REGIONAL DISTRICT NORTH OKANAGAN

STAFF REPORT

TO:	**Board of Directors**	**File No:**	**19-0906-C-RZ**
FROM:	**Planning Department**	**Date:**	**February 16, 2023**

SUBJECT: Zoning Amendment Bylaw No. 2850, 2019

RECOMMENDATION:

That Zoning Amendment Bylaw No. 2850, 2019 which proposes to rezone the property legally described as Lot 1, Sec 25, Twp 8, ODYD, Plan 2558, Except Plan 37038 and Plan EPP74629 and located at 7500 McLennan Road, Electoral Area "C" from the Non-Urban (N.U) zone to the Country Residential (C.R) zone be given Second Reading and be forwarded to a Public Hearing; and further,

That the Public Hearing for Zoning Amendment Bylaw No. 2850 be delegated to the Electoral Area Advisory Committee under Section 231 of the *Local Government Act*.

BACKGROUND:

The subject application proposes to rezone an approximately 17 ha property located at 7500 McLennan Road from the Non-Urban (N.U) zone to the Country Residential (C.R) zone. If successful in rezoning the property, the applicant is proposing an eight (8) lot subdivision.

At the Regular Meeting held on December 11, 2019, the Board of Directors considered the application and gave First Reading to the associated Zoning Amendment Bylaw No. 2850, 2019. The Board resolved that Second Reading of Bylaw No. 2850 be withheld until the Regional District completes the Keddleston Groundwater Study and the study has confirmed the adequacy of water supply for the level of potential development in the study area. The Board further resolved that Final Adoption of Bylaw No. 2850 be withheld until the applicant has made suitable arrangements with the Regional District to provide an approximate 0.5 m to 1.0 m wide public hiking trail within a 6 m wide Statutory Right of Way that would link McLennan Road through the subject property to the existing Grey Canal Trail.

At the Regular Meeting held on May 20, 2020, the Board of Directors again resolved that further consideration of Bylaw No. 2850 be withheld until the comprehensive review of the water supply in Aquifer 351 had been completed.

In 2021, the property was sold to new owners. The new owners have indicated they wish to proceed with the rezoning application.

At the Regular Meeting held on December 14, 2022, the Board considered the application and resolved that further consideration of Bylaw No. 2850 be withheld until the applicant has submitted a hydrogeological report that provides an evaluation of how the proposal aligns with the findings and recommendations of the Keddleston Groundwater Study – Phase 2 and which demonstrates:

1. that groundwater sources would be available to service the full buildout potential of the subject property (8 lots) in accordance with the provisions of Subdivision Servicing Bylaw No. 2600; and
2. that the use of the groundwater supplies would not have a negative impact on the use of existing wells that obtain water from Aquifer 351.

DISCUSSION:

In follow-up to the above noted Board resolution, the applicant has provided the attached assessment of groundwater supply by Interior Geoscience Inc. dated January 23, 2023. The report takes into account the Golder Report – Phase 2, providing a comparison of the findings of the assessment for the subject site against the findings and recommendations contained within the Golder Report. The report concludes that "groundwater sources are available to service the full buildout potential of eight lots in accordance with the provisions of Subdivision Servicing Bylaw No. 2600, and the use of groundwater supplies for the proposed development at full buildout (8 Lots), will not have a negative impact on the use of existing wells that are completed into Aquifer 351."

The Planning Department suggests that the applicant has satisfied the Board requirement relating to groundwater availability and the proposals can therefore be given Second Reading. Final Adoption of Bylaw No. 2850 would be withheld until the following condition of the Board has been satisfied:

1. the applicant has made suitable arrangements with the Regional District to provide an approximate 0.5 m to 1.0 m wide public hiking trail within a 6 m wide Statutory Right of Way that would link McLennan Road through the subject property to the existing Grey Canal Trail.

Public Notification

As the subject property is located within Keddleston Groundwater Study Area, it is recommended that Zoning Amendment Bylaw No. 2850 be forwarded to a Public Hearing. This would afford persons that believe they may be affected by the proposal an opportunity to provide comment directly to the Board of Directors. However, as Bylaw No. 2850 is consistent with the policies and land use designation of the Electoral Areas "B" and "C" Official Community Plan, the Board could decide not to hold a Public Hearing and to instead provide notice in accordance with the new provisions of Section 467 of the *Local Government Act* advising the public that the Board of Directors would be considering giving First Reading to Zoning Amendment Bylaw No. 2850 at a future meeting. To do this, First Reading of Bylaw No. 2850 would have to be rescinded as the Bylaw has already received First Reading.

Submitted by:

Heather Shannon
Planner

Reviewed by:

Greg Routley
Deputy Planning Manager

Endorsed by:

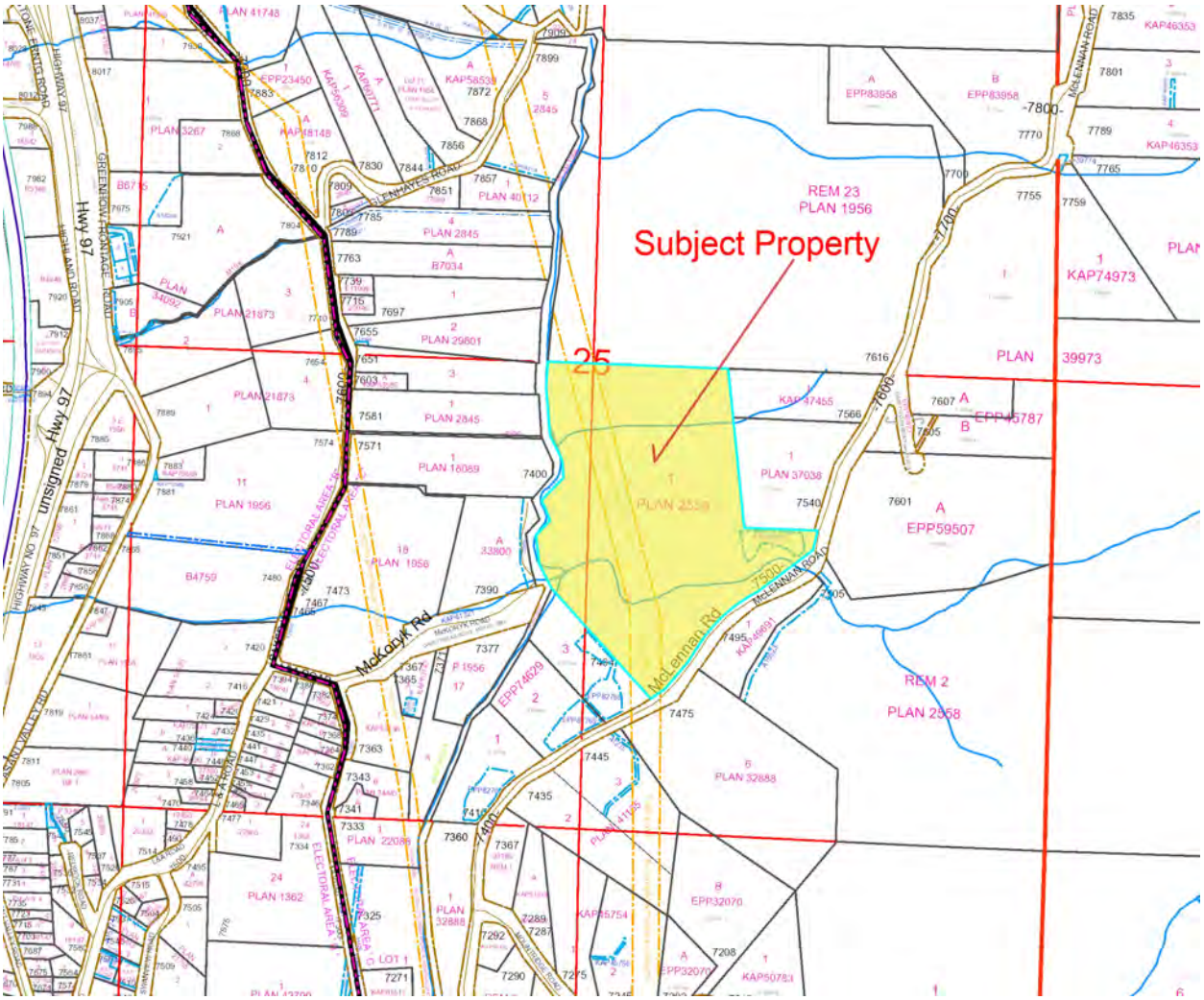
Rob Smailes, RPP, MCIP
General Manager, Planning and Building

Approved for Inclusion:

David Sewell
Chief Administrative Officer

SUBJECT PROPERTY MAP

File: **19-0906-C-RZ**
Owner/Applicant: **Viktor Malyakin**
Location: **7500 McLennan Road**



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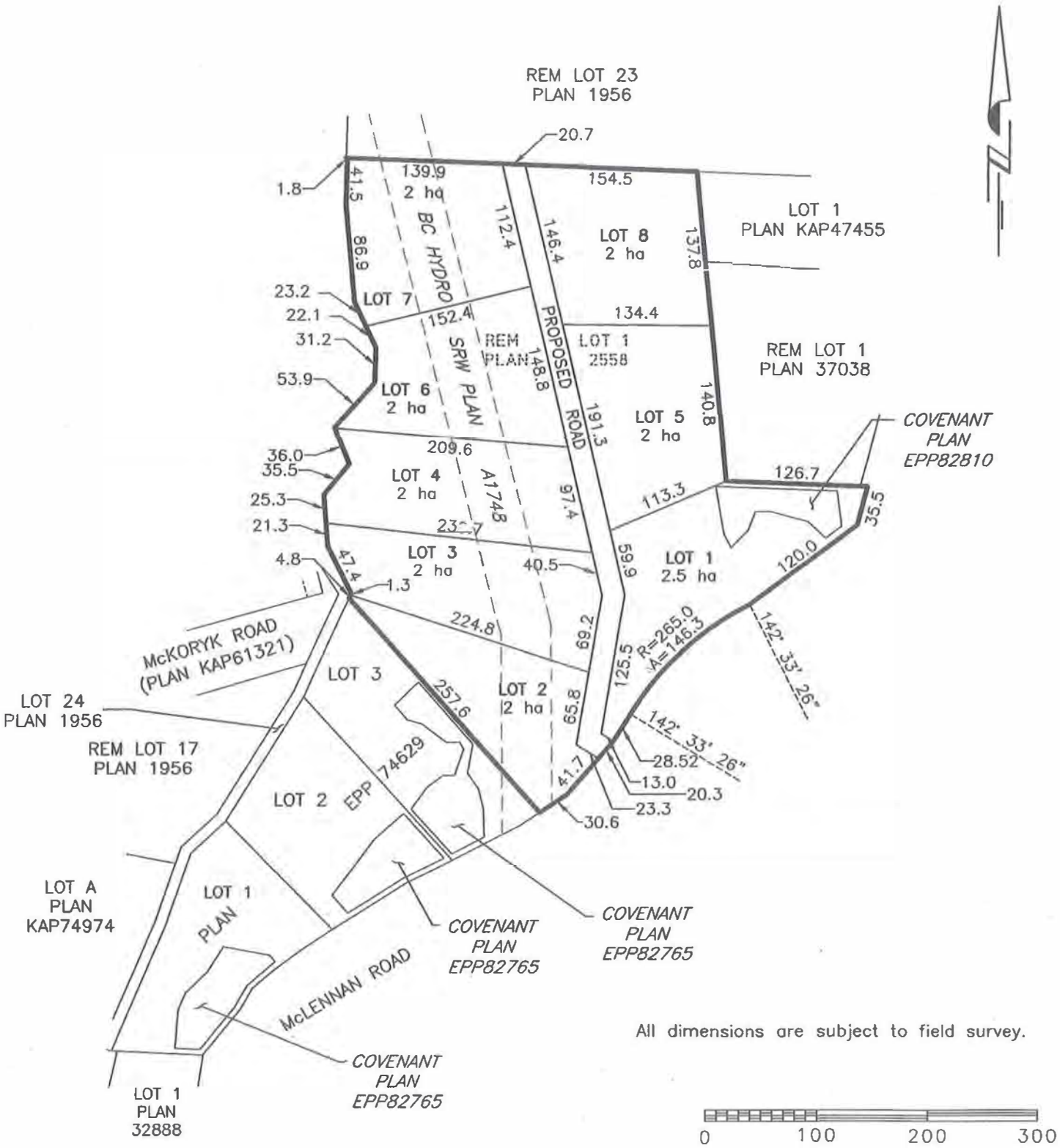

PLAN OF PROPOSED REZONING AND SUBDIVISION OF LOT 1, PLAN 2558, SEC 25, TP 8, ODYD EXCEPT PLANS 37038 & EPP74629

106750A01

SCALE: 1 : 5000	OUR FILE: R10675
DATE: 30 Sep 2019	DRAWN: KG

Dacron Enterprises Ltd

MADDOX & COMPANY
LAND SURVEYORS
3500 – 30th STREET
VERNON, BC V1T 5E8
TELEPHONE: (250) 542-4343

REGIONAL DISTRICT OF NORTH OKANAGAN

BYLAW No. 2850

A bylaw to rezone lands and amend the Zoning Map attached to the Regional District of North Okanagan Zoning Bylaw No. 1888, 2003 to change a zone designation

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WHEREAS pursuant to Section 479 [Zoning bylaws] of the *Local Government Act*, the Board of the Regional District of North Okanagan may, by Bylaw, divide the whole or part of the Regional District into zones, name each zone, establish boundaries for the zones and regulate uses within those zones;

AND WHEREAS the Board has created zones, named each zone, established boundaries for these zones and regulated uses within those zones by Bylaw No. 1888, being the *"Regional District of North Okanagan Zoning Bylaw No. 1888, 2003"* as amended;

AND WHEREAS, pursuant to Section 460 *[Development approval procedures]* of the *Local Government Act*, the Board must, by bylaw, define procedures under which an owner of land may apply for an amendment to a Zoning Bylaw and must consider every application for an amendment to the bylaw;

AND WHEREAS the Board has enacted the *"Regional District of North Okanagan Development Application Procedures and Administrative Fees Bylaw No. 2677, 2018"* as amended to establish procedures to amend an Official Community Plan, a Zoning Bylaw, or a Rural Land Use Bylaw, or to issue a Permit:

AND WHEREAS the Board has received an application to rezone property;

NOW THEREFORE, the Board of the Regional District of North Okanagan in open meeting assembled, hereby **ENACTS AS FOLLOWS**:

CITATION

1. This Bylaw may be cited as ***"Zoning Amendment Bylaw No. 2850, 2019"***.

AMENDMENTS

2. The zoning of the property legally described as Lot 1, Sec 25, Twp 8, ODYD, Plan 2558, Except Plan 37038 and Plan EPP74629 and located at McLennan Road, Electoral Area "C" is hereby changed on Schedule "A" of the *Regional District of North Okanagan Zoning Bylaw No. 1888, 2003* from the ***Non-Urban Zone [N.U]*** to the ***Country Residential Zone [C.R]***.

