

July 27, 2018

WWAL Project: 18-030-01

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**Re: Evaluation of Water Quantity and Quality in support of a Proposed 2-Lot Subdivision,
PID 008-096-937, Tappen, B.C.**

Western Water Associates Ltd. (WWAL) is pleased to provide this hydrogeological assessment for a groundwater source in support of a pending application for a 2-lot subdivision located in the Ford Road area, Tappen, B.C, within Electoral Area “C” of the Columbia Shuswap Regional District (CSRD). The purpose of this study is to verify that the proposed groundwater source meets the requirements of the CSRD Subdivision Servicing Bylaw #641 regarding quantity and year-round availability of groundwater. The address of the subject property is:

- Legal Address: L 1 Sec 22 TP 21 R 10 W of the 6th Meridian Kamloops Division Yale District PL 38427; PID: 008-096-937
- Civic Address: 3453 Ford Road, Tappen, BC V0E 2X2

PROJECT BACKGROUND

It is our understanding that an application for a proposed two lot subdivision (one new lot and a remainder) has been submitted to the CSRD. The property is currently 18.3 hectares and operated as a gravel pit. We also understand that the proposed subdivision would create a 2 hectare lot in the northwest corner of the site.

The property is currently zoned Medium Holdings, which has a minimum lot size of 8 hectares. Based on the documentation reviewed, a portion of the property will have to be rezoned to allow for a 2 hectare lot to be created and rezoning must occur before the subdivision application will be considered by the CSRD. Figure 1 illustrates the general location of the property, and Figure 2 displays the proposed subdivision layout.

REGULATORY REQUIREMENTS

The CSRD Subdivision Bylaw 641 (“the Bylaw”) requires proof of adequate onsite water supply as part of the subdivision permit process. There are two approaches outlined in the Bylaw: the owner-directed approach and the professional-directed approach. In this case, the CSRD requested that the professional-directed approach be followed for the subject property.

Key components of the Bylaw include:

- Section 8.8 of the Bylaw states that for each parcel, the groundwater source must be capable of sustainably providing 2,275 litres per day (0.42 US gpm) of water year-round. Testing to demonstrate sustainable well yield must be performed, and an assessment of well recovery and the potential for interference with nearby wells must be conducted.

- Well testing and subsequent reporting is to be carried out under the supervision of Professional Geoscientist or Engineer.
- Section 8.4 of the Bylaw requires that all groundwater sources must be located on the parcel which they will serve.
- Sections 8.11 through 8.13 outline documentation requirements requested by the CSRD, including information on the type and location of water sources and the location of potential contamination sources.
- Raw groundwater quality must be assessed and evaluated against the Guidelines for Canadian Drinking Water Quality. Where raw groundwater is found to be not potable, a Section 219 Covenant must be registered against the property, and a treatment system may need to be implemented to make the water potable.
- Section 8.1 of the Bylaw exempts lots with pre-existing dwelling units and onsite water sources from quantity and quality testing.

Schedule B of the Bylaw contains guidelines for the assessment and demonstration of water quality and quantity which were generally followed.

SITE PHYSIOGRAPHY AND GEOLOGY

The subject property is located on Ford Road, east of Trans-Canada Highway (Highway 1), approximately 3 km northeast of Tappen, B.C. The western portion of the property, where gravel pit operations are currently taking place, is moderately sloped towards the west. The eastern portion is composed predominately of forested, undeveloped land and is more steeply sloped than the western portion of the property. Elevations on the property range from approximately 768 m above sea level (m-asl) in the northeast corner to 506 m-asl in the northwest corner. A small residential subdivision is present to the north of the site. A mix of agricultural and industrial properties are present to the west and south of the site. Lands to the east are forested and undeveloped.

Hydrologic features in the area include a small tributary that is mapped on BC Water Resources Atlas as crossing the property from east to west, although surface water features were not directly observed at the site. This tributary is mapped as flowing to the western side of Highway 1 where it joins with White Creek, which subsequently flows to the south and discharges into Shuswap Lake at Tappen Bay, approximately 3.5 km from the site. WWAL completed an assessment of the reported small tributary within the context of the Riparian Areas Regulation (RAR) and found that the RAR was not applicable (WWAL 2018).

Bedrock in the area is mapped as sedimentary rocks of the Mount Ida Assemblage, which consist of mudstone, siltstone, limestone and shale. These rocks are reported as Cambrian to Silurian in age (408 to 570 million years before present) and are also a part of the Omenica metamorphic belt (ENV 2018).

Surficial geology in this area has been mapped as discontinuous benches of glacial drift and older deposits. The origin of these deposits is undetermined and may be the result of glacial and/or erosional events. (Fulton, Berti and Smith, 1963-1965)

HYDROGEOLOGIC SETTING AND NEARBY WELLS

The project site is located in the Monashee mountain region and within the South Thompson River watershed. The 1981-2010 climate normal data for the Salmon Arm Airport (Station ID: 1166R45; Environment Canada, 2018) indicates 653 mm of average annual precipitation.

Provincially mapped Aquifer 231IIC (the Sunnybrae Aquifer) is located beneath the project site. This sand and gravel aquifer is confined by a layer composed of clay and/or sandy clay with silty sand interbeds and has an average thickness of 68 m. Aquifer 231 is characterized as having moderate demand, moderate productivity and, due to the thick confining layer, low vulnerability to surface contamination. Flowing artesian conditions have been noted in records for several wells near Shuswap lake.

A search of the B.C. Water Resources Atlas (ENV, 2018) indicates ten wells are located within 250 m of the proposed new lot location. Information on these wells is contained in Table 1 and the location of the subject well and the nearby wells are shown in Figure 2. Nine of the eleven nearby wells are completed in an unconsolidated aquifer, and two are completed in bedrock.

Table 1. Select details for wells near the subject property

Well Tag Number (WTN)	Static Water Level (ft)	Well Depth (ft)	Aquifer Lithology	Construction Date	Reported Well Yield (US gpm)
39672	60	120	Bedrock	1978	15
37680	78	111	Sand	1977	3
39829	85	105	Sand & Gravel	1978	5
58167	-	200	Bedrock	1988	-
58099	-	220	Gravel	1988	60
39147	70	128	-	1978	8
31549	-	163	Sand & Gravel	1974	4
33697	80	203	Gravel	1975	4
32927	-	92	Sand & Gravel	1975	4
97314	208	334	Gravel	2009	5

WELL CONSTRUCTION AND TEST PUMPING

The well installed on proposed Lot 1 was drilled by Aqua Source Drilling of Vernon, B.C. (Qualified Well Driller WD 05081001) between April 2 and 10, 2018. The well was initially completed in an unconsolidated, sand and gravel unit. A well screen size of 0.050 of an inch (i.e. 50 slot) was selected and the screen was installed between 52.7 and 54.1 m (173 ft and 177.5 ft).

Under the supervision of WWAL, a 24-hour pumping test was completed on April 26 and 27, 2018 by Monashee Aquifer Testing (WD No. 05112301) using a temporary submersible pump powered by a generator. Pumping rates were verified by a flow meter and water depth measurements were collected regularly using an electric sounder, with the most frequent readings occurring early in the test and again at the beginning of recovery. The test was initially run at 0.3 L/s (5 US gpm), upped to 0.6 L/s (10 US gpm) after 20 minutes and returned to 0.3 L/s (5 US gpm) after 4 hours. Towards the end of the test, WWAL collected a water quality sample for comprehensive

potability testing and submitted the samples in an ice filled cooler under chain of custody documentation to CARO Analytical Services (CARO) of Kelowna, B.C.

At the completion of the test, a total drawdown of 7.05 m (23.1 ft) was noted, with little to no recovery observed in the well two hours after the test. The test results indicated the sand and gravel material in which the well was screened was likely of limited areal extent, and possibly an isolated perched aquifer with limited recharge. As a result, the decision to deepen the well into bedrock was made. We note that WWAL returned to the site approximately 3 weeks after the April 26-27 pumping test and measured water levels in the well, at which time water levels had almost fully recovered. This result could be in part due to water pumped from the well infiltrating and returning to the aquifer, or in part due to recharge by two heavy precipitation events that occurred in the intervening weeks. In either event, the fact that the aquifer recovered indicates that the sand and gravel aquifer at the site is unconfined and recharged by infiltration locally.

Aqua Source Drilling returned to the site in May 2018 to deepen the well. Bedrock was encountered at 71 m-bgs (233 ft) and the well was drilled to a total depth of 91 m-bgs (300 ft-bgs). As completed, the well complies with the requirements of the *Groundwater Protection Regulation* including an annular surface seal, an adequate casing stick-up height, and appropriate capping and flood protection. At the conclusion of drilling, Aqua Source affixed steel Well ID Plate # 50347 to the well casing.

