

Sparwood Landfill

2021 Groundwater Monitoring Annual Report



PREPARED FOR: REGIONAL DISTRICT OF EAST KOOTENAY

PREPARED BY: SPERLING HANSEN ASSOCIATES

January, 2022

PRJ21063



- Landfill Engineering
- Solid Waste Planning
- Environmental Monitoring
- Landfill Fire Control

1. INTRODUCTION

Sperling Hansen Associates (SHA) was retained by the Regional District of East Kootenay (RDEK) in 2020 to develop an updated Groundwater Monitoring Program (GMP) for seven (7) Solid Waste Management facilities located within the RDEK. As part of this GMP update SHA, along with Subconsultant Bear Environmental Limited (BEAR), will conduct four (4) groundwater sampling events per year, and provide one interim report per event for each site. The goal of this program is to provide the RDEK with valuable information regarding the groundwater quality at disposal sites and to assist in developing appropriate monitoring and management measures for the next five years.

In 2021, sampling events occurred in January, April, July, and November over a week period. Typically, the fall event is completed in October, however this year BEAR and SHA encountered delays in equipment availability due to supply shortages. As a result, the fall event in 2021 was completed in early November. Samples taken from each site are recorded below, and water quality analysis discussed in Section 3. This report details the sampling notes, lab analysis results, and trends observed at the wells throughout 2021. Section 5 presents recommendations for the next year of monitoring.



Photo 1-1. Sparwood Landfill Site Location.

1.1 Location and Setting

The Sparwood Transfer Station and Landfill is located in the District of Sparwood within the Elk Valley Subregion. The site is at 1001 off Hwy 3. The longitude and latitude are 49°69'592" N and 114°89'499" W respectively.



Photo 1-2. Sparwood Site Layout.

1.2 Site Operations

The facility has been operating for 50 years since it opened in the early 1970's. The site has operated as a construction and demolition waste center since 2000. The site operates Monday to Saturday, from 9:00 am to 5:00 pm. The site accepts MSW, recycling, yard and garden waste, and some commercial waste.

The site is approximately 15 hectares in size and services a population of approximately 12,500. The Operating Permit issued by the Ministry of Environment is attached to this report as Appendix A.

Monitoring well locations are identified in Figure 1.

2. MONITORING PROGRAM

Site monitoring requirements are outlined in Operational Certificate 107745 (OC). The requirements include development of a monitoring plan by a Qualified Professional per guidance set out in the Landfill Criteria for Municipal Solid Waste and the Guideline for Environmental Monitoring at Municipal Solid Waste Landfills.

Per the Site's DOCP from 2017, the monitoring program consists of quarterly sampling of six (6) groundwater monitoring wells which include upgradient and downgradient wells, as shown on Figure 1.

The following wells were sampled in 2021, as outlined in Table 2-1 below.

Table 2-1: Groundwater Monitoring Plan Wells

Event	MW14-1	MW14-4	MW15-2	MW14-3	MW14-2
January Q1	Insufficient recharge	X	X	X	Damaged
April Q2	X	X	X	X	Damaged
July Q3	X	X	X	X	Insufficient recharge
November Q4	X	Obstructed	X	X	Dry

2.1 Methodology

BEAR conducts the field sampling at the seven sites. Each well sampled is tested for a set of parameters that are intended to determine landfill impact. Some parameters are tested quarterly while others are only tested annually. Sampling was conducted in accordance with the BC Field Sampling Manual. Certificates of Analysis are included in Appendix C. Table 2-2 shows the parameters sampled for during each quarterly event of 2021.

Table 2-2. Groundwater Monitoring Parameters.

Site	Quarterly Params	Yearly Params
Sparwood Landfill	Temperature	Temperature
	Conductivity	Conductivity
	pH	pH
	Nitrite (N)	Nitrite (N)
	Nitrate (N)	Nitrate (N)
	Ammonia Nitrogen (NH3)	Ammonia Nitrogen (NH3)
	Fluoride (F)	Fluoride (F)
	Dissolved Sulphate (SO4)	Dissolved Sulphate (SO4)
	Dissolved Chloride (Cl)	Dissolved Chloride (Cl)
	Dissolved Hardness	Dissolved Hardness
	Total Alkalinity	Total Alkalinity
	Total Suspended Solids	Total Suspended Solids
	Dissolved Metals	Dissolved Metals
		PAH/VOC in wells that show the greatest impacts

2.2 Groundwater Flow

The Sparwood Landfill is located approximately 120 m directly east of the Elk River. Per the 2017 DOCP, the site is situated on glaciofluvial sand and gravel deposits as well as fine grained silt and clay.

The BC Water Resources Atlas shows no mapped aquifers below the site; however, Aquifer 1078 is located to the north underlying the Municipality of Sparwood and is described as confined with low vulnerability and domestic and commercial water uses. The area's topography shows elevation decreases toward Elk River and the site naturally slopes to the west. The regional groundwater flow is expected to be west or southwest in tandem with the Elk River. Locally, groundwater flow can be affected by building foundations, recharge areas, drainage and subsurface utilities. Depending on their depth, underground structures may significantly influence shallow groundwater flow in the vicinity of the Site. Locally, groundwater is assumed to flow west. Well details are shown in Table 2-3 below.

Table 2-3. Well Details and Water Level

Well ID	Well Construction	Q1 Water Level (m)	Q2 Water Level (m)	Q3 Water Level (m)	Q4 Water Level (m)
MW15-2	2" PVC	25.355	25.155	24.570	25.095
MW14-3	2" PVC	32.225	32.450	32.535	33.140
MW14-1	2" PVC	40.415	40.655	40.260	40.185
MW14-4	2" PVC	33.770	31.700	32.600	Obstructed
MW14-2	2" PVC	-	-	38.300	Dry

MW14-2 was reported to be damaged in 2019 and 2020. In 2021, the RDEK inspected and was able to restore the well for sampling. In July, the well was able to be dipped for water level, but had insufficient volume for sampling. Similarly, in November the well was dry. MW14-4 is suspected to be obstructed since July, due to a blockage in the well at 33.02m.

2.3 Nomenclature

The reporting of monitoring wells at the RDEK sites has previously been a combination of Environmental Monitoring System Numbers (EMSN) and site number names that are the more common naming convention (MW-1). Sparwood does not have EMSN nomenclature, but rather the site number names. For this site these number names will be used unless EMS numbers are identified, in which case they will be the default.

2.4 Regulatory Criteria

Per the OC published in 2016, ground and surface water quality should be assessed using the most recent Approved and Working Criteria for Water Quality prepared by the Water Management Division of the Ministry of Environment, Lands, and Parks at or beyond the landfill property boundary.

The BC Contaminated Sites Regulation (CSR) Protocol 21 indicates that Aquatic Life Standards (AW) generally apply to all groundwater located within 500 m of a surface water body containing aquatic life. The Site is located approximately 120m east of Elk River, therefore the Aquatic Life for Freshwater (AW) standards will apply.

The CSR Protocol 21 indicates that Drinking Water (DW) Standards generally apply to groundwater and surface water where drinking water sources are within 500m of a site, or if a property is situated on an aquifer that could be used in the future for Drinking Water. A search for water wells revealed that there are no domestic use water wells within 500m of the Site (WTN 22959 exists on the Site to a depth of approximately 18mbgs). Information from the BC Water Atlas indicates that there are no mapped aquifers underlying the Site. Although current DW use appears to not apply to the site, without further investigation, future DW standards are assumed to apply. Note that future drinking water use applies where information is unavailable or inadequate to demonstrate an absence of drinking water aquifers below a site.

Recent standards and guidelines have been applied by SHA to include:

- The Schedule 3.2 of the BC CSR with consideration to Aquatic Life (AW) and Drinking Water (DW);

These standards and guidelines are the most recent published by BC ENV used to assess groundwater at contaminated sites and the quality of drinking water. These standards are also the most recent iteration of the criteria to be used for the Sparwood site as per Section 2.8 of the 2017 DOCP for the site.

3. RESULTS

The parameters tested during 2021 include:

- Temperature, conductivity, pH, nitrite, nitrate, ammonia nitrogen, fluoride, dissolved sulphate, dissolved chloride, dissolved hardness, total alkalinity, total suspended solids, and dissolved metals.

Appendix B, Table B-1 outlines the water quality analysis alongside the applicable water standards.

All parameters tested were below applicable BC CSR AW standards.

Two parameters were detected above BC CSR DW standards:

- Dissolved Lithium
- Dissolved Nickel

Table 3-1 presents a summary of observed exceedances by analyte. Details are provided in the Sections below.

Table 3-1. Exceedances Summary by Analyte

	MW14-1	MW14-3	MW14-4	MW15-2
Lab Results				
Dissolved Metals				
Lithium (dissolved)	X	X	X	X

3.1 Exceedances

Dissolved lithium above the BC CSR DW standard was detected at MW14-1, MW15-2, MW14-4, and MW14-3. The maximum concentration is shown in Table 3-2 below:

Table 3-2. Observed Exceedances in Parameters by Sampled Wells

Parameter	BC CSR DW Standard	Maximum Concentration (µg/L)	Well Name
Dissolved Lithium (Li)	8 µg/L	24.3	MW15-2

Green shading with bold font indicates the maximum concentration observed above BC CSR DW standards.

3.2 Notes on Regional Background Concentrations

As per the British Columbia Contaminated Sites Regulation (CSR) Schedule 3.2, 2019, the drinking water limit for Lithium (Li) is 8 µg/L or 0.008 mg/L. Many regions in B.C. have background concentrations of lithium that exceed this limit, which poses a complication for monitored sites that are required under Operation Certificates or Permits to avoid exceedances of harmful parameters. In response, the B.C. Ministry of Environment and Climate Change (BC ENV) published a document in 2018 qualifying the limit and providing background concentrations for three regions in the province for five metals, including lithium. The limits published in the *Technical Bulletin 3: Regional Background Concentrations for Select Inorganic Substances in Groundwater* account for naturally occurring levels of the five metals, and are therefore higher than the limit within the CSR currently.

However, these three regions only comprise the Lower Mainland, South Vancouver Island, and Thompson-Okanagan. SHA believes the exceedances in lithium observed at the RDEK sites are attributable to natural background concentrations that are not accounted for in the CSR Schedule 3.2 or *Technical Bulletin 3*. It should be noted that Eco/Logic did not have a limit for lithium, which explains the discrepancy in exceedances despite there being little difference between 2019 and 2021 results.

Thompson-Okanagan, the nearest region to the RDEK with a back ground concentration qualifier for lithium, has a qualified concentration in the Bulletin of 96 µg/L, or 0.096 mg/L. None of the wells monitored in July, 2021 would exceed a limit of 0.096 mg/L, so SHA recommends keeping a note of this

and a close eye on this parameter in ongoing monitoring. SHA does not believe the RD needs to look into remediation measures at this point, but recommends the RD flag this exceedance history in the case that the Ministry publishes a background concentration for the Kootenay region.

4. DISCUSSION

All parameters tested were below applicable standards BC CSR AW and DW standards with the exception of the following parameters:

- Dissolved Lithium

Lithium was detected in concentrations above the BC CSR DW standard with a maximum concentration approximately 3 times the applicable standard. The maximum concentration of lithium was found at MW15-2 at 24.3 µg/L versus the BC CSR DW standard of 8 µg/L. Based on the surrounding water use, i.e groundwater at a radial distance of 500m from the site is not currently used as a drinking water source, and concentrations for all parameters were below applicable BC CSR AW standards, SHA considers the impacts from the landfill on the surrounding environment to be low. Note that elevated metals parameters were not accompanied by other typical elevated landfill leachate parameters such as sulphate, chloride, and nitrate.

As metals parameters, specifically, lithium is detected in slightly elevated concentrations, SHA recommends that low flow sampling be conducted to minimized the resuspension of colloidal material that can occur when using Waterra or bailer sampling methods.

4.1 Trend Analysis

To illustrate the trends observed in key parameters at the wells sampled, SHA has prepared figures that combine the 2021 analytical results with the applicable criteria limits. These figures are attached to this report in Appendix D.

- Figure 2 – Lithium concentrations
- Figure 3 – Sulfate concentrations
- Figure 4 – Sodium concentrations
- Figure 5 – Chloride concentrations
- Figure 6 – Nitrate Concentrations
- Figure 7 – Specific Conductance (Conductivity)

Lithium is the parameter with an observable consistent trend above the CSR DW limit. Sulfate, sodium, chloride, nitrate, and conductivity are graphed because they are typical landfill indicators. As shown in the graphs, these parameters are below allowable limits and show the landfill is not impacting groundwater chemistry beyond regulatory standards.

Please note that the graphs provided are for observing trends, and data less than or equal to the detection limit for a parameter appears on graphs as trace concentrations. If a well shows to have no data on the graph, please refer to the master data table for the exact parameter concentration.

5. CONCLUSIONS AND RECOMMENDATIONS

In 2021, sampling at the Site occurred in accordance with the OC. Parameters sampled in 2021 generally associated with landfill leachate including, but not limited to, chloride, nitrate, and sulfate were all below applicable standards. All parameters were detected below BC CSR AW standards. However, lithium was detected slightly above BC CSR DW standards. SHA reviewed surrounding water use per BC Protocol 21 and has determined that although current drinking water use does not appear to apply to the Site, without further investigation into the underlying unmapped aquifer, future drinking water is assumed to apply.

As elevated lithium was not accompanied by other typically elevated landfill leachate parameters such as sulphate, chloride, and nitrate, and all parameters were below applicable BC CSR AW standards, SHA considers the impacts from the landfill on the surrounding environment to be low.

Note that in conducting analyses for seven different sites within the RDEK with similar exceedances of lithium under the CSR DW limit, SHA believes these elevated concentrations are a region-wide occurrence caused by existing background concentrations rather than impacts caused by activities at the solid waste sites.

SHA recommends the following:

Parameter concentrations of dissolved metals slightly above applicable standards were detected in the Site groundwater monitoring wells. Based on surrounding land use, and relatively low impact to the immediate environment, SHA does not envision a change to the sampling method is warranted at this time. However, if exceeding parameters begin to form a consistently increasing trend, the RDEK may consider groundwater sampling methods using a low flow technique, where possible, to minimize the re-suspension of colloidal materials that can be caused during sampling with bailers and/or Waterra inertia pumps. If this sampling method is effective in providing a more accurate interpretation of groundwater data and able to show the groundwater exceedances are a result of suspended materials from bailer sampling, then SHA could make a recommendation to the Regional District to implement this sampling method for the monitoring going forward.

The next sampling event is scheduled for April, 2022.

6. STATEMENT OF LIMITATIONS

This report has been prepared by Sperling Hansen Associates. (SHA) on behalf of the Regional District of East Kootenay (RDEK) in accordance with generally accepted engineering practices to a level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions in British Columbia.

The report is based on site visits, project experience, and analysis by SHA staff of data compiled during the preparation of this report from a number of sources. Except where specifically stated to the contrary, the information on which this study is based has been obtained from external sources. This external information has not been independently verified or otherwise examined by SHA to determine its accuracy and completeness. SHA has relied in good faith on this information and does not accept responsibility of any deficiency, misstatements or inaccuracies contained in the reports as a result of omissions, misinterpretation and/or fraudulent acts of the persons interviewed or contacted, or errors or omissions in the reviewed documentation.

The report is intended solely for the use of the RDEK. Any use which other parties makes of this report, or any reliance on, or decisions to be made based on it, are the responsibilities of such other parties. SHA does not accept any responsibility for other uses of the material contained herein nor for damages, if any, suffered by any third party because of decisions made or actions based on this report. Copying of this intellectual property for other purposes is not permitted.

The findings and conclusions of this report are valid only as of the date of this report. The interpretations presented in this report and the conclusions and recommendations that are drawn are based on information that was made available to SHA during the course of this project. Should additional new data become available in the future, SHA should be requested to re-evaluate the findings of this report and modify the conclusions and recommendations drawn, as required.

Should you have any questions on this report or require further assistance or information, please feel free to contact the undersigned at 778-471-7088 or 604-986-7723.

Report prepared by:



Chloe Hetherington
Environmental Analyst Assistant

Report reviewed by:



Scott Garthwaite
Sr. Civil Technologist

7. REFERENCES

Eco/Logic Environmental, Sparwood Post-Closure Groundwater Monitoring 2019, prepared for the Regional District of East Kootenay.

Environmental Management Act, BC Contaminated Sites Regulation Schedule 3.2, 2019.

Ministry of Environment, BC Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture Summary Report, August 2019.

RDEK Public Web Map 2020, retrieved from <https://www.rdek.bc.ca/departments/mapping>



GROUNDWATER MONITORING LOCATIONS

*

No Environmental Monitoring System (EMS) Numbers for this site.



SPERLING
HANSEN
ASSOCIATES



PROJECT:

**SOLID WASTE FACILITY
MONITORING
PROGRAM 2020-2025**

TITLE:

**SPARWOOD
LANDFILL
MONITORING LOCATIONS**

SCALE:
N/A

DATE:
2022/01/10
yyyy/mm/dd

PROJECT NO:
21063

DESIGNED

DRAWN

CHECKED

DRAWING NO:

Figure 1

APPENDICES

APPENDIX A
Operational Certificate



November 17, 2016

Tracking Number: 337659
Authorization Number: 107745

REGISTERED MAIL

REGIONAL DISTRICT OF EAST KOOTENAY
19 24 AVE S
CRANBROOK, BC
V1C 3H8

Dear Operational Certificate Holder:

Enclosed is Operational Certificate 107745 issued under the provisions of the *Environmental Management Act*. Your attention is respectfully directed to the terms and conditions outlined in the operational certificate. An annual fee will be determined according to the Permit Fees Regulation.

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

This decision may be appealed to the Environmental Appeal Board in accordance with Part 8 of the *Environmental Management Act*. An appeal must be delivered within 30 days from the date that notice of this decision is given. For further information, please contact the Environmental Appeal Board at (250) 387-3464.

.../2

Administration of this permit will be carried out by staff from the Environmental Protection Division's Regional Operations Branch. Plans, data and reports pertinent to the permit are to be submitted by email or electronic transfer to the Director, designated Officer, or as further instructed.

Yours truly,

A handwritten signature in dark ink, appearing to be 'Avtar S. Sundher', written in a cursive style.

Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
Authorizations - South Region

Enclosure

cc: Environment Canada



MINISTRY OF
ENVIRONMENT

OPERATIONAL CERTIFICATE

107745

Under the Provisions of the Environmental Management Act

REGIONAL DISTRICT OF EAST KOOTENAY

**19 24 AVENUE S
CRANBROOK, BC
V1C 3H8**

is authorized to manage municipal solid waste and recyclable material and discharge construction & demolition waste to the ground and contaminants to the air at a landfill located in Sparwood, British Columbia subject to the conditions herein. Contravention of any of these conditions is a violation of the Environmental Management Act and may result in prosecution.

This Operational Certificate supersedes permit 1671 and is issued under Section 28, of the *Environmental Management Act (EMA)*. All ministry guidelines specified in this document refer to the most current versions of these guidelines.

DEFINITIONS

For the purposes of this Operational Certificate –

“Attractant” refers to waste, municipal solid waste, refuse, organic matter, compost, garbage, food or food waste that attracts bears or other wildlife.

“Commercial quality soil” refers to soil which does not contain any substance with a concentration exceeding the lowest applicable numerical soil standard for commercial land as set forth in the Contaminated Sites Regulation.

“Director” refers to the Director or a person delegated to act on behalf of the Director, as defined in the *Environmental Management Act*;

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for Director, *Environmental Management Act*
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“Construction and Demolition (C&D) Waste” refers to waste material that is produced in the process of construction, renovation, or demolition of structures. Structures include buildings of all types (both residential and non-residential) as well as roads and bridges. Components of C&D debris typically include concrete, asphalt, wood, metals, gypsum wallboard, and roofing. Land clearing debris, such as stumps, rocks, and dirt, may also be a part of C&D waste. This waste stream is a part of the Municipal Solid Waste (MSW) stream.

“Duly Authorized Person” refers to an individual or a position having responsibility for the overall operation of the landfill or an individual or position having overall responsibility for environmental or solid waste matters.

“Industrial quality soil” refers to soil which does not contain any substance with a concentration exceeding the lowest applicable numerical soil standard for industrial land as set forth in the Contaminated Sites Regulation.

“Landfill Footprint” refers to the area of the landfill site where MSW is approved to be deposited.

“Landfill Site” refers to the landfill footprint and buffer zone.

“Landfill Site Boundary” refers to the perimeter boundary of the landfill site.

“Open burning” means the combustion of material with or without control of the combustion air and without a stack or chimney to vent the emitted products of combustion to the atmosphere.

“Qualified Professional” refers to an applied scientist or technologist specializing in a particular applied science including, but not necessarily limited to, agrology, biology, chemistry, engineering, geology, or hydrogeology and

- who is registered in British Columbia with their appropriate professional organization, acting under that association’s Code of Ethics and subject to disciplinary action by that association, and
- who, through suitable education, experience, accreditation and knowledge, respecting solid waste management and related engineering disciplines for the management of leachate, surface water, storm water, groundwater and landfill gas and other specialist disciplines may be reasonably relied on to provide advice within their area of expertise;

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for Director, *Environmental Management Act*
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“Regional Director” means Regional Director, Environmental Protection Division, of the Ministry of Environment, or someone designated to carry out permit administration duties on behalf of the Regional Director.

“Vector” refers to an organism or carrier capable of transmitting a pathogen from one organism to another including, but not limited to flies and other insects, rodents, and birds.

“Wood Waste” refers to clean burning land clearing debris.

1. AUTHORIZED DISCHARGES

1.1 This section applies to the discharge of Construction & Demolition (C&D) Waste to a SANITARY LANDFILL at a site known as the SPARWOOD LANDFILL in Sparwood, BC. The site reference number for this discharge is E210063.

