

January 24, 2018  
File: 2017-8241

Bill Wood  
5192 Hwy 97B SE  
Salmon Arm, BC  
V1E 2P7  
(sent via email: wjllwood@gmail.com)

**Re: HYDROGEOLOGICAL ASSESSMENT IN SUPPORT OF REZONING AT 5192 HWY 97B SE,  
SALMON ARM, BC**

Dear Mr. Wood:

Associated Environmental Consultants Inc. (Associated) completed a hydrogeological assessment of a dug well at 5192 Highway 97B (the Property) in support of a rezoning application with the Columbia Shuswap Regional District (CSRD). The dug well has the BC Well Identification Number (WIN) 43088, and will be referred to as WIN 43088 in this report.

## 1 OBJECTIVES AND SCOPE OF WORK

We understand that you are planning on rezoning the Property for two dwellings. Under the Rancho/Deep Creek Official Community Plan Bylaw No. 750 (the OCP) Section 3.6, Objective 7, the CSRD has requested that a hydrogeological assessment of the water source (WIN 43088) be performed (CSRD 2014a). The objective of this assessment is to ensure the long-term reliability of the source to supply potable water<sup>1</sup> to two dwellings on the Property and to verify that the use of the water source will not have significant negative impacts on the quality and quantity of neighbouring water supplies. The OCP does not indicate what constitutes potable water or what daily volume is required for each dwelling. We followed the proof of water quantity and proof of water quality (potability) guidelines as outlined in the CSRD Subdivision Servicing Bylaw 641 (CSRD 2014b), after discussions with Dan Passmore, Senior Planner, CSRD (D. Passmore, personal communication, 2017). This Bylaw identifies which water quality constituents should be sampled to meet proof of water quality and indicates that each dwelling requires 2,275 L/day for proof of water quantity. For the proposed two dwellings, WIN 43088 is required to produce at least 4,550 L/day to meet proof of water quantity.

To satisfy the hydrogeological assessment, Associated completed the following scope of work:

1. Proof of Water Quantity: to assess long-term reliability of the source to supply adequate volume of water to two dwellings on the Property, and verify that the use of the water source will not have significant negative impacts on the quantity of the neighbouring water supplies, we:
  - a. reviewed the site physiography and aquifer setting;

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<sup>1</sup> The source water must supply water that is potable or made potable after treatment.

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- b. completed a desktop study of water availability for the Gardiner Lake watershed to determine the proportion of water proposed to be used at the Property in order to assess impact on quantity of neighbouring water supplies; and
    - c. designed and oversaw a 24-hour constant rate pumping test at a rate of 4,550 L/day.
  2. Proof of Water Quality: to assess groundwater quality and to verify that the use of the water source will not have significant negative impacts on the quality of neighbouring water supplies, we:
    - a. reviewed the construction of WIN 43088; and
    - b. collected water quality samples, compared the results to Health Canada guidelines, and provided treatment recommendations to make the water potable if necessary.
  3. Prepared a report (this document) outlining the results of the hydrogeological assessment.

## **2 METHODS**

### **2.1 PROOF OF WATER QUANTITY**

#### **2.1.1 Site Physiography and Aquifer Setting**

We reviewed the physiographic and aquifer setting of the Property using publicly available information including contour maps, surficial geology maps, mapped aquifers and well logs in the Ministry of Environment's databases. We also interviewed people familiar with the area to understand neighbouring water supplies.

#### **2.1.2 Desktop Water Availability Study**

To assess the potential impact on neighbouring water supplies in the area, we performed a desktop water availability study for Gardiner Lake watershed. Note that WIN 43088 is hydraulically connected to Gardiner Lake (this was confirmed during the pumping test, see Section 3.1.3).

To estimate annual runoff to Gardiner Lake, we determined the contributing watershed area for the Gardiner Lake outlet and used regionalized runoff estimates developed by Obedkoff (1998). This method relates median elevation of a watershed to annual runoff for the standard period (1961-1990). The annual runoff values consider losses to evaporation and transpiration.

The annual runoff (in m<sup>3</sup>/year) was multiplied by the watershed area (in m<sup>2</sup>) to determine the annual runoff volume (in cubic decameters/year [dam<sup>3</sup>/yr]).<sup>2</sup> The volume of water required by the Property with two dwellings (4,550 L/day or 1.66 dam<sup>3</sup>/yr) was then converted to a percentage of the annual runoff volume.

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<sup>2</sup> 1 dam<sup>3</sup> is 1,000 m<sup>3</sup> or 1,000,000 L.

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### **2.1.3 Pumping Test**

Associated coordinated and oversaw a 24-hour constant rate pumping test on WIN 43088. Corley Drilling (Corley) supplied and operated the submersible pump during the test under Associated's direction. WIN 43088 is currently used at the Property for water supply, so the existing pump was disconnected and the well was not used for 12 hours prior to the test to allow the groundwater level to stabilize. Associated instructed Corley to perform a 24-hour constant rate test at 0.13 L/s (2 US gpm). The test was started at 09:50 on December 12, 2017. Groundwater was discharged towards the outlet of Gardiner Lake at Canoe Creek, 75 m northwest of WIN 43088. The discharge rate was monitored with a bucket and stop watch and controlled with a ball valve.

Dataloggers were installed in WIN 43088 and a neighbouring dug well located 40 m northwest of WIN 43088 on December 12, 2017 to record water levels during the test. They were left in place until December 22, 2017 to record any seasonal variability in the groundwater levels and to monitor water levels in WIN 43088 during normal operation at the Property.

The data from the pumping test were analyzed following the Guidelines for Evaluating Long-term Well Capacity for a Certification of Public Convenience and Necessity (CPCN) (MOE 2007). This method extrapolates pumping water levels in the pumped well and observation well(s) to 100 days and calculates a sustainable pumping rate based on the 100-day specific capacity multiplied by the available drawdown. The sustainable pumping rate is then reduced by a safety factor, often 30%, which is reserved for: (1) housing the submersible pump, (2) seasonal and drought water levels that may occur, and (3) accommodating any future drop in well efficiency during operation.

## **2.2 PROOF OF WATER QUALITY**

### **2.2.1 Well Construction**

To ensure that the use of the water source will not have significant negative impacts on the quality of neighbouring water supplies, we compared the construction of WIN 43088 to the *Groundwater Protection Regulation* (GWPR) (B.C. Reg. 39/2016). The results are provided in Section 3.2.1.

### **2.2.2 Water Sampling**

To determine if the water meets potable water guidelines, Associated collected a groundwater sample from WIN 43088 following 23 hours of pumping, and dispensed the water into laboratory-supplied sterile containers. Prior to sampling, field parameters (pH, conductivity, oxidation-reduction potential, temperature,

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and dissolved oxygen) were recorded and observed to stabilize. Samples were submitted to CARO Analytical Services (CARO) in Kelowna, BC for the constituents for groundwater outlined in Bylaw 641:

- *Escherichia coli*
- Total and Faecal Coliforms
- Heterotrophic Plate Count
- Alkalinity
- Sulphate
- Total Kjeldahl Nitrogen
- Total Metals
- Ammonia-N
- Colour
- Conductivity
- Total and Dissolved Organic Carbon
- Total Dissolved Solids (TDS)
- Total Suspended Solids (TSS)
- Dissolved Metals
- Hardness
- Nitrate-N
- Nitrite-N
- pH
- Sulphide
- Turbidity
- UV transmittance

We compared the results with the Guidelines for Canadian Drinking Water Quality (GCDWQ) (Health Canada 2017). Guideline levels specified in the GCDWQ are designated as either a maximum acceptable concentration (MAC), an aesthetic objective (AO), or an operational guideline (OG). The MAC guidelines are health-risk-based and determined based on the known health effects associated with the substance. The AO guidelines apply to those variables that adversely affect taste or intended, typical water uses (e.g., staining of laundry) but do not pose a health hazard. The OG guidelines apply to parameters that may impact water treatment processes.

Treatment is required if MAC guidelines are exceeded to improve water quality to consider it potable.

### **3 RESULTS AND DISCUSSION**

#### **3.1 PROOF OF WATER QUANTITY**

##### **3.1.1 Site Physiography and Aquifer Setting**

The Property is located approximately 6 km southeast of Salmon Arm, BC in a southeast-northwest trending valley, at an elevation of roughly 520 metres above mean sea level (mamsl) (Figure 3-1). The Property is approximately 10 m from Gardiner Lake, which discharges into Canoe Creek, eventually discharging to Shuswap Lake.

The surficial geology of the area is described as bog deposits in the vicinities of the lakes (peat and muck), although predominantly kettle terrace deposits form much of the valley bottom (gravel and sand) (Fulton 1965). There is no well log available for WIN 43088 but it is likely installed within the kettle terrace deposits due to its productivity.

The Water Resources Atlas does not indicate any wells within 100 m of WIN 43088. Based on conversations with Bill Wood and following a site visit, the neighbouring water supplies include:

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- Canoe Creek Golf Course, which has deep irrigation wells located 870 m southwest of WIN 43088;
- Gardiner Lake Mobile Home Park, which has water supply well(s) (e.g. WIN 39436) located 130 m northwest of WIN 43088;
- Private domestic water supply wells northwest and southeast of WIN 43088; and
- The neighbour's well, located 40 m northwest of WIN 43088. The well has a static water level of 0.524 m btoc, a depth of 1.09 m btoc, and a diameter of 1.2 m. The well is not currently in use.

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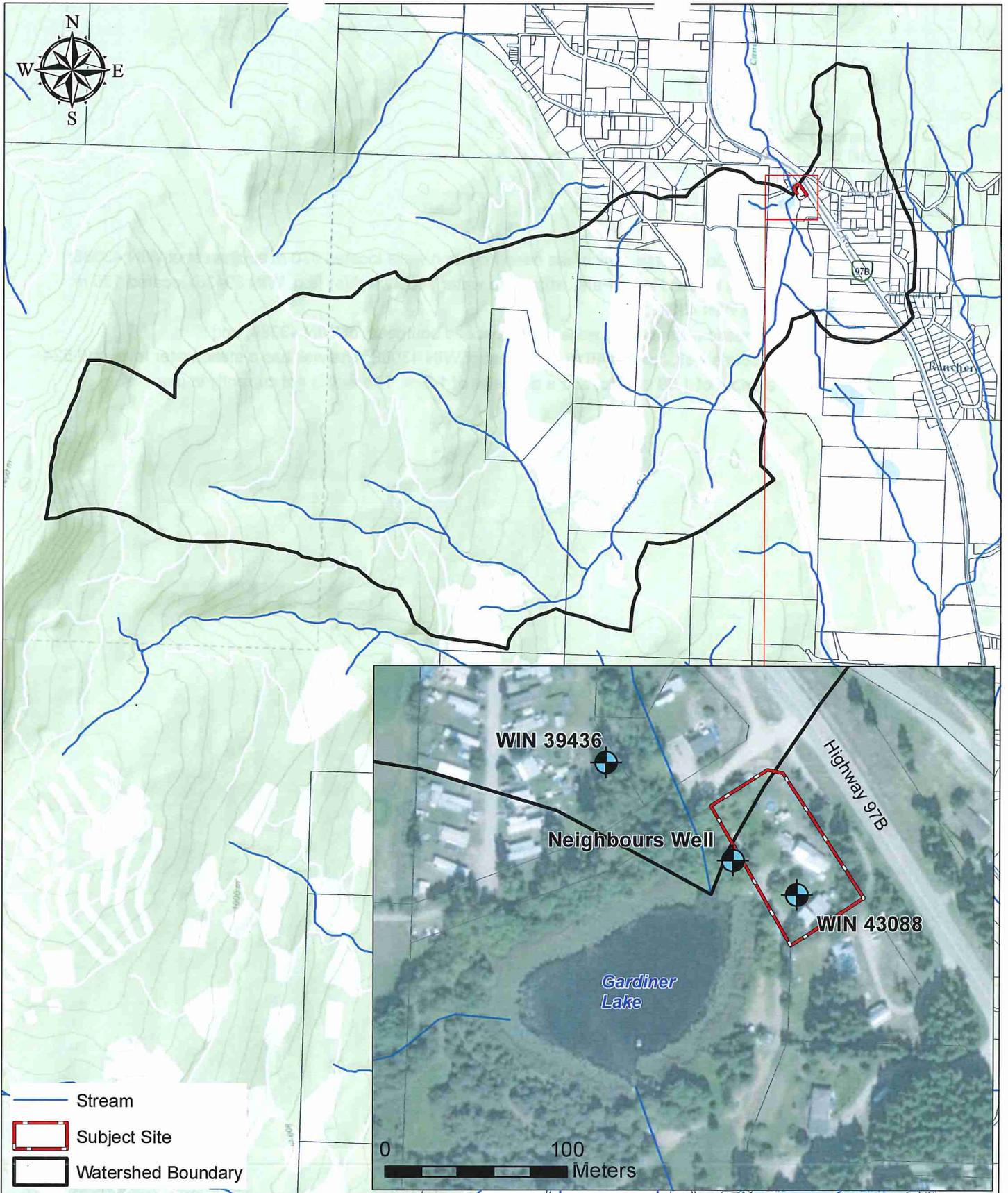


Figure 1 BC.mxd / 1/23/2018 / 3:36:20 PM

-  Stream
-  Subject Site
-  Watershed Boundary



PROJECT NO.: 2017-8241.000.000  
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**FIGURE 3-1: SITE PLAN AND WATERSHED**