On June 4, 2018, Monashee Aquifer Testing returned to the site to complete a second 24-hour pumping test at a rate of 0.2 L/s (3 US gpm) on WPN 50347. In the days immediately prior to the pumping test, approximately 5 mm of rain fell. Water level data from the second pumping test are attached in Table A1 and plotted hydrographs of the data are presented in Figures A1 and A2. After an initial decrease of approximately 0.06 m (0.2 ft), water levels quickly stabilized in the well. A few minor fluctuations in water levels were observed throughout the test that were likely the result of flow adjustments and/or barometric pressure influences. A second water quality sample was collected towards the end of the test and submitted to the laboratory for analysis. At the conclusion of pumping, a total of drawdown of 0.2 m (0.4 ft) was observed and the water level recovered to above the initial static measurement within seven minutes.

Short and Long-Term Well Yield Assessment

In keeping with industry standards, WWAL typically calculates the long-term sustainable yield of a well based on the guidelines published by the province for evaluating long-term well capacity for a Certificate of Public Convenience and Necessity (CPCN Guidelines, Allen et al., 1999). The procedure involves projecting the drawdown trend measured in the well to a theoretical 100-day pumping duration and applying a 30% safety factor. Using a semi-logarithmic plot of the time versus the drawdown level, an extrapolation of the drawdown trend is made during the latter part of the tests (Figure A3).

In cases where pumping water levels stabilize during testing, the CPCN formula cannot be applied as intended. Since this is the case for this site, the subject well is rated at its test pumping rate of 3 US gpm, which surpasses the CSRD Bylaw requirement of 0.42 US gpm. The aquifer's response to pumping indicates that higher pumping rates from the well may be possible (the well drillers estimated a yield of 75 US gpm, which is quite high for a bedrock well). If the well is intended to be pumped at rates higher than those used for this assessment, additional testing should be carried out to confirm a suitable pumping rate.

Seasonal Water Level Variations

The Ministry of Environment does not maintain a monitoring well in the Tappen area, therefore direct observation of groundwater level variation in the bedrock aquifer is not available. Based on our experience with bedrock well installations located in lower elevation settings (i.e. not in mountainous terrain), a yearly water level variation on the order of 2 – 4 m is expected in response to seasonal changes in recharge. Annual high-water levels are likely to occur in May and June with lows in late winter. Although this testing program was carried out during inferred higher than average groundwater levels, over 14 m of drawdown was available¹ at the beginning of the test and the response to pumping was such that a decrease of one or even several metres in static water level will not hinder the well's ability to meet CSRD Bylaw requirements.

Potential for Well Interference

Well interference, where significant enough, can be a limiting factor to well yield. Groundwater development in the area is relatively low, and there are only two bedrock wells reported within 250 m of the site, both of which appear to be for domestic use (Figure 2). The potential for well interference is considered low due to the low density of wells in the area and the apparent productivity of the local bedrock aquifer source.

WATER QUALITY ASSESSMENT

For water quality assessment, WWAL defines the term potability as water which is pure enough and of sufficient quality to be consumed or used with low risk of immediate or long-term harm. With respect to evaluation against the Guidelines for Canadian Drinking Water Quality (GCDWQ – Health Canada 20118), potable water meets all health-based Maximum Allowable Concentrations (MAC). In samples where parameters are found to exceed only Aesthetic Objectives (AO), the water is considered to be potable but treatment may be desired to address taste or odor concerns.

All water testing was completed by CARO Analytical Services, in Kelowna, B.C., a CALA accredited laboratory. Table 2 below provides a summary of the water quality results compared to applicable water quality guidelines. Complete laboratory reports are provided as an attachment.

The water quality results from the well are good, and all parameters are within health-based MAC guidelines. Aesthetically, iron was detected at a concentration that exceeds AO guidelines. Iron is one of the most common elements in the earth's crust and its presence in groundwater is typically attributed to the weathering of rocks and minerals. At concentrations greater than 0.3 mg/L, iron is capable of staining plumbing fixtures, producing an unpalatable taste and generating an objectionable red-brown colour in water (Health Canada, 2018). Turbidity was detected at levels that exceed operational guidelines for water treatment systems. Although elevated turbidity does not directly pose a health risk, high particle content in water can harbor microorganisms and contain heavy metals (Health Canada, 2018).

With regard to water quality and private well water treatment, this is the homeowner's responsibility as the Ministry of Health does not regulate private water sources. Commercial home water treatment systems are readily-available and, when properly maintained and operated, treatment systems are capable of reducing

¹ Available drawdown in this well is the difference between the static water level and the bottom of the steel casing as installed (233 ft below ground). The bedrock borehole below the steel casing was not lined, and pump installation below 233 ft is not recommended. Additional available drawdown could be obtained by lining the lower part of the borehole and installing a pump at greater depth.

concentrations to below guideline levels. For private wells, selection, operation and maintenance of such systems are the homeowner's responsibility. Additional water quality testing is typically required both prior to treatment system installation and after installation, with the initial sampling results used as a guide for designing the system.

Table 2. Groundwater Quality Summary WPN 50347

Field Parameter	Units	June 5, 2018	GCDWQ
pH (field/lab)	pH units	6.9/7.69	AO = 6.5 – 10.5
Conductivity (field/lab)	us/cm	695/754	n/a
Turbidity (field/lab)	NTU	3.90/4.03	OG < 1
General Parameters and Nutrients			
Total Dissolved Solids	mg/L	464	AO < 500
Hardness	mg/L	416	n/a
Alkalinity, CaCO ₃ (total)	mg/L	312	n/a
Fluoride	mg/L	0.15	MAC = 1.5
Nitrate, N	mg/L	<0.010	MAC = 10
Nitrite, N	mg/L	<0.010	MAC = 1
Chloride	mg/L	1.35	AO < 250
Sulfate	mg/L	116	AO < 500
Selected Total Ions and Metals			
Aluminum	mg/L	0.0959	AO < 0.1
Antimony	mg/L	<0.00020	MAC = 0.006
Arsenic	mg/L	<0.00050	MAC = 0.01
Barium	mg/L	0.0378	MAC = 1
Boron	mg/L	<0.0050	MAC = 5
Cadmium	mg/L	0.000043	MAC = 0.005
Chromium	mg/L	<0.00050	MAC = 0.05
Copper	mg/L	0.00698	AO < 1
Iron	mg/L	0.416	AO < 0.30
Lead	mg/L	0.00045	MAC = 0.01
Manganese	mg/L	0.0340	AO < 0.05
Selenium	mg/L	<0.00050	MAC = 0.01
Sodium	mg/L	9.51	AO < 200
Uranium	mg/L	0.00271	MAC = 0.02
Zinc	mg/L	0.0100	AO < 5
Bacteriological Parameters			
Total Coliforms	CFU/100mL	< 1	MAC < 1
E. Coli	CFU/100mL	<1	MAC < 1

Notes:

1. GCDWQ = Guidelines for Canadian Drinking Water Quality (Health Canada, 2018)
2. Green shaded values indicate exceedances of Aesthetic Objective (AO) or Operational Guideline (OG)

POTENTIAL GROUNDWATER DEVELOPMENT ON PROPOSED REMAINDER LOT

At present, Covenant X201400 is registered on the title of the subject property that “prohibits construction or location of any residential dwelling or mobile home until such time as an onsite water supply is provided meeting the standards of the subdivision servicing bylaw”. It is our understanding that the proponent is planning to apply for a Development Variance Permit to waive the proof of water requirements for the proposed Remainder lot, or potentially transfer the existing covenant to the Remainder lot. The Remainder lot is currently operated as a gravel pit and, as such, does not require a source of water at this time. Should future development of the Remainder lot necessitate a water source, it is our opinion that a viable groundwater well, capable of meeting all CSRD requirements, can be constructed within the boundaries of the Remainder.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our assessment we offer the following conclusions:

- C1** Our assessment of groundwater availability (i.e. quantity) is favourable. WPN 50347 is capable of supplying the CSRD Bylaw 641, Section 8.8 quantity requirement of providing 0.42 USgpm (2,275 liters per day). Our conclusion takes into account the potential for well interference with nearby wells, as well as seasonal fluctuations in groundwater levels.
- C2** Evaluation of the water quality sample collected indicates that raw water is of good quality and all health-based guidelines were met. Iron concentrations were detected at levels that exceed aesthetic guidelines and elevated levels of turbidity were observed. Treatments options to address both of these concerns are readily available.
- C3** If future modifications to the Remainder require the development of an additional water source, it is our opinion that it is feasible to construct a well on the remainder that would be capable of meeting CSRD subdivision bylaw requirements. It is our opinion that it would be reasonable to establish a new covenant or transfer the existing no building covenant to the Remainder lot until such time a water source on the Remainder is needed.

