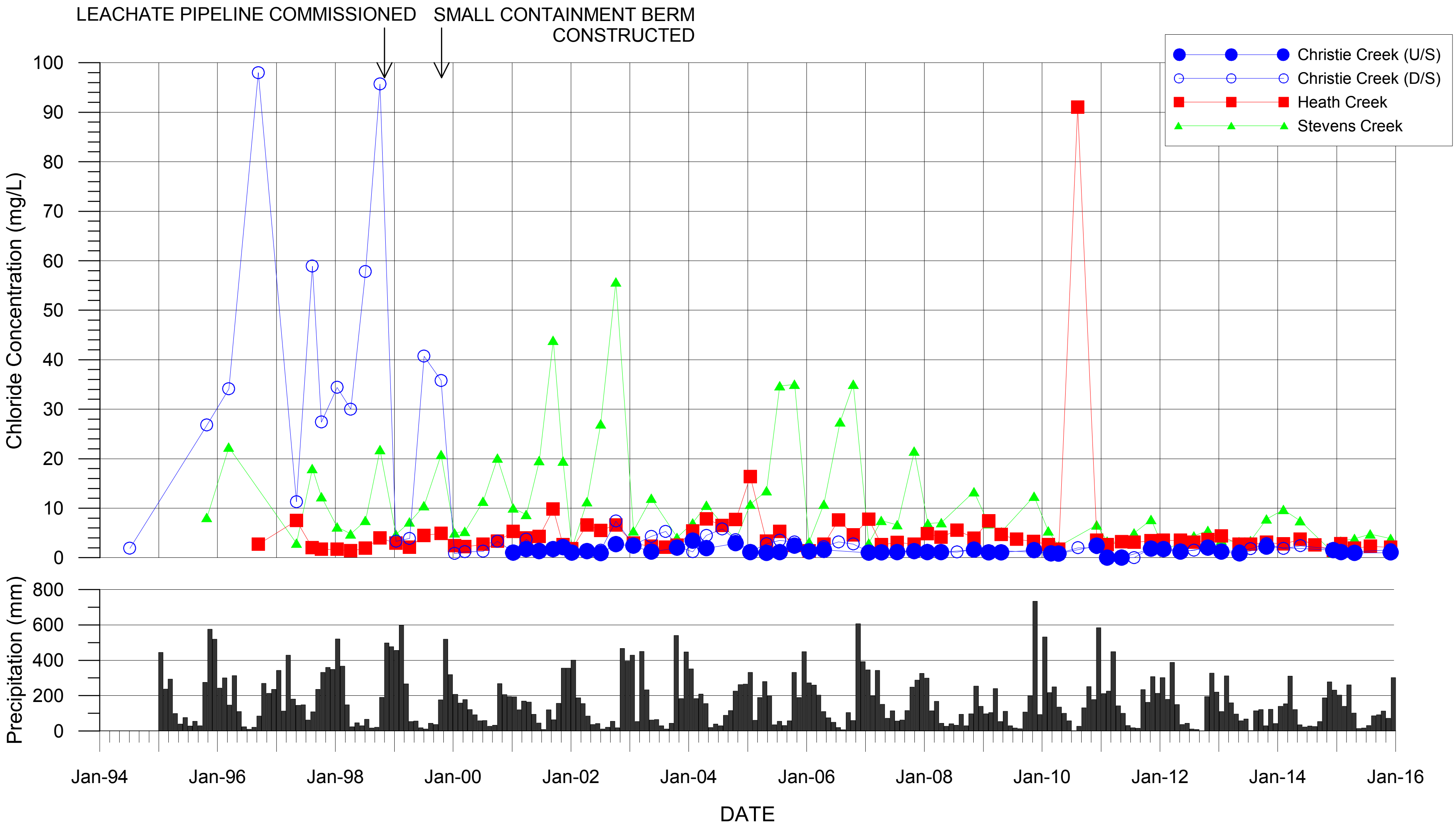




NOTE:
Christie Creek chloride concentrations dropped from a level indicative of severe leachate impact (approaching 100 mg/L), to less than 5 mg/L, and are now below background concentrations observed in Heath Creek. Values typically increase in summer, during a period of lower dilution, but are expected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