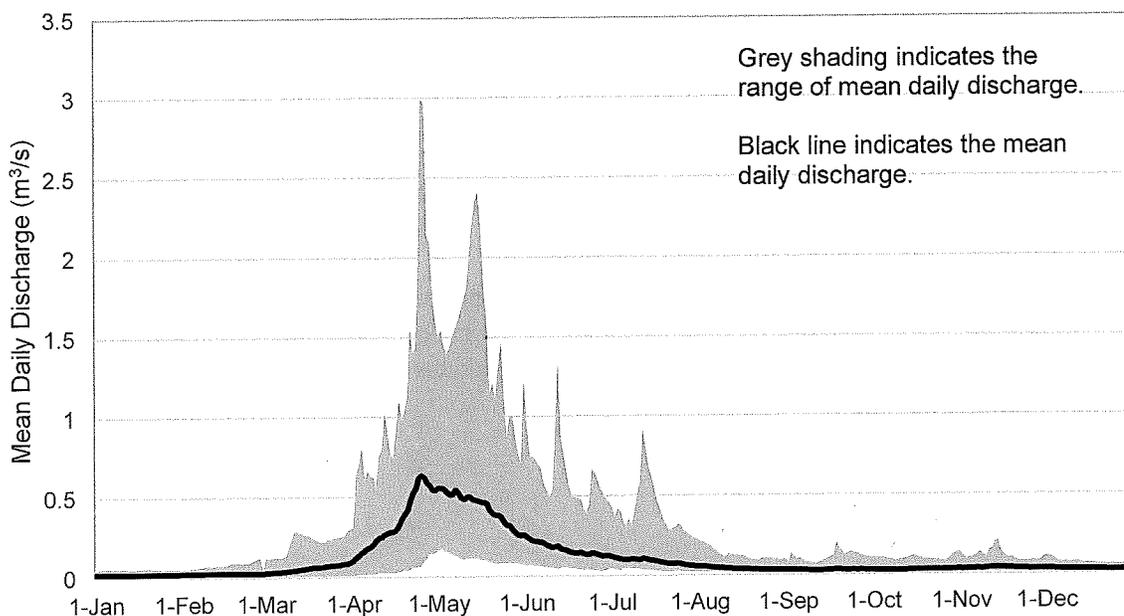
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 Hydrogeological Assessment

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### 3.1.2 Desktop Water Availability Study

Gardiner Lake has a contributing watershed area of 10.1 km<sup>2</sup> (Figure 3-1). Gardiner Lake and the Property are located within the Southern Interior Region hydrologic zone (#13, subzone "f") (Obedkoff 1998). Streamflows in this region are characterized by peak flows in spring, due to snowmelt. Lower flows generally occur from September to March, with the lowest flows typically in January and February. The nearest creek with streamflow data is East Canoe Creek, which is located approximately 4 km northeast from the Property in the same hydrologic zone as Gardiner Lake. Water Survey of Canada (WSC) operate a hydrometric station on East Canoe Creek above the Dam (Station No. 08LE108). Figure 3-2 illustrates the mean daily discharge recorded at this station.



**Figure 3-2**  
**Mean daily discharge recorded at East Canoe Creek Above Dam (WSC Station No. 08LE108), 1983-2014**

The median elevation of the watershed contributing to Gardiner Lake is 728 mamsl. The relationship developed by Obedkoff (1998) yields an annual runoff of approximately 0.255 m. This annual runoff value includes contributions from both surface runoff and groundwater inflows. The resultant annual runoff volume to Gardiner Lake is approximately 2,564 dam<sup>3</sup>/year. In comparison, the two dwellings on the Property will likely use 1.66 dam<sup>3</sup>/year, or <0.1% of annual runoff. This is an insignificant portion of the available water;

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therefore, the use of water at this Property will not have a significant negative impact on the neighbouring water supplies.

### **3.1.3 Pumping Test**

Table 3-1 outlines the specifications and results of the pumping test. Pumping test data, figures showing water levels in pumping wells and observation wells, and drawdown data extrapolated to 100 days are attached in Appendix A. The sustainable pumping rate exceeds 4,550 L/day. Therefore, WIN 43088 can supply 2,275 L/day to each dwelling.

WIN 43088 recovered to 95% of the original static water level within 211 minutes. During the test, no drawdown was observed in the neighbour's well (40 m away). The nearest well in use is over 130 m away, so the extraction of water from WIN 43088 will not have a significant negative impact on the quantity of neighbouring water supplies.

During the test, groundwater levels stabilized at 0.631 m btoc (0.17 m drawdown) after 250 min of pumping, indicating that a positive head boundary was intercepted and that WIN 43088 is hydraulically connected to Gardiner Lake.

The water level data collected following the test (Appendix A, Figure 3) indicate that normal use of the well causes a drawdown of 0.08 m (approximately half that observed during the test). Groundwater levels in the area fluctuated by a few centimetres between December 12 and December 22, indicating that no seasonal fluctuation occurred during the test.

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**Table 3-1 Summary and results of constant rate pumping test on WIN 43088**

	WIN 43088
<b>PUMPING SPECIFICATIONS</b>	
Pumping rate (L/s)	0.13
Test duration (hours)	24
Depth of pump intake (m btoc)	2.14
Static water level (m btoc)	0.45
Depth to top of screen (m btoc)	n/a
Depth of well (m btoc)	2.44
<b>RECOVERY</b>	
Length of recovery (min)	211
% recovered	95
<b>CPCN INPUTS</b>	
Pumping rate (L/s)	0.13
Available drawdown (m)	1.69
Drawdown at 100 days (m)	0.18
<b>CPCN OUTPUTS</b>	
100-day specific capacity (L/s/m)	0.741
Calculated sustainable pumping rate (L/s)	0.88
<b>Sustainable pumping rate (L/s)</b>	<b>0.13</b>
<b>Sustainable pumping rate (L/d)</b>	<b>11,232</b>

Notes:

m btoc = metres below top of casing

<sup>1</sup> The available drawdown is the difference between the static water level and 30 cm above the bottom of the well.

<sup>2</sup> The 100-day drawdown is the sum of the 100-day drawdown in the pumping well and the 100-day drawdown in the observation well(s), and in this way includes well interference. No drawdown was observed in the neighbour's well.

<sup>3</sup> The theoretical sustainable yield for WIN 43088 was greater than the rate it was tested at. However, a well cannot be rated higher than it was tested; therefore, the yield at which WIN 43088 is rated is 0.13 L/s.

### 3.2 PROOF OF WATER QUALITY

#### 3.2.1 Well Construction

WIN 43088 is 2.442 m deep with a static water level of 0.454 metres below top of casing (m btoc). It is located approximately 20 m northeast of the nearest surface waterbody, Gardiner Lake. The well comprises an approximately 1.2 m diameter steel culvert driven to an unknown depth. The culvert is sealed around the

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annulus with concrete. Within the steel culvert, 305 mm HDPE pipe (casing) has been installed to a depth of 2.442 m btoc and the production intake is located within this pipe. A small, sealed house structure has been mounted over top of the steel culvert, sealing the culvert from the outside. The casing is accessed inside the house via trap door.

The house structure is a custom-designed well cap and well cover as defined in the GWPR. By meeting the GWPR, the well's construction reduces the risk of contaminating the groundwater source, and therefore does not have significant impact on water quality of neighbouring water sources.

### 3.2.2 Water Sampling

A groundwater quality summary table showing all results compared with the GCDWQ is included in Appendix B and the original laboratory report is included in Appendix C. Exceedances of the GCDWQ values (differentiated as either MAC or AO) are summarized in Table 3-2.

**Table 3-2 Concentrations of parameters that exceeded the GCDWQ MAC or AO**

Constituent	Guideline Value	Guideline Type	WIN 43088
Total Dissolved Solids (mg/L)	500	AO	<b>670</b>
Manganese (total; mg/L)	0.05	AO	<b>0.349</b>
Manganese (dissolved; mg/L)	0.05	AO	<b>0.318</b>
Total Coliforms (CFU/100 mL)	0	MAC	<b>8</b>

Notes:

**Bolded** values exceed the GCDWQ AO. **Bolded red** values exceed the GCDWQ MAC.

TDS exceeded the GCDWQ AO. Elevated TDS concentrations can be naturally occurring, but can affect taste and cause excessive scaling of water pipes, boilers, and appliances (Health Canada 1991). Total manganese exceeded the GCDWQ AO. Elevated levels of manganese can discolour water, affect palatability, and stain plumbing fixtures (Health Canada 1987). Although the current guideline is not based on health concerns, treatment is recommended to prevent staining/unpalatability. Treatment recommendations are provided in Section 4.

Total coliforms exceeded the GCDWQ MAC. This is common in shallow wells that are near surface waterbodies, because there is little natural filtration available in the aquifer to remove coliforms commonly present in surface water.

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Due to the shallow construction of WIN 43088 (Section 3.2.1), the well does not meet Criteria D1<sup>3</sup> in the BC Ministry of Health (MOH) *Guidance Document for Determining Groundwater at Risk of Containing Pathogens* (GARP) (MOH 2017) and is therefore considered to be GARP. GARP wells should be treated as surface water wells and therefore we recommend WIN 43088 be treated as surface water. Treatment objectives<sup>4</sup> should include filtration and disinfection to achieve a minimum 3-log (99.9%) removal and inactivation of *Giardia* and *Cryptosporidium* and 4-log (99.99%) inactivation of viruses (MOH 2012).

Current treatment of WIN 43088 includes UV disinfection, and water softening. However, this treatment system was not reviewed as part of this assessment and treatment efficacy cannot be confirmed.

#### 4 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of this hydrogeological assessment, Associated makes the following conclusions:

1. The use of groundwater from the two wells on the Property is a reliable long-term supply, and will not significantly negatively impact the water quantity in neighbouring water supplies. This conclusion is based on the following findings:
  - a. WIN 43088 is hydraulically connected to Gardiner Lake. Proposed water use at WIN 43088 is less than 0.1% of the annual discharge of the Gardiner Lake watershed, which is negligible.
  - b. During the pumping test, the groundwater level in the nearest neighbouring well was not affected.
  - c. The sustainable well yield of WIN 43088 exceeds 4,550 L/day. The well is capable of supplying 2,275 L/day to each dwelling.
2. The use of groundwater from WIN 43088 will not negatively impact the water quality in neighbouring water supplies. Groundwater from WIN 43088 can be made potable with treatment. This conclusion is based on the following findings:
  - a. The well cap and well cover of WIN 43088 meets the GWPR and therefore reduces the risk of contamination of the groundwater source in the area.
  - b. The presence of total coliforms exceeds the GCDWQ health-based MAC and therefore disinfection is required. Due to the shallow nature of the well, the groundwater is at risk of containing pathogens (GARP) and treatment should meet the surface water treatment objectives (MOH 2012).
  - c. TDS and manganese exceeded the GCDWQ aesthetic objective. Currently, these are not health-based guidelines, and treatment for these exceedances is not required to make the

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<sup>3</sup> The well's intake depth is less than 15 m below ground.

<sup>4</sup> Ministry of Health Drinking Water Treatment Objectives (Microbiological) for Surface Water Supplies in British Columbia

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water potable. However, high levels of TDS and manganese can cause issues with palatability and staining/scaling of distribution lines/appliances.

Based on the results of this hydrogeological assessment, the following treatment options may be considered:

- Filtration
- Disinfection

Filtration should achieve a finished water turbidity of 0.3 NTU or less, depending on the filtration method selected. Cartridge filtration is a common treatment option for small-scale and residential systems. Turbidity in the well was 0.84 NTU on December 13, 2017 and should not vary throughout the year. Filters have a finite capacity (maximum filtration volume), which will impact the service life of the filter depending on water use.

After removal of particulate matter with filtration, the water needs to be disinfected to inactivate any potential pathogenic microorganisms in the water. A Point of Entry (POE) Ultraviolet (UV) disinfection unit would be a suitable option at each dwelling. The UV system should be certified to NSF/ANSI standard 55 with the additional Class A classification. Class A UV systems are designed to provide a UV dose of 40 mJ/cm<sup>2</sup> to disinfect microorganisms including pathogenic bacteria, viruses, *Cryptosporidium* and *Giardia*.

The treatment processes described above are those recommended for potable (drinking) water. The treatment can be applied to all water entering a household (Point of Entry), or can be modified to provide treatment only to drinking water faucets (Point of Use), or a combination of the two. The most comprehensive approach is to treat all water entering the dwellings to potable standards. Point of Use devices can be used for further treatment to improve the aesthetic quality of the water including taste.

Although current Health Canada guidelines do not list manganese as a health-based parameter, Health Canada has recently proposed amending the current guideline for manganese. The proposed amendment includes a total manganese health-based MAC of 0.1 mg/L and a reduced AO from 0.05 mg/L to 0.02 mg/L (Health Canada 2016). WIN 43088 is above the proposed health-based MAC of 0.1 mg/L based on results of this assessment. Furthermore, the concentration of manganese exceeded the AO levels in the current guidelines. At these levels, the water may lead to staining of fixtures and laundry. For this reason, we recommend whole house (Point of Entry) treatment for manganese, achievable by ion exchange (e.g., water softener) or greensand filtration.

When selecting a treatment system, only consider those that are NSF (National Sanitation Foundation) certified (NSF International 2016). Note that all components in contact with water must be NSF 61 certified, and all products added to the water must be NSF 60 certified. Point of Use devices fall under NSF

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Residential Drinking Water Treatment Standards. At minimum, the filters should meet NSF 53: Drinking Water Treatment Units – Health Effects, and UV should meet NSF 55: Ultraviolet Microbiological Water Treatment Systems (Class A). Because of the natural variability of water quality, we recommend that the water be periodically tested especially for microbiological parameters to confirm the microbial water quality guidelines are met.

## 5 CLOSURE

The services provided by Associated in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practising under similar conditions. No other warranty expressed or implied is made.

We trust this completes our assessment to your satisfaction. Please contact the undersigned if you have any questions or would like to discuss any aspect of this report.