Based on the above conclusions, the following recommendations are made:

- R1** We recommend that all private well owners check their water quality periodically to ensure water they are consuming complies remains safe. WWAL recommends yearly water samples be collected and analyzed. Confirming and ensuring water potability is the responsibility of the well owner.
- R2** At present, inground septic disposal has not been installed on either lot. Should this change in the future, septic systems should be located a minimum of 30 m from any well.
- R3** The subject well has steel casing that extends to the bedrock interface located at 233 ft below ground. An open bedrock borehole is present between 233 ft and 300 ft and has not been lined with a PVC liner. If a PVC liner is not installed, we recommend that the submersible pump installed in the well be installed no deeper than the depth of the steel casing.

R4 This assessment was completed to assess the subject well's ability to meet the CSRD quantity requirement. We understand that the proposed use of the well, which will supply water to a possible log home building operation, may include uses other than private domestic use. If the well is to be used for anything other than private domestic purposes, the well will require a new-use groundwater licence under the *Water Sustainability Act*.

WELL OWNER RESPONSIBILITIES

In November 2005, a new Groundwater Protection Regulation was enacted in British Columbia intended to improve the safety and quality of groundwater in the Province. This regulation was replaced by a new Groundwater Protection Regulation on 29 February 2016 (BC Reg 29/2016) and continues previously established standards to protect groundwater supplies by requiring all water wells in British Columbia be properly constructed, maintained and, at the end of their service, properly decommissioned. More specifically, all newly constructed and altered wells must meet minimum construction standards including incorporation of a surface annular seal, a minimum of 30 cm casing stickup [above existing or modified ground surface], appropriate drainage away from the well, and completion with a secure well cap plus well identification plate drilled, responsibility for the well transfers to the owner to maintain the casing stickup, surface drainage away from the well, secure cap and well identification plate. This also includes maintaining the surface annular seal, if a pitless adapter is installed. Part 3 of the regulation has requirements for siting wells. Most significantly, Part 10 requires that well construction reports for all new and altered water supply wells be submitted to the Province. Prior to 2016, submission of well reports was voluntary.

With regard to water quality and private well water treatment, as noted above, this is the homeowner's responsibility as the Ministry of Health does not regulate private water sources. Finally, Division 2 of the Groundwater Protection Regulation says that all work on the well must be undertaken by a qualified well driller (QWD) or qualified pump installer (QPI). Registered QPI and QWD have identification cards issued by the BC MFLNRO and a list of such qualified professionals is maintained on line by the MFLNRO at <http://www2.gov.bc.ca/gov/content/environment/air-land-water/water/groundwater-wells/information-for-well-drillers-well-pump-installers>

CLOSURE

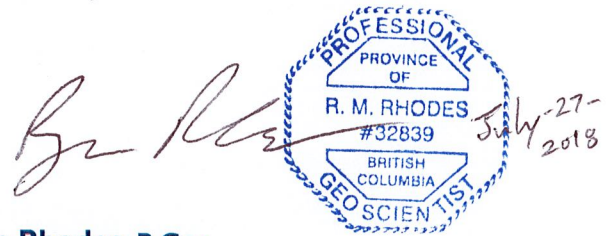
We trust that the professional opinions and advice presented in this document are sufficient for your current requirements. Please note that there are restrictions and limitations that apply to the scope of our services and conclusions provided herein, as outlined on the attached Pump Test Report Limitations page. Should you have any questions, or if we can be of further assistance in this matter, please contact the undersigned.

WESTERN WATER ASSOCIATES LTD.

Reviewed by:

Paul Williamson, M.Sc., GIT
Hydrogeologist

Ryan Rhodes, P.Geo.
Senior Hydrogeologist



Attachments:

Figure 1: General Location of Project Site
Figure 2: Detailed Site Orthophoto and Well Site
Tables A1; Figures A1 and A2;
Well Driller's Logs (For original and ultimate well completion)
Laboratory WQ report

REFERENCES

Allen, D., A. Badry, B. Ingimundson, G. Wendling, B. Worobets, and N. Morrison. 1999. Evaluating long-term well capacity for a Certificate of Public Convenience and Necessity. Water Management Branch, B.C. Ministry of Environment, Land and Parks. Victoria.

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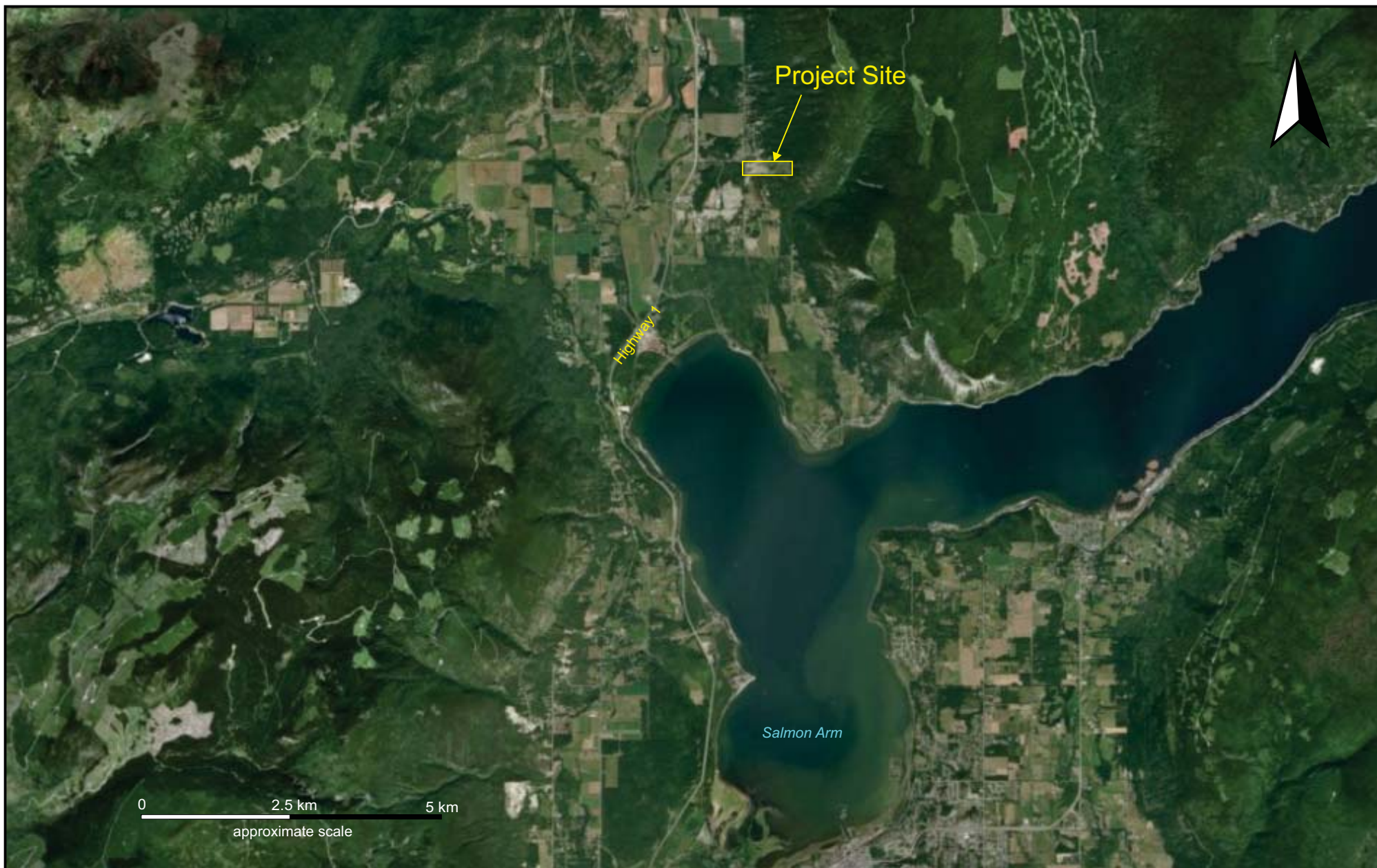


Figure 1 - General Location of Project Site

Date: July 2018

Image Source: Google Earth

WWAL Project: 18-030-01

Drawn by: RR

Checked by: DG

Client: Zaponne

Client Project:


western water
 ASSOCIATES LTD
 Consultants in Hydrogeology and Water Resources Management