Read a First Time	this	11th	day of	December, 2019
Read a Second Time	this		day of	, 2023
Advertised on	this		day of	, 2023
	this		day of	, 2023
Public Hearing held	this		day of	, 2023
Read a Third Time	this		day of	, 2023

ADOPTED this day of , 2023

Chair

Corporate Officer

Interior Geoscience Inc
Anthony Friesen M.Sc., P.Geo
250-306-4477
tony@interiorgeoscience.com

January 23, 2023
Job Number 2022-006
Viktor Malyakin (Owner)

7500 McLennan Rd.
Vernon BC.
V1B 3S7

Dear Mr. Malyakin,

Re: HYDROGEOLOGICAL ASSESSMENT OF GROUNDWATER SUPPLY IN SUPPORT OF REZONGING APPLICATION, AT 7500 MCLENNAN RD, ELECTORAL AREA C, IN THE REGIONAL DISTRICT OF THE NORTH OKAKAGAN.

Interior Geoscience Inc. (IGI) has been retained to complete a hydrogeological assessment of groundwater resources to support a rezoning application, at 7500 McLennan Rd in Electoral Area 'C' within the Regional District of the North Okanagan (RDNO).

1. PROPERTY INFORMATION

The proposed parcel (the Site) to be rezoned is located north of the City of Vernon at 7500 McLennan Rd. Vernon BC. Legal descriptions: Lot 1: Sec 25, Twp 8, ODYD, Plan 2558, Except Plan 37038 and Plan EPP74629. General location of proposed rezoning is shown in Figure 1. The parcel of land being considered currently comprises one lot totaling 24.21 ha in size. Please note, that it is our understanding that the client is currently in the process of subdividing this parcel into two lots under the current zoning, and this assessment is intended to support the rezoning application of both lots once they have been established. A site plan showing the proposed two lot subdivision is provided in Attachment A.

The proposed rezoning is from Non-Urban (NU) to Country Residential (CR), which is the O.C.P designation for the subject parcel. The rezoning would allow for a total of **8 lots**, each 2 ha or larger in size at presented in Attachment B. Each of the lots is to be serviced by individual wells that would provide potable water to each future residence.

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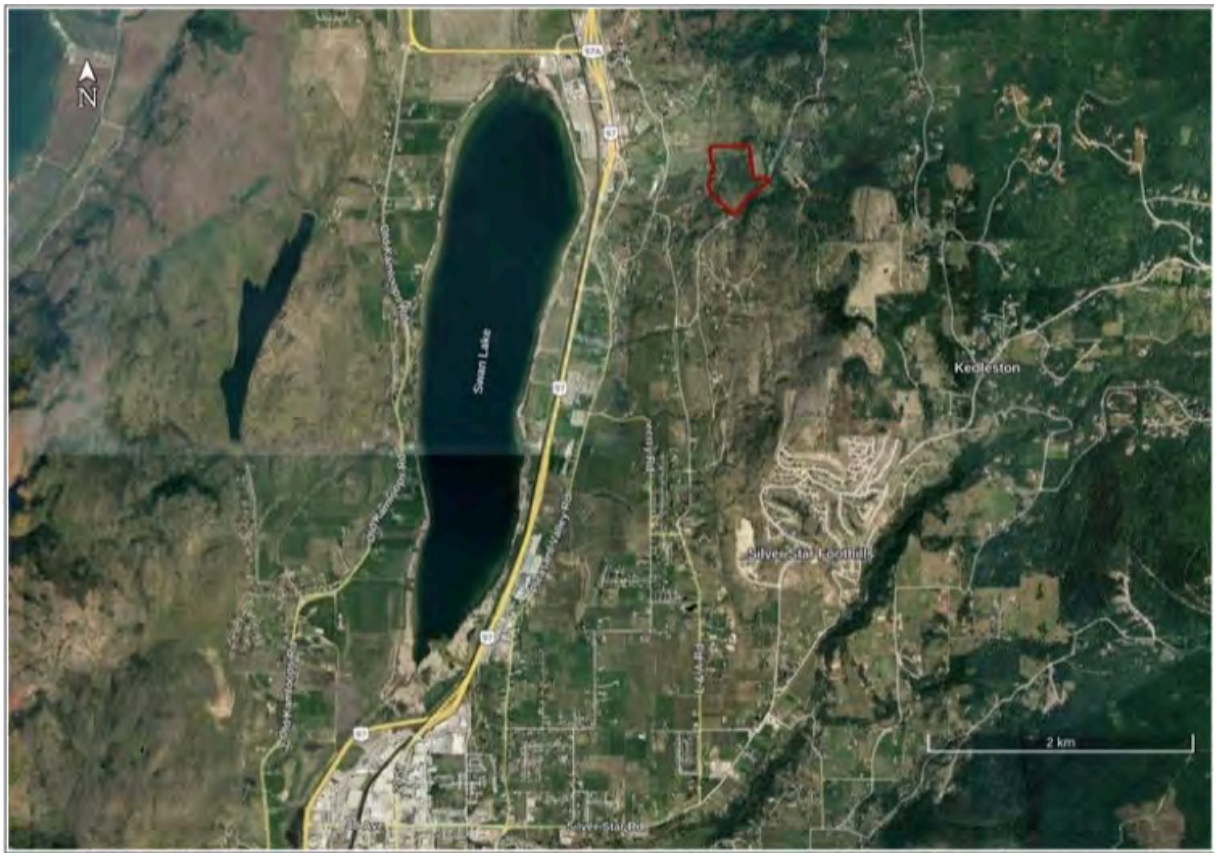

Figure 1: Subject Property Location in relation to Vernon and Swan Lake.

2. OBJECTIVES AND REGULATORY FRAMEWORK

The purpose of this assessment is to evaluate the availability of potable water supplies for the proposed development against the RDNO bylaw 2600 section 406 and 407, which pertains to private water sources from proposed subdivisions. Section 406 states that if the proposed water source is a groundwater well then there must be evidence that each well can produce 6,550 litres/day [1.0 Imperial gallons/minute (I gpm)] year-round, that the water be potable, and that the well not interfere with neighbouring wells. Section 407 stipulates, that in cases where proposed lots are 2 ha (4.942 acres) or larger (which applies to this project) a hydrogeological report that addresses general groundwater availability is typically acceptable prior to rezoning approval. Either before or after final subdivision approval, water sources (wells) must still be installed and quantity and potability confirmed, prior to final subdivision and/or a building permit being issued.

3. FUTURE SUBDIVISION WATER SUPPLY REQUIREMENTS

Assuming 6 additional lots (This assumes the approval of the ongoing subdivision application), this translates to a potential groundwater requirement of 52,400 L/day or about 9.6 US gpm. This flow of water must be available year round and not cause significant interference between wells (i.e. when pumping from a well or wells causes an unacceptable water level drop in a nearby well)

or surface water. An assessment of the potential effects of seasonal variations in groundwater levels, where such seasonal data are available, is also considered during the hydrogeological assessment for rural subdivision wells.

This report details the findings of our assessment.

4. SCOPE OF WORK

IGI conducted the following work program to complete the hydrogeological evaluation and report:

- Assembled and reviewed available data including reports and well logs for the area from the Ministry of Environment, and weather/climate data from Environment Canada.
- Reviewed the conceptual layout of the subdivision as shown on the attached site plan.
- Assembled and reviewed existing reports on wells drilled on the subject property and neighbouring properties.
- Reviewed Ministry of Environment aquifer mapping for the area.
- Assessed groundwater availability / potential on the proposed new lots;
- Contrasted the finding of this assessment, with the Keddleston Groundwater Study-Phase 2 (2022 Golder), and
- Prepared this hydrogeological report for submission to the RDNO, signed off by a B.C. registered professional geoscientist.

5. SITE DESCRIPTION AND GEOLOGICAL SETTING

Site Physiography
The proposed development is located the approximately 5 km northeast of the City of Vernon on the east side of the valley overlooking Swan Lake to the west. The site itself is sloped east to west with elevations ranging from 600 m asl on the west boundary to 655 m asl at the most eastern point. The site comprises some cleared grassland areas situated between mature forested areas. The land surrounding the subject parcel is primary acreage estates with similar vegetation.

Climate normal data are available for 1981-2010 from the North Vernon climate station (Climate ID 1128583), located at 50º 20’39.600” N and -119º 16’ 17.000” W, at an elevation of 538 m asl (Table 1). According to the climate normal data, daily average temperatures range from -2.8 ºC in January to 21.0 ºC in July, with an average annual temperature of 8.8ºC. The average annual precipitation is 487.0 mm, with the majority occurring as snowfall from October to April (142.1 cm) and rainfall year-round (344.9 mm) (ECCC 2022).

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Table 1: Summary of Climate data from Climate Station ID 11258583

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	
Temperature													Yearly Average
Monthly Ave (C°)	-2.8	-0.2	4.2	9.4	13.9	17.4	21.0	20.5	15.3	7.9	1.8	-2.2	8.8
Precipitation													Yearly Total
Rainfall (mm)	11.6	11.7	17.0	27.2	46.3	49.6	35.4	31.9	32.7	40.7	31.1	9.7	344.9
Snowfall (cm)	40.5	13.5	11.7	1.8	0.0	0.0	0.0	0.0	0.0	0.9	26.5	47.3	142.1
Total (mm)	52.2	25.2	28.7	29.0	46.3	49.6	35.4	31.9	32.7	41.5	57.5	57.0	487.0

6. GEOLOGY

Bedrock

The proposed development is completed on the boundary of two bedrock formations. The formation that underlies much of the site is defined as a metamorphic rock within the Silver Creek formation from the Proterozoic to Paleozoic period. The formation is described as an undivided quartz felspathic gneiss, biotite-quartz schist, with lesser carbonaceous schist and marble (ENV 2022). The bedrock formation underlying the western portion of the site is defined as the Chase formation consisting of white to light grey, cliff-forming, calcareous quartzite having a coarse, pitted texture on the weather surfaces. There is a mapped north south fault that runs just east of the proposed development (Figure 2). This is relevant because generally bedrock near a fault zone has likely been subjected to increased geologic stresses, and as a result, an increase in fracturing can occur, along with an increase in porosity within the bedrock. Based on the well testing program completed for this project (See subsequent sections of this report) and the higher reported yields of wells at in the area, it appears that this may be the case.

Surficial Geology

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The overburden at the location of the water supply wells is not mapped; however, available well logs in the area indicate about 10-12 m of silt, sand and gravel with some clay material (till) above bedrock, which is likely a product of glacial activity (ENV 2022).

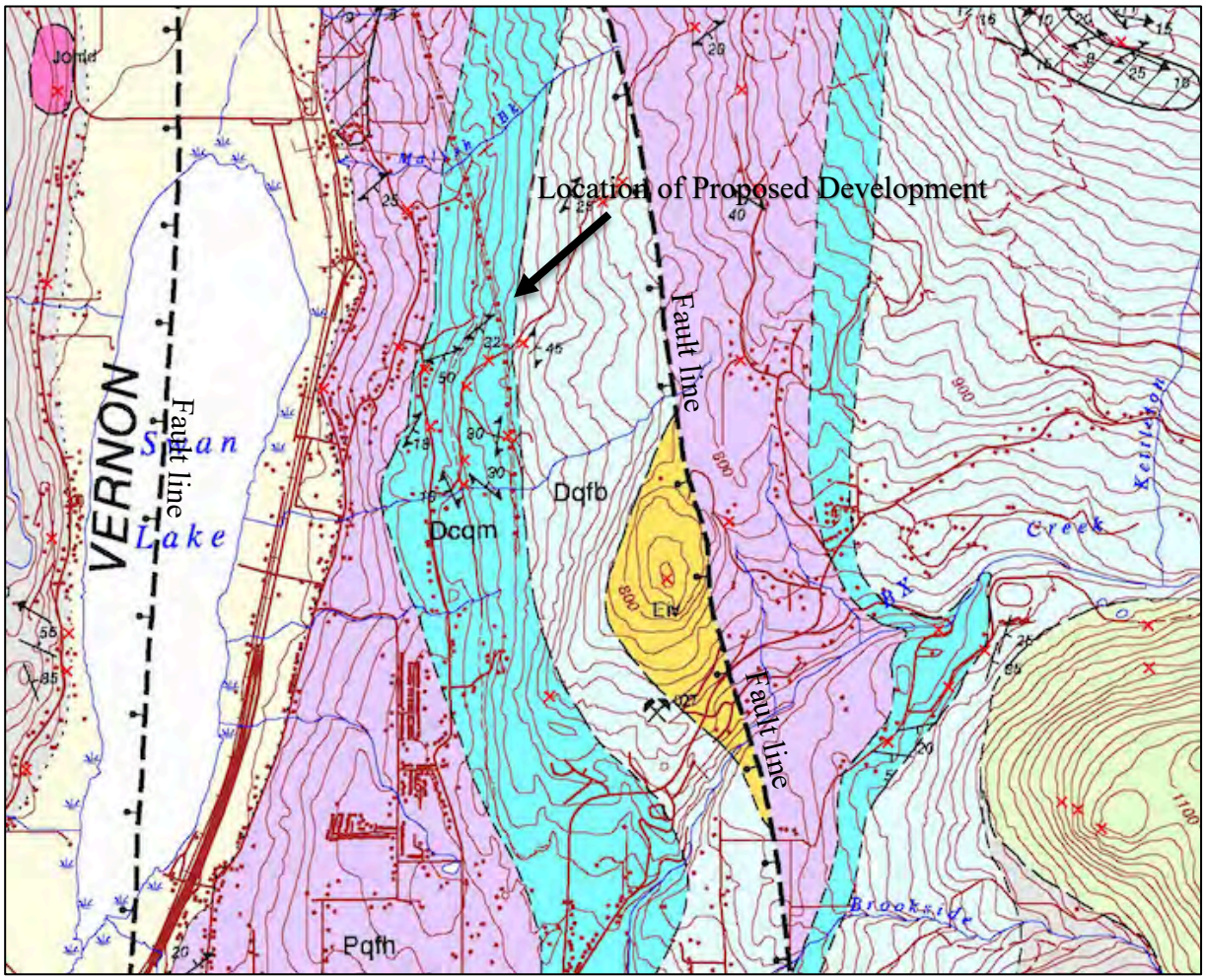

Figure 2: Geological mapping for the proposed development, showing parent bedrock material and fault locations nearby the proposed development. (Thompson and Unterschutz, 2004)

7. AQUIFER AND WELLS

Aquifer

The proposed development is underlain by mapped Aquifer 351, which is a bedrock aquifer, 21.8 km^2 in area and extends from Swan Lake to the west, to Silverstar Rd to the south, and to Silverstar Mountain Resort to the east (Figure 3). It is identified as having low demand, low vulnerability and low productivity (ENV 2022). Based on topography and static water levels in the mapped wells, it is reasonable to assume that the general flow direction in the aquifer is

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east to west. Recharge to Aquifer 351 occurs through direct infiltration of rainfall and snowmelt, along with losses from creeks and streams that flow over the aquifer. Aquifer 351 has a total of 148 wells that have been correlated to this Aquifer. Of these wells only 5 have been licenses for commercial use, none of which are assign for agricultural purposes. For the whole aquifer, reported well yields range from 0.27 L/s to 0.07 L/s with an average yield of 0.1L/s (compared to the Bylaw rate of 0.076 L/s).