Yours truly,



Marta Green, P. Geo.  
Senior Hydrogeologist



Linda Wojcicka, M.A.Sc., P.Eng., ENV SP  
Water Process Engineer

### Attachments:

- Appendix A – Pump Test Data
- Appendix B – Water Quality Data
- Appendix C – Lab Reports

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Passmore, D. Senior Planner, Development Services, Columbia Shuswap Regional District. December 3, 2017. Personal communication (in-person meeting) with M. Green and M. Weldon of Associated.

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## Appendix A - Pumping Test Data

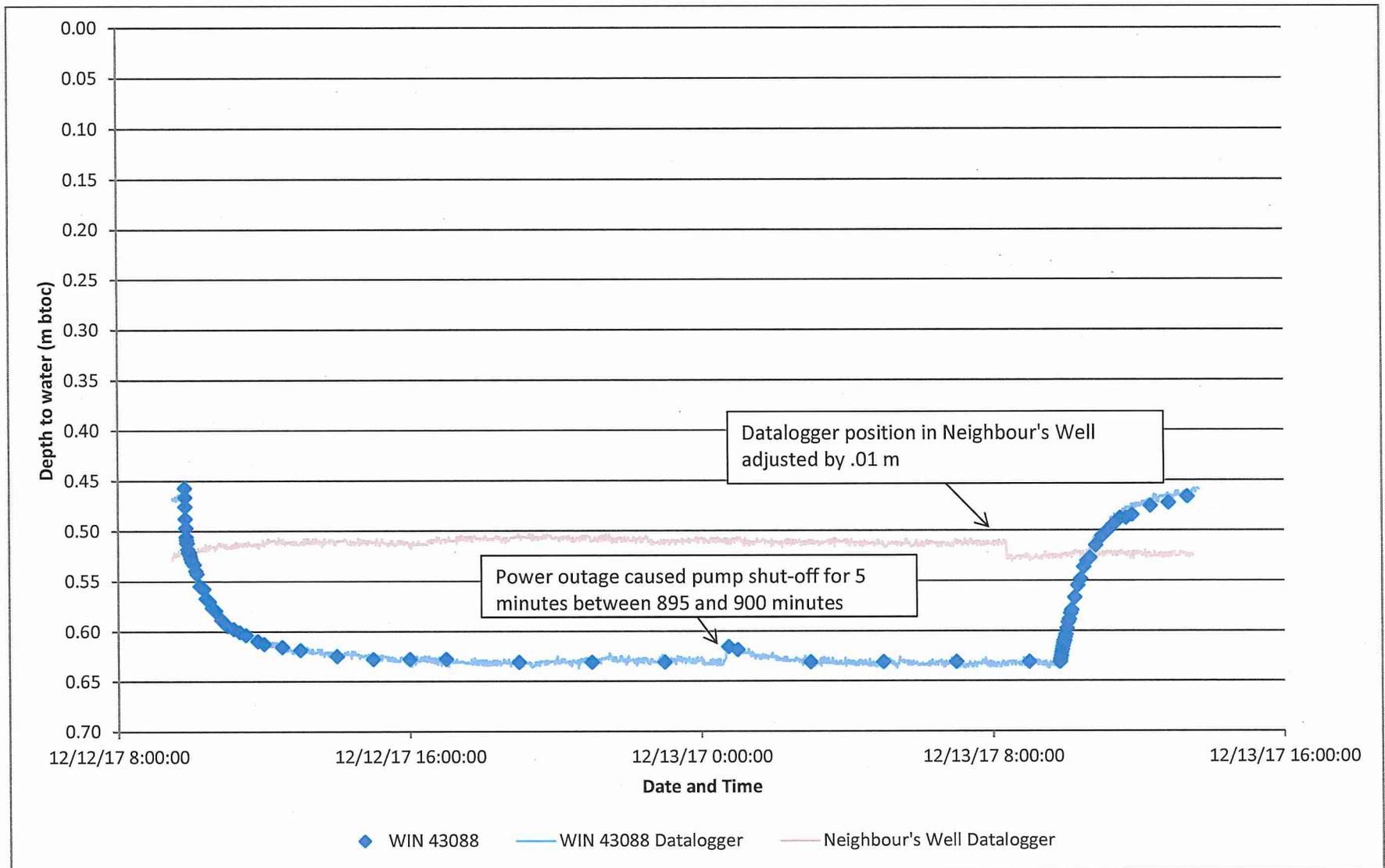
Table 1  
Pumping Test Data



<b>Well ID:</b>	WIN 43088	<b>Static Water Level (mbtoc)</b>	0.454	
<b>Start Date/Time</b>	12/12/17 9:50 AM	<b>Pre-Test Water Level (mbtoc)</b>	0.457	
<b>Client</b>	Bill Wood	<b>Total Well Depth (mbtoc)</b>	2.442	
<b>Project</b>	2017-8241.000.000	<b>Pump Intake Depth (mbtoc)</b>	2.14	
<b>Test</b>	Constant Rate Test	<b>Pump Used</b>	Grundfos 1 HP	
<b>Contractor</b>	Corley Drilling	<b>Pumping Rate (L/s)</b>	0.13	
<b>Clock Time</b>	<b>Time Elapsed (min)</b>	<b>Depth to Water (m)</b>	<b>Drawdown (m)</b>	<b>Comments</b>
12/12/17 9:50:00	0.00	0.457	0.00	
12/12/17 9:50:30	0.50	0.466	0.01	
12/12/17 9:51:00	1.00	0.475	0.02	
12/12/17 9:51:30	1.50	0.488	0.03	
12/12/17 9:52:00	2.00	0.497	0.04	
12/12/17 9:52:30	2.50	0.506	0.05	
12/12/17 9:53:00	3.00	0.509	0.05	
12/12/17 9:53:30	3.50	0.512	0.06	
12/12/17 9:54:00	4.00	0.512	0.06	
12/12/17 9:55:00	5.00	0.518	0.06	
12/12/17 9:56:00	6.00	0.521	0.06	
12/12/17 9:57:00	7.00	0.521	0.06	
12/12/17 9:58:00	8.00	0.521	0.06	
12/12/17 9:59:00	9.00	0.524	0.07	
12/12/17 10:00:00	10.00	0.527	0.07	
12/12/17 10:02:00	12.00	0.530	0.07	
12/12/17 10:05:00	15.00	0.533	0.08	
12/12/17 10:08:00	18.00	0.539	0.08	
12/12/17 10:10:00	20.00	0.543	0.09	
12/12/17 10:15:00	25.00	0.555	0.10	
12/12/17 10:21:00	31.00	0.558	0.10	
12/12/17 10:25:00	35.00	0.567	0.11	
12/12/17 10:30:00	40.00	0.570	0.11	
12/12/17 10:35:00	45.00	0.576	0.12	
12/12/17 10:40:00	50.00	0.579	0.12	
12/12/17 10:50:00	60.00	0.588	0.13	
12/12/17 11:00:00	70.00	0.594	0.14	
12/12/17 11:10:00	80.00	0.597	0.14	
12/12/17 11:20:00	90.00	0.600	0.14	
12/12/17 11:30:00	100.00	0.604	0.15	
12/12/17 11:50:00	120.00	0.610	0.15	
12/12/17 12:00:00	130.00	0.613	0.16	
12/12/17 12:30:00	160.00	0.616	0.16	
12/12/17 13:00:00	190.00	0.619	0.16	
12/12/17 14:00:00	250.00	0.625	0.17	
12/12/17 15:00:00	310.00	0.628	0.17	
12/12/17 16:00:00	370.00	0.628	0.17	
12/12/17 17:00:00	430.00	0.628	0.17	
12/12/17 19:00:00	550.00	0.631	0.17	

Table 1  
 Pumping Test Data

Clock Time	Time Elapsed (min)	Depth to Water (m)	Drawdown (m)	Comments
12/12/17 21:00:00	670.00	0.631	0.17	
12/12/17 23:00:00	790.00	0.631	0.17	
12/13/17 0:45:00	895.00	0.616	0.16	Power to pump cut-off for 5 min at 00:45
12/13/17 1:00:00	910.00	0.619	0.16	
12/13/17 3:00:00	1030.0	0.631	0.17	
12/13/17 5:00:00	1150.0	0.631	0.17	
12/13/17 7:00:00	1270.0	0.631	0.17	
12/13/17 9:00:00	1390.0	0.631	0.17	
12/13/17 9:50:00	1440.0	0.631	0.17	Shut-off pump, start recovery.
12/13/17 9:50:30	1440.5	0.631	0.17	
12/13/17 9:51:00	1441.0	0.628	0.17	
12/13/17 9:51:30	1441.5	0.628	0.17	
12/13/17 9:52:00	1442.0	0.625	0.17	
12/13/17 9:52:30	1442.5	0.625	0.17	
12/13/17 9:53:00	1443.0	0.622	0.16	
12/13/17 9:54:00	1444.0	0.619	0.16	
12/13/17 9:55:00	1445.0	0.616	0.16	
12/13/17 9:56:00	1446.0	0.613	0.16	
12/13/17 9:57:00	1447.0	0.610	0.15	
12/13/17 9:58:00	1448.0	0.610	0.15	
12/13/17 9:59:00	1449.0	0.607	0.15	
12/13/17 10:00:00	1450.0	0.604	0.15	
12/13/17 10:02:00	1452.0	0.597	0.14	
12/13/17 10:04:00	1454.0	0.591	0.13	
12/13/17 10:06:00	1456.0	0.588	0.13	
12/13/17 10:08:00	1458.0	0.582	0.13	
12/13/17 10:10:00	1460.0	0.579	0.12	
12/13/17 10:15:00	1465.0	0.567	0.11	
12/13/17 10:20:00	1470.0	0.555	0.10	
12/13/17 10:25:00	1475.0	0.549	0.09	
12/13/17 10:30:00	1480.0	0.536	0.08	
12/13/17 10:35:00	1485.0	0.530	0.07	
12/13/17 10:40:00	1490.0	0.527	0.07	
12/13/17 10:50:00	1500.0	0.515	0.06	
12/13/17 11:00:00	1510.0	0.506	0.05	
12/13/17 11:10:00	1520.0	0.500	0.04	
12/13/17 11:20:00	1530.0	0.494	0.04	
12/13/17 11:30:00	1540.0	0.488	0.03	
12/13/17 11:40:00	1550.0	0.488	0.03	
12/13/17 11:50:00	1560.0	0.485	0.03	
12/13/17 12:20:00	1590.0	0.475	0.02	
12/13/17 12:50:00	1620.0	0.472	0.02	
12/13/17 13:21:00	1651.0	0.466	0.01	Water level recovered to 95% of static.