1.1.1 The maximum rate of discharge is 4030 tonnes/year.

1.1.2 The authorized discharge is Construction and Demolition (C&D) waste and other waste as may be authorized by the Director in writing.

1.1.3 Contaminated soil that contains contaminants in concentrations less than hazardous waste as defined in the Hazardous Waste Regulation may be disposed at the landfill. Disposal of commercial quality soil and industrial quality soil includes but is not limited to monofilling, co-disposal with other wastes, and use as daily or intermediate cover material. The use of these soils as final cover material is prohibited if contaminants in soil exceed industrial land use standards as specified in the Contaminated Sites Regulation.

1.1.4 The disposal of waste asbestos in compliance with the requirements of Section 40 of the Hazardous Waste Regulation under the *Environmental Management Act* is permitted. In accordance with Section 40 “Management of Waste Asbestos”, under part 6 “Management of Specific Hazardous Wastes” of the Hazardous Waste Regulation, the waste asbestos disposed at a landfill other than a secure landfill must be immediately covered with a minimum of 0.5 metre of cover material.

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for Director, *Environmental Management Act*
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- 1.1.5 The authorized works are a sanitary landfill and include berms, cover soil or cover material, locking gates, weigh scale, electrified bear fence, surface water diversionary works, environmental monitoring systems and related appurtenances pertaining to the works and discharges specified in this section.

The authorized works are located approximately as shown on the attached Site Plan A.

- 1.1.6 The location of the point of discharge is that portion of District Lot 4589 that lies west of Highway 3 and lies northwesterly of BCH and PA R/W Plan.

- 1.2 This section applies to the discharge of contaminants to air and residue of combustion to ground from open burning of wood waste. The site reference number for this discharge is E222779.

- 1.2.1 The maximum volume of wood waste open burned shall be 50 cubic meters per burn in 2016, 25 cubic meters per burn in 2017, 10 cubic meters per burn in 2018 and zero cubic meters per burn in 2019. Burning must cease by 2019.

- 1.2.2 The frequency of the burns in 2016, 2017 and 2018 shall not exceed one burn in each calendar month.

2. **DESIGN & PERFORMANCE REQUIREMENTS**

2.1 **Design Operations & Closure Plan (DOCP)**

A Design, Operations and Closure Plan (DOCP) prepared by a Qualified Professional must be submitted to the Director within 12 months of the date of issuance of this Operational Certificate. The Plan must address applicable sections of the Landfill Criteria for Municipal Solid Waste and the Guideline for Environmental Monitoring at Municipal Solid Waste Landfills.

The facilities must be developed, operated and closed in accordance with the Plan. On site materials handling and storage of any materials including recycling materials must be in accordance with the DOCP and applicable regulations.

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The DOCP must be reviewed and updated by a Qualified Professional as needed and at least once every five years to encompass the next 10 years of landfill operations and/or closure activities. Any updated hydrogeological reviews and information from annual monitoring must be considered in the review and update of the DOCP.

Requirements of regulations under the *Environmental Management Act*, and applicable bylaws must be incorporated into DOCP reviews as appropriate.

The Director may require additional reviews of the DOCP based on the compliance history and design performance of the site.

2.2 **Groundwater & Surface Water Quality Protection**

Discharge of municipal solid waste and other waste materials into water is prohibited. The Operational Certificate holder must construct adequate surface water and groundwater diversion works to minimize surface water run-off and groundwater seepage from entering the landfill.

The Operational Certificate holder must take appropriate measures to ensure that groundwater and surface water quality at the landfill site boundary does not decrease beyond that specified by the British Columbia Approved and Working Water Quality Guidelines or background levels or other appropriate criteria as specified by the Director. If exceedances to the specified water quality criteria occur at the landfill property boundary as a result of landfill operations, suitable corrective measures must be undertaken. The Regional Director must be notified of such measures when they are implemented within 30 days.

2.3 **Hydrogeology and Hydrology Review**

The Operational Certificate holder must characterize the hydrogeology, and hydrology at and near the landfill site. The hydrogeology assessment must address seasonal groundwater quality, seasonal flow direction and assess the adequacy of the groundwater monitoring program at the site.

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The hydrogeology and hydrology assessments must meet the Landfill Criteria for Municipal Solid Waste and the must be incorporated into the DOCP as required in Section 2.1 and form the basis of recommendations to the groundwater and surface water monitoring program. This review must be completed by December 31st 2017.

2.4 **Buffer Zones**

The Operational Certificate holder must maintain at a minimum, a 50 metre buffer zone between the landfill footprint and the landfill site boundary.

3. **LANDFILL OPERATIONS**

3.1 **Inspections**

3.1.1 **Waste Inspections**

The waste acceptance process at the landfill gate must include procedures to ensure that only construction & demolition waste is discharged at the landfill. Inspection procedures must ensure that no putrescible or organic waste is discharged at the active face.

3.1.2 **Inspections of Authorized Works**

The Operational Certificate holder must inspect the authorized works and property boundaries in accordance with the DOCP and to ensure compliance with this Operational Certificate and the Landfill Criteria. A record of the inspections (including a photographic record) and action items must be maintained in the operating record at the site office and made available to the Regional Director upon request.

3.2 **Site Access & Supervision**

Locking gates must be maintained at all access routes to the landfill site. Gates, perimeter fencing and/or barriers must be installed where necessary to prevent unauthorized access to the site by vehicles. Gates must be locked during non-operating hours. Onsite signage must be in accordance with the Landfill Criteria.

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The Operational Certificate holder shall ensure that the site is assigned sufficient staff to ensure proper, orderly, and safe operation of all materials handling equipment and access control. The Operational Certificate holder must ensure that any person(s) authorized to work within the landfill boundary is fully cognizant of this Operational Certificate and the DOCP. A landfill operator that has received BC Qualified Landfill Operator training (BCQLO) and is familiar with the requirements of the Operational Certificate and the DOCP must be present at all times during operating hours.

Training records for staff must be maintained and made available to the Regional Director upon request.

3.3 **Scavenging & Salvaging**

Uncontrolled scavenging of waste is prohibited. The controlled separation of salvageable waste stream components by persons authorized by the Operational Certificate holder is permitted in areas designated for separation and storage of these materials.

3.4 **Public Health, Safety & Nuisance**

The landfill must be operated in a manner such that it will not create a public nuisance or become a significant threat to public health or safety with respect to landfill gas, unauthorized access, roads, traffic, airport activity, noise, dust, litter, vectors, or wildlife attraction.

3.5 **Waste Deposition, Compaction & Cover**

The Operational Certificate holder must ensure that waste deposition and compaction is in accordance with the DOCP. The working face must be confined to the smallest practical area.

3.5.1 **Daily Cover**

Daily cover consisting of a minimum of 0.15 meters of soil or a functionally Alternate Daily Cover (ADC) must be applied to the working face at the end of each operating day. Adequate measures must be taken to ensure that sufficient cover soil or cover material is available onsite at all times.

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3.5.2 **Intermediate Cover**

An Intermediate cover consisting of 0.3meters of soil or functionally equivalent intermediate cover in accordance with the Landfill Criteria must be applied within thirty (30) days to any area of the landfill which will not receive any further waste for thirty (30) days.

3.5.3 **Final Cover**

Final cover must be installed and maintained in accordance with the requirements of the Landfill Criteria. Completed portions of the landfill are to progressively receive final cover during the active life of the landfill and as specified in the DOCP. The Operational Certificate holder must apply final cover within 365 days to any area of the landfill which will not receive any further waste as per the DOCP.

3.6 **Litter, Wildlife & Vector Control**

The Operational Certificate holder must ensure that litter is controlled by compacting the waste, minimizing the working face, applying cover at the required frequencies, providing litter control fences and instituting a regular litter pickup and general good housekeeping program.

Vector and wildlife attractants as a result of routine waste transfer and landfilling operations at the site must be minimized through:

- a. The application of cover material in a timely and consistent manner in compliance with the requirements of the Landfill Criteria.
- b. The installation and maintenance of electrified wildlife bear control fencing around the active landfill cell. The fence must be energized during the active bear season and electrified fence warning signs must be posted along the fence. Bear warning signs must be posted in the event of bear activity being detected at the site.

Date issued: November 17, 2016



Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
Authorizations - South Region

3.7 **Operations, Maintenance & Emergency Procedures Manual**

The Operational Certificate holder must prepare an Operations, Maintenance and Emergency Procedures Manual. This manual must be reviewed and kept updated to reflect current site conditions. A copy of the manual must be available at the site office and must be made available to the Regional Director upon request.

3.8 **Fire Prevention & Control**

The Operational Certificate Holder must take all reasonable measures to prevent fires from occurring at the landfill site and must provide and maintain firefighting equipment and materials as required for the site. Adequate fire breaks that are free of combustibles must be maintained around the perimeter of the landfill footprint.

In the event of a landfill fire the following must be notified immediately:

- a. The Fire Department
- b. Provincial Emergency Program (PEP)
- c. The Regional Director

3.9 **Maintenance of Works & Emergency Procedures**

The Operational Certificate holder must maintain the authorized works in good working order. In the event of an emergency or condition which prevents continuing operation of the authorized works and/or the continued performance of the prescribed methods of operation, the Operational Certificate holder must immediately notify the Regional Director and take appropriate remedial action in consultation with a Qualified Professional as applicable.

Any activity or construction at the disposal site must be carried out in a manner that protects the integrity of the areas under final cover and without compromising landfill stability and without damage to the authorized works.

Any settlement of areas under final cover or differential settlement that prevents the authorized works from functioning as intended in the DOCP must be addressed/ remedied immediately.

Date issued: November 17, 2016



Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
Authorizations - South Region

All access roads, within the landfill boundary, used for transporting waste and equipment must be maintained as necessary to assure safe and reliable all-weather access to the active face at all times.

3.10 **Qualified Professionals**

Information pertaining to the landfill including details of works, plans, assessments, investigations, surveys, programs and reports, must be prepared and certified by a Qualified Professional.

3.11 **Additional Facilities, Works, Plans and Studies**

The Director may specify additional requirements including requirements for additional, improved and amended facilities, works and information including any plans, drawings, assessments, investigations, studies, surveys, programs, monitoring and reports.

3.12 **Landfill Gas**

The Operational Certificate holder must ensure that operation of the landfill does not cause combustible gas concentrations to exceed the lower explosive limit in soils at the property boundary or 25% of the lower explosive limit at or in on-site or off-site structures.

The Operational Certificate holder must ensure that the facility is in compliance with the requirements of the *Landfill Gas Management Regulation*. The requirements of the regulation and its guideline documents must be incorporated by into the DOCP revisions as they come into effect and as applicable.

3.13 **Operational Requirements for Open Burning**

Open burning shall be subject to the following conditions -

- a. Each burn must comprise one continuous period necessary to reduce stockpiled waste to ashes and must not exceed one operating day.
- b. Burning must take place only when an attendant is on duty.
- c. Burning must only take place when conditions promote rapid combustion and dispersion of combustion products. This means that the Venting Index published for the day must be GOOD.
- d. No burning may occur during periods of fire hazard nor when burning is prohibited by other government agencies.

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for Director, *Environmental Management Act*
Authorizations - South Region

- e. On site fire extinguishing equipment and material must be available during an open burn. These include a pressurized water supply, chemical type fire extinguishers, an earth stockpile and earth moving equipment.
- f. A fireguard must be cleared and maintained free of combustible equipment.
- g. Residue of combustion must be cooled to ambient temperatures and incorporated into the landfill.

4. **MONITORING REQUIREMENTS**

4.1 **Environmental Monitoring Plan**

The Operational Certificate holder must ensure that a Qualified Professional develops a monitoring plan to identify potential impacts to the environment and public health from the facility. The plan must meet the requirements set forth in the Landfill Criteria for Municipal Solid Waste and the Guideline for Environmental Monitoring at Municipal Solid Waste Landfills.

The monitoring plan must be reviewed and reported on annually. The review must take into consideration results from previous monitoring programs and any other investigations conducted at the site. The need for subsequent increased or decreased monitoring must be assessed annually on the basis of available monitoring data. The Operational Certificate holder must include an appendix at the end of the Environmental Monitoring Plan that tracks all changes made to program over the years.

Based on the results of monitoring, or any other information relevant to the site, the Director may vary the frequency, location and analyses of environmental monitoring.

The Operational Certificate holder must ensure that groundwater monitoring wells are established and maintained to allow for uninterrupted monitoring as specified by the monitoring plan. If due to any considerations groundwater monitoring wells are to be decommissioned, other monitoring well locations should be identified and wells installed in a timely manner to replace them.

Date issued: November 17, 2016



Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
Authorizations - South Region

The location and installation of all monitoring wells must be specified and supervised by a Qualified Professional who is knowledgeable in the fields of Hydrogeology and Landfill Impact Assessment. The Operational Certificate holder must ensure that monitoring wells and other equipment are adequately secured and maintained, including provisions to ensure protection from damage due to weather, vehicles or vandalism. In the event of damage to the wells or monitoring equipment which could affect/compromise the integrity of monitoring data, the Operational Certificate holder must take immediate and necessary measures to ensure that conditions for uninterrupted monitoring are restored.

The Operational Certificate holder must maintain records of all monitoring program data and analyses and make these available to the Director upon request.

4.2 **Field Sampling Techniques**

Sampling must be carried out in accordance with the procedures described in the most recent edition of the "British Columbia Field Sampling Manual for Continuous Monitoring Plus the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples", or by suitable alternative procedures as authorized by the Director. A copy of the manual is available on the BC Ministry of Environment Sampling, Methods & Quality Assurance webpage - <http://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/sampling-methods-quality-assurance>

4.3 **Laboratory Analysis**

Analyses are to be carried out in accordance with procedures described in the most recent edition of the "British Columbia Environmental Laboratory Manual for the Analysis of Water, Wastewater, Sediment and Biological Materials", or by suitable alternative procedures as authorized by the Director. A copy of the manual is available on the BC Ministry of Environment Sampling, Methods & Quality Assurance webpage – <http://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/sampling-methods-quality-assurance>

Date issued: November 17, 2016



Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
Authorizations - South Region

5. **REPORTING**

5.1 **Report Submission & Records Retention**

All reports and submissions identified in this Operational Certificate must be submitted electronically to the Ministry in accordance with the Ministry's electronic reporting (eReporting) guidelines, or as otherwise specified by the Director.

All reports submitted as per the Routine Reporting section below must be signed by a duly authorized representative of the Operational Certificate holder.

5.2 **Non-Compliance Reporting**

The Operational Certificate holder must immediately notify the Regional Director of any non-compliance with the requirements of this Operational Certificate. The non-compliance report must be submitted in accordance with the Ministry's non-compliance reporting procedures. The Operational Certificate holder must identify the non-compliance, the cause of non-compliance and any remedial action to address the non-compliance.

5.3 **Routine Environmental Reporting**

5.3.1 **Annual Report**

The Operational Certificate holder must submit to the Regional Director an Annual Report for the facility by March 31 of each year. The first report is due in 2017. The report is intended as an operational update and monitoring report and also a self-assessment and review of compliance with the conditions of this Operational Certificate. The content of the report should provide the Ministry sufficient details to confirm that monitoring activities for the site have been completed for the subject year and to make an informed assessment of the environmental performance of the site. The report must be prepared by a Qualified Professional and must include but not be limited to:

- a. An executive summary;

Date issued: November 17, 2016



Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
Authorizations - South Region

- b. The type, volume and tonnage of waste received, recycled, stored on-site and discharged/landfilled for the calendar year reported;
- c. An update on the operational status of the authorized works and related appurtenances. The update must include information on operations, construction, inspections, emergencies, maintenance work and repair activities during the subject year. The update must identify any problems/issues and the corrective actions taken to address them;
- d. A current topographic map detailing airspace consumption, on-site borrow pit changes and future developments;
- e. Volume and density analysis or an in-place material summary, updated estimates for the remaining capacity, site life, revised closure date for the current landfill phase or sequence and revised closure date for the current landfill footprint;
- f. Monitoring data for the calendar year including sample data, information on analytical procedures, quality assurance and control, comparison to groundwater and surface water quality standards, data tabulation, graphs, trend analysis, interpretation, any current non-compliances, conclusions and recommendations for any changes to the environmental monitoring plan;
- g. Results of any landfill gas monitoring if applicable;
- h. A summary of planned operational activities for the next calendar year;
- i. An update on the financial assurance for the site including a statement of the current dollar value of the Closure Fund;
- j. An assessment of the progress towards made towards achieving the objectives of the Regional District of East Kootenay's current Solid Waste Management plan;
- k. A summary of significant occurrences or observations of wildlife (medium and large carnivores) at the landfill;
- l. A summary of public complaints received and their resolution;
- m. A list of training programs completed for landfill operators during the subject year;
- n. A summary of any new information that could affect the authorized works, plans, assessments, surveys, programs and reports;

Date issued: November 17, 2016



Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
Authorizations - South Region

- o. Non-compliances with this operational certificate, and causes, effects, remedial action, and an action plan and schedule, as applicable to achieve compliance; and
- p. Any additional information pertaining to the facility if specified by the Director.

5.3.2 **Design, Operations and Closure Plan Review**

The DOCP review and update specified in Section 2 must be submitted to the Ministry 90 days after completion.

5.3.3 **Engineering Drawings**

“As built” drawings certified by a Qualified Professional must be submitted to the Regional Director within 90 days of the completion of engineered construction or closure works at the site.

5.4 **Other Reporting & Recordkeeping**

5.4.1 **Wildlife Reporting**

The Operational Certificate holder must maintain an onsite log of any ongoing bear activity such as digging around the perimeter of the electric fencing or other attempts to penetrate the fencing, and any observations pertaining to wildlife intrusion attempts. Any penetrations of the fencing by bears should be immediately reported to the Conservation Officer Service (COS) via the Report All Poachers & Polluters reporting line at 1 877 952 7277.

5.4.2 **Spill Reporting**

The Operational Certificate holder must ensure that reportable spills as per the Spill Reporting Regulation (SRR) are reported to the Ministry as per prescribed reporting methods.

5.4.3 **Ozone Depleting Substances Recordkeeping**

The Operational Certificate holder must ensure that storage of appliances at the landfill site complies with the labelling and record keeping requirements of the Ozone Depleting Substances and Other Halocarbons Regulation.

Date issued: November 17, 2016



Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
Authorizations - South Region

6. **CLOSURE & POST CLOSURE REQUIREMENTS**

6.1 **Closure Plan**

A Closure Plan and Final Cover Design that meets or exceeds the requirements of the Landfill Criteria and prepared by a Qualified Professional must be submitted to the Regional Director at least 2 years prior to decommissioning of the landfill.

Completion of closure works in accordance with the Closure Plan and Final Cover Design must be certified by a Qualified Professional within 60 days of the implementation of the Final Cover Design.

6.2 **Post Closure Plan**

The Closure Plan must also include post closure or aftercare measures including a post closure environmental monitoring plan for the closed landfill. The post closure elements of the Plan must be reviewed every five years throughout the post closure period.

6.3 **Closure Fund**

The Operational Certificate holder must provide for the funding of progressive closure operations, final closure and operations beyond closure by accruing a closure fund during the operational life of the landfill. The value of the closure fund must meet or exceed the estimated closure and post-closure costs plus a reasonable contingency for any post closure remediation which may be required.

Alternately, a closure and post-closure financial security acceptable to the Director may be built over time.

The Operations Certificate holder must take measures during the operational life of the landfill to ensure that the closure and post-closure funds or financial security will ultimately meet or exceed the estimated closure and post-closure costs and also costs for any remediation that may be required.

An annual financial statement of the fund must be prepared for each year during the operational life of the landfill.

Date issued: November 17, 2016



Avtar S. Sundher BSc.
for Director, *Environmental Management Act*
Authorizations - South Region

6.4 **Site Decommissioning**

In accordance with Section 40 of the *Environmental Management Act* and Part 2 of the Contaminated Sites Regulation, the Operational Certificate holder must submit a site profile to the manager at least 10 days prior to decommissioning the facilities authorized in Section 1.