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CHLORIDE CONCENTRATION TIME-SERIES PLOT FOR CREEK SAMPLING SITES

| BY: | DATE: |
|---|---|
| CM | APR 16 |
| APPROVED: | FIG: |
| ATH | B-12 |

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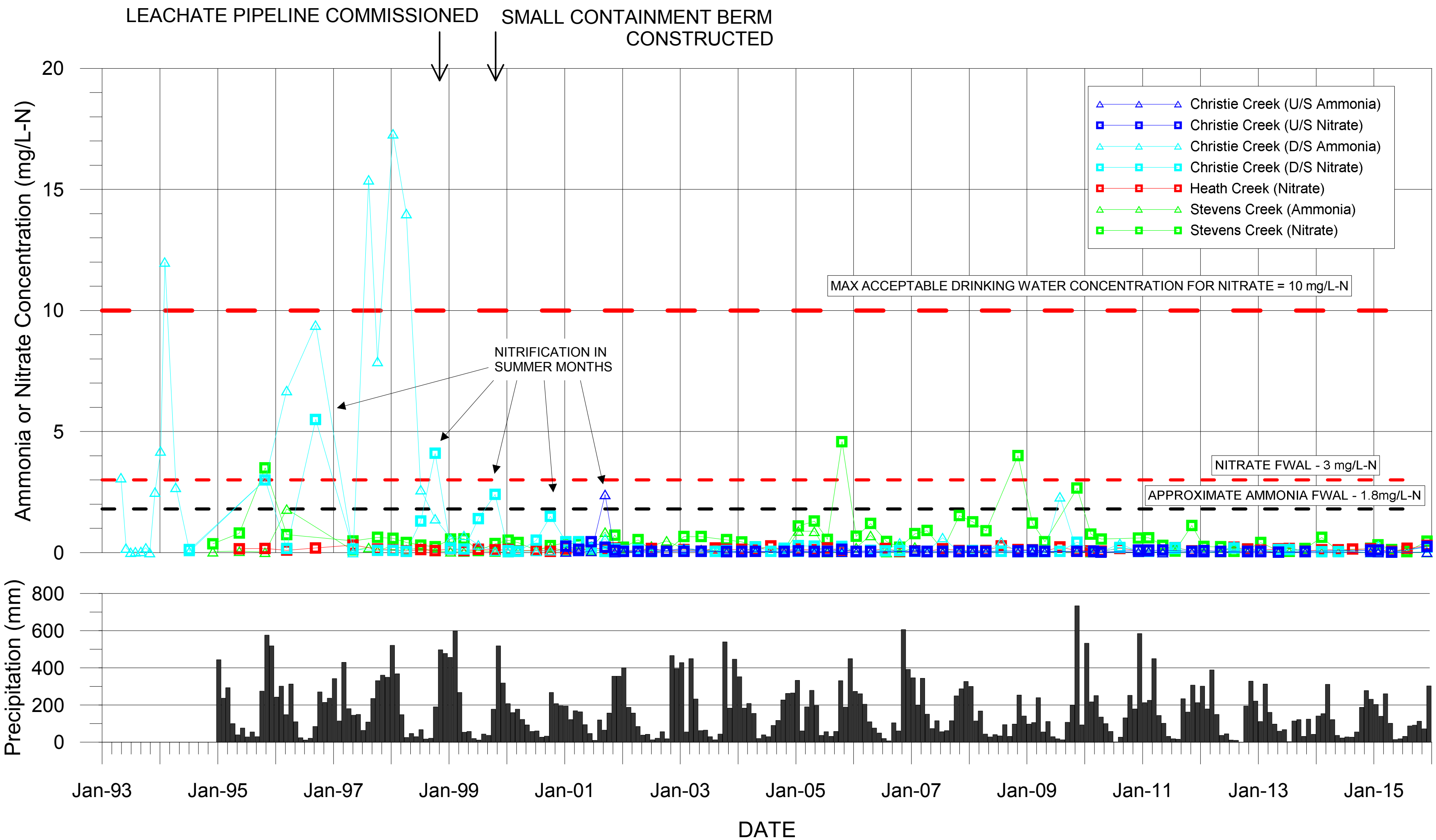