PROJECT: 2017-8241.000.000

DATE: 9-Jan-18

DRAWN BY: M. Weldon

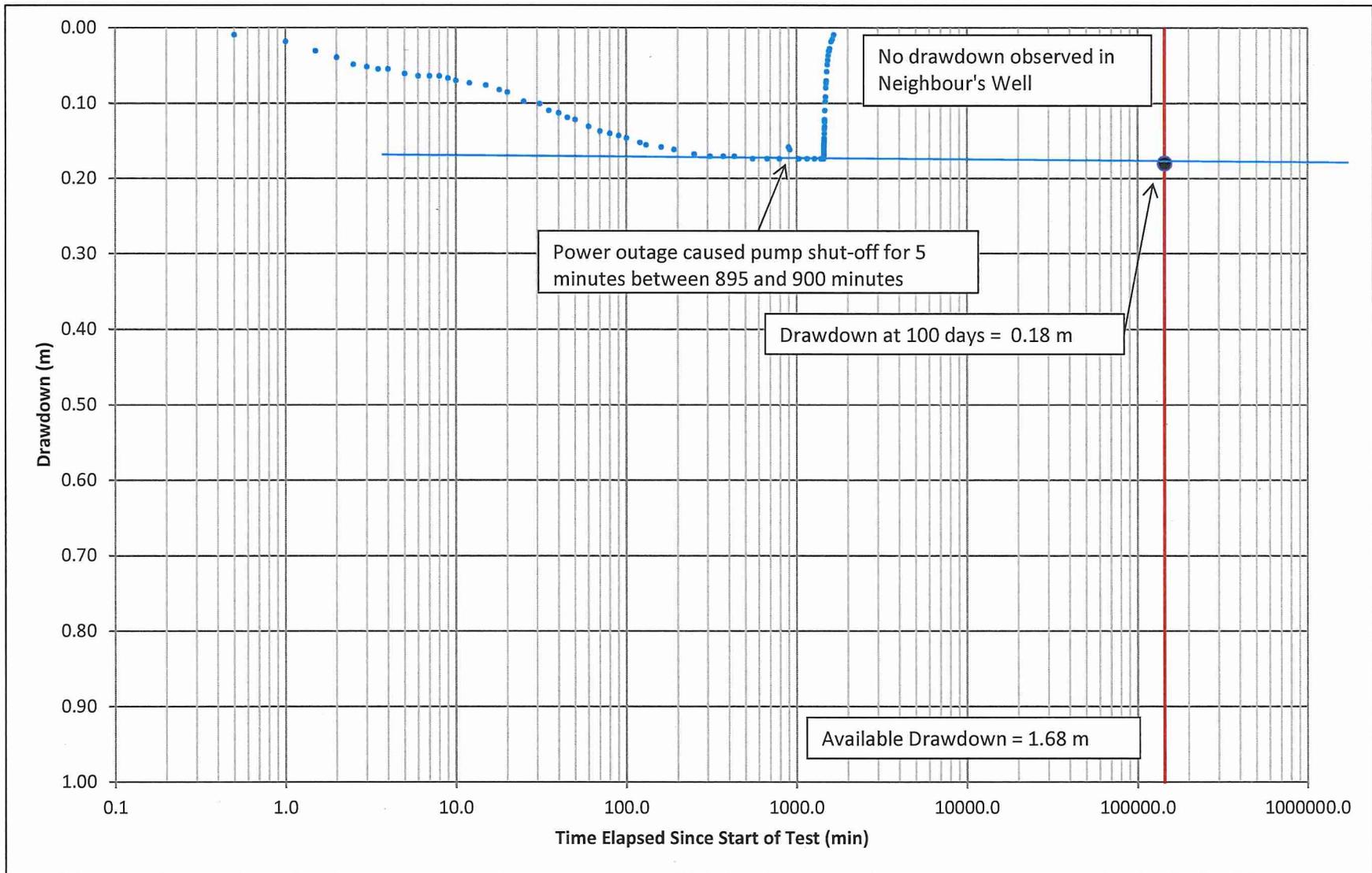
PREPARED FOR

Bill Wood

Figure 1

Pump test data

WIN 43088



PROJECT: 2017-8241.000.000

DATE: 9-Jan-18

DRAWN BY: M. Weldon

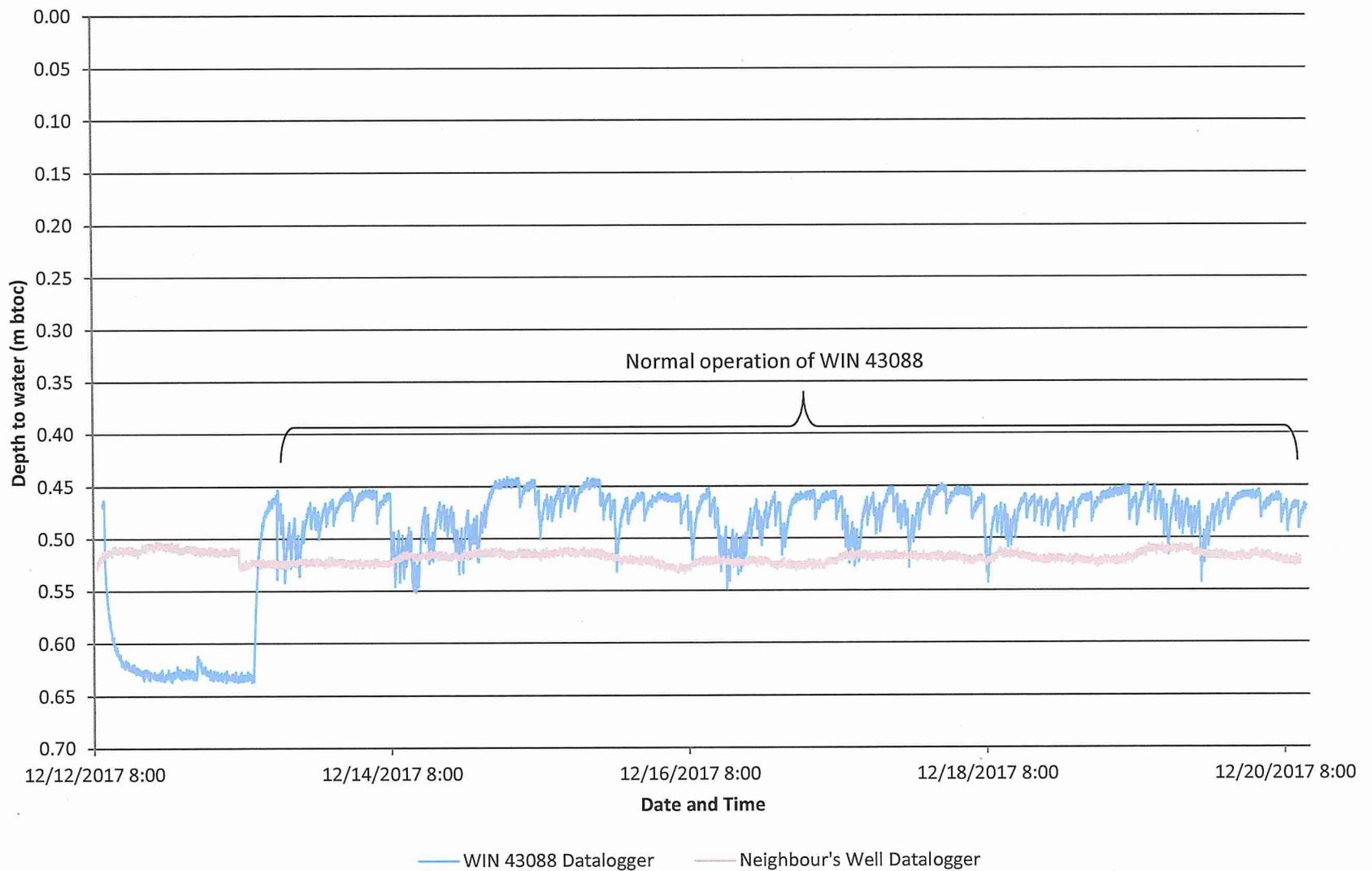
PREPARED FOR

Bill Wood

Figure 2

Drawdown extrapolated to 100 days

WIN 43088



PROJECT: 2017-8241.000.000

DATE: 9-Jan-18

DRAWN BY: M. Weldon

PREPARED FOR

Bill Wood

Figure 3

Long Term Data

WIN 43088

## Appendix B - Water Quality Data

**Hydrogeological Investigation**  
Water Quality Results from WIN 43088

		Sampling Location		WIN 43088
		Date Sampled		13-Dec-17
		Lab Sample ID		7121073-01
Analyte	Unit	Guideline		
		GCDWQ MAC	GCDWQ AO	
<b>Field Results</b>				
Conductivity	µS/cm	NG	NG	993
pH		NG	7.0 - 10.5 <sup>2.1</sup>	7.46
Temperature	°C	NG	15	9.12
Turbidity	NTU	N <sup>1.1</sup>	NG	0.19
<b>Lab Results</b>				
<b>General</b>				
Alkalinity (bicarbonate, as CaCO <sub>3</sub> )	mg/L	NG	NG	287
Alkalinity (carbonate, as CaCO <sub>3</sub> )	mg/L	NG	NG	<1.0
Alkalinity (hydroxide, as CaCO <sub>3</sub> )	mg/L	NG	NG	<1.0
Alkalinity (phenolphthalein, as CaCO <sub>3</sub> )	mg/L	NG	NG	<1.0
Alkalinity (total, as CaCO <sub>3</sub> )	mg/L	NG	NG	287
Chloride	mg/L	NG	250	116
Colour	CU	NG	15	5.9
Conductivity	µS/cm	NG	NG	980
Total cyanide	mg/L	0.2 <sup>1.2</sup>	NG	<0.0020
Dissolved organic carbon	mg/L	NG	NG	2.74
Fluoride	mg/L	1.5	NG	0.10
Hardness, Total (dissolved as CaCO <sub>3</sub> )	mg/L	NG	NG	343
pH		NG	7.0 - 10.5 <sup>2.2</sup>	7.82
Sulphate	mg/L	NG	500 <sup>2.3</sup>	9.8
Total dissolved solids	mg/L	NG	500	<b>670</b>
Total organic carbon	mg/L	NG	NG	2.74
Total suspended solids	mg/L	NG	NG	<2.0
Turbidity	NTU	N <sup>1.3</sup>	NG	0.84
UV transmittance at 254 nm	%	NG	NG	87.5
<b>Nutrients</b>				
Ammonia (total, as N)	mg/L	NG	NG	0.050
Nitrate (as N)	mg/L	10	NG	3.15
Nitrate + Nitrite (as N) (calculated)	mg/L	10 <sup>1.4</sup>	NG	3.15
Nitrite (as N)	mg/L	1	NG	<0.010
Total kjeldahl nitrogen	mg/L	NG	NG	0.222
Phosphorus (dissolved, by ICPMS/ICPOES)	mg/L	NG	NG	0.072
Phosphorus (total, by ICPMS/ICPOES)	mg/L	NG	NG	<0.050
Potassium (dissolved)	mg/L	NG	NG	4.00
Potassium (total)	mg/L	NG	NG	4.47
<b>Microbiological</b>				
E. coli (counts)	CFU/100 mL	0 <sup>1.5</sup>	NG	<1
Fecal coliforms (counts)	CFU/100 mL	0 <sup>1.6</sup>	NG	<1
Heterotrophic Plate Count (counts)	CFU/mL	N <sup>1.7</sup>	NG	460
Total coliforms (counts)	CFU/100 mL	0 <sup>1.8</sup>	NG	<b>8</b>
<b>Total Metals</b>				
Aluminum (total)	mg/L	NG	N <sup>2.4</sup>	0.0054
Antimony (total)	mg/L	0.006	NG	<0.00020
Arsenic (total)	mg/L	0.010 <sup>1.9</sup>	NG	<0.00050
Barium (total)	mg/L	1.0	NG	0.0831

**Hydrogeological Investigation**  
Water Quality Results from WIN 43088

		Sampling Location		WIN 43088
		Date Sampled		13-Dec-17
		Lab Sample ID		7121073-01
Analyte	Unit	Guideline		
		GCDWQ MAC	GCDWQ AO	
Beryllium (total)	mg/L	NG	NG	<0.00010
Bismuth (total)	mg/L	NG	NG	<0.00010
Boron (total)	mg/L	5	NG	0.0363
Cadmium (total)	mg/L	0.005	NG	<0.000010
Calcium (total)	mg/L	NG	NG	118
Chromium (total)	mg/L	0.05	NG	0.00078
Cobalt (total)	mg/L	NG	NG	0.00064
Copper (total)	mg/L	NG	1.0	0.00109
Iron (total)	mg/L	NG	0.3	0.178
Lead (total)	mg/L	0.010	NG	<0.00020
Lithium (total)	mg/L	NG	NG	0.00734
Magnesium (total)	mg/L	NG	NG	18.8
Manganese (total)	mg/L	NG	0.05	<b>0.349</b>
Mercury (total)	mg/L	0.001	NG	<0.000010
Molybdenum (total)	mg/L	NG	NG	0.00166
Nickel (total)	mg/L	NG	NG	0.00266
Selenium (total)	mg/L	0.05	NG	0.00250
Silicon (total, as Si)	mg/L	NG	NG	13.3
Silver (total)	mg/L	NG	NG	<0.000050
Sodium (total)	mg/L	NG	200	68.6
Strontium (total)	mg/L	NG	NG	0.604
Sulphide (total, as S)	mg/L	NG	0.047 <sup>2.5</sup>	<0.020
Sulphur (total)	mg/L	NG	NG	3.8
Tellurium (total)	mg/L	NG	NG	<0.00050
Thallium (total)	mg/L	NG	NG	0.000029
Thorium (total)	mg/L	NG	NG	<0.00010
Tin (total)	mg/L	NG	NG	<0.00020
Titanium (total)	mg/L	NG	NG	<0.0050
Tungsten (total)	mg/L	NG	NG	<0.0010
Uranium (total)	mg/L	0.02	NG	0.0125
Vanadium (total)	mg/L	NG	NG	0.0016
Zinc (total)	mg/L	NG	5.0	0.257
Zirconium (total)	mg/L	NG	NG	<0.00010
<b>Dissolved Metals</b>				
Aluminum (dissolved)	mg/L	NG	N <sup>2.6</sup>	0.0064
Antimony (dissolved)	mg/L	0.006	NG	<0.00020
Arsenic (dissolved)	mg/L	0.010 <sup>1.10</sup>	NG	<0.00050
Barium (dissolved)	mg/L	1.0	NG	0.0723
Beryllium (dissolved)	mg/L	NG	NG	<0.00010
Bismuth (dissolved)	mg/L	NG	NG	<0.00010
Boron (dissolved)	mg/L	5	NG	0.0267
Cadmium (dissolved)	mg/L	0.005	NG	<0.000010
Calcium (dissolved)	mg/L	NG	NG	110
Chromium (dissolved)	mg/L	0.05	NG	0.00059
Cobalt (dissolved)	mg/L	NG	NG	0.00059
Copper (dissolved)	mg/L	NG	1.0	0.00099
Iron (dissolved)	mg/L	NG	0.3	0.152
Lead (dissolved)	mg/L	0.010	NG	<0.00020
Lithium (dissolved)	mg/L	NG	NG	0.00602

**Hydrogeological Investigation**  
Water Quality Results from WIN 43088

Analyte	Unit	Guideline		Result
		GCDWQ MAC	GCDWQ AO	
		Magnesium (dissolved)	mg/L	
Manganese (dissolved)	mg/L	NG	0.05	<b>0.318</b>
Mercury (dissolved)	mg/L	0.001	NG	<0.000010
Molybdenum (dissolved)	mg/L	NG	NG	0.00154
Nickel (dissolved)	mg/L	NG	NG	0.00238
Selenium (dissolved)	mg/L	0.05	NG	0.00230
Silicon (dissolved, as Si)	mg/L	NG	NG	11.9
Silver (dissolved)	mg/L	NG	NG	<0.000050
Sodium (dissolved)	mg/L	NG	200	59.8
Strontium (dissolved)	mg/L	NG	NG	0.571
Sulphur (dissolved)	mg/L	NG	NG	<3.0
Tellurium (dissolved)	mg/L	NG	NG	<0.00050
Thallium (dissolved)	mg/L	NG	NG	0.000026
Thorium (dissolved)	mg/L	NG	NG	<0.00010
Tin (dissolved)	mg/L	NG	NG	<0.00020
Titanium (dissolved)	mg/L	NG	NG	<0.0050
Tungsten (dissolved)	mg/L	NG	NG	<0.0010
Uranium (dissolved)	mg/L	0.02	NG	0.0112
Vanadium (dissolved)	mg/L	NG	NG	0.0012
Zinc (dissolved)	mg/L	NG	5.0	0.240
Zirconium (dissolved)	mg/L	NG	NG	0.00033

Sampling Location WIN 43088  
Date Sampled 13-Dec-17  
Lab Sample ID 7121073-01

Legend	
<	Less than reported detection limit
N	Narrative type of guideline or standard, or Result Note.
NG	No Guideline
<b>GCDWQ AO</b>	Highlighted value exceeds the Guidelines for Canadian Drinking Water Quality - Aesthetic Objectives (GCDWQ AO)
<b>GCDWQ MAC</b>	Highlighted value exceeds the Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentrations (GCDWQ MAC)



## **Guideline Notes**

### **1. Notes for Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentrations (GCDWQ MAC)**

#### **Note 1.1 for Turbidity:**

Waterworks systems that use a surface water source or a groundwater source under the direct influence of surface water should filter the source water to meet health-based turbidity limits, as defined for specific treatment technologies. Where possible, filtration systems should be designed and operated to reduce turbidity levels as low as possible, with a treated water turbidity target of less than 0.1 NTU at all times. Where this is not achievable, the treated water turbidity levels from individual filters should meet the requirements described in GCDWQ.