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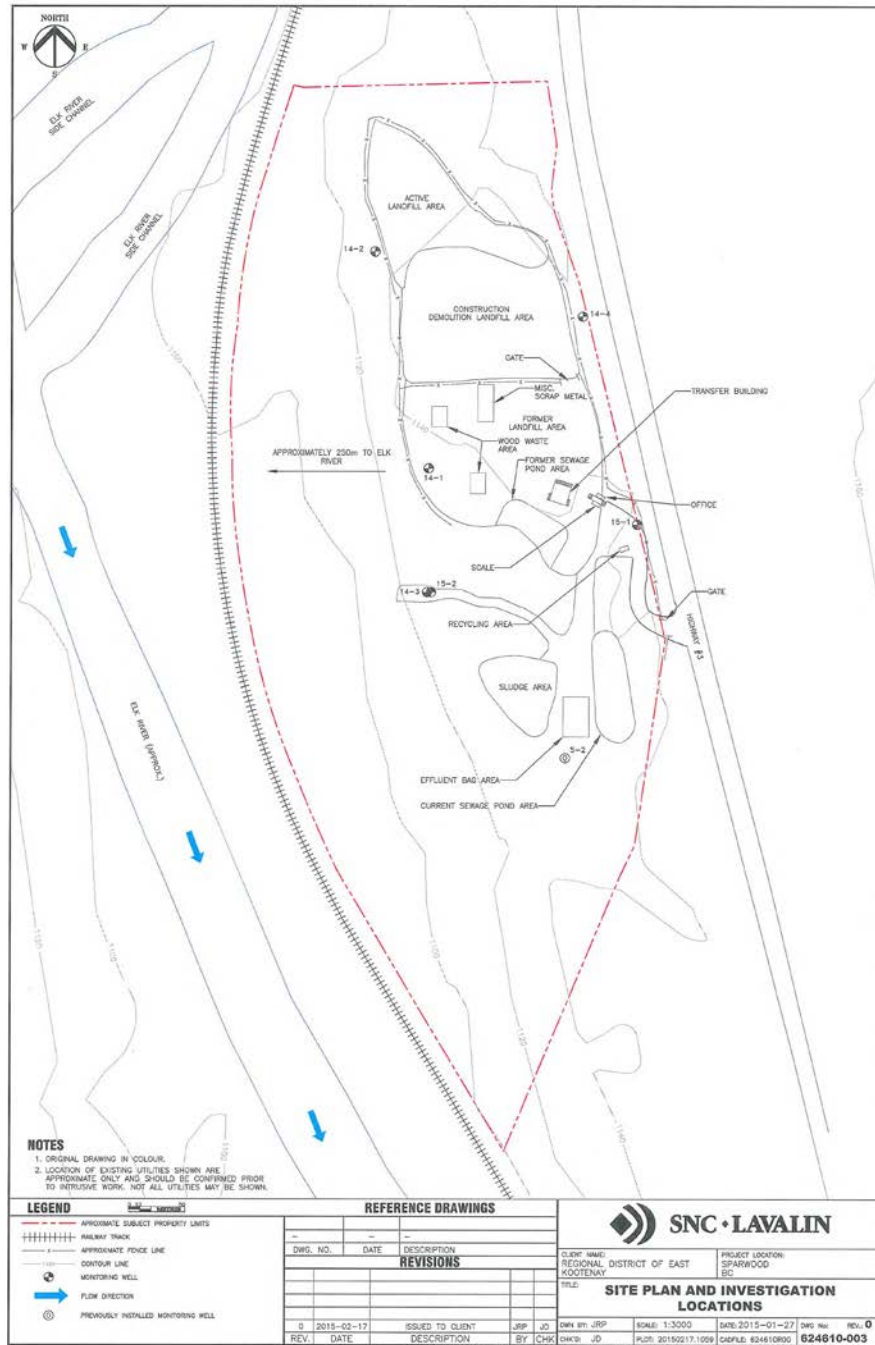
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Location of Transfer Station & Landfill

Date issued: November 17, 2016

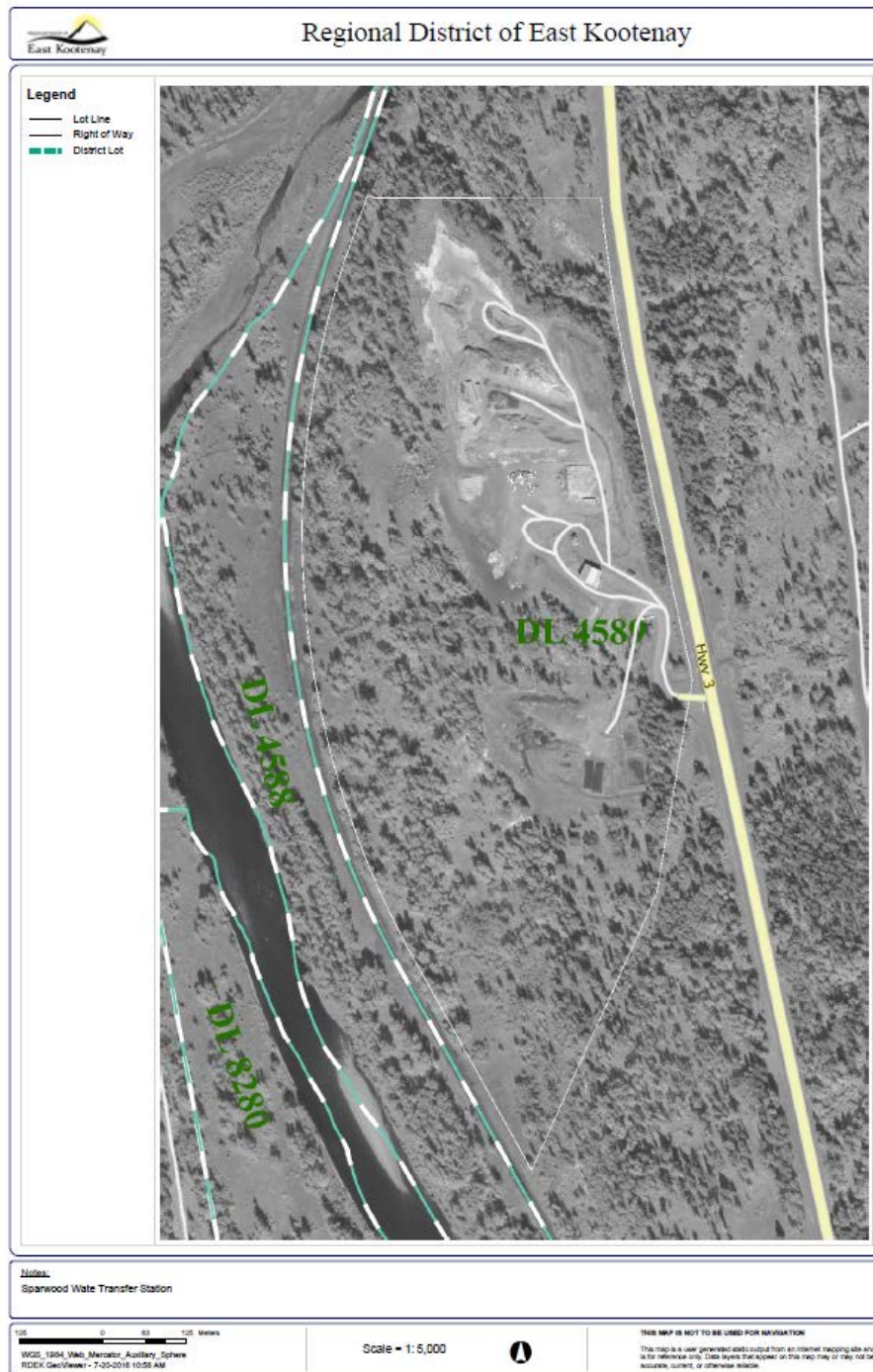
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Site Plan

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Authorizations - South Region



Aerial View of Site

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for Director, *Environmental Management Act*
Authorizations - South Region

APPENDIX B
Water Quality Results

Table B-1 Water Quality Analysis

Sampling Location			MW14-1	MW14-1	MW14-1	MW14-1	MW14-1	MW14-3	MW14-3	MW14-3	MW14-3	MW14-3	MW14-3	MW14-4	MW14-4	MW14-4	MW14-4	MW14-4	MW15-2	MW15-2	MW15-2	MW15-2	MW15-2	MW15-2		
Date Sampled			22-Jul-20	22-Oct-20	28-Apr-21	22-Jul-21	22-Apr-21	22-Oct-20	22-Apr-21	28-Apr-21	29-Apr-21	29-Apr-21	29-Apr-21	22-Jul-20	22-Jul-20	22-Oct-20	14-Jan-21	29-Apr-21	22-Oct-20	22-Oct-20	14-Jan-21	28-Apr-21	28-Jul-21	10-Nov-21		
Lab Sample ID			L2480410-10	L2521326-1	L2583620-1	L2621324-1	L2663297-1	L2480410-13	L2521326-4	L2549477-3	L2583620-4	L2621324-4	L2663297-3	L2480410-11	L2521326-2	L2549477-1	L2583620-2	L2621324-2	L2480410-12	L2521326-3	L2549477-2	L2583620-3	L2621324-3	L2663297-2		
Sample Type																										
Analyte	Unit	Guideline																								
		CSR AW	CSR DW																							
Lab Results																										
Anions and Cations in meq/L unit																										
Aluminum (meq/L) (calculated)	meq/L	NG	NG	0.00014	0.00042	0.00117	0.00076	0.00261	<0.00011	0.00012	0.00018	0.00018	0.00014	<0.00011	0.00016	0.00027	0.00014	0.00024	0.00011	<0.00011	0.00012	0.00017	0.00013	0.00037	0.00150	
Barium (meq/L) (calculated)	meq/L	NG	NG	0.000628	0.000472	0.000552	0.000472	0.000124	0.00201	0.00154	0.00188	0.00186	0.00199	0.00224	0.00211	0.00236	0.00028	0.00386	0.00221	0.00421	0.00644	0.0067	0.00668	0.00520	0.00565	
Bicarbonate (HCO3) (meq/L) (calculated)	meq/L	NG	NG	12.7	32.45	8.82	11.1	13.7	8.64	7.1	7.59	8.64	7.33	11.9	6.54	8.83	8.18	6.52	8.13	10.4	13.9	12.2	7.31	10.9	13.8	
Boron (meq/L) (calculated)	meq/L	NG	NG	0.0463	0.0463	0.0416	0.0438	0.0436	0.0078	0.0080	0.008	0.0080	0.0078	0.0072	0.0075	0.0067	0.0075	0.0064	0.0053	0.0072	0.0075	0.0064	0.011	<0.014		
Calcium (meq/L) (calculated)	meq/L	NG	NG	13.9	12.8	12.3	9.98	10.5	6.04	4.5	5.94	5.09	4.92	5.44	5.59	5.69	6.49	7.68	5.84	8.23	9.88	11.8	9.98	9.78	9.43	
Carbonate (CO3) (meq/L) (calculated)	meq/L	NG	NG	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17		
Chloride (meq/L) (calculated)	meq/L	NG	NG	2.85	2.96	2.49	2.75	2.6	1.22	0.702	1.02	0.959	0.869	1.15	0.104	0.547	1.36	3.05	0.238	1.2	2.32	2.6	2.61	1.95	2.38	
Chromium (meq/L) (calculated)	meq/L	NG	NG	0.0000988	0.000148	0.000026	0.0000819	0.0000664	<0.000058	0.000057	0.0000917	0.000040	0.0000589	0.0000664	<0.000058	0.0000912	0.000026	0.0000351	0.0000779	<0.000058	0.000120	0.000141	0.000241	0.000140	0.000110	
Copper (meq/L) (calculated)	meq/L	NG	NG	0.0000362	0.0000327	0.0000204	0.0000047	0.000044	0.000014	<0.000063	0.0000098	0.0000076	<0.000063	0.0000063	0.000019	0.0000328	0.0000334	0.0000478	0.000011	0.000014	0.0000468	0.0000393	0.000021	<0.000031		
Fluoride (meq/L) (calculated)	meq/L	NG	NG	<0.0053	<0.0053	<0.0053	<0.0053	<0.0053	0.0170	0.0160	0.0140	0.00921	0.011	0.00611	0.0051	0.005	<0.0053	0.0018	<0.0053	<0.0053	<0.0053	<0.0053	<0.0053	<0.0053		
Hydroxide (OH) (meq/L) (calculated)	meq/L	NG	NG	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29	<0.29		
Lead (meq/L) (calculated)	meq/L	NG	NG	<0.00000048	<0.00000048	0.00000136	<0.00000024	<0.00000024	<0.00000048	<0.00000048	<0.00000048	<0.00000048	<0.00000048	<0.00000048	<0.00000048	<0.00000048	<0.00000048	<0.00000048	<0.00000048	<0.00000048	<0.00000048	<0.00000048	<0.00000048	<0.00000024		
Lithium (meq/L) (calculated)	meq/L	NG	NG	0.003	0.00297	0.00318	0.00288	0.00288	0.00244	0.00254	0.00281	0.00272	0.00251	0.00262	0.00210	0.0023	0.00223	0.00313	0.00245	0.00269	0.00314	0.00350	0.00318	0.00305	0.00317	
Magnesium (meq/L) (calculated)	meq/L	NG	NG	6.12	5.72	4.99	4.73	4.32	3.33	2.72	3.32	2.79	2.8	2.88	2.09	2.35	2.58	2.92	2.25	3.93	3.9	4.4	3.79	3.93	3.63	
Potassium (meq/L) (calculated)	meq/L	NG	NG	0.144	0.144	0.134	0.122	0.126	0.0606	0.0430	0.0476	0.0489	0.0517	0.0537	0.0317	0.0340	0.0373	0.0481	0.0315	0.0565	0.072	0.0788	0.0819	0.0821	0.0726	
Sodium (meq/L) (calculated)	meq/L	NG	NG	2.85	2.9	3.07	2.69	2.49	0.596	0.44	0.513	0.483	0.483	0.531	0.356	0.631	0.974	1.71	0.457	0.561	0.796	1.0	1.07	1.02	0.887	
Strontium (meq/L) (calculated)	meq/L	NG	NG	0.00842	0.00813	0.00765	0.00694	0.00669	0.0112	0.0106	0.0117	0.0112	0.0107	0.0110	0.00749	0.00856	0.00831	0.0118	0.00868	0.00710	0.00797	0.00831	0.00836	0.00801	0.00760	
Sulfate (meq/L) (calculated)	meq/L	NG	NG	7.00	7.35	5.6	5.1	4.81	0.785	0.664	0.712	0.668	0.608	0.745	0.446	0.568	0.658	0.577	0.777	1.06	1.0	0.929	0.926	1.05		
Zinc (meq/L) (calculated)	meq/L	NG	NG	0.00019	0.000330	0.00018	0.00021	0.00019	0.00014	0.000049	0.00020	0.000076	0.000092	0.000095	0.00010	0.000052	0.0003	0.000440	0.00025	0.000425	0.00018	0.000743	0.000743	0.000462	0.00029	
Dissolved Metals																										
Aluminum (dissolved)	µg/L	NG	NG	9500 ^{2.1}	1.3	3.8	10.5	6.8	23.5	<1.0	1.1	1.6	1.6	1.3	<1.0	1.4	2.4	1.3	2.2	1.0	<1.0	1.1	1.5	1.2	3.3	13.5
Antimony (dissolved)	µg/L	90	6	<0.10	0.15	<0.10	<0.50	<0.50	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.16	<0.10	<0.10	0.21	0.12	<0.10	<0.10	0.14	<0.10	<0.10	<0.50	
Arsenic (dissolved)	µg/L	50	10	0.17	0.26	0.17	<0.50	<0.50	0.26	0.16	0.23	0.44	0.67	2.88	0.23	0.15	<0.10	0.15	0.24	0.21	0.15	0.21	0.22	0.18	3.22	
Barium (dissolved)	µg/L	10000	1000	43.1	32.4	37.9	32.4	85.1	138	106	129	128	137	154	145	162	190	265	152	289	442	460	459	357	388	
Beryllium (dissolved)	µg/L	1.5	8	<0.020	<0.020	<0.020	<0.10	<0.10	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.10	
Bismuth (dissolved)	µg/L	NG	NG	<0.050	<0.050	<0.050	<0.25	<0.25	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.25	
Boron (dissolved)	µg/L	12000	5000	167	167	150	158	157	28	29	30	29	29	29	27	27	29	27	29	27	29	29	29	29	<50	
Cadmium (dissolved)	mg/L	Calc ^{1.1}	NG	0.005	0.000148	0.000323	0.000159	0.000109	0.000098	0.0000317	0.000021	0.0000315	0.0000197	0.0000236	0.0000216	0.0000135	0.0000701	0.000106	0.0000485	0.0000222	0.0000926	0.0000974	0.0000952	0.000090	0.000090	
Calcium (dissolved)	µg/L	NG	NG	278000	257000	247000	200000	211000	121000	90100	119000	102000	98600	109000	112000	114000	130000	154000	117000	165000	198000	237000	200000	196000	189000	
Chromium (dissolved)	µg/L	10 ^{1.2}	50 ^{2.2}	0.17	2.57	0.45	1.42	1.15	<0.10	0.99	1.59	0.69	1.02	1.15	<0.10	1.58	4.5	6.09	1.35	2.08	2.45	4.18	2.42	1.91	1.91	
Cobalt (dissolved)	µg/L	40	20 ^{2.3}	0.14	6.23	0.14	<0.50	<0.50	0.42	0.14	1.73	1.11	0.93	0.60	0.13	0.24	0.99	1.12	0.13	0.55	0.49	4.53	0.67	0.72	0.51	
Copper (dissolved)	µg/L	Calc ^{1.3}	1500 ^{1.4}	1.15	1.04	6.49	1.5	1.4	0.45	<0.20	0.31	0.24	<0.20	0.20	0.61	0.61	0.89	1.06	1.52	0.34	0.43	1.55	1.25	0.66	<1.0	
Hardness, Total (dissolved as CaCO3)	mg/L	NG	NG	1000	928	866	737	743	468	361	464	395	386	417	385	403	454	530	403	608	688	815	689	687	653	
Iron (dissolved)	µg/L	NG	NG	6500 ^{1.5}	<10	26	16	<50	<50	417	91	206	283	465	565	40	32	49	231	28	189	29	35	83	82	92
Lead (dissolved)	µg/L	Calc ^{1.4}	10	<0.050	<0.050	0.141	<0.25	&																		

APPENDIX C
Certificates of Analysis



Sperling Hansen Associates Inc.
ATTN: Scott Garthwaite
#8 - 1225 East Keith Road
North Vancouver BC V7J 1J3

Date Received: 04-MAY-21
Report Date: 14-MAY-21 16:27 (MT)
Version: FINAL

Client Phone: 604-986-7723

Certificate of Analysis

Lab Work Order #: L2583620
Project P.O. #: NOT SUBMITTED
Job Reference: 20050 SPARWOOD
C of C Numbers:
Legal Site Desc:

Patryk Wojciak, B.Sc., P.Chem.
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 2559 29 Street NE, Calgary, AB T1Y 7B5 Canada | Phone: +1 403 291 9897 | Fax: +1 403 291 0298
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID		L2583620-1 GROUNDWATER 29-APR-21 MW14-1	L2583620-2 GROUNDWATER 29-APR-21 MW14-4	L2583620-3 GROUNDWATER 29-APR-21 MW15-2	L2583620-4 GROUNDWATER 29-APR-21 MW14-3	
Grouping	Analyte					
WATER						
Physical Tests	Hardness (as CaCO ₃) (mg/L)	866	530	689	395	
	Temperature (Degree C)	20.8	20.1	20.0	20.1	
Anions and Nutrients	Alkalinity, Total (as CaCO ₃) (mg/L)	441	326	366	259	
	Ammonia as N (mg/L)	0.0075	0.0073	0.0180	0.0572	
	Bicarbonate (HCO ₃) (mg/L)	538	398	446	316	
	Carbonate (CO ₃) (mg/L)	<5.0	<5.0	<5.0	<5.0	
	Chloride (Cl) (mg/L)	88.3 ^{DLHC}	108 ^{DLHC}	92.5 ^{DLHC}	34.0	
	Conductivity (EC) (uS/cm)	1,464.00	976	987	608	
	Fluoride (F) (mg/L)	<0.10	<0.10	<0.10	0.266	
	Hydroxide (OH) (mg/L)	<5.0	<5.0	<5.0	<5.0	
	Nitrate and Nitrite (as N) (mg/L)	3.25	0.242	0.445	0.0096	
	Nitrate (as N) (mg/L)	3.25 ^{DLHC}	0.237 ^{DLHC}	0.445 ^{DLHC}	0.0080	
	Nitrite (as N) (mg/L)	<0.0050 ^{DLHC}	0.0053 ^{DLHC}	<0.0050 ^{DLHC}	0.0016	
	pH (pH)	7.62	7.88	7.61	7.86	
	Sulfate (SO ₄) (mg/L)	269 ^{DLHC}	31.6 ^{DLHC}	44.6 ^{DLHC}	32.1	
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Aluminum (Al)-Dissolved (mg/L)	0.0105	0.0022	0.0012	0.0016	
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00012	<0.00010	<0.00010	
	Arsenic (As)-Dissolved (mg/L)	0.00017	0.00015	0.00022	0.00044	
	Barium (Ba)-Dissolved (mg/L)	0.0379	0.265	0.459	0.128	
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Boron (B)-Dissolved (mg/L)	0.150	0.027	0.023	0.029	
	Cadmium (Cd)-Dissolved (mg/L)	0.000159	0.000106	0.0000974	0.0000197	
	Calcium (Ca)-Dissolved (mg/L)	247	154	200	102	
	Chromium (Cr)-Dissolved (mg/L)	0.00045	0.00609	0.00418	0.00069	
	Cobalt (Co)-Dissolved (mg/L)	0.00014	0.00112	0.00067	0.00111	
	Copper (Cu)-Dissolved (mg/L)	0.00649	0.00106	0.00125	0.00024	
	Iron (Fe)-Dissolved (mg/L)	0.016	0.231	0.083	0.283	
	Lead (Pb)-Dissolved (mg/L)	0.000141	<0.000050	<0.000050	<0.000050	
	Lithium (Li)-Dissolved (mg/L)	0.0221	0.0217	0.0221	0.0189	
	Magnesium (Mg)-Dissolved (mg/L)	60.6	35.5	46.1	33.9	
	Manganese (Mn)-Dissolved (mg/L)	0.0260	0.0565	0.244	0.358	
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	0.000887	0.00503	0.00550	0.00440	
	Nickel (Ni)-Dissolved (mg/L)	0.00667	0.0160	0.0181	0.0115	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID Description Sampled Date Sampled Time Client ID	L2583620-1 GROUNDWATER 29-APR-21 MW14-1	L2583620-2 GROUNDWATER 29-APR-21 MW14-4	L2583620-3 GROUNDWATER 29-APR-21 MW15-2	L2583620-4 GROUNDWATER 29-APR-21 MW14-3	
Grouping	Analyte						
WATER							
Dissolved Metals	Phosphorus (P)-Dissolved (mg/L)		<0.050	<0.050	<0.050	<0.050	
	Potassium (K)-Dissolved (mg/L)		5.22	1.88	3.20	1.91	
	Selenium (Se)-Dissolved (mg/L)		0.000294	0.000182	0.000066	0.000158	
	Silicon (Si)-Dissolved (mg/L)		8.39	6.22	7.86	5.72	
	Silver (Ag)-Dissolved (mg/L)		<0.000010	<0.000010	<0.000010	<0.000010	
	Sodium (Na)-Dissolved (mg/L)		70.6	39.2	24.7	11.1	
	Strontium (Sr)-Dissolved (mg/L)		0.335	0.519	0.366	0.489	
	Sulfur (S)-Dissolved (mg/L)		98.7	12.9	17.8	11.5	
	Thallium (Tl)-Dissolved (mg/L)		0.000070	0.000043	0.000036	0.000060	
	Tin (Sn)-Dissolved (mg/L)		0.00014	<0.00010	<0.00010	<0.00010	
	Titanium (Ti)-Dissolved (mg/L)		<0.00030	<0.00030	<0.00030	<0.00030	
	Uranium (U)-Dissolved (mg/L)		0.00130	0.000630	0.00121	0.00202	
	Vanadium (V)-Dissolved (mg/L)		<0.00050	<0.00050	<0.00050	<0.00050	
	Zinc (Zn)-Dissolved (mg/L)		0.0058	0.0144	0.0243	0.0025	
	Zirconium (Zr)-Dissolved (mg/L)		<0.00030	<0.00030	<0.00030	<0.00030	
Volatile Organic Compounds	Benzene (mg/L)				<0.00050		
	Ethylbenzene (mg/L)				<0.00050		
	Methyl-tert-Butyl Ether (mg/L)				<0.00050		
	Styrene (mg/L)				<0.00050		
	Toluene (mg/L)				<0.00050		
	o-Xylene (mg/L)				<0.00050		
	m+p-Xylene (mg/L)				<0.00050		
	Xylenes (mg/L)				<0.00071		
	Volatile Hydrocarbons (VH6-10) (mg/L)				<0.10		
	Surrogate: 4-Bromofluorobenzene (%)				95.4		
	Surrogate: 3,4-Dichlorotoluene (%)				105.7		
	Surrogate: 1,4-Difluorobenzene (%)				97.8		
Hydrocarbons	EPH10-19 (ug/L)				<100		
	EPH19-32 (ug/L)				<100		
	VPH (C6-C10) (mg/L)				<0.10		
	Surrogate: 2-Bromobenzotrifluoride (%)				76.0		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
EHR	Exceeded Recommended Holding Time prior to receipt at the lab. - NO2/NO3 EXCEED HOLD TIME ON RECEIPT

