INFRASTRUCTURE SERVICES COMMITTEE

Thursday, January 24, 2019
SCRD Boardroom, 1975 Field Road, Sechelt, B.C.

AGENDA

CALL TO ORDER 9:30 a.m.

AGENDA

1. Adoption of Agenda

PRESENTATIONS AND DELEGATIONS

2. Marta Green, Associated Environmental Consultants Inc. — Verbal
Regarding Groundwater Investigation Phase 2

REPORTS

3. General Manager, Infrastructure Services — Annex A
Groundwater Investigation Phase 2 Results — pp 1 - 232
(Voting – A, B, D E, F, Sechelt)

4. General Manager, Corporate Services / Chief Financial Officer — Annex B
Regional Water Service Area 2019 Rate Bylaw Amendment — pp 233 - 237
(Voting – A, B, D, E, F, Sechelt)

5. General Manager, Corporate Services / Chief Financial Officer — Annex C
South Pender Harbour Water Service Area 2019 Rate Bylaw Amendment — pp 238 – 241
(Voting – All)

6. General Manager, Corporate Services / Chief Financial Officer — Annex D
North Pender Harbour Water Service Area 2019 Rate Bylaw Amendment — pp 242 – 245
(Voting – All)

7. Manager, Financial Services — Annex E
Bylaw 627 Administrative Fees and Charges — pp 246 – 250
(Voting – All)

8. General Manager, Infrastructure Services — Annex F
2018 WildSafeBC Sunshine Coast Annual Report — pp 251 – 267
(Voting – All)

9.	General Manager, Infrastructure Services Transit Service Overview **(Voting – B, D, E, F, Sechelt, SIGD, Gibsons)**	Annex G pp 268 – 274
10.	General Manager, Corporate Services / Chief Financial Officer BC Transit Annual Operating Agreement (AOA) **(Voting – B, D, E, F, Sechelt, SIGD, Gibsons)**	Annex H pp 275 – 279
11.	Deputy Corporate Officer 2019 Resolutions to the Association of Vancouver Island and Coastal Communities (AVICC) **(Voting – All)**	Annex I pp 280 – 281
12.	Infrastructure Services Department – 2018 Q4 Report **(Voting – All)**	Annex J pp 282 – 296

COMMUNICATIONS

NEW BUSINESS

IN CAMERA

ADJOURNMENT

SUNSHINE COAST REGIONAL DISTRICT STAFF REPORT

TO: Infrastructure Committee Meeting - January 24, 2019

AUTHOR: Remko Rosenboom – General Manager, Infrastructure Services

SUBJECT: **GROUNDWATER INVESTIGATION PHASE 2 RESULTS**

RECOMMENDATION(S)

THAT the report titled Groundwater Investigation Phase 2 Results be received;

AND THAT a 2019 Round 1 budget proposal with respect to the permitting phase for a well field in the Church Road area be brought forward;

AND THAT the Dusty Road site not be pursued at this time;

AND FURTHER THAT a feasibility report with respect to a production well on the Gray Creek site and Mahan Road site be brought to Committee in Q4 2019.

BACKGROUND

The following resolution was adopted at the regular Board meeting of April 26, 2018:

Infrastructure **It was moved and seconded**

138/18 **Recommendation No. 1** *Phase 2 Test Drilling of the Groundwater Investigation*

THAT the report titled Phase 2 Test Drilling of the Groundwater Investigation be received;

AND THAT the SCRD proceed with Phase 2 of the Groundwater Investigation and that staff bring forward future reports with the results and analysis;

AND THAT the SCRD exchange information with local governments, First Nations and other potentially affected parties on Phase 2 Test Drilling of the Groundwater Investigation;

AND THAT the SCRD collaborate on a framework with the Town of Gibsons and the Sḵwx̱wú7mesh Nation to establish a Groundwater Management Zone and plan related to the Gibsons Aquifer and that staff bring forward a future report;

AND FURTHER THAT the SCRD establish a working group with infrastructure staff from local governments, *shíshálh* Nation and Sḵwx̱wú7mesh Nation to share information and opportunities for cooperation on groundwater management.

CARRIED

The Comprehensive Regional Water Plan as approved in June 2013 identified several projects to increase the water supply for the Chapman Creek water supply system. One of those projects is the Groundwater Investigation project which explores the potential development of production wells as an additional water supply source. The table below presents an overview of the phases of this project.

Phase 1 (2017-18)	• Desktop feasability study
Phase 2 (2018-19)	• Field confirmation feasability • Initial cost estimates
Phase 3 (2019-21)	• Communication with general public and First Nations • Permitting (inclduding associated assessments) • Conceptual design and cost estimates
Phase 4 (2021-22)	• Detailed design • Construction and comissioning

Phase 1 of this project was concluded in the spring 2018 and included a desktop feasibility study of sites to develop production wells. This report includes the results of Phase 2 of the Groundwater Investigation project (Attachment A). During this project a small diameter test well was drilled on each of the four sites selected during Phase 1. Subsequently, test pumps were temporarily installed to test productivity of the well, potential for impacts to other well owners and the environment, and to test water quality.

Phase 3 and 4 of the development of a future production well would include the following:

- Application for a Water Licence under the *Water Sustainability Act* (including completion of any mandatory assessments);
- Communication with the public, local governments, *shíshálh* Nation and/or Sḵwx̱wú7mesh Nation;
- Preparation of detailed design and cost estimate;
- Tendering process for a construction contractor;
- Drilling of large diameter production well;
- Construction of auxiliary infrastructure (water mains, pumps, back-up generator, treatment and utility building);
- Commissioning (including approval from Vancouver Coastal Heath Authority).

In May 2018 the Board approved the Water Sourcing Policy – Framework and updated the policy objective for the water supply of the Chapman Creek System:

> *The SCRD intends to supply sufficient water at Stage 2 levels throughout the year to communities dependent on water from the Chapman Creek System.*
>
> *Emergency circumstances could result in increased Stage levels.*
>
> *If, due to emergency circumstances, the water supply for Chapman Creek is completely unavailable, the SCRD strives to have adequate alternative water supply sources available to address all essential community water demands for at least one week.*

At the December 13, 2018 Planning and Community Development Committee meeting, the report titled 2018 Water Demand Analysis was received. This report presented an outlook of the annual shortfall in the amount of water to satisfy the water supply objective as outlined in the Water Sourcing Policy Framework. This shortfall is called the Water Supply Deficit.

The table presented below is taken from that report and presents the Water Supply Deficit (in Million cubic metres) for three levels of effectiveness of water conservation initiatives and a 2% average annual population growth within the area supplied by the Chapman Creek System.

Effectiveness of water conservation initiatives (per capita, compared to 2010)	**Water supply deficit (Million m^3)**		
	2025	**2035**	**2050**
Service Area Population	26,000	32,000	43,000
10% reduction	2.01	2.83	4.35
20% reduction	1.65	2.39	3.76
33% reduction	1.22	1.82	2.98

Groundwater resources are generally considered to be less susceptible to impacts of climate change and in particular the impacts of drier summers. The development of additional groundwater water supply sources would also increase the overall resilience of the Chapman Creek water supply system.

The purpose of this report is to present the outcome of the Groundwater Investigation Phase 2, as directed by the Board (138/18):

> AND THAT the SCRD proceed with Phase 2 of the Groundwater Investigation and that staff bring forward future reports with the results and analysis;

The other directives of recommendation 138/18 will be the subject of future reports.

DISCUSSION

The table below summarizes the key results of the Groundwater Investigation Phase 2 for each test well site.

	Gray Creek	Dusty Road	Mahan Road	Church Road
Potential productivity well (litres per second)	N/A	64	36	26
Water Quality (poor, moderate, good)	N/A	Good	Good	Good
Risk of contamination or reduced yield (low, moderate, high)	N/A	High	Low	Low
Risk for impacts to other wells (low, moderate, high)	N/A	Low	Low	Low
Risk for environmental impacts (low, moderate, high)	N/A	Low	Low	Low
Ranking Development Costs (3=lowest, 1=highest)	N/A	3	2	1
Ranking Operational Costs (3=lowest, 1=highest)	N/A	3	2	1

Gray Creek

The drilling of a test well at the Gray Creek site was not successful in tapping into an aquifer. The location of the test well selected was the closest location on public land to where the aquifer was anticipated to be. The unsuccessful test drilling confirmed that the only option for a production well is on private property.

Given the potential of a highly productive production well at this site, staff recommend that further information (feasibility and costs) for the development of a production well report be brought back to Committee by Q4 2019.

Dusty Road

The test well drilling, subsequent pump test and analysis confirmed that this site is very suitable to develop a production well with a very high yield.

During Phase 1 of the Groundwater Investigation project, it was determined that the location of the Sechelt Landfill would not pose a risk to the water quality of a production well at this location. However, the anticipated use of the land upstream of this site for future large scale quarry activities could, in the long-term, impact the water quality at this well site. The aquifer at this location is non-confined, which means it is not protected by an impermeable clay layer on top of

the aquifer and is therefore vulnerable to contamination. Due to the lack of a confining clay layer in this area, any such contamination would impact the water quality to the extent that it would no longer be suitable as a drinking water supply.

Staff recommend that this site not be pursued at this time.

Mahan Road

The test well drilling, subsequent pump test and analysis confirmed that this site is very suitable to develop a production well with a high yield.

In 2018, the Town of Gibsons expressed concerns that a production well at this site may impact their water supply. The study confirmed that it is unlikely that a production well at this site would impact the Town's water supply. Staff discussed the test results for this well site with the Director of Infrastructure Services for the Town of Gibsons during a meeting on January 15, 2019.

Currently, the province of British Columbia is updating the mapping of all the aquifers on the Sunshine Coast. This information is expected to be published in Q3 2019.

Staff recommend the SCRD await the development of a Groundwater Protection Plan framework (as per recommendation 138/18) and the publication of updated provincial aquifer maps, prior to advancing the development of a production well at this location.

A report with an update on the feasibility of the development of a production well at the Mahan site will be brought to Committee in Q4 2019.

Church Road

The test well drilling, subsequent pump test and analysis confirmed that this site is very suitable to develop a production well with a high yield.

A single production well at this location is expected to produce a minimum of 26 litres per second. This volume would be sufficient to meet the demand of the area currently served by the Grantham's well and contribute to the SCRD Zone 3 within the Chapman Creek System.

It is common for an aquifer to sustain several production wells in close proximity to each other and operate as one combined water supply source. A combination of wells is called a well field. Well fields require only one water licence for all wells included in the well field. Local governments develop well fields to divert water from aquifers more economically than is possible with one oversized well.

Based on the results of the test well, there is potential to develop a well field consisting of at least two wells in the Church Road area: one well at the test well location (Church Road) and one at the site of the current Granthams reservoir, at the corner of Fisher Road and Reed Road. Both sites are SCRD-owned properties. This well field is expected to produce at least 51 litres per second.

The productivity of a well or well field can only be confirmed after drilling the actual production wells and is likely higher than what is currently being estimated.

The table below presents the costs for the development and operation of an individual well and a well field consisting of two wells.

	Single Well	Well field
Development costs	$2,400,00	$3,100,00
Operational costs (per year)	$42,000	$79,000

It is estimated that the development of a single well or a well field and all associated infrastructure could be completed by 2022.

With the development of a well field, staff recommend an analysis of tie-in options to the current distribution network be completed. This would allow for the assessment of options to also have the Elphinstone area and a large portion of Roberts Creek be served by the well field. This analysis was outside the scope of this project.

The Water Sourcing Policy – Framework specifies objectives for water supply during drought and emergency situations. A single well or a well field at Church Road would support both objectives. The expected reduction in the Water Supply Deficit during drought situations with the development of a single well and a well field are summarized in the table below (Attachment B).

	2025	2035
Water Supply Deficit (m^3)	1,650,000	2,390,000
Single well	25%	17%
Well field	50%	35%

The development of a well field in the Church Road area is more cost effective than the development of a single well. A well field would result in a significant contribution towards the SCRD meeting the objectives of the Water Sourcing Policy – Framework. Staff, therefore, recommend to proceed with Phase 3 of the development of a well field at the Church Road site in 2019 and 2020.

Staff recommend Phase 3 to include:

- Application for a Water Licence under the W*ater Sustainability Act* (including completion of any associate assessments);
- Communication with the public, local governments, *shíshálh* Nation and/or Sḵwx̱wú7mesh Nation;
- Assessment of tie-in options to current infrastructure;
- Preliminary design and costs estimates;
- Confirmation of funding options.

A subsequent Phase 4 (2021-2022) would include:

- Drilling of large diameter production wells and confirmation of actual yields
- Preparation of detailed design and cost estimate;
- Tendering process for a construction contractor;
- Construction of auxiliary infrastructure (water mains, pumps, back-up generator, treatment and utility building);
- Commissioning (including approval from Vancouver Coastal Heath Authority).

Note: costs associated with these activities are included in the $3.1 million development costs estimate.

The development of a well field could facilitate the decommissioning of the Grantham's well, which is currently not meeting all requirements of the *2016 Groundwater Protection Regulation* and would require upgrades for continued use.

Organizational and Intergovernmental Implications

Development of one or more production wells at the Church Road site would not impact the interests of the Town of Gibsons or other community members.

The requirement for any additional staffing time or resources to operate and maintain a new well or well field and associated infrastructure can only be quantified once the detailed design of the infrastructure is complete. This information will be brought forward in 2020.

Communication Strategy

Information on this project will be shared broadly through paid advertising, corporate newsletters, social media and the SCRD website. Additional information will be provided to properties within the Church Road area.

Staff will reach out to the *shíshálh* Nation and Sḵwx̱wú7mesh Nation to share the general findings of Phase 1 and 2 of this project. The plans for the development of a well field in the Church Road area, if approved, will be discussed separately with the Sḵwx̱wú7mesh Nation.

STRATEGIC PLAN AND RELATED POLICIES

The Groundwater Investigation Project is intended to supplement the existing water supply and ensure the SCRD can continue to meet its mission of providing quality services to our community through effective and responsive government.

CONCLUSION

The Groundwater Investigation Phase 2 project concluded that:

- Additional efforts are required to confirm the feasibility of the development of production wells at the Gray Creek area and the Mahan Road area in 2019;
- The development of a production well at the Dusty Road site not be pursued at this time due to an increased risk of contamination of the aquifer;
- The development of a production well at the Mahan site should be held in abeyance until there is more shared understanding between the SCRD and the Town of Gibsons around the mapping of aquifers and the protection of the aquifers in the area;
- The development of a production well or well field at the Church Road site is feasible. The water supply situation for the Chapman Creek System would be significantly improved by the development of a well field. A budget proposal for Phase 3 of the development of a well field at this site is recommended to be brought forward to Round 1 budget deliberations.

Attachment A: Groundwater Investigation Report (Consultant Report)
Attachment B: Reduction in Water Supply Deficit by well development Church Road

Reviewed by:			
Manager		Finance	
GM		Legislative	
CAO	X-J. Loveys	GM	X-I. Hall

Associated Environmental

REPORT

Sunshine Coast Regional District

Groundwater Investigation Phase 2 Project: Final Report and Preliminary Design of Production Wells at Dusty Rd, Mahan Rd, and Church Rd Well Sites

January 2019

Table of Contents

List of Tables

List of Figures

1 Introduction

1.1 BACKGROUND

The Sunshine Coast Regional District (SCRD) operates seven water systems, the largest of which is the Chapman Water System. Supplying approximately 23,000 persons, the Chapman Water System extends from Secret Cove in Electoral Area B to the inland section of Electoral Area F. The Chapman Water System is supplied mainly from the Chapman Creek watershed, with Gray Creek watershed and Chaster Well providing secondary sources. Typically, the Gray Creek watershed and Chaster Well are used to supplement supply from Chapman Creek only during dry summer months, in which water usage is at its peak. Small water systems Langdale, Soames Point, and Granthams Landing, are also owned and operated by the SCRD and provide water to the Langdale and Gibsons areas. These small water systems are supplied by wells and are close to the Chapman Water System. Within the Chapman Creek watershed, limited storage is provided by two small lakes (Chapman Lake and Edwards Lake), that are the primary source of the drinking water supply for the SCRD water service area.

The Comprehensive Regional Water Plan completed in 2013 recommended that the SCRD undertake a groundwater investigation to determine the feasibility of supplying groundwater to meet long-term water source requirements. As a result of recommendations from the Comprehensive Regional Water Plan, coupled with recent drought conditions across many areas of southern BC (i.e., summer 2015 and summer 2018), the SCRD is actively investigating the feasibility of supplementing the Chapman Water System with a reliable source of groundwater. A Water Demand Analysis study has been completed by Integrated Sustainability (Integrated Sustainability, 2018) to model projected future water demands to the year 2050. Based on an annual population growth of 2%, a supply deficit of 5,114 ML is estimated for 2050 assuming there is zero reduction in water demand compared to the 2010 demand. This is equal to 322 L/s (5,099 USgpm) over the 184 day drought period that the calculations are based on. If there was a high reduction in water demand (a 33% reduction from the 2010 demand) there would be a supply deficit of 2,988 ML (equivalent to 188 L/s or 2,979 USgpm for 184 days). If groundwater supply was to make up all of the difference, three to five 400 mm (16 inch) diameter wells, each capable of providing flows of about 63 L/s (1000 USgpm) would be required, depending on the size of the supply deficit.

Building upon the Comprehensive Regional Water Plan, the SCRD commissioned the Phase 1 Groundwater Investigation, identifying well sites that could sustain a minimum of at least 545 m^3/day (100 USgpm), among other criteria (Waterline 2017). The investigation report concluded that four sites were suitable for further exploration: Mahan Road, Soames Point, Dusty Road, and Grey Creek.

SCRD issued a request for proposal for a consultant to complete the Groundwater Investigation Phase 2 project, and Associated was retained as the most qualified consultant to complete the project.

1.2 OBJECTIVES

The ultimate objective of the groundwater investigation project is to reduce the dependency on water from Chapman and Edwards Lakes during the dry summer months by supplementing flow from groundwater

supply wells. Building upon the Phase 1 investigation, the objective of Phase 2 was to drill exploratory wells at each selected site and assess their suitability for municipal supply, and determine the next steps to incorporate the wells into the SCRD water system.

1.3 SCOPE OF WORK

As part of the RFP process, Associated developed a scope of work and services to satisfy the objectives of the investigation. Table 1-1 summarises the approach, broken down into nine work tasks.

Table 1-1
Scope of work

Task	Details
1	Project start-up meeting, review background information, confirm well site locations, and borehole and drilling specifications.
2	Drill and install four test wells[1].
3	Undertake aquifer testing on the wells to determine aquifer characteristics and calculate sustainable yields.
4	Assess potential environmental concerns and impacts on other users.
5	Prepare an Interim report and complete preliminary design of production wells.
6	Evaluate the well sites. Facilitate a workshop to assess the well sites against multiple criteria to select which well sites to move forward with
7	Assess infrastructure and operational requirements for selected sites.
8	Final report.
9	Presentation of Final report to the Board of Directors.

Notes:
1. During drilling of the Gray Creek site, it became apparent that the aquifer characteristics at this location were not conducive for the development of a groundwater source due to thinner than anticipated sand and gravel deposits and an unsuitable well yield (<50 USgpm). Consequently, this well site is not considered further in this report, except where drilling and construction details are provided in Section 4.

This report provides a summary of the work completed to meet the objectives of the Phase 2 investigation and provides recommendations for the next steps in developing a new groundwater source.

2 Physical and Hydrologic Setting

2.1 PHYSICAL SETTING

The location of the four well sites – Gray Creek, Dusty Road, Mahan Road and Church Road (formerly known as Elphinstone Avenue) are shown on Figure 2-1. The well sites are located near the coast, close to the urbanised areas of the District of Sechelt and the Town of Gibsons, and are situated relatively close to existing SCRD water mains infrastructure.

Fig 2-1 overview.mxd / 1/4/2019 / 3:22:24 PM

Associated Environmental

PROJECT NO.: 2016-8125.040.000
DATE: January 2019
DRAWN BY: DA

FIGURE 2-1 SITE LOCATION PLAN

Sunshine Coast Regional District

SCRD Groundwater Investigation Phase 2

The topography is dominated by the Coast Mountains with Mount Elphinstone located to the north of Gibsons and Mount Crucial to the north-east of Sechelt. The topography falls steeply towards the coast from mountain highs of 1260m, the gradient becoming shallower on the lower slopes of the mountains where glacial material was deposited (see Section 3).

The mountain sides are typically forested with numerous creeks providing drainage to the coast. Closer to the coast, where the ground topography shallows, residential, commercial and industrial development is present.

2.2 CLIMATE

The region experiences a temperate coastal climate; climate normals data are available for 1981-2010 from the Gibsons climate station (Climate ID 1043150), located at 49º 23' N and 123º 30' W, at an elevation of 62 masl (Environment Canada 2018). The majority of the precipitation falls in winter as rain. Table 2-1 summarizes the climate data.

Table 2-1
Climate Normal Data (1981-2010) at Gibsons Climate Station

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Average (ºC)	4.4	5.2	7.2	9.8	13.0	15.7	18.0	18.2	15.1	10.6	6.4	4.0	10.6
Rainfall (mm)	174.4	103.6	122.2	104.2	91.3	66.8	41.1	48.8	60.5	152.0	211.0	166.6	1342.4
Snowfall (cm)	9.1	6.2	3.2	0.1	0.0	0.0	0.0	0.0	0.0	0.3	1.9	7.7	28.4
Precipitation (mm)	183.4	109.8	125.4	104.3	91.3	66.8	41.1	48.8	60.5	152.3	212.9	174.3	1370.8

Note: Precipitation data includes rainfall and snowfall data.

2.3 HYDROLOGY

As detailed above, numerous creeks drain the mountain range flowing down to the coast. Additional details for the creeks located closest to the three completed wells is provided below. The location of these are shown on Figure 2-1.

2.3.1 Irgens Creek (Dusty Road Well)

The headwater of Irgens Creek is shown to rise approximately 2.5 km to the east of Porpoise Bay, in forested land just to the north of Sechelt Landfill at an elevation of approximately 230 masl. From here the creek flows in a westerly direction through a forested area towards Porpoise Bay where it eventually discharges.

No flow data could be found for this creek, however, personal correspondence with Dave Bates (Senior Biologist with FSCI Biological Consultants) suggests that the creek tends to dry out during the drier months but maintains a series of pools capable of supporting fish).

2.3.2 Charman Creek (Mahan Road Well)

Charman Creek, also known as Charmin Creek, is approximately 2 km in length which originates from a pipe discharging runoff south of the intersection of Park Road and Gibsons Way (AECOM, 2010), at an elevation of approximately 130 masl. The creek flows in a southerly direction through a series of man-made retention ponds in White Tower Park designed to help manage flooding. The creek continues southwards across relatively flat ground before becoming an incised valley. The main creek is joined by two small tributaries along the first half of its reach. After approximately 1 km, the creek gradually changes direction, eventually flowing in an easterly direction. It emerges from a woodland area into the urbanised Lower Town of Gibsons where it flows through a variety of natural, channelized and culverted sections before ultimately discharging at Gibsons Marina.

No long-term flow monitoring data could be found for this creek; however, the creek is known to experience extremely low flows in the summer (UBC Urban Studio, 2000) and is also known to dry (DFO, 1991). Flow in the creek is believed to be supported by storm water drainage and baseflow from shallow groundwater in its upper and middle reaches where the creek flows through Capilano sediments (see Section 3). AECOM (2000) used a short period of available flow data to model monthly base flows throughout the year. Their model results suggested creek baseflows of 40 L/s through the winter months, reducing to 1 L/s through August, September and October.

2.3.3 Soames Creek (Church Road Well – formerly known as Elphinstone Avenue Well)

Soames Creek is a short watercourse, its headwaters located at an elevation of approximately 140 masl, one km to the northwest of Granthams Landing. It flows in a south-easterly direction towards the coast, discharging into the sea at Granthams Landing. The creek flows through woodland and has cut a steeply incised ravine through the underlying geology. No flow data could be found for this creek.