NOTE:
Winter ammonia concentrations in Christie Creek in years previous to 1999 ranged from about 6 to 17 mg/L-N, generally exceeding the aquatic life criteria of about 1.8 mg/L-N (temperature dependent). Since 2002 concentrations have stayed below 0.07mg/L-N, well below the aquatic life criteria, with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



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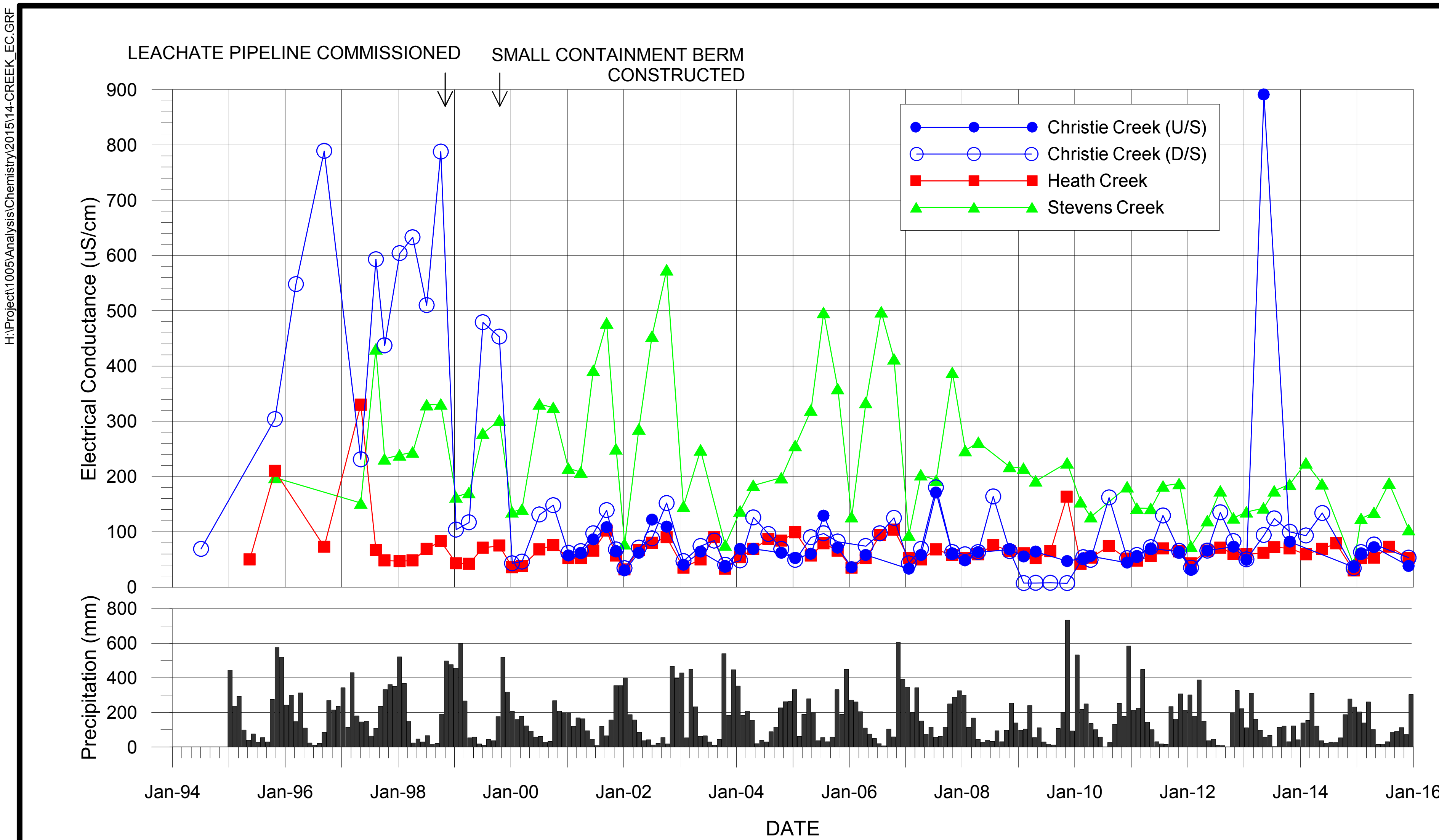
NITROGEN CONCENTRATION TIME-SERIES PLOT FOR CREEK SAMPLING SITES