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2583620-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2583620-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2583620-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2583620-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-CL	Water	Diss. Be (low) in Water by CRC ICPMS Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS. Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.	APHA 3030B/6020A (mod)
BTXSM-HS-MS-CL	Water	BTEX, Styrene and MTBE The water sample, with added reagents, is heated in a sealed vial to equilibrium. The headspace from the vial is transferred into a gas chromatograph. BTEX Target compound concentrations are measured using mass spectrometry detection.	EPA 8260C/5021A
CL-L-IC-N-CL	Water	Chloride in Water by IC Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.	EPA 300.1 (mod)
EPH-L-ME-FID-CL	Water	EPH (C10-C19) & EPH (C19-C32) EPH is extracted from water using a hexane micro-extraction technique, with analysis by GC-FID, as per the BC Lab Manual. EPH results include PAHs and are therefore not equivalent to LEPH or HEPH.	BC Lab manual
F-L-IC-CL	Water	Fluoride	APHA 4110 B-Ion Chromatography
HARDNESS-CALC-CL	Water	Hardness Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.	APHA 2340 B
HG-D-CVAA-CL	Water	Dissolved Mercury in Water by CVAAS Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS.	APHA 3030B/EPA 1631E (mod)
MET-D-CCMS-CL	Water	Dissolved Metals in Water by CRC ICPMS Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS. Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.	APHA 3030B/6020A (mod)
N2N3-CALC-CL	Water	Nitrate+Nitrite	CALCULATION
NH3-L-F-CL	Water	Ammonia, Total (as N) This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Weston et al.	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC
NO2-L-IC-N-CL	Water	Nitrite in Water by IC (Low Level) Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.	EPA 300.1 (mod)
NO3-L-IC-N-CL	Water	Nitrate in Water by IC (Low Level) Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.	EPA 300.1 (mod)
PH/EC/ALK-CL	Water	pH, Conductivity and Total Alkalinity All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed) pH measurement is determined from the activity of the hydrogen ions using a hydrogen electrode and a reference electrode. Alkalinity measurement is based on the sample's capacity to neutralize acid	APHA 4500H,2510,2320

Reference Information

Conductivity measurement is based on the sample's capacity to convey an electric current

SO4-L-IC-N-CL Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TEMP-CL Water Temperature APHA 2550-Thermometer

VH-HS-FID-CL Water VHs BC Env. Lab Manual (VH in Water)

The water sample, with added reagents, is heated in a sealed vial to equilibrium. The headspace from the vial is transferred into a gas chromatograph. Compounds eluting between n-hexane and n-decane are measured and summed together using flame-ionization detection.

VPH-CALC-CL Water VPH Calculation BC MOE LABORATORY MANUAL (2005)

These results are determined according to the British Columbia Ministry of Environment, Lands, and Parks Analytical Method for Contaminated Sites "Calculation of Volatile Petroleum Hydrocarbons in Solids or Water" (Version 2.1, July 20, 1999). According to this method, the concentrations of specific Monocyclic Aromatic Hydrocarbons (Benzene, Toluene, Ethylbenzene, Xylenes and Styrene) are subtracted from the collective concentration of Volatile Hydrocarbons (VH) that elute between n-hexane (nC6) and n-decane (nC10). Analysis of Volatile Hydrocarbons adheres to all prescribed elements of BCMELP method "Volatile Hydrocarbons in Solids by GC/FID" (Version 2.1, July 20, 1999).

XYLENES-CALC-CL Water Sum of Xylene Isomer Concentrations CALCULATION

Calculation of Total Xylenes

Total Xylenes is the sum of the concentrations of the ortho, meta, and para Xylene isomers. Results below detection limit (DL) are treated as zero. The DL for Total Xylenes is set to a value no less than the square root of the sum of the squares of the DLs of the individual Xylenes.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg ww - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2583620

Report Date: 14-MAY-21

Page 1 of 10

Client: Sperling Hansen Associates Inc.

#8 - 1225 East Keith Road

North Vancouver BC V7J 1J3

Contact: Scott Garthwaite

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
BE-D-L-CCMS-CL Water								
Batch	R5454857							
WG3531421-6 LCS		TMRM						
Beryllium (Be)-Dissolved			99.8		%		80-120	08-MAY-21
WG3531421-5 MB								
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	08-MAY-21
BTXSM-HS-MS-CL Water								
Batch	R5454166							
WG3530692-5 DUP		L2583620-3						
Benzene		<0.00050	<0.00050	RPD-NA	mg/L	N/A	30	07-MAY-21
Ethylbenzene		<0.00050	<0.00050	RPD-NA	mg/L	N/A	30	07-MAY-21
Methyl-tert-Butyl Ether		<0.00050	<0.00050	RPD-NA	mg/L	N/A	30	07-MAY-21
o-Xylene		<0.00050	<0.00050	RPD-NA	mg/L	N/A	30	07-MAY-21
m+p-Xylene		<0.00050	<0.00050	RPD-NA	mg/L	N/A	30	07-MAY-21
Styrene		<0.00050	<0.00050	RPD-NA	mg/L	N/A	30	07-MAY-21
Toluene		<0.00050	<0.00050	RPD-NA	mg/L	N/A	30	07-MAY-21
WG3530692-2 LCS								
Benzene			100.7		%		70-130	07-MAY-21
Ethylbenzene			109.2		%		70-130	07-MAY-21
Methyl-tert-Butyl Ether			103.2		%		70-130	07-MAY-21
o-Xylene			112.8		%		70-130	07-MAY-21
m+p-Xylene			103.9		%		70-130	07-MAY-21
Styrene			106.9		%		70-130	07-MAY-21
Toluene			101.0		%		70-130	07-MAY-21
WG3530692-1 MB								
Benzene			<0.00050		mg/L		0.0005	07-MAY-21
Ethylbenzene			<0.00050		mg/L		0.0005	07-MAY-21
Methyl-tert-Butyl Ether			<0.00050		mg/L		0.0005	07-MAY-21
o-Xylene			<0.00050		mg/L		0.0005	07-MAY-21
m+p-Xylene			<0.00050		mg/L		0.0005	07-MAY-21
Styrene			<0.00050		mg/L		0.0005	07-MAY-21
Toluene			<0.00050		mg/L		0.0005	07-MAY-21
Surrogate: 4-Bromofluorobenzene			88.6		%		70-130	07-MAY-21
Surrogate: 1,4-Difluorobenzene			92.1		%		70-130	07-MAY-21
WG3530692-6 MS		L2583620-3						
Benzene			97.4		%		50-140	07-MAY-21
Ethylbenzene			96.9		%		50-140	07-MAY-21
Methyl-tert-Butyl Ether			97.0		%		50-140	07-MAY-21

Quality Control Report

Workorder: L2583620

Report Date: 14-MAY-21

Page 2 of 10

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
BTXSM-HS-MS-CL		Water						
Batch	R5454166							
WG3530692-6	MS	L2583620-3						
o-Xylene			95.1		%		50-140	07-MAY-21
m+p-Xylene			84.7		%		50-140	07-MAY-21
Styrene			92.0		%		50-140	07-MAY-21
Toluene			86.8		%		50-140	07-MAY-21
CL-L-IC-N-CL		Water						
Batch	R5455239							
WG3531965-12	DUP	L2583620-4						
Chloride (Cl)		34.0	34.0		mg/L	0.2	20	05-MAY-21
WG3531965-11	LCS		100.2		%		85-115	05-MAY-21
Chloride (Cl)								
WG3531965-14	LCS		100.2		%		85-115	05-MAY-21
Chloride (Cl)								
WG3531965-2	LCS		102.8		%		85-115	05-MAY-21
Chloride (Cl)								
WG3531965-5	LCS		100.6		%		85-115	05-MAY-21
Chloride (Cl)								
WG3531965-8	LCS		101.0		%		85-115	05-MAY-21
Chloride (Cl)								
WG3531965-1	MB		<0.10		mg/L		0.1	05-MAY-21
Chloride (Cl)								
WG3531965-10	MB		<0.10		mg/L		0.1	05-MAY-21
Chloride (Cl)								
WG3531965-13	MB		<0.10		mg/L		0.1	05-MAY-21
Chloride (Cl)								
WG3531965-4	MB		<0.10		mg/L		0.1	05-MAY-21
Chloride (Cl)								
WG3531965-7	MB		<0.10		mg/L		0.1	05-MAY-21
Chloride (Cl)								
EPH-L-ME-FID-CL		Water						
Batch	R5453956							
WG3528816-2	LCS							
EPH10-19			101.0		%		70-130	11-MAY-21
EPH19-32			92.8		%		70-130	11-MAY-21
WG3528816-1	MB							
EPH10-19			<100		ug/L		100	11-MAY-21
EPH19-32			<100		ug/L		100	11-MAY-21
Surrogate: 2-Bromobenzotrifluoride			81.0		%		60-140	11-MAY-21

Quality Control Report

Workorder: L2583620

Report Date: 14-MAY-21

Page 3 of 10

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
F-L-IC-CL		Water						
Batch	R5455239							
WG3531965-12	DUP	L2583620-4						
Fluoride (F)		0.266	0.264		mg/L	0.8	20	05-MAY-21
WG3531965-11	LCS							
Fluoride (F)			94.3		%		85-115	05-MAY-21
WG3531965-14	LCS							
Fluoride (F)			92.6		%		85-115	05-MAY-21
WG3531965-2	LCS							
Fluoride (F)			93.4		%		85-115	05-MAY-21
WG3531965-5	LCS							
Fluoride (F)			94.5		%		85-115	05-MAY-21
WG3531965-8	LCS							
Fluoride (F)			94.7		%		85-115	05-MAY-21
WG3531965-1	MB							
Fluoride (F)			<0.020		mg/L		0.02	05-MAY-21
WG3531965-10	MB							
Fluoride (F)			<0.020		mg/L		0.02	05-MAY-21
WG3531965-13	MB							
Fluoride (F)			<0.020		mg/L		0.02	05-MAY-21
WG3531965-4	MB							
Fluoride (F)			<0.020		mg/L		0.02	05-MAY-21
WG3531965-7	MB							
Fluoride (F)			<0.020		mg/L		0.02	05-MAY-21
HG-D-CVAA-CL		Water						
Batch	R5455905							
WG3532700-3	DUP	L2583620-4						
Mercury (Hg)-Dissolved		<0.0000050	<0.0000050	RPD-NA	mg/L	N/A	20	11-MAY-21
WG3532700-2	LCS							
Mercury (Hg)-Dissolved			101.0		%		80-120	11-MAY-21
WG3532700-1	MB							
Mercury (Hg)-Dissolved			<0.0000050		mg/L		0.000005	11-MAY-21
WG3532700-4	MS	L2583620-4						
Mercury (Hg)-Dissolved			90.1		%		70-130	11-MAY-21
MET-D-CCMS-CL		Water						
Batch	R5454857							
WG3531421-6	LCS	TMRM						
Aluminum (Al)-Dissolved			103.4		%		80-120	08-MAY-21
Antimony (Sb)-Dissolved			106.8		%		80-120	08-MAY-21
Arsenic (As)-Dissolved			100.5		%		80-120	08-MAY-21

Quality Control Report

Workorder: L2583620

Report Date: 14-MAY-21

Page 4 of 10

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	Water							
Batch	R5454857							
WG3531421-6	LCS	TMRM						
Barium (Ba)-Dissolved			105.7		%		80-120	08-MAY-21
Bismuth (Bi)-Dissolved			98.9		%		80-120	08-MAY-21
Boron (B)-Dissolved			96.1		%		80-120	08-MAY-21
Cadmium (Cd)-Dissolved			101.5		%		80-120	08-MAY-21
Calcium (Ca)-Dissolved			99.9		%		80-120	08-MAY-21
Chromium (Cr)-Dissolved			103.6		%		80-120	08-MAY-21
Cobalt (Co)-Dissolved			103.4		%		80-120	08-MAY-21
Copper (Cu)-Dissolved			100.8		%		80-120	08-MAY-21
Iron (Fe)-Dissolved			101.7		%		80-120	08-MAY-21
Lead (Pb)-Dissolved			99.0		%		80-120	08-MAY-21
Lithium (Li)-Dissolved			102.2		%		80-120	08-MAY-21
Magnesium (Mg)-Dissolved			100.8		%		80-120	08-MAY-21
Manganese (Mn)-Dissolved			102.4		%		80-120	08-MAY-21
Molybdenum (Mo)-Dissolved			105.5		%		80-120	08-MAY-21
Nickel (Ni)-Dissolved			102.1		%		80-120	08-MAY-21
Phosphorus (P)-Dissolved			106.8		%		70-130	08-MAY-21
Potassium (K)-Dissolved			102.9		%		80-120	08-MAY-21
Selenium (Se)-Dissolved			94.8		%		80-120	08-MAY-21
Silicon (Si)-Dissolved			102.3		%		60-140	08-MAY-21
Silver (Ag)-Dissolved			104.3		%		80-120	08-MAY-21
Sodium (Na)-Dissolved			101.7		%		80-120	08-MAY-21
Strontium (Sr)-Dissolved			103.8		%		80-120	08-MAY-21
Sulfur (S)-Dissolved			112.2		%		80-120	08-MAY-21
Thallium (Tl)-Dissolved			99.9		%		80-120	08-MAY-21
Tin (Sn)-Dissolved			102.6		%		80-120	08-MAY-21
Titanium (Ti)-Dissolved			96.5		%		80-120	08-MAY-21
Uranium (U)-Dissolved			99.9		%		80-120	08-MAY-21
Vanadium (V)-Dissolved			104.6		%		80-120	08-MAY-21
Zinc (Zn)-Dissolved			103.7		%		80-120	08-MAY-21
Zirconium (Zr)-Dissolved			105.5		%		80-120	08-MAY-21
WG3531421-5	MB							
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	08-MAY-21
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	08-MAY-21
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	08-MAY-21

Quality Control Report

Workorder: L2583620

Report Date: 14-MAY-21

Page 5 of 10

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	Water							
Batch	R5454857							
WG3531421-5 MB								
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	08-MAY-21
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	08-MAY-21
Boron (B)-Dissolved			<0.010		mg/L		0.01	08-MAY-21
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	08-MAY-21
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	08-MAY-21
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	08-MAY-21
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	08-MAY-21
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	08-MAY-21
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	08-MAY-21
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	08-MAY-21
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	08-MAY-21
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	08-MAY-21
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	08-MAY-21
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	08-MAY-21
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	08-MAY-21
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	08-MAY-21
Potassium (K)-Dissolved			<0.050		mg/L		0.05	08-MAY-21
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	08-MAY-21
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	08-MAY-21
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	08-MAY-21
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	08-MAY-21
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	08-MAY-21
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	08-MAY-21
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	08-MAY-21
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	08-MAY-21
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	08-MAY-21
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	08-MAY-21
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	08-MAY-21
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	08-MAY-21
Zirconium (Zr)-Dissolved			<0.00020		mg/L		0.0002	08-MAY-21
NH3-L-F-CL	Water							

Quality Control Report

Workorder: L2583620

Report Date: 14-MAY-21

Page 6 of 10

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-L-F-CL		Water						
Batch	R5454777							
WG3531211-7	DUP	L2583620-2						
Ammonia as N		0.0073	0.0079		mg/L	7.9	20	07-MAY-21
WG3531211-6	LCS							
Ammonia as N			101.6		%		85-115	07-MAY-21
WG3531211-5	MB							
Ammonia as N			<0.0050		mg/L		0.005	07-MAY-21
WG3531211-8	MS	L2583620-2						
Ammonia as N			94.8		%		75-125	07-MAY-21
NO2-L-IC-N-CL		Water						
Batch	R5455239							
WG3531965-12	DUP	L2583620-4						
Nitrite (as N)		0.0016	0.0012	J	mg/L	0.0004	0.002	05-MAY-21
WG3531965-11	LCS							
Nitrite (as N)			100.7		%		90-110	05-MAY-21
WG3531965-14	LCS							
Nitrite (as N)			100.6		%		90-110	05-MAY-21
WG3531965-2	LCS							
Nitrite (as N)			104.1		%		90-110	05-MAY-21
WG3531965-5	LCS							
Nitrite (as N)			101.3		%		90-110	05-MAY-21
WG3531965-8	LCS							
Nitrite (as N)			101.7		%		90-110	05-MAY-21
WG3531965-1	MB							
Nitrite (as N)			<0.0010		mg/L		0.001	05-MAY-21
WG3531965-10	MB							
Nitrite (as N)			<0.0010		mg/L		0.001	05-MAY-21
WG3531965-13	MB							
Nitrite (as N)			<0.0010		mg/L		0.001	05-MAY-21
WG3531965-4	MB							
Nitrite (as N)			<0.0010		mg/L		0.001	05-MAY-21
WG3531965-7	MB							
Nitrite (as N)			<0.0010		mg/L		0.001	05-MAY-21
NO3-L-IC-N-CL		Water						
Batch	R5455239							
WG3531965-12	DUP	L2583620-4						
Nitrate (as N)		0.0080	0.0077		mg/L	3.8	20	05-MAY-21
WG3531965-11	LCS							
Nitrate (as N)			100.4		%		90-110	05-MAY-21

Quality Control Report

Workorder: L2583620

Report Date: 14-MAY-21

Page 7 of 10

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-L-IC-N-CL		Water						
Batch R5455239								
WG3531965-14	LCS							
Nitrate (as N)			100.5		%		90-110	05-MAY-21
WG3531965-2	LCS							
Nitrate (as N)			103.2		%		90-110	05-MAY-21
WG3531965-5	LCS							
Nitrate (as N)			100.9		%		90-110	05-MAY-21
WG3531965-8	LCS							
Nitrate (as N)			101.3		%		90-110	05-MAY-21
WG3531965-1	MB							
Nitrate (as N)			<0.0050		mg/L		0.005	05-MAY-21
WG3531965-10	MB							
Nitrate (as N)			<0.0050		mg/L		0.005	05-MAY-21
WG3531965-13	MB							
Nitrate (as N)			<0.0050		mg/L		0.005	05-MAY-21
WG3531965-4	MB							
Nitrate (as N)			<0.0050		mg/L		0.005	05-MAY-21
WG3531965-7	MB							
Nitrate (as N)			<0.0050		mg/L		0.005	05-MAY-21
PH/EC/ALK-CL		Water						
Batch R5457043								
WG3534115-49	LCS							
Conductivity (EC)			108.2		%		90-110	12-MAY-21
Alkalinity, Total (as CaCO3)			105.0		%		85-115	12-MAY-21
WG3534115-50	MB							
Conductivity (EC)			<2.0		uS/cm		2	12-MAY-21
Bicarbonate (HCO3)			<5.0		mg/L		5	12-MAY-21
Carbonate (CO3)			<5.0		mg/L		5	12-MAY-21
Hydroxide (OH)			<5.0		mg/L		5	12-MAY-21
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	12-MAY-21
Batch R5457806								
WG3534393-4	LCS							
Conductivity (EC)			103.7		%		90-110	11-MAY-21
Alkalinity, Total (as CaCO3)			103.1		%		85-115	11-MAY-21
WG3534393-5	MB							
Conductivity (EC)			<2.0		uS/cm		2	11-MAY-21
Bicarbonate (HCO3)			<5.0		mg/L		5	11-MAY-21
Carbonate (CO3)			<5.0		mg/L		5	11-MAY-21