2.4 SIGNIFICANT AQUATIC VALUES

Information on fish and other aquatic life for the creeks is desk-based only and has been collected from a variety of sources:

- Personal communication with Dave Bates, FSCI Biological Consultants (November 2018).
- Official Community Plan, District of Sechelt Bylaw 492, 2010 (adopted July 2011).
- Fish Habitat and Inventory & Information Program. Department of Fisheries and Oceans, 1991.
- Fresh Eyes on Gibsons. Community Analysis. UBC Urban Studio, 2000.
- Town of Gibsons Integrated Stormwater Management Plan. AECOM, 2010.

Based on information provided by the sources above, Table 2-2 provides details of the fish that are known to be present or have been present in the past in the three creeks located closest to the well sites.

Table 2-2
Creek fish species

Task	Known fish species, present or observed and other comments
Irgens Creek (Dusty Road Well)	• Cutthroat trout throughout. Survive in pools during the summer periods when most of the creek dries out. • Coho and chum salmon in the lower reach below Sechelt Inlet Road, close to Porpoise Bay 'in a good year' (Dave Bates, 2018).
Charman Creek (Mahan Road Well)	• Cutthroat trout reported in the upper reaches. • Coho and chum salmon and cutthroat trout in the lower reaches. • Conditions in the urbanised area of Gibsons vary greatly over very short distances from natural to manmade channels and culverts. Fish habitat values in the upper reaches are very low due to scarcity of pool, lack of cover and low water flows during the summer.
Soames Creek (Church Road Well)	• Coho salmon that were introduced into Gibsons Harbour by local enhancement groups. • Only Cutthroat trout reported to be present in the upper reaches.

Detailed, up-to-date information on fish and the sensitivity of the creek habitats would require a habitat biological assessment to be undertaken on each creek, with site visits completed at various times of the year and at various creek flows. Such a study was not included as part of the scope of works for this investigation. However, should any of the well sites be taken forward for development to a production well, a habitat assessment may be required as part of the technical assessment (required for licensing purposes) to ensure that the aquatic ecology will not be detrimentally impacted by groundwater abstraction. If it is considered that there will be an impact, mitigation measures may need to be implemented, which will add additional costs to the overall well development proposal. This scenario is particularly likely if the creek is hydraulically connected to the aquifer that groundwater is being abstracted from. Section 6 provides an assessment of the hydraulic connection between groundwater and the creeks near each well site.

3 Hydrogeological Setting

3.1 GEOLOGY

Geological information is provided in the Phase 1 Groundwater Investigation report (Waterline 2017), therefore, only a summary of regional geology is provided below.

3.1.1 Unconsolidated superficial deposits

Quaternary deposits up to 300 m thick were deposited in the area during several glacial and intervening interglacial period during the last 50,000 years. During this time the repeated advance and retreat of the glaciers resulted in sea level changes of up to 200 m changing the depositional environment.

The deposits found along the Sunshine Coast can be split into three main units, from oldest to youngest: Pre-Vashon outwash deposits associated with advancing ice sheets, consisting of silts, sands and some gravels. These are overlain by Vashon Till deposits when glaciers extended over the area and consist of a very dense low permeability silty sandy till with occasional lenses of sand and gravel. Finally, Capilano sediments which consist of a mixture of glacio-fluvial, glacio-marine and marine sediments deposited as the glaciers retreated following climate warming, predominantly comprised of sands and gravels, however at the base of the Capilano sediments, clay deposits are found. Modern day deposits formed by the reworking of the older sediments are known as the Salish Sediments.

3.1.2 Bedrock geology

Underlying the unconsolidated superficial deposits, granodiorite - a coarse grained intrusive igneous rock - is found across most of the study area (Cui et al, 2015). To the north of the Town of Gibsons and mapped below the Church Road Well, metamorphic sedimentary and meta-volcanic rocks are found (Waterline, 2017).

3.2 AQUIFERS

During this phase of the groundwater investigation, the Capilano sand and gravel sediments and the Pre-Vashon silts and sands were the target aquifers for the drilling phase.

The Capilano sediments are typically unconfined with no low permeability overlying strata present. Recharge to this ‘upper’ aquifer is predominantly via direct infiltration into the ground from rainfall and snow melt and from leakage through the bed of creeks (“losing” streams) that flow over these sediments. The base of this aquifer sits upon the Vashon Till.

The Pre-Vashon sediments in the region are typically covered by the low permeability Vashon Till (an aquitard). This low permeability layer provides an element of protection to the aquifer from contamination, however it also restricts infiltration of water from above. The majority of recharge to this ‘lower’ aquifer is therefore likely occurring at the base of the mountains where the confining till layer is not present (Waterline, 2013). Recharge is also possible at other locations closer to the well sites, including stratigraphic windows (i.e., where the confining layer is absent or thin), “losing” streams, and, to a lesser extent (orders of magnitude less), from confining layers “leaking” water to the aquifer.

4 Drilling

4.1 METHODS

4.1.1 Well Construction

Drillwell Enterprises Ltd (Drillwell), operated by Qualified Well Drillers Scott Burrows [WD 04121407] and Shawn Slade [WD 15052001] was contracted by Associated to drill and install groundwater wells at the four

pre-determined sites: Gray Creek, Dusty Road, Mahan Road and Church Road. Drilling commenced at the Gray Creek site on 18 September 2018. Drillwell used a truck mounted Foremost DR24 dual rotary rig to advance steel casing through the unconsolidated overburden. A carbide studded casing shoe was welded to the bottom of the casing string and a drill string with hammer bit ran through the centre of the casing to aid drilling and removal of the materials encountered. The rig uses drill rods that are 20 ft in length together with 6-inch casing, also 20 ft in length. As the well advances, new sections of casing are welded onto the casing in the ground. Compressed air was used to remove the cuttings, with clean water added from the surface as necessary to help cuttings removal whilst the well was still being drilled within unsaturated material. Associated's environmental scientist and hydrogeologist Steve Colebrook, B.Sc, and Tony Friesen, GIT, were on site to supervise the drilling, collect samples, record lithology, and design well construction. Marta Green, P.Geo., oversaw the field program.

Prior to advancing the 6-inch production casing, 10-inch casing was advanced to a depth of at least 5 m (16.5 ft). The 6-inch casing was then lowered into the hole and bentonite chips poured into the annulus between the 6 and 10-inch casing. The 10-inch casing was then removed to leave a 2-inch sanitary seal between the 6-inch casing and the ground material to meet the requirements of the Ground Water Protection Regulations[1] (GWPR) for water wells.

Drilling with production casing (6 inch) was advanced until the base of the aquifer was identified, or the aquifer material became less productive. Samples were collected at 10 ft intervals in unsaturated material and at 5 ft or less intervals within the aquifer. During drilling, and once the well was within water bearing strata, airlifting was used to estimate potential flow rates at various depths. Associated's field hydrogeologist determined the depth at which drilling should cease and whether it should be backfilled to a higher level prior to screen being installed.

Following the end of drilling, Associated's field hydrogeologist conducted dry sieve analysis of the material recovered to surface to determine the screen slot size to be installed in each well. Johnson Screens 6-inch 60-wire telescopic stainless-steel screens (4 ft lengths) with end cap at base and k-packer above, were installed in each well, with screen slot size based on the results of sieve analysis. A screen length with a theoretical screen transmitting capacity of at least 300 USgpm was designed for each well (except at Church Road where the geology present and technical issues during screen installation restricted the theoretical transmitting capacity to 220 USgpm). The 300 USgpm transmitting capacity was chosen to meet the maximum pumping rate that could be expected from a 6-inch diameter well.

Following installation of the screens, the wells were developed by mechanical bailing of material from within the screen section and airlifting and surging above the screen. Development continued in each well until virtually no sediment was being removed from the well during airlifting and the water ran clear; well development time varied from 7 hours to over 10 hours. The wells were completed with casing stick-ups to meet the GWPR and included a vermin and tamper proof well cap, and a well identifier number.

[1] Groundwater Protection Regulation. 2016. *Water Sustainability Act.* http://www.bclaws.ca/civix/document/id/complete/statreg/39_2016

A memo was sent to the drilling contractor. The memo sets out the drilling requirements, procedures for sampling and well development, and lines of communication throughout. It also provided details of best practice and procedures to protect the environment and other receptors during drilling. Maps provided to the driller are provided in Appendix A. Well logs can be found in Appendix B.

Full details of the final construction of each well can be found in Table 4-1 in Section 4.2.

4.2 RESULTS

Final well construction details are provided in Table 4-1.

Table 4-1
Well construction details

Well Name	Gray Creek	Dusty Road	Mahan Road	Church Road
Well ID Plate No.	54942	54929	54943	54928
Date constructed	19/Sep/20018	23/Sep/2018	01/Oct/2018	05/Oct/2018
Approximate ground elevation[1] (ft asl)	85.3 (26 masl)	121.4 (37 masl)	351 (107 masl)	128 (39 masl)
Drilled Depth (ft bgl)	136 (41.5 m)	280 (85.3 m)	435 (132.6 m)	190 (57.9 m)
Completed Depth (ft bgl)	n/a	274 (83.5 m)	390 (118.9 m)	144 (43.9 m)
Casing diameter (in.)	6	6	6	6
Static water level (ft bgl)	13 (4.0 m)	101.5 (30.9 m)	274 (83.5 m)	47 (14.3 m)
Casing stick-up (ft)	n/a	2.8 (0.85 m)	2.0 (0.61 m)	2.0 (0.61 m)
Base of screen (ft bgl)	n/a	273.8 (83.5 m)	389.8 (118.8 m)	143.8 (43.8 m)
Top of screen (ft bgl)	n/a	261 (79.6 m)	377 (114.9 m)	137.5 (41.9 m)
Top of K-packer (ft bgl)	n/a	258.8 (78.9 m)	374.8 (114.2m)	133.25 (40.6 m)
Screen design (from base upwards)	n/a	1 x 80 slot; 1 x 100 slot; 1 x 80 slot (12' of screen)	1 x 50 slot; 2 x 40 slot 12' of screen)	2 x 100 slot (8' of screen but only 6' exposed)
Theoretical screen transmitting capacity (USgpm)	n/a	430	330	220
Drillers estimated yield (USgpm)	35-50 (2.2-3.2 L/s)	100+ (6.3+ L/s)	100+ (6.3+ L/s)	100+ (6.3+ L/s)

Well Name	Gray Creek	Dusty Road	Mahan Road	Church Road
Aquifer Type	Unconfined sand and gravel	Unconfined sand and gravel	Unconfined sand and gravel (with low permeability layer above)	Confined sand and gravel
Depth to top of a confining unit (ft bgl)	n/a	n/a	6 (1.8 m) [2]	54 (16.5 m)
Depth to base of confining unit (ft bgl)	n/a	n/a	67 (20.4 m) [2]	69 (21.0 m)
Additional comments	No screen was installed as the superficial deposits are thinner than originally anticipated. Well casing remains in ground with wellhead completed within a manhole chamber.		During well development, airlifted flow of c.50 USgpm recorded but drillers think yield restricted by well depth and static W/L depth causing back pressure when airlifting. Drillers expect considerably higher yield with submersible pump.	Only 6' of screen exposed by casing due to need to protect screen from pulling in overlying fine material.

Notes:
[1] Approximate ground elevation based on topographic contour maps
[2] This is a low permeability unit above a deep unconfined aquifer

A decision was made not to install well screen in the Gray Creek Well due to the limited aquifer depth and lower aquifer yields encountered during drilling. This well is sited in a road layby so it was decided, for safety reasons, to cut the casing off just below ground level, install a vermin and tamper proof well cap and construct a manhole chamber around the casing stick-up with a vehicle weight-bearing manhole cover. The manhole chamber was designed by a Qualified Professional from Associated (Marta Green, P.Geo.) and includes casing stick up in the chamber, drainage to prevent flooding within the chamber, and the ground surface around the manhole sloped away from the cover to prevent surface water run-off entering the chamber.

Whilst this well location was deemed unsuccessful for the requirements of this exploratory phase of drilling due to the limited aquifer depth and lower yields, a wellfield located in the fish farm property (Northern Divine) immediately to the west of the Gray Creek Well provide flow rates in excess of 100's of USgpm. Personal communication with Bryan Marshall (General Manager of Northern Divine Aquafarms Ltd.) indicated that the fish farm is willing to discuss with the SCRD the potential of developing a new water supply well(s) located within their property where the aquifer is thicker.

5 Pumping Tests

5.1 METHODS

Following completion of well drilling, aquifer pumping tests were undertaken at the three completed wells: Dusty Road, Mahan Road and Church Road, to help determine aquifer characteristics and indicate a sustainable long term pumping rate. Monashee Aquifer Testing was contracted by Associated to supply, install, and operate the pump for the aquifer tests.

The tests commenced at Dusty Road on 26 October 2018 and were completed at Church Road on 02 November 2018. Associated's field hydrogeologist was on site to oversee the testing, which included variable rate (step) tests, constant rate tests, and recovery. At each well, groundwater was allowed to recover to a minimum of 95% of it's static water level prior to further pumping commencing from that well.

At each well location the well water discharge line was directed downgradient of the well. At Dusty Road the discharge point was located approximately 150 m from the well to avoid recirculation of the pumped water in this unconfined aquifer, as the ground surface is comprised of permeable sands and gravels. The discharge points at Mahan Road and Elphinstone Avenue were located closer to the wells as these two wells are screened within aquifers that are protected from infiltration by low permeability confining units. At all three locations the discharge water was not allowed to discharge directly to surface water and measures were put in place to reduce sedimentation and erosion at the point of discharge.

Flow rates were measured using an inline flow meter. Groundwater levels in the test wells were measured with an electronic water level sounding tape at the frequency specified by the BC Ministry of Environment[2] and HOBO™ pressure transducer dataloggers installed within sounding tubes. Nearby observation monitoring wells had previously been identified and, following agreement from the owners, these wells were monitored as part of the pumping tests using either an electronic water level sounding tape, acoustic sounder and, where feasible, HOBO™ pressure transducer dataloggers.

During the pumping tests, water quality field parameters (pH, temperature, conductivity, total dissolved solids) were monitored to observe for changes in chemistry. Given the relatively close location of all three wells to the sea, monitoring of conductivity was particularly important to ensure that saline intrusion was not occurring.

A memo was provided to the pumping test contractor. The memo set out the requirements of the pumping test, procedures for monitoring during the tests and lines of communication throughout. It also provided details of best practice and procedures to protect the environment and other receptors during the pumping tests. The figures provided to the pumping test contractor are provided in Appendix C.

Table 5-1 provides a summary of the specifications of the aquifer tests for each well.

[2] Ministry of Environment. 2008. Pumping Test Report Form January 2008.

Table 5-1
Pumping Test Specifications

		Pumping Well		
		Dusty Rd (54929)	**Mahan Rd (54943)**	**Church Rd (54928)**
Observation Wells		- Lehigh Quarry Well 5 - 6109 Sechelt Inlet Rd	- 498 Mahan Road - OW 460	- Soames Well - Granthams well - 901 Sentinel Lane - Soames Point MW
Step Tests				
Start Date		25/Oct/2018	29/Oct/2018	01/Nov/2018
Step 1	Rate (USgpm)	100	100	100
	Duration (min)	60	60	60
Step 2	Rate (USgpm)	165	165	170
	Duration (min)	60	60	100[1]
Step 3	Rate (USgpm)	240	240	240
	Duration (min)	60	60	30[2]
Step 4	Rate (USgpm)	300	300	n/a
	Duration (min)	60	60	n/a
Constant Rate Tests				
Start Date		25/Oct/2018	29/ Oct/2018	01/Nov/2018[3]
Rate (USgpm)		300	300	170
Duration (Hours)		48	43	23.5

Notes:
[1] Extended step duration to try to clean up discharge to obtain a water sample (pumping silt and sand)
[2] Short duration 'step' due to large quantity of silt and sand being abstracted
[3] Pumping sand during the step test resulted in a decision not to stop the step test and instead continue straight into the constant rate test at a rate of 170 USgpm.

Data from the constant rate pumping tests were analyzed following the Guidelines for Evaluating Long-term Well Capacity for a Certification of Public Convenience and Necessity (CPCN) (MOE 2007). This method extrapolates drawdown in pumping wells and observation wells during pumping to 100 days[3] and calculates a sustainable long term pumping rate based on the extrapolation line. The sustainable pumping rate is then reduced by a safety factor of 30%, to account for changes in water levels over the seasons and over longer periods in cases where water level fluctuations are unknown. The following equation was used to calculate the sustainable pumping rate:

Q = 0.7 x specific capacity at 100 days x available drawdown in the well

5.2 PUMPING TEST RESULTS

5.2.1 Dusty Road Well

Step Tests

Table 5-2 outlines the results of the step tests for Dusty Road Well.

Table 5-2
Dusty Road step test results

Step	Duration (mins)	Pumping Rate (USgpm)	Drawdown (ft)	Specific Capacity (USgpm/ft)
1	60	100	7.37	13.57
2	60	165	12.84	12.85
3	61	240	19.23	12.48
4	60	300	25.34	11.84

Step testing commenced at 11:48 on 25 October 2018; each step was conducted for approximately 60 minutes with a total of four steps tested. During each step an initial rapid drawdown in water level was recorded followed by relatively static water levels. A rate of 300 USgpm (18.93 L/s) was selected for the constant rate test based on the drawdown observed during the step tests. This was the maximum rate achievable from the pump within the 6-inch diameter well.

Water levels recovered rapidly following the end of the step test with 95% recovery achieved within 1 minute of turning the pump off.

[3] This is based on 100 days with no recharge, however, climate change could extend the number of days beyond this during extreme drought years.

Constant Rate Test

The constant rate test commenced at 16:48 on 25 October 2018 at a rate of 300 USgpm. The test was conducted for a period of 48 hours. The results of the constant rate test indicate that the calculated sustainable long term pumping rate for Dusty Road is 1011 USgpm. Table 5-3 provides a summary of the inputs and resulting 100-day sustainable well yield. Raw pumping test data and figures showing water levels and 100-day extrapolations are included in Appendix D.

A step up in the water level of approximately two feet is apparent after 1,080 minutes (18 hours) of the constant rate test. It is not clear what caused this rise in water level but possible causes could be: an unknown large, local water abstraction being switched off, although this seems unlikely as a search of all nearby users was conducted and there is no indication in the data of this unknown abstraction going back on again. In addition, the intermittent groundwater pumping from the nearby Lehigh Quarry Well #5 is not observed in the Dusty Rd Well data. It therefore seems more likely that it is a result of a change in the test pumping rate, perhaps following an adjustment in flow rate as the well continued developing. In determining the 100-day sustainable well yield the more conservative lower water level values were extrapolated forward.

Water levels recovered rapidly following the end of the constant rate test with 95% recovery achieved within 2 minutes of turning the pump off and 98% recovery after 4 hours.

A water sample was collected at 09:30 on 26 October, approximately 17 hours after the constant rate test commenced. The sample was collected at this stage of the test in order to get the sample to CARO Analytical Services (CARO) laboratory in Richmond for processing within 24 hours, taking into account courier availability, ferry crossings and laboratory hours of operation.

Impact on observation wells

Two observation wells were identified to be monitored during the pumping tests: Lehigh Quarry Well #5 and a private well located at 6109 Sechelt Inlet Rd (see Figure 5-1). A data logger was installed at 6109 Sechelt Inlet Rd but could not be installed in Lehigh Quarry Well #5 so manual dip measurements were taken at this location instead.

The data shows that there was no apparent impact from the pumping tests on water levels at 6109 Sechelt Inlet Rd. A small semi-diurnal tidal influence can be observed in the hydrograph with a range in water level of up to 0.3 m observed between high and low tides. Since the tidal influence to the aquifer is minimal, this diurnal curve information is not contained within this report.

During the tests, access to Lehigh Quarry Well #5 proved problematic due to it being an active quarry and with difficulties contacting the quarry manager or other quarry employees to arrange a quarry staff member to escort Associated's field hydrogeologist to the well. In addition, Lehigh Quarry Well #5 was intermittently used for quarry operational purposes throughout the test, affecting the water levels observed within this

monitoring well. The limited dip data obtained for Lehigh Quarry Well #5 did not provide any conclusive evidence of an impact from the Dusty Road pumping test.

Table 5-3
Dusty Road sustainable yield

PUMPING SPECIFICATIONS	----------
Pumping rate (USgpm)	300
Test duration (hours)	48
Depth of pump intake during test (ftbtoc)	218.00
Static water level (ftbtoc)	103.96
Depth to top of screen (ftbtoc)	263.50
Depth of well (ftbtoc)	276.50
RECOVERY	----------
Length of recovery (min)	240
% recovered	98
CPCN INPUTS	----------
Pumping rate (USgpm)	300
Available drawdown (ft)	130
Drawdown at 100 days (ft)	27
CPCN OUTPUTS	----------
100-day specific capacity (USgpm/ft)	11.1
Calculated sustainable pumping rate (USgpm)	1445
Calculated sustainable pumping rate with BC safety factor of 30% (USgpm)	**1011**

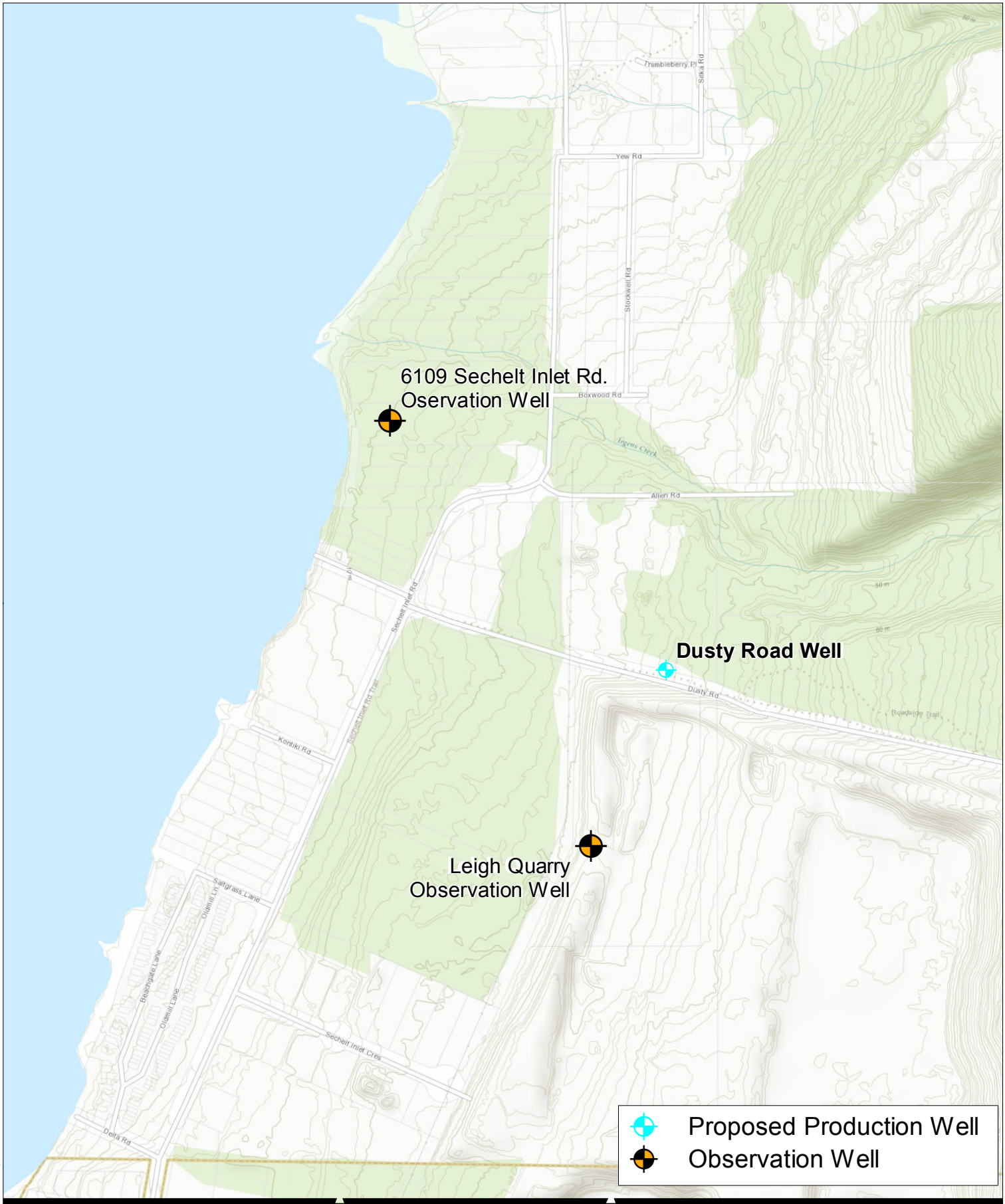

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FIGURE 5-1: DUSTY ROAD WELL AND OBSERVATION WELLS

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SCRD Groundwater Investigation Phase 2

5.2.2 Mahan Road Well

Step Tests

Table 5-4 outlines the results of the step tests for Mahan Road Well.