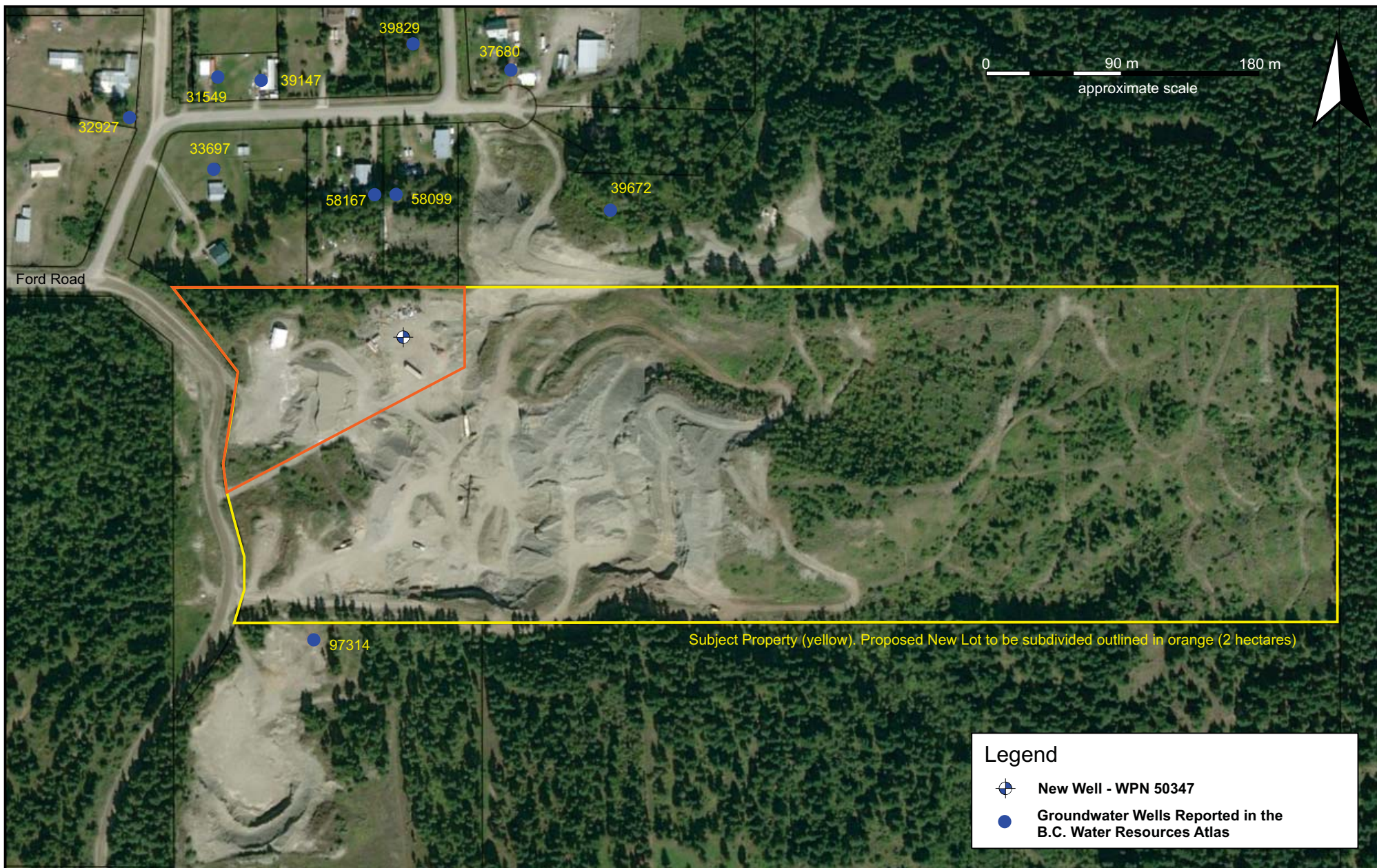


Figure 2 - Detailed Site Orthophoto and Well Site

Date: July 2018

Image Source: BC Water Resources Atlas

WWAL Project: 18-030-01

Drawn by: RR

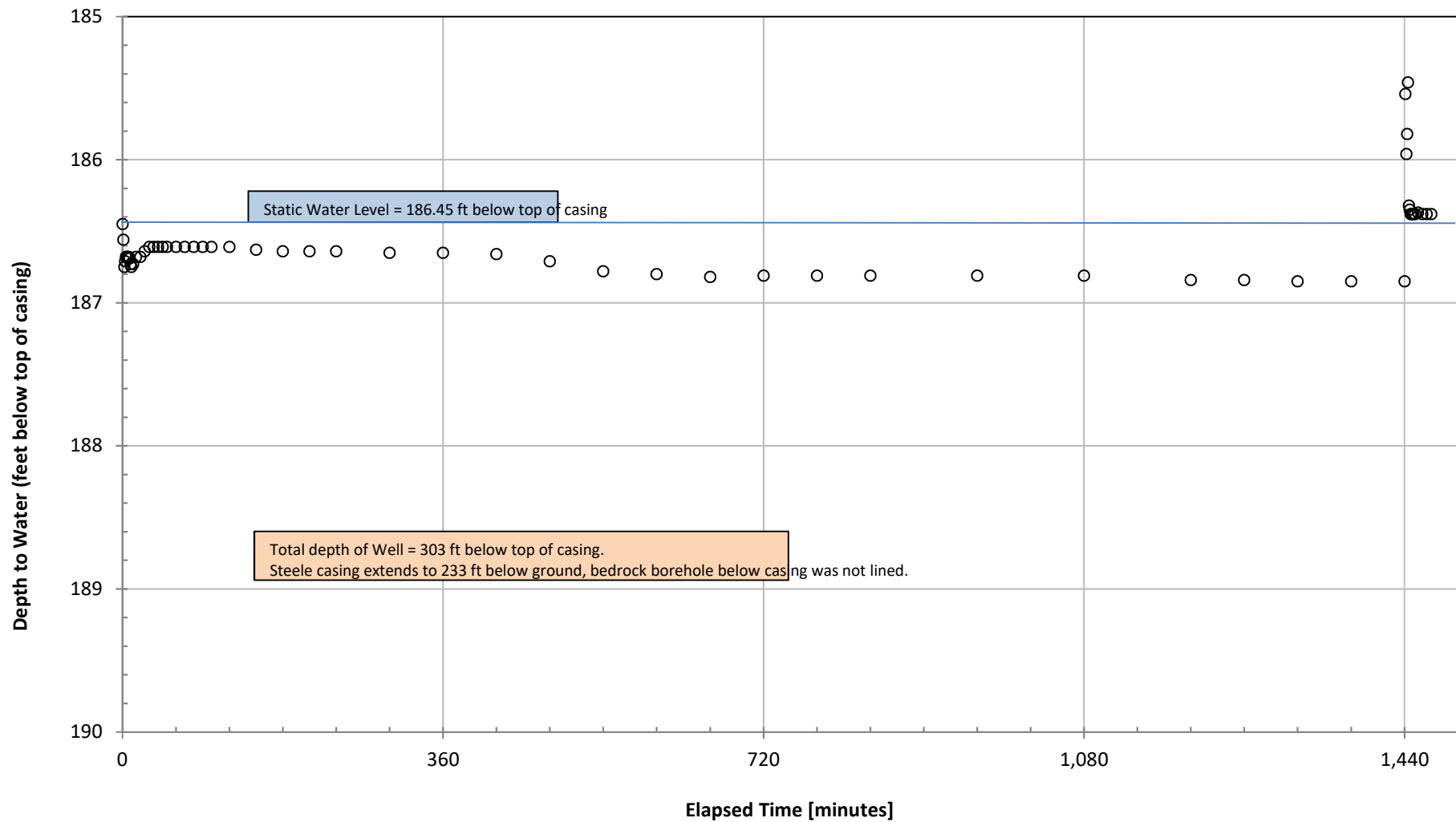
Checked by: DG

Client: Zaponne

Client Project:

Project No: 18-030-01, Table A1: Constant Rate Test - WPN 50347 - Zappone Well Assessment - Started June 4, 2018