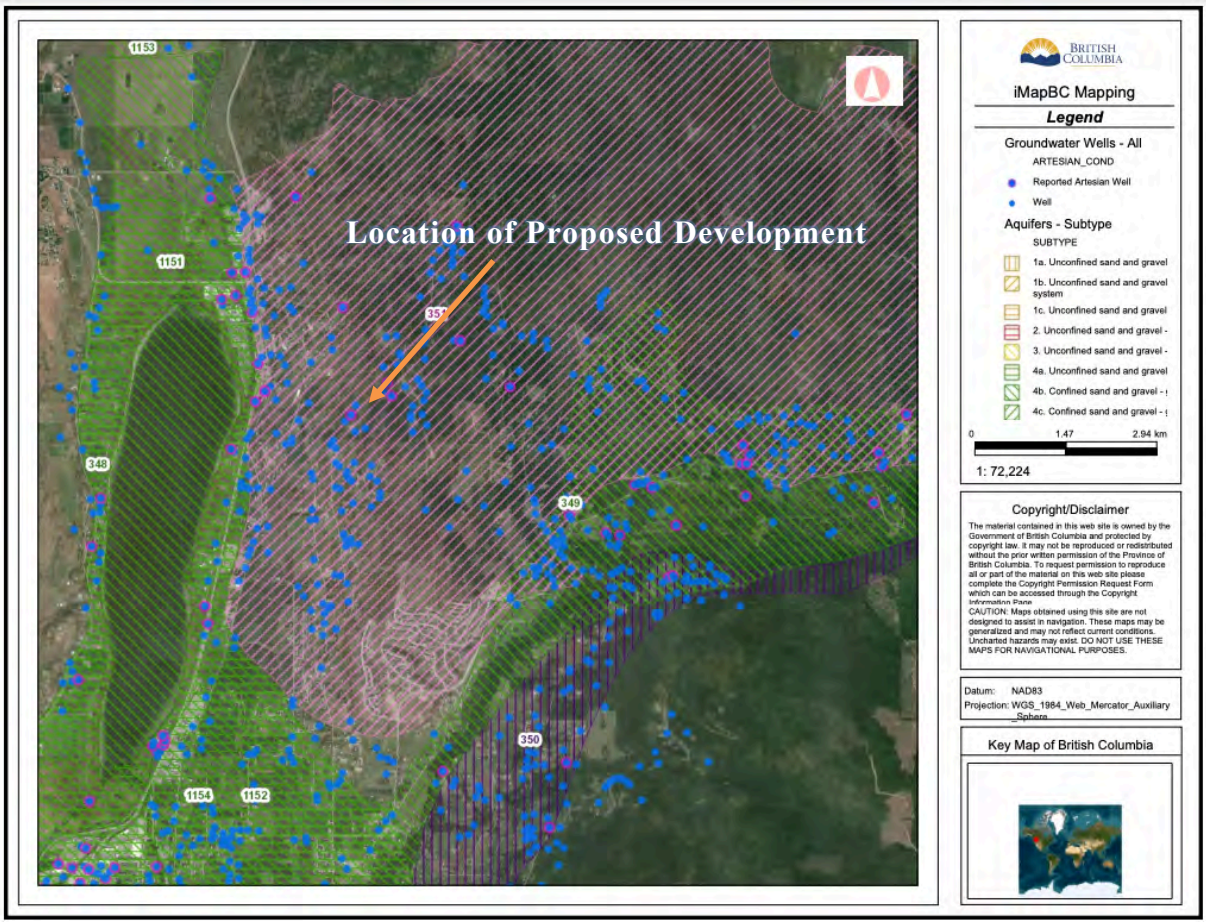

Figure 3: Image showing the Mapped aquifer 351 and wells in relation to the subject site.

Figure 4 (below) presents the approximate location the mapped fault zone and the mapped wells with their corresponding estimated well yields in the area. The strong correlation to the significantly higher estimated yield of wells that are near the fault line is further evidence that the faulting in this area has clearly resulted in Aquifer 351 being more productive in this zone.

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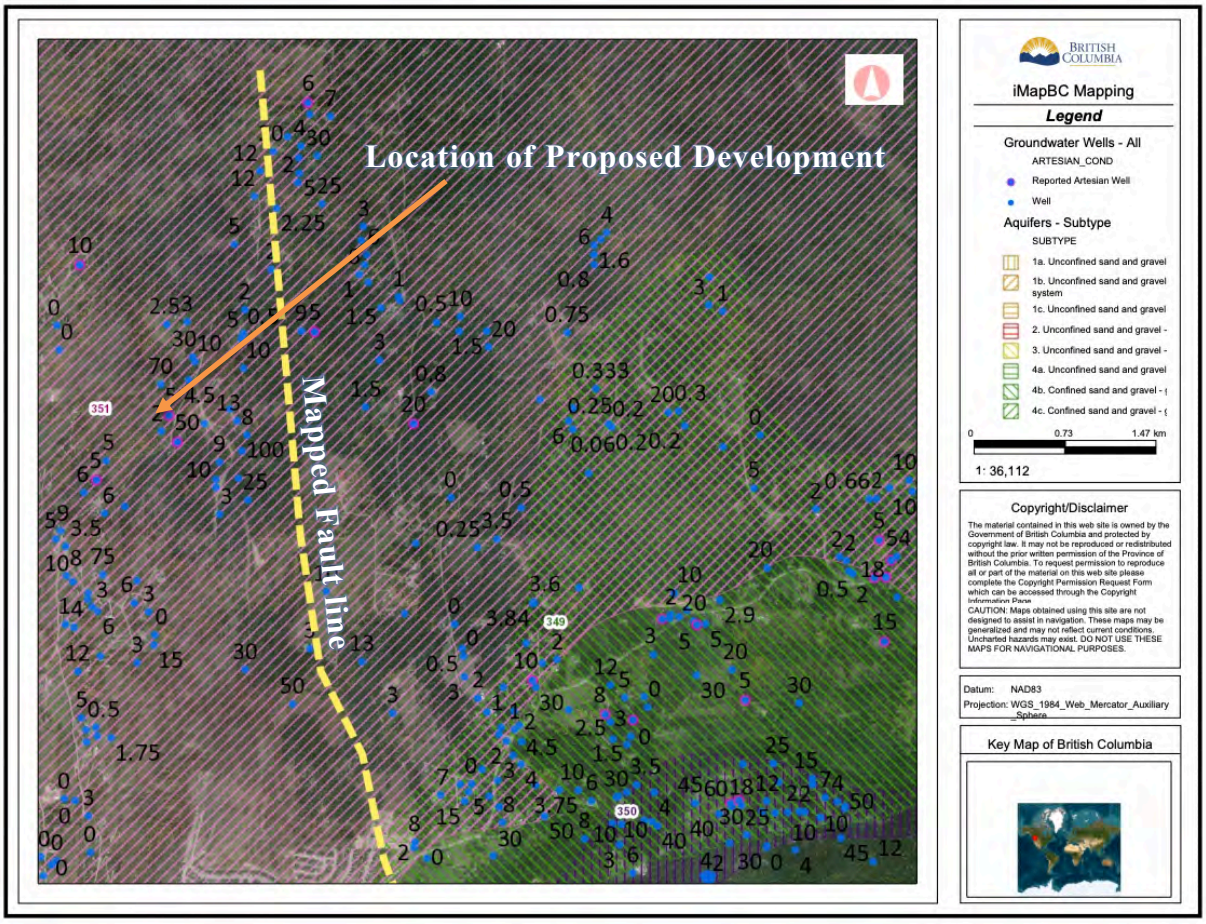

Figure 4: Images showing the location the mapped fault line near the proposed development, and drillers estimated yields in US gpm.

There are two existing wells on the property. Well Plate Identification (WPID) 47667 which is located at the southwest boundary of the parcel (lot 1), and WPID 66090 which is located at the southeast corner of the site, on the future lot 2 (Well logs Attached). As part of an earlier assessment, WPID 66090 was pump tested to determine the long-term sustainable yield of the well (IGI, 2022). At this time, based on the CPCN method, the sustainable yield was calculated to be an estimated 0.23 L/s (4.0 US gpm). To account for the seasonal variability in the water levels and well interference, a 30% safety factor as per the CPCN guidelines. After the 30% safety factor was applied, the sustainable pumping rated calculated is 0.16 L/s (2.5 US gpm). Or 13,827 L/day (2.1 times the bylaw requirement). WPID was not tested, due to the fact that it meets the quantity requirement of the bylaw on account of having drillers estimate of 5 US gpm (27,360 L/day) (4.2 times the bylaw requirement).

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There are an additional 21 mapped wells located within 500 m of the proposed development. The nearest wells (WTN 62362 and WTN 49632) are located 98 m northeast and 105 m east of subject well, respectively. The average yield for each of the wells within 500 m of the subject well is 95,904 L/day (14.6 times the bylaw rate). A summary of the onsite wells and the neighbouring wells is presented in Table 2 below and presented in Figure 4.

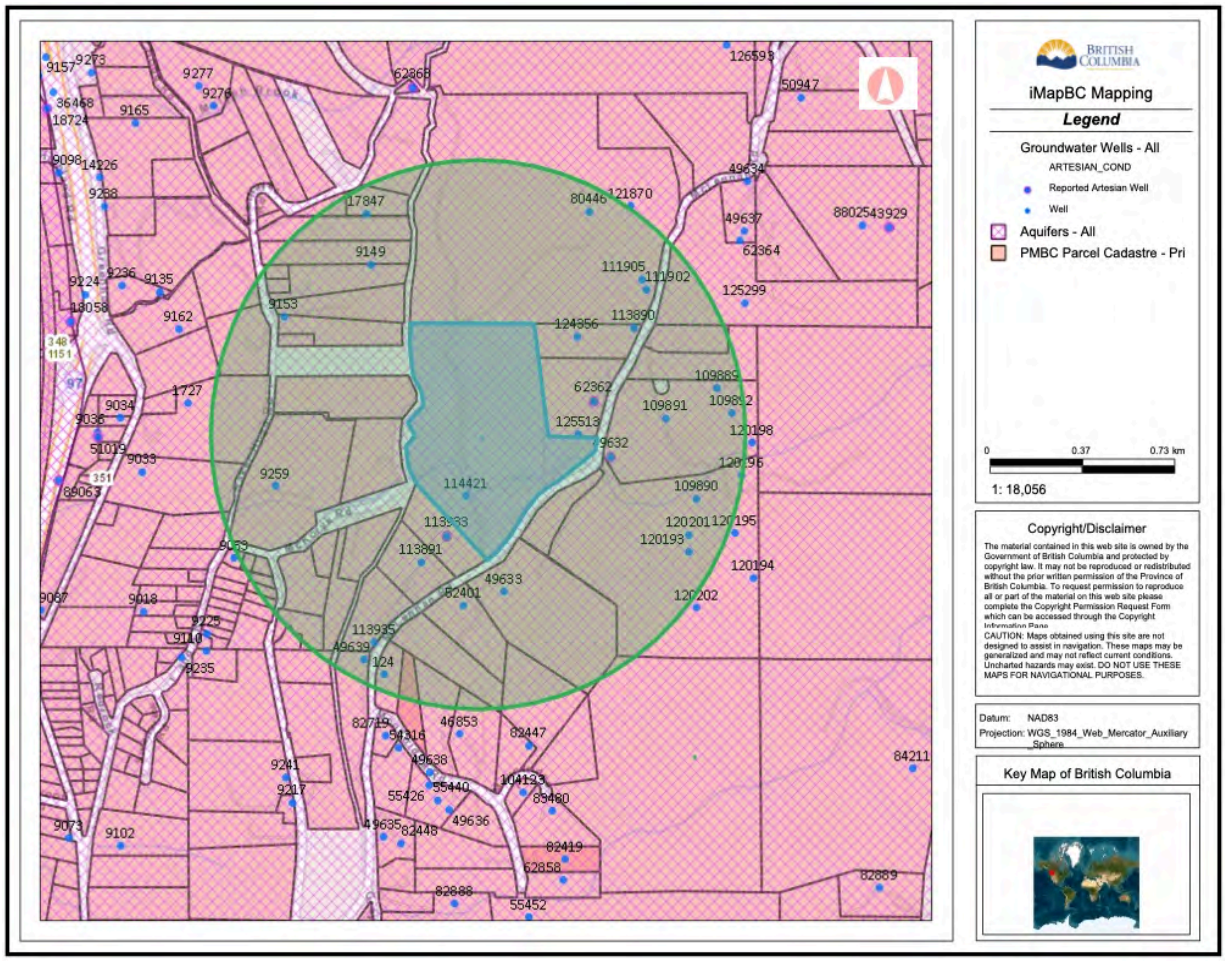

Figure 4: Image showing Mapped aquifers, and surrounding wells.