Table 5-4
Mahan Road step test results

Step	Duration (mins)	Pumping Rate (USgpm)	Drawdown (ft)	Specific Capacity (USgpm/ft)
1	60	100	9.98	10.02
2	60	170	15.72	10.81
3	60	240	23.68	10.14
4	60	300	30.02	9.99

Step testing commenced at 08:46 on 29 October 2018; each step was conducted for 60 minutes with a total of four steps tested. During each step an initial rapid drawdown was recorded followed by relatively static water levels, although some water level recovery was also noted during the steps, probably reflecting ongoing well development increasing the efficiency of the well. A rate of 300 USgpm (18.93 L/s) was selected for the constant rate test. This was the maximum rate achievable from the pump within the 6-inch diameter well.

Water levels recovered rapidly following the end of the step test with 95% recovery achieved within 20 minutes from turning the pump off.

Constant Rate Test

The constant rate test commenced at 13:30 on 29 October 2018 at a rate of 300 USgpm. The test was conducted for a period of 43 hours. The results of the constant rate test indicate a calculated sustainable pumping rate for Mahan Road of approximately 572 USgpm. Table 5-5 provides a summary of the inputs and resulting 100-day sustainable long term well yield. Raw pumping test data and figures showing water levels and 100-day extrapolations are included in Appendix D.

A semi-diurnal tidal influence is observed in the water level data at Mahan Road with an apparent 2-3 hour delay in groundwater level response to the tidal cycle at Gibsons. The influence of the tidal cycle on groundwater level makes analysis of the data more difficult, particularly over a short duration pumping test. After the initial drawdown in water levels, the tidal influence is observed to have a greater impact on water levels than the effects of pumping with a rising and falling water level in response to the tidal cycle. The general trend shows a rise in groundwater level which reflects the increasing rise in tide height (e.g.: there was a 60 cm rise in groundwater levels attributed to the high-high tide cycle on October 30, compared to a

total drawdown of 8.5 m during the first 24 hours of pumping, and 71 m of available drawdown, as shown on the Figures in Appendix D). It was decided to stop the test after 43 hours, following collection of data for one full tidal cycle of low-low tides as no more data of beneficial value was expected after 48 hours of testing due to the continued rising trend. The 100-day sustainable long term well yield is based on the most conservative values obtained during the test (i.e. extrapolating forward from the lowest water levels recorded that were experiencing drawdown).

Table 5-5
Mahan Road sustainable yield

PUMPING SPECIFICATIONS	----------
Pumping rate (USgpm)	300
Test duration (hours)	43
Depth of pump intake during test (ftbtoc)	367.00
Static water level (ftbtoc)	277.36
Depth to top of screen (ftbtoc)	378.00
Depth of well (ftbtoc)	392.00
RECOVERY	----------
Length of recovery (min)	120
% recovered	100[1]
CPCN INPUTS	----------
Pumping rate (USgpm)	300
Available drawdown (ft)	83
Drawdown at 100 days (ft)	30.5
CPCN OUTPUTS	----------
100-day specific capacity (USgpm/ft)	9.84
Calculated sustainable pumping rate (USgpm)	816
Calculated sustainable pumping rate with BC safety factor of 30% (USgpm)	**572**

Notes:
[1] Percentage recovery is based on the water level at start of constant rate test but tidal effects on groundwater level will have impacted what the actual 100% water level recovery would have been.

Water levels recovered rapidly following the end of the constant rate test with 95% recovery achieved within 12 minutes of turning the pump off and 100% recovery after 90 minutes. However, it should be recognised that the tidal effect on groundwater levels will have resulted in the actual 100% recovery level being different from the water level recorded at the start of the constant rate test; therefore, the actual recovery may be less than 100% (but still over 95%).

A water sample was collected at 10:30 on 30 October, 21hours after the constant rate test commenced and sent via courier to the CARO laboratory in Richmond.

Impact on observation wells

Two wells were selected for monitoring during the pumping test: The Ministry of Environment's (MOE) monitoring well OW 460 (also known as WL10-02), and a private well at 498 Mahan Rd (see Figure 5-2). Data loggers were installed in both wells, the MOE having installed their own logger in OW 460.

The water level in OW 460 responds to the pumping tests approximately 6 hours after the start of the step test. A water level drawdown of approximately 0.5 m is observed during the test. The tidal influence on groundwater levels is also observed in this well.

Unfortunately, the logger installed in 498 Mahan Rd did not record any water level readings as the logger appears to have hung above the water level. It is thought that it may have become stuck on some cables or other infrastructure within this private well which did not have a sounding tube installed. Water level data collected using an acoustic sounder suggests there may have been an impact on the water level of approximately 0.6-0.7 m, assuming a similar tidal influence to that observed at OW 460 is present. No impact on water levels in the Mahan Road Well is observed as a result of this well being used to supply the private residence.

At this location the aquifer is unconfined so the cone of depression was not expected to extend out as far as the monitoring wells during the short duration constant rate pumping test. The observations recorded are more typical of a confined aquifer response to pumping. This may be explained by the presence of the low permeability layer that overlies the aquifer resulting in the aquifer becoming 'air confined'[4].

[4] This scenario is discussed in more detail by: Jiao and Guo, 2009. Airflow induced by pumping tests in unconfined aquifer with a low permeability cap. Water Resources Research, Vol. 45, W10445.

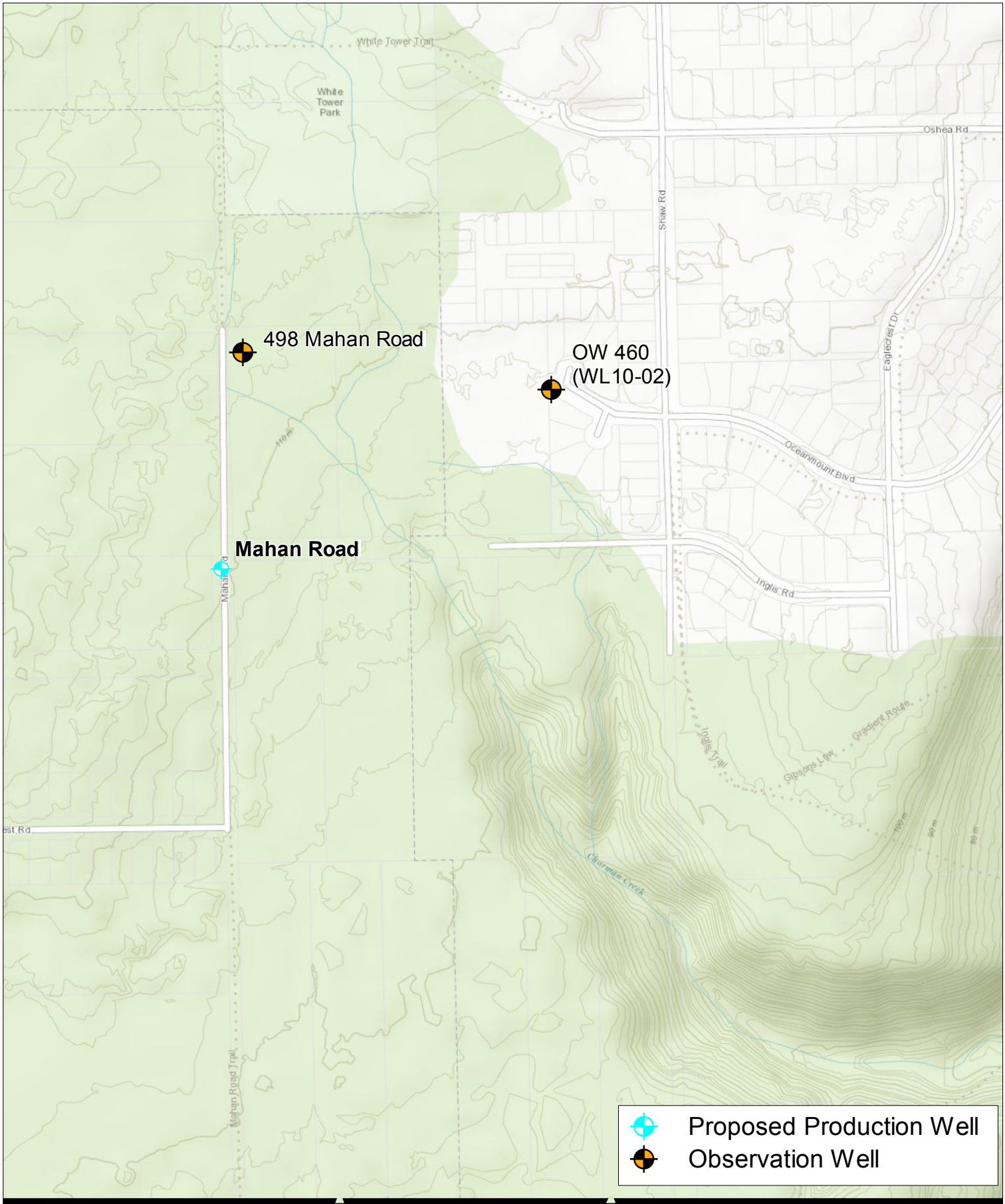

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FIGURE 5-2: MAHAN ROAD WELL AND OBSERVATION WELLS

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SCRD Groundwater Investigation Phase 2

5.2.3 Church Road well

Step Tests

Table 5-6 outlines the results of the step tests for Church Road Well.

Table 5-6
Church Road step test results

Step	Duration (mins)	Pumping Rate (USgpm)	Drawdown (ft)	Specific Capacity (USgpm/ft)
1	60	100	11.84	13.57
2	100	170	20.00	12.85
3	30	240	19.04	12.61

Step testing commenced at 09:30 on 01 November 2018. During the first step, brown sand was observed in the discharge water; this reduced during the 60 minutes but some sand remained. Following an increase in the pumping rate to 170 USgpm the amount of silt and sand being pumped also increased with a turbidity of 15-18 NTU recorded. After 60 minutes, silt and sand were still present so it was decided to keep pumping to improve (lower) the sand content in order to collect a water sample that could be sent for laboratory analysis to CARO in Richmond[5]. After 100 minutes, significantly less sand was present (the discharge water had a turbidity of 4.6 NTU) and, following collection of the water sample, it was decided to up the rate of pumping to 240 USgpm. At this rate a significant amount of sand was pulled into the well and discharged at surface, the Rossum Sand Trap became plugged within seconds. After 30 minutes of pumping significant quantities of sand was still being pulled into the well so the abstraction rate was throttled back to 170 USgpm to reduce the amount of sand being pumped to protect the pump.

The well continued to pump silt and sand at the reduced pumping rate of 170 USgpm (but to a lesser extent than observed at 240 USgpm), so a collective decision was made by Associated and Monashee to not stop the step test and allow recovery prior to the constant rate test but to continue pumping at the rate of 170 USgpm. The continued pumping at 170 USgpm allowed the water to continue 'cleaning up' without the risk of pulling in significantly more sand following a switch off and pump start up which could have damaged the pump.

The presence of sand and silt being pumped from the well indicates that material finer than the screen slot size is being pulled into the well. The additional well development of the well during pumping pulling in material that was not encountered during well development when the screen was installed. This likely demonstrates the highly heterogenous nature of the deposit at this location with more fine layers than

[5] The water sample had to be collected at this stage of testing in order to get it to the laboratory for processing within the 24-hour hold time, taking into account weekend laboratory opening hours and courier availability.

observed from the samples that were returned to the surface during drilling. Consequently, it is recommended that any future drilling in this aquifer utilises a drilling technique that will provide a better representative sample of the ground conditions, such as cable tool drilling, which will enable the appropriate screen slot size to be determined. For example, if fine sand layers are only 0.3 m thick, a screen with a slot size appropriate for that sand, would be selected, even if the screen overlaps coarser gravel layers.

Constant Rate Test

As detailed above, the constant rate test deviated from standard pumping test guidelines by becoming a continuation of the step tests due to the silt and sanding problems encountered during pumping. The constant rate test was conducted for a period of 23.5 hours and, for the purposes of assessment, the start time was taken as the time at which the pumping rate first reached 170 USgpm. Whilst the pumping test had to be modified from the standard testing procedure, the data obtained has been used to estimate a sustainable pumping rate. A 1.3 ft jump in water level is apparent in the data which corresponds to a period when the flow meter stopped, required repairing and once operational the flow rate subsequently adjusted. This jump indicates a change (reduction) in the pumping rate following repair of the flow meter. Extrapolation of the data to 100 days using the most conservative approach was undertaken to estimate the sustainable pumping rate for Church Road and resulted in an estimated sustainable pumping rate of 407 USgpm. However, given the difficulties during this test, this pumping rate should be treated with some caution. Table 5-7 provides a summary of the inputs and resulting 100-day sustainable well yield. Raw data and figures showing water levels and 100-day extrapolations are included in Appendix D.

Water levels recovered rapidly following the end of the constant rate test with 95% recovery achieved within 4 minutes of turning the pump off and 100% recovery after 30 minutes.

Table 5-7
Church Road sustainable yield

PUMPING SPECIFICATIONS	----------
Pumping rate (USgpm)	170
Test duration (hours)	23.5
Depth of pump intake during test (ftbtoc)	134.00
Static water level (ftbtoc)	51.05
Depth to top of screen (ftbtoc)	135.50
Depth of well (ftbtoc)	146.30
RECOVERY	----------
Length of recovery (min)	30
% recovered	100
CPCN INPUTS	----------
Pumping rate (USgpm)	170
Available drawdown (ft)	72
Drawdown at 100 days (ft)	21
CPCN OUTPUTS	----------
100-day specific capacity (USgpm/ft)	8.1
Calculated sustainable pumping rate (USgpm)	582
Calculated sustainable pumping rate with BC safety factor of 30% (USgpm)	**407**

Impact on observation wells

Four wells located near to the test well were monitored for a response in water level during the pumping tests (see Figure 5-3). Data loggers were installed in the private well at 901 Sentinel Road and at Soames Point MW to record water level changes, and also at the flowing artesian Grantham Landing Well to measure a change in water pressure as a result of the tests. A data logger could not be installed in Soames Well due to the small diameter opening in the well head. Some manual dip data was collected during the test from Soames Well however access to the well is restricted due to its location in middle of a road.

The results show no response to pumping from the test well is observed at 901 Sentinel Road or at the Soames Point monitoring well. A response is observed at Grantham Landing Well; however, it cannot be quantified due to the monitoring set up. The dip data that was collected from Soames Well is insufficient to determine whether pumping from Church Road Well had any impact. The Grantham Landing Well and Soames Well are owned and operated by the SCRD so any impact on water levels in these wells as a result of pumping from the Church Road Well is not considered a cause for concern. However, Grantham Landing Well is a flowing artesian well which essentially acts as a spring augmenting flow in Soames Creek when water from this well is not being diverted for potable supply. Therefore, any impact on these artesian

flows as a result of abstracting water from the Church Road Well would reduce flow in the Creek. This is discussed further in Section 6.

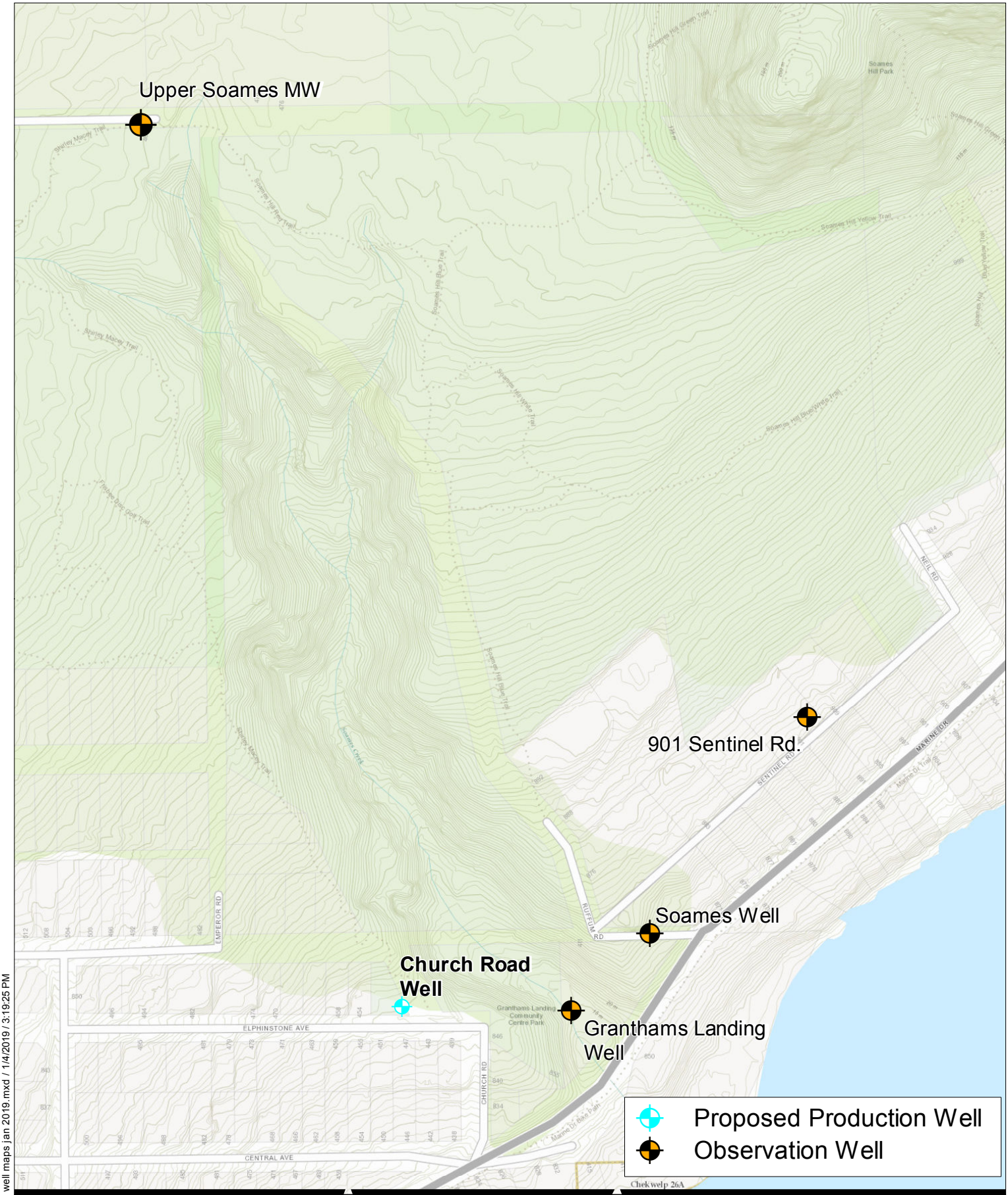
5.3 WATER QUALITY SAMPLING

During the pumping tests, water samples were collected following the procedures outlined in the British Columbia Field Sampling Manual (MWLAP 2013). Field parameters (pH, temperature, conductivity, oxidation-reduction potential [ORP], dissolved oxygen, and turbidity) were measured prior to sampling, using calibrated equipment. The samples were collected when field parameters had stabilised and turbidity was at an acceptable level (<1 NTU at Dusty Road and Mahan Road sites and 4 NTU at Church Road). The samples were collected in laboratory-supplied containers. Samples for dissolved phase constituents were passed through a 0.45 micron filter prior to collection.

All water samples were transported under chain-of-custody protocol in cool boxes with ice to CARO Analytical Services in Richmond, BC for analysis of the following parameters:

- General water quality parameters (alkalinity, chloride, true colour, conductivity, cyanide, fluoride, hardness, nitrilotriacetic acid, pH, sulphate, sulphide, TDS, TSS, total organic carbon [TOC], turbidity, and UV transmittance at 254 nm);
- Nutrients (ammonia, nitrate, nitrite, total phosphorus, total dissolved phosphorus);
- Bacteriological (total coliforms, *E. coli*, iron bacteria and sulphate reducing bacteria);
- Dissolved and total metals;
- Radiological parameters (gross alpha and gross beta activity).

Water quality results were compared with the GCDWQ MAC and AO (Health Canada 2017). The results are discussed in Section 8.



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DATE: November 2018
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FIGURE 5-3: CHURCH ROAD WELL AND OBSERVATION WELLS

Sunshine Coast Regional District

SCRD Groundwater Investigation Phase 2

6 Assessment of Impacts on Other Users

In this section, we assess the hydraulic connection, or the connection between an aquifer and a stream, and the impacts to aquatic environments and other groundwater users. Before granting a new groundwater licence, the Province must consider the rights of any existing groundwater licence holder and the rights of surface water licence holders if the aquifer is considered hydraulically connected to the stream that the surface water licence is on. In addition, environmental flow needs must be considered if the aquifer is considered hydraulically connected to a stream that contains fish.

6.1 HYDRAULIC CONNECTION

The *Water Sustainability Act* (WSA) was introduced to British Columbia on 29 February 2016 to ensure a sustainable supply of fresh water that can meet the current and future water needs of BC's citizens. The WSA is the principal law for managing the diversion and use of water resources, including groundwater. The WSA and the Water Sustainability Regulation (WSR) provide a means to allocate the diversion and use of groundwater for a water use purpose in British Columbia through the issuance of a licence (Todd *et al*, 2016), and a means to manage water use conflicts in times of water scarcity. A large component of the WSA is the introduction of environmental flow needs in streams (EFNs). The Province must consider EFNs when evaluating new licence applications.

A Technical Assessment may be required by the statutory decision maker as part of a new groundwater use licence application and must be completed by a professional with competency in hydrogeology. Based on the quantity of water that the SCRD wish to abstract and the proximity of the wells to other users, it is highly likely that a Technical Assessment will be required for any licence application made for any of the sites. The Technical Assessment involves compiling and interpreting existing information (desk-based) and, where necessary, obtaining and interpreting data collected at and surrounding the site to further inform the hydrogeological regime. This information will provide a better understanding of the impacts that a new groundwater use may have on the environment and other users. Part of the Technical Assessment requires an assessment of the likelihood of hydraulic connection between water in the aquifer and any streams. If a hydraulic connection exists, abstraction from the aquifer could affect existing water rights or harm aquatic ecosystems if streamflow falls below the critical environmental flow threshold for EFNs.

A desk-based assessment of the hydraulic connection between each well and their nearby surface water features is discussed for the three well sites below. In the absence of available flow data for the creeks in the areas of interest, a desk-based surface water study was completed to estimate flow draining from the total catchment of Charman Creek near Mahan Road Well and Soames Creek near Church Road Well. These two creeks are considered the most likely to be impacted by abstraction if there is a hydraulic connection between the aquifer and the creeks. Average monthly flow hydrographs for Charman Creek and Soames Creek were developed using data from surrogate catchments with similar characteristics. The study also estimated the 10-year return period, 7-day low flows for each creek (see Appendix E for details of the methodology and full results). Flows were not estimated for Irgens Creek near Dusty Road as, during well evaluation discussions with the SCRD at a meeting on 28 November 2018, the Dusty Road site was

considered the least favourable option to move forward with at this stage (see Section 10 for further details).

6.1.1 Dusty Road Well

Irgens Creek is located approximately 170 m to the north east of the Dusty Road Well at its closest point. When the creek bed elevation is compared to the measured groundwater level at the Dusty Road well, the data shows that the creek is perched along much of its reach (note: the current Dusty Road groundwater level is likely to be affected by dewatering at the nearby quarry). Leakage of water through the creek bed where it is perched over the aquifer probably provides recharge to the aquifer.