| BY: CM | DATE: APR 16 |
|---|---|
| APPROVED: ATH | FIG: B-13 |




NOTE:
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: CM | DATE: APR 16 |
| --- | --- |
| APPROVED: ATH | FIG: B-14 |

# APPENDIX E

Waste Categorization from 1995 to 2015

&

Estimated Alberni Valley Landfill Waste Composition - 2015

**Summary of AVL Weigh Scale Records - 1995 to 2015 (tonnes)**

| | Year | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Waste Composition** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** |
| **Mixed Waste (Residential & Commercial)** | 14,049 | 12,714 | 14,405 | 12,824 | 11,558 | 12,037 | 11,235 | 11,554 | 12,423 | 13,670 | 14,832 | 15,395 | 17,134 | 13,332 | - | - | - | | | |
| **Residential Mixed Waste** | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 590 | 10,519 | 12,072 | 9,041 | 8,977 | 8,510 | 8,000 |
| **Indistrial, Commercial & Institutional Mixed Waste** | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 376 | 5,638 | 6,268 | 6,642 | 6,531 | 6,362 | 6,268 |
| **Construction** | | | | | | | | | | | | | | | | | | | | |
| Roofing | 1,718 | 1,218 | 837 | 927 | 1,486 | 1,385 | 669 | 880 | 731 | 832 | 1,278 | 1,518 | 1,861 | 1,624 | 1,154 | 776 | 737 | 1,230 | 1,092 | 793 |
| Gyproc | 48 | 136 | 56 | 28 | 38 | 59 | 60 | 55 | 53 | 60 | 120 | 152 | 192 | 209 | 175 | 188 | 128 | 108 | 99 | 106 |
| Mixed Demo | 2,483 | 641 | 854 | 1,449 | 1,097 | 1,130 | 1,200 | 881 | 1,254 | 1,827 | 2,789 | 2,209 | 2,412 | 2,785 | 2,376 | 2,573 | 2,228 | 2,020 | 1,876 | 2,319 |
| **Contaminated Soil** | 587 | 587 | 516 | 811 | 1,735 | 313 | 258 | 70 | 173 | 64 | 163 | 117 | 369 | 74 | 2,982 | 0 | 136 | 30 | 0 | 9 |
| **Asbestos** | 5 | 39 | 11 | 78 | 13 | 15 | 13 | 39 | 34 | 20 | 16 | 31 | 51 | 26 | 23 | 53 | 29 | 592 | 214 | 619 |
| **Land Clearing/Branches** | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 291 |
| **Compost** | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 341 |
| **Service Road Cleanup** | 763 | 0 | 15 | 84 | 32 | 27 | 27 | 21 | 4 | 6 | 0 | 0 | 0 | 10 | 11 | 1 | 1 | 0 | 2 | 3 |
| **Animal Carcasses** | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| **Total =** | **19,653** | **15,335** | **16,694** | **16,201** | **15,959** | **14,966** | **13,462** | **13,500** | **14,672** | **16,479** | **19,198** | **19,422** | **22,019** | **19,026** | **22,878** | **21,931** | **18,942** | **19,488** | **18,155** | **18,749** |