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Table 2: Summary of wells located on the Subject Parcel

Well Tag Number	Well Plate ID Number	Finished Well Depth (m)	Static Water Level (m btoc)[1]	Depth to Bedrock (m bgs)	Estimated Well Yield L/Day (US gpm)
Well located within the subject Development					
125513	66090	152.0	4.36	10.67	13,824 (2.5)
114421	47667	67.10	23.16	5.00	27,216 (5)
Wells located within 500 meters of Proposed Development					
124356	62172	153	24.08	5.49	381,024 (70)
113890	47649	183	31.09	9.14	24,494 (4.5)
111905	39422	128	30.78	2.13	163,296 (30)
111902	39421	122	31.09	4.27	54,432(10)
120202	50399	73	19.14	5.49	16,330 (3)
120193	50393	91	19.58	1.83	54,432 (10)
120201	50398	104	20.11	4.88	8,162 (1.5)
120195	50395	110	NA	3.048	13,608 (2.5)
114421	47667	67	23.16	1.52	27,216 (5)
109890	38543	55	14.94	0.91	48,989 (9)
120196	50396	69	0.91	2.13	544,320 (100)
120198	50397	79	3.66	6.40	43,546 (8)
109891	38542	67	11.89	23.77	163,296 (30)
109892	38541	61	6.09	14.33	70,762 (13)
109889	38544	104	33.83	11.58	8,165 (1.5)
113891	47647	140	28.35	NA	32,659 (6)
113933	47648	55	NA	3.66	27,216 (5)
52401	NA	49	NA	NA	32,659 (6)
49633	NA	73	NA	NA	NA
49632	NA	64	NA	NA	272,160 (50)
62362	NA	94	NA	NA	27,216 (5)
AVERAGE YIELD ALL WELLS					95,904 (18.5)

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8. SEASONAL VARIATION AND WELL INTERFERENCE IN GROUNDWATER WELLS

Season Variation

Groundwater levels in Aquifer 351 are monitored by the Ministry of Environment at Observation Well 311 (OBW 311) which is located 2 km southeast of the proposed development on Keddleston Road. Water levels in OBW 311 have been monitored since 1991 to present, with a gap in the data from 2001 to 2006. Figures 6 and 7, below, present water levels in OBW 311 over the period of record. Groundwater levels in OBW 311 are observed to fluctuate between 0.3 and 0.5 annually, with the lows occurring in the late winter to seasonal highs that occur in summer. Over the period of record, groundwater levels have fluctuated more significantly. After rising a little between 1991 and 1998, groundwater levels appear to have steadily declined on the order of roughly 2 m, to 2011. After 2011 until present, groundwater levels appear to have recovered ~2.5 m and are currently higher than at any other time in the recorded history of the well. The average available drawdown (defined as the difference between the static water level and the likely depth of pump intake) is 75 m or more, which is sufficient to support the well pumping for the household use with an allowance of season variation of 0.5 m.

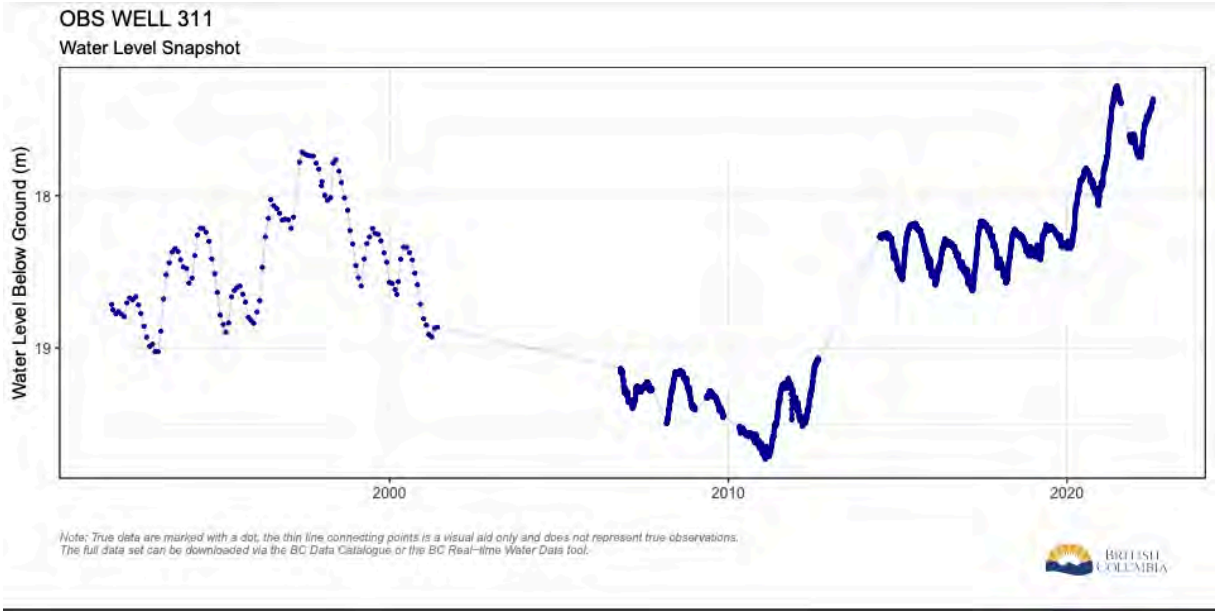

Figure 6: Plot of water levels over time in observation well 311.

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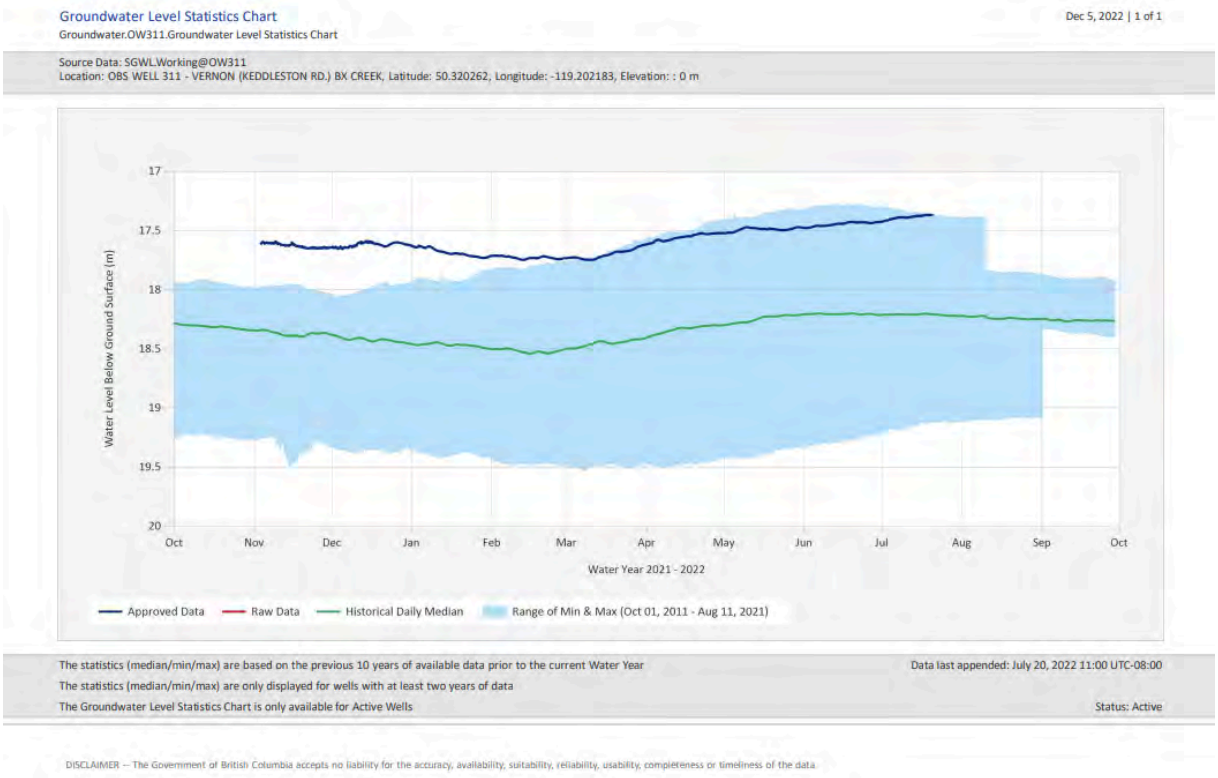

Figure 7: Plot showing the Annual statistical Hydrograph for Observation Well 311, for 2011 to 2021.

Well Interference

The reported well yields combined with the amount of available drawdown indicate that pumping the wells at the bylaw rate will not cause excessive well interference. During the pumping test on WPID 66090 the groundwater levels in WPID 47667 were monitored, in which no change in groundwater level was observed during the pumping test. This indicates that the water bearing fractures in each of the wells are either not connected or both the radius of influence for the duration of the pumping test, and as a result, the sustainable pumping rate is inclusive of this factor.

9. WATER QUALITY ASSESSMENT

As part of the subdivision process water quality samples were taken from both of the wells located on the subject site. WPID 66090 was sampled during the pumping test program and WPID 47667 was sampled on November 3, 2022. Water quality results were compared to GCDWQ described as either “maximum acceptable concentrations” (MAC), “aesthetic objectives” (AO) or operational guidance value (OG). The MAC guidelines are health-based and are determined based on the known health effects associated with the substance. The AO guidelines apply to those variables that affect taste or laundry (e.g. by staining), but do

not pose a health hazard. The OG guidelines are established based on operational considerations regarding treatment requirements. The laboratory results are included as Attachment D.

There were no exceedances of the MAC in either of the wells, indicating the water quality in the area is quite good. However, there were some exceedances of the Aesthetic Objectives and Operational guideline in both wells. Total dissolved solids (TDS) concentrations and Turbidity exceeded the guidelines in both wells and Iron concentrations exceeded the AO guiltiness in WPID 47667. Table 3 outlines the exceedances in both wells (Health Canada 2020).

Table 3: Summary of exceedances the GCDWQ in WPID 66090 and WPID 47667

Analyte	Guideline Value	Guideline Type	WTN 66090	WPID 47667
Total Dissolved Solids	<500 mg/L	AO	610 mg/L	619 mg/L
Turbidity	<1 NTU	OG	12.4 NTU	2.61 NTU
Iron	0.3 mg/L	AO	0.293 mg/L	0.469 mg/L

Elevated TDS concentrations can be naturally occurring but can affect taste and cause excessive scaling of water pipes, boilers, and appliances (Health Canada 1991).

The turbidity was high in all nine wells and exceed the GCDWQ operational guidance of 1.0 NTU. In some cases, turbidity is an indication of natural-occurring organic and/or inorganic particles in the water (e.g., metals, organics, and/or microorganisms). It may also be the case that much of the turbidity is a result of residual fines from the drilling process still present in the wells, and these may clean up with additional pumping when the permanent pump is installed. Particles can harbor microorganisms and shield them from disinfection. For operational efficiencies, Health Canada suggests turbidity should be below 1.0 NTU in groundwater but that a responsible party may choose to allow turbidity increases for individual systems, in light of a risk assessment that takes into account local knowledge of the system's capabilities and performance (Health Canada 2012). Turbidity does not have a maximum acceptable concentration (health-based) guideline.

High levels or iron can cause staining of distribution lines/appliances and laundry, and can result in an undesirable taste, 2 and are already being treated for with the current treatment system located in the pump house. For more information, read the Health Canada Guideline Technical Documents for Iron. See the hyperlinks in the footnotes below.

Helpful guidance documents for the treatment of the exceeding parameters are available on Health Canada's website, as follows:

TDS (Health Canada 1991): https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-drinking-water-quality-guideline-technical-document-total-dissolved-solids-tds.html.

Turbidity (Health Canada 2012): https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-drinking-water-quality-turbidity.html.

Iron (Health Canada. 1987) Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Iron. Available at: https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-drinking-water-quality-guideline-technical-document-iron.html

It should be noted that although not in exceedance of the MAC, fluoride concentrations were measured to be equal to the MAC of 1.5 mg/L. Helpful guidance documents for the treatment of fluoride are available on Health Canada's website, as follows:

Fluoride (Health Canada 2010): https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-drinking-water-quality-guideline-technical-document-fluoride.html.

10. REVIEW OF 2022 GOLDER REPORT (KEDDLESTON GROUNDWATER STUDY-PHASE 2)

The RDNO has published several recent studies focusing on the groundwater availability from provincially mapped aquifers 349, 350 and 351 including, Associated Engineering 2007, Golder 2020, and most recently Golder 2022 (Keddleston Groundwater Study-Phase 2). Based on the most recent RDNO Staff report (File No: 22-0403-C-TA) from November 28, 2022, it is our understanding that the RDNO planning department has recommended that future hydrogeological studies in this area specifically address Phase 2 of the Keddleston Groundwater Study (Golder 2022), and therefor was the focus of this background review.

The focus of the Golder study was to assess the water supply wells in the Keddleston area and associated groundwater withdrawals from the local aquifers.

In summary, the 2022 Golder report was based primarily on a review of climate data, existing well logs and aquifer mapping data, land use data, feedback from well owners in study area by way of a well survey, two 24-hour pumping tests, and seven months of water level data from 16 monitoring wells located throughout the study area.

The study concludes that with respect to aquifer 351 (the aquifer underlying the subject site), when accounting for full buildout of the existing lots, and 50% of the ALR land being irrigated, approximately 49% - 60% of the water was predicted to be withdrawn relative to aquifer recharge. It goes on to state that if irrigation use is applied to 100% the agricultural land within the study area, this estimate increases to 147%-188% of aquifer recharge.
It further, concludes that the areas of Wilson-Jackson-Upper, Keddleston-Clearview Road, should be considered limited in available groundwater, and infers that western (downgradient), and eastern (upgradient) portions of the aquifer may be limited in their groundwater availability, and further assessment should be completed to prove water in these areas before further development is approved.

Specific to the 'Western' (downgradient) portion the Aquifer 351 which includes the location the proposed development, Section 7.2.4 of the Golder report indicates that these conclusions are based on the following:

- seven months of water level data shows, significant seasonal variation in water levels in two of the monitoring wells (120 and 189) in this area, which the report infers that may be due to higher usage as corroborated by the relatively higher numbers of residential properties in this area, and

- two well survey responses reported a water shortage,

- the fact that the western portion is downgradient of the two areas that are stated to be limited in available groundwater supply.

In review of Golder report, IGI feels that several of the assumption/conclusions made in the report, do not accurately represent the aquifer conditions at the location of the subject site, for the following reasons:

- The water balance presented in the Golder report assumes that at the low end, 50% of all the ALR land within the study area is being irrigated, and at the high end, 100% of the ALR is being irrigated. It also assumes that at the high end, every parcel of land within the study area, is currently using the full 6,550 L/day as per the applicable bylaw. However, based on the fact that there are only a total of 7 groundwater licenses registered within the study area, none of which are registered for irrigation purposes (Env 2022), and the likely scenarios that typical household use in rural areas is generally more in line with the 2.27 m^3 /day guidelines used in most of the other electoral areas within the RDNO, it seem highly likely that the upper bounds of Golder's water budget does not represent the actual use. It is also worth noting, that the Ministry has identified the BX Creek watershed as "Fully Recorded", which generally suggests that no more groundwater licenses will be allocated to this watershed going forward.

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- The Golder study reports that two well surveys from the 'Western' portion of Aquifer 351, reported to have water issues. Golder uses these two responses, as evidence of a general lack of water in the area. However, in both cases, the wells, are reported to be less than 50 m deep (47 m and 49 m respectively), which is much shallower than the average depth of mapped wells in the within 500 m of the proposed development (84.7 m bgs). It should be noted that the report mentions that one of these wells was drilled deeper, but there is no mention if whether it resulted in a higher yield.