Well depth = 300 ft			Well diameter = 6 in		Measurement method =		flowmeter	Pump Depth = 230 ft					
Comments	Real Time	Time since pump started, t (minutes)	Water level measurement (btoc) (m)	Water level measurement (btoc) (ft)	Water level changes (m)	Drawdown (ft)	Drawdown (m)	Pumping Rate (l/s)	Pumping Rate (USgpm)	Specific Capacity			
										L/s/m	Usgpm/ft		
STATIC	June 4 10:00 AM	0.00	56.83	186.45	--	0.00	0.00	0.00	0	--	--		
		1	56.86	186.56	0.03	0.11	0.03	0.19	3.0	5.6	27.3		
		2	56.92	186.75	0.06	0.30	0.09	0.19	3.0	2.1	10.0		
		3	56.91	186.71	-0.01	0.26	0.08	0.19	3.0	2.4	11.5		
		4	56.90	186.68	-0.01	0.23	0.07	0.19	3.0	2.7	13.0		
		5	56.90	186.68	0.00	0.23	0.07	0.19	3.0	2.7	13.0		
		6	56.90	186.68	0.00	0.23	0.07	0.19	3.0	2.7	13.0		
		7	56.90	186.68	0.00	0.23	0.07	0.19	3.0	2.7	13.0		
		8	56.90	186.69	0.00	0.24	0.07	0.19	3.0	2.6	12.5		
		9	56.91	186.73	0.01	0.28	0.09	0.19	3.0	2.2	10.7		
		10	56.92	186.75	0.01	0.30	0.09	0.19	3.0	2.1	10.0		
		12	56.91	186.73	-0.01	0.28	0.09	0.19	3.0	2.2	10.7		
		15	56.90	186.68	-0.02	0.23	0.07	0.19	3.0	2.7	13.0		
		20	56.90	186.68	0.00	0.23	0.07	0.19	3.0	2.7	13.0		
		25	56.89	186.64	-0.01	0.19	0.06	0.19	3.0	3.3	15.8		
		30	56.88	186.61	-0.01	0.16	0.05	0.19	3.0	3.9	18.7		
		35	56.88	186.61	0.00	0.16	0.05	0.19	3.0	3.9	18.7		
		40	56.88	186.61	0.00	0.16	0.05	0.19	3.0	3.9	18.7		
		45	56.88	186.61	0.00	0.16	0.05	0.19	3.0	3.9	18.7		
		50	56.88	186.61	0.00	0.16	0.05	0.19	3.0	3.9	18.7		
		60	56.88	186.61	0.00	0.16	0.05	0.19	3.0	3.9	18.7		
		70	56.88	186.61	0.00	0.16	0.05	0.19	3.0	3.9	18.7		
		80	56.88	186.61	0.00	0.16	0.05	0.19	3.0	3.9	18.7		
		90	56.88	186.61	0.00	0.16	0.05	0.19	3.0	3.9	18.7		
		100	56.88	186.61	0.00	0.16	0.05	0.19	3.0	3.9	18.7		
		120	56.88	186.61	0.00	0.16	0.05	0.19	3.0	3.9	18.7		
		150	56.88	186.63	0.01	0.18	0.05	0.19	3.0	3.5	16.7		
		180	56.89	186.64	0.00	0.19	0.06	0.19	3.0	3.3	15.8		
		210	56.89	186.64	0.00	0.19	0.06	0.19	3.0	3.3	15.8		
		240	56.89	186.64	0.00	0.19	0.06	0.19	3.0	3.3	15.8		
		300	56.89	186.65	0.00	0.20	0.06	0.19	3.0	3.1	15.0		
		360	56.89	186.65	0.00	0.20	0.06	0.19	3.0	3.1	15.0		
		420	56.89	186.66	0.00	0.21	0.06	0.19	3.0	3.0	14.3		
		480	56.91	186.71	0.02	0.26	0.08	0.19	3.0	2.4	11.5		
		540	56.93	186.78	0.02	0.33	0.10	0.19	3.0	1.9	9.1		
		600	56.93	186.80	0.01	0.35	0.11	0.19	3.0	1.8	8.6		
		660	56.94	186.82	0.01	0.37	0.11	0.19	3.0	1.7	8.1		
		720	56.94	186.81	0.00	0.36	0.11	0.19	3.0	1.7	8.3		
		780	56.94	186.81	0.00	0.36	0.11	0.19	3.0	1.7	8.3		
		840	56.94	186.81	0.00	0.36	0.11	0.19	3.0	1.7	8.3		
		960	56.94	186.81	0.00	0.36	0.11	0.19	3.0	1.7	8.3		
		1080	56.94	186.81	0.00	0.36	0.11	0.19	3.0	1.7	8.3		
		1200	56.95	186.84	0.01	0.39	0.12	0.19	3.0	1.6	7.7		
		1260	56.95	186.84	0.00	0.39	0.12	0.19	3.0	1.6	7.7		
		1320	56.95	186.85	0.00	0.40	0.12	0.19	3.0	1.6	7.5		
		1380	56.95	186.85	0.00	0.40	0.12	0.19	3.0	1.6	7.5		
		1440	56.95	186.85	0.00	0.40	0.12	0.19	3.0	1.6	7.5		
Recovery		1441	56.55	185.54	-0.40	-0.91	-0.28	--	--	--	--		
		1442	56.68	185.96	0.13	-0.49	-0.15	--	--	--	--		
		1443	56.64	185.82	-0.04	-0.63	-0.19	--	--	--	--		
		1444	56.53	185.46	-0.11	-0.99	-0.30	--	--	--	--		
		1445	56.79	186.32	0.26	-0.13	-0.04	--	--	--	--		
		1446	56.80	186.35	0.01	-0.10	-0.03	--	--	--	--		
		1447	56.81	186.38	0.01	-0.07	-0.02	--	--	--	--		
		1448	56.81	186.38	0.00	-0.07	-0.02	--	--	--	--		
		1449	56.81	186.38	0.00	-0.07	-0.02	--	--	--	--		
		1450	56.81	186.38	0.00	-0.07	-0.02	--	--	--	--		
		1452	56.81	186.38	0.00	-0.07	-0.02	--	--	--	--		
		1455	56.80	186.37	0.00	-0.08	-0.02	--	--	--	--		
		1460	56.81	186.38	0.00	-0.07	-0.02	--	--	--	--		
		1465	56.81	186.38	0.00	-0.07	-0.02	--	--	--	--		
		1470	56.81	186.38	0.00	-0.07	-0.02	--	--	--	--		



Zappone Well Assessment
(WPN 50347)