## Estimated Alberni Valley Landfill Waste Composition - 2015

| Waste Type | Mass (tonnes) | Mass (%) | Waste Category (tonnes): Relatively Inert | Waste Category (tonnes): Moderately Decomposable | Waste Category (tonnes): Decomposable |
|---|---|---|---|---|---|
| **1. Residential Mixed Waste** | **8,582** | **-** | | | |
| Organics | 4,111 | 47.9 | - | - | 4,111 |
| Paper | 1,613 | 18.8 | - | 1,613 | - |
| Plastics | 944 | 11.0 | 944 | - | - |
| Multi-material | 815 | 9.5 | 815 | - | - |
| Textiles & Rubber | 403 | 4.7 | 403 | - | - |
| Other | 172 | 2.0 | - | 172 | - |
| Wood | 34 | 0.4 | - | 34 | - |
| Ferrous | 193 | 2.3 | 193 | - | - |
| Glass | 163 | 1.9 | 163 | - | - |
| Renovation | 51 | 0.6 | 51 | - | - |
| Non-ferrous | 73 | 0.8 | 73 | - | - |
| Haz-waste | 9 | 0.1 | 9 | - | - |
| | | Subtotal = | 2,652 | 1,819 | 4,111 |
| **2. Industrial, Commercial and Institutional Mixed Waste** | **5,869** | **-** | | | |
| Organics | 1,865 | 31.8 | - | - | 1,865 |
| Paper | 2,304 | 39.3 | - | 2,304 | - |
| Plastics | 541 | 9.2 | 541 | - | - |
| Wood | 345 | 5.9 | - | 345 | - |
| Multi-material | 22 | 0.4 | 22 | - | - |
| Renovation | 0 | 0.0 | 0 | - | - |
| Textiles & Rubber | 67 | 1.1 | 67 | - | - |
| Ferrous | 289 | 4.9 | 289 | - | - |
| Glass | 406 | 6.9 | 406 | - | - |
| Other | 1 | 0.0 | - | 1 | - |
| Haz-waste | 9 | 0.1 | - | 9 | - |
| Non-ferrous | 21 | 0.4 | 21 | - | - |
| | | Subtotal = | 1,346 | 2,658 | 1,865 |
| **3. Construction, Renovation & Demolition** | **3,369** | - | | | |
| Roofing | **1,198** | | 1,198 | - | - |
| Gyproc | **138** | | 138 | - | - |
| Mixed Demolition | **2,033** | | - | - | - |
| Wood | 616 | 30.3 | - | 616 | - |
| Other | 597 | 29.3 | 597 | - | - |
| Concrete | 345 | 17.0 | 345 | - | - |
| Drywall | 219 | 10.8 | 219 | - | - |
| Asphalt | 162 | 8.0 | 162 | - | - |
| Non-ferrous | 53 | 2.6 | 53 | - | - |
| Paper product | 25 | 1.2 | - | 25 | - |
| Ferrous | 16 | 0.8 | 16 | - | - |
| | | Subtotal = | 2,728 | 641 | 0 |
| **4. Contaminated Soil** | **199** | - | 199 | - | - |
| **5. Asbestos** | **688** | - | 688 | - | - |
| **6. Land Clearing / Branches** | **33** | - | - | - | 33 |
| **7. Compost** | **68** | - | - | - | 68 |
| **8. Service Road Cleanup** | **0** | - | - | - | 0 |
| **9. Animal Carcasses** | **28** | - | - | - | 28 |
| **Total Waste (tonnes)=** | **18,809** | | **7,613** | **5,118** | **6,105** |
| **Percentage (%) =** | **100%** | | **40.5%** | **27.2%** | **32.5%** |