For systems that use groundwater that is not under the direct influence of surface water, which are considered less vulnerable to faecal contamination, turbidity should generally be below 1.0 NTU.

For effective operation of the distribution system, it is good practice to ensure that water entering the distribution system has turbidity levels below 1.0 NTU.

#### **Note 1.2 for Total cyanide:**

The MAC for free cyanide is 0.2 mg/L. A maximum of 0.2 mg/L was used, in this report, to identify exceedances for total cyanide as a means for determining the potential for exceeding the free cyanide guideline.

#### **Note 1.3 for Turbidity:**

Waterworks systems that use a surface water source or a groundwater source under the direct influence of surface water should filter the source water to meet health-based turbidity limits, as defined for specific treatment technologies. Where possible, filtration systems should be designed and operated to reduce turbidity levels as low as possible, with a treated water turbidity target of less than 0.1 NTU at all times. Where this is not achievable, the treated water turbidity levels from individual filters should meet the requirements described in GCDWQ.

For systems that use groundwater that is not under the direct influence of surface water, which are considered less vulnerable to faecal contamination, turbidity should generally be below 1.0 NTU.

For effective operation of the distribution system, it is good practice to ensure that water entering the distribution system has turbidity levels below 1.0 NTU.

#### **Note 1.4 for Nitrate + Nitrite (as N) (calculated):**

The MAC for Nitrate (as N) is 10 mg/L.

#### **Note 1.5 for E. coli (counts):**

MAC is none detectable per 100 mL.

#### **Note 1.6 for Fecal coliforms (counts):**

The GCDWQ does not have a guideline for fecal coliforms. The GCDWQ were revised in 2006 when the guideline for fecal coliforms was deleted, and a guideline for E. coli was added. However the GCDWQ has a guideline for total coliforms that includes the following statement: "The MAC of total coliforms in water leaving a treatment plant in a public system and throughout semi-public and private supply systems is none detectable per 100 mL." Therefore a guideline of none detectable per 100 mL was used for fecal coliforms for this report.

Note that the Drinking Water Protection Regulation (2003), under the BC Drinking Water Protection Act, has a water quality standard for potable water for fecal coliforms of "No detectable fecal coliform bacteria per 100 mL".

#### **Note 1.7 for Heterotrophic Plate Count (counts):**

There is no guideline for heterotrophic plate count (HPC) bacteria. Following is an excerpt from "Guidance on the use of heterotrophic plate counts in Canadian drinking water supplies", Health Canada (2012), prepared by the Federal-Provincial-Territorial Committee on Drinking Water:

Measuring HPC is an analytic method that is a useful operational tool for monitoring general bacteriological water quality throughout the treatment process and in the distribution system. HPC results are not an indicator of water safety and, as such, should not be used as an indicator of potential adverse human health effects. Each drinking water system will have a baseline range of HPC bacteria levels depending on the site-specific characteristics. Unexpected increases in the HPC baseline range could indicate a change in the treatment process, a disruption or contamination in the distribution system, or a change in the general bacteriological quality of the water.

If an unusual, rapid, or unexpected increase in HPC bacteria concentrations does occur, the system should be inspected and the cause determined.

#### **Note 1.8 for Total coliforms (counts):**

The maximum acceptable concentration (MAC) of total coliforms in water leaving a treatment plant and in non-disinfected groundwater leaving the well is none detectable per 100 mL.

Total coliforms should be monitored in the distribution system because they are used to indicate changes in water quality.

Detection of total coliforms from consecutive samples from the same site or from more than 10% of the samples collected in a given sampling period should be investigated.

#### **Note 1.9 for Arsenic (total):**

Every effort should be made to maintain arsenic levels in drinking water as low as reasonably achievable.

#### **Note 1.10 for Arsenic (dissolved):**

Every effort should be made to maintain arsenic levels in drinking water as low as reasonably achievable.

**Hydrogeological Investigation**  
Water Quality Results from WIN 43088

**2. Notes for Guidelines for Canadian Drinking Water Quality - Aesthetic Objectives (GCDWQ AO)**

**Note 2.1 for pH:**

The operational guideline for pH is a range of 7.0 to 10.5 in finished drinking water.

**Note 2.2 for pH:**

The operational guideline for pH is a range of 7.0 to 10.5 in finished drinking water.

**Note 2.3 for Sulphate:**

There may be a laxative effect in some individuals when sulphate levels exceed 500 mg/L. Health authorities should be notified of drinking water sources containing above 500 mg/L.

**Note 2.4 for Aluminum (total):**

This is an operational guidance value, designed to apply only to drinking water treatment plants using aluminum-based coagulants. The operational guidance value of 0.1 mg/L applies to conventional treatment plants, and 0.2 mg/L applies to other types of treatment systems.

**Note 2.5 for Sulphide (total, as S):**

The aesthetic objective for sulphide (as H<sub>2</sub>S) is 0.05 mg/L. This is equivalent to 0.047 mg/L sulphide (as S).

**Note 2.6 for Aluminum (dissolved):**

This is an operational guidance value, designed to apply only to drinking water treatment plants using aluminum-based coagulants. The operational guidance value of 0.1 mg/L applies to conventional treatment plants, and 0.2 mg/L applies to other types of treatment systems.

## Appendix C - Laboratory Report



## CERTIFICATE OF ANALYSIS

<b>REPORTED TO</b>	Associated Environmental Consultants Inc. (Vernon) #200 - 2800 29th Street Vernon, BC V1T 9P9	<b>WORK ORDER</b>	7121073
<b>ATTENTION</b>	Mike Weldon	<b>RECEIVED / TEMP REPORTED</b>	2017-12-13 14:15 / 6°C
<b>PO NUMBER</b>		<b>REPORTED</b>	2018-01-15 13:55
<b>PROJECT</b>	2017-8241.000.000	<b>COC NUMBER</b>	A03899
<b>PROJECT INFO</b>	Hydrogeological Assessment		

### Introduction:

CARO Analytical Services is a testing laboratory full of smart, engaged scientists driven to make the world a safer and healthier place. Through our clients' projects we become an essential element for a better world. We employ methods conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts. CARO is accredited by the Canadian Association for Laboratories Accreditation (CALA) to ISO 17025:2005 for specific tests listed in the scope of accreditation approved by CALA.

#### Big Picture Sidekicks



You know that the sample you collected after snowshoeing to site, digging 5 meters, and racing to get it on a plane so you can submit it to the lab for time sensitive results needed to make important and expensive decisions (whew) is VERY important. We know that too.

#### We've Got Chemistry



It's simple. We figure the more you enjoy working with our fun and engaged team members; the more likely you are to give us continued opportunities to support you.

#### Ahead of the Curve



Through research, regulation knowledge, and instrumentation, we are your analytical centre for the technical knowledge you need, BEFORE you need it, so you can stay up to date and in the know.

### Work Order Comments:

This is a revised report; please refer to Appendix 3 for details.

*If you have any questions or concerns, please contact me at [sgulenchyn@caro.ca](mailto:sgulenchyn@caro.ca)*

#### Authorized By:

Sara Gulenchyn, B.Sc, P.Chem.  
Client Service Manager

1-888-311-8846 | [www.caro.ca](http://www.caro.ca)

#110 4011 Viking Way Richmond, BC V6V 2K9 | #102 3677 Highway 97N Kelowna, BC V1X 5C3 | 17225 109 Avenue Edmonton, AB T5S 1H7



## TEST RESULTS

**REPORTED TO PROJECT** Associated Environmental Consultants Inc. (Vernon)  
2017-8241.000.000

**WORK ORDER REPORTED** 7121073  
2018-01-15 13:55

Analyte	Result	Guideline	RL Units	Analyzed	Qualifier
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**WIN 43088 (7121073-01) | Matrix: Water | Sampled: 2017-12-13 08:45**

### Anions

Chloride	116	AO ≤ 250	0.10 mg/L	2017-12-16	
Fluoride	0.10	MAC = 1.5	0.10 mg/L	2017-12-16	
Nitrate (as N)	3.15	MAC = 10	0.010 mg/L	2017-12-16	
Nitrite (as N)	< 0.010	MAC = 1	0.010 mg/L	2017-12-16	
Sulfate	9.8	AO ≤ 500	1.0 mg/L	2017-12-16	

### General Parameters

Alkalinity, Total (as CaCO <sub>3</sub> )	287	N/A	1.0 mg/L	2017-12-14	
Alkalinity, Phenolphthalein (as CaCO <sub>3</sub> )	< 1.0	N/A	1.0 mg/L	2017-12-14	
Alkalinity, Bicarbonate (as CaCO <sub>3</sub> )	287	N/A	1.0 mg/L	2017-12-14	
Alkalinity, Carbonate (as CaCO <sub>3</sub> )	< 1.0	N/A	1.0 mg/L	2017-12-14	
Alkalinity, Hydroxide (as CaCO <sub>3</sub> )	< 1.0	N/A	1.0 mg/L	2017-12-14	
Ammonia, Total (as N)	0.050	None Required	0.020 mg/L	2017-12-20	
Carbon, Total Organic	2.74	N/A	0.50 mg/L	2017-12-14	
Carbon, Dissolved Organic	2.74	N/A	0.50 mg/L	2017-12-14	
Colour, True	5.9	AO ≤ 15	5.0 CU	2017-12-15	
Conductivity (EC)	980	N/A	2.0 µS/cm	2017-12-14	
Cyanide, Total	< 0.0020	MAC = 0.2	0.0020 mg/L	2017-12-19	
Nitrogen, Total Kjeldahl	0.222	N/A	0.050 mg/L	2017-12-16	
pH	7.82	7.0-10.5	0.10 pH units	2017-12-14	HT2
Solids, Total Dissolved	670	AO ≤ 500	15 mg/L	2017-12-15	
Solids, Total Suspended	< 2.0	N/A	2.0 mg/L	2017-12-14	
Sulfide, Total	< 0.020	AO ≤ 0.05	0.020 mg/L	2017-12-15	
Turbidity	0.84	OG < 1	0.10 NTU	2017-12-15	
UV Transmittance @ 254nm	87.5	N/A	0.10 % T	2017-12-15	

### Calculated Parameters

Hardness, Total (as CaCO <sub>3</sub> )	343	None Required	0.500 mg/L	N/A	
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### Dissolved Metals

Aluminum, dissolved	0.0064	N/A	0.0050 mg/L	2017-12-18	
Antimony, dissolved	< 0.00020	N/A	0.00020 mg/L	2017-12-18	
Arsenic, dissolved	< 0.00050	N/A	0.00050 mg/L	2017-12-18	
Barium, dissolved	0.0723	N/A	0.0050 mg/L	2017-12-18	
Beryllium, dissolved	< 0.00010	N/A	0.00010 mg/L	2017-12-18	
Bismuth, dissolved	< 0.00010	N/A	0.00010 mg/L	2017-12-18	
Boron, dissolved	0.0267	N/A	0.0050 mg/L	2017-12-18	
Cadmium, dissolved	< 0.000010	N/A	0.000010 mg/L	2017-12-18	
Calcium, dissolved	110	N/A	0.20 mg/L	2017-12-18	
Chromium, dissolved	0.00059	N/A	0.00050 mg/L	2017-12-18	
Cobalt, dissolved	0.00059	N/A	0.00010 mg/L	2017-12-18	
Copper, dissolved	0.00099	N/A	0.00040 mg/L	2017-12-18	
Iron, dissolved	0.152	N/A	0.010 mg/L	2017-12-18	