- The Golder report relies heavily on the upper estimates of water usage for the water budget to conclude that water availability may be limited for whole of Aquifer 351. This approach fails to consider that the 'Western' portion of the aquifer is within a different catchment, is characterized by differences in geology/hydrogeology then the remainder of the aquifer. Although not addressed specifically in the Golder report, there is a mapped fault zone that runs right between the Wilson-Jackson-Upper, Keddleston-Clearview Road and the 'Western' Portion of the aquifer (Figure 2). This is reflected in the Cross-section B-B' presented on Figure 6 of the Golder report with the two wells located on McLennan Rd (896-62006 and 896-50394) showing a higher number of water bearing fractures then the wells further to the east. This is also seen in well log for WPID 66090 located on the subject site which reports multiple water bearing fractures from 30 m to 152 m bgs. The impact of this fault zone is reflected in the stark difference in estimated wells yields between the wells located near the fault zone, and the estimated yield of wells further to the east. Using Figure M (Golder 2022), as a guide, the Ministry well database indicates that the average reported well yield for the wells in the areas of concern is 2.4 US gpm. In contrast, the average yield for the wells in the 'Western' portion of the Aquifer have an estimated yield is 11.7 US gpm (Figure 4).

- The Golder study makes conclusions on the seasonal variability of water levels in the aquifers based on data from a single year between May and December (7 months). Interestingly, although data from Observation Well 311 is included in the report, which shows a general increase in groundwater levels over the last 10 years despite ongoing development during this time, no conclusions are made based on this data. With respect water level data from the four wells located on McLennan Rd which represent trends in the 'Western' portion of Aquifer 351, two of the wells showed little to no overall change in the water levels, and the other two showed significant increases over the same period, with no correlation between any of these wells. The report goes on to conclude that the higher variability in reported well yields and seasonal water levels in the 'Western' portion of Aquifer is likely a result of higher use based on a higher number of residences in this area. In contrast, IGI believes that it is more appropriate to interpret this difference as a reflection of being in a different catchment, different geological conditions, since the wells density doesn't seem to be any higher in one area over the other.

11. CONCLUSIONS AND RECOMMENDATIONS

Based on the results of this hydrogeological assessment, it is reasonable to conclude that groundwater sources are available to service the full buildout potential of eight lots in accordance with the provisions of Subdivision Servicing Bylaw No. 2600, and the use of groundwater supplies for the proposed development at full buildout (8 Lots), will not have a negative impact on the use of existing wells that are completed into Aquifer 351. The following conclusions support this assessment:

- Based on existing well data, hydrogeological conditions underlying the Site appear to be favorable for the development of wells capable of meeting the RDNO bylaw production rate of 6,550 litres/day (1.2 US gpm) without causing problems of well interference with nearby wells or surface water.
- Accounting for seasonal variation and well interference, the existing on site have an estimated yield of 13,824 and 27,216 liters per day. Just these two wells are enough water to supply 6 of the 8 proposed lots base the required bylaw amount of 6,550 L/day.
- Future wells drilled on the Site would likely encounter Aquifer 351, which based on the evidence looks to be capable of supporting additional drilled wells used for domestic water supply for the proposed development of the eight lots.
- In order to penetrate water-bearing fractures, and to create sufficient available drawdown, the likely depth of wells drilled on the Site is expected to range from approximately 65 to 150 m;
- Due to large available drawdown in the surrounding bedrock wells, and the seasonal fluctuations observed in observation well 311, seasonal variation will likely not be an issue in any of the future potential wells drilled on site.
- Water quality results from the existing wells indicate that there are no exceedances of the MAC guidelines, but there are some exceedances of the AO and OG guidelines that may result in some level of treatment being necessary to optimize system operations.
- The efforts and conclusions of the 2022 Golder report are primarily focused on the areas of Wilson-Jackson-Upper, Keddleston-Clearview Road, and include little evidence to support the conclusions made with respect to the ‘Western’ (downgradient) portion of Aquifer 351. Although, no doubt there are portions of Aquifer 351, and/or individual wells that may be limited with respect to groundwater availability, the fact that the proposed development is within a separate catchment

from the remainder of Aquifer 351, with evidence of highly fractured bedrock as a result of a known fault in the area, suggests that the assumptions that may be applied to some areas of Aquifer 351 are not entirely relevant to the aquifer conditions near the proposed development.

Based on the results of this hydrogeological assessment, IGI provides the following recommendations and treatment options:

- Permit the subject parcel of land to be rezoned to allow for the potential to develop the land into a maximum buildout of 8 lots.
- After drilling, well drillers reports should be reviewed by a qualified professional, and any well with a driller-reported yield less than 3.0 Imperial gpm (especially bedrock aquifer wells) should be tested for a minimum of 48-72 hours to confirm capacity and potability, with oversight and reporting of the test(s) provided by a qualified professional
- Locate wells so that they are at least 50 m (165 ft) from each other and from neighbouring wells, if possible, to minimize the potential for well interference; and
- Locate wells at least 30 m (100 ft) from existing or proposed septic tanks and sewage disposal fields.

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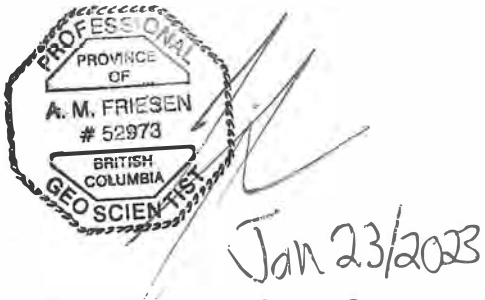
12. CLOSURE

This report was prepared for Victor Malyakin to provide a hydrogeological assessment in support of a rezoning application at 7500 McLennan Road, in the North Okanagan Regional District.

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

Respectfully submitted,



Tony Friesen M.Sc., P.Geo
Hydrogeologist

Permit To Practice Number 1004322

Attachments:

Attachment A – Site Plan showing proposed two Lot subdivision
Attachment B – Site Plan showing proposed layout for 8 lots.
Attachment C – Drillers Logs for WPID 66090 and WPID 47667.
Attachment D – Laboratory reports

References

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Attachment A – Site Plan showing proposed two Lot subdivision

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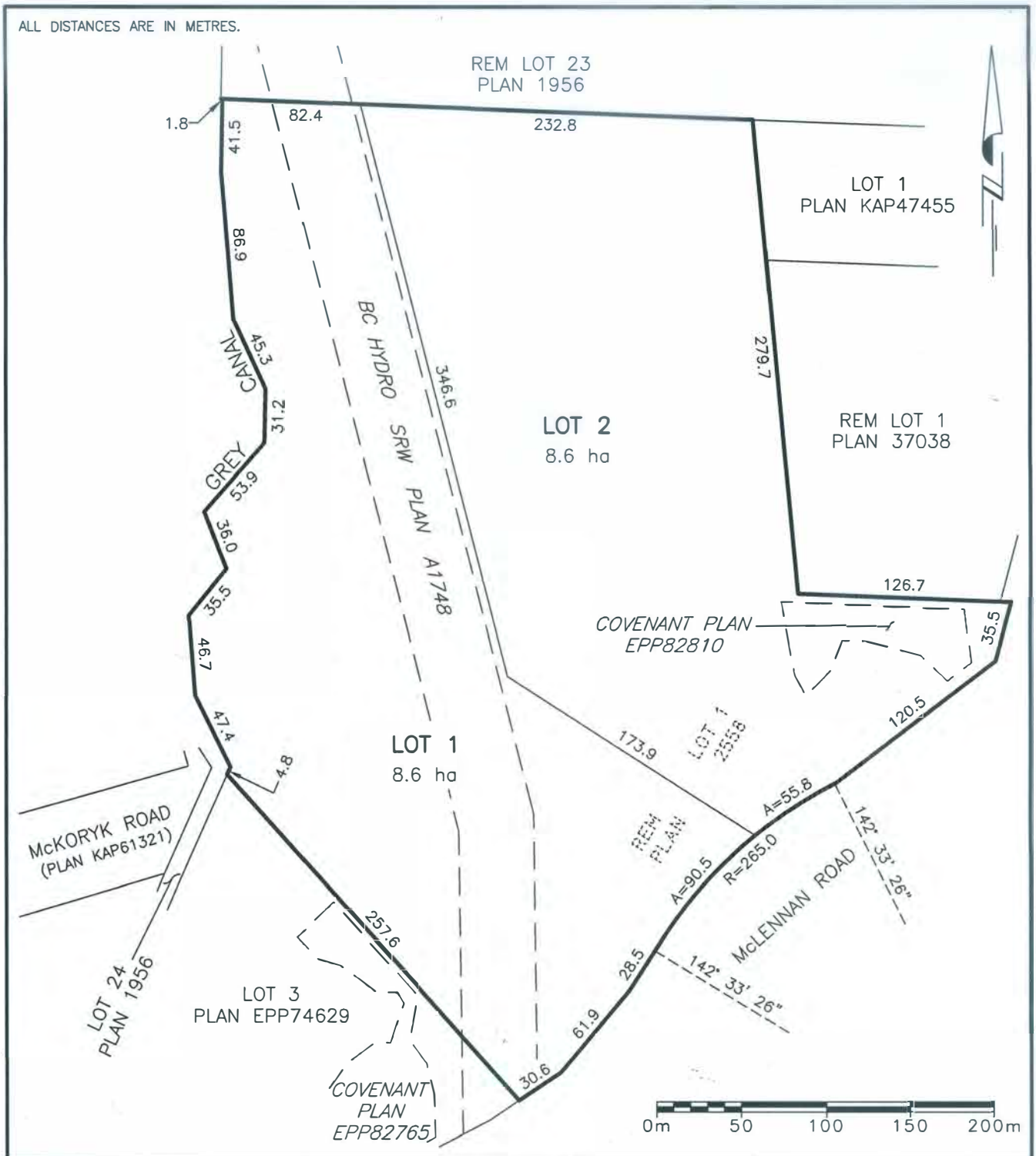

PLAN OF PROPOSED SUBDIVISION OF LOT 1, PLAN 2558, SEC 25, TP 8, ODYD EXCEPT PLANS 37038 & EPP74629

112860A00

SCALE: 1 : 3000	OUR FILE: R11286
DATE: 12 May 2022	DRAWN: KDG

Viktor Malyakin/Malkin Construction Ltd.

McPherson Maddox
Land Surveying
3500 – 30th Street
Vernon, BC V1T 5E8
Telephone: (250) 542-4343

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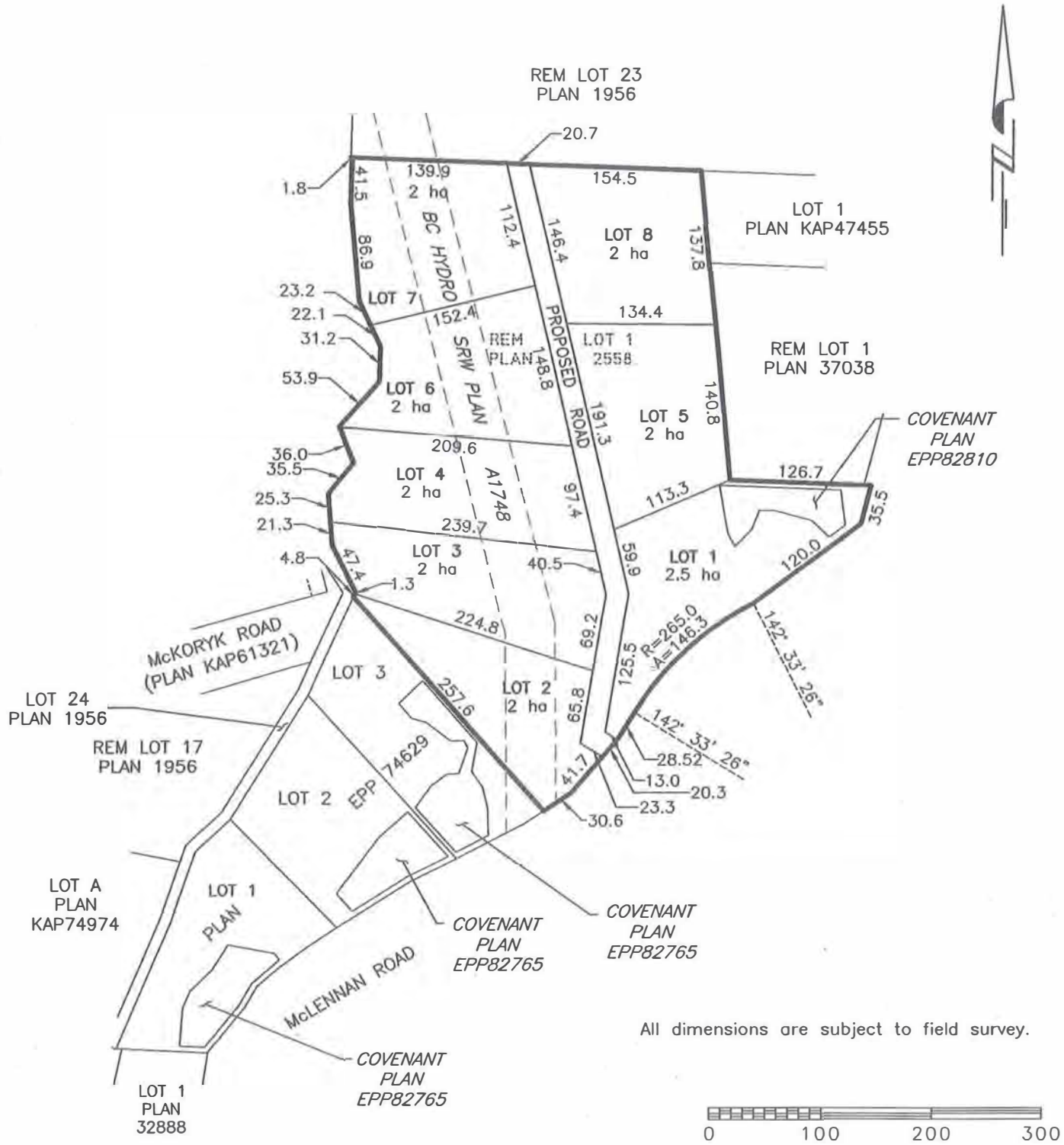
Attachement B – Site Plan showing proposed layout for 8 lots.

ALL DISTANCES ARE IN METRES.



PLAN OF PROPOSED REZONING AND SUBDIVISION OF LOT 1, PLAN 2558, SEC 25, TP 8, ODYD EXCEPT PLANS 37038 & EPP74629

106750A01

SCALE: 1 : 5000	OUR FILE: R10675
DATE: 30 Sep 2019	DRAWN: KG

Dacron Enterprises Ltd

MADDOX & COMPANY
LAND SURVEYORS
3500 – 30th STREET
VERNON, BC V1T 5E8
TELEPHONE: (250) 542-4343

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Attachment C – Drillers Logs for WPID 66090 and WPID 47667.