# APPENDIX F

Landfill Gas Generation Model Results

| | | | |
|---|---|---|---|
| Year of Assessment | 2016 | | LFG Management Regulation Reference |
| Annual Tonnage in Preceding Year | 18,837 | (tonnes/year) | 4-2-a |
| Total waste in Place in the Preceding Y | 530,976 | (tonnes/year) | 4-2-c |
| Methane generation in the Preceding Y | 991 | (tonnes CH4/year) | 4-2-d |

| Next Five Years | Waste Tonnage (tonnes) | Methane Generation (tonnes CH4/year) | |
|---|---|---|---|
| 2016 | 18,921 | 999 | 4-2-b & 4-2-e |
| 2017 | 18,978 | 1,006 | 4-2-b & 4-2-e |
| 2018 | 19,035 | 1,013 | 4-2-b & 4-2-e |
| 2019 | 19,092 | 1,020 | 4-2-b & 4-2-e |
| 2020 | 19,149 | 1,027 | 4-2-b & 4-2-e |

| | Relatively Inert | Moderately Decomposabl | Decomposable | |
|---|---|---|---|---|
| Gas Production potential, Lo = | 20 | 120 | 160 | $m^3$ CH4/tonne |
| lag time before start of gas production, lag = | 1 | years | | |
| Historical Data Used (years) | 30 | | | |
| 1st Year of Historical Data Used | 1986 | | | |
| 4 Years after Reporting Year | 2020 | | | |
| methane (by volume) | 50% | | | |
| carbon dioxide (by volume) | 50% | | | |
| methane (density) - 1atm, 25C | 0.6557 | $kg/m^3$ | (25C,SP) | |
| carbon dioxide (density) | 1.7988 | $kg/m^3$ | (25C,SP) | |