TITLE

Figure A1 - Constant Rate Test Hydrograph, 3 US gpm



DRAWN PW

DATE June 4 - 5, 2018

JOB NO. 18-030-01

CHECKED RR

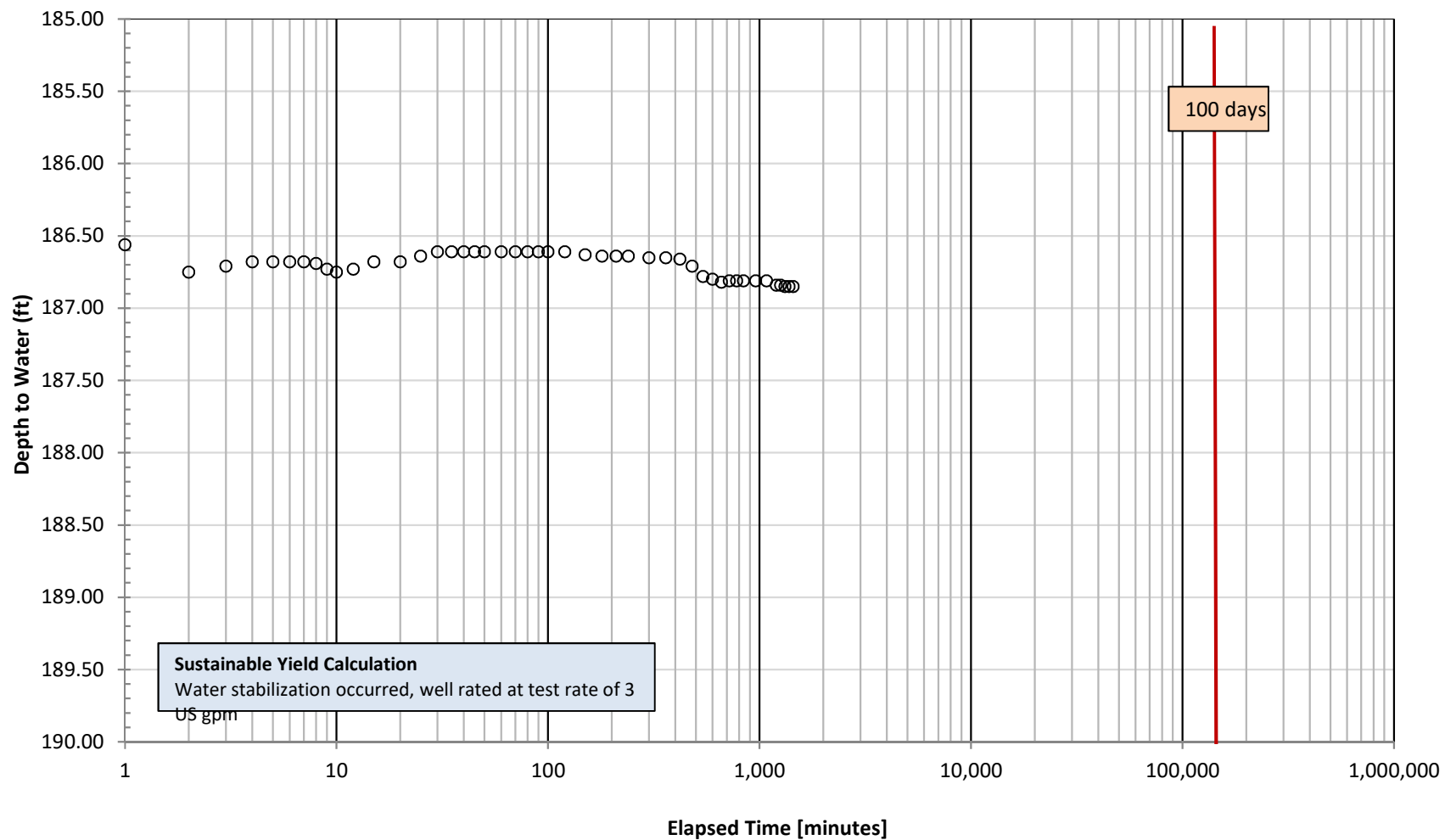
SCALE n/a

DWG. NO. n/a

REVIEWED

FILE NO.

FIGURE NO. A1



Zappone Well Assessment
(WPN 50347)



TITLE

Figure A2 - Semi Log Plot - Constant Rate Pumping Test (3 US gpm)

DRAWN PW

DATE June 4 - 5, 2018

JOB NO. 18-030-01

CHECKED RR

SCALE n/a

DWG. NO. n/a

REVIEWED

FILE NO.

FIGURE NO. A2

CERTIFICATE OF ANALYSIS

REPORTED TO Western Water Associates Ltd
106 - 5145 26th Street
Vernon, BC V1T 8G4

ATTENTION Ryan Rhodes

PO NUMBER

PROJECT 18-030-01

PROJECT INFO

WORK ORDER 8060373

RECEIVED / TEMP 2018-06-05 14:45 / 7°C

REPORTED 2018-06-12 16:30

COC NUMBER B62383

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.

If you have any questions or concerns, please contact me at jnobrega@caro.ca

Authorized By:

Jessica Nobrega, B.Sc.
Client Service Manager

1-888-311-8846 | 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 Western Water Associates Ltd
18-030-01

WORK ORDER REPORTED 8060373
2018-06-12 16:30

Analyte	Result	Guideline	RL Units	Analyzed	Qualifier
50347 (8060373-01) Matrix: Water Sampled: 2018-06-05 10:00					
Anions					
Chloride	1.35	AO ≤ 250	0.10 mg/L	2018-06-06	
Fluoride	0.15	MAC = 1.5	0.10 mg/L	2018-06-06	
Nitrate (as N)	< 0.010	MAC = 10	0.010 mg/L	2018-06-06	
Nitrite (as N)	< 0.010	MAC = 1	0.010 mg/L	2018-06-06	
Sulfate	116	AO ≤ 500	1.0 mg/L	2018-06-06	
General Parameters					
Alkalinity, Total (as CaCO ₃)	312	N/A	1.0 mg/L	2018-06-07	
Alkalinity, Phenolphthalein (as CaCO ₃)	< 1.0	N/A	1.0 mg/L	2018-06-07	
Alkalinity, Bicarbonate (as CaCO ₃)	312	N/A	1.0 mg/L	2018-06-07	
Alkalinity, Carbonate (as CaCO ₃)	< 1.0	N/A	1.0 mg/L	2018-06-07	
Alkalinity, Hydroxide (as CaCO ₃)	< 1.0	N/A	1.0 mg/L	2018-06-07	
Colour, True	< 5.0	AO ≤ 15	5.0 CU	2018-06-06	
Conductivity (EC)	754	N/A	2.0 µS/cm	2018-06-07	
Cyanide, Total	< 0.0020	MAC = 0.2	0.0020 mg/L	2018-06-07	
pH	7.69	7.0-10.5	0.10 pH units	2018-06-07	HT2
Temperature, at pH	23.9	N/A	°C	2018-06-07	HT2
Turbidity	4.03	OG < 1	0.10 NTU	2018-06-06	
Calculated Parameters					
Hardness, Total (as CaCO ₃)	416	None Required	0.500 mg/L	N/A	
Langelier Index	0.8	N/A	-5.0 -	2018-06-12	
Solids, Total Dissolved	464	AO ≤ 500	2.00 mg/L	N/A	
Total Metals					
Aluminum, total	0.0959	OG < 0.1	0.0050 mg/L	2018-06-10	
Antimony, total	< 0.00020	MAC = 0.006	0.00020 mg/L	2018-06-10	
Arsenic, total	< 0.00050	MAC = 0.01	0.00050 mg/L	2018-06-10	
Barium, total	0.0378	MAC = 1	0.0050 mg/L	2018-06-10	
Boron, total	< 0.0050	MAC = 5	0.0050 mg/L	2018-06-10	
Cadmium, total	0.000043	MAC = 0.005	0.000010 mg/L	2018-06-10	
Calcium, total	109	None Required	0.20 mg/L	2018-06-10	
Chromium, total	< 0.00050	MAC = 0.05	0.00050 mg/L	2018-06-10	
Cobalt, total	0.00030	N/A	0.00010 mg/L	2018-06-10	
Copper, total	0.00698	AO ≤ 1	0.00040 mg/L	2018-06-10	
Iron, total	0.416	AO ≤ 0.3	0.010 mg/L	2018-06-10	
Lead, total	0.00045	MAC = 0.01	0.00020 mg/L	2018-06-10	
Magnesium, total	35.1	None Required	0.010 mg/L	2018-06-10	
Manganese, total	0.0340	AO ≤ 0.05	0.00020 mg/L	2018-06-10	
Mercury, total	< 0.000040	MAC = 0.001	0.000040 mg/L	2018-06-10	CT5
Molybdenum, total	0.00116	N/A	0.00010 mg/L	2018-06-10	
Nickel, total	0.00093	N/A	0.00040 mg/L	2018-06-10	
Potassium, total	2.50	N/A	0.10 mg/L	2018-06-10	

TEST RESULTS

REPORTED TO PROJECT Western Water Associates Ltd
18-030-01

WORK ORDER REPORTED 8060373
2018-06-12 16:30

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
50347 (8060373-01) Matrix: Water Sampled: 2018-06-05 10:00, Continued						
Total Metals, Continued						
Selenium, total	< 0.00050	MAC = 0.05	0.00050	mg/L	2018-06-10	
Sodium, total	9.51	AO ≤ 200	0.10	mg/L	2018-06-10	
Strontium, total	3.60	N/A	0.0010	mg/L	2018-06-10	
Uranium, total	0.00271	MAC = 0.02	0.000020	mg/L	2018-06-10	
Zinc, total	0.0100	AO ≤ 5	0.0040	mg/L	2018-06-10	
Microbiological Parameters						
Coliforms, Total	< 1	MAC = 0	1	CFU/100 mL	2018-06-06	
Background Colonies	> 200	N/A	200	CFU/100 mL	2018-06-06	
E. coli	< 1	MAC = 0	1	CFU/100 mL	2018-06-06	

Sample Qualifiers:

CT5 This sample has been incorrectly preserved for Mercury analysis
HT2 The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO Western Water Associates Ltd
PROJECT 18-030-01

WORK ORDER 8060373
REPORTED 2018-06-12 16:30

Analysis Description	Method Ref.	Technique	Location
Alkalinity in Water	SM 2320 B* (2011)	Titration with H ₂ SO ₄	Kelowna
Anions in Water	SM 4110 B (2011)	Ion Chromatography	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
E. coli in Water	SM 9222* (2006)	Membrane Filtration / Chromocult Agar	Kelowna
Hardness in Water	SM 2340 B* (2011)	Calculation: 2.497 [total Ca] + 4.118 [total Mg] (Est)	N/A
Langelier Index in Water	SM 2330 B (2010)	Calculation	N/A
pH in Water	SM 4500-H+ B (2011)	Electrometry	Kelowna
Solids, Total Dissolved in Water	SM 1030 E (2011)	Calculation: 100 x ([Cations]-[Anions])/([Cations]+[Anions])	N/A
Total Metals in Water	EPA 200.2* / EPA 6020B	HNO ₃ +HCl Hot Block Digestion / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	Richmond
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