Quality Control Report

Workorder: L2583620

Report Date: 14-MAY-21

Page 8 of 10

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH/EC/ALK-CL		Water						
Batch	R5457806							
WG3534393-5 MB								
Hydroxide (OH)			<5.0		mg/L		5	11-MAY-21
Alkalinity, Total (as CaCO ₃)			<2.0		mg/L		2	11-MAY-21
SO4-L-IC-N-CL		Water						
Batch	R5455239							
WG3531965-12 DUP		L2583620-4						
Sulfate (SO ₄)		32.1	32.1		mg/L	0.1	20	05-MAY-21
WG3531965-11 LCS								
Sulfate (SO ₄)			99.2		%		85-115	05-MAY-21
WG3531965-14 LCS								
Sulfate (SO ₄)			99.2		%		85-115	05-MAY-21
WG3531965-2 LCS								
Sulfate (SO ₄)			101.7		%		85-115	05-MAY-21
WG3531965-5 LCS								
Sulfate (SO ₄)			99.6		%		85-115	05-MAY-21
WG3531965-8 LCS								
Sulfate (SO ₄)			99.8		%		85-115	05-MAY-21
WG3531965-1 MB								
Sulfate (SO ₄)			<0.050		mg/L		0.05	05-MAY-21
WG3531965-10 MB								
Sulfate (SO ₄)			<0.050		mg/L		0.05	05-MAY-21
WG3531965-13 MB								
Sulfate (SO ₄)			<0.050		mg/L		0.05	05-MAY-21
WG3531965-4 MB								
Sulfate (SO ₄)			<0.050		mg/L		0.05	05-MAY-21
WG3531965-7 MB								
Sulfate (SO ₄)			<0.050		mg/L		0.05	05-MAY-21
VH-HS-FID-CL		Water						
Batch	R5454167							
WG3530693-4 DUP		L2583620-3						
Volatile Hydrocarbons (VH6-10)		<0.10	<0.10	RPD-NA	mg/L	N/A	30	07-MAY-21
WG3530693-2 LCS								
Volatile Hydrocarbons (VH6-10)			105.7		%		70-130	07-MAY-21
WG3530693-1 MB								
Volatile Hydrocarbons (VH6-10)			<0.10		mg/L		0.1	07-MAY-21
Surrogate: 3,4-Dichlorotoluene			114.3		%		70-130	07-MAY-21

Quality Control Report

Workorder: L2583620

Report Date: 14-MAY-21

Page 9 of 10

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Workorder: L2583620

Report Date: 14-MAY-21

Page 10 of 10

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Anions and Nutrients							
Nitrate in Water by IC (Low Level)							
	1	29-APR-21	05-MAY-21 13:10	3	6	days	EHTR
	2	29-APR-21	05-MAY-21 13:10	3	6	days	EHTR
	3	29-APR-21	05-MAY-21 13:10	3	6	days	EHTR
	4	29-APR-21	05-MAY-21 13:10	3	6	days	EHTR
Nitrite in Water by IC (Low Level)							
	1	29-APR-21	05-MAY-21 13:10	3	6	days	EHTR
	2	29-APR-21	05-MAY-21 13:10	3	6	days	EHTR
	3	29-APR-21	05-MAY-21 13:10	3	6	days	EHTR
	4	29-APR-21	05-MAY-21 13:10	3	6	days	EHTR

Legend & Qualifier Definitions:

EHTR-FM: Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR: Exceeded ALS recommended hold time prior to sample receipt.
EHTL: Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT: Exceeded ALS recommended hold time prior to analysis.
Rec. HT: ALS recommended hold time (see units).

Notes*:

Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2583620 were received on 04-MAY-21 09:00.

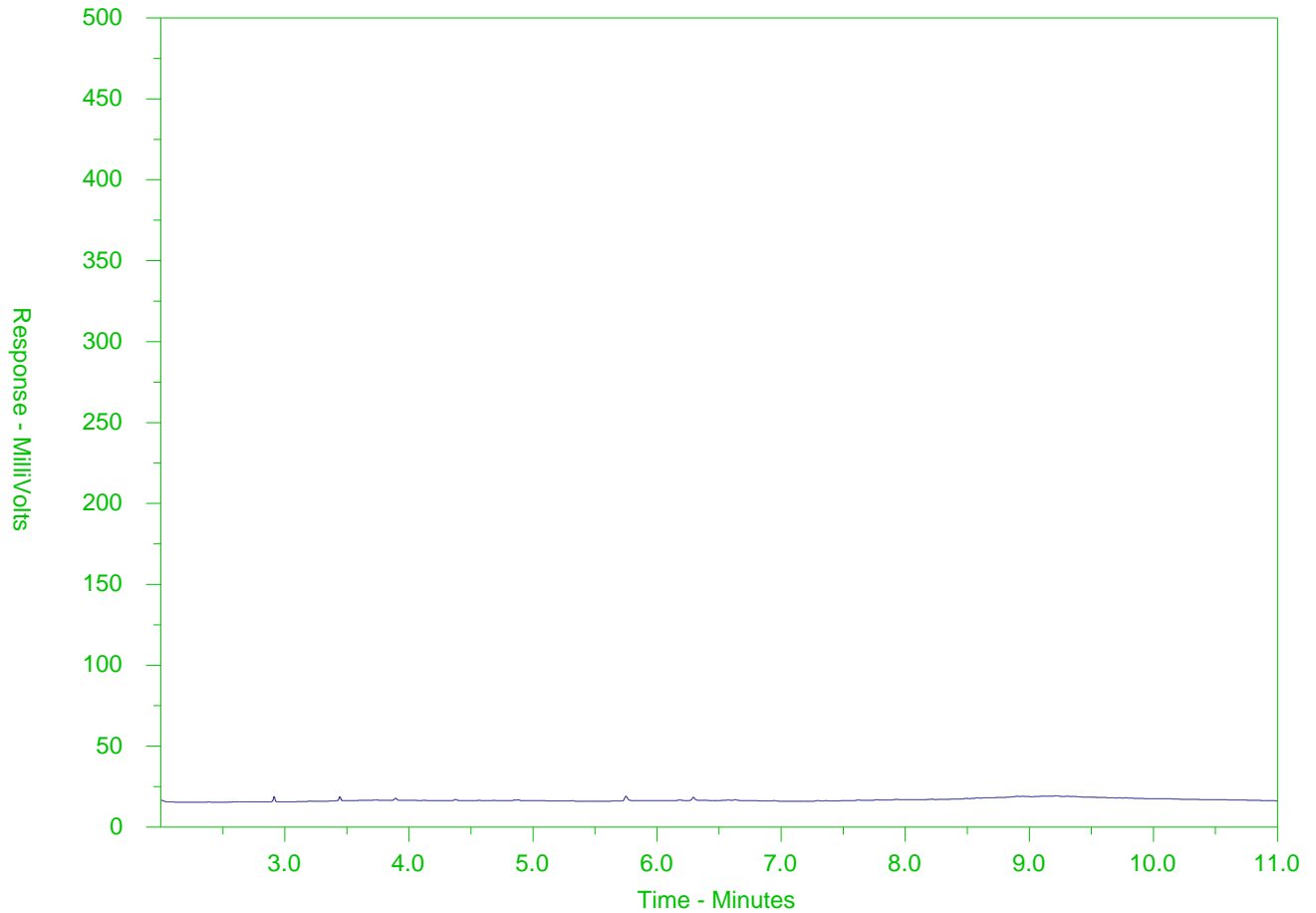
ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

BC EPH HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L2583620-3
Client Sample ID: MW15-2



← EPH10-19 →		← EPH19-32 →	
nC10	nC19	nC32	
174°C	330°C	467°C	
346°F	626°F	873°F	
← Gasoline →	← Motor Oils/ Lube Oils/ Grease →		
← Diesel/ Jet Fuels →			

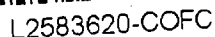
The BC EPH Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and three n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

A "-L-" in the sample ID denotes a low level sample. A "-S-" denotes a silica gel cleaned sample.

Note: This chromatogram was produced using GC conditions that are specific to the ALS Canada EPH method. Refer to the ALS Canada EPH Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR library can be found at www.alsglobal.com.



Canada Toll Free: 1 800 668 9878

COC Number: 20 -

Page 1

REFER TO BACK PAGE FOR AIS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY

YELLOW - CLIENT COPY

AUG 2020 EDITION

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges that the user is not a health care professional and is not providing a clinical specimen for analysis.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW GOC form.



Sperling Hansen Associates Inc.
ATTN: Scott Garthwaite
#8 - 1225 East Keith Road
North Vancouver BC V7J 1J3

Date Received: 30-JUL-21
Report Date: 10-AUG-21 14:29 (MT)
Version: FINAL

Client Phone: 604-986-7723

Certificate of Analysis

Lab Work Order #: L2621324
Project P.O. #: NOT SUBMITTED
Job Reference: 20050 SPARWOOD
C of C Numbers:
Legal Site Desc:

Patryk Wojciak, B.Sc., P.Chem.
Account Manager

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ADDRESS: 2559 29 Street NE, Calgary, AB T1Y 7B5 Canada | Phone: +1 403 291 9897 | Fax: +1 403 291 0298
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID		L2621324-1 Groundwater 29-JUL-21 12:00 MW14-1	L2621324-2 Groundwater 29-JUL-21 12:00 MW14-4	L2621324-3 Groundwater 29-JUL-21 12:00 MW15-2	L2621324-4 Groundwater 29-JUL-21 12:00 MW14-3	
Grouping	Analyte					
WATER						
Physical Tests	Hardness (as CaCO ₃) (mg/L)	737	403	687	386	
	Temperature (Degree C)	20.2	20.5	20.3	20.3	
Anions and Nutrients	Alkalinity, Total (as CaCO ₃) (mg/L)	557	407	543	366	
	Ammonia as N (mg/L)	0.0114	0.0115	0.0154	0.0505	
	Bicarbonate (HCO ₃) (mg/L)	679	496	662	447	
	Carbonate (CO ₃) (mg/L)	<5.0	<5.0	<5.0	<5.0	
	Chloride (Cl) (mg/L)	97.4	8.42	69.3	30.8	
	Conductivity (EC) (uS/cm)	1550	720	1140	744	
	Fluoride (F) (mg/L)	<0.10 ^{DLDS}	0.035	<0.10 ^{DLDS}	0.175	
	Hydroxide (OH) (mg/L)	<5.0	<5.0	<5.0	<5.0	
	Nitrate and Nitrite (as N) (mg/L)	3.39	0.0113	0.235	0.0141	
	Nitrate (as N) (mg/L)	3.39	0.0113	0.235	0.0130	
	Nitrite (as N) (mg/L)	<0.0050 ^{DLDS}	<0.0010	<0.0050 ^{DLDS}	0.0011	
	pH (pH)	7.58	7.99	7.41	7.74	
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Aluminum (Al)-Dissolved (mg/L)	0.0068 ^{DLDS}	0.0010	0.0033	0.0013	
	Antimony (Sb)-Dissolved (mg/L)	<0.00050 ^{DLDS}	<0.00010	<0.00010	<0.00010	
	Arsenic (As)-Dissolved (mg/L)	<0.00050 ^{DLDS}	0.00024	0.00018	0.00067	
	Barium (Ba)-Dissolved (mg/L)	0.0324 ^{DLDS}	0.152	0.357	0.137	
	Beryllium (Be)-Dissolved (mg/L)	<0.00010 ^{DLDS}	<0.000020	<0.000020	<0.000020	
	Bismuth (Bi)-Dissolved (mg/L)	<0.00025 ^{DLDS}	<0.000050	<0.000050	<0.000050	
	Boron (B)-Dissolved (mg/L)	0.158 ^{DLDS}	0.023	0.039	0.028	
	Cadmium (Cd)-Dissolved (mg/L)	0.000109 ^{DLDS}	0.0000485	0.0000952	0.0000236	
	Calcium (Ca)-Dissolved (mg/L)	200 ^{DLDS}	117	196	98.6	
	Chromium (Cr)-Dissolved (mg/L)	0.00142 ^{DLDS}	0.00135	0.00242	0.00102	
	Cobalt (Co)-Dissolved (mg/L)	<0.00050 ^{DLDS}	0.00013	0.00072	0.00093	
	Copper (Cu)-Dissolved (mg/L)	0.0015 ^{DLDS}	0.00152	0.00066	<0.00020	
	Iron (Fe)-Dissolved (mg/L)	<0.050 ^{DLDS}	0.028	0.082	0.465	
	Lead (Pb)-Dissolved (mg/L)	<0.00025 ^{DLDS}	<0.000050	<0.000050	<0.000050	
	Lithium (Li)-Dissolved (mg/L)	0.0186 ^{DLDS}	0.0170	0.0212	0.0174	
	Magnesium (Mg)-Dissolved (mg/L)	57.5 ^{DLDS}	27.3	47.7	34.0	
	Manganese (Mn)-Dissolved (mg/L)	0.0165 ^{DLDS}	0.0114	0.248	0.392	
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050 ^{DLDS}	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	0.00087 ^{DLDS}	0.000977	0.00328	0.00481	
	Nickel (Ni)-Dissolved (mg/L)	0.0041 ^{DLDS}	0.00256	0.0148	0.0161	
	Phosphorus (P)-Dissolved (mg/L)	<0.25 ^{DLDS}	<0.050	<0.050	<0.050	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID		L2621324-1 Groundwater 29-JUL-21 12:00 MW14-1	L2621324-2 Groundwater 29-JUL-21 12:00 MW14-4	L2621324-3 Groundwater 29-JUL-21 12:00 MW15-2	L2621324-4 Groundwater 29-JUL-21 12:00 MW14-3	
Grouping	Analyte					
WATER						
Dissolved Metals	Potassium (K)-Dissolved (mg/L)	4.78 ^{DLDS}	1.23	3.21	2.02	
	Selenium (Se)-Dissolved (mg/L)	<0.00025 ^{DLDS}	0.000076	0.000073	0.000137	
	Silicon (Si)-Dissolved (mg/L)	7.54 ^{DLDS}	5.23	8.39	5.91	
	Silver (Ag)-Dissolved (mg/L)	<0.000050 ^{DLDS}	<0.000010	<0.000010	<0.000010	
	Sodium (Na)-Dissolved (mg/L)	61.9 ^{DLDS}	10.5	23.5	11.1	
	Strontium (Sr)-Dissolved (mg/L)	0.304 ^{DLDS}	0.380	0.351	0.469	
	Sulfur (S)-Dissolved (mg/L)	86.3 ^{DLDS}	11.4	24.6	11.0	
	Thallium (Tl)-Dissolved (mg/L)	0.000067 ^{DLDS}	0.000023	0.000042	0.000066	
	Tin (Sn)-Dissolved (mg/L)	<0.00050 ^{DLDS}	<0.00010	<0.00010	<0.00010	
	Titanium (Ti)-Dissolved (mg/L)	<0.0015 ^{DLDS}	<0.00030	<0.00030	<0.00030	
	Uranium (U)-Dissolved (mg/L)	0.00112 ^{DLDS}	0.000554	0.00121	0.00204	
	Vanadium (V)-Dissolved (mg/L)	<0.0025 ^{DLDS}	<0.00050	<0.00050	<0.00050	
	Zinc (Zn)-Dissolved (mg/L)	0.0070 ^{DLDS}	0.0081	0.0151	0.0030	
	Zirconium (Zr)-Dissolved (mg/L)	<0.0010 ^{DLDS}	<0.00030	<0.00030	<0.00030	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-CL	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			
CL-L-IC-N-CL	Water	Chloride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
F-L-IC-CL	Water	Fluoride	APHA 4110 B-Ion Chromatography
HARDNESS-CALC-CL	Water	Hardness	APHA 2340 B
Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO ₃ equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.			
HG-D-CVAA-CL	Water	Dissolved Mercury in Water by CVAAS	APHA 3030B/EPA 1631E (mod)
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS.			
MET-D-CCMS-CL	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			
N2N3-CALC-CL	Water	Nitrate+Nitrite	CALCULATION
NH3-L-F-CL	Water	Ammonia, Total (as N)	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC
This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.			
NO2-L-IC-N-CL	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-L-IC-N-CL	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
PH/EC/ALK-CL	Water	pH, Conductivity and Total Alkalinity	APHA 4500H,2510,2320
All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed)			
pH measurement is determined from the activity of the hydrogen ions using a hydrogen electrode and a reference electrode.			
Alkalinity measurement is based on the sample's capacity to neutralize acid			
Conductivity measurement is based on the sample's capacity to convey an electric current			
TEMP-CL	Water	Temperature	APHA 2550-Thermometer

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg ww - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2621324

Report Date: 10-AUG-21

Page 1 of 5

Client: Sperling Hansen Associates Inc.

#8 - 1225 East Keith Road

North Vancouver BC V7J 1J3

Contact: Scott Garthwaite

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
BE-D-L-CCMS-CL Water								
Batch	R5546923							
WG3593345-2 LCS		TMRM						
Beryllium (Be)-Dissolved			96.0		%		80-120	09-AUG-21
WG3593345-1 MB								
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	09-AUG-21
CL-L-IC-N-CL Water								
Batch	R5544557							
WG3590662-7 DUP		L2621324-4						
Chloride (Cl)		30.8	30.6		mg/L	0.7	20	31-JUL-21
WG3590662-6 LCS								
Chloride (Cl)			99.3		%		85-115	31-JUL-21
WG3590662-5 MB								
Chloride (Cl)			<0.10		mg/L		0.1	31-JUL-21
WG3590662-8 MS		L2621324-4						
Chloride (Cl)			99.9		%		75-125	31-JUL-21
F-L-IC-CL Water								
Batch	R5544557							
WG3590662-7 DUP		L2621324-4						
Fluoride (F)		0.175	0.183		mg/L	4.4	20	31-JUL-21
WG3590662-6 LCS								
Fluoride (F)			91.8		%		85-115	31-JUL-21
WG3590662-5 MB								
Fluoride (F)			<0.020		mg/L		0.02	31-JUL-21
WG3590662-8 MS		L2621324-4						
Fluoride (F)			99.2		%		75-125	31-JUL-21
HG-D-CVAA-CL Water								
Batch	R5546057							
WG3592354-6 LCS								
Mercury (Hg)-Dissolved			89.1		%		80-120	07-AUG-21
WG3592354-5 MB								
Mercury (Hg)-Dissolved			<0.0000050		mg/L		0.000005	07-AUG-21
MET-D-CCMS-CL Water								
Batch	R5546923							
WG3593345-2 LCS		TMRM						
Aluminum (Al)-Dissolved			100.2		%		80-120	09-AUG-21
Antimony (Sb)-Dissolved			99.6		%		80-120	09-AUG-21
Arsenic (As)-Dissolved			99.4		%		80-120	09-AUG-21
Barium (Ba)-Dissolved			104.2		%		80-120	09-AUG-21

Quality Control Report

Workorder: L2621324

Report Date: 10-AUG-21

Page 2 of 5

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL								
Water								
Batch	R5546923							
WG3593345-2	LCS	TMRM						
Bismuth (Bi)-Dissolved			100.6		%		80-120	09-AUG-21
Boron (B)-Dissolved			91.4		%		80-120	09-AUG-21
Cadmium (Cd)-Dissolved			97.1		%		80-120	09-AUG-21
Calcium (Ca)-Dissolved			97.5		%		80-120	09-AUG-21
Chromium (Cr)-Dissolved			98.8		%		80-120	09-AUG-21
Cobalt (Co)-Dissolved			97.8		%		80-120	09-AUG-21
Copper (Cu)-Dissolved			95.4		%		80-120	09-AUG-21
Iron (Fe)-Dissolved			101.7		%		80-120	09-AUG-21
Lead (Pb)-Dissolved			99.4		%		80-120	09-AUG-21
Lithium (Li)-Dissolved			99.8		%		80-120	09-AUG-21
Magnesium (Mg)-Dissolved			99.1		%		80-120	09-AUG-21
Manganese (Mn)-Dissolved			98.6		%		80-120	09-AUG-21
Molybdenum (Mo)-Dissolved			103.8		%		80-120	09-AUG-21
Nickel (Ni)-Dissolved			96.7		%		80-120	09-AUG-21
Phosphorus (P)-Dissolved			102.6		%		70-130	09-AUG-21
Potassium (K)-Dissolved			98.2		%		80-120	09-AUG-21
Selenium (Se)-Dissolved			95.9		%		80-120	09-AUG-21
Silicon (Si)-Dissolved			102.1		%		60-140	09-AUG-21
Silver (Ag)-Dissolved			98.5		%		80-120	09-AUG-21
Sodium (Na)-Dissolved			97.9		%		80-120	09-AUG-21
Strontium (Sr)-Dissolved			106.8		%		80-120	09-AUG-21
Sulfur (S)-Dissolved			97.0		%		80-120	09-AUG-21
Thallium (Tl)-Dissolved			99.3		%		80-120	09-AUG-21
Tin (Sn)-Dissolved			100.8		%		80-120	09-AUG-21
Titanium (Ti)-Dissolved			95.8		%		80-120	09-AUG-21
Uranium (U)-Dissolved			95.8		%		80-120	09-AUG-21
Vanadium (V)-Dissolved			99.5		%		80-120	09-AUG-21
Zinc (Zn)-Dissolved			97.1		%		80-120	09-AUG-21
Zirconium (Zr)-Dissolved			104.9		%		80-120	09-AUG-21
WG3593345-1	MB							
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	09-AUG-21
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	09-AUG-21
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	09-AUG-21
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	09-AUG-21