| Year | Year Number | Annual Tonnage (tonnes) | Cumulative Waste-in-place (tonnes) | Waste Tonnage Relatively Inert (tonnes) | Moderately Decomposable (tonnes) | Decomposable (tonnes) | Methane Generation Rate, k Relatively Inert ($year^{-1}$) | Moderately Decomposable ($year^{-1}$) | Decomposable ($year^{-1}$) | Annual Methane Production (tonnes/yr) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1986 | 1 | 17,730 | 17,730 | 7,274 | 4,310 | 6,145 | 0.02 | 0.06 | 0.11 | 0.00 |
| 1987 | 2 | 17,593 | 35,323 | 7,218 | 4,277 | 6,098 | 0.02 | 0.06 | 0.11 | 89.23 |
| 1988 | 3 | 17,455 | 52,778 | 7,161 | 4,244 | 6,050 | 0.02 | 0.06 | 0.11 | 169.54 |
| 1989 | 4 | 17,317 | 70,095 | 7,105 | 4,210 | 6,002 | 0.02 | 0.06 | 0.11 | 241.80 |
| 1990 | 5 | 17,179 | 87,274 | 7,048 | 4,176 | 5,954 | 0.02 | 0.06 | 0.11 | 306.78 |
| 1991 | 6 | 17,042 | 104,316 | 6,992 | 4,143 | 5,907 | 0.02 | 0.06 | 0.11 | 365.19 |
| 1992 | 7 | 16,917 | 121,233 | 6,941 | 4,113 | 5,864 | 0.02 | 0.06 | 0.11 | 417.65 |
| 1993 | 8 | 17,062 | 138,295 | 7,000 | 4,148 | 5,914 | 0.02 | 0.06 | 0.11 | 464.80 |
| 1994 | 9 | 17,115 | 155,410 | 7,022 | 4,161 | 5,932 | 0.02 | 0.06 | 0.11 | 508.50 |
| 1995 | 10 | 19,653 | 175,063 | 8,063 | 4,778 | 6,812 | 0.02 | 0.06 | 0.11 | 548.63 |
| 1996 | 11 | 15,335 | 190,398 | 5,945 | 4,113 | 5,277 | 0.02 | 0.06 | 0.11 | 598.01 |
| 1997 | 12 | 16,694 | 207,092 | 5,973 | 4,782 | 5,938 | 0.02 | 0.06 | 0.11 | 622.57 |
| 1998 | 13 | 16,201 | 223,293 | 6,423 | 4,313 | 5,465 | 0.02 | 0.06 | 0.11 | 655.49 |
| 1999 | 14 | 15,959 | 239,252 | 7,310 | 3,658 | 4,991 | 0.02 | 0.06 | 0.11 | 678.42 |
| 2000 | 15 | 14,966 | 254,218 | 5,902 | 4,005 | 5,059 | 0.02 | 0.06 | 0.11 | 691.52 |
| 2001 | 16 | 13,462 | 267,680 | 4,935 | 3,845 | 4,683 | 0.02 | 0.06 | 0.11 | 705.63 |
| 2002 | 17 | 13,500 | 281,180 | 4,835 | 3,884 | 4,781 | 0.02 | 0.06 | 0.11 | 713.58 |
| 2003 | 18 | 14,672 | 295,852 | 5,283 | 4,254 | 5,135 | 0.02 | 0.06 | 0.11 | 722.29 |
| 2004 | 19 | 16,479 | 312,331 | 6,019 | 4,782 | 5,679 | 0.02 | 0.06 | 0.11 | 736.14 |
| 2005 | 20 | 19,198 | 331,529 | 7,653 | 5,284 | 6,261 | 0.02 | 0.06 | 0.11 | 757.55 |
| 2006 | 21 | 19,422 | 350,951 | 7,635 | 5,329 | 6,458 | 0.02 | 0.06 | 0.11 | 786.38 |
| 2007 | 22 | 22,019 | 372,970 | 8,931 | 5,868 | 7,220 | 0.02 | 0.06 | 0.11 | 815.21 |
| 2008 | 23 | 19,026 | 391,996 | 7,877 | 5,061 | 6,087 | 0.02 | 0.06 | 0.11 | 852.82 |
| 2009 | 24 | 22,878 | 414,874 | 10,504 | 5,532 | 6,841 | 0.02 | 0.06 | 0.11 | 870.82 |
| 2010 | 25 | 21,931 | 436,805 | 7,947 | 6,209 | 7,775 | 0.02 | 0.06 | 0.11 | 898.57 |
| 2011 | 26 | 18,942 | 455,747 | 6,873 | 5,627 | 6,442 | 0.02 | 0.06 | 0.11 | 936.75 |
| 2012 | 27 | 19,488 | 475,235 | 7,615 | 5,497 | 6,376 | 0.02 | 0.06 | 0.11 | 954.04 |
| 2013 | 28 | 18,155 | 493,390 | 6,778 | 5,277 | 6,100 | 0.02 | 0.06 | 0.11 | 968.90 |
| 2014 | 29 | 18,749 | 512,139 | 7,025 | 5,265 | 6,459 | 0.02 | 0.06 | 0.11 | 978.40 |
| 2015 | 30 | 18,837 | 530,976 | 7,613 | 5,118 | 6,105 | 0.02 | 0.06 | 0.11 | 991.25 |
| 2016 | 31 | 18,921 | 549,897 | 7,647 | 5,141 | 6,132 | 0.02 | 0.06 | 0.11 | 998.71 |
| 2017 | 32 | 18,978 | 568,874 | 7,670 | 5,156 | 6,151 | 0.02 | 0.06 | 0.11 | 1006.13 |
| 2018 | 33 | 19,035 | 587,909 | 7,693 | 5,172 | 6,169 | 0.02 | 0.06 | 0.11 | 1013.37 |
| 2019 | 34 | 19,092 | 607,001 | 7,716 | 5,187 | 6,188 | 0.02 | 0.06 | 0.11 | 1020.44 |
| 2020 | 35 | 19,149 | 626,150 | 7,740 | 5,203 | 6,206 | 0.02 | 0.06 | 0.11 | 1027.35 |