Groundwater Wells and Aquifers

Well Summary

Well Tag Number: 125513
Well Identification Plate Number: 66090
Owner Name: Viktor Malyakin
Intended Water Use: Private Domestic
Artesian Condition: No

Well Status: New
Well Class: Water Supply
Well Subclass: Not Applicable
Aquifer Number:

Observation Well Number:
Observation Well Status:
Environmental Monitoring System (EMS) ID:
Alternative specs submitted: No

Licensing Information

Licensed Status: Unlicensed

Licence Number:

Location Information

Street Address: 7500 McLennan Rd
Town/City: Vernon

Legal Description:

Lot	
Plan	
District Lot	
Block	
Section	
Township	
Range	
Land District	
Property Identification Description (PID)	

Description of Well Location:

Geographic Coordinates - North American Datum of 1983 (NAD 83)
Latitude: 50.33028 **Longitude:** -119.22389
UTM Easting: 341722 **UTM Northing:** 5577719
Zone: 11 **Coordinate Acquisition Code:** (10 m accuracy) Handheld GPS with accuracy of +/- 10 metres

Well Activity

Activity	Work Start Date	Work End Date	Drilling Company	Date Entered
Construction report	2021-10-15	2021-10-22	Integrity Drilling Inc.	April 4th 2022 at 7:16 PM

Well Work Dates

Start Date of Construction	End Date of Construction	Start Date of Alteration	End Date of Alteration	Start Date of Decommission	End Date of Decommission
2021-10-15	2021-10-22				

Well Completion Data

Total Depth Drilled: 500 ft bgl
Finished Well Depth: 500 ft bgl
Final Casing Stick Up: 29 inches
Depth to Bedrock: 34 feet bgl
Ground elevation: 2099 feet

Estimated Well Yield: 2 USgpm
Well Cap: vermine proof
Well Disinfected Status: Disinfected
Drilling Method: Air Rotary
Method of determining elevation: GPS

Static Water Level (BTOC): 120 feet btoc
Artesian Flow:
Artesian Pressure (head):
Artesian Pressure (PSI):
Orientation of Well: VERTICAL

Lithology

From (ft bgl)	To (ft bgl)	Raw Data	Description	Moisture	Colour	Hardness	Observations	Water Bearing Flow Estimate (USGPM)
0	34	til						
34	35	sasnd/gravel						
35	40	light grey bedrock						
40	77	light brn bedrock						
77	80	dark grey bedriock						
80	100	grey		Damp				
100	200	dark grey						1.2
200	220	dark grey						
220	240	dark grey and white		Wet				
240	300	grey						
300	400	grey and white						
400	500	grey and white						0.8

Casing Details

From (ft bgl)	To (ft bgl)	Casing Type	Casing Material	Diameter (in)	Wall Thickness (in)	Drive Shoe
0	35	Surface casing	Steel	6		Installed

Surface Seal and Backfill Details

Surface Seal Material: Bentonite clay
Surface Seal Installation Method: Poured
Surface Seal Thickness: 1 inches
Surface Seal Depth: 15 feet

Backfill Material Above Surface Seal:
Backfill Depth:

Liner Details

Liner Material: PVC
Liner Diameter: 5 inches
Liner from: 10 (ft bgl)

Liner Thickness:
Liner to: 500 (ft bgl)

Liner perforations

From (ft bgl)	To (ft bgl)
170	175
270	275
370	375
470	475

Screen Details

Intake Method:
Type:
Material:
Opening:
Bottom:

Installed Screens

From (ft bgl)	To (ft bgl)	Diameter (in)	Assembly Type	Slot Size
There are no records to show				

Well Development

Developed by: Air lifting

Development Total Duration: 3 hours

Well Yield

Estimation Method: Air Lifting
Estimation Rate: 2 USgpm
Estimation Duration: 2 hours
Static Water Level Before Test: 120 ft (btoc)
Drawdown: 500 ft (btoc)
Hydrofracturing Performed: Yes
Increase in Yield Due to Hydrofracturing:

Well Decommission Information

Reason for Decommission:
Method of Decommission:
Sealant Material:
Backfill Material:
Decommission Details:

Comments

No comments submitted

Alternative Specs Submitted: Yes

Documents

No additional documentation available for this well.

Disclaimer

BRITISH COLUMBIA
Ministry of Environment

☑ **Well Construction Report**
☐ **Well Closure Report**
☐ **Well Alteration Report**

Dan-Gare Drilling
Stamp: company name/address/ phone/fax/e-mail here, if desired.

Ministry Well ID Plate Number: 47667
Ministry Well Tag Number: 114421
☐ Confirmation/alternative specs. attached
☐ Original well construction report attached

Red lettering indicates minimum mandatory information. **See reverse for notes & definitions of abbreviations.**

Owner name: Daron Enterprises Ltd.
Mailing address: 7566 McLennan Rd. Town Vernon Prov. B.C. Postal Code
Well Location: Address: Street no. 7566 Street name McLennan Rd. Town Vernon
(or) **Legal description:** Lot 4 Plan D.L. Block Sec. Twp. Rg. Land District
(or) **PID:** (and) **Description of well location (attach sketch, if nec.):** Lot 4 of Proposed subdivision of 7566 McLennan Rd.
NAD 83: Zone: 11U (see note 2) (and) **UTM Northing:** 6341434 m (or) **Latitude (see note 3):**
UTM Easting: 5577576 m **Longitude:**
Method of drilling: ☑ air rotary ☐ cable tool ☐ mud rotary ☐ auger ☐ driving ☐ jetting ☐ excavating ☐ other (specify):
Orientation of well: ☑ vertical ☐ horizontal Ground elevation: 1964 ft (asl) Method (see note 4): GPS
Class of well (see note 5): Water Supply **Sub-class of well:** Domestic
Water supply wells: indicate intended water use: ☑ private domestic ☐ water supply system ☐ irrigation ☐ commercial or industrial ☐ other (specify):

Lithologic description (see notes 7-14) or closure description (see notes 15 and 16)

From ft (bgl)	To ft (bgl)	Relative Hardness	Colour	Material Description (Use recommended terms on reverse. List in order of decreasing amount, if applicable)	Water-bearing Estimated Flow (USgpm)	Observations (e.g., fractured, weathered, well sorted, silty wash), closure details
0	5		Brown	Clay & Rocks		
5	220		White	Bedrock		
180	220			Bedrock	5	
						Recommended Pump Setting 200

Casing details

From ft (bgl)	To ft (bgl)	Dia in	Casing Material / Open Hole	Wall Thickness in	Drive Shoe
+2	16	6	Steel	.219	Yes

Screen details

From ft (bgl)	To ft (bgl)	Dia in	Type (see note 18)	Slot Size

Surface seal: Type: Bentonite Depth: 16 ft
Method of installation: ☐ Poured ☐ Pumped Thickness: 1 in
Backfill: Type: Depth: ft
Liner: ☑ PVC ☐ Other (specify):
Diameter: 4 in Thickness: .250 in
From: 6 ft (bgl) To: 220 ft (bgl) Perforated: From: 180 ft (bgl) To: 220 ft (bgl)

Intake: ☐ Screen ☐ Open bottom ☐ Uncased hole
Screen type: ☐ Telescope ☐ Pipe size
Screen material: ☐ Stainless steel ☐ Plastic ☐ Other (specify):
Screen opening: ☐ Continuous slot ☐ Slotted ☐ Perforated pipe
Screen bottom: ☐ Bail ☐ Plug ☐ Plate ☐ Other (specify):
Filter pack: From: ft To: ft Thickness: in
Type and size of material:

Developed by:

☑ Air lifting ☐ Surging ☐ Jetting ☐ Pumping ☐ Bailing
☐ Other (specify): Total duration: hrs
Notes:

Well yield estimated by:

☐ Pumping ☑ Air lifting ☐ Bailing ☐ Other (specify):
Rate: 5 USgpm Duration: hrs
SWL before test: ft (btoc) Pumping water level: ft (btoc)

Obvious water quality characteristics:

☑ Fresh ☐ Salty ☐ Clear ☐ Cloudy ☐ Sediment ☐ Gas
Colour/odour: No Water sample collected: ☑

Well driller (print clearly):

Name (first, last) (see note 19): Logan Flett 08042501
Registration no. (see note 20):
Consultant (if applicable; name and company):

DECLARATION: Well construction, well alteration or well closure, as the case may be, has been done in accordance with the requirements in the *Water Act* and the Ground Water Protection Regulation.
Signature of Driller Responsible Logan Flett

Final well completion data:

Total depth drilled: 220 ft Finished well depth: 220 ft (bgl)
Final stick up: 24 in Depth to bedrock: 5 ft (bgl)
SWL: 76 ft (btoc) Estimated well yield: 5 USgpm
Artesian flow: USgpm, or Artesian pressure: ft
Type of well cap: Aluminum Well disinfected: ☑ Yes ☐ No
Where well ID plate is attached: Stick-up

Well closure information:

Reason for closure:
Method of closure: ☐ Poured ☐ Pumped
Sealant material: Backfill material:
Details of closure (see note 17):

Date of work (YYYY/MM/DD):

Started: 2017/05/28 **Completed:** 2017/05/29
Comments:

PLEASE NOTE: The information recorded in this well report describes the works and hydrogeologic conditions at the time of construction, alteration or closure, as the case may be. Well yield, well performance and water quality are not guaranteed as they are influenced by a number of factors, including natural variability, human activities and condition of the works, which may change over time.

white: Customer copy
canary: Driller copy
pink: Ministry copy

Sheet ____ of ____

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Attachment D – Laboratory reports

CERTIFICATE OF ANALYSIS

REPORTED TO	Interior Geoscience Inc. 8544 Greenaway Rd. Vernon, BC V1B 3M6		
ATTENTION	Tony Friesen	**WORK ORDER**	22C2535
PO NUMBER		**RECEIVED / TEMP**	2022-03-18 09:06 / 1.8°C
PROJECT	General Potability	**REPORTED**	2022-04-04 10:09
PROJECT INFO		**COC NUMBER**	No Number

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/IEC 17025:2017 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 teamcaro@caro.ca

Authorized By:

Team CARO
Client Service Representative

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	Interior Geoscience Inc.	**WORK ORDER**	22C2535
PROJECT	General Potability	**REPORTED**	2022-04-04 10:09

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
WPID 66090 (22C2535-01) | Matrix: Water | Sampled: 2022-03-17 13:00						
Anions						
Chloride	**11.4**	AO ≤ 250	0.10	mg/L	2022-03-20	
Fluoride	**1.50**	MAC = 1.5	0.10	mg/L	2022-03-20	
Nitrate (as N)	**0.015**	MAC = 10	0.010	mg/L	2022-03-20	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	2022-03-20	
Sulfate	**235**	AO ≤ 500	1.0	mg/L	2022-03-20	
Calculated Parameters						
Hardness, Total (as CaCO3)	**399**	None Required	0.500	mg/L	N/A	
Langelier Index	< -5.0	N/A	-5.0		2022-03-25	
Solids, Total Dissolved	**610**	AO ≤ 500	10.0	mg/L	N/A	
General Parameters						
Alkalinity, Total (as CaCO3)	**290**	N/A	1.0	mg/L	2022-03-22	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2022-03-22	
Alkalinity, Bicarbonate (as CaCO3)	**290**	N/A	1.0	mg/L	2022-03-22	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2022-03-22	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2022-03-22	
Colour, True	**5.4**	AO ≤ 15	5.0	CU	2022-03-21	HT1
Conductivity (EC)	**949**	N/A	2.0	µS/cm	2022-03-22	
Cyanide, Total	< 0.0020	MAC = 0.2	0.0020	mg/L	2022-03-24	
pH	**8.08**	7.0-10.5	0.10	pH units	2022-03-22	HT2
Temperature, at pH	**22.4**	N/A		°C	2022-03-22	HT2
Turbidity	**12.4**	OG < 1	0.10	NTU	2022-03-21	HT1
Microbiological Parameters						
Coliforms, Total	< 1	MAC = 0	1	CFU/100 mL	2022-03-18	
E. coli	< 1	MAC = 0	1	CFU/100 mL	2022-03-18	
Total Metals						
Aluminum, total	**0.0499**	OG < 0.1	0.0050	mg/L	2022-03-23	
Antimony, total	< 0.00020	MAC = 0.006	0.00020	mg/L	2022-03-23	
Arsenic, total	< 0.00050	MAC = 0.01	0.00050	mg/L	2022-03-23	
Barium, total	**0.0260**	MAC = 2	0.0050	mg/L	2022-03-23	
Boron, total	< 0.0500	MAC = 5	0.0500	mg/L	2022-03-23	
Cadmium, total	**0.000015**	MAC = 0.005	0.000010	mg/L	2022-03-23	
Calcium, total	**64.5**	None Required	0.20	mg/L	2022-03-23	
Chromium, total	**0.00111**	MAC = 0.05	0.00050	mg/L	2022-03-23	
Cobalt, total	**0.00043**	N/A	0.00010	mg/L	2022-03-23	
Copper, total	**0.00534**	MAC = 2	0.00040	mg/L	2022-03-23	
Iron, total	**0.293**	AO ≤ 0.3	0.010	mg/L	2022-03-23	
Lead, total	**0.00029**	MAC = 0.005	0.00020	mg/L	2022-03-23	
Magnesium, total	**57.8**	None Required	0.010	mg/L	2022-03-23	
Manganese, total	**0.0279**	MAC = 0.12	0.00020	mg/L	2022-03-23	
Mercury, total	< 0.000010	MAC = 0.001	0.000010	mg/L	2022-03-24	

TEST RESULTS

REPORTED TO	Interior Geoscience Inc.	**WORK ORDER**	22C2535
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Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
WPID 66090 (22C2535-01) | Matrix: Water | Sampled: 2022-03-17 13:00, Continued						
Total Metals, Continued						
Molybdenum, total	**0.00276**	N/A	0.00010	mg/L	2022-03-23	
Nickel, total	**0.00238**	N/A	0.00040	mg/L	2022-03-23	
Potassium, total	**8.05**	N/A	0.10	mg/L	2022-03-23	
Selenium, total	< 0.00050	MAC = 0.05	0.00050	mg/L	2022-03-23	
Sodium, total	**56.6**	AO ≤ 200	0.10	mg/L	2022-03-23	
Strontium, total	**2.65**	MAC = 7	0.0010	mg/L	2022-03-23	
Uranium, total	**0.000446**	MAC = 0.02	0.000020	mg/L	2022-03-23	
Zinc, total	**0.0336**	AO ≤ 5	0.0040	mg/L	2022-03-23	

Sample Qualifiers:

HT1 The sample was prepared and/or analyzed past the recommended holding time.