Glossary of Terms:

RL	Reporting Limit (default)
<	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
>	Greater than the specified Result
°C	Degrees Celcius
AO	Aesthetic Objective
CFU/100 mL	Colony Forming Units per 100 millilitres
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 Western Water Associates Ltd
PROJECT 18-030-01

WORK ORDER 8060373
REPORTED 2018-06-12 16:30

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 B8F0421

Blank (B8F0421-BLK1)			Prepared: 2018-06-06, Analyzed: 2018-06-06						
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							

Blank (B8F0421-BLK2)			Prepared: 2018-06-06, Analyzed: 2018-06-06						
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 (B8F0421-BS1)			Prepared: 2018-06-06, Analyzed: 2018-06-06						
Chloride	16.3	0.10 mg/L	16.0		102	90-110			
Fluoride	3.95	0.10 mg/L	4.00		99	88-108			
Nitrate (as N)	4.10	0.010 mg/L	4.00		102	93-108			
Nitrite (as N)	2.10	0.010 mg/L	2.00		105	85-114			
Sulfate	16.1	1.0 mg/L	16.0		101	91-109			

LCS (B8F0421-BS2)			Prepared: 2018-06-06, Analyzed: 2018-06-06						
Chloride	16.1	0.10 mg/L	16.0		101	90-110			
Fluoride	3.93	0.10 mg/L	4.00		98	88-108			
Nitrate (as N)	4.11	0.010 mg/L	4.00		103	93-108			
Nitrite (as N)	2.10	0.010 mg/L	2.00		105	85-114			
Sulfate	16.2	1.0 mg/L	16.0		101	91-109			

General Parameters, Batch B8F0414

Blank (B8F0414-BLK1)			Prepared: 2018-06-06, Analyzed: 2018-06-06						
Turbidity	< 0.10	0.10 NTU							
Blank (B8F0414-BLK2)			Prepared: 2018-06-06, Analyzed: 2018-06-06						
Turbidity	< 0.10	0.10 NTU							

APPENDIX 2: QUALITY CONTROL RESULTS

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18-030-01

WORK ORDER REPORTED 8060373
2018-06-12 16:30

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
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General Parameters, Batch B8F0414, Continued

LCS (B8F0414-BS1)			Prepared: 2018-06-06, Analyzed: 2018-06-06						
Turbidity	38.6	0.10 NTU	40.0		96	90-110			
LCS (B8F0414-BS2)			Prepared: 2018-06-06, Analyzed: 2018-06-06						
Turbidity	38.7	0.10 NTU	40.0		97	90-110			

General Parameters, Batch B8F0448

Blank (B8F0448-BLK1)			Prepared: 2018-06-07, Analyzed: 2018-06-07						
Cyanide, Total	< 0.0020	0.0020 mg/L							
LCS (B8F0448-BS1)			Prepared: 2018-06-07, Analyzed: 2018-06-07						
Cyanide, Total	0.0195	0.0020 mg/L	0.0200		98	82-120			
LCS Dup (B8F0448-BSD1)			Prepared: 2018-06-07, Analyzed: 2018-06-07						
Cyanide, Total	0.0200	0.0020 mg/L	0.0200		100	82-120	3	10	

General Parameters, Batch B8F0458

Blank (B8F0458-BLK1)			Prepared: 2018-06-06, Analyzed: 2018-06-06						
Alkalinity, Total (as CaCO ₃)	< 1.0	1.0 mg/L							
Alkalinity, Phenolphthalein (as CaCO ₃)	< 1.0	1.0 mg/L							
Alkalinity, Bicarbonate (as CaCO ₃)	< 1.0	1.0 mg/L							
Alkalinity, Carbonate (as CaCO ₃)	< 1.0	1.0 mg/L							
Alkalinity, Hydroxide (as CaCO ₃)	< 1.0	1.0 mg/L							
Conductivity (EC)	< 2.0	2.0 µS/cm							
Blank (B8F0458-BLK2)			Prepared: 2018-06-07, Analyzed: 2018-06-07						
Alkalinity, Total (as CaCO ₃)	< 1.0	1.0 mg/L							
Alkalinity, Phenolphthalein (as CaCO ₃)	< 1.0	1.0 mg/L							
Alkalinity, Bicarbonate (as CaCO ₃)	< 1.0	1.0 mg/L							
Alkalinity, Carbonate (as CaCO ₃)	< 1.0	1.0 mg/L							
Alkalinity, Hydroxide (as CaCO ₃)	< 1.0	1.0 mg/L							
Conductivity (EC)	< 2.0	2.0 µS/cm							
LCS (B8F0458-BS1)			Prepared: 2018-06-06, Analyzed: 2018-06-06						
Alkalinity, Total (as CaCO ₃)	101	1.0 mg/L	100		101	92-106			
LCS (B8F0458-BS2)			Prepared: 2018-06-07, Analyzed: 2018-06-07						
Alkalinity, Total (as CaCO ₃)	104	1.0 mg/L	100		104	92-106			
LCS (B8F0458-BS3)			Prepared: 2018-06-06, Analyzed: 2018-06-06						
Conductivity (EC)	1380	2.0 µS/cm	1410		98	95-104			
LCS (B8F0458-BS4)			Prepared: 2018-06-07, Analyzed: 2018-06-07						
Conductivity (EC)	1400	2.0 µS/cm	1410		100	95-104			
Reference (B8F0458-SRM1)			Prepared: 2018-06-06, Analyzed: 2018-06-06						
pH	7.02	0.10 pH units	7.01		100	98-102			
Reference (B8F0458-SRM2)			Prepared: 2018-06-07, Analyzed: 2018-06-07						
pH	7.02	0.10 pH units	7.01		100	98-102			

General Parameters, Batch B8F0468

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO PROJECT Western Water Associates Ltd
18-030-01

WORK ORDER REPORTED 8060373
2018-06-12 16:30

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B8F0468, Continued									
Blank (B8F0468-BLK1)				Prepared: 2018-06-06, Analyzed: 2018-06-06					
Colour, True	< 5.0	5.0 CU							
LCS (B8F0468-BS1)				Prepared: 2018-06-06, Analyzed: 2018-06-06					
Colour, True	10	5.0 CU	10.0		102	85-115			
Microbiological Parameters, Batch B8F0392									
Blank (B8F0392-BLK1)				Prepared: 2018-06-06, Analyzed: 2018-06-06					
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
Blank (B8F0392-BLK2)				Prepared: 2018-06-06, Analyzed: 2018-06-06					
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
Blank (B8F0392-BLK3)				Prepared: 2018-06-06, Analyzed: 2018-06-06					
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
Blank (B8F0392-BLK4)				Prepared: 2018-06-06, Analyzed: 2018-06-06					
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
Blank (B8F0392-BLK5)				Prepared: 2018-06-06, Analyzed: 2018-06-06					
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
Blank (B8F0392-BLK6)				Prepared: 2018-06-06, Analyzed: 2018-06-06					
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
Blank (B8F0392-BLK7)				Prepared: 2018-06-06, Analyzed: 2018-06-06					
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
Blank (B8F0392-BLK8)				Prepared: 2018-06-06, Analyzed: 2018-06-06					
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
Blank (B8F0392-BLK9)				Prepared: 2018-06-06, Analyzed: 2018-06-06					
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
Blank (B8F0392-BLKA)				Prepared: 2018-06-06, Analyzed: 2018-06-06					
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
Blank (B8F0392-BLKB)				Prepared: 2018-06-06, Analyzed: 2018-06-06					
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
Blank (B8F0392-BLKC)				Prepared: 2018-06-06, Analyzed: 2018-06-06					
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
Blank (B8F0392-BLKD)				Prepared: 2018-06-06, Analyzed: 2018-06-06					
Coliforms, Total	< 1	1 CFU/100 mL							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO PROJECT Western Water Associates Ltd
18-030-01