## TEST RESULTS

**REPORTED TO PROJECT** Associated Environmental Consultants Inc. (Vernon)  
2017-8241.000.000

**WORK ORDER REPORTED** 7121073  
2018-01-15 13:55

Analyte	Result	Guideline	RL Units	Analyzed	Qualifier
<b>WIN 43088 (7121073-01)   Matrix: Water   Sampled: 2017-12-13 08:45, Continued</b>					
<i>Dissolved Metals, Continued</i>					
Lead, dissolved	< 0.00020	N/A	0.00020 mg/L	2017-12-18	
Lithium, dissolved	<b>0.00602</b>	N/A	0.00010 mg/L	2017-12-18	
Magnesium, dissolved	<b>16.5</b>	N/A	0.010 mg/L	2017-12-18	
Manganese, dissolved	<b>0.318</b>	N/A	0.00020 mg/L	2017-12-18	
Mercury, dissolved	< 0.000010	N/A	0.000010 mg/L	2017-12-19	
Molybdenum, dissolved	<b>0.00154</b>	N/A	0.00010 mg/L	2017-12-18	
Nickel, dissolved	<b>0.00238</b>	N/A	0.00040 mg/L	2017-12-18	
Phosphorus, dissolved	<b>0.072</b>	N/A	0.050 mg/L	2017-12-18	
Potassium, dissolved	<b>4.00</b>	N/A	0.10 mg/L	2017-12-18	
Selenium, dissolved	<b>0.00230</b>	N/A	0.00050 mg/L	2017-12-18	
Silicon, dissolved	<b>11.9</b>	N/A	1.0 mg/L	2017-12-18	
Silver, dissolved	< 0.000050	N/A	0.000050 mg/L	2017-12-18	
Sodium, dissolved	<b>59.8</b>	N/A	0.10 mg/L	2017-12-18	
Strontium, dissolved	<b>0.571</b>	N/A	0.0010 mg/L	2017-12-18	
Sulfur, dissolved	< 3.0	N/A	3.0 mg/L	2017-12-18	
Tellurium, dissolved	< 0.00050	N/A	0.00050 mg/L	2017-12-18	
Thallium, dissolved	<b>0.000026</b>	N/A	0.000020 mg/L	2017-12-18	
Thorium, dissolved	< 0.00010	N/A	0.00010 mg/L	2017-12-18	
Tin, dissolved	< 0.00020	N/A	0.00020 mg/L	2017-12-18	
Titanium, dissolved	< 0.0050	N/A	0.0050 mg/L	2017-12-18	
Tungsten, dissolved	< 0.0010	N/A	0.0010 mg/L	2017-12-18	
Uranium, dissolved	<b>0.0112</b>	N/A	0.000020 mg/L	2017-12-18	
Vanadium, dissolved	<b>0.0012</b>	N/A	0.0010 mg/L	2017-12-18	
Zinc, dissolved	<b>0.240</b>	N/A	0.0040 mg/L	2017-12-18	
Zirconium, dissolved	<b>0.00033</b>	N/A	0.00010 mg/L	2017-12-18	
<i>Total Metals</i>					
Aluminum, total	<b>0.0054</b>	OG < 0.1	0.0050 mg/L	2017-12-18	
Antimony, total	< 0.00020	MAC = 0.006	0.00020 mg/L	2017-12-18	
Arsenic, total	< 0.00050	MAC = 0.01	0.00050 mg/L	2017-12-18	
Barium, total	<b>0.0831</b>	MAC = 1	0.0050 mg/L	2017-12-18	
Beryllium, total	< 0.00010	N/A	0.00010 mg/L	2017-12-18	
Bismuth, total	< 0.00010	N/A	0.00010 mg/L	2017-12-18	
Boron, total	<b>0.0363</b>	MAC = 5	0.0050 mg/L	2017-12-18	
Cadmium, total	< 0.000010	MAC = 0.005	0.000010 mg/L	2017-12-18	
Calcium, total	<b>118</b>	None Required	0.20 mg/L	2017-12-18	
Chromium, total	<b>0.00078</b>	MAC = 0.05	0.00050 mg/L	2017-12-18	
Cobalt, total	<b>0.00064</b>	N/A	0.00010 mg/L	2017-12-18	
Copper, total	<b>0.00109</b>	AO ≤ 1	0.00040 mg/L	2017-12-18	
Iron, total	<b>0.178</b>	AO ≤ 0.3	0.010 mg/L	2017-12-18	
Lead, total	< 0.00020	MAC = 0.01	0.00020 mg/L	2017-12-18	
Lithium, total	<b>0.00734</b>	N/A	0.00010 mg/L	2017-12-18	
Magnesium, total	<b>18.8</b>	None Required	0.010 mg/L	2017-12-18	



## TEST RESULTS

REPORTED TO Associated Environmental Consultants Inc. (Vernon)  
PROJECT 2017-8241.000.000

WORK ORDER 7121073  
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Analyte	Result	Guideline	RL Units	Analyzed	Qualifier
<b>WIN 43088 (7121073-01)   Matrix: Water   Sampled: 2017-12-13 08:45, Continued</b>					
<b>Total Metals, Continued</b>					
Manganese, total	0.349	AO ≤ 0.05	0.00020 mg/L	2017-12-18	
Mercury, total	< 0.000010	MAC = 0.001	0.000010 mg/L	2017-12-18	
Molybdenum, total	0.00166	N/A	0.00010 mg/L	2017-12-18	
Nickel, total	0.00266	N/A	0.00040 mg/L	2017-12-18	
Phosphorus, total	< 0.050	N/A	0.050 mg/L	2017-12-18	
Potassium, total	4.47	N/A	0.10 mg/L	2017-12-18	
Selenium, total	0.00250	MAC = 0.05	0.00050 mg/L	2017-12-18	
Silicon, total	13.3	N/A	1.0 mg/L	2017-12-18	
Silver, total	< 0.000050	None Required	0.000050 mg/L	2017-12-18	
Sodium, total	68.6	AO ≤ 200	0.10 mg/L	2017-12-18	
Strontium, total	0.604	N/A	0.0010 mg/L	2017-12-18	
Sulfur, total	3.8	N/A	3.0 mg/L	2017-12-18	
Tellurium, total	< 0.00050	N/A	0.00050 mg/L	2017-12-18	
Thallium, total	0.000029	N/A	0.000020 mg/L	2017-12-18	
Thorium, total	< 0.00010	N/A	0.00010 mg/L	2017-12-18	
Tin, total	< 0.00020	N/A	0.00020 mg/L	2017-12-18	
Titanium, total	< 0.0050	N/A	0.0050 mg/L	2017-12-18	
Tungsten, total	< 0.0010	N/A	0.0010 mg/L	2017-12-18	
Uranium, total	0.0125	MAC = 0.02	0.000020 mg/L	2017-12-18	
Vanadium, total	0.0016	N/A	0.0010 mg/L	2017-12-18	
Zinc, total	0.257	AO ≤ 5	0.0040 mg/L	2017-12-18	
Zirconium, total	< 0.00010	N/A	0.00010 mg/L	2017-12-18	

### Microbiological Parameters

Coliforms, Total	8	MAC = 0	1 CFU/100 mL	2017-12-14	
Coliforms, Fecal	< 1	N/A	1 CFU/100 mL	2017-12-14	
Heterotrophic Plate Count	460	N/A	5 CFU/mL	2017-12-14	
E. coli	< 1	MAC = 0	1 CFU/100 mL	2017-12-14	

#### Sample Qualifiers:

HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.



## APPENDIX 1: SUPPORTING INFORMATION

**REPORTED TO PROJECT** Associated Environmental Consultants Inc. (Vernon)  
2017-8241.000.000

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Analysis Description	Method Ref.	Technique	Location
Alkalinity in Water	SM 2320 B* (2011)	Titration with H2SO4	Kelowna
Ammonia, Total in Water	SM 4500-NH3 G* (2011)	Automated Colorimetry (Phenate)	Kelowna
Anions in Water	SM 4110 B (2011)	Ion Chromatography	Kelowna
Carbon, Dissolved Organic in Water	SM 5310 B (2011)	Combustion, Infrared CO2 Detection	Kelowna
Carbon, Total Organic in Water	SM 5310 B (2011)	Combustion, Infrared CO2 Detection	Kelowna
Coliforms, Fecal in Water	SM 9222 D (2006)	Membrane Filtration / m-FC Agar	Kelowna
Coliforms, Total in Water	SM 9222* (2006)	Membrane Filtration / Chromocult Agar	Kelowna
Colour, True in Water	SM 2120 C (2011)	Spectrophotometry (456 nm)	Kelowna
Conductivity in Water	SM 2510 B (2011)	Conductivity Meter	Kelowna
Cyanide, SAD in Water	ASTM D7511-12	Flow Injection with In-Line UV Digestion and Amperometry	Kelowna
Dissolved Metals in Water	EPA 200.8 / EPA 6020B	0.45 µm Filtration / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	Richmond
E. coli in Water	SM 9222* (2006)	Membrane Filtration / Chromocult Agar	Kelowna
Hardness in Water	SM 2340 B (2011)	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	N/A
Heterotrophic Plate Count in Water	SM 9215 D (2004)	Membrane Filtration / Membrane Filtration	Kelowna
Mercury, dissolved in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Nitrogen, Total Kjeldahl in Water	SM 4500-Norg D* (2011)	Block Digestion and Flow Injection Analysis	Kelowna
pH in Water	SM 4500-H+ B (2011)	Electrometry	Kelowna
Solids, Total Dissolved in Water	SM 2540 C* (2011)	Gravimetry (Dried at 103-105C)	Kelowna
Solids, Total Suspended in Water	SM 2540 D* (2011)	Gravimetry (Dried at 103-105C)	Kelowna
Sulfide, Total in Water	SM 4500-S2 D* (2011)	Colorimetry (Methylene Blue)	Edmonton
Total Metals in Water	EPA 200.2* / EPA 6020B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	Richmond
Transmissivity at 254 nm in Water	SM 5910 B* (2013)	Ultraviolet Absorption	Kelowna
Turbidity in Water	SM 2130 B (2011)	Nephelometry	Kelowna

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method



## APPENDIX 1: SUPPORTING INFORMATION

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### Glossary of Terms:

RL	Reporting Limit (default)
% T	Percent Transmittance
<	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
AO	Aesthetic Objective
CFU/100 mL	Colony Forming Units per 100 millilitres
CFU/mL	Colony Forming Units per millilitre
CU	Colour Units (referenced against a platinum cobalt standard)
MAC	Maximum Acceptable Concentration (health based)
mg/L	Milligrams per litre
NTU	Nephelometric Turbidity Units
OG	Operational Guideline (treated water)
pH units	pH < 7 = acidic, pH > 7 = basic
µS/cm	Microsiemens per centimetre
ASTM	ASTM International Test Methods
EPA	United States Environmental Protection Agency Test Methods
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

### General Comments:

The results in this report apply to the samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.



## APPENDIX 2: QUALITY CONTROL RESULTS

**REPORTED TO PROJECT** Associated Environmental Consultants Inc. (Vernon)  
2017-8241.000.000

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The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk):** A blank sample that undergoes sample processing identical to that carried out for the test samples. Method blank results are used to assess contamination from the laboratory environment and reagents.
- **Duplicate (Dup):** An additional or second portion of a randomly selected sample in the analytical run carried through the entire analytical process. Duplicates provide a measure of the analytical method's precision (reproducibility).
- **Blank Spike (BS):** A sample of known concentration which undergoes processing identical to that carried out for test samples, also referred to as a laboratory control sample (LCS). Blank spikes provide a measure of the analytical method's accuracy.
- **Matrix Spike (MS):** A second aliquot of sample is fortified with with a known concentration of target analytes and carried through the entire analytical process. Matrix spikes evaluate potential matrix effects that may affect the analyte recovery.
- **Reference Material (SRM):** A homogenous material of similar matrix to the samples, certified for the parameter(s) listed. Reference Materials ensure that the analytical process is adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10-20 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
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### Anions, Batch B7L0960

Blank (B7L0960-BLK1)			Prepared: 2017-12-19, Analyzed: 2017-12-19						
Chloride	< 0.10	0.10 mg/L							
Fluoride	< 0.10	0.10 mg/L							
Nitrate (as N)	< 0.010	0.010 mg/L							
Nitrite (as N)	< 0.010	0.010 mg/L							
Sulfate	< 1.0	1.0 mg/L							

LCS (B7L0960-BS1)			Prepared: 2017-12-19, Analyzed: 2017-12-19						
Chloride	15.9	0.10 mg/L	16.0		99	90-110			
Fluoride	4.01	0.10 mg/L	4.00		100	88-108			
Nitrate (as N)	3.93	0.010 mg/L	4.00		98	93-108			
Nitrite (as N)	1.97	0.010 mg/L	2.00		99	85-114			
Sulfate	17.5	1.0 mg/L	16.0		109	91-109			

### Dissolved Metals, Batch B7L1186

Blank (B7L1186-BLK1)			Prepared: 2017-12-18, Analyzed: 2017-12-18						
Aluminum, dissolved	< 0.0050	0.0050 mg/L							
Antimony, dissolved	< 0.00020	0.00020 mg/L							
Arsenic, dissolved	< 0.00050	0.00050 mg/L							
Barium, dissolved	< 0.0050	0.0050 mg/L							
Beryllium, dissolved	< 0.00010	0.00010 mg/L							
Bismuth, dissolved	< 0.00010	0.00010 mg/L							
Boron, dissolved	< 0.0050	0.0050 mg/L							
Cadmium, dissolved	< 0.000010	0.000010 mg/L							
Calcium, dissolved	< 0.20	0.20 mg/L							
Chromium, dissolved	< 0.00050	0.00050 mg/L							
Cobalt, dissolved	< 0.00010	0.00010 mg/L							
Copper, dissolved	< 0.00040	0.00040 mg/L							
Iron, dissolved	< 0.010	0.010 mg/L							
Lead, dissolved	< 0.00020	0.00020 mg/L							
Lithium, dissolved	< 0.00010	0.00010 mg/L							
Magnesium, dissolved	< 0.010	0.010 mg/L							
Manganese, dissolved	< 0.00020	0.00020 mg/L							
Molybdenum, dissolved	< 0.00010	0.00010 mg/L							
Nickel, dissolved	< 0.00040	0.00040 mg/L							



## APPENDIX 2: QUALITY CONTROL RESULTS

**REPORTED TO PROJECT** Associated Environmental Consultants Inc. (Vernon)  
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**WORK ORDER REPORTED** 7121073  
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Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
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**Dissolved Metals, Batch B7L1186, Continued**

**Blank (B7L1186-BLK1), Continued**

Prepared: 2017-12-18, Analyzed: 2017-12-18

Phosphorus, dissolved	< 0.050	0.050 mg/L							
Potassium, dissolved	< 0.10	0.10 mg/L							
Selenium, dissolved	< 0.00050	0.00050 mg/L							
Silicon, dissolved	< 1.0	1.0 mg/L							
Silver, dissolved	< 0.000050	0.000050 mg/L							
Sodium, dissolved	< 0.10	0.10 mg/L							
Strontium, dissolved	< 0.0010	0.0010 mg/L							
Sulfur, dissolved	< 3.0	3.0 mg/L							
Tellurium, dissolved	< 0.00050	0.00050 mg/L							
Thallium, dissolved	< 0.000020	0.000020 mg/L							
Thorium, dissolved	< 0.00010	0.00010 mg/L							
Tin, dissolved	< 0.00020	0.00020 mg/L							
Titanium, dissolved	< 0.0050	0.0050 mg/L							
Tungsten, dissolved	< 0.0010	0.0010 mg/L							
Uranium, dissolved	< 0.000020	0.000020 mg/L							
Vanadium, dissolved	< 0.0010	0.0010 mg/L							
Zinc, dissolved	< 0.0040	0.0040 mg/L							
Zirconium, dissolved	< 0.00010	0.00010 mg/L							