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

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	Interior Geoscience Inc.	**WORK ORDER**	22C2535
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Analysis Description	Method Ref.	Technique	Accredited	Location
Alkalinity in Water	SM 2320 B* (2017)	Titration with H2SO4	✓	Kelowna
Anions in Water	SM 4110 B (2017)	Ion Chromatography	✓	Kelowna
Coliforms, Total in Water	SM 9222* (2017)	Membrane Filtration / Chromocult Agar	✓	Kelowna
Colour, True in Water	SM 2120 C (2017)	Spectrophotometry (456 nm)	✓	Kelowna
Conductivity in Water	SM 2510 B (2017)	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* (2017)	Membrane Filtration / Chromocult Agar	✓	Kelowna
Hardness in Water	SM 2340 B* (2017)	Calculation: 2.497 [total Ca] + 4.118 [total Mg] (Est)	✓	N/A
Langelier Index in Water	SM 2330 B (2017)	Calculation		N/A
Mercury, total in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	✓	Richmond
pH in Water	SM 4500-H+ B (2017)	Electrometry	✓	Kelowna
Solids, Total Dissolved in Water	SM 1030 E (2017)	SM 1030 E (2011)		N/A
Total Metals in Water	EPA 200.2 / EPA 6020B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	✓	Richmond
Turbidity in Water	SM 2130 B (2017)	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
°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

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	Interior Geoscience Inc.	**WORK ORDER**	22C2535
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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 or once samples expire, whichever comes first. Longer hold is possible if agreed to in writing.

Results in **Bold** indicate values that are above CARO's method reporting limits. Any results that are above regulatory limits are highlighted **red**. Please note that results will only be highlighted red if the regulatory limits are included on the CARO report. Any Bold and/or highlighted results do not take into account method uncertainty. If you would like method uncertainty or regulatory limits to be included on your report, please contact your Account Manager:teamcaro@caro.ca

Please note any regulatory guidelines applied to this report are added as a convenience to the client, at their request, to help provide some initial context to analytical results obtained. Although CARO makes every effort to ensure accuracy of the associated regulatory guideline(s) applied, the guidelines applied cannot be assumed to be correct due to a variety of factors and as such CARO Analytical Services assumes no liability or responsibility for the use of those guidelines to make any decisions. The original source of the regulation should be verified and a review of the guideline (s) should be validated as correct in order to make any decisions arising from the comparison of the analytical data obtained to the relevant regulatory guideline for one's particular circumstances. Further, CARO Analytical Services assumes no liability or responsibility for any loss attributed from the use of these guidelines in any way.

APPENDIX 2: QUALITY CONTROL RESULTS

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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 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
Anions, Batch B2C2122										
Blank (B2C2122-BLK1)				Prepared: 2022-03-19, Analyzed: 2022-03-19						
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							
Blank (B2C2122-BLK2)				Prepared: 2022-03-20, Analyzed: 2022-03-20						
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 (B2C2122-BS1)				Prepared: 2022-03-19, Analyzed: 2022-03-19						
Chloride	15.7	0.10	mg/L	16.0		98	90-110			
Fluoride	4.02	0.10	mg/L	4.00		100	88-108			
Nitrate (as N)	3.86	0.010	mg/L	4.00		97	90-110			
Nitrite (as N)	2.06	0.010	mg/L	2.00		103	85-115			
Sulfate	15.9	1.0	mg/L	16.0		99	90-110			
LCS (B2C2122-BS2)				Prepared: 2022-03-20, Analyzed: 2022-03-20						
Chloride	15.8	0.10	mg/L	16.0		99	90-110			
Fluoride	4.01	0.10	mg/L	4.00		100	88-108			
Nitrate (as N)	3.87	0.010	mg/L	4.00		97	90-110			
Nitrite (as N)	2.02	0.010	mg/L	2.00		101	85-115			
Sulfate	15.9	1.0	mg/L	16.0		100	90-110			
General Parameters, Batch B2C2174										
Blank (B2C2174-BLK1)				Prepared: 2022-03-21, Analyzed: 2022-03-21						
Colour, True	< 5.0	5.0	CU							
Blank (B2C2174-BLK2)				Prepared: 2022-03-21, Analyzed: 2022-03-21						
Colour, True	< 5.0	5.0	CU							

APPENDIX 2: QUALITY CONTROL RESULTS

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Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B2C2174, Continued										
LCS (B2C2174-BS1)				Prepared: 2022-03-21, Analyzed: 2022-03-21						
Colour, True	21	5.0	CU	20.0		107	85-115			
LCS (B2C2174-BS2)				Prepared: 2022-03-21, Analyzed: 2022-03-21						
Colour, True	22	5.0	CU	20.0		111	85-115			
General Parameters, Batch B2C2262										
Blank (B2C2262-BLK1)				Prepared: 2022-03-21, Analyzed: 2022-03-21						
Turbidity	< 0.10	0.10	NTU							
Blank (B2C2262-BLK2)				Prepared: 2022-03-21, Analyzed: 2022-03-21						
Turbidity	< 0.10	0.10	NTU							
LCS (B2C2262-BS1)				Prepared: 2022-03-21, Analyzed: 2022-03-21						
Turbidity	38.6	0.10	NTU	40.0		96	90-110			
LCS (B2C2262-BS2)				Prepared: 2022-03-21, Analyzed: 2022-03-21						
Turbidity	39.7	0.10	NTU	40.0		99	90-110			
General Parameters, Batch B2C2385										
Blank (B2C2385-BLK1)				Prepared: 2022-03-22, Analyzed: 2022-03-22						
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							
Temperature, at pH	23.2		°C							
Blank (B2C2385-BLK2)				Prepared: 2022-03-22, Analyzed: 2022-03-22						
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							
Temperature, at pH	24.3		°C							
LCS (B2C2385-BS1)				Prepared: 2022-03-22, Analyzed: 2022-03-22						
Alkalinity, Total (as CaCO3)	107	1.0	mg/L	100		107	80-120			
LCS (B2C2385-BS2)				Prepared: 2022-03-22, Analyzed: 2022-03-22						
Alkalinity, Total (as CaCO3)	107	1.0	mg/L	100		107	80-120			
LCS (B2C2385-BS3)				Prepared: 2022-03-22, Analyzed: 2022-03-22						
Conductivity (EC)	1440	2.0	µS/cm	1410		102	95-105			
LCS (B2C2385-BS4)				Prepared: 2022-03-22, Analyzed: 2022-03-22						
Conductivity (EC)	1460	2.0	µS/cm	1410		103	95-105			
Reference (B2C2385-SRM1)				Prepared: 2022-03-22, Analyzed: 2022-03-22						
pH	7.00	0.10	pH units	7.01		100	98-102			
Reference (B2C2385-SRM2)				Prepared: 2022-03-22, Analyzed: 2022-03-22						
pH	7.00	0.10	pH units	7.01		100	98-102			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Interior Geoscience Inc.	**WORK ORDER**	22C2535
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Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B2C2676										
Blank (B2C2676-BLK1)				Prepared: 2022-03-24, Analyzed: 2022-03-24						
Cyanide, Total	< 0.0020	0.0020	mg/L							
Blank (B2C2676-BLK2)				Prepared: 2022-03-24, Analyzed: 2022-03-24						
Cyanide, Total	< 0.0020	0.0020	mg/L							
LCS (B2C2676-BS1)				Prepared: 2022-03-24, Analyzed: 2022-03-24						
Cyanide, Total	0.0191	0.0020	mg/L	0.0200		96	82-120			
LCS (B2C2676-BS2)				Prepared: 2022-03-24, Analyzed: 2022-03-24						
Cyanide, Total	0.0191	0.0020	mg/L	0.0200		96	82-120			
LCS Dup (B2C2676-BSD1)				Prepared: 2022-03-24, Analyzed: 2022-03-24						
Cyanide, Total	0.0193	0.0020	mg/L	0.0200		97	82-120	1	10	
LCS Dup (B2C2676-BSD2)				Prepared: 2022-03-24, Analyzed: 2022-03-24						
Cyanide, Total	0.0200	0.0020	mg/L	0.0200		100	82-120	5	10	
Microbiological Parameters, Batch B2C2077										
Blank (B2C2077-BLK1)				Prepared: 2022-03-18, Analyzed: 2022-03-18						
Coliforms, Total	< 1	1	CFU/100 mL							
E. coli	< 1	1	CFU/100 mL							
Blank (B2C2077-BLK2)				Prepared: 2022-03-18, Analyzed: 2022-03-18						
Coliforms, Total	< 1	1	CFU/100 mL							
E. coli	< 1	1	CFU/100 mL							
Blank (B2C2077-BLK3)				Prepared: 2022-03-18, Analyzed: 2022-03-18						
Coliforms, Total	< 1	1	CFU/100 mL							
E. coli	< 1	1	CFU/100 mL							
Blank (B2C2077-BLK4)				Prepared: 2022-03-18, Analyzed: 2022-03-18						
Coliforms, Total	< 1	1	CFU/100 mL							
E. coli	< 1	1	CFU/100 mL							
Blank (B2C2077-BLK5)				Prepared: 2022-03-18, Analyzed: 2022-03-18						
Coliforms, Total	< 1	1	CFU/100 mL							
E. coli	< 1	1	CFU/100 mL							
Total Metals, Batch B2C2428										
Blank (B2C2428-BLK1)				Prepared: 2022-03-23, Analyzed: 2022-03-23						
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	< 0.0500	0.0500	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							

APPENDIX 2: QUALITY CONTROL RESULTS

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Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Total Metals, Batch B2C2428, Continued										
Blank (B2C2428-BLK1), Continued				Prepared: 2022-03-23, Analyzed: 2022-03-23						
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 (B2C2428-BS1)				Prepared: 2022-03-23, Analyzed: 2022-03-23						
Aluminum, total	0.0161	0.0050	mg/L	0.0200		81	80-120			
Antimony, total	0.0191	0.00020	mg/L	0.0200		95	80-120			
Arsenic, total	0.0190	0.00050	mg/L	0.0200		95	80-120			
Barium, total	0.0172	0.0050	mg/L	0.0200		86	80-120			
Boron, total	< 0.0500	0.0500	mg/L	0.0200		97	80-120			
Cadmium, total	0.0192	0.000010	mg/L	0.0200		96	80-120			
Calcium, total	1.78	0.20	mg/L	2.00		89	80-120			
Chromium, total	0.0187	0.00050	mg/L	0.0200		94	80-120			
Cobalt, total	0.0188	0.00010	mg/L	0.0200		94	80-120			
Copper, total	0.0213	0.00040	mg/L	0.0200		107	80-120			
Iron, total	2.02	0.010	mg/L	2.00		101	80-120			
Lead, total	0.0200	0.00020	mg/L	0.0200		100	80-120			
Magnesium, total	1.88	0.010	mg/L	2.00		94	80-120			
Manganese, total	0.0184	0.00020	mg/L	0.0200		92	80-120			
Molybdenum, total	0.0206	0.00010	mg/L	0.0200		103	80-120			
Nickel, total	0.0197	0.00040	mg/L	0.0200		99	80-120			
Potassium, total	1.95	0.10	mg/L	2.00		98	80-120			
Selenium, total	0.0194	0.00050	mg/L	0.0200		97	80-120			
Sodium, total	2.01	0.10	mg/L	2.00		100	80-120			
Strontium, total	0.0173	0.0010	mg/L	0.0200		87	80-120			
Uranium, total	0.0189	0.000020	mg/L	0.0200		95	80-120			
Zinc, total	0.0188	0.0040	mg/L	0.0200		94	80-120			
Reference (B2C2428-SRM1)				Prepared: 2022-03-23, Analyzed: 2022-03-23						
Aluminum, total	0.194	0.0050	mg/L	0.198		98	70-130			
Antimony, total	0.0243	0.00020	mg/L	0.0230		106	70-130			
Arsenic, total	0.0214	0.00050	mg/L	0.0200		107	70-130			
Barium, total	0.0147	0.0050	mg/L	0.0161		91	70-130			
Boron, total	0.184	0.0500	mg/L	0.191		97	70-130			
Cadmium, total	0.00412	0.000010	mg/L	0.00404		102	70-130			
Calcium, total	0.94	0.20	mg/L	0.938		100	70-130			
Chromium, total	0.0251	0.00050	mg/L	0.0256		98	70-130			
Cobalt, total	0.0222	0.00010	mg/L	0.0214		104	70-130			
Copper, total	0.0330	0.00040	mg/L	0.0322		102	70-130			
Iron, total	0.064	0.010	mg/L	0.0580		111	70-130			
Lead, total	0.00878	0.00020	mg/L	0.00796		110	70-130			
Magnesium, total	0.108	0.010	mg/L	0.112		97	70-130			
Manganese, total	0.0117	0.00020	mg/L	0.0120		97	70-130			
Molybdenum, total	0.0451	0.00010	mg/L	0.0438		103	70-130			
Nickel, total	0.0415	0.00040	mg/L	0.0394		105	70-130			
Potassium, total	0.87	0.10	mg/L	0.820		106	70-130			
Selenium, total	0.123	0.00050	mg/L	0.117		105	70-130			
Sodium, total	0.53	0.10	mg/L	0.490		108	70-130			
Strontium, total	0.258	0.0010	mg/L	0.276		93	70-130			
Uranium, total	0.00995	0.000020	mg/L	0.00970		103	70-130			
Zinc, total	0.0843	0.0040	mg/L	0.0884		95	70-130			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Interior Geoscience Inc.	**WORK ORDER**	22C2535
PROJECT	General Potability	**REPORTED**	2022-04-04 10:09

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Total Metals, Batch B2C2643										
Blank (B2C2643-BLK1)				Prepared: 2022-03-23, Analyzed: 2022-03-24						
Mercury, total	< 0.000010	0.000010	mg/L							
Blank (B2C2643-BLK2)				Prepared: 2022-03-23, Analyzed: 2022-03-24						
Mercury, total	< 0.000010	0.000010	mg/L							
Blank (B2C2643-BLK3)				Prepared: 2022-03-23, Analyzed: 2022-03-24						
Mercury, total	< 0.000010	0.000010	mg/L							
Reference (B2C2643-SRM1)				Prepared: 2022-03-23, Analyzed: 2022-03-24						
Mercury, total	0.000268	0.000010	mg/L	0.000250		107	0-200			
Reference (B2C2643-SRM2)				Prepared: 2022-03-23, Analyzed: 2022-03-24						
Mercury, total	0.000260	0.000010	mg/L	0.000250		104	0-200			
Reference (B2C2643-SRM3)				Prepared: 2022-03-23, Analyzed: 2022-03-24						
Mercury, total	0.000265	0.000010	mg/L	0.000250		106	0-200			

CERTIFICATE OF ANALYSIS

REPORTED TO Tony Friesen (Interior Geoscience Inc.)
8544 Greenaway Rd.
Vernon, BC V1B 3M6

SITE INFO
CARO WO# 22K0663

RECEIVED / TEMP 2022-11-04 14:30 / 8.9°C
REPORTED 2022-11-09

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/IEC 17025:2017 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.