Whilst the creek is perched above the aquifer over much of its reach, given the unconfined nature of the aquifer and the permeable nature of the sand and gravel material present from ground surface to the base of the aquifer, it is considered that there will be a hydraulic connection between groundwater and surface water on the lowest reaches of the creek near Porpoise Bay, where groundwater levels and creek bed elevation are expected to be at similar levels.

It is probable that much of the groundwater that flows through the aquifer from the east (following topography) discharges directly into Porpoise Bay, so the extent of any abstraction impact on flow in Irgen Creek may be limited. However, as part of a technical assessment that would accompany any future groundwater abstraction licence application for a well or wellfield located in this area, it is very likely that further investigation will be required to determine the impact on creek flows and on the associated aquatic habitat. If an impact is identified, mitigation measures would need to be implemented.

6.1.2 Mahan Road Well

Charman Creek (also known as Charmin Creek) is located 190m to the northeast of Mahan Road Well at its closest point. However, the creek elevation is significantly above the groundwater level in the upper and middle reaches (at its closest point to Mahan Road Well the aquifer water table is found at a depth of approximately 84 m below the creek). Furthermore, a low permeability clay and till layer (an aquitard) separates the aquifer - which is unconfined at this location - from the creek. Therefore, the aquifer cannot be hydraulically connected to the upper and middle reaches of the creek. As the creek elevation falls towards the coast, the relative elevation between the creek and aquifer water table reduces and eventually reverses with the aquifer becoming confined with and a piezometric pressure head above ground level.

There are few well logs located along the creek, but from well log information that is available, together with the presence of artesian wells close to the lower reaches of the creek, the aquitard appears to be present along the majority if not all of the creek's length. A simplified cross-section, A-A', has been constructed (Figure 6-1) along a line of section which incorporates a number of well logs in the Lower Town of Gibsons area, where the aquifer becomes confined and artesian flowing conditions are observed. This cross-section shows that at this location, Charman Creek remains situated above or within the low permeability aquitard which prevents/restricts upward movement of water from the aquifer below. There are no well logs close to the creek downgradient of this location, however a long section (B-B') drawn from the higher ground to the

west, across and down the escarpment to the coast (Figure 6-2), utilising lithological logs from a line of wells located to the north of the creek (and likely to be representative of the geological succession in this area), suggests that the aquitard could extend out below the sea and prevent/restrict groundwater from emerging at the surface.

Isolated groundwater springs believed to be from the confined aquifer are found in the Town of Gibsons and indicate that some upward flow paths do exist, however these are not located next to Charman Creek. Furthermore, there are references of Charman creek experiencing extremely low water levels and the creek becoming dry during some summers (DFO, 1991 and UBC, 2000). The non-pumping groundwater piezometric head in the confined aquifer is not thought to recess below the level of the creek along its lower reach in the Lower Town of Gibsons, as data indicates that the Town of Gibsons wells retain their flowing artesian conditions throughout the entire year when the wells are not in use (Waterline, 2013). All of this information would indicate that there is no or very minor flow contribution to the creek from the confined aquifer. However, given the small number of well logs available, located in close proximity to the creek, there may be a requirement to investigate if there are any locations within the creek that groundwater could be providing some baseflow. This could occur if the creek incises the aquitard reducing its thickness or cutting through it entirely.

The surface water desk study estimated the 10-year return period, 7-day low flow for Charman Creek is 1.56 L/s, with an average August low flow of 3.6 L/s. These low flows compare well with the observations of the creek experiencing extremely low flows and on some occasions drying during summer months and is not indicative of the creek receiving groundwater baseflow.

Based on the data available, it is considered unlikely that the underlying confined aquifer that the Mahan Road Well was completed in and Charman Creek are hydraulically connected. Therefore groundwater abstraction is unlikely to have an impact on creek flow. However, if further investigation is required by the regulators to confirm this disconnect, we recommend that shallow exploratory holes are drilled/dug into the ground along the lower reach of the creek to the coast to confirm the continued presence of the low permeability confining layer (given the artesian nature of the aquifer here we recommend only drilling/digging to a depth sufficient to confirm the low permeability layer's presence and do not recommend drilling through the confining layer as this will likely result in flowing artesian conditions that may be difficult to control). In addition, flow gauging at various points along the lower reach of the creek, starting where the piezometric head of the aquifer is close to the creek elevation, be conducted a few times throughout a year (and particularly at times of low flow) to identify where/if the creek gains in flow, potentially from groundwater springs from the lower aquifer.

6.1.3 Church Road Well

Soames Creek is located just 50m to the north-east of Church Road Well, however a confining layer of low permeability material separates the aquifer from the creek in a similar situation to that seen at Charman Creek. Simplified cross-section C-C' has been constructed across the creek, using lithological data from the new Church Road Well and from other well logs in the vicinity (Figure 6-3). The section shows that the aquifer is confined by the low permeability deposits (aquitard) which extends below the base of the creek

and has resulted in the flowing artesian conditions observed at the Granthams Landing Well. Currently there is no information available if this aquitard is present along the entire length of the creek and extends out to the sea, or whether it thins out, or if Soames creek incises through it. If the aquitard is present along the entire reach it will restrict upward groundwater flow from the confined aquifer, therefore there would be no hydraulic connection between the aquifer and the creek. However, if the low permeability thins significantly, is not present, or is fully incised by the creek further downstream towards the coast, this would allow discharge from the aquifer into the creek, therefore any additional abstraction from the aquifer (over and above the volume abstracted from the existing abstractions from the Granthams Landing and Soames Wells) could impact flows in the creek and consequently have an impact on the aquatic habitat. Further investigation, such as flow accretion profiles to determine the presence of gaining reaches, exploratory boreholes to confirm the presence of the confining layer, and potentially a habitat assessment will likely be required to confirm the extent of any impact on creek flow and habitat present.

No flow data is available for Soames Creek, but the hydrological desk study (Appendix E) indicated that the 10 year return period 7-day low flow for Soames Creek is 1.97 L/s, with an average August flow of 5.5 L/s. However, flow in Soames Creek is 'augmented' by the flowing artesian discharge from the Granthams Landing Well which is not taken into account in the estimated flows. Measurements of the artesian discharge taken by the SCRD in 2017 indicated an artesian overflow rate into the creek of 2.9 L/s during pumping conditions and 4.5 L/s under non-pumping conditions (cited in Waterline, 2017), which is almost double the average August flow.

The flowing artesian well essentially acts like a groundwater spring discharge. This 'man-made' discharge has been present since 1990 ,when the well was constructed and the aquatic habitat will have responded and adapted to this increase in creek flow. Consequently, the aquifer may now be considered 'hydraulically connected' to the creek. As part of the permitting process for new licence applications, there is a requirement for there to be no detrimental impact on the existing environmental conditions; therefore, a groundwater abstraction from the Church Road Well which reduces the artesian flow from the Grantham Landing Well could be considered a detrimental impact, even though the discharge is not natural. In conflict with this requirement, the Ground Water Protection Regulations (GWPR) state that flowing artesian wells should be properly sealed and flows controlled. If a production well or wellfield is to be developed in this aquifer in the future, we recommend discussing this unusual scenario with the relevant regulators early in the technical assessment stage to fully understand what their requirements will be in this situation.

Reference is made in a 2004 Drinking Water Source Assessment Report (Alluvia Environmental Services, 2004) to 'Grantham Springs', a five foot deep, open bottom concrete structure, which has water bubbling up through sediments and was part of a former pumphouse located on the opposite side of the creek to the Granthams Landing Well (as per Figure 2 in the Alluvia report). It is not apparent from the information available whether this is a natural spring discharge that has been utilised to provide a water supply, or if it is the result of a previous well drilled/dug into the aquifer, or if it is an old surface water diversion with a slow sand filtration system. Further research will be required to understand the background/history of this structure.

0m
250m
500m
A
A'
50m
25
0m
(sea level)
Charman Creek
WTN53237-(TW3)
WTN 33950 (TW2 – 50m to NW)
WTN 11667 ('spring')
WTN 19896
WTN 76196 (25m to E)
Low permeability
confining layer
(aquitard)
Vashon Drift
Till +
Boulders
Silty Sand
+ Gravel
Silty Sand
+ Gravel
Compact Clay
Silt + Gravel
Gravel (wb)
Silty Sand
+ Gravel (wb)
Silty Sand + Cobbles
Compact Sandy Silt
Boulders
Sand + Gravel (wb)
Sand (wb)
Silty Sand
Gravel +
Boulders
Till
Silty-Sand
+ Gravel
Sand + Gravel
Confined
Aquifer
Pre Vashon
?
?
?
B
B'
A
A'
113189 (ow460)
74430
76196 (TW4)
5468
(spring)
19896 (TW1)
11661
(spring)
33950 (TW2)
76155
53237 (TW3)
Gibbons
Abbs Rd
Fletcher Rd
Charman Creek
0
250
Meters
N

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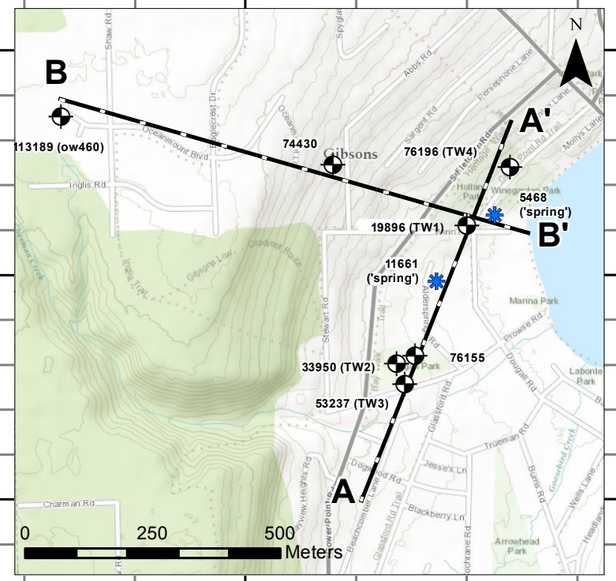
FIGURES 6-1: SECTION A-A' CHARMAN CR. CROSS-SECTION (MAHAN ROAD WELL)

Sunshine Coast Regional District

SCRD Groundwater Investigation Phase 2

0m
500m
1.0km
B
B'
WTN 113189 (OW 460)
Charman Crk, (100 m S)
Clay Some Gravel
Sand Gravel
Capilano Sediments
100m
Vashon Drift
Till?
Low permeability confining layer (aquitard)
WTN 74430 (25 m to N)
Boulders + Clay
Clay, Cobbles + Sand
Silty S + G
Compact Sand, Silt + Gravel
50m
Sand + Gravel
Pre Vashon
Till
Nov. '87
S+G (wb)
Water Table
Piezometric Surface
WTN 19896 (TW1)
'Spring' WTN 5468 (25 m to N)
Unconfined Aquifer
Silty Sand
Compact Sandy Silt
Boulders
Sand + Gravel (wb)
Sand
Confined Aquifer
0m (sea level)



B-B' Mahan.mxd / 1/10/2019 / 11:53:56 AM

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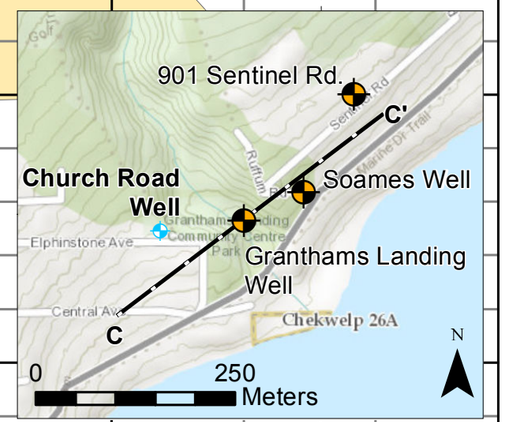
FIGURE 6-2: SECTION B-B' CHARMAN CREEK ESCARPMENT LONG SECTION (MAHAN RD. WELL)

Sunshine Coast Regional District

SCRD Groundwater Investigation Phase 2

0m
100m
200m
300m
400m
C
C'
50m
0m
-30m
Church Rd (40m to NW)
Granthams Well (flowing artesian)
Soames Well (10m to SE)
901 Sentinel Rd (40m to NW)
Soames Creek
Capilano Sediments
Vashon Drift
Pre Vashon (confined aquifer)
Unknown Statrigraphy
Piezometric Surface
S + G
Till
Dense Silty S + G
S + G (wb)
Till
S + G (wb)
S + G
Compact Sand
Compact Sand and Gravel with some Silt
V. Compact Silty Gravel Till
S + G (wb)
Lower permeability confining layer (aquitard)
Till and Cobbles
Silty S + G
Sand
Till
S + G (wb)
Clay
Sand
?


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Associated Environmental

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FIGURE 6-3: SECTION C-C' SOAMES CREEK CROSS-SECTION (CHURCH ROAD WELL)

Sunshine Coast Regional District

SCRD Groundwater Investigation Phase 2

6.2 ASSESSMENT OF POTENTIAL IMPACTS

6.2.1 Impacts to Aquatic Environments

Fish are reported to be present in all creeks local to the wells so where it is determined that the aquifer is hydraulically connected to the creeks the presence and impact on fish and other aquatic species will have to be considered as part of a technical assessment submitted to support a groundwater licence application.

Dusty Road – Whilst much of the nearby Irgens Creek is perched above the water table, the unconfined nature of the aquifer makes it probable that the aquifer is hydraulically connected to Irgens Creek at the lowest reaches of the creek, close to Porpoise Bay. Fish are known to be present in the creek so should a groundwater abstraction have an impact on flow in the creek in the lower reaches, it could detrimentally impact the fish species present by reducing their habitat or impeding their path further up or downstream.

Mahan Road – The hydrogeological setting developed from well logs and the documented observations and flow estimations of low or no flow in Charman Creek suggest that there is no hydraulic connection between the confined 'lower' aquifer that Mahan Road Well draws water from and the local creeks. Consequently, based on the information available, it is considered that there is unlikely to be an impact on the aquatic environment from groundwater abstraction.

Church Road – A low permeability layer was identified at the Church Road Well, confining the aquifer below the level of Soames Creek. Well logs from other wells in the vicinity confirm that this confining layer extends below Soames Creek near the Church Road Well, restricting groundwater flow from the aquifer entering the creek. Nevertheless, there is insufficient information available to confirm whether this low permeability layer is present below the entire reach of the creek down to its discharge point into the sea.

However, Granthams Landing Well, located in the valley floor adjacent to Soames Creek, is an uncontrolled flowing artesian well, which discharges groundwater into the creek from the same aquifer that Church Road Well is completed in. This well behaves like a groundwater spring, augmenting flow in the creek. On the opposite side of the creek is 'Grantham Spring'. Little is known about this feature and whether it was formerly a natural spring that was utilised for supply, a drilled well, a dug well, or a diversion from Soames Creek with a slow sand filter; however, if it is a drilled well providing flow from the aquifer into the creek, this would suggest a hydraulic connection. As such, it will need to be investigated further.

Abstraction from the Church Road Well during the pumping test was shown to have an impact at Granthams Landing Well (although the impact was not able to be quantified during the pumping test due to the complex arrangement of pipe infrastructure at Granthams Landing Well), reducing the flow of water that discharges from this well. Therefore, a production well or wellfield located in this aquifer which lowers the water level/pressure in the aquifer could potentially impact the aquatic habitat by reducing flow from this man-made connection between the aquifer and the creek, as well as from 'Grantham Spring', if it is indeed a spring sourced from the lower Aquifer.

6.2.2 Impact on Nearby Groundwater Users

Dusty Road – Two wells were monitored during the pumping test at Dusty Road, the well at 6109 Sechelt Inlet Rd showed no evidence of an impact. Insufficient data was obtained from the Lehigh Quarry Well #5 to determine an impact; however, given the proximity of the Dusty Road Well to Lehigh Quarry, water levels in #5 Well are likely to drop during long-term pumping. The extent of any impact on this well is unknown at this stage due to a lack of data collected during the pumping test.

Mahan Road – Two wells were monitored during the pumping test at Mahan Rd, the private well at 498 Mahan Rd and MOE monitoring well OW 460. Water level data from both wells show a response to the pumping test with groundwater levels lowered by approximately 0.7 and 0.5 m respectively.

The Mahan Road Well is completed in the same aquifer as that of the Town of Gibsons public supply wells; consequently, prior to development of a production well at this site, the likely impact on the Town of Gibsons existing public water supply wells will need to be considered in detail. In addition, a number of private residences in the vicinity of the Mahan Road Well are not connected to a main water supply, and therefore, are likely to have unregistered wells. Any effect on these private water supplies would require mitigation should there be a detrimental impact on supplies.

Church Road – Four wells were monitored during the pumping test at Elphinstone Ave. Of these, an impact was only observed at the SCRD owned Granthams Landing Well, although impact can not be quantified from the data obtained given the set-up of this flowing artesian well. No impact was observed during the pumping test in the private well at 901 Sentinel Rd or from Soames Point MW. Insufficient water level data was available to conclude if there was any impact at the SCRD owned Soames Well.

Prior to the development of production wells at any of the sites, we recommend that a detailed well and water features survey is conducted to identify any users who may not have registered their wells with the Province of BC and are currently unknown. This would be completed as part of the Technical Assessment. Details such as well depth, pump depth, and water level drawdown in their well when it is in use will help to determine whether a SCRD production well would have an impact upon these private abstractions. If it is deemed likely that a detrimental impact will occur, mitigation measures will need to be implemented such as lowering of pumps to maintain a sufficient head of water above the pump, drilling new wells, or connecting the affected properties to the public water supply.

7 Issues Related to Proposed Works, Land, Public Safety, and Environment

Marta Green, P.Geo, inspected the Granthams Landing well head on November 15, 2016, as part of site visits for the SCRD Well Protection Plan project, completed in March 2017. Based on this site visit, a review of available reports, and discussions with Dave Crosby, Capital Projects Manager of SCRD at that time, the Grantham's wellhead is a sealed above-ground steel casing located inside a locked concrete

culvert above ground. The bottom of the concrete culvert box is coarse gravel. No surface seal is present and ponded water was visible around the concrete culvert. In addition, a 30 mm diameter pipe carries flow from the concrete culvert box and is discharged nearby to Soames Creek. It is unclear whether this flow is coming from the outside of the steel casing, and inside the locked concrete culvert, or from within the steel casing.

Section 53 of the Water Sustainability Act (WSA) states that the owner of a flowing artesian well must engage a well driller who is qualified in respect of the activity or a professional and ensure that the well driller or professional, as applicable, stops the flow of that well or brings the flow of that well under control. A well is considered under control when:

(a) the artesian flow

(i) is clear of sediment,

(ii) is entirely conveyed through the well's production casing to the wellhead, if the well has a production casing,

(iii) may be mechanically stopped for an indefinite period in a manner that prevents leakage onto the surface of the ground or into another aquifer penetrated by the well, and

(iv) does not pose a threat to property, public safety or the environment, or

(b) if the artesian flow cannot be controlled in accordance with paragraph (a), the well is decommissioned

(i) in accordance with the regulations,

(ii) by a person authorized under section 49 [restrictions on constructing or decommissioning wells], and,

(iii) in a manner that allows no artesian flow at the surface of the ground or leakage into another aquifer penetrated by the well.

Based on Ms. Green's site visit and review of the Granthams Landing well, the artesian flow is not entirely conveyed through the well's production casing therefore, the Granthams Landing Well is an uncontrolled flowing artesian well, and this does not meet section 53 of the WSA.

The Church Road Well, if developed into a production well, could be used as a replacement well to Granthams Landing and Soames wells. Once the Granthams Landing and Soames wells are disconnected from the system, a decommissioning plan can be developed, and the Granthams Landing well can be closed, bringing the SCRD into compliance with the WSA. The Soames Well may be able to be used as a dewatering well as part of the decommissioning. If Granthams Landing Well is to be decommissioned, a new dedicated augmentation well and pipeline, or a new pipeline from an existing well such as Soames Well, may be required to augment creek flows to replace the water that would no longer discharge from Granthams Landing Well. This would need to be further assessed, and we have included it as part of the Technical Assessment in support of a new Groundwater Use Licence Application (see recommendations in Section 12.2)

8 Water Quality Assessment

8.1 WATER QUALITY RESULTS

The results of the water samples analysed by CARO are presented in Appendix F.

The water for all three wells meets the Guidelines for Canadian Drinking Water Quality for both the health based maximum acceptable concentrations (MAC) and aesthetic objectives (AO), with one exception: total iron from the Church Road well with 0.441 mg/L total iron against a GCDWQ AO guideline of 0.3 mg/L. However, as noted in Section 5.2.3 silt and sand was being pulled into the well during the pumping test and this is likely to be the source of the elevated iron. The results for dissolved iron is 0.016 mg/L which is well below the guideline, and is more likely a true indication of iron in this groundwater.

Langelier Index is an approximate measure of the degree of saturation of calcium carbonate. Under-saturated water will tend to be corrosive, whilst over-saturated water will tend to deposit calcium carbonate. The results indicate that the water at Dusty Road is undersaturated so may be corrosive to the pipework. The water at Mahan Road and Church Road is over-saturated so may result in calcium carbonate deposition. This affects various pipe materials differently and this can be further studied at the detailed design stage.

It should be acknowledged that only one water sample has been collected from each well so the results should be treated with some caution as they could change over time during pumping or seasonally. However, the results from these first samples are encouraging and indicate very good quality water.

Additional considerations

High iron concentrations have previously been found in the Mahan Road area. Personal communication with the owners of the well at 498 Mahan Rd suggests that they have high iron concentrations in the water they abstract with iron staining present on their sinks and baths. Water samples previously collected at OW 460 (WL10-02) are reported to have exceeded the GCDWQ guidelines for iron and manganese and on occasion aluminium (Waterline, 2013).

The Ministry of Environment recommends monitoring for specific conductance when drilling in coastal areas (MOE, 2016). Field measurements were taken throughout the pumping tests to monitor changes in specific conductivity. The readings remained consistent throughout with no increase indicating that pumping did not induce saline water into the well. The wells are the following distances from the coast: Dusty: 450 m; Mahan: 1200 m; Church Rd: 170 m. The Ministry of Environment suggests avoiding drilling locations within 50 m. Based on this, the water quality monitoring to date, and the capture zones we calculated (as discussed in Section 8.2.1), it is unlikely that salt water intrusion will be an issue with any of the three well sites. However, pumping tests during future phases should include conductivity measurements to confirm.

8.2 PRELIMINARY ASSESSMENT OF POTENTIAL DRINKING WATER HAZARDS

We assessed potential drinking water hazards as follows:

1. We estimated the capture zone, or the area within which rain or snow melt would eventually be captured by the well during pumping over a certain time frame, following standard equations.
2. Within each capture zone, we assessed hazards to the drinking water source. This was completed by interviews during our site visits and through reviewing publicly available air photos.
3. Compared water quality results to Guidelines for Canadian Drinking Water Quality and assessed the aquifer setting (confined vs unconfined) and its implications on water quality to be expected.

8.2.1 Delineation of Capture Zones

Table 1-4 in Module 1 of the Source-to-Tap Guideline summarizes the different capture zone delineation methods, from simple to more complex, and recommends which one to follow depending on the size of the water system and the hydrogeologic setting (MHLS 2010). For water systems with 100 to 10,000 connections, the Source-to-Tap Guideline recommends using analytical equations and hydrogeological mapping to delineate the capture zones. For the purposes of this study it has been assumed that each well will have connections in this range, therefore, we used a combination of desk-based hydrogeological mapping and the analytical equation method outlined by Ceric and Haitjema (2005), which includes a mathematical approach to justify the method selection between the circular, eccentric circular, and boat-shaped capture zone analytical equations that are presented in the BC Well Protection Toolkit (MOE 2000). The analytical equations require estimating the aquifer's hydraulic conductivity (m/s), thickness (m), hydraulic gradient (unitless), and porosity (unitless) as well as the pumping rate of the well (m^3/s) and the timeframe of interest.