Workorder: L2621324

Report Date: 10-AUG-21

Page 3 of 5

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL		Water						
Batch	R5546923							
WG3593345-1 MB								
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	09-AUG-21
Boron (B)-Dissolved			<0.010		mg/L		0.01	09-AUG-21
Cadmium (Cd)-Dissolved			<0.000005C		mg/L		0.000005	09-AUG-21
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	09-AUG-21
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	09-AUG-21
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	09-AUG-21
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	09-AUG-21
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	09-AUG-21
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	09-AUG-21
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	09-AUG-21
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	09-AUG-21
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	09-AUG-21
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	09-AUG-21
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	09-AUG-21
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	09-AUG-21
Potassium (K)-Dissolved			<0.050		mg/L		0.05	09-AUG-21
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	09-AUG-21
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	09-AUG-21
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	09-AUG-21
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	09-AUG-21
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	09-AUG-21
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	09-AUG-21
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	09-AUG-21
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	09-AUG-21
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	09-AUG-21
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	09-AUG-21
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	09-AUG-21
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	09-AUG-21
Zirconium (Zr)-Dissolved			<0.00020		mg/L		0.0002	09-AUG-21
NH3-L-F-CL		Water						
Batch	R5541844							
WG3589253-12		DUP	L2621324-2					
Ammonia as N		0.0115	0.0098		mg/L	16	20	01-AUG-21
WG3589253-10		LCS						

Quality Control Report

Workorder: L2621324

Report Date: 10-AUG-21

Page 4 of 5

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-L-F-CL								
Water								
Batch	R5541844							
WG3589253-10	LCS							
Ammonia as N			91.2		%		85-115	01-AUG-21
WG3589253-9	MB							
Ammonia as N			<0.0050		mg/L		0.005	01-AUG-21
WG3589253-11	MS	L2621324-2	91.1		%		75-125	01-AUG-21
Ammonia as N								
NO2-L-IC-N-CL								
Water								
Batch	R5544557							
WG3590662-7	DUP	L2621324-4						
Nitrite (as N)		0.0011	0.0015	J	mg/L	0.0004	0.002	31-JUL-21
WG3590662-6	LCS							
Nitrite (as N)			99.8		%		90-110	31-JUL-21
WG3590662-5	MB							
Nitrite (as N)			<0.0010		mg/L		0.001	31-JUL-21
WG3590662-8	MS	L2621324-4	110.6		%		75-125	31-JUL-21
Nitrite (as N)								
NO3-L-IC-N-CL								
Water								
Batch	R5544557							
WG3590662-7	DUP	L2621324-4						
Nitrate (as N)		0.0130	0.0141		mg/L	8.1	20	31-JUL-21
WG3590662-6	LCS							
Nitrate (as N)			99.4		%		90-110	31-JUL-21
WG3590662-5	MB							
Nitrate (as N)			<0.0050		mg/L		0.005	31-JUL-21
WG3590662-8	MS	L2621324-4	102.8		%		75-125	31-JUL-21
Nitrate (as N)								
PH/EC/ALK-CL								
Water								
Batch	R5546843							
WG3593251-5	LCS							
Conductivity (EC)			102.2		%		90-110	07-AUG-21
Alkalinity, Total (as CaCO3)			103.6		%		85-115	07-AUG-21
WG3593251-4	MB							
Conductivity (EC)			<2.0		uS/cm		2	07-AUG-21
Bicarbonate (HCO3)			<5.0		mg/L		5	07-AUG-21
Carbonate (CO3)			<5.0		mg/L		5	07-AUG-21
Hydroxide (OH)			<5.0		mg/L		5	07-AUG-21
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	07-AUG-21

Quality Control Report

Workorder: L2621324

Report Date: 10-AUG-21

Page 5 of 5

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.



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L2621324-COFC

Study (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

COC Number: 20 -

Page 1 of 1

Report To Contact and company name below will appear on the final report Company: Sperling Hansen Associates Inc. Contact: Scott Garthwaite Phone: 778-471-7088 Company address below will appear on the final report Street: 1225 East Keith Road City/Province: North Vancouver, B.C. Postal Code: V7J 1J3		Reports / Recipients Select Report Format: <input type="checkbox"/> PDF <input checked="" type="checkbox"/> EXCEL <input type="checkbox"/> EDD (DIGITAL) Merge QC/QCI Reports with COA <input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> N/A <input checked="" type="checkbox"/> Compare Results to Criteria on Report - provide details below if box checked Select Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX Email 1 or Fax: sgarthwaite@sperlinghansen.com Email 2: chetherington@sperlinghansen.com Email 3:		Turnaround Time (TAT) Requested <input checked="" type="checkbox"/> Routine [R] if received by 3pm M-F - no surcharges apply <input type="checkbox"/> 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimum <input type="checkbox"/> 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimum <input type="checkbox"/> 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimum <input type="checkbox"/> 1 day [E] if received by 3pm M-F - 100% rush surcharge minimum <input type="checkbox"/> Same day [E2] if received by 10am M-S - 200% rush surcharge. Additional fees may apply to rush requests on weekends, statutory holidays and non-routine tests Date and Time Required for all E&P TATs: dd-mm-yy hh:mm am/pm		AFFIX ALS BARCODE LABEL HERE (ALS use only)																																																																																																																
Invoice To Same as Report To <input checked="" type="checkbox"/> YES <input checked="" type="checkbox"/> NO Copy of Invoice with Report <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO Company: Contact:		Invoice Recipients Select Invoice Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX Email 1 or Fax: chetherington@sperlinghansen.com Email 2:		For all tests with rush TATs requested, please contact your AM to confirm availability.																																																																																																																		
Project Information ALS Account # / Quote #: Q80923 Job #: 20050 Sparwood PO / AFE: LSD:		Oil and Gas Required Fields (client use) AFE/Cost Center: PO# Major/Minor Code: Routing Code: Requisitioner: Location:		Analysis Request Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below <table border="1"> <thead> <tr> <th rowspan="2">NUMBER OF CONTAINERS</th> <th colspan="12">Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below</th> <th rowspan="2">SAMPLES ON HOLD</th> <th rowspan="2">EXTENDED STORAGE REQUIRED</th> <th rowspan="2">SUSPECTED HAZARD (see notes)</th> </tr> <tr> <th>anions</th> <th>temperature, conductivity, pH</th> <th>Total Alkalinity</th> <th>nitrate, nitrite</th> <th>Dissolved Metals (F/P)</th> <th>Ammonia</th> <th>fluoride, chloride, sulfate</th> <th>hardness</th> <th></th> <th></th> <th></th> <th></th> </tr> </thead> <tbody> <tr> <td>1</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>2</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>3</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>4</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td>R</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>		NUMBER OF CONTAINERS	Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below												SAMPLES ON HOLD	EXTENDED STORAGE REQUIRED	SUSPECTED HAZARD (see notes)	anions	temperature, conductivity, pH	Total Alkalinity	nitrate, nitrite	Dissolved Metals (F/P)	Ammonia	fluoride, chloride, sulfate	hardness					1	R	R	R	R	R	R	R	R									2	R	R	R	R	R	R	R	R									3	R	R	R	R	R	R	R	R									4	R	R	R	R	R	R	R	R										R	R	R	R	R	R	R	R								
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ALS Lab Work Order # (ALS use only):		ALS Contact: Dean Watt		Sampler: TM																																																																																																																		
ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mm-yy)	Time (hh:mm)	Sample Type																																																																																																																		
1	MW14-1	29-07-21	11	Groundwater																																																																																																																		
2	MW14-4	11	11	Groundwater																																																																																																																		
3	MW15-2	11	11	Groundwater																																																																																																																		
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	MW14-2			Groundwater																																																																																																																		

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION
 Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.
 1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.



Sperling Hansen Associates Inc.
ATTN: Scott Garthwaite
#8 - 1225 East Keith Road
North Vancouver BC V7J 1J3

Date Received: 16-NOV-21
Report Date: 25-NOV-21 16:43 (MT)
Version: FINAL

Client Phone: 604-986-7723

Certificate of Analysis

Lab Work Order #: L2663297
Project P.O. #: NOT SUBMITTED
Job Reference: 20050 SPARWOOD
C of C Numbers:
Legal Site Desc:

Patryk Wojciak, B.Sc., P.Chem.
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 2559 29 Street NE, Calgary, AB T1Y 7B5 Canada | Phone: +1 403 291 9897 | Fax: +1 403 291 0298
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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID		L2663297-1 GROUNDWATER 10-NOV-21 12:00 MW14-1	L2663297-2 GROUNDWATER 10-NOV-21 12:00 MW15-2	L2663297-3 GROUNDWATER 10-NOV-21 12:00 MW14-3		
Grouping	Analyte					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)	743	653	417		
	Temperature (Degree C)	21.9	22.3	22.1		
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	685	691	595		
	Ammonia as N (mg/L)	0.0482	0.0135	0.0435		
	Bicarbonate (HCO3) (mg/L)	835	843	726		
	Carbonate (CO3) (mg/L)	<5.0	<5.0	<5.0		
	Chloride (Cl) (mg/L)	92.3	84.2	40.8		
	Conductivity (EC) (uS/cm)	1610	1340	962		
	Fluoride (F) (mg/L)	<0.10 ^{DLDS}	<0.10 ^{DLDS}	0.20		
	Hydroxide (OH) (mg/L)	<5.0	<5.0	<5.0		
	Nitrate and Nitrite (as N) (mg/L)	3.23	0.417	0.028		
	Nitrate (as N) (mg/L)	3.23	0.408	0.028		
	Nitrite (as N) (mg/L)	<0.0050 ^{DLDS}	0.0094	<0.0050 ^{DLDS}		
	pH (pH)	7.28	7.30	7.55		
	Sulfate (SO4) (mg/L)	231	50.2	35.8		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0235 ^{DLDS}	0.0135 ^{DLDS}	<0.0010		
	Antimony (Sb)-Dissolved (mg/L)	<0.00050 ^{DLDS}	<0.00050 ^{DLDS}	0.00016		
	Arsenic (As)-Dissolved (mg/L)	<0.00050 ^{DLDS}	0.00322 ^{DLDS}	0.00288		
	Barium (Ba)-Dissolved (mg/L)	0.0851 ^{DLDS}	0.388 ^{DLDS}	0.154		
	Beryllium (Be)-Dissolved (mg/L)	<0.00010 ^{DLDS}	<0.00010 ^{DLDS}	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.00025 ^{DLDS}	<0.00025 ^{DLDS}	<0.000050		
	Boron (B)-Dissolved (mg/L)	0.157 ^{DLDS}	<0.050 ^{DLDS}	0.029		
	Cadmium (Cd)-Dissolved (mg/L)	0.000098 ^{DLDS}	0.000060 ^{DLDS}	0.0000216		
	Calcium (Ca)-Dissolved (mg/L)	211 ^{DLDS}	189 ^{DLDS}	109		
	Chromium (Cr)-Dissolved (mg/L)	0.00115 ^{DLDS}	0.00191 ^{DLDS}	0.00115		
	Cobalt (Co)-Dissolved (mg/L)	<0.00050 ^{DLDS}	0.00051 ^{DLDS}	0.00060		
	Copper (Cu)-Dissolved (mg/L)	0.0014 ^{DLDS}	<0.0010 ^{DLDS}	0.00020		
	Iron (Fe)-Dissolved (mg/L)	<0.050 ^{DLDS}	0.092 ^{DLDS}	0.565		
	Lead (Pb)-Dissolved (mg/L)	<0.00025 ^{DLDS}	<0.00025 ^{DLDS}	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	0.0200 ^{DLDS}	0.0220 ^{DLDS}	0.0182		
	Magnesium (Mg)-Dissolved (mg/L)	52.5 ^{DLDS}	44.1 ^{DLDS}	35.0		
	Manganese (Mn)-Dissolved (mg/L)	0.0164 ^{DLDS}	0.232 ^{DLDS}	0.387		
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050 ^{DLDS}	<0.0000050 ^{DLDS}	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00244 ^{DLDS}	0.00569 ^{DLDS}	0.00314		
	Nickel (Ni)-Dissolved (mg/L)	0.0037 ^{DLDS}	0.0094 ^{DLDS}	0.00726		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID		L2663297-1 GROUNDWATER 10-NOV-21 12:00 MW14-1	L2663297-2 GROUNDWATER 10-NOV-21 12:00 MW15-2	L2663297-3 GROUNDWATER 10-NOV-21 12:00 MW14-3		
Grouping	Analyte					
WATER						
Dissolved Metals	Phosphorus (P)-Dissolved (mg/L)	DLDS <0.25	DLDS <0.25	<0.050		
	Potassium (K)-Dissolved (mg/L)	DLDS 4.92	DLDS 2.84	2.10		
	Selenium (Se)-Dissolved (mg/L)	DLDS <0.00025	DLDS <0.00025	0.000217		
	Silicon (Si)-Dissolved (mg/L)	DLDS 7.36	DLDS 7.39	5.85		
	Silver (Ag)-Dissolved (mg/L)	DLDS <0.000050	DLDS <0.000050	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	DLDS 57.2	DLDS 20.4	12.2		
	Strontium (Sr)-Dissolved (mg/L)	DLDS 0.293	DLDS 0.333	0.481		
	Sulfur (S)-Dissolved (mg/L)	DLDS 74.9	DLDS 18.1	12.9		
	Thallium (Tl)-Dissolved (mg/L)	DLDS 0.000070	DLDS <0.000050	0.000058		
	Tin (Sn)-Dissolved (mg/L)	DLDS <0.00050	DLDS <0.00050	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	DLDS <0.0015	DLDS <0.0015	<0.00030		
	Uranium (U)-Dissolved (mg/L)	DLDS 0.00120	DLDS 0.00120	0.00245		
	Vanadium (V)-Dissolved (mg/L)	DLDS <0.0025	DLDS <0.0025	<0.00050		
	Zinc (Zn)-Dissolved (mg/L)	DLDS 0.0063	DLDS 0.0094	0.0031		
	Zirconium (Zr)-Dissolved (mg/L)	DLDS <0.0010	DLDS <0.0010	<0.00030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Qualifiers for Individual Parameters Listed:			
Qualifier	Description		
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.		

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-CL	Water	Diss. Be (low) in Water by CRC ICPMS Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS. Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.	APHA 3030B/6020A (mod)
CL-L-IC-N-CL	Water	Chloride in Water by IC Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.	EPA 300.1 (mod)
F-L-IC-CL	Water	Fluoride	APHA 4110 B-Ion Chromatography
HARDNESS-CALC-CL	Water	Hardness Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.	APHA 2340 B
HG-D-CVAA-CL	Water	Dissolved Mercury in Water by CVAAS Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS.	APHA 3030B/EPA 1631E (mod)
MET-D-CCMS-CL	Water	Dissolved Metals in Water by CRC ICPMS Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS. Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.	APHA 3030B/6020A (mod)
N2N3-CALC-CL	Water	Nitrate+Nitrite	CALCULATION
NH3-L-F-CL	Water	Ammonia, Total (as N) This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Weston et al.	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC
NO2-L-IC-N-CL	Water	Nitrite in Water by IC (Low Level) Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.	EPA 300.1 (mod)
NO3-L-IC-N-CL	Water	Nitrate in Water by IC (Low Level) Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.	EPA 300.1 (mod)
PH/EC/ALK-CL	Water	pH, Conductivity and Total Alkalinity All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed) pH measurement is determined from the activity of the hydrogen ions using a hydrogen electrode and a reference electrode. Alkalinity measurement is based on the sample's capacity to neutralize acid Conductivity measurement is based on the sample's capacity to convey an electric current	APHA 4500H,2510,2320
SO4-L-IC-N-CL	Water	Sulfate in Water by IC Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.	EPA 300.1 (mod)
TEMP-CL	Water	Temperature	APHA 2550-Thermometer

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg ww - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2663297

Report Date: 25-NOV-21

Page 1 of 6

Client: Sperling Hansen Associates Inc.
#8 - 1225 East Keith Road
North Vancouver BC V7J 1J3

Contact: Scott Garthwaite

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
BE-D-L-CCMS-CL Water								
Batch	R5653911							
WG3661410-6	LCS							
Beryllium (Be)-Dissolved			91.8		%		80-120	18-NOV-21
WG3661410-5	MB							
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	18-NOV-21
CL-L-IC-N-CL Water								
Batch	R5653519							
WG3660787-2	LCS							
Chloride (Cl)			101.7		%		85-115	17-NOV-21
WG3660787-1	MB							
Chloride (Cl)			<0.10		mg/L		0.1	17-NOV-21
F-L-IC-CL Water								
Batch	R5653519							
WG3660787-2	LCS							
Fluoride (F)			99.7		%		85-115	17-NOV-21
WG3660787-1	MB							
Fluoride (F)			<0.020		mg/L		0.02	17-NOV-21
HG-D-CVAA-CL Water								
Batch	R5652633							
WG3660347-2	LCS							
Mercury (Hg)-Dissolved			101.0		%		80-120	17-NOV-21
WG3660347-6	LCS							
Mercury (Hg)-Dissolved			93.9		%		80-120	17-NOV-21
WG3660347-1	MB							
Mercury (Hg)-Dissolved			<0.000005C		mg/L		0.000005	17-NOV-21
WG3660347-5	MB							
Mercury (Hg)-Dissolved			<0.000005C		mg/L		0.000005	17-NOV-21
MET-D-CCMS-CL Water								
Batch	R5653911							
WG3661410-6	LCS							
Aluminum (Al)-Dissolved			94.2		%		80-120	18-NOV-21
Antimony (Sb)-Dissolved			102.8		%		80-120	18-NOV-21
Arsenic (As)-Dissolved			92.4		%		80-120	18-NOV-21
Barium (Ba)-Dissolved			93.8		%		80-120	18-NOV-21
Bismuth (Bi)-Dissolved			96.5		%		80-120	18-NOV-21
Boron (B)-Dissolved			90.4		%		80-120	18-NOV-21
Cadmium (Cd)-Dissolved			93.1		%		80-120	18-NOV-21
Calcium (Ca)-Dissolved			93.9		%		80-120	18-NOV-21

Quality Control Report

Workorder: L2663297

Report Date: 25-NOV-21

Page 2 of 6

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	Water							
Batch	R5653911							
WG3661410-6	LCS							
Chromium (Cr)-Dissolved			96.5		%		80-120	18-NOV-21
Cobalt (Co)-Dissolved			96.4		%		80-120	18-NOV-21
Copper (Cu)-Dissolved			92.6		%		80-120	18-NOV-21
Iron (Fe)-Dissolved			91.5		%		80-120	18-NOV-21
Lead (Pb)-Dissolved			94.9		%		80-120	18-NOV-21
Lithium (Li)-Dissolved			98.3		%		80-120	18-NOV-21
Magnesium (Mg)-Dissolved			88.8		%		80-120	18-NOV-21
Manganese (Mn)-Dissolved			93.2		%		80-120	18-NOV-21
Molybdenum (Mo)-Dissolved			98.7		%		80-120	18-NOV-21
Nickel (Ni)-Dissolved			93.4		%		80-120	18-NOV-21
Phosphorus (P)-Dissolved			94.9		%		70-130	18-NOV-21
Potassium (K)-Dissolved			98.3		%		80-120	18-NOV-21
Selenium (Se)-Dissolved			91.4		%		80-120	18-NOV-21
Silicon (Si)-Dissolved			96.6		%		60-140	18-NOV-21
Silver (Ag)-Dissolved			97.2		%		80-120	18-NOV-21
Sodium (Na)-Dissolved			95.8		%		80-120	18-NOV-21
Strontium (Sr)-Dissolved			94.3		%		80-120	18-NOV-21
Sulfur (S)-Dissolved			105.1		%		80-120	18-NOV-21
Thallium (Tl)-Dissolved			96.1		%		80-120	18-NOV-21
Tin (Sn)-Dissolved			96.0		%		80-120	18-NOV-21
Titanium (Ti)-Dissolved			91.5		%		80-120	18-NOV-21
Uranium (U)-Dissolved			97.1		%		80-120	18-NOV-21
Vanadium (V)-Dissolved			98.3		%		80-120	18-NOV-21
Zinc (Zn)-Dissolved			90.6		%		80-120	18-NOV-21
Zirconium (Zr)-Dissolved			94.5		%		80-120	18-NOV-21
WG3661410-5	MB							
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	18-NOV-21
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	18-NOV-21
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	18-NOV-21
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	18-NOV-21
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	18-NOV-21
Boron (B)-Dissolved			<0.010		mg/L		0.01	18-NOV-21
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	18-NOV-21
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	18-NOV-21



Workorder: L2663297

Page 3 of 6

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL		Water						
Batch	R5653911							
WG3661410-5		MB						
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	18-NOV-21
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	18-NOV-21
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	18-NOV-21
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	18-NOV-21
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	18-NOV-21
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	18-NOV-21
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	18-NOV-21
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	18-NOV-21
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	18-NOV-21
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	18-NOV-21
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	18-NOV-21
Potassium (K)-Dissolved			<0.050		mg/L		0.05	18-NOV-21
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	18-NOV-21
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	18-NOV-21
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	18-NOV-21
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	18-NOV-21
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	18-NOV-21
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	18-NOV-21
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	18-NOV-21
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	18-NOV-21
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	18-NOV-21
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	18-NOV-21
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	18-NOV-21
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	18-NOV-21
Zirconium (Zr)-Dissolved			<0.00020		mg/L		0.0002	18-NOV-21
NH3-L-F-CL		Water						
Batch	R5656585							
WG3664205-6		LCS						
Ammonia as N			101.6		%		85-115	23-NOV-21
WG3664205-5		MB						
Ammonia as N			<0.0050		mg/L		0.005	23-NOV-21
NO2-L-IC-N-CL		Water						

Quality Control Report

Workorder: L2663297

Report Date: 25-NOV-21

Page 4 of 6

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-L-IC-N-CL	Water							
Batch	R5653519							
WG3660787-2 LCS								
Nitrite (as N)			103.1		%		90-110	17-NOV-21
WG3660787-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	17-NOV-21
NO3-L-IC-N-CL	Water							
Batch	R5653519							
WG3660787-2 LCS								
Nitrate (as N)			102.6		%		90-110	17-NOV-21
WG3660787-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	17-NOV-21
PH/EC/ALK-CL	Water							
Batch	R5653667							
WG3660920-8 LCS								
Conductivity (EC)			99.5		%		90-110	17-NOV-21
Alkalinity, Total (as CaCO3)			110.2		%		85-115	17-NOV-21
WG3660920-7 MB								
Conductivity (EC)			<2.0		uS/cm		2	17-NOV-21
Bicarbonate (HCO3)			<5.0		mg/L		5	17-NOV-21
Carbonate (CO3)			<5.0		mg/L		5	17-NOV-21
Hydroxide (OH)			<5.0		mg/L		5	17-NOV-21
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	17-NOV-21
SO4-L-IC-N-CL	Water							
Batch	R5653519							
WG3660787-2 LCS								
Sulfate (SO4)			104.6		%		85-115	17-NOV-21
WG3660787-1 MB								
Sulfate (SO4)			<0.050		mg/L		0.05	17-NOV-21

Quality Control Report

Workorder: L2663297

Report Date: 25-NOV-21

Page 5 of 6

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Quality Control Report

Workorder: L2663297

Report Date: 25-NOV-21

Page 6 of 6

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Anions and Nutrients							
Nitrate in Water by IC (Low Level)	1	10-NOV-21 12:00	17-NOV-21 09:51	3	7	days	EHTR
	2	10-NOV-21 12:00	17-NOV-21 09:51	3	7	days	EHTR
	3	10-NOV-21 12:00	17-NOV-21 09:51	3	7	days	EHTR
Nitrite in Water by IC (Low Level)	1	10-NOV-21 12:00	17-NOV-21 09:51	3	7	days	EHTR
	2	10-NOV-21 12:00	17-NOV-21 09:51	3	7	days	EHTR
	3	10-NOV-21 12:00	17-NOV-21 09:51	3	7	days	EHTR

Legend & Qualifier Definitions:

EHTR-FM: Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR: Exceeded ALS recommended hold time prior to sample receipt.
EHTL: Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT: Exceeded ALS recommended hold time prior to analysis.
Rec. HT: ALS recommended hold time (see units).