WORK ORDER REPORTED 8060373
2018-06-12 16:30

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Microbiological Parameters, Batch B8F0392, Continued									
Blank (B8F0392-BLKD), Continued					Prepared: 2018-06-06, Analyzed: 2018-06-06				
E. coli	< 1	1 CFU/100 mL							
Blank (B8F0392-BLKE)					Prepared: 2018-06-06, Analyzed: 2018-06-06				
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
Blank (B8F0392-BLKF)					Prepared: 2018-06-06, Analyzed: 2018-06-06				
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
Blank (B8F0392-BLKG)					Prepared: 2018-06-06, Analyzed: 2018-06-06				
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							
Blank (B8F0392-BLKH)					Prepared: 2018-06-06, Analyzed: 2018-06-06				
Coliforms, Total	< 1	1 CFU/100 mL							
E. coli	< 1	1 CFU/100 mL							

Total Metals, Batch B8F0755

Blank (B8F0755-BLK1)					Prepared: 2018-06-09, Analyzed: 2018-06-10				
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							
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							
Magnesium, total	< 0.010	0.010 mg/L							
Manganese, total	< 0.00020	0.00020 mg/L							
Mercury, total	< 0.000040	0.000040 mg/L							
Molybdenum, total	< 0.00010	0.00010 mg/L							
Nickel, total	< 0.00040	0.00040 mg/L							
Potassium, total	< 0.10	0.10 mg/L							
Selenium, total	< 0.00050	0.00050 mg/L							
Sodium, total	< 0.10	0.10 mg/L							
Strontium, total	< 0.0010	0.0010 mg/L							
Uranium, total	< 0.000020	0.000020 mg/L							
Zinc, total	< 0.0040	0.0040 mg/L							
LCS (B8F0755-BS1)					Prepared: 2018-06-09, Analyzed: 2018-06-10				
Aluminum, total	0.0218	0.0050 mg/L	0.0200		109	80-120			
Antimony, total	0.0222	0.00020 mg/L	0.0200		111	80-120			
Arsenic, total	0.0188	0.00050 mg/L	0.0200		94	80-120			
Barium, total	0.0201	0.0050 mg/L	0.0200		101	80-120			
Boron, total	0.0179	0.0050 mg/L	0.0200		89	80-120			
Cadmium, total	0.0197	0.000010 mg/L	0.0200		98	80-120			
Calcium, total	1.99	0.20 mg/L	2.00		100	80-120			
Chromium, total	0.0186	0.00050 mg/L	0.0200		93	80-120			
Cobalt, total	0.0190	0.00010 mg/L	0.0200		95	80-120			
Copper, total	0.0199	0.00040 mg/L	0.0200		100	80-120			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO PROJECT Western Water Associates Ltd
18-030-01

WORK ORDER REPORTED 8060373
2018-06-12 16:30

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Total Metals, Batch B8F0755, Continued									
LCS (B8F0755-BS1), Continued					Prepared: 2018-06-09, Analyzed: 2018-06-10				
Iron, total	1.90	0.010 mg/L	2.00		95	80-120			
Lead, total	0.0205	0.00020 mg/L	0.0200		103	80-120			
Magnesium, total	2.09	0.010 mg/L	2.00		104	80-120			
Manganese, total	0.0183	0.00020 mg/L	0.0200		91	80-120			
Mercury, total	0.000851	0.000040 mg/L	0.00100		85	80-120			
Molybdenum, total	0.0190	0.00010 mg/L	0.0200		95	80-120			
Nickel, total	0.0187	0.00040 mg/L	0.0200		94	80-120			
Potassium, total	2.06	0.10 mg/L	2.00		103	80-120			
Selenium, total	0.0194	0.00050 mg/L	0.0200		97	80-120			
Sodium, total	2.08	0.10 mg/L	2.00		104	80-120			
Strontium, total	0.0192	0.0010 mg/L	0.0200		96	80-120			
Uranium, total	0.0237	0.000020 mg/L	0.0200		119	80-120			
Zinc, total	0.0198	0.0040 mg/L	0.0200		99	80-120			
Reference (B8F0755-SRM1)					Prepared: 2018-06-09, Analyzed: 2018-06-10				
Aluminum, total	0.313	0.0050 mg/L	0.303		103	82-114			
Antimony, total	0.0558	0.00020 mg/L	0.0511		109	88-115			
Arsenic, total	0.116	0.00050 mg/L	0.118		98	88-111			
Barium, total	0.829	0.0050 mg/L	0.823		101	83-110			
Boron, total	3.54	0.0050 mg/L	3.45		103	80-118			
Cadmium, total	0.0495	0.000010 mg/L	0.0495		100	90-110			
Calcium, total	11.8	0.20 mg/L	11.6		101	85-113			
Chromium, total	0.240	0.00050 mg/L	0.250		96	88-111			
Cobalt, total	0.0380	0.00010 mg/L	0.0377		101	90-114			
Copper, total	0.493	0.00040 mg/L	0.486		101	90-117			
Iron, total	0.494	0.010 mg/L	0.488		101	90-116			
Lead, total	0.212	0.00020 mg/L	0.204		104	90-110			
Magnesium, total	4.01	0.010 mg/L	3.79		106	88-116			
Manganese, total	0.107	0.00020 mg/L	0.109		98	88-108			
Mercury, total	0.00461	0.000040 mg/L	0.00489		94	80-120			
Molybdenum, total	0.199	0.00010 mg/L	0.198		101	88-110			
Nickel, total	0.240	0.00040 mg/L	0.249		96	90-112			
Potassium, total	7.69	0.10 mg/L	7.21		107	87-116			
Selenium, total	0.120	0.00050 mg/L	0.121		99	90-122			
Sodium, total	8.02	0.10 mg/L	7.54		106	86-118			
Strontium, total	0.375	0.0010 mg/L	0.375		100	86-110			
Uranium, total	0.0304	0.000020 mg/L	0.0306		99	88-112			
Zinc, total	2.40	0.0040 mg/L	2.49		96	90-113			

Western Water Associates Ltd. – Standard Disclaimer for Private Well Capacity Tests

Subject to the following conditions and limitations, Western Water Associates Ltd. (WWAL) conducted the investigation described in this report in a manner consistent with a reasonable level of care and skill normally exercised by members of the hydrogeology profession currently practicing under similar conditions in British Columbia.

1. The Scope of Work for the investigation has been limited by the budget set for the investigation in the work program. The scope of work completed has been reasonable having regard to that budget constraint.
2. The pumping test analysis results are solely intended to demonstrate private domestic well compliance with the water production requirements in the applicable Regional District or local government bylaw(s), and the test and water production results or findings may not be applicable at higher production rates.
3. The investigation described in this report has relied upon information provided by third parties concerning climate, local and regional geology, the history of well development, borehole stratigraphy, presence of aquifers, and existence of nearby wells as indicated by a search of the provincial databases. Except as stated in this report, we have not made an independent verification of third-party information.
4. The investigation documented in this report has been made in the context of existing government regulations and guidelines in effect as of the date of this report. Except as specifically noted herein, the investigation did not take into account any government regulations not in effect or promulgated as of the date of this report.
5. The findings and conclusions in this report are valid only for the specific property or properties and well or wells identified in the report; and may be considered current for a period of up to one year from the date of this report. Water quality sample results, if contained herein, unless stated otherwise herein, represent a single sample collected during the investigation and may or may not represent the long-term water quality produced by the well or wells, unless specifically commented on.
6. Well capacity, expressed as specific capacity or long-term sustainable yield, can change over time due to short and/or long-term climate fluctuations, changing conditions in the aquifer including the placement of more wells, and borehole or pumping system factors. It is the private well owner's responsibility to use water wisely, to periodically check the well and pump operation and engage water industry professionals at appropriate intervals in order to maintain reliable well production.
7. For more information on the responsibilities of private well owners, please visit the B.C. Ministry of Environment website at http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/index.html

This report is intended for the exclusive use of Mike and Rhonda Zappone. It may not be used or relied upon in any manner whatsoever, or for any purpose whatsoever, by any other party. WWAL makes no representation of fact or opinion of any nature whatsoever to any person or entity other than Mike or Rhonda Zappone.

In accepting delivery of this report, Mike and Rhonda Zappone hereby agree that any and all claims which it may have against WWAL or any of its servants, agents, owners, or employees arising out of or in any way connected with the investigation described in this report or the preparation of this report, whether such claims are in contract or in tort, and whether such claims are based on negligence or otherwise, shall be limited to a total amount equal to the fees payable to WWAL under contract with Mike and Rhonda Zappone.



Groundwater Supply Development and Management

Source Water Assessment and Protection

Well Monitoring & Maintenance

Environmental & Water Quality Monitoring

Storm & Wastewater Disposal to Ground

Groundwater Modeling

Aquifer Test Design and Analysis

Geothermal / Geoexchange Systems

Policy and Guideline Development

Applied Research

Rural Subdivision Services

Environmental Assessment & Permitting