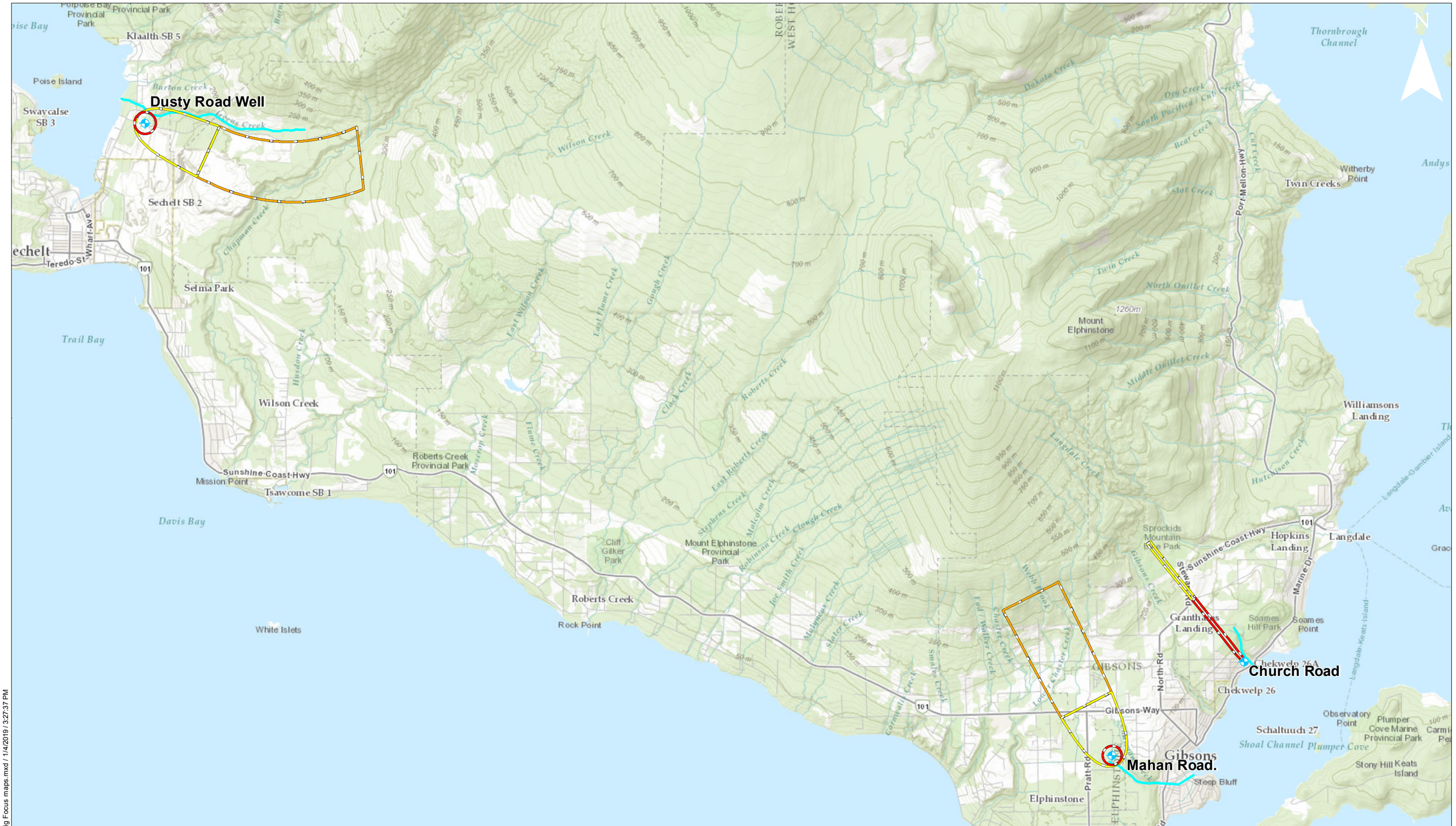
For this study, capture zones are based on the maximum calculated (sustainable) well pumping rate, not the actual well pumping rate. Following this approach, we mapped the 200-day, 5-year and 20-year capture zones for each well. A 200-day capture zone represents the survival time of pathogens (including viruses) and is consistent with the new version of the BC Ministry of Health's Guideline for Determining Groundwater at Risk of Containing Pathogens (MoH 2015)[6]. Similar to Ontario's approach, a 5-year capture zone represents the time it would take to remediate a hydrocarbon spill or leak; and a 20-year capture zone represents the time it may take chemical hazards such as nitrates to reach the well. An overview of the delineated capture zones for all wells is shown on Figure 8-1, and Table 8-1 lists the parameters that were used to delineate the capture zones. The capture zones shown should be treated as preliminary at this stage as further hydrogeological information is required to better delineate the extent and shape of the capture zone.

[6] Pathogens are disease causing organisms. There are three types of water-born pathogens of concern to humans: viruses, bacteria, and protozoa, each with different sizes, life cycles, and characteristics.

Table 8-1
List of parameters used to delineate the capture zones

		Dusty Road	Mahan Rd	Church Rd
Aquifer description based on well logs		Unconfined, sand and gravel aquifer	Unconfined, sand and gravel aquifer	Confined, sand and gravel aquifer
Analytical equation used	200-day	Eccentric circular	Eccentric circular	Boat-shaped
	5-year	Boat-shaped	Boat-shaped	Boat-shaped
	20-year	Boat-shaped	Boat-shaped	Boat-shaped
Hydraulic conductivity (m/s)[1]		$9x10^{-5}$ m/s	$1.6x10^{-4}$ m/s	$2x10^{-3}$ m/s
Aquifer thickness (m)[2]		50	35	22
Porosity[3]		0.25	0.25	0.25
Hydraulic gradient[4]		0.02	0.006	0.02
Pumping rate[5]		1011 USgpm (63.7L/s)	572 USgpm (36.1 L/s)	407 USgpm (25.7 L/s)
Changes to analytical equation results based on hydrogeological mapping		No changes made to the analytical equation results.		The capture zones were large and extended beyond Mt. Elphinstone so they were ended at what is estimated to be the contact of the bedrock and the surficial sediments.

Source:
[1] The hydraulic conductivity was calculated by dividing the aquifer transmissivity by aquifer thickness. Values calculated are typical for medium sand to fine gravel unconsolidated deposits (Freeze and Cherry, 1979).
[2] Based on geology encountered during drilling.
[3] Typical porosity for sand and gravel (from BC Well Protection Toolkit).
[4] Dusty Rd: calculated based on well water level and assuming groundwater is at 0 masl at coast; Mahan Rd: from Waterline report using groundwater contours; Church Rd: from Associated Well Protection report using same gradient as that used for Soames and Granthams Wells.
[5] Calculated 100-day sustainable yield from the October/November 2018 pumping tests.



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Associated Environmental

Well Location

Creeks of Interest

Well Capture Zones

A - 200 Day

B - 5 Year

C - 20 Year

PROJECT NO.:	2018-8152.000.001
DATE:	January 2019
DRAWN BY:	DA

0 1 2 Kilometers

FIGURE 8-1: WELL CAPTURE ZONES

Sunshine Coast Regional District

SCRD Groundwater Investigation Phase 2

8.2.2 Potential Hazards

Groundwater can enter a water supply well through:

1. groundwater flow from an up-gradient aquifer,
2. overland flow and then infiltration near the well-head,
3. through geological factures, annular spaces along improperly closed boreholes and other larger openings in an aquifer, and
4. via direct entry to the well if the well head completion is not sealed properly.

Hazards can be both human-related or natural. Examples of hazards are:

- Naturally occurring: pathogens from wildlife including bacteria (E. coli), and protozoa such as Giardia lamblia.
- Agricultural: nitrates, phosphates, pesticides
- Forestry-related: turbidity
- Municipal: fertilizers and pesticides from fields/parks, stormwater run-off from roads
- Commercial: contaminants from airports, auto repair shops, dry cleaners
- Industrial: specific contaminants from specific industrial land uses
- Residential: pathogens and nitrates from septic tanks, pesticides, and/or solvents

Table 8-2 presents potential hazards identified for each well site and distances to the hazard where known.

Table 8-2
Potential drinking water hazards for each well site

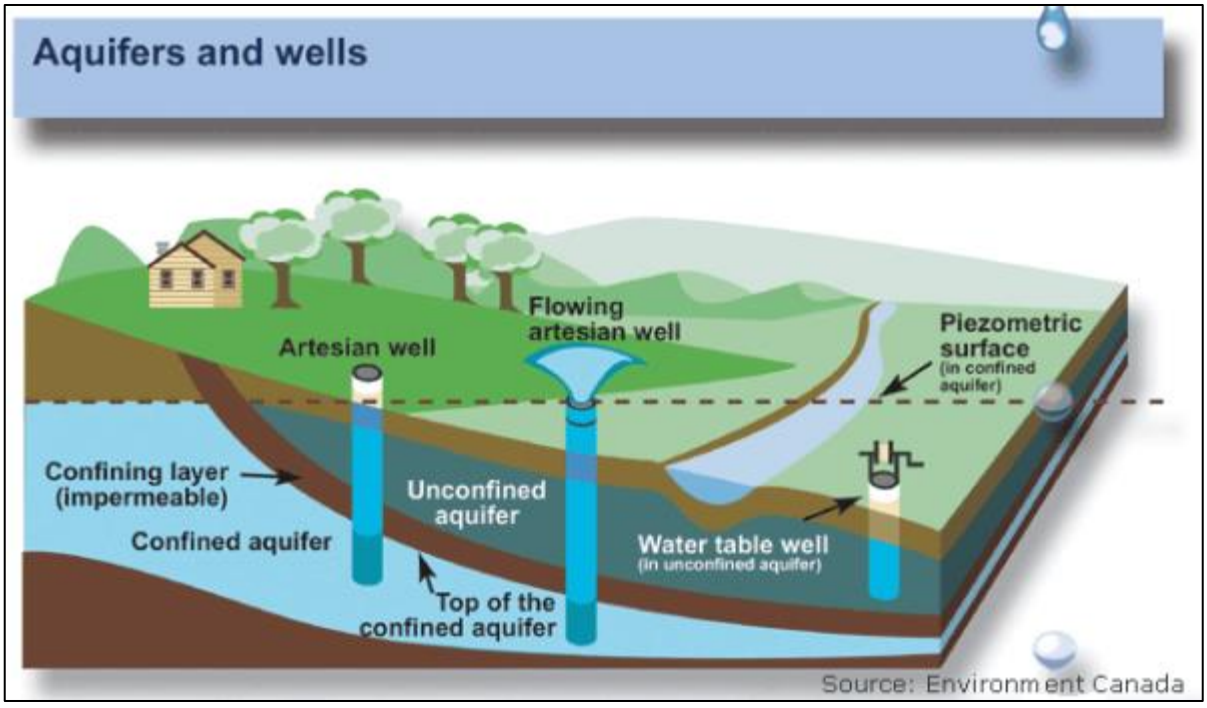
Dusty Road	Mahan Road	Elphinstone Avenue
• Dusty Road Sewage Treatment Plant (0.5 km to east) • Sechelt Landfill (1.9 km to east) • Sechelt Public Works (adjacent to well) • Road drainage, including minor oil spills and salt (5 m to south) • Industry – quarry, including minor and major oil spills and leaks (50 m to south) • Hydrocarbon and chemical storage – above and below ground storage private, commercial and industrial (closest is adjacent to site)	• Private septic tanks (closest private dwelling is 10 m to east) • Hydrocarbon and chemical storage – above and below ground storage for private, commercial and industrial use (closest private dwelling is 10 m to east) • Road drainage (adjacent to site)	• Private septic tanks (closest private dwelling is 20 m to south) • Industrial area (1.5km to northwest) • Hydrocarbon and chemical storage – above and below ground storage private, commercial and industrial (closest private dwelling is 20 m to south) • Road drainage (5 m to south) • Disused landfill (2.1 km to north west)

8.2.3 Review of Water Quality and Aquifer Setting

A review of the water quality does not indicate any unusual parameters of concern; however, the pumping tests were short term while long term pumping draws water in from a larger area; therefore, the water quality is only representative of existing water quality concerns in the area under non-pumping conditions.

The aquifer setting in which water supply wells are installed will dictate the vulnerability of the wells to contamination from surface, and the time it will take for contaminants to transport through the aquifer. In confined aquifers, there is a layer of less permeable material, such as clay or silt, overlying the aquifer. This layer helps to protect the aquifer from contamination directly above because contaminants will take a very long time to percolate through. Unconfined aquifers do not have this overlying layer of less permeable material and are therefore more susceptible to contamination from the surface (Figure 8-2).

Figure 8-2
Schematic diagram of confined and unconfined aquifers (Geological Survey Canada, 2017)



Dusty Road is likely to be most at risk from surface or near-surface potential hazards because this well is located within an unconfined aquifer with no overlying low permeability geological strata present, that would otherwise provide a measure of protection from contaminants. The current proximity of Lehigh Quarry to the well and the potential for expansion of the quarry around and upgradient of the well poses a significant risk of contamination to the aquifer. Oil spills and leaks from heavy machinery and continued daily round trip gravel truck deliveries, that operate in and to/from the quarry, as well as leaks from fuel or chemical storage facilities, could pass through the sand and gravel deposits reaching the aquifer and the cone of depression formed by pumping and consequently become drawn towards the well. Quarries typically excavate material

to a level close to or below the water table, thereby increasing the risk of contamination by reducing the amount of unsaturated material present above the water table that would otherwise help filter any contamination prior to it reaching the aquifer. Consequently, the intense industrial nature of the land use in this area is seen as a major risk to the development of a production well or wellfield at this location.

Low permeability clay and till formations exist over the aquifers in which Mahan Road and Church Road wells were drilled and this layer will provide a measure of protection from contaminants migrating into the aquifer and reduces the risk of contamination occurring. However, there may be zones where this low permeability layer is thin or non-existent and therefore pathways could still exist for contaminants to migrate downwards into the aquifers.

The potential drinking water hazards, water quality data, and aquifer setting were considered as part of Task 6, Evaluation of well sites (see Section 10).

8.3 GARP SCREENING

The *Drinking Water Protection Regulation* (B.C. Reg. 200/2003) requires that the drinking water from a water supply system be disinfected by a water supplier if the water originates from groundwater that, in the opinion of a Drinking Water Officer (DWO), is at risk of containing pathogens[7]. The BC Ministry of Health (MOH) Guidance Document for Determining Groundwater at Risk of Containing Pathogens (GARP) (herein referred to as the GARP Guideline) was released in September 2017, and helps inform DWOs on the steps involved to make a GARP determination.

The GARP Guideline includes 13 hazards that each well is screened against. The hazards are categorized into three groups: water quality results, well location, and well construction. If a hazard is “present” at the screening stage, then the hazard is moved to the “assessment” stage. After the assessment stage, the assessor recommends a “determination” for the groundwater. Wells can be determined to be considered:

1. Low risk GARP: The well is at low risk to GARP and does not require disinfection. The assessor then moves on to Stage 4 Long-Term Monitoring.
2. At risk GARP-viruses only: The well is at risk to viruses only and the assessor then moves on to Stage 3 Risk Mitigation, which can include treatment to meet only the provincial drinking water objectives for viruses.
3. At risk: The well is at risk to pathogens and the assessor then moves on to Stage 3 Risk Mitigation, which can include treatment to meet the provincial drinking water objectives.
4. At risk (due to unavailable information): If there is information that is unavailable or inconclusive, the well is determined to be “at risk” and the assessor then moves on to Level 2 or 3 Investigation (Preliminary or Detailed Hydrogeological Investigations).

[7] There are three main groups of pathogens, or disease-causing organisms: viruses, bacteria, and protozoa. More information about the types of pathogens, and how they move differently in groundwater, is available here: https://www.bcwwa.org/news-announcements/2018-10-29-new-technical-information-brochure-available-for-m/.

To determine if the groundwater from the three wells should be considered GARP (Groundwater at Risk of containing Pathogens), Associated conducted a GARP screening following the GARP Guideline) (MOH 2017). The GARP Guideline outlines four stages:

1. Hazard Screening and Assessment
2. GARP Determination
3. Risk Mitigation
4. Long-term Monitoring

For this study, we performed the first (screening only) and second stage of the GARP Guideline (determination). The hazard screening portion of Stage 1 involved a review of each well's location, construction, aquifer properties and water sample results. This information was used to inform the GARP determination.

Results

The GARP screening and assessment checklists for each well are provided in Appendix G. Based on this screening and assessment, all three wells are determined to be "at-risk to viruses only". Consequently, one method of treatment is needed, and treatment is to meet 4-log virus inactivation/removal for each well site. For long-term monitoring, we recommend the following, for the first year of operation, at which time a GARP-determination update can be completed and a review of long-term monitoring parameters and frequency can be completed:

- Regular (at a minimum every four hours) monitoring of turbidity; and
- Weekly *E.coli* and total coliform testing of raw water.

The results of the GARP determination helped inform treatment requirements, Task 11, and recommendations.

9 Production Well Design

Appendix H provides sketches of our proposed well design for each site. Careful consideration of the drill methods will be needed to ensure that representative soil samples will be collected at Mahan Road and Church Road where the formation is made up of thin sand/gravel layers. A combination of cable tool and dual rotary rigs may need to be used. In addition, a review of the open storm water ditch capacity at each site will be needed, including the capacity of any downstream culverts that may present a restriction to flow. This is to confirm that the ditches/culverts can handle the calculated well yields.

10 Evaluation of Four Well Sites (Task 6)

A meeting was held on November 28, 2018 between Associated and SCRD to evaluate the three well sites and rank them in order of preference based on multiple criteria from four general categories: well supply, engineering, land access, and environmental. A matrix was developed with scores agreed upon for each well against the evaluation criteria in each category. An importance weighting was built in to the matrix as some criteria are considered more important than others. A memo outlining the evaluation criteria and the

scoring method used is provided in Appendix I together with the minutes of the meeting. The completed evaluation matrix is shown in Table 10-1.

Church Road Well - The results show that Church Road Well scores highest and is therefore evaluated as the preferred well site to prioritise for development.

During the meeting on 28 November 2018, the potential of developing a wellfield at Shirley Macey Park, located 500 m to the northwest of the well was discussed. This park is owned by the SCRD and is expected to be located above the same aquifer as that of the Church Road Well and would provide a greater area of land in which to develop production wells and treatment facilities. A cost estimate to investigate the potential of this area with the drilling of two new exploratory wells (to assess water level drawdown interference between two wells), pumping tests and consultancy support was developed. However, due to the significant expected depth to the top of the aquifer of nearly 100m, the depth of the wells would likely be around 150m and pumping would require the groundwater to be lifted a significant height at greater cost than pumping from a shallower depth to groundwater. The cost to complete this exploratory drilling and testing of two new wells is estimated to be in the region of $350K. An alternative is the development of a wellfield along Elphinstone Avenue with a production well located close to the recently drilled Church Road Well and potentially a second well drilled on land next to the Granthams Landing Reservoir at the corner of Elphinstone Avenue and Fisher Road. Both wells would then also be located on property owned by the SCRD (see Sections 11 and 12).

Mahan Road Well – The Mahan Road final evaluation score was relatively close to that of Church Road, however difficulties may be encountered concerning the development of a production well close to the Town of Gibsons public supply wells and the impact a SCRD abstraction might have on their existing and future supply needs. This consideration makes development of a well at this location less favourable than at Church Road at this time.

We recommend that an aquifer mapping study be conducted in this area to better define the extent of the aquifer and the resource available. We recommend that a collaborative approach be taken for such a study that involves the SCRD, the Town of Gibsons and the Provincial Government.

Dusty Road Well – Dusty Road has the lowest score of the three wells despite having the highest calculated sustainable yield, the overall score is significantly impacted by its low source protection score, which has the highest weighting of all the criteria. This reflects the unconfined nature of the aquifer and its location next to Lehigh Quarry, putting the aquifer at high risk from contamination which could effectively render the well(s) unusable in the future. The risk from contamination is deemed too high to justify well development costs when there are other groundwater options to explore at this time.

Gray Creek – Gray Creek was also discussed during the meeting and a groundwater supply well in this area has not been discounted at this stage, given the apparent productive aquifer that Northern Divine Aquafarms have constructed a wellfield in. The SCRD could explore this if this company is willing to discuss options for the potential development of a public water supply well(s) on their property. Furthermore, the SCRD have an existing surface water licence to divert water from Gray Creek for public water supply (3

million litres per day [550 USgpm]) and all or part of this licence could be transferred to a groundwater abstraction licence in the future should a well be developed here.

Table 10-1
Well Evaluation Matrix

General Category	Grading Criterion	Score			Importance Weighting	Notes
		Dusty Road Well	Mahan Road Well	Church Road Well		
Well Supply	Long term sustainable well yield	*5*	*4*	*3*	*15%*	Dusty Road: unconfined aquifer. Sand and Gravel: 64 L/s. Mahan Road: deep well, 400 ft deep well. Also unconfined although there is a local confining unit which provides protection. Yields: pumped 300 USgpm: rated at 570 USgpm. Church Road: Confined aquifer (confining layer: till) and sand and gravel below that. Issues with drilling. Drilling didn't give clear picture of what's down there. Screen got lost first time. Put another screen in and then pumping test started pulling in sands and silts at 240 USgpm. Dialed back to 170 USgpm. Rated at 407 USgpm.
	Well interference (drawdown) with other wells	*3*	*3*	*5*	*5%*	Dusty: inconclusive due to lack of data. Mahan: monitored two wells: 300m to North (private well): 70 cm drawdown. MOE's observation well: 400 m away 50 cm drawdown (difficult to interpret with tidal influence). Gibsons wells farther away so negligible interference is expected but could use 50 cm as worst case scenario. Also will need a detailed (door to door) survey to confirm water users (every house near the border but in the Town of Gibsons can be assumed to have a well). Everyone ok with ongoing monitoring and discussion with other well owners. An independent aquifer mapping study across entire study may be useful. See if can partner with BC FLNR Surrey office and Town of Gibsons. Church Road: monitored pressure changes in Granthams, and Soames well minimal interference observed but data was limited. Also private well: no interference.
Engineering	Interconnecting Pipe Size	*3*	*5*	*4*	*10%*	Limiting factor on pipe capacity in bold: Dusty Rd: well 64 L/s and pipe **47 L/s**. Mahan Rd: well **37 L/s**, pipe 94 L/s (pipe along Pratt Road, and could flow in other direction). Church Rd: well **26 L/s**, pipe 47 L/s. Lots of pipe room in Mahan.
	Production Wells, Treatment, Storage, Tie-In and Energy Costs (Capital)	*5*	*3*	*4*	*15%*	All sites designed with 4-log treatment (chlorination). Expensive to connect Mahan to 3-phase power as will come from Gibsons Way, approx. 600m to north. Church Road also requires a new 3-phase power connection. Dusty Rd already has 3-phase power.
	O&M and Long term Energy Costs	*5*	*4*	*3*	*5%*	Generally the same per well except for energy costs (Mahan has highest drilling costs due to depth). O&M for pumps may be seasonal.
Access Issues	Room for Production Well, Treatment Plant, and Storage, Land ownership/agreement	*4*	*3*	*5*	*10%*	SCRD staff will look into this further. Board may wish to have ownership vs right of way only from MOTI, so Mahan scores lower. Church Road is also on right of way but there is room owned by SCRD.
	Land Use Fit	*5*	*5*	*5*	*0%*	Everyone agreed there will be minimal disturbance and sufficient room at each site. Community is used to wells in parks and in residential areas.
Environmental	Source Protection	*1*	*4*	*5*	*20%*	Dusty has a very high risk: one of largest gravel extraction mines in North America. Plans for expansion all around this well. Unconfined aquifer so any spills or leaks from oil or gas for machines could make its way to aquifer and drawdown cone of well.
	Hydraulic Connection and Impacts to Environmental Flow Needs (needed to support new Groundwater Use Licence Application)	*2*	*5*	*5*	*15%*	Aquifer at Dusty Road site is likely connected to Irgins Creek so could require mitigation to augment EFNs. Mahan and Church Rd not likely naturally connected to Charman and Soames Creek, respectively. Will know more by final report because AE is doing more hydrology work. Aquatic values are very important for community.
	Other regulations (e.g.: Environmental Assessment Act and Ground Water Protection Regulation)	*3*	*3*	*5*	*5%*	EAA: All wells below 75 L/s as long as each well considered a different "project". If in separate watersheds should be ok. For GWPR, Church Road would allow Granthams to be closed (uncontrolled flowing artesian well) to be be in compliance with GWPR.
Total score with importance weighting		*3.25*	*3.9*	*4.35*	100%	

11 Assessment of Infrastructure and Operations Requirements (Task 7)

The following sections provide an assessment of the treatment, infrastructure and operational requirements and costs to develop a production well at each of the three well sites. A preliminary assessment of requirements and capital costs was completed prior to the well evaluation meeting on 28 November 2018 (Sections 11.1 to 11.3 below). This information was considered as part of the well evaluation process (Section 10).