Report Highlights:

The results in this report apply to the samples analyzed in accordance with your submission. The following parameter(s) exceed the Guidelines for Canadian Drinking Water Quality (Jan 2020):

Sample Name: WIPD 47667

1. Iron, total (AO)
2. Solids, Total Dissolved (AO)
3. Turbidity (OG)

For more information, please visit http://www.caro.ca/reports/

By engaging our services, you are agreeing to CARO Analytical Service's Standard Terms and Conditions outlined here: https://www.caro.ca/terms-conditions

Laboratory Recommendations:

For assistance reading your report, please visit
https://www.caro.ca/wp-content/uploads/2020/07/How-to-read-your-report-1.pdf
For information about bacteria in water results, please visit
https://www.caro.ca/you-need-to-know-about-bacteria-in-water-analytical-report/
If you have any additional questions or concerns, please contact us at TeamCaro@caro.ca.

Authorized By:

Team CARO
Client Service Representative

TEST RESULTS

REPORTED TO Tony Friesen (Interior Geoscience Inc.)
CARO WO# 22K0663 **REPORTED** 2022-11-09

Parameter	Result	Guideline	RL	Units	Analyzed	Note
Sample Name: WIPD 47667 | Matrix: Water | Sampled: 2022-11-03 21:00						
Anions						
Chloride	**12.2**	AO ≤ 250	0.10	mg/L	2022-11-05	
Fluoride	**1.33**	MAC = 1.5	0.10	mg/L	2022-11-05	
Nitrate (as N)	< 0.010	MAC = 10	0.010	mg/L	2022-11-05	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	2022-11-05	
Sulfate	**237**	AO ≤ 500	1.0	mg/L	2022-11-05	
Calculated Parameters						
Hardness, Total (as CaCO3)	**411**	None Required	0.500	mg/L	N/A	
Solids, Total Dissolved	**619**	AO ≤ 500	10.0	mg/L	N/A	
General Parameters						
Alkalinity, Total (as CaCO3)	**283**	N/A	1.0	mg/L	2022-11-07	
Conductivity (EC)	**974**	N/A	2.0	µS/cm	2022-11-07	
Cyanide, Total	< 0.0020	MAC = 0.2	0.0020	mg/L	2022-11-08	
pH	**8.15**	7.0-10.5	0.10	pH units	2022-11-07	HT2
Turbidity	**2.61**	OG < 1	0.10	NTU	2022-11-06	
Microbiological Parameters						
Coliforms, Total	< 1	MAC = 0	1	CFU/100 mL	2022-11-04	
E. coli	< 1	MAC = 0	1	CFU/100 mL	2022-11-04	
Total Metals						
Aluminum, total	**0.0065**	OG < 0.1	0.0050	mg/L	2022-11-08	
Antimony, total	< 0.00020	MAC = 0.006	0.00020	mg/L	2022-11-08	
Arsenic, total	< 0.00050	MAC = 0.01	0.00050	mg/L	2022-11-08	
Barium, total	**0.0256**	MAC = 2	0.0050	mg/L	2022-11-08	
Boron, total	< 0.0500	MAC = 5	0.0500	mg/L	2022-11-08	
Cadmium, total	< 0.000010	MAC = 0.005	0.000010	mg/L	2022-11-08	
Calcium, total	**74.2**	None Required	0.20	mg/L	2022-11-08	
Chromium, total	**0.00200**	MAC = 0.05	0.00050	mg/L	2022-11-08	
Copper, total	**0.0116**	MAC = 2	0.00040	mg/L	2022-11-08	
Iron, total	**0.469**	AO ≤ 0.3	0.010	mg/L	2022-11-08	
Lead, total	**0.00057**	MAC = 0.005	0.00020	mg/L	2022-11-08	
Magnesium, total	**54.8**	None Required	0.010	mg/L	2022-11-08	
Manganese, total	**0.0482**	MAC = 0.12	0.00020	mg/L	2022-11-08	
Potassium, total	**9.41**	N/A	0.10	mg/L	2022-11-08	
Selenium, total	< 0.00050	MAC = 0.05	0.00050	mg/L	2022-11-08	
Sodium, total	**59.4**	AO ≤ 200	0.10	mg/L	2022-11-08	
Strontium, total	**1.83**	MAC = 7	0.0010	mg/L	2022-11-08	
Uranium, total	**0.00193**	MAC = 0.02	0.000020	mg/L	2022-11-08	
Zinc, total	**0.0099**	AO ≤ 5	0.0040	mg/L	2022-11-08	

Note Descriptions:

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

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO Tony Friesen (Interior Geoscience Inc.)
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Analysis Description	Method Ref.	Technique	Accredited	Location
Alkalinity in Water	SM 2320 B* (2017)	Titration with H2SO4	✓	Kelowna
Anions in Water	SM 4110 B (2017)	Ion Chromatography	✓	Kelowna
Coliforms, Total in Water	SM 9222* (2017)	Membrane Filtration / Chromocult Agar	✓	Kelowna
Conductivity in Water	SM 2510 B (2017)	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* (2017)	Membrane Filtration / Chromocult Agar	✓	Kelowna
Hardness in Water	SM 2340 B* (2017)	Calculation: 2.497 [total Ca] + 4.118 [total Mg] (Est)	✓	N/A
pH in Water	SM 4500-H+ B (2017)	Electrometry	✓	Kelowna
Solids, Total Dissolved in Water	SM 1030 E (2017)	SM 1030 E (2011)		N/A
Total Metals in Water	EPA 200.2 / EPA 6020B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	✓	Richmond
Turbidity in Water	SM 2130 B (2017)	Nephelometry	✓	Kelowna

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

Glossary:

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
AO	Aesthetic Objective
CFU/100 mL	Colony Forming Units per 100 millilitres
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

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO Tony Friesen (Interior Geoscience Inc.)
CARO WO# 22K0663 **REPORTED** 2022-11-09

General Comments:

For assistance reading your report, please visit
https://www.caro.ca/wp-content/uploads/2020/07/How-to-read-your-report-1.pdf

For information about bacteria in water results, please visit
https://www.caro.ca/you-need-to-know-about-bacteria-in-water-analytical-report/

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 or once samples expire, whichever comes first. Longer hold is possible if agreed to in writing.

Results in **Bold** indicate values that are above CARO's method reporting limits. Any results that are above regulatory limits are highlighted **red**. Please note that results will only be highlighted red if the regulatory limits are included on the CARO report. Any Bold and/or highlighted results do not take into account method uncertainty. If you would like method uncertainty or regulatory limits to be included on your report, please contact your Account Manager:TeamCaro@caro.ca

Please note any regulatory guidelines applied to this report are added as a convenience to the client, at their request, to help provide some initial context to analytical results obtained. Although CARO makes every effort to ensure accuracy of the associated regulatory guideline(s) applied, the guidelines applied cannot be assumed to be correct due to a variety of factors and as such CARO Analytical Services assumes no liability or responsibility for the use of those guidelines to make any decisions. The original source of the regulation should be verified and a review of the guideline (s) should be validated as correct in order to make any decisions arising from the comparison of the analytical data obtained to the relevant regulatory guideline for one's particular circumstances. Further, CARO Analytical Services assumes no liability or responsibility for any loss attributed from the use of these guidelines in any way.

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO Tony Friesen (Interior Geoscience Inc.)
CARO WO# 22K0663 **REPORTED** 2022-11-09

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 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	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B2K0597										
Blank (B2K0597-BLK1)				Prepared: 2022-11-05, Analyzed: 2022-11-05						
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 (B2K0597-BS1)				Prepared: 2022-11-05, Analyzed: 2022-11-05						
Chloride	15.2	0.10	mg/L	16.0		95	90-110			
Fluoride	4.02	0.10	mg/L	4.00		101	88-108			
Nitrate (as N)	4.05	0.010	mg/L	4.00		101	90-110			
Nitrite (as N)	1.84	0.010	mg/L	2.00		92	85-115			
Sulfate	15.3	1.0	mg/L	16.0		95	90-110			
General Parameters, Batch B2K0743										
Blank (B2K0743-BLK1)				Prepared: 2022-11-06, Analyzed: 2022-11-06						
Turbidity	< 0.10	0.10	NTU							
LCS (B2K0743-BS1)				Prepared: 2022-11-06, Analyzed: 2022-11-06						
Turbidity	43.1	0.10	NTU	40.0		108	90-110			
General Parameters, Batch B2K0844										
Blank (B2K0844-BLK1)				Prepared: 2022-11-07, Analyzed: 2022-11-07						
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							
Blank (B2K0844-BLK2)				Prepared: 2022-11-07, Analyzed: 2022-11-07						
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							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO Tony Friesen (Interior Geoscience Inc.)
CARO WO# 22K0663 **REPORTED** 2022-11-09

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
General Parameters, Batch B2K0844, Continued										
Blank (B2K0844-BLK2), Continued				Prepared: 2022-11-07, Analyzed: 2022-11-07						
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							
Blank (B2K0844-BLK3)				Prepared: 2022-11-07, Analyzed: 2022-11-07						
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							
LCS (B2K0844-BS1)				Prepared: 2022-11-07, Analyzed: 2022-11-07						
Alkalinity, Total (as CaCO3)	96.7	1.0	mg/L	100		97	80-120			
LCS (B2K0844-BS2)				Prepared: 2022-11-07, Analyzed: 2022-11-07						
Alkalinity, Total (as CaCO3)	99.0	1.0	mg/L	100		99	80-120			
LCS (B2K0844-BS3)				Prepared: 2022-11-07, Analyzed: 2022-11-07						
Alkalinity, Total (as CaCO3)	99.8	1.0	mg/L	100		100	80-120			
LCS (B2K0844-BS4)				Prepared: 2022-11-07, Analyzed: 2022-11-07						
Conductivity (EC)	1410	2.0	µS/cm	1410		100	95-105			
LCS (B2K0844-BS6)				Prepared: 2022-11-07, Analyzed: 2022-11-07						
Conductivity (EC)	1410	2.0	µS/cm	1410		100	95-105			
Reference (B2K0844-SRM1)				Prepared: 2022-11-07, Analyzed: 2022-11-07						
pH	7.02	0.10	pH units	7.01		100	98-102			
Reference (B2K0844-SRM2)				Prepared: 2022-11-07, Analyzed: 2022-11-07						
pH	7.01	0.10	pH units	7.01		100	98-102			
Reference (B2K0844-SRM3)				Prepared: 2022-11-07, Analyzed: 2022-11-07						
pH	7.02	0.10	pH units	7.01		100	98-102			
General Parameters, Batch B2K0924										
Blank (B2K0924-BLK1)				Prepared: 2022-11-08, Analyzed: 2022-11-08						
Cyanide, Total	< 0.0020	0.0020	mg/L							
Blank (B2K0924-BLK2)				Prepared: 2022-11-08, Analyzed: 2022-11-08						
Cyanide, Total	< 0.0020	0.0020	mg/L							
LCS (B2K0924-BS1)				Prepared: 2022-11-08, Analyzed: 2022-11-08						
Cyanide, Total	0.0204	0.0020	mg/L	0.0200		102	82-120			
LCS (B2K0924-BS2)				Prepared: 2022-11-08, Analyzed: 2022-11-08						
Cyanide, Total	0.0194	0.0020	mg/L	0.0200		97	82-120			
LCS Dup (B2K0924-BSD1)				Prepared: 2022-11-08, Analyzed: 2022-11-08						
Cyanide, Total	0.0203	0.0020	mg/L	0.0200		102	82-120	< 1	10	
LCS Dup (B2K0924-BSD2)				Prepared: 2022-11-08, Analyzed: 2022-11-08						
Cyanide, Total	0.0203	0.0020	mg/L	0.0200		101	82-120	4	10	
Microbiological Parameters, Batch B2K0570										

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO Tony Friesen (Interior Geoscience Inc.)
CARO WO# 22K0663 **REPORTED** 2022-11-09

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Microbiological Parameters, Batch B2K0570, Continued										
Blank (B2K0570-BLK1)				Prepared: 2022-11-04, Analyzed: 2022-11-04						
Coliforms, Total	< 1	1	CFU/100 mL							
E. coli	< 1	1	CFU/100 mL							
Blank (B2K0570-BLK2)				Prepared: 2022-11-04, Analyzed: 2022-11-04						
Coliforms, Total	< 1	1	CFU/100 mL							
E. coli	< 1	1	CFU/100 mL							
Blank (B2K0570-BLK3)				Prepared: 2022-11-04, Analyzed: 2022-11-04						
Coliforms, Total	< 1	1	CFU/100 mL							
E. coli	< 1	1	CFU/100 mL							
Blank (B2K0570-BLK4)				Prepared: 2022-11-04, Analyzed: 2022-11-04						
Coliforms, Total	< 1	1	CFU/100 mL							
E. coli	< 1	1	CFU/100 mL							
Blank (B2K0570-BLK5)				Prepared: 2022-11-04, Analyzed: 2022-11-04						
Coliforms, Total	< 1	1	CFU/100 mL							
E. coli	< 1	1	CFU/100 mL							
Total Metals, Batch B2K0967										
Blank (B2K0967-BLK1)				Prepared: 2022-11-08, Analyzed: 2022-11-08						
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	< 0.0500	0.0500	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							
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							
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 (B2K0967-BS1)				Prepared: 2022-11-08, Analyzed: 2022-11-08						
Aluminum, total	3.99	0.0050	mg/L	4.00		100	80-120			
Antimony, total	0.0384	0.00020	mg/L	0.0400		96	80-120			
Arsenic, total	0.0404	0.00050	mg/L	0.0400		101	80-120			
Barium, total	0.0388	0.0050	mg/L	0.0400		97	80-120			
Boron, total	< 0.0500	0.0500	mg/L	0.0400		106	80-120			
Cadmium, total	0.0389	0.000010	mg/L	0.0400		97	80-120			
Calcium, total	4.08	0.20	mg/L	4.00		102	80-120			
Chromium, total	0.0397	0.00050	mg/L	0.0400		99	80-120			
Copper, total	0.0398	0.00040	mg/L	0.0400		99	80-120			
Iron, total	3.97	0.010	mg/L	4.00		99	80-120			
Lead, total	0.0392	0.00020	mg/L	0.0400		98	80-120			
Magnesium, total	3.89	0.010	mg/L	4.00		97	80-120			
Manganese, total	0.0398	0.00020	mg/L	0.0400		99	80-120			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO Tony Friesen (Interior Geoscience Inc.)
CARO WO# 22K0663 **REPORTED** 2022-11-09

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Metals, Batch B2K0967, Continued										
LCS (B2K0967-BS1), Continued				Prepared: 2022-11-08, Analyzed: 2022-11-08						
Potassium, total	4.08	0.10	mg/L	4.00		102	80-120			
Selenium, total	0.0396	0.00050	mg/L	0.0400		99	80-120			
Sodium, total	3.97	0.10	mg/L	4.00		99	80-120			
Strontium, total	0.0398	0.0010	mg/L	0.0400		99	80-120			
Uranium, total	0.0396	0.000020	mg/L	0.0400		99	80-120			
Zinc, total	0.0394	0.0040	mg/L	0.0400		98	80-120			