Notes*:

Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2663297 were received on 16-NOV-21 08:50.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.



COC Number: 20 -

Canada Toll Free: 1 800 668 9878

Page of

Report To Contact and company name below will appear on the final report		Reports / Recipients		Turnaround Time (TAT) Requested		AFFIX ALS BARCODE LABEL HERE (ALS use only)			
Company: Sperling Hansen Associates Inc.		Select Report Format: <input type="checkbox"/> PDF <input checked="" type="checkbox"/> EXCEL <input type="checkbox"/> EDD (DIGITAL)		<input checked="" type="checkbox"/> Routine [R] if received by 3pm M-F - no surcharges apply					
Contact: Scott Garthwaite		Merge QC/QCI Reports with COA <input type="checkbox"/> YES <input type="checkbox"/> NO <input type="checkbox"/> N/A		<input type="checkbox"/> 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimum					
Phone: 778-471-7088		<input checked="" type="checkbox"/> Compare Results to Criteria on Report - provide details below if box checked		<input type="checkbox"/> 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimum					
Company address below will appear on the final report		Select Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX		<input type="checkbox"/> 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimum					
Street: 1225 East Keith Road		Email 1 or Fax: sgarthwaite@sperlinghansen.com		<input type="checkbox"/> 1 day [E] if received by 3pm M-F - 100% rush surcharge minimum					
City/Province: North Vancouver, B.C.		Email 2: chetherington@sperlinghansen.com		Same day [E2] if received by 10am M-S - 200% rush surcharge. Additional fees may apply to rush requests on weekends, statutory holidays and non-routine tests					
Postal Code: V7J 1J3		Email 3:		Date and Time Required for all E&P TATs:		dd-mmm-yy hh:mm am/pm			
Invoice To		Invoice Recipients		For all tests with rush TATs requested, please contact your AM to confirm availability.					
Same as Report To <input checked="" type="checkbox"/> YES <input checked="" type="checkbox"/> NO		Select Invoice Distribution: <input checked="" type="checkbox"/> EMAIL <input type="checkbox"/> MAIL <input type="checkbox"/> FAX							
Copy of Invoice with Report <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO		Email 1 or Fax: chetherington@sperlinghansen.com							
Company:		Email 2:							
Contact:		Email 3:							
Project Information		Oil and Gas Required Fields (client use)		Analysis Request					
ALS Account # / Quote #: Q80923		AFE/Cost Center:		Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below					
Job #: 20050 Sparwood		Major/Minor Code:							
PO / AFE:		Requisitioner:							
LSD:		Location:							
ALS Lab Work Order # (ALS use only):		ALS Contact: Dean Watt		Sampler: TM					
ALS Sample # (ALS use only)		Sample Identification and/or Coordinates (This description will appear on the report)		Date (dd-mmm-yy)		Time (hh:mm)		Sample Type	
1		MW14-1		10-11-21				Groundwater	
2		MW14-4		10-11-21				Groundwater	
3		MW15-2		10-11-21				Groundwater	
4		MW14-3		10-11-21				Groundwater	
5		MW14-2		10-11-21				Groundwater	
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REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY - YELLOW - CLIENT COPY

AL 16 2030 FROM

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.



Sperling Hansen Associates Inc.
ATTN: Scott Garthwaite
#8 - 1225 East Keith Road
North Vancouver BC V7J 1J3

Date Received: 19-JAN-21
Report Date: 26-JAN-21 12:59 (MT)
Version: FINAL

Client Phone: 604-986-7723

Certificate of Analysis

Lab Work Order #: L2549477
Project P.O. #: NOT SUBMITTED
Job Reference: 20050 SPARWOOD
C of C Numbers:
Legal Site Desc:

Patryk Wojciak, B.Sc., P.Chem.
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 2559 29 Street NE, Calgary, AB T1Y 7B5 Canada | Phone: +1 403 291 9897 | Fax: +1 403 291 0298
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID		L2549477-1 Groundwater 14-JAN-21 12:00 MW14-4	L2549477-2 Groundwater 14-JAN-21 12:00 MW15-2	L2549477-3 Groundwater 14-JAN-21 12:00 MW14-3		
Grouping	Analyte					
WATER						
Physical Tests	Hardness (as CaCO ₃) (mg/L)	454	815	464		
	Total Suspended Solids (mg/L)	625 ^{DLHC}	2700 ^{DLHC}	314 ^{DLHC}		
Anions and Nutrients	Alkalinity, Total (as CaCO ₃) (mg/L)	409	610	380		
	Ammonia as N (mg/L)	<0.0050	0.0096	0.0275		
	Bicarbonate (HCO ₃) (mg/L)	499	744	463		
	Carbonate (CO ₃) (mg/L)	<5.0	<5.0	<5.0		
	Chloride (Cl) (mg/L)	48.1 ^{DLHC}	92.2 ^{DLHC}	36.2		
	Conductivity (EC) (uS/cm)	847	1270	738		
	Fluoride (F) (mg/L)	0.10 ^{DLHC}	<0.10 ^{DLHC}	0.304		
	Hydroxide (OH) (mg/L)	<5.0	<5.0	<5.0		
	Nitrate and Nitrite (as N) (mg/L)	0.087	0.352	<0.0051		
	Nitrate (as N) (mg/L)	0.087 ^{DLHC}	0.352 ^{DLHC}	<0.0050		
	Nitrite (as N) (mg/L)	<0.0050 ^{DLHC}	<0.0050 ^{DLHC}	<0.0010		
	pH (pH)	7.69	7.03	7.73		
	Sulfate (SO ₄) (mg/L)	27.3 ^{DLHC}	50.0 ^{DLHC}	34.2		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0013	0.0015	0.0016		
	Antimony (Sb)-Dissolved (mg/L)	0.00021	0.00014	<0.00010		
	Arsenic (As)-Dissolved (mg/L)	<0.00010	0.00021	0.00023		
	Barium (Ba)-Dissolved (mg/L)	0.190	0.460	0.129		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	0.024	0.027	0.030		
	Cadmium (Cd)-Dissolved (mg/L)	0.0000701	0.0000926	0.0000315		
	Calcium (Ca)-Dissolved (mg/L)	130	237	119		
	Chromium (Cr)-Dissolved (mg/L)	0.00450	0.00245	0.00159		
	Cobalt (Co)-Dissolved (mg/L)	0.00099	0.00453	0.00173		
	Copper (Cu)-Dissolved (mg/L)	0.00089	0.00155	0.00031		
	Iron (Fe)-Dissolved (mg/L)	0.049	0.035	0.206		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	0.0155	0.0243	0.0195		
	Magnesium (Mg)-Dissolved (mg/L)	31.3	54.0	40.3		
	Manganese (Mn)-Dissolved (mg/L)	0.0280	0.229	0.355		
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00204	0.00420	0.00251		
	Nickel (Ni)-Dissolved (mg/L)	0.00451	0.0115	0.00403		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID		L2549477-1 Groundwater 14-JAN-21 12:00 MW14-4	L2549477-2 Groundwater 14-JAN-21 12:00 MW15-2	L2549477-3 Groundwater 14-JAN-21 12:00 MW14-3		
Grouping	Analyte					
WATER						
Dissolved Metals	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Dissolved (mg/L)	1.46	3.08	1.86		
	Selenium (Se)-Dissolved (mg/L)	0.000108	0.000094	0.000057		
	Silicon (Si)-Dissolved (mg/L)	5.24	8.29	5.99		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	22.4	24.0	11.8		
	Strontium (Sr)-Dissolved (mg/L)	0.364	0.364	0.512		
	Sulfur (S)-Dissolved (mg/L)	9.66	19.1	12.5		
	Thallium (Tl)-Dissolved (mg/L)	0.000047	0.000047	0.000054		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		
	Uranium (U)-Dissolved (mg/L)	0.000523	0.00127	0.00204		
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050		
	Zinc (Zn)-Dissolved (mg/L)	0.0100	0.0243	0.0064		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
EHR	Exceeded Recommended Holding Time prior to receipt at the lab. - NO3/NO2 went past hold time prior to receipt at ALS

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-CL	Water	Diss. Be (low) in Water by CRC ICPMS Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS. Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.	APHA 3030B/6020A (mod)
CL-L-IC-N-CL	Water	Chloride in Water by IC Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.	EPA 300.1 (mod)
F-L-IC-CL	Water	Fluoride	APHA 4110 B-Ion Chromatography
HARDNESS-CALC-CL	Water	Hardness Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.	APHA 2340 B
HG-D-CVAA-CL	Water	Dissolved Mercury in Water by CVAAS Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS.	APHA 3030B/EPA 1631E (mod)
MET-D-CCMS-CL	Water	Dissolved Metals in Water by CRC ICPMS Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS. Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.	APHA 3030B/6020A (mod)
N2N3-CALC-CL	Water	Nitrate+Nitrite	CALCULATION
NH3-L-F-CL	Water	Ammonia, Total (as N) This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC
NO2-L-IC-N-CL	Water	Nitrite in Water by IC (Low Level) Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.	EPA 300.1 (mod)
NO3-L-IC-N-CL	Water	Nitrate in Water by IC (Low Level) Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.	EPA 300.1 (mod)
PH/EC/ALK-CL	Water	pH, Conductivity and Total Alkalinity All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed) pH measurement is determined from the activity of the hydrogen ions using a hydrogen electrode and a reference electrode. Alkalinity measurement is based on the sample's capacity to neutralize acid Conductivity measurement is based on the sample's capacity to convey an electric current	APHA 4500H,2510,2320
SO4-L-IC-N-CL	Water	Sulfate in Water by IC Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.	EPA 300.1 (mod)
TSS-L-CL	Water	Total Suspended Solids This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total suspended solids (TSS) are determined by filtering a sample through a glass fibre filter, and by drying the filter at 104 deg. C.	APHA 2540 D-Gravimetric

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Reference Information

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg ww - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2549477

Report Date: 26-JAN-21

Page 2 of 11

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL		Water						
Batch	R5357483							
WG3478433-3	DUP	L2549477-1						
Aluminum (Al)-Dissolved		0.0013	<0.0010	RPD-NA	mg/L	N/A	20	25-JAN-21
Antimony (Sb)-Dissolved		0.00021	0.00017		mg/L	20	20	25-JAN-21
Arsenic (As)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	25-JAN-21
Barium (Ba)-Dissolved		0.190	0.194		mg/L	2.3	20	25-JAN-21
Bismuth (Bi)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	25-JAN-21
Boron (B)-Dissolved		0.024	0.024		mg/L	1.2	20	25-JAN-21
Cadmium (Cd)-Dissolved		0.0000701	0.0000668		mg/L	4.9	20	25-JAN-21
Calcium (Ca)-Dissolved		130	135		mg/L	3.6	20	25-JAN-21
Chromium (Cr)-Dissolved		0.00450	0.00447		mg/L	0.8	20	25-JAN-21
Cobalt (Co)-Dissolved		0.00099	0.00101		mg/L	1.8	20	25-JAN-21
Copper (Cu)-Dissolved		0.00089	0.00096		mg/L	8.4	20	25-JAN-21
Iron (Fe)-Dissolved		0.049	0.050		mg/L	1.9	20	25-JAN-21
Lead (Pb)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	25-JAN-21
Lithium (Li)-Dissolved		0.0155	0.0164		mg/L	5.9	20	25-JAN-21
Magnesium (Mg)-Dissolved		31.3	32.5		mg/L	3.9	20	25-JAN-21
Manganese (Mn)-Dissolved		0.0280	0.0287		mg/L	2.3	20	25-JAN-21
Molybdenum (Mo)-Dissolved		0.00204	0.00210		mg/L	3.0	20	25-JAN-21
Nickel (Ni)-Dissolved		0.00451	0.00460		mg/L	1.8	20	25-JAN-21
Phosphorus (P)-Dissolved		<0.050	<0.050	RPD-NA	mg/L	N/A	20	25-JAN-21
Potassium (K)-Dissolved		1.46	1.49		mg/L	1.8	20	25-JAN-21
Selenium (Se)-Dissolved		0.000108	0.000092		mg/L	16	20	25-JAN-21
Silicon (Si)-Dissolved		5.24	5.41		mg/L	3.1	20	25-JAN-21
Silver (Ag)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	25-JAN-21
Sodium (Na)-Dissolved		22.4	23.2		mg/L	3.5	20	25-JAN-21
Strontium (Sr)-Dissolved		0.364	0.378		mg/L	3.8	20	25-JAN-21
Sulfur (S)-Dissolved		9.66	9.88		mg/L	2.3	20	25-JAN-21
Thallium (Tl)-Dissolved		0.000047	0.000043		mg/L	7.5	20	25-JAN-21
Tin (Sn)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	25-JAN-21
Titanium (Ti)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	25-JAN-21
Uranium (U)-Dissolved		0.000523	0.000557		mg/L	6.4	20	25-JAN-21
Vanadium (V)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	25-JAN-21
Zinc (Zn)-Dissolved		0.0100	0.0099		mg/L	0.7	20	25-JAN-21
Zirconium (Zr)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	25-JAN-21
WG3478433-2	LCS	TMRM						

Quality Control Report

Workorder: L2549477

Report Date: 26-JAN-21

Page 3 of 11

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	Water							
Batch	R5357483							
WG3478433-2	LCS	TMRM						
Aluminum (Al)-Dissolved			102.1		%		80-120	25-JAN-21
Antimony (Sb)-Dissolved			107.8		%		80-120	25-JAN-21
Arsenic (As)-Dissolved			104.0		%		80-120	25-JAN-21
Barium (Ba)-Dissolved			106.1		%		80-120	25-JAN-21
Bismuth (Bi)-Dissolved			104.4		%		80-120	25-JAN-21
Boron (B)-Dissolved			101.6		%		80-120	25-JAN-21
Cadmium (Cd)-Dissolved			103.0		%		80-120	25-JAN-21
Calcium (Ca)-Dissolved			102.5		%		80-120	25-JAN-21
Chromium (Cr)-Dissolved			103.4		%		80-120	25-JAN-21
Cobalt (Co)-Dissolved			102.5		%		80-120	25-JAN-21
Copper (Cu)-Dissolved			103.5		%		80-120	25-JAN-21
Iron (Fe)-Dissolved			98.2		%		80-120	25-JAN-21
Lead (Pb)-Dissolved			104.3		%		80-120	25-JAN-21
Lithium (Li)-Dissolved			101.8		%		80-120	25-JAN-21
Magnesium (Mg)-Dissolved			111.8		%		80-120	25-JAN-21
Manganese (Mn)-Dissolved			106.7		%		80-120	25-JAN-21
Molybdenum (Mo)-Dissolved			103.5		%		80-120	25-JAN-21
Nickel (Ni)-Dissolved			100.6		%		80-120	25-JAN-21
Phosphorus (P)-Dissolved			103.0		%		70-130	25-JAN-21
Potassium (K)-Dissolved			110.8		%		80-120	25-JAN-21
Selenium (Se)-Dissolved			99.4		%		80-120	25-JAN-21
Silicon (Si)-Dissolved			108.2		%		60-140	25-JAN-21
Silver (Ag)-Dissolved			100.9		%		80-120	25-JAN-21
Sodium (Na)-Dissolved			108.8		%		80-120	25-JAN-21
Strontium (Sr)-Dissolved			101.8		%		80-120	25-JAN-21
Sulfur (S)-Dissolved			108.5		%		80-120	25-JAN-21
Thallium (Tl)-Dissolved			108.8		%		80-120	25-JAN-21
Tin (Sn)-Dissolved			106.6		%		80-120	25-JAN-21
Titanium (Ti)-Dissolved			99.98		%		80-120	25-JAN-21
Uranium (U)-Dissolved			97.2		%		80-120	25-JAN-21
Vanadium (V)-Dissolved			105.3		%		80-120	25-JAN-21
Zinc (Zn)-Dissolved			102.7		%		80-120	25-JAN-21
Zirconium (Zr)-Dissolved			93.5		%		80-120	25-JAN-21
WG3478433-6	LCS	TMRM						

Quality Control Report

Workorder: L2549477

Report Date: 26-JAN-21

Page 4 of 11

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	Water							
Batch	R5357483							
WG3478433-6	LCS	TMRM						
Aluminum (Al)-Dissolved			101.0		%		80-120	25-JAN-21
Antimony (Sb)-Dissolved			107.9		%		80-120	25-JAN-21
Arsenic (As)-Dissolved			103.1		%		80-120	25-JAN-21
Barium (Ba)-Dissolved			105.3		%		80-120	25-JAN-21
Bismuth (Bi)-Dissolved			109.9		%		80-120	25-JAN-21
Boron (B)-Dissolved			115.7		%		80-120	25-JAN-21
Cadmium (Cd)-Dissolved			94.6		%		80-120	25-JAN-21
Calcium (Ca)-Dissolved			100.4		%		80-120	25-JAN-21
Chromium (Cr)-Dissolved			101.8		%		80-120	25-JAN-21
Cobalt (Co)-Dissolved			102.2		%		80-120	25-JAN-21
Copper (Cu)-Dissolved			101.8		%		80-120	25-JAN-21
Iron (Fe)-Dissolved			89.6		%		80-120	25-JAN-21
Lead (Pb)-Dissolved			110.0		%		80-120	25-JAN-21
Lithium (Li)-Dissolved			99.5		%		80-120	25-JAN-21
Magnesium (Mg)-Dissolved			110.6		%		80-120	25-JAN-21
Manganese (Mn)-Dissolved			105.8		%		80-120	25-JAN-21
Molybdenum (Mo)-Dissolved			101.8		%		80-120	25-JAN-21
Nickel (Ni)-Dissolved			104.6		%		80-120	25-JAN-21
Phosphorus (P)-Dissolved			99.6		%		70-130	25-JAN-21
Potassium (K)-Dissolved			103.4		%		80-120	25-JAN-21
Selenium (Se)-Dissolved			98.1		%		80-120	25-JAN-21
Silicon (Si)-Dissolved			108.1		%		60-140	25-JAN-21
Silver (Ag)-Dissolved			101.6		%		80-120	25-JAN-21
Sodium (Na)-Dissolved			108.1		%		80-120	25-JAN-21
Strontium (Sr)-Dissolved			114.8		%		80-120	25-JAN-21
Sulfur (S)-Dissolved			86.5		%		80-120	25-JAN-21
Thallium (Tl)-Dissolved			106.3		%		80-120	25-JAN-21
Tin (Sn)-Dissolved			105.7		%		80-120	25-JAN-21
Titanium (Ti)-Dissolved			105.7		%		80-120	25-JAN-21
Uranium (U)-Dissolved			104.6		%		80-120	25-JAN-21
Vanadium (V)-Dissolved			102.2		%		80-120	25-JAN-21
Zinc (Zn)-Dissolved			101.5		%		80-120	25-JAN-21
Zirconium (Zr)-Dissolved			94.3		%		80-120	25-JAN-21
WG3478433-1	MB							