Following the well evaluation discussions, it was concluded that the Church Road site should be prioritised for further investigation and development. Two development options have been identified:

- Option A: the construction of a single production well at the recently drilled Church Road site.
- Option B: the construction of a 'wellfield' consisting of two production wells, one well at the Church Road site and a second well adjacent to the SCRD Granthams Landing Well on the corner of Elphinstone Avenue and Fisher Road.

Both options would tie into the Chapman and Granthams Landing and Soames service areas.

Detailed development costs for these two options are provided in Section 11.4.

11.1 TREATMENT REQUIREMENTS

The treatment requirements vary depending on the well location and water quality obtained from the well sampling.

11.1.1 Dusty Road

This well is considered GARP (Viruses only). Water quality testing report indicated that all parameters tested complied with the CDWQG. Physically, the well is located in an area with no existing reservoirs in the vicinity that a dedicated watermain could reasonably connect the well to. In order to meet the CT (concentration X time) requirements for 4-log inactivation of viruses the connection to the distribution will be an oversized 300 mm main of about 300 m length. The sizing has been based on a chlorine residual of 1.5 mg/l.

Treatment required: Chlorine injection providing primary (for virus inactivation) and secondary disinfection (for residual). It is proposed to use sodium hypochlorite solution (SHS) as the SCRD has experience in using this delivered liquid chemical.

Infrastructure Required: 300mm main approximately 300m in length.

Assumed Facility Flow Rate: 47 L/s. This is based on a full 200mm pipe (the existing main on Sechelt Inlet Road) with water running in south direction only. If it is confirmed that flow could be sent north during the maximum day water demand (MDD) condition, i.e. Grey Creek intake is not used, then this could be increased to include the demand north of Grey Creek intake to a maximum of 94 L/s if an additional well(s) was drilled.

11.1.2 Mahan Road

Background: This well is considered GARP (Viruses only). Water quality testing report indicated that all parameters tested complied with the CDWQG. The nearest reservoir that could be tied into is the Reed Road Reservoir which is located approximately 2.2 km from the Mahan Road well. Installing a dedicated main of this length would be expensive ($814,000 for a 200 mm watermain and $528,000 for paving alone). Instead a new dedicated main could run along Kearton Road to tie in along Pratt Road. This main will be oversized at 250mm to provide adequate CT prior to reaching the first user. The sizing has been based on a chlorine residual of 1.5 mg/l.

Treatment Required: Chlorine injection providing primary (for virus inactivation) and secondary disinfection (for residual). It is proposed to use SHS.

Infrastructure Required: 250mm main approximately 410m in length. A new 3-phase electrical service connection is also required to run the well pump.

Assumed Facility Flow Rate: 37 L/s. This is based on the well yield, but could be increased up to 94 L/s if additional wells were drilled.

11.1.3 Church Road

The well is considered to be GARP (Viruses only). As listed in the Drinking Water Treatment Objectives for Ground Water Supplies in BC, only one form of treatment is required to provide potable water for this type of water source. The water quality testing report also indicated that the iron was above the aesthetic objective of 0.3 mg/L with a reading of 0.44 mg/L. Turbidity was also noted to be well above the Objective limits of 1.0 NTU with a reading of 10.2 NTU. We anticipate that the turbidity resulted from the formation collapse around the well screen. The iron levels may also have been elevated because of this collapse. As the well is further developed we anticipate that turbidity will drop below 1.0 NTU. Often the turbidity reading can be skewed higher by iron precipitating out of the sample jar during transport to the laboratory. It is recommended to determine what the turbidity of the water is on site before proceeding with additional treatment. It's also recommended to re-test the iron levels prior to finalising treatment requirements. For this report it has been assumed that iron levels will return to levels seen in other wells in the area which show iron levels below the aesthetic limit and therefore filtration has not been shown in this conceptual design. This should be noted as a risk to this well that iron level could stay elevated and filtration could be required.

Treatment Required: Chlorine injection providing primary (for virus inactivation) and secondary disinfection (for residual). It is proposed to use SHS.

Storage and Infrastructure Required: Tie into the nearby Grantham Reservoir (which currently only feeds the Granthams Landing service area) with a dedicated raw water main from the well to a new chlorination water treatment plant (WTP) located adjacent to the reservoir (250m). The Grantham reservoir would be retrofitted with baffles inside to increase the baffling factor in the reservoir in order to achieve adequate concentration x time (CT) for 4-log virus inactivation.

A pump station, complete with backup emergency generator, would be required to pump water into the Chapman service area since the new well would produce more water than what is used by the Grantham's Landing and Soames services areas. The new pump station would be located within the new WTP and would pump treated water from the hydraulic grade of 80m up to the 210m which is what the Chapman system is run at (Henry Road Reservoir TWL) and what the existing main along Reed road is operated at according to Figure 3-2B of the Comprehensive Regional Water Plan (Opus DaytonKnight, 2013). A new dedicated watermain would be installed along Reed Road and tie in at Chamberlin Road to provide water to the Chapman system. A new 3-phase electrical service connection is also required at the new WTP location to run the pump station and the well pump. Power and control wiring would run from the new WTP to the well pump so that no building would be required in the park adjacent to the well, only the wellhead would be visible.

Assumed Facility Flow rate: 26 L/s. This is based on the well yield and also flow through a 150mm existing pipe along Reed Road. This could be increased to approximately 47 L/s if this pipe was upsized to 200mm and an additional well was drilled.

11.2 COMPARISON OF CLASS D CAPITAL COST ESTIMATES FOR EACH WELL SITE

Preliminary Class D capital cost estimates (with 40% contingency included) for the development of one production well, treatment plant and associated infrastructure at each site are summarised in Table 11-1. These costs are for comparative purpose only (for use during the well evaluation process – see Section 10) and only include construction costs, with no detailed design and consultancy support costs included as it is anticipated that these costs would be similar for each well site. A breakdown of these construction costs together with preliminary plans showing proposed infrastructure are provided in Appendix J.

Table 11-1
Comparison of Class D capital costs for development of a production well at each site

Well Site	Class D capital construction cost[1]
Dusty Road	$1.38M
Mahan Road	$1.75M
Church Road	$2.01M

[1] Construction cost estimates only

11.3 COMPARISON OF OPERATIONAL COST ESTIMATES FOR EACH WELL SITE

Annual electricity and SHS cost estimates for each well are provided in Appendix J and summarised in Table 11-2 for comparative purposes.

Table 11-2
Annual operating costs

Well Site (and pumping rate)	Estimated annual electricity cost	Estimated annual SHS cost
Dusty Road (64 L/s)	$19,372	$13,271
Mahan Road (37 (L/s)	$28,769	$7,672
Church Road (26 (L/s)	$37,050	$5,391

Assumptions:

- These costs are for comparison purposes and based on approximate motor sizes for each well
- Replacement costs not included
- Miscellaneous costs like SCADA network, water sampling, insurance, operator wages, engineering support, tech support not included since this is for comparison purposes
- Assume wells operate for 4 months a year at their calculated sustainable rates
- SHS costs are $0.02 per m^3 (1000 litres) for each well, based on current SCRD chlorine costs for existing wells.

11.4 COST ESTIMATES TO DEVELOP A WELL OR WELLFIELD AT CHURCH ROAD

Cost estimates have been prepared for the development of either one production well (Option A), or two production wells (Option B). For the purposes of costing we have assumed each option would be comprised of the following:

- Option A: a single production well (with well yield estimated at 25.7 L/s) adjacent to the Church Road exploratory well (Church Road Production Well) with new chlorination water treatment plant at Granthams Reservoir and tie in to Pressure Zone 3 distribution network at Chamberlin Road.

- Option B: construct two production wells (with a combined well yield estimated at 51.4 L/s), one adjacent to the Church Road exploratory well (Church Road Production Well) and the second well located at the corner of Elphinstone Avenue and Fisher Road (Fisher Road Production Well) with treatment facility and tie in at Granthams Reservoir and tie in to Pressure Zone 3 distribution network at Chamberlin Road (with upgraded pipe size to accommodate a flow up to 47 L/s).

11.4.1 Class D Capital Cost Estimate

Table 11-3 shows the estimated capital cost, including 40% contingency, to develop both options and includes costs for: detailed design, construction, additional exploratory drilling and testing (where required for Option B), permitting (including any environmental assessments), and engineering construction support. A more detailed breakdown of these costs is provided in Appendix K.

Table 11-3
Class D cost estimates for construction of Option A and Option B (Church Road)

Option (and pumping rate)	Class D Cost Estimate[1]
Option A – 1 Production Well (26L/s)[2]	$2.4M
Option B – 2 Production Wells (47 L/s)[3]	$3.1M

[1] A contingency of 40% has been added to all cost estimates
[2] Pumping rate based on calculated sustainable yield
[3] Pumping rate based on maximum calculated flow rate from two wells through existing infrastructure

11.4.2 Operating Cost Estimates

Operating cost estimates are provided in Table 11-4 for both options.

Table 11-4
Annual operating cost estimates for Option A and Option B (Church Road)

Option (and pumping rate)	Estimated annual electricity cost	Estimated annual hypochlorite cost
Option A – 1 Production Well (26 (L/s)	$37,050 (per Table 11-2)	$5,391
Option B – 2 Production Wells (47 L/s)	$69,306	$9,746

Assumptions:
- These costs are based on approximate motor sizes for each well
- Replacement costs not included
- Miscellaneous costs like SCADA network, water sampling, insurance, operator wages, engineering support, tech support not included
- Wells operate for 4 months a year at the pumping rates shown
- SHS costs are $0.02 per m^3 (1000 litres) for each well, based on current SCRD chlorine costs for existing wells.

12 Conclusions and Recommendations

12.1 CONCLUSIONS

All tasks of the Phase 2 Groundwater Investigation Project have been completed. Based on the findings of the study, we conclude the following:

1. Three of the four well sites were completed and tested, and have been considered for development into production wells. The pumped rate, and the calculated sustainable well yield of each well is shown in Table 12-1. Looking at the modelled gap in water supply for 2050 of 188 L/s (2,979 USgpm) to 322 L/s (5,099 USgpm) for 184 days, Associated concludes that the aquifers in the vicinity of the wells sites at Dusty Rd, Mahan Rd, and Church Rd could make up this supply gap, considering water quantity alone. Interestingly, the results of the drilling and pumping test program suggest that the groundwater resources on this part of the Sunshine Coast are larger than previously thought.

Table 12-1
Summary of Drilling

	Units	Dusty Road	Mahan Road	Church Road
Well Depth	m	83.5	118.9	43.9
Tested Rate	USgpm	300	300	170
	L/s	18.9	18.9	10.7
Calculated sustainable well yield per well	USgpm	1011	572	407
	L/s	63.8	36.1	25.7

2. Desktop hydraulic connection studies have been undertaken for the three well sites. Based on the information available, the aquifer at Dusty Road is considered to be connected to the lower reach of nearby Irgens Creek; the aquifer at Mahan Road is considered unlikely to be hydraulically connected to the nearby Charman Creek; and the aquifer at Church Road is connected to Soames Creek via a man-made pathway: the flowing artesian Granthams Landing Well. This information will become important when completing the technical assessment in support of a new groundwater use licence application.

3. Water quality from all three well sites is excellent, and no health-based exceedances were observed, other than high NTU at Church Road due to the well formation collapse and which is expected to reduce to less than 1 NTU for a completed well.

4. The wells are considered GARP-viruses only. One method of treatment is needed, and treatment must provide 4-log inactivation of viruses. Recommendations for long-term monitoring once the production wells are brought on-line are presented in Section 8.

5. The Mahan Road and Church Road wells are located in areas with few hazards and are protected by a low permeability clayey till layer above the aquifer of interest. The Dusty Road well is deemed to be at greater health risk from contamination, with drilling showing that no protective low permeability layer is present (the aquifer is unconfined). This is unfortunate given the location of Dusty Road within an industrial area.

6. A review of the piping infrastructure concluded that the following flow rates (Table 12-2) could be possible at each site with new mains and upgrades to the existing infrastructure.

Table 12-2
Maximum facility flow rate at each site

	Units	Dusty Road	Mahan Road	Church Road
Calculated sustainable well yield	USgpm	1011	572	407
	L/s	63.8	36.1	25.7
Maximum facility flow rate[1]	L/s	94	94	47

[1] Based on using multiple wells and existing infrastructure

7. The three wells were evaluated and ranked based on a number of weighted criteria.
    a. Church Road had the highest score and development of this site should be prioritised.
    b. Mahan Road scored lower in the well interference and land availability criteria. The Mahan Road well would be developed in the same aquifer of the Town of Gibsons public water supply wells, and other private supplies, so more work would be needed to map the aquifer and better understand well interference. We understand the Ministry of Environment is updating their aquifer mapping information on the Sunshine Coast in 2019, which will help with the well interference criteria, and may allow Mahan Road to become an area to develop at a later date.
    c. The Dusty Road Well is calculated to have the highest sustainable yield of the three wells, more than double the calculated sustainable yield calculated for Church Road Well, so it scored highly on the costing and yield criteria. However, the aquifer at this location is susceptible to contamination given its location adjacent to Lehigh Quarry (which is also expected to expand around the well site) and the unconfined nature of the aquifer with no protective low permeability layer. The risk from contamination was deemed too high to human health to justify production well development costs when there are other groundwater options available at this time, therefore the Dusty Road well scored low in the Source Protection criterion.

8. A well located in the Gray Creek area, downstream of where the Gray Creek exploratory well was drilled, should not be discounted at this stage. The relatively thin aquifer and lower yields encountered during drilling are believed to reflect the well location at the apex of the alluvial fan. A well further downstream should intercept a thicker aquifer with higher yields, as observed from wells operated by Northern Divine Aquafarms.

12.2 RECOMMENDATIONS

Based on these conclusions, Associated recommends the following next steps:

1. Prioritise the Church Road site for further development – the 'Church Road Wellfield Project' – to develop a wellfield capable of providing up to 47L/s (the maximum flow the existing supply infrastructure will allow). This will require:
    - Completing a Technical Assessment that would be submitted to support an application for a new groundwater use licence of up to 74 L/s. Although the infrastructure in the area currently only allows for 47 L/s, there could be an option to develop a transmission line on Reed Road to the Reed Road Pump Station, which feeds the Henry Road reservoir. Henry Road reservoir feeds Pressure Zone 3, which is where the demand is. This scenario would allow for 74 L/s more supply. Applying for this amount will provide the SCRD with some flexibility in the future should the production well(s) - once developed - produce a yield in excess of 47 L/s. Applying for a project volume above this rate is not recommended because an Environmental Impact Assessment reviewable by the Environmental Assessment Office will be triggered. Note that the Ministry of Forests, Lands and Natural Resources has a minimum target review time of 140 days and that their current timelines for the processing of applications could be a year or more. This assessment should be undertaken prior to the construction of a production well. The Technical Assessment will make use of the information collected during Phase 1 and Phase 2 of the Groundwater Investigation but will also likely require the following:
        - Consulting with the relevant regulators (FLNRO, DFO) at an early stage with regard to the unique situation in Soames Creek where the Granthams Landing Well augments flow. This will enable the SCRD to understand what any future licence conditions are likely to be, i.e., will an augmentation flow continue to be required if the Granthams Landing Well is sealed and the uncontrolled artesian flow stops, or if abstraction from the aquifer significantly reduces the artesian pressure and therefore reduces flow to the creek.
        - Confirm whether there is any hydraulic connection between the aquifer and Soames Creek (other than through the man-made connection at Granthams Landing Well). This would be achieved by:
            - Collecting flow data at various points along Soames Creek to develop flow accretion profiles to help identify whether there are any groundwater discharges into the creek. These accretion profiles should be conducted at various times during the year but particularly during a period of low flow.
            - Undertaking shallow intrusive ground investigation to confirm or exclude the presence of the low permeability layer beneath Soames Creek downstream of the Granthams Landing Well to the coast.
            - It may be necessary to construct a hydrometric monitoring station to allow collection of continuous creek flow throughout the year to better understand seasonal flows and how this might have an effect on the aquatic habitat, particularly if the current artesian flow from Granthams Landing Well is removed from the creek.

- Undertake a habitat assessment of the creek. This will initially include reconnaissance work to establish the reaches of the creek, collection of fish habitat data (e.g., channel size, gradient, substrate, cover, riparian area properties, etc.) at representative sites within each potentially affected reach, recording of any fish passage barriers, and fish sampling to determine presence/absence.

The cost to complete the above tasks, including the Technical Assessment and submission of a groundwater licence application is estimated to be **$112,000** (with a 40% contingency included). The schedule of the Technical Assessment must include high and low flow periods, so May through to December, with reporting completed by end of February in the following year. With a review target turnaround time of 140 days, the earliest a licence could be received would be June 2020, however given their current backlog in processing similar applications it is more realistic to expect that that would occur in 2021. We recommend allowing 1 year for scheduling purposes, i.e., the licence received around March 2021.

2. Concurrent to completing the Technical Assessment, design and drill a pilot well along Elphinstone Avenue at a location – potentially on the corner of Elphinstone Avenue and Fisher Road – where a second production well could be constructed to help meet SCRD's water demand shortfall. The estimated cost to drill and test the pilot well is at a minimum **$140,000**, including drilling, testing, hydrogeology consulting, and a 40% contingency. The testing should be completed in late summer, with reporting following in fall 2019.

3. Once the groundwater abstraction licence has been received, complete detailed design and drill and test a production well at the Church Road site. Use the information gained to develop plans to increase the water supply through construction of a second production well, potentially sited at the corner of Elphinstone Avenue and Fisher Road, next to the existing Granthams Landing Reservoir and the proposed new water treatment plant.

   Option A: The cost to construct a single production well (with well yield estimated at 25.7 L/s) at the Church Road site with new chlorination water treatment plant at Granthams Reservoir and tie in to Pressure Zone 3 distribution network at Chamberlin Road, is estimated to be **$2.4M** (includes 40% contingency for construction works plus engineering and environmental consultancy fees).

   Option B: The cost to construct two production wells (with a combined well yield estimated at 51.4 L/s) with treatment facility and tie in at Granthams Reservoir and tie in to Pressure Zone 3 distribution network at Chamberlin Road (with upgraded pipe size to accommodate a flow up to 47 L/s) is estimated to be **$3.1M** (includes 40% contingency for construction works plus engineering and environmental consultancy fees).

4. Consider further exploratory groundwater investigations in Shirley Macey Park, which is in Pressure Zone 3, where the water demand is needed, to further help meet the supply gap of 175 L/s, and because this is in any area owned by the SCRD, and a park area, excellent for source protection. Initially, this would include drilling two new exploratory wells to confirm the presence and thickness of

the aquifer and undertake pumping tests at both wells to determine aquifer characteristics, well yields and well interference. Due to the depth of the water table (94 m), the cost to design, drill and test two wells is estimated at **$350,000.**

5. Complete further investigation of the potential for a well at Mahan Road by conducting an aquifer mapping study; ideally this would be in collaboration with the Town of Gibsons and the Provincial Government. This study would help to delineate the extent of the aquifer and available water resources that could be utilised by all parties. We understand the Provincial Government is working on aquifer mapping; however, we recommend the SCRD to be an active partner in this mapping because of the knowledge the SCRD has gained about the aquifers on the Coast from their various recent projects.

6. Approach Northern Divine Aquafarms Ltd. to discuss the feasibility of drilling an exploratory test well within Northern Divine's property near Gray Creek, where the aquifer is expected to be thicker and provide a greater yield than that observed at the Gray Creek exploratory test well drilled during this investigation. A production well or wellfield located at this location would help the SCRD meet their water supply demand in this zone of their supply network.

7. Abandon consideration of the Dusty Road site as a new groundwater source as drilling demonstrated that the aquifer here is unconfined sand and gravel with no low permeability (clay) layer protecting it from contamination from the surface. This lack of a confining layer is important given the location, scale and the potential risk of contamination posed by the adjacent quarry (oil spills and leaks from trucks and machinery). The SCRD has other options to site a well that do not have this risk (e.g: Gray Creek is also an unconfined aquifer setting, but is not surrounded by industrial use. Other areas within the SCRD (e.g.: Mahan Road, Langdale, and Church Road wells are in a confined aquifer setting, allowing for the protective cap).

Closure

This report was prepared for the Sunshine Coast Regional District to summarise the drilling and testing of four exploratory water supply wells to augment supply to the Chapman Creek water system.

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

Respectfully submitted,
Associated Environmental Consultants Inc.