**LCS (B7L1186-BS1)**

Prepared: 2017-12-18, Analyzed: 2017-12-18

Aluminum, dissolved	0.0220	0.0050 mg/L	0.0200		110	80-120			
Antimony, dissolved	0.0180	0.00020 mg/L	0.0200		90	80-120			
Arsenic, dissolved	0.0186	0.00050 mg/L	0.0200		93	80-120			
Barium, dissolved	0.0176	0.0050 mg/L	0.0200		88	80-120			
Beryllium, dissolved	0.0179	0.00010 mg/L	0.0200		89	80-120			
Bismuth, dissolved	0.0189	0.00010 mg/L	0.0200		95	80-120			
Boron, dissolved	0.0164	0.0050 mg/L	0.0200		82	80-120			
Cadmium, dissolved	0.0182	0.000010 mg/L	0.0200		91	80-120			
Calcium, dissolved	1.99	0.20 mg/L	2.00		100	80-120			
Chromium, dissolved	0.0208	0.00050 mg/L	0.0200		104	80-120			
Cobalt, dissolved	0.0193	0.00010 mg/L	0.0200		96	80-120			
Copper, dissolved	0.0203	0.00040 mg/L	0.0200		102	80-120			
Iron, dissolved	1.97	0.010 mg/L	2.00		99	80-120			
Lead, dissolved	0.0186	0.00020 mg/L	0.0200		93	80-120			
Lithium, dissolved	0.0171	0.00010 mg/L	0.0200		85	80-120			
Magnesium, dissolved	2.05	0.010 mg/L	2.00		102	80-120			
Manganese, dissolved	0.0199	0.00020 mg/L	0.0200		99	80-120			
Molybdenum, dissolved	0.0181	0.00010 mg/L	0.0200		91	80-120			
Nickel, dissolved	0.0195	0.00040 mg/L	0.0200		97	80-120			
Phosphorus, dissolved	1.89	0.050 mg/L	2.00		95	80-120			
Potassium, dissolved	2.07	0.10 mg/L	2.00		103	80-120			
Selenium, dissolved	0.0189	0.00050 mg/L	0.0200		94	80-120			
Silicon, dissolved	1.9	1.0 mg/L	2.00		95	80-120			
Silver, dissolved	0.0187	0.000050 mg/L	0.0200		93	80-120			
Sodium, dissolved	2.03	0.10 mg/L	2.00		101	80-120			
Strontium, dissolved	0.0185	0.0010 mg/L	0.0200		93	80-120			
Sulfur, dissolved	4.1	3.0 mg/L	5.00		82	80-120			
Tellurium, dissolved	0.0175	0.00050 mg/L	0.0200		87	80-120			
Thallium, dissolved	0.0188	0.000020 mg/L	0.0200		94	80-120			
Thorium, dissolved	0.0181	0.00010 mg/L	0.0200		90	80-120			
Tin, dissolved	0.0190	0.00020 mg/L	0.0200		95	80-120			
Titanium, dissolved	0.0199	0.0050 mg/L	0.0200		100	80-120			
Tungsten, dissolved	0.0172	0.0010 mg/L	0.0200		86	80-120			
Uranium, dissolved	0.0195	0.000020 mg/L	0.0200		98	80-120			
Vanadium, dissolved	0.0186	0.0010 mg/L	0.0200		93	80-120			
Zinc, dissolved	0.0222	0.0040 mg/L	0.0200		111	80-120			



## APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO PROJECT Associated Environmental Consultants Inc. (Vernon)  
2017-8241.000.000

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Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
<b>Dissolved Metals, Batch B7L1186, Continued</b>									
<b>LCS (B7L1186-BS1), Continued</b>					Prepared: 2017-12-18, Analyzed: 2017-12-18				
Zirconium, dissolved	0.0184	0.00010 mg/L	0.0200		92	80-120			
<b>Reference (B7L1186-SRM1)</b>					Prepared: 2017-12-18, Analyzed: 2017-12-18				
Aluminum, dissolved	0.229	0.0050 mg/L	0.233		98	79-114			
Antimony, dissolved	0.0422	0.00020 mg/L	0.0430		98	89-123			
Arsenic, dissolved	0.430	0.00050 mg/L	0.438		98	87-113			
Barium, dissolved	3.03	0.0050 mg/L	3.35		91	85-114			
Beryllium, dissolved	0.199	0.00010 mg/L	0.213		93	79-122			
Boron, dissolved	1.49	0.0050 mg/L	1.74		85	79-117			
Cadmium, dissolved	0.211	0.000010 mg/L	0.224		94	89-112			
Calcium, dissolved	7.56	0.20 mg/L	7.69		98	85-120			
Chromium, dissolved	0.432	0.00050 mg/L	0.437		99	87-113			
Cobalt, dissolved	0.129	0.00010 mg/L	0.128		101	90-117			
Copper, dissolved	0.847	0.00040 mg/L	0.844		100	90-115			
Iron, dissolved	1.27	0.010 mg/L	1.29		98	86-112			
Lead, dissolved	0.107	0.00020 mg/L	0.112		95	90-113			
Lithium, dissolved	0.0929	0.00010 mg/L	0.104		89	77-127			
Magnesium, dissolved	6.82	0.010 mg/L	6.92		99	84-116			
Manganese, dissolved	0.346	0.00020 mg/L	0.345		100	85-113			
Molybdenum, dissolved	0.396	0.00010 mg/L	0.426		93	87-112			
Nickel, dissolved	0.830	0.00040 mg/L	0.840		99	90-114			
Phosphorus, dissolved	0.476	0.050 mg/L	0.495		96	74-119			
Potassium, dissolved	3.26	0.10 mg/L	3.19		102	78-119			
Selenium, dissolved	0.0324	0.00050 mg/L	0.0331		98	89-123			
Sodium, dissolved	18.6	0.10 mg/L	19.1		97	81-117			
Strontium, dissolved	0.850	0.0010 mg/L	0.916		93	82-111			
Thallium, dissolved	0.0376	0.000020 mg/L	0.0393		96	90-113			
Uranium, dissolved	0.249	0.000020 mg/L	0.266		94	87-113			
Vanadium, dissolved	0.838	0.0010 mg/L	0.869		96	85-110			
Zinc, dissolved	0.870	0.0040 mg/L	0.881		99	88-114			

### Dissolved Metals, Batch B7L1252

<b>Blank (B7L1252-BLK1)</b>					Prepared: 2017-12-18, Analyzed: 2017-12-19				
Mercury, dissolved	< 0.000010	0.000010 mg/L							
<b>Duplicate (B7L1252-DUP1)</b>					Prepared: 2017-12-18, Analyzed: 2017-12-19				
Mercury, dissolved	< 0.000010	0.000010 mg/L		Source: 7121073-01	< 0.000010		20		
<b>Reference (B7L1252-SRM1)</b>					Prepared: 2017-12-18, Analyzed: 2017-12-19				
Mercury, dissolved	0.00478	0.000010 mg/L	0.00489		98	80-120			

### General Parameters, Batch B7L1011

<b>Blank (B7L1011-BLK1)</b>					Prepared: 2017-12-15, Analyzed: 2017-12-15				
Turbidity	< 0.10	0.10 NTU							
<b>LCS (B7L1011-BS1)</b>					Prepared: 2017-12-15, Analyzed: 2017-12-15				
Turbidity	37.3	0.10 NTU	40.0		93	90-110			

### General Parameters, Batch B7L1012

<b>Blank (B7L1012-BLK1)</b>					Prepared: 2017-12-14, Analyzed: 2017-12-14				
Solids, Total Suspended	< 2.0	2.0 mg/L							



## APPENDIX 2: QUALITY CONTROL RESULTS

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Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
<b>General Parameters, Batch B7L1012, Continued</b>									
<b>LCS (B7L1012-BS1)</b>			Prepared: 2017-12-14, Analyzed: 2017-12-14						
Solids, Total Suspended	97.0	10.0 mg/L	100		97	91-106			
<b>Reference (B7L1012-SRM1)</b>			Prepared: 2017-12-14, Analyzed: 2017-12-14						
Solids, Total Suspended	390	20.0 mg/L	443		88	80-120			
<b>General Parameters, Batch B7L1015</b>									
<b>Blank (B7L1015-BLK1)</b>			Prepared: 2017-12-14, Analyzed: 2017-12-16						
Nitrogen, Total Kjeldahl	< 0.050	0.050 mg/L							
<b>Blank (B7L1015-BLK2)</b>			Prepared: 2017-12-14, Analyzed: 2017-12-16						
Nitrogen, Total Kjeldahl	< 0.050	0.050 mg/L							
<b>LCS (B7L1015-BS1)</b>			Prepared: 2017-12-14, Analyzed: 2017-12-16						
Nitrogen, Total Kjeldahl	1.02	0.050 mg/L	1.00		102	84-121			
<b>LCS (B7L1015-BS2)</b>			Prepared: 2017-12-14, Analyzed: 2017-12-16						
Nitrogen, Total Kjeldahl	0.948	0.050 mg/L	1.00		95	84-121			
<b>General Parameters, Batch B7L1023</b>									
<b>Blank (B7L1023-BLK1)</b>			Prepared: 2017-12-14, Analyzed: 2017-12-14						
Alkalinity, Total (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1.0	1.0 mg/L							
Conductivity (EC)	< 2.0	2.0 µS/cm							
<b>Blank (B7L1023-BLK2)</b>			Prepared: 2017-12-14, Analyzed: 2017-12-14						
Alkalinity, Total (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1.0	1.0 mg/L							
Conductivity (EC)	< 2.0	2.0 µS/cm							
<b>Blank (B7L1023-BLK3)</b>			Prepared: 2017-12-14, Analyzed: 2017-12-14						
Alkalinity, Total (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1.0	1.0 mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1.0	1.0 mg/L							
Conductivity (EC)	< 2.0	2.0 µS/cm							
<b>LCS (B7L1023-BS1)</b>			Prepared: 2017-12-14, Analyzed: 2017-12-14						
Alkalinity, Total (as CaCO3)	102	1.0 mg/L	100		102	92-106			
<b>LCS (B7L1023-BS2)</b>			Prepared: 2017-12-14, Analyzed: 2017-12-14						
Conductivity (EC)	1410	2.0 µS/cm	1410		100	95-104			
<b>LCS (B7L1023-BS3)</b>			Prepared: 2017-12-14, Analyzed: 2017-12-14						
Alkalinity, Total (as CaCO3)	102	1.0 mg/L	100		102	92-106			
<b>LCS (B7L1023-BS4)</b>			Prepared: 2017-12-14, Analyzed: 2017-12-14						
Conductivity (EC)	1430	2.0 µS/cm	1410		101	95-104			



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Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
<b>General Parameters, Batch B7L1023, Continued</b>									
<b>LCS (B7L1023-BS5)</b>					Prepared: 2017-12-14, Analyzed: 2017-12-14				
Alkalinity, Total (as CaCO <sub>3</sub> )	103	1.0 mg/L	100		103	92-106			
<b>LCS (B7L1023-BS6)</b>					Prepared: 2017-12-14, Analyzed: 2017-12-14				
Conductivity (EC)	1420	2.0 µS/cm	1410		101	95-104			
<b>Reference (B7L1023-SRM1)</b>					Prepared: 2017-12-14, Analyzed: 2017-12-14				
pH	7.00	0.10 pH units	7.00		100	98-102			
<b>Reference (B7L1023-SRM2)</b>					Prepared: 2017-12-14, Analyzed: 2017-12-14				
pH	7.00	0.10 pH units	7.00		100	98-102			
<b>Reference (B7L1023-SRM3)</b>					Prepared: 2017-12-14, Analyzed: 2017-12-14				
pH	7.01	0.10 pH units	7.00		100	98-102			
<b>General Parameters, Batch B7L1031</b>									
<b>Blank (B7L1031-BLK1)</b>					Prepared: 2017-12-14, Analyzed: 2017-12-14				
Carbon, Total Organic	< 0.50	0.50 mg/L							
Carbon, Dissolved Organic	< 0.50	0.50 mg/L							
<b>LCS (B7L1031-BS1)</b>					Prepared: 2017-12-14, Analyzed: 2017-12-14				
Carbon, Total Organic	9.85	0.50 mg/L	10.0		98	78-116			
Carbon, Dissolved Organic	9.66	0.50 mg/L	10.0		97	78-116			
<b>General Parameters, Batch B7L1094</b>									
<b>Blank (B7L1094-BLK1)</b>					Prepared: 2017-12-15, Analyzed: 2017-12-15				
Sulfide, Total	< 0.020	0.020 mg/L							
<b>LCS (B7L1094-BS1)</b>					Prepared: 2017-12-15, Analyzed: 2017-12-15				
Sulfide, Total	0.529	0.020 mg/L	0.500		106	82-116			
<b>General Parameters, Batch B7L1113</b>									
<b>Blank (B7L1113-BLK1)</b>					Prepared: 2017-12-15, Analyzed: 2017-12-15				
Solids, Total Dissolved	< 15	15 mg/L							
<b>LCS (B7L1113-BS1)</b>					Prepared: 2017-12-15, Analyzed: 2017-12-15				
Solids, Total Dissolved	244	15 mg/L	240		102	85-115			
<b>General Parameters, Batch B7L1210</b>									
<b>Blank (B7L1210-BLK1)</b>					Prepared: 2017-12-15, Analyzed: 2017-12-15				
UV Transmittance @ 254nm	< 0.10	0.10 % T							
<b>LCS (B7L1210-BS1)</b>					Prepared: 2017-12-15, Analyzed: 2017-12-15				
UV Transmittance @ 254nm	47.3	0.10 % T	48.5		98	98-103			
<b>General Parameters, Batch B7L1213</b>									
<b>Blank (B7L1213-BLK1)</b>					Prepared: 2017-12-15, Analyzed: 2017-12-15				
Colour, True	< 5.0	5.0 CU							