Quality Control Report

Workorder: L2549477

Report Date: 26-JAN-21

Page 5 of 11

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	Water							
Batch	R5357483							
WG3478433-1 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	25-JAN-21
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	25-JAN-21
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	25-JAN-21
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	25-JAN-21
Boron (B)-Dissolved			<0.010		mg/L		0.01	25-JAN-21
Boron (B)-Dissolved			<0.010		mg/L		0.01	25-JAN-21
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	25-JAN-21
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	25-JAN-21
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	25-JAN-21
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	25-JAN-21
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	25-JAN-21
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	25-JAN-21
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	25-JAN-21
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	25-JAN-21
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	25-JAN-21
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	25-JAN-21
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	25-JAN-21
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	25-JAN-21
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	25-JAN-21
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	25-JAN-21
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	25-JAN-21
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	25-JAN-21

Quality Control Report

Workorder: L2549477

Report Date: 26-JAN-21

Page 6 of 11

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL		Water						
Batch R5357483								
WG3478433-1 MB								
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	25-JAN-21
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	25-JAN-21
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	25-JAN-21
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	25-JAN-21
Potassium (K)-Dissolved			<0.050		mg/L		0.05	25-JAN-21
Potassium (K)-Dissolved			<0.050		mg/L		0.05	25-JAN-21
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	25-JAN-21
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	25-JAN-21
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	25-JAN-21
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	25-JAN-21
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	25-JAN-21
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	25-JAN-21
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	25-JAN-21
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	25-JAN-21
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	25-JAN-21
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	25-JAN-21
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	25-JAN-21
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	25-JAN-21
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	25-JAN-21
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	25-JAN-21
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	25-JAN-21
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	25-JAN-21
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	25-JAN-21
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	25-JAN-21
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	25-JAN-21
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	25-JAN-21
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	25-JAN-21
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	25-JAN-21
Zirconium (Zr)-Dissolved			<0.00020		mg/L		0.0002	25-JAN-21
Zirconium (Zr)-Dissolved			<0.00020		mg/L		0.0002	25-JAN-21
WG3478433-5 MB								
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	25-JAN-21

Quality Control Report

Workorder: L2549477

Report Date: 26-JAN-21

Page 7 of 11

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	Water							
Batch	R5357483							
WG3478433-5 MB								
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	25-JAN-21
Boron (B)-Dissolved			<0.010		mg/L		0.01	25-JAN-21
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	25-JAN-21
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	25-JAN-21
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	25-JAN-21
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	25-JAN-21
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	25-JAN-21
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	25-JAN-21
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	25-JAN-21
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	25-JAN-21
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	25-JAN-21
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	25-JAN-21
Potassium (K)-Dissolved			<0.050		mg/L		0.05	25-JAN-21
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	25-JAN-21
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	25-JAN-21
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	25-JAN-21
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	25-JAN-21
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	25-JAN-21
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	25-JAN-21
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	25-JAN-21
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	25-JAN-21
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	25-JAN-21
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	25-JAN-21
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	25-JAN-21
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	25-JAN-21
Zirconium (Zr)-Dissolved			<0.00020		mg/L		0.0002	25-JAN-21
NH3-L-F-CL	Water							

Quality Control Report

Workorder: L2549477

Report Date: 26-JAN-21

Page 8 of 11

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-L-F-CL	Water							
Batch	R5356695							
WG3477416-2 LCS								
Ammonia as N			93.9		%		85-115	22-JAN-21
WG3477416-1 MB								
Ammonia as N			<0.0050		mg/L		0.005	22-JAN-21
NO2-L-IC-N-CL	Water							
Batch	R5356914							
WG3477689-2 LCS								
Nitrite (as N)			105.8		%		90-110	19-JAN-21
WG3477689-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	19-JAN-21
NO3-L-IC-N-CL	Water							
Batch	R5356914							
WG3477689-2 LCS								
Nitrate (as N)			106.4		%		90-110	19-JAN-21
WG3477689-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	19-JAN-21
PH/EC/ALK-CL	Water							
Batch	R5355666							
WG3476222-14 LCS								
Conductivity (EC)			98.0		%		90-110	19-JAN-21
Alkalinity, Total (as CaCO3)			101.9		%		85-115	19-JAN-21
WG3476222-13 MB								
Conductivity (EC)			<2.0		uS/cm		2	19-JAN-21
Bicarbonate (HCO3)			<5.0		mg/L		5	19-JAN-21
Carbonate (CO3)			<5.0		mg/L		5	19-JAN-21
Hydroxide (OH)			<5.0		mg/L		5	19-JAN-21
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	19-JAN-21
SO4-L-IC-N-CL	Water							
Batch	R5356914							
WG3477689-2 LCS								
Sulfate (SO4)			106.0		%		85-115	19-JAN-21
WG3477689-1 MB								
Sulfate (SO4)			<0.050		mg/L		0.05	19-JAN-21
TSS-L-CL	Water							



Quality Control Report

Workorder: L2549477

Report Date: 26-JAN-21

Page 9 of 11

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TSS-L-CL	Water							
Batch	R5355961							
WG3475471-8	LCS							
Total Suspended Solids			100.8		%		85-115	20-JAN-21
WG3475471-7	MB							
Total Suspended Solids			<1.0		mg/L		1	20-JAN-21

Quality Control Report

Workorder: L2549477

Report Date: 26-JAN-21

Page 10 of 11

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Workorder: L2549477

Report Date: 26-JAN-21

Page 11 of 11

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Anions and Nutrients							
Nitrate in Water by IC (Low Level)							
	1	14-JAN-21 12:00	19-JAN-21 10:00	3	5	days	EHTR
	2	14-JAN-21 12:00	19-JAN-21 10:00	3	5	days	EHTR
	3	14-JAN-21 12:00	19-JAN-21 10:00	3	5	days	EHTR
Nitrite in Water by IC (Low Level)							
	1	14-JAN-21 12:00	19-JAN-21 10:00	3	5	days	EHTR
	2	14-JAN-21 12:00	19-JAN-21 10:00	3	5	days	EHTR
	3	14-JAN-21 12:00	19-JAN-21 10:00	3	5	days	EHTR

Legend & Qualifier Definitions:

EHTR-FM: Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR: Exceeded ALS recommended hold time prior to sample receipt.
EHTL: Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT: Exceeded ALS recommended hold time prior to analysis.
Rec. HT: ALS recommended hold time (see units).

Notes*:

Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2549477 were received on 19-JAN-21 08:50.

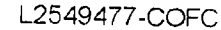
ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.



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[illegible]

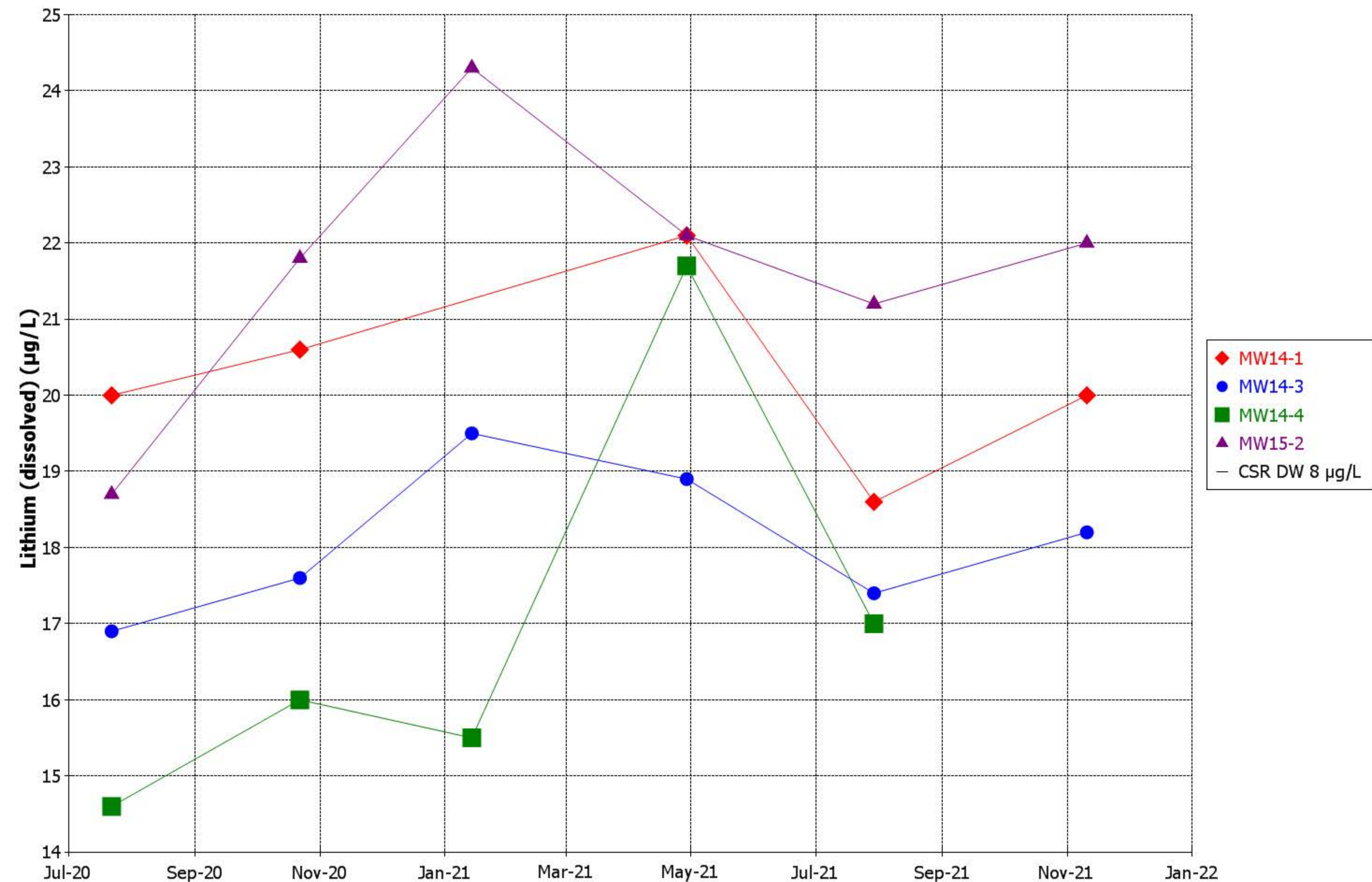
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Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

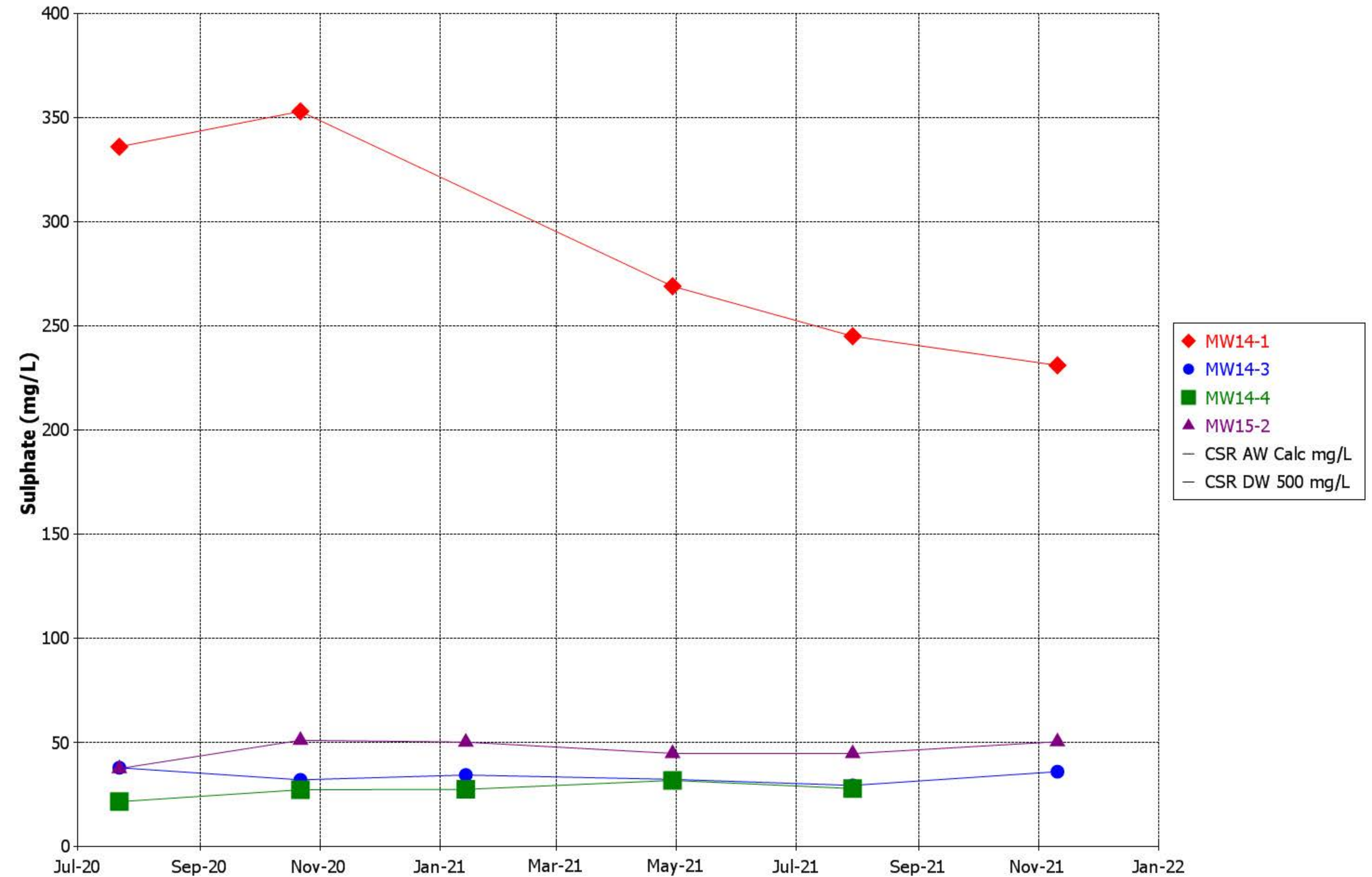
1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

APPENDIX D
Trending Figures

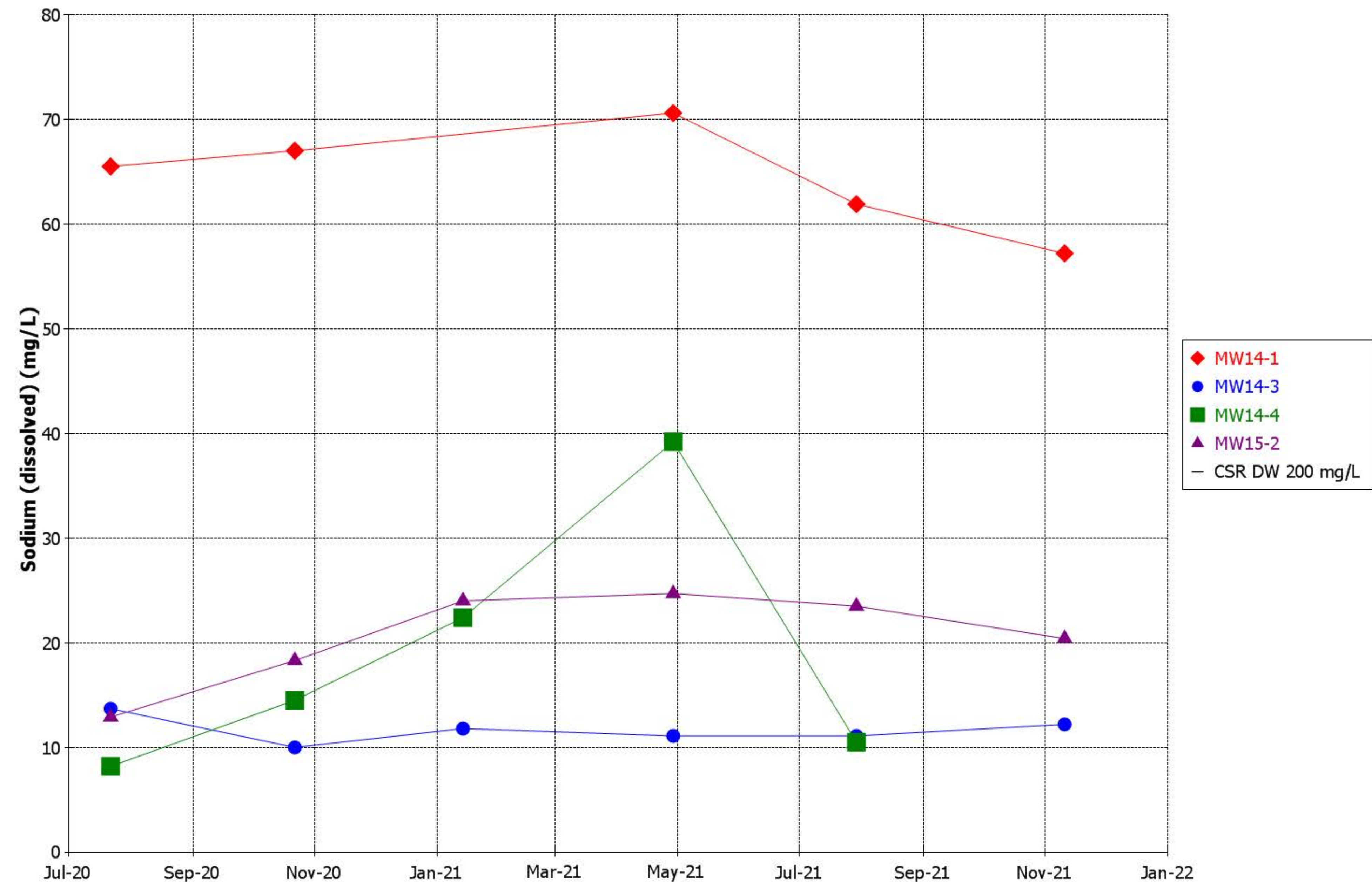
Time Series Plot For Lithium (dissolved) Sparwood Landfill



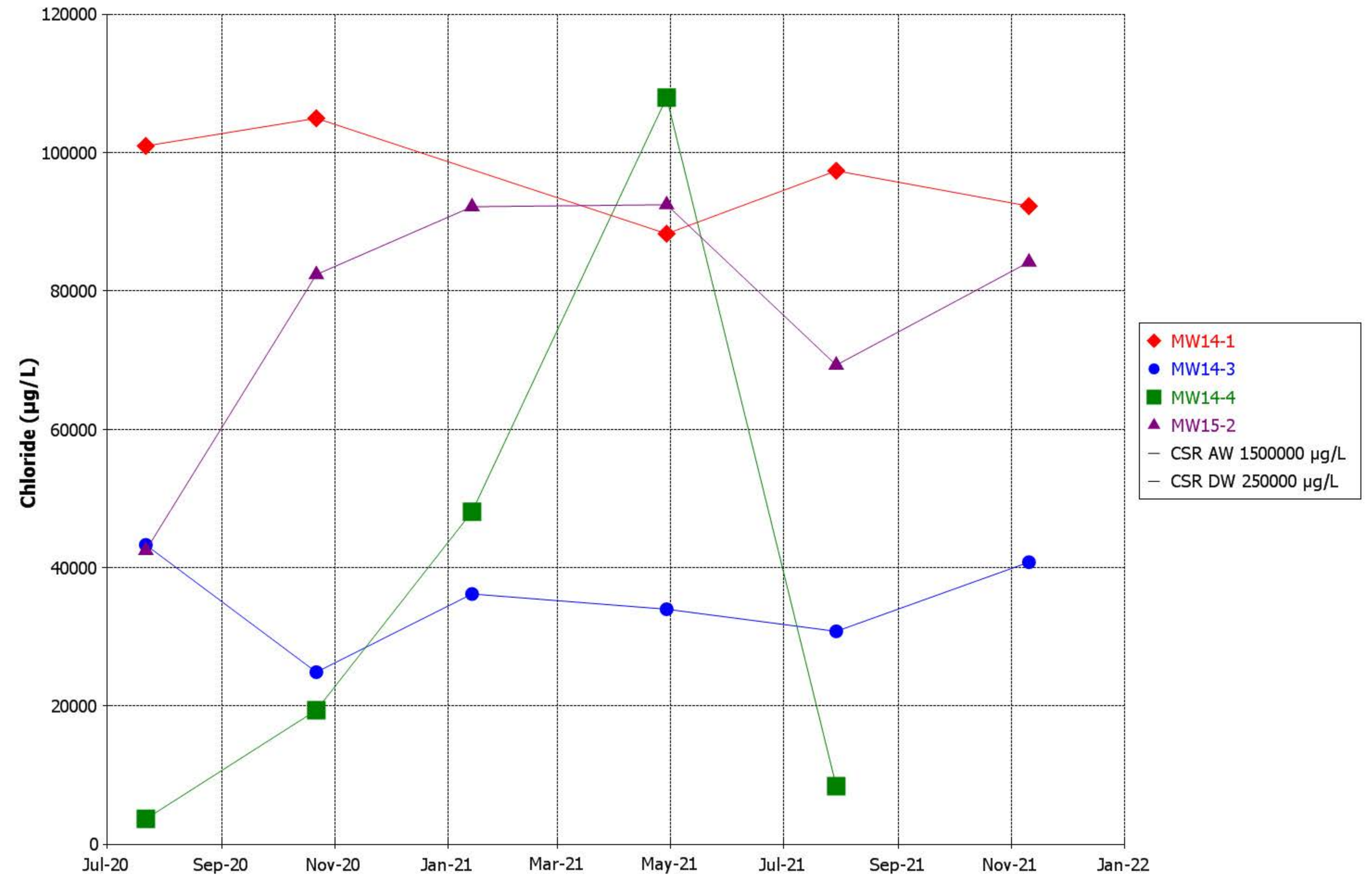
Time Series Plot For Sulphate Sparwood Landfill



Time Series Plot For Sodium (dissolved) Sparwood Landfill



Time Series Plot For Chloride Sparwood Landfill



Time Series Plot For Nitrate (as N) Sparwood Landfill