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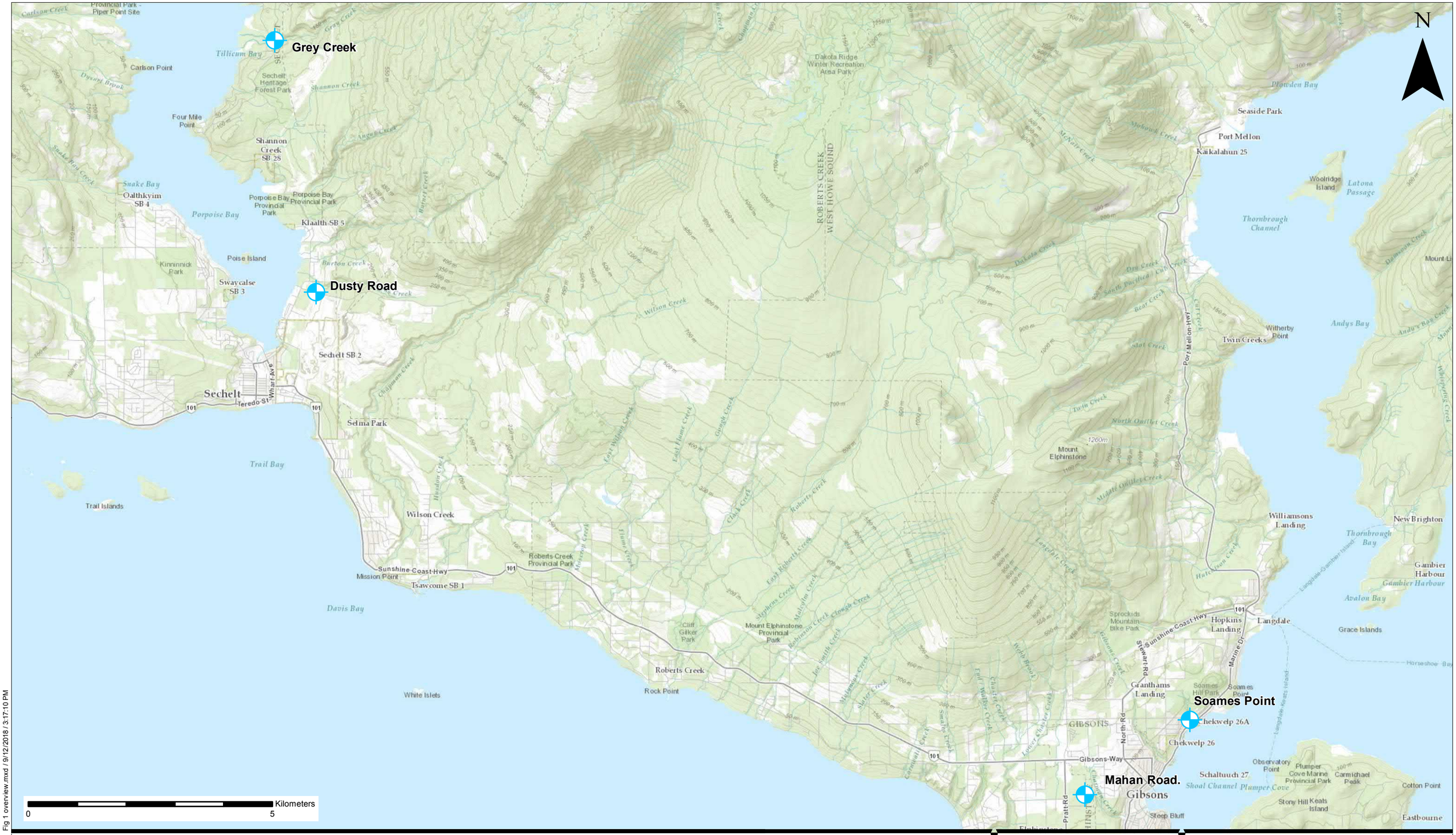
Appendix A - Maps provided to drillers



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Associated Environmental

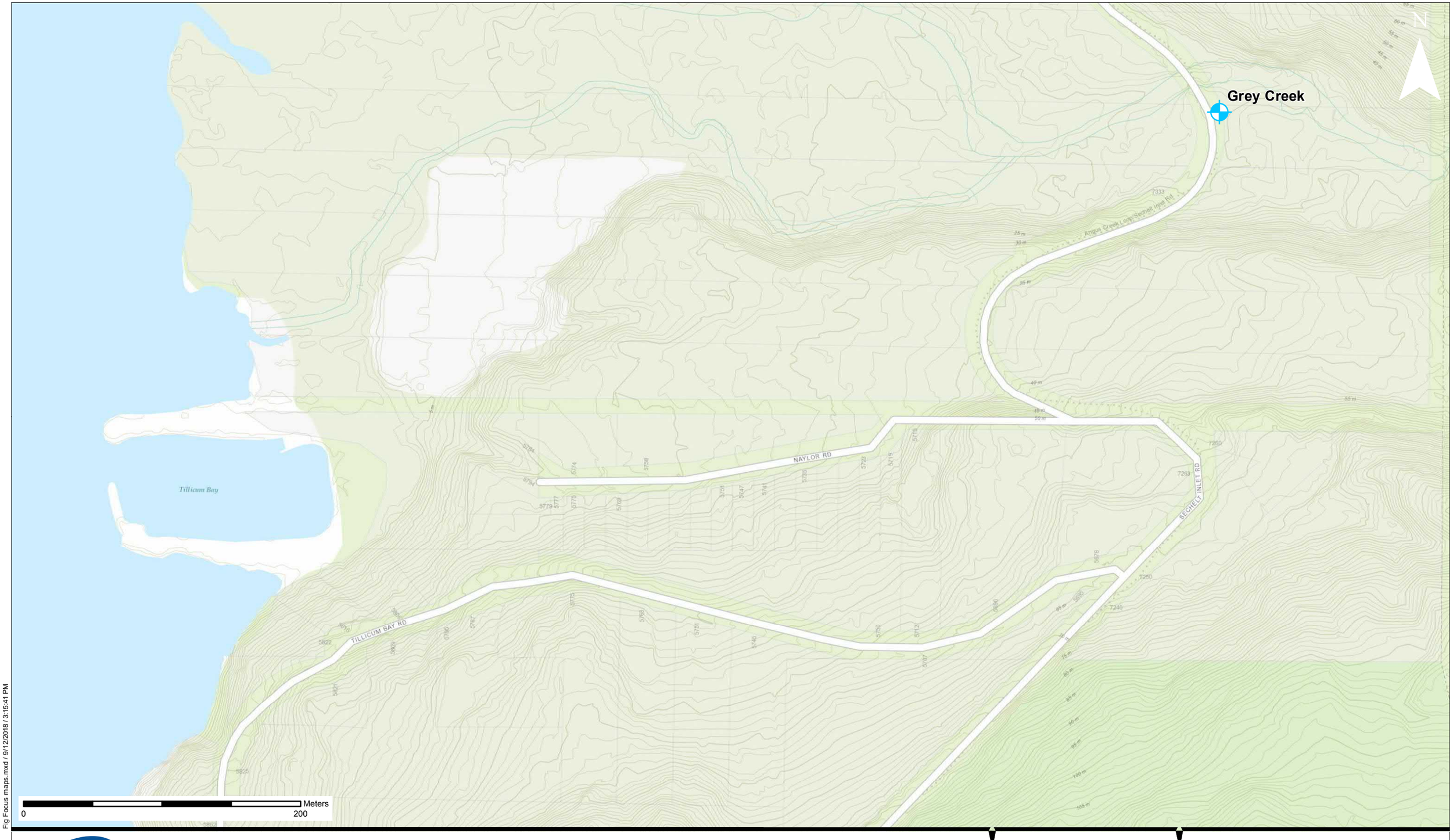
Well Location

PROJECT NO.:	2018-8152.000.001
DATE:	September 2018
DRAWN BY:	DA

FIGURE A1: WELL LOCATIONS

Sunshine Coast Regional District

SCRD Groundwater Investigation Phase 2



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Associated Environmental

Well Location

PROJECT NO.:	2018-8152.000.001
DATE:	September 2018
DRAWN BY:	DA

FIGURE A2: GREY CREEK

Sunshine Coast Regional District

SCRD Groundwater Investigation Phase 2

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Associated Environmental

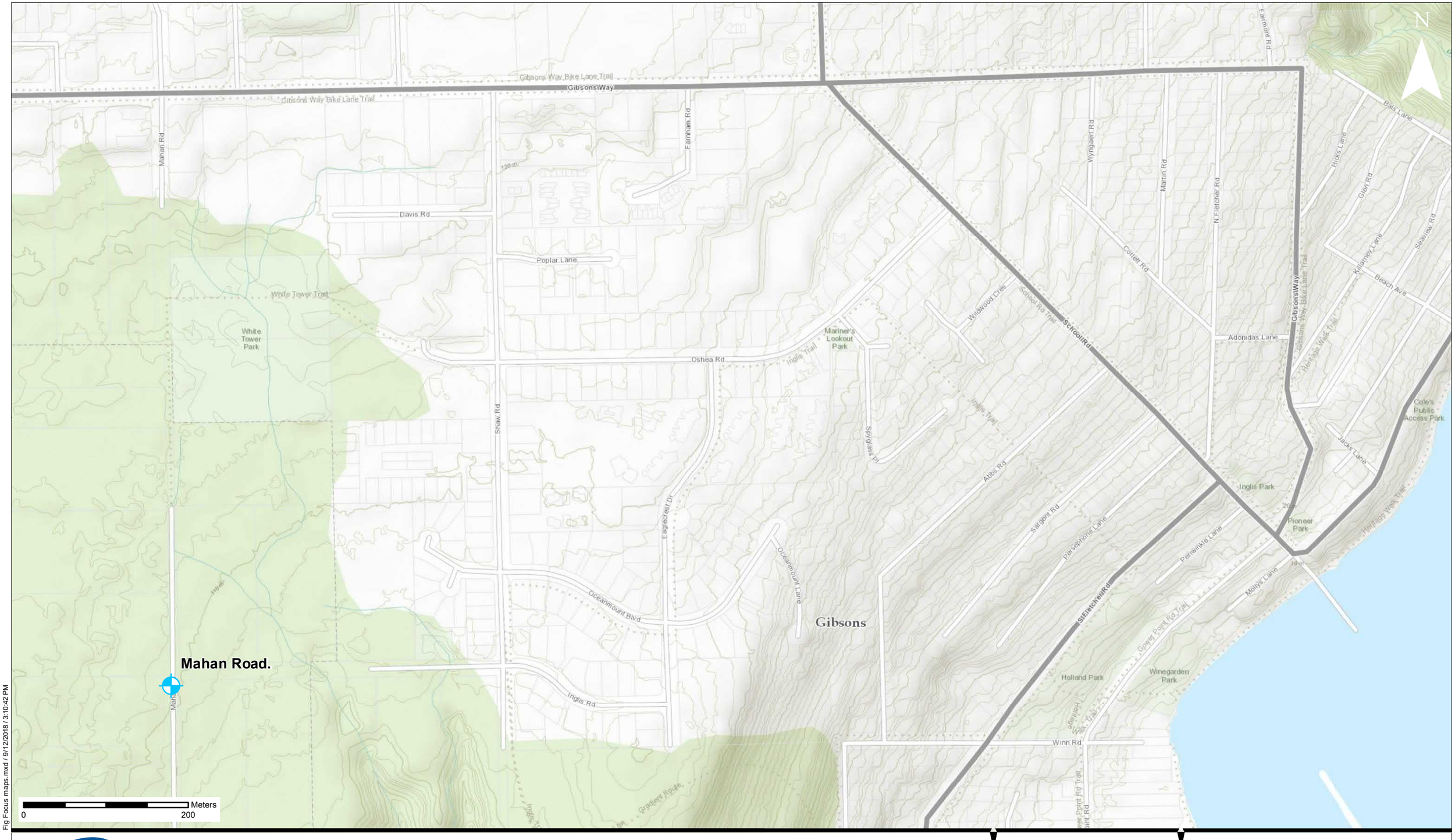
Well Location

PROJECT NO.:	2018-8152.000.001
DATE:	September 2018
DRAWN BY:	DA

FIGURE A3: DUSTY ROAD

Sunshine Coast Regional District

SCRD Groundwater Investigation Phase 2



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Associated Environmental

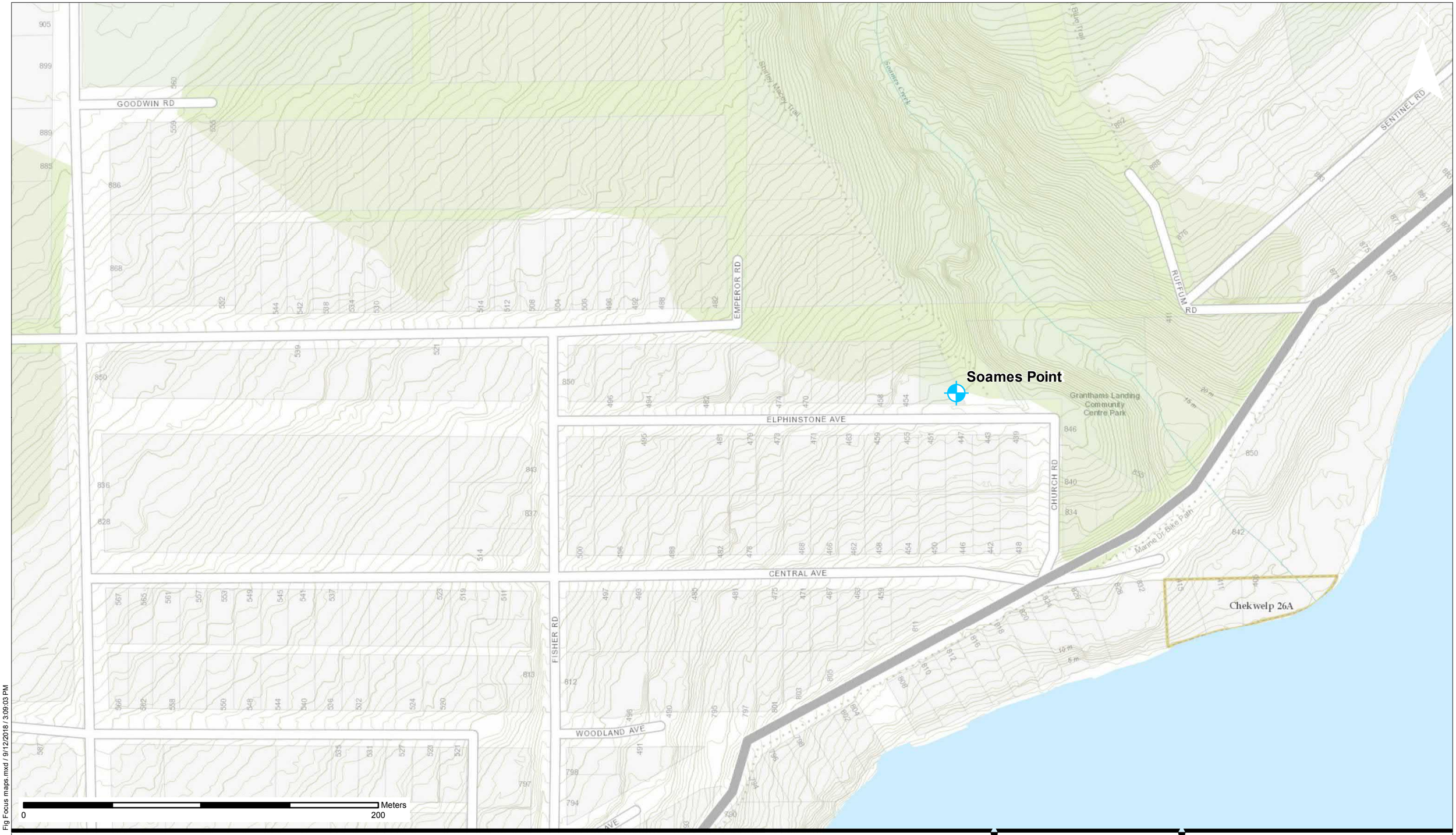
Well Location

PROJECT NO.:	2018-8152.000.001
DATE:	September 2018
DRAWN BY:	DA

FIGURE A4: MAHAN

Sunshine Coast Regional District

SCRD Groundwater Investigation Phase 2



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Associated Environmental

Well Location

PROJECT NO.: 2018-8152.000.001
DATE: September 2018
DRAWN BY: DA

FIGURE A5: SOAMES

Sunshine Coast Regional District

SCRD Groundwater Investigation Phase 2

Appendix B - Well Logs

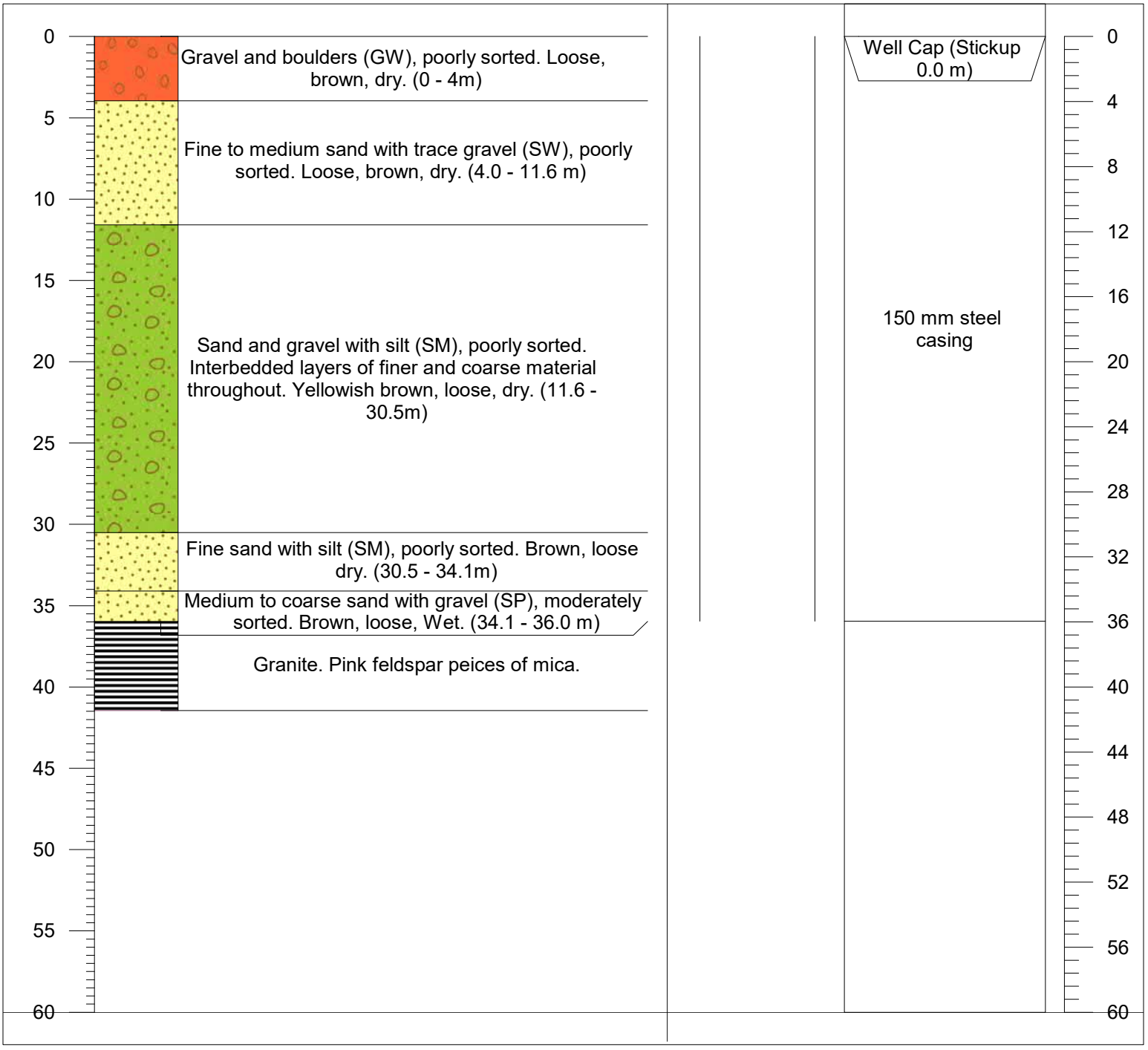
Project Details		WIN 54942	Location	
Project Number:	2018-8152		Northing (m):	5487511
Client:	SCRD		Easting (m):	445385
Location:	Gray Creek		Elevation (m):	c.26

Subsurface Profile

Depth (m)	Graphic Log	Description
0		Gravel and boulders (GW), poorly sorted. Loose, brown, dry. (0 - 4m)
4		Fine to medium sand with trace gravel (SW), poorly sorted. Loose, brown, dry. (4.0 - 11.6 m)
11.6		Sand and gravel with silt (SM), poorly sorted. Interbedded layers of finer and coarse material throughout. Yellowish brown, loose, dry. (11.6 - 30.5m)
30.5		Fine sand with silt (SM), poorly sorted. Brown, loose dry. (30.5 - 34.1m)
34.1		Medium to coarse sand with gravel (SP), moderately sorted. Brown, loose, Wet. (34.1 - 36.0 m)
36.0		Granite. Pink feldspar peices of mica.

Well Completion

Well Construction	Details	Depth (m)
	Well Cap (Stickup 0.0 m)	0
	150 mm steel casing	36



Lithology Legend

Bedrock | Sand | Sand and Gravel | Gravel

Contractor:	Drillwell
Operator:	Scott Burrows
Date of Construction:	18 / Sep / 2018

Associated Environmental

80

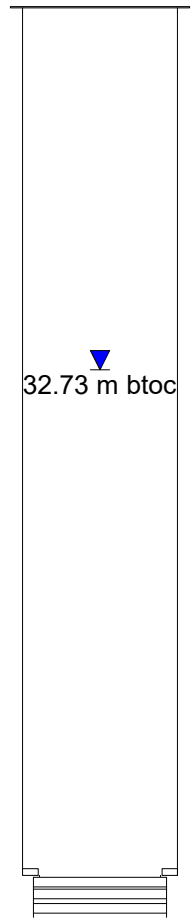
Drawn by: Tony Friesen

Project Details		WIN 54929	Location	
Project Number:	2018-8152		Northing (m):	5482370
Client:	SCRD		Easting (m):	446211
Location:	Dusty Road		Elevation (m):	c.37

Subsurface Profile

Depth (m)	Graphic Log	Description
0		Fine to medium sand (SW), well sorted. Pale yellow, loose, dry. (0.0 - 2.44 m)
5		Sand and gravel (GW), poorly sorted. Brown, loose, dry (2.44 - 15.24 m).
10		
15		Fine to medium sand (SW), moderately sorted. Pale yellow, loose, dry. (15.2 - 18.28 m)
20		Fine gravel with coarse sand (GP), moderately sorted. Brown, loose, dry. (18.3 - 22.9 m)
25		Medium to coarse sand (SP), well sorted. Brown, loose. wet (22.9 - 30.5 m)
30		
35		
40		
45		
50		Sand and gravel (GW), poorly sorted. Brown, loose, wet (30.5 - 83.8 m).
55		
60		
65		
70		
75		
80		
85		Clay with trace sand (CL), well sorted. Blue, dense, moist (83.8 - 86.0m)
90		
95		
100		
105		
110		
115		
120		

Well Completion



Well Construction	Details	Depth (m)
	Well Cap	-2
		2
		6
		10
		14
		18
		22
		26
		30
		34
	150 mm steel casing	38
		42
		46
		50
		54
		58
		62
		66
		70
		74
		78
	K-Packer	82
	600 mm riser	86
	Stainless steel screen (143 mm ID 80-slot) (79.79-80.9 m)	90
		94
	Stainless steel screen (143 mm ID 100-slot) (80.9-82.22 m)	98
		102
		106
	Stainless steel screen (143 mm ID 80-slot) (82.22-83.5 m)	110
		114
		118

Associated Environmental

Lithology Legend

Clay and Sand | Sand | Sand and Gravel | Gravel

Contractor:	Drillwell
Operator:	Scott Burrows
Date of Construction:	23 / Sep / 2018
Drawn by:	Tony Friesen

Project Details		WIN 54943	Location	
Project Number:	2018-8152		Northing (m):	5471991
Client:	SCRD		Easting (m):	461984
Location:	Mahan Road		Elevation (m):	c.107

Subsurface Profile

Well Completion

Depth (m)	Graphic Log	Description	Well Construction	Details	Depth (m)
0		Medium to coarse sand, silt and gravel (GM), poorly sorted. Brown, loose, dry. (0.0 - 1.8 m)		Well Cap (Stickup 0.5m)	-2
		Clay with gravel (GC), well sorted. Blueish grey, dense, dry (1.8 - 6.0 m)			2
5					6
10		Medium to coarse sand and gravel (GW), poorly sorted. Interbedded layers of sand and gravel within clay matrix. Brown, loose,dry. (6.0 - 21.0 m)			10
15					14
20					18
					22
25					26
30					30
35					34
40					38
					42
45					46
50					50
55				150 mm steel casing	54
					58
60					62