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Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
<b>General Parameters, Batch B7L1213, Continued</b>									
<b>LCS (B7L1213-BS1)</b>					Prepared: 2017-12-15, Analyzed: 2017-12-15				
Colour, True	10	5.0 CU	10.0		104	85-115			
<b>General Parameters, Batch B7L1285</b>									
<b>Blank (B7L1285-BLK1)</b>					Prepared: 2017-12-19, Analyzed: 2017-12-19				
Cyanide, Total	< 0.0020	0.0020 mg/L							
<b>LCS (B7L1285-BS1)</b>					Prepared: 2017-12-19, Analyzed: 2017-12-19				
Cyanide, Total	0.0214	0.0020 mg/L	0.0200		107	82-120			
<b>LCS Dup (B7L1285-BSD1)</b>					Prepared: 2017-12-19, Analyzed: 2017-12-19				
Cyanide, Total	0.0223	0.0020 mg/L	0.0200		112	82-120	4	10	
<b>General Parameters, Batch B7L1289</b>									
<b>Blank (B7L1289-BLK1)</b>					Prepared: 2017-12-19, Analyzed: 2017-12-19				
Ammonia, Total (as N)	< 0.020	0.020 mg/L							
<b>Blank (B7L1289-BLK2)</b>					Prepared: 2017-12-19, Analyzed: 2017-12-19				
Ammonia, Total (as N)	< 0.020	0.020 mg/L							
<b>LCS (B7L1289-BS1)</b>					Prepared: 2017-12-19, Analyzed: 2017-12-19				
Ammonia, Total (as N)	1.02	0.020 mg/L	1.00		102	90-115			
<b>LCS (B7L1289-BS2)</b>					Prepared: 2017-12-19, Analyzed: 2017-12-19				
Ammonia, Total (as N)	1.06	0.020 mg/L	1.00		106	90-115			
<b>Microbiological Parameters, Batch B7L0963</b>									
<b>Blank (B7L0963-BLK1)</b>					Prepared: 2017-12-14, Analyzed: 2017-12-14				
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
<b>Blank (B7L0963-BLK2)</b>					Prepared: 2017-12-14, Analyzed: 2017-12-14				
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
<b>Blank (B7L0963-BLK3)</b>					Prepared: 2017-12-14, Analyzed: 2017-12-14				
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
<b>Blank (B7L0963-BLK4)</b>					Prepared: 2017-12-14, Analyzed: 2017-12-14				
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
<b>Blank (B7L0963-BLK5)</b>					Prepared: 2017-12-14, Analyzed: 2017-12-14				
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
<b>Blank (B7L0963-BLK6)</b>					Prepared: 2017-12-14, Analyzed: 2017-12-14				
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
<b>Blank (B7L0963-BLK7)</b>					Prepared: 2017-12-14, Analyzed: 2017-12-14				
Coliforms, Total	< 1	1 CFU/100 mL							



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Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
<b>Microbiological Parameters, Batch B7L0963, Continued</b>									
<b>Blank (B7L0963-BLK7), Continued</b> Prepared: 2017-12-14, Analyzed: 2017-12-14									
E. coli	< 1	1 CFU/100 mL							
<b>Microbiological Parameters, Batch B7L0992</b>									
<b>Blank (B7L0992-BLK1)</b> Prepared: 2017-12-14, Analyzed: 2017-12-14									
Coliforms, Fecal	< 1	1 CFU/100 mL							
<b>Microbiological Parameters, Batch B7L0995</b>									
<b>Blank (B7L0995-BLK1)</b> Prepared: 2017-12-14, Analyzed: 2017-12-14									
Heterotrophic Plate Count	< 5	5 CFU/mL							
<b>Blank (B7L0995-BLK2)</b> Prepared: 2017-12-14, Analyzed: 2017-12-14									
Heterotrophic Plate Count	< 5	5 CFU/mL							
<b>Duplicate (B7L0995-DUP3) Source: 7121073-01</b> Prepared: 2017-12-14, Analyzed: 2017-12-14									
Heterotrophic Plate Count	410	5 CFU/mL		460			11	67	
<b>Total Metals, Batch B7L1165</b>									
<b>Blank (B7L1165-BLK1)</b> Prepared: 2017-12-18, Analyzed: 2017-12-18									
Aluminum, total	< 0.0050	0.0050 mg/L							
Antimony, total	< 0.00020	0.00020 mg/L							
Arsenic, total	< 0.00050	0.00050 mg/L							
Barium, total	< 0.0050	0.0050 mg/L							
Beryllium, total	< 0.00010	0.00010 mg/L							
Bismuth, total	< 0.00010	0.00010 mg/L							
Boron, total	< 0.0050	0.0050 mg/L							
Cadmium, total	< 0.000010	0.000010 mg/L							
Calcium, total	< 0.20	0.20 mg/L							
Chromium, total	< 0.00050	0.00050 mg/L							
Cobalt, total	< 0.00010	0.00010 mg/L							
Copper, total	< 0.00040	0.00040 mg/L							
Iron, total	< 0.010	0.010 mg/L							
Lead, total	< 0.00020	0.00020 mg/L							
Lithium, total	< 0.00010	0.00010 mg/L							
Magnesium, total	< 0.010	0.010 mg/L							
Manganese, total	< 0.00020	0.00020 mg/L							
Molybdenum, total	< 0.00010	0.00010 mg/L							
Nickel, total	< 0.00040	0.00040 mg/L							
Phosphorus, total	< 0.050	0.050 mg/L							
Potassium, total	< 0.10	0.10 mg/L							
Selenium, total	< 0.00050	0.00050 mg/L							
Silicon, total	< 1.0	1.0 mg/L							
Silver, total	< 0.000050	0.000050 mg/L							
Sodium, total	< 0.10	0.10 mg/L							
Strontium, total	< 0.0010	0.0010 mg/L							
Sulfur, total	< 3.0	3.0 mg/L							
Tellurium, total	< 0.00050	0.00050 mg/L							
Thallium, total	< 0.000020	0.000020 mg/L							
Thorium, total	< 0.00010	0.00010 mg/L							
Tin, total	< 0.00020	0.00020 mg/L							
Titanium, total	< 0.0050	0.0050 mg/L							
Tungsten, total	< 0.0010	0.0010 mg/L							



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Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
<b>Total Metals, Batch B7L1165, Continued</b>									
<b>Blank (B7L1165-BLK1), Continued</b>					Prepared: 2017-12-18, Analyzed: 2017-12-18				
Uranium, total	< 0.000020	0.000020 mg/L							
Vanadium, total	< 0.0010	0.0010 mg/L							
Zinc, total	< 0.0040	0.0040 mg/L							
Zirconium, total	< 0.00010	0.00010 mg/L							
<b>LCS (B7L1165-BS1)</b>					Prepared: 2017-12-18, Analyzed: 2017-12-18				
Aluminum, total	0.0220	0.0050 mg/L	0.0200		110	80-120			
Antimony, total	0.0195	0.00020 mg/L	0.0200		97	80-120			
Arsenic, total	0.0207	0.00050 mg/L	0.0200		104	80-120			
Barium, total	0.0203	0.0050 mg/L	0.0200		102	80-120			
Beryllium, total	0.0177	0.00010 mg/L	0.0200		89	80-120			
Bismuth, total	0.0213	0.00010 mg/L	0.0200		107	80-120			
Boron, total	0.0199	0.0050 mg/L	0.0200		99	80-120			
Cadmium, total	0.0199	0.000010 mg/L	0.0200		99	80-120			
Calcium, total	2.11	0.20 mg/L	2.00		106	80-120			
Chromium, total	0.0219	0.00050 mg/L	0.0200		109	80-120			
Cobalt, total	0.0217	0.00010 mg/L	0.0200		108	80-120			
Copper, total	0.0228	0.00040 mg/L	0.0200		114	80-120			
Iron, total	2.17	0.010 mg/L	2.00		109	80-120			
Lead, total	0.0209	0.00020 mg/L	0.0200		104	80-120			
Lithium, total	0.0207	0.00010 mg/L	0.0200		103	80-120			
Magnesium, total	2.31	0.010 mg/L	2.00		116	80-120			
Manganese, total	0.0216	0.00020 mg/L	0.0200		108	80-120			
Molybdenum, total	0.0197	0.00010 mg/L	0.0200		98	80-120			
Nickel, total	0.0219	0.00040 mg/L	0.0200		109	80-120			
Phosphorus, total	2.17	0.050 mg/L	2.00		108	80-120			
Potassium, total	2.30	0.10 mg/L	2.00		115	80-120			
Selenium, total	0.0221	0.00050 mg/L	0.0200		111	80-120			
Silicon, total	2.0	1.0 mg/L	2.00		102	80-120			
Silver, total	0.0208	0.000050 mg/L	0.0200		104	80-120			
Sodium, total	2.22	0.10 mg/L	2.00		111	80-120			
Strontium, total	0.0197	0.0010 mg/L	0.0200		99	80-120			
Sulfur, total	5.5	3.0 mg/L	5.00		110	80-120			
Tellurium, total	0.0186	0.00050 mg/L	0.0200		93	80-120			
Thallium, total	0.0209	0.000020 mg/L	0.0200		105	80-120			
Thorium, total	0.0200	0.00010 mg/L	0.0200		100	80-120			
Tin, total	0.0203	0.00020 mg/L	0.0200		102	80-120			
Titanium, total	0.0222	0.0050 mg/L	0.0200		111	80-120			
Tungsten, total	0.0206	0.0010 mg/L	0.0200		103	80-120			
Uranium, total	0.0218	0.000020 mg/L	0.0200		109	80-120			
Vanadium, total	0.0211	0.0010 mg/L	0.0200		106	80-120			
Zinc, total	0.0239	0.0040 mg/L	0.0200		119	80-120			
Zirconium, total	0.0201	0.00010 mg/L	0.0200		101	80-120			
<b>Reference (B7L1165-SRM1)</b>					Prepared: 2017-12-18, Analyzed: 2017-12-18				
Aluminum, total	0.325	0.0050 mg/L	0.303		107	82-114			
Antimony, total	0.0495	0.00020 mg/L	0.0511		97	88-115			
Arsenic, total	0.124	0.00050 mg/L	0.118		105	88-111			
Barium, total	0.821	0.0050 mg/L	0.823		100	83-110			
Beryllium, total	0.0442	0.00010 mg/L	0.0496		89	80-119			
Boron, total	3.44	0.0050 mg/L	3.45		100	80-118			
Cadmium, total	0.0488	0.000010 mg/L	0.0495		99	90-110			
Calcium, total	11.6	0.20 mg/L	11.6		100	85-113			
Chromium, total	0.272	0.00050 mg/L	0.250		109	88-111			
Cobalt, total	0.0422	0.00010 mg/L	0.0377		112	90-114			
Copper, total	0.551	0.00040 mg/L	0.486		113	90-117			



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Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
<b>Total Metals, Batch B7L1165, Continued</b>									
<b>Reference (B7L1165-SRM1), Continued</b>					Prepared: 2017-12-18, Analyzed: 2017-12-18				
Iron, total	0.551	0.010 mg/L	0.488		113	90-116			
Lead, total	0.206	0.00020 mg/L	0.204		101	90-110			
Lithium, total	0.408	0.00010 mg/L	0.403		101	79-118			
Magnesium, total	4.21	0.010 mg/L	3.79		111	88-116			
Manganese, total	0.116	0.00020 mg/L	0.109		107	88-108			
Molybdenum, total	0.198	0.00010 mg/L	0.198		100	88-110			
Nickel, total	0.272	0.00040 mg/L	0.249		109	90-112			
Phosphorus, total	0.249	0.050 mg/L	0.227		110	72-118			
Potassium, total	8.16	0.10 mg/L	7.21		113	87-116			
Selenium, total	0.136	0.00050 mg/L	0.121		112	90-122			
Sodium, total	8.56	0.10 mg/L	7.54		114	86-118			
Strontium, total	0.373	0.0010 mg/L	0.375		100	86-110			
Thallium, total	0.0831	0.000020 mg/L	0.0805		103	90-113			
Uranium, total	0.0304	0.000020 mg/L	0.0306		99	88-112			
Vanadium, total	0.409	0.0010 mg/L	0.386		106	87-110			
Zinc, total	2.67	0.0040 mg/L	2.49		107	90-113			

**Total Metals, Batch B7L1173**

<b>Blank (B7L1173-BLK1)</b>					Prepared: 2017-12-18, Analyzed: 2017-12-18				
Mercury, total	< 0.000010	0.000010 mg/L							
<b>Reference (B7L1173-SRM1)</b>					Prepared: 2017-12-18, Analyzed: 2017-12-18				
Mercury, total	0.00474	0.000010 mg/L	0.00489		97	80-120			



### APPENDIX 3: REVISION HISTORY

<b>REPORTED TO PROJECT</b>	Associated Environmental Consultants Inc. (Vernon) 2017-8241.000.000			<b>WORK ORDER REPORTED</b>	7121073 2018-01-15 13:55
<b>Sample ID</b>	<b>Changed</b>	<b>Change</b>	<b>Analysis</b>	<b>Analyte(s)</b>	
7121073-01	2018-01-09	Date Sampled	N/A	N/A	
7121073-01	2018-01-15	Sample ID	N/A	N/A	