Associated Environmental

Lithology Legend

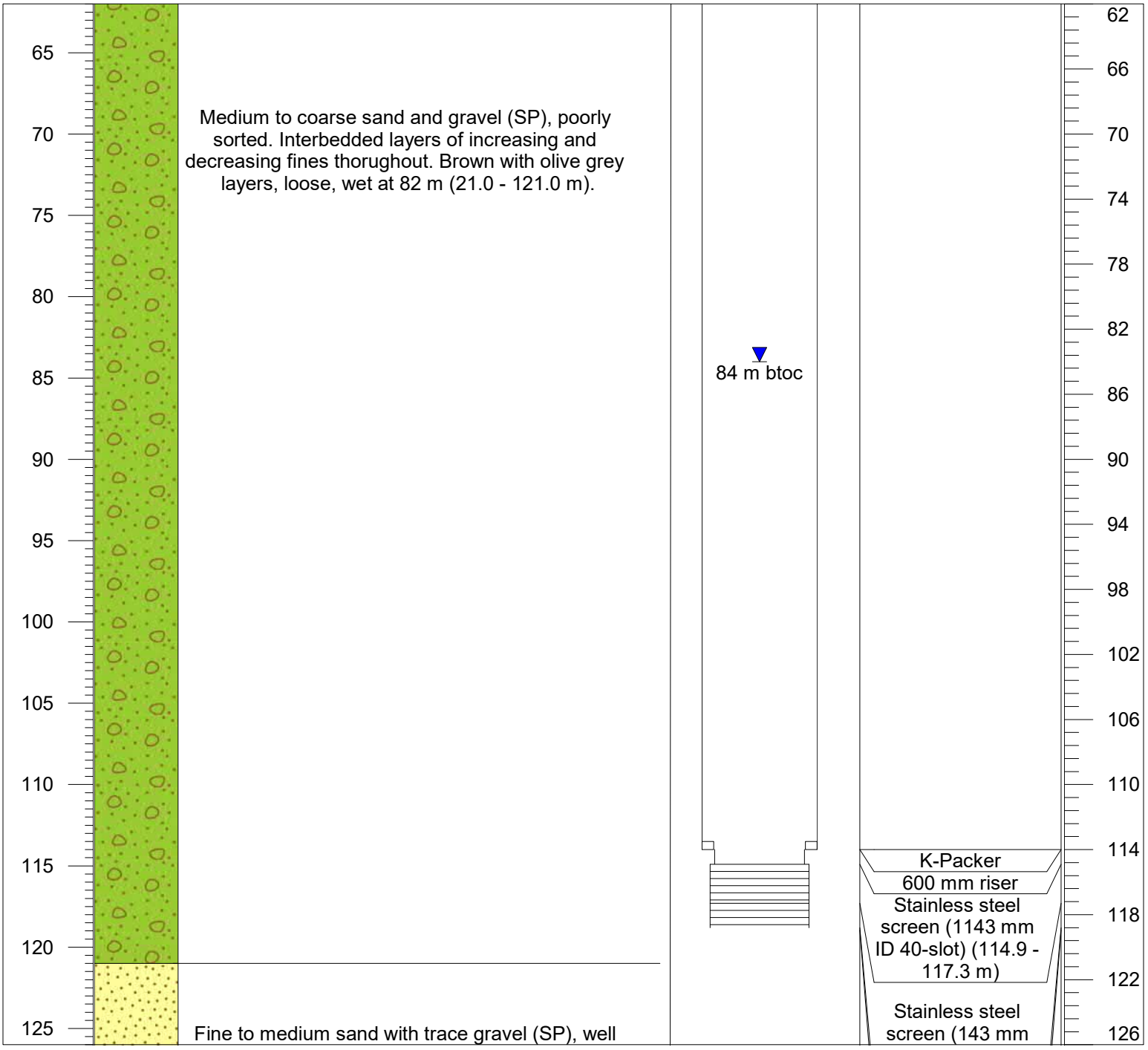
Clay and Sand | Sand | Sand and Gravel

Contractor:	Drillwell
Operator:	Scott Burrows
Date of Construction:	26 / Sep / 2018

Drawn by: Tony Friesen

Project Details		WIN 54943	Location	
Project Number:	2018-8152		Northing (m):	5471991
Client:	SCRD		Easting (m):	461984
Location:	Mahan Road		Elevation (m):	c.107

Subsurface Profile			Well Completion		
Depth (m)	Graphic Log	Description	Well Construction	Details	Depth (m)



Associated Environmental

Lithology Legend

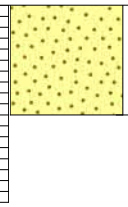
Clay and Sand | Sand | Sand and Gravel

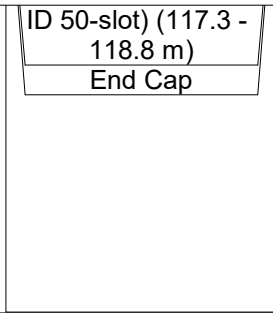
Contractor:	Drillwell
Operator:	Scott Burrows
Date of Construction:	26 / Sep / 2018

Drawn by: Tony Friesen

Project Details		WIN 54943	Location	
Project Number:	2018-8152		Northing (m):	5471991
Client:	SCRD		Easting (m):	461984
Location:	Mahan Road		Elevation (m):	c.107

Subsurface Profile			Well Completion		
Depth (m)	Graphic Log	Description	Well Construction	Details	Depth (m)
130		sorted. Brown, loose, wet (121.0 - 131.0m)		ID 50-slot) (117.3 - 118.8 m) End Cap	126 130
135					





Lithology Legend

Clay and Sand | Sand | Sand and Gravel

Associated Environmental

Contractor:	Drillwell
Operator:	Scott Burrows
Date of Construction:	26 / Sep / 2018
Drawn by: Tony Friesen	

Project Details		WIN 54928	Location	
Project Number:	2018-8152		Northing (m):	5473607
Client:	SCRD		Easting (m):	464129
Location:	Church Road		Elevation (m):	c.39

Subsurface Profile

Depth (m)	Graphic Log	Description
0		Medium to coarse sand and gravel (GW), poorly sorted. Interbedded layers of well sorted sand. Brown, loose, moist. (0-14.9 m)
15		Medium to fine sand (SM), well sorted. Brown, loose, moist. (14.9 -16.46 m)
20		Fine to coarse sand and gravel with silt and clay (GC) (Till), poorly sorted. Brown, moderately dense, dry. (16.46 - 18.29 m)
		Clay with silt and trace gravel (GC), poorly sorted. Dark grey, dense, wet (18.29-21.30 m).
25		Medium to coarse sand (SP), well sorted. Brown, loose, wet (21.30 - 24.38 m).
30		Interbedded fine to coarse sand and gravel (GW-SW), poorly sorted. Brownish grey, loose, wet (35USgpm+) (24.38 - 39.0 m).
35		
40		Medium to fine sand, well sorted (SP). Brown, loose, wet. (39.0 - 41.15 m)
45		Coarse sand and gravel with large boulders (GP), poorly sorted, brown, loose, wet (50 USgpm+) (41.15 - 47.24 m).
50		Fine to medium sand, well sorted (SM). Brown, loose, wet (47.24 - 57.9 m)
55		
60		Sand, silt and clay, poorly sorted (SC). Brown, semi dense, moist (57.9 - 60.0 m)

Well Completion

Well Construction	Details	Depth (m)
15.06 m btoc	Well Cap (Stickup 0.6 m)	-1
		4
		9
		14
	150 mm steel casing	19
		24
		29
		34
		39
	K-Packer	44
	600mm riser	
	Stainless steel screen (143 mm ID 100-slot) (42.9-46.17 m)	49
	End Cap	54
		59

Lithology Legend

Clay and Sand | Sand | Sand and Gravel

Contractor:	Drillwell
Operator:	Shaun Slade
Date of Construction:	5 / Oct / 2018

Associated Environmental

85

Drawn by: Tony Friesen

Appendix C - Figures provided to pumping test contractor

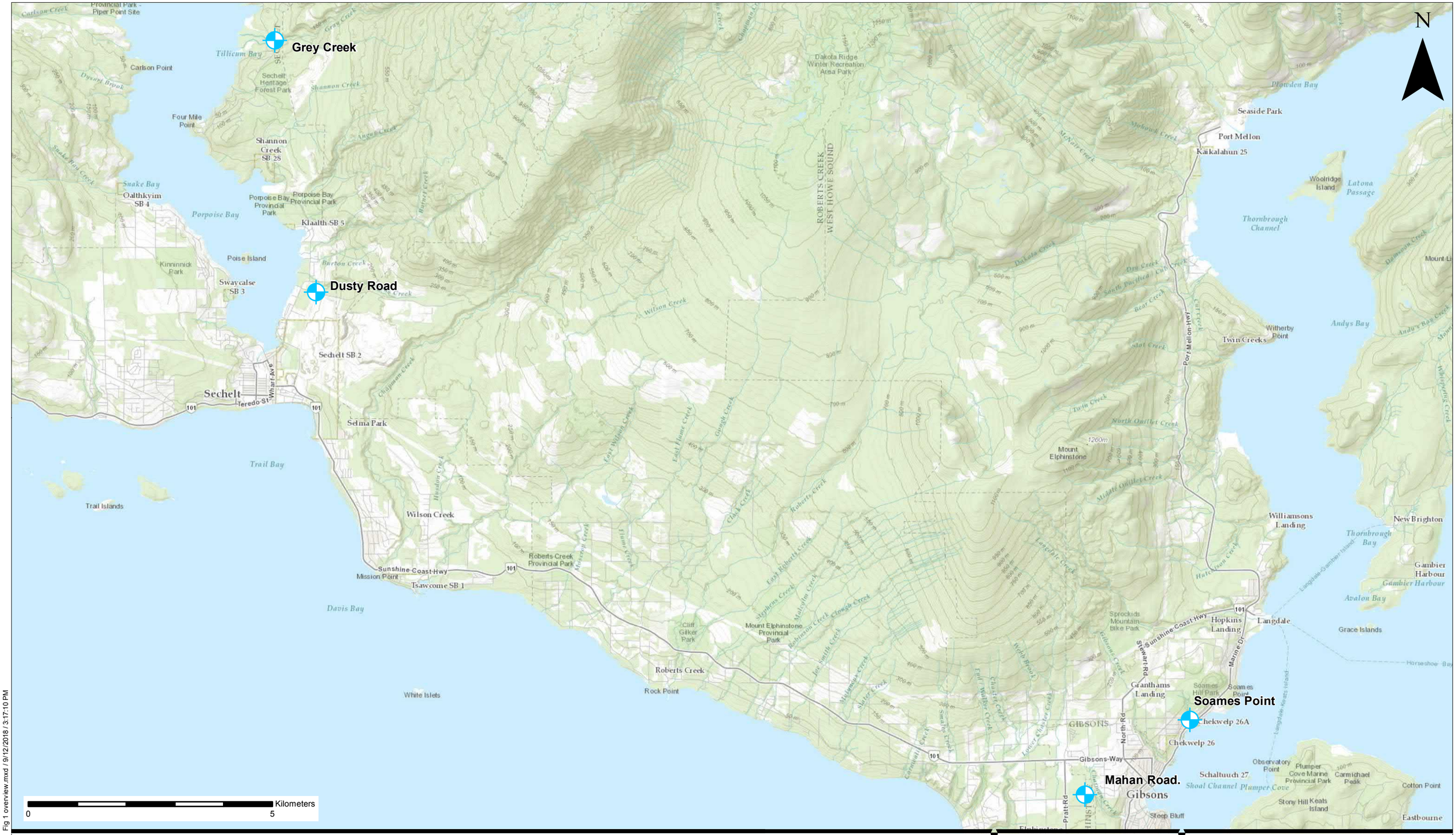


Fig 1 overview.mxd / 9/12/2018 / 3:17:10 PM

Associated Environmental

Well Location

PROJECT NO.:	2018-8152.000.001
DATE:	September 2018
DRAWN BY:	DA

FIGURE C1: WELL LOCATIONS

Sunshine Coast Regional District

SCRD Groundwater Investigation Phase 2


Figure C2
Dusty Road Well and monitoring well location
Legend
Dusty Road Well
Dusty Road Well
Quarry Well 5
Google Earth
Image SCRD
N
200 m

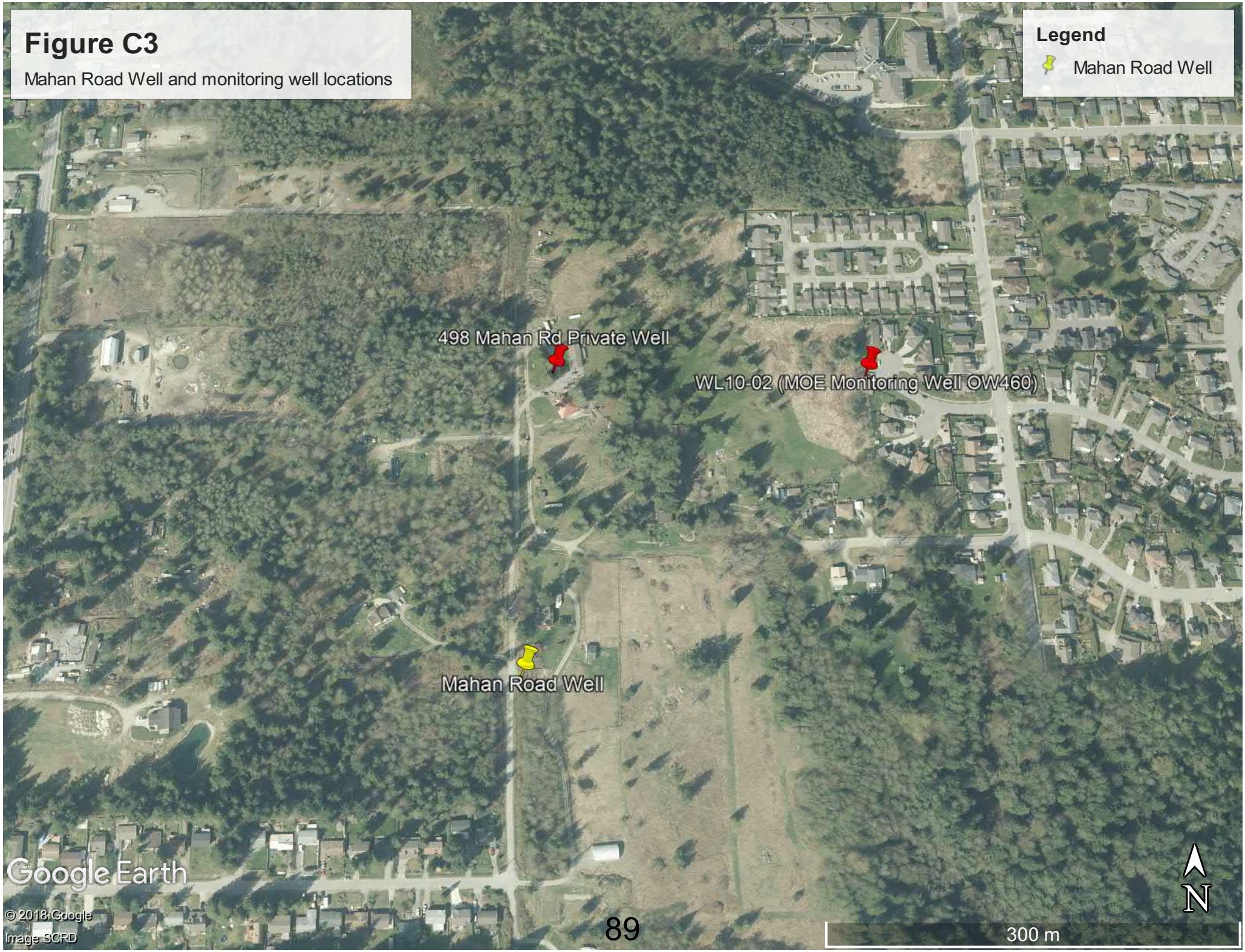


Figure C3
Mahan Road Well and monitoring well locations
Legend
Mahan Road Well
498 Mahan Rd Private Well
WL10-02 (MOE Monitoring Well OW460)
Mahan Road Well
Google Earth
© 2018 Google
Image SCRD
N
300 m

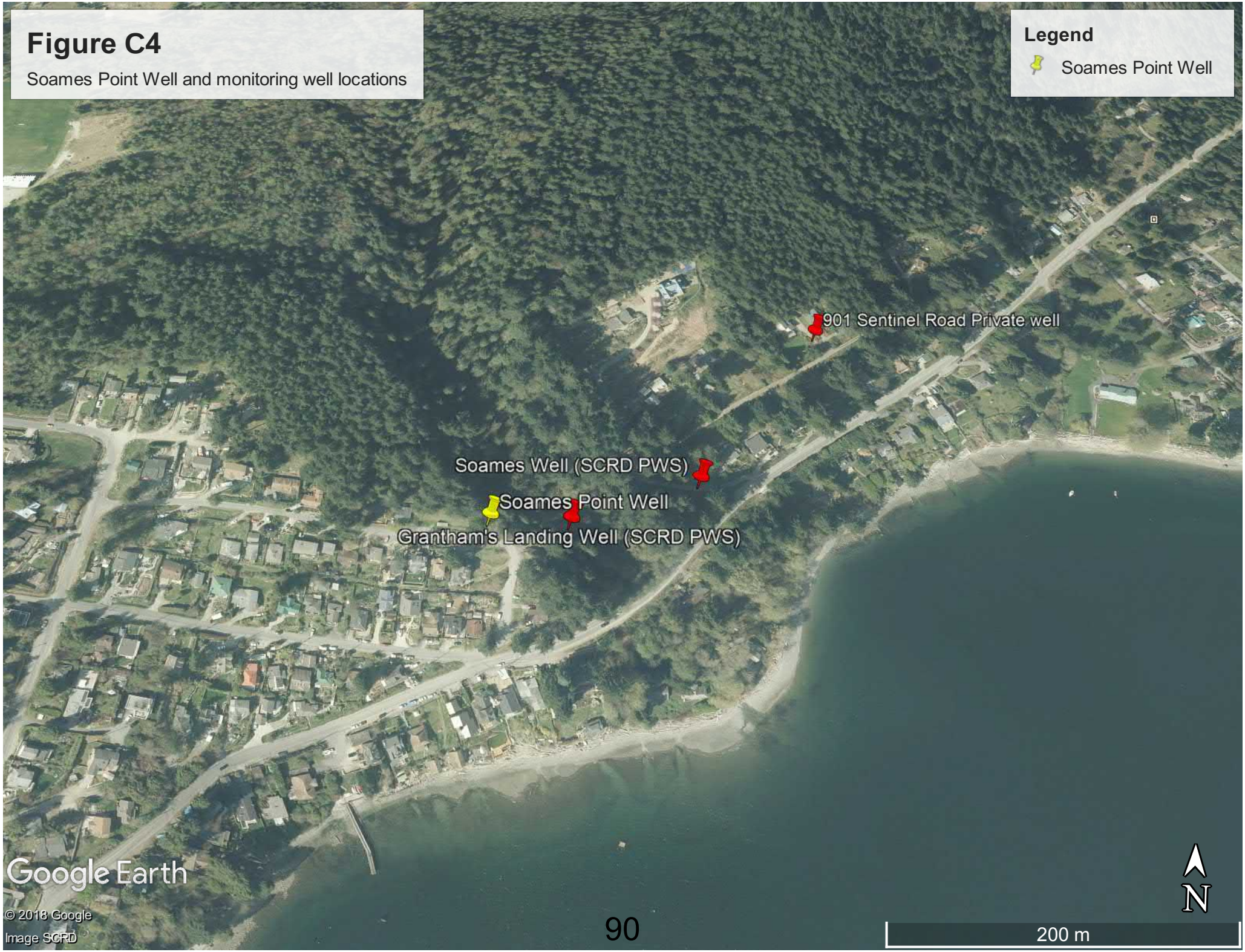


Figure C4
Soames Point Well and monitoring well locations
Legend
Soames Point Well
901 Sentinel Road Private well
Soames Well (SCRD PWS)
Soames Point Well
Grantham's Landing Well (SCRD PWS)
Google Earth
© 2018 Google
Image SCRD
N
200 m

Appendix D - Pumping test data and sustainable yield figures

DUSTY ROAD
STEP TEST DATA

Well ID:	WIN 54929	Static Water Level (ftbtoc)	103.96
Start Date/Time	10/26/18 11:48 AM	Pre-Test Water Level (ftbtoc)	103.96
Client	SCRD	Total Well Depth (ft)	274.00
Project	2018-8152	Pump Intake Depth (ftbtoc)	218.00
Test	Step Test	Pump Used	Grundfos
Contractor	Monashee	Pumping Rate (L/s)	Various

Clock Time	Time Elapsed (min)	Depth to Water (ft)	Drawdown (ft)	Comments
10/26/18 11:49:00	1	108.75	4.79	Step 1 (100 Usgpm)
10/26/18 11:50:00	2	109.28	5.32	
10/26/18 11:51:00	3	110.12	6.16	
10/26/18 11:52:00	4	110.28	6.32	
10/26/18 11:53:00	5	110.22	6.26	
10/26/18 11:54:00	6	110.98	7.02	
10/26/18 11:55:00	7	110.99	7.03	
10/26/18 11:56:00	8	111	7.04	
10/26/18 11:57:00	9	111	7.04	
10/26/18 11:58:00	10	111.02	7.06	
10/26/18 12:00:00	12	111.02	7.06	
10/26/18 12:03:00	15	111.02	7.06	
10/26/18 12:08:00	20	111.21	7.25	
10/26/18 12:13:00	25	111.32	7.36	
10/26/18 12:18:00	30	111.34	7.38	
10/26/18 12:23:00	35	111.33	7.37	
10/26/18 12:28:00	40	111.33	7.37	
10/26/18 12:33:00	45	111.32	7.36	
10/26/18 12:38:00	50	111.32	7.36	
10/26/18 12:48:00	60	111.33	7.37	
10/26/18 12:49:00	61	115.5	11.54	Step 2 (165 Usgpm)
10/26/18 12:50:00	62	115.67	11.71	
10/26/18 12:51:00	63	115.64	11.68	
10/26/18 12:52:00	64	115.6	11.64	
10/26/18 12:53:00	65	115.62	11.66	
10/26/18 12:54:00	66	115.65	11.69	
10/26/18 12:55:00	67	115.65	11.69	
10/26/18 12:56:00	68	115.65	11.69	
10/26/18 12:57:00	69	115.45	11.49	
10/26/18 12:58:00	70	116.5	12.54	
10/26/18 13:00:00	72	116.69	12.73	
10/26/18 13:03:00	75	#N/A	#N/A	
10/26/18 13:08:00	80	116.7	12.74	
10/26/18 13:13:00	85	116.7	12.74	
10/26/18 13:18:00	90	116.72	12.76	
10/26/18 13:23:00	95	116.75	12.79	
10/26/18 13:28:00	100	116.74	12.78	
10/26/18 13:33:00	105	116.75	12.79	
10/26/18 13:38:00	110	116.8	12.84	
10/26/18 13:48:00	120	#N/A	#N/A	Step 3 (240 Usgpm)
10/26/18 13:49:00	121	123.18	19.22	
10/26/18 13:50:00	122	123.4	19.44	

DUSTY ROAD
STEP TEST DATA

Clock Time	Time Elapsed (min)	Depth to Water (ft)	Drawdown (ft)	Comments
10/26/18 13:51:00	123	123.54	19.58	
10/26/18 13:52:00	124	123.1	19.14	
10/26/18 13:53:00	125	123.08	19.12	
10/26/18 13:54:00	126	123.09	19.13	
10/26/18 13:55:00	127	123.1	19.14	
10/26/18 13:56:00	128	123.1	19.14	
10/26/18 13:57:00	129	123.08	19.12	
10/26/18 13:58:00	130	123.09	19.13	
10/26/18 14:00:00	132	123.08	19.12	
10/26/18 14:03:00	135	123.09	19.13	
10/26/18 14:08:00	140	123.08	19.12	
10/26/18 14:13:00	145	123.09	19.13	
10/26/18 14:18:00	150	123.05	19.09	
10/26/18 14:23:00	155	123.06	19.10	
10/26/18 14:28:00	160	123.04	19.08	
10/26/18 14:33:00	165	123.01	19.05	
10/26/18 14:38:00	170	123.02	19.06	
10/26/18 14:48:00	180	123	19.04	Step 3 (300 Usgpm)
10/26/18 14:49:00	181	128	24.04	
10/26/18 14:50:00	182	128.71	24.75	
10/26/18 14:51:00	183	128.92	24.96	
10/26/18 14:52:00	184	129.05	25.09	
10/26/18 14:53:00	185	129.1	25.14	
10/26/18 14:54:00	186	129.1	25.14	
10/26/18 14:55:00	187	129.09	25.14	
10/26/18 14:56:00	188	129.09	25.13	
10/26/18 14:57:00	189	129.05	25.13	
10/26/18 14:58:00	190	129.07	25.09	
10/26/18 15:00:00	192	129.12	25.11	
10/26/18 15:03:00	195	129.09	25.16	
10/26/18 15:08:00	200	129.07	25.13	
10/26/18 15:13:00	205	129.08	25.11	
10/26/18 15:18:00	210	128.98	25.12	
10/26/18 15:23:00	215	129.05	25.02	
10/26/18 15:28:00	220	129.1	25.09	
10/26/18 15:33:00	225	129.11	25.14	
10/26/18 15:38:00	230	129.1	25.15	
10/26/18 15:48:00	240	129.11	25.14	
10/26/18 11:48:00				

DUSTY ROAD
CONSTANT RATE TEST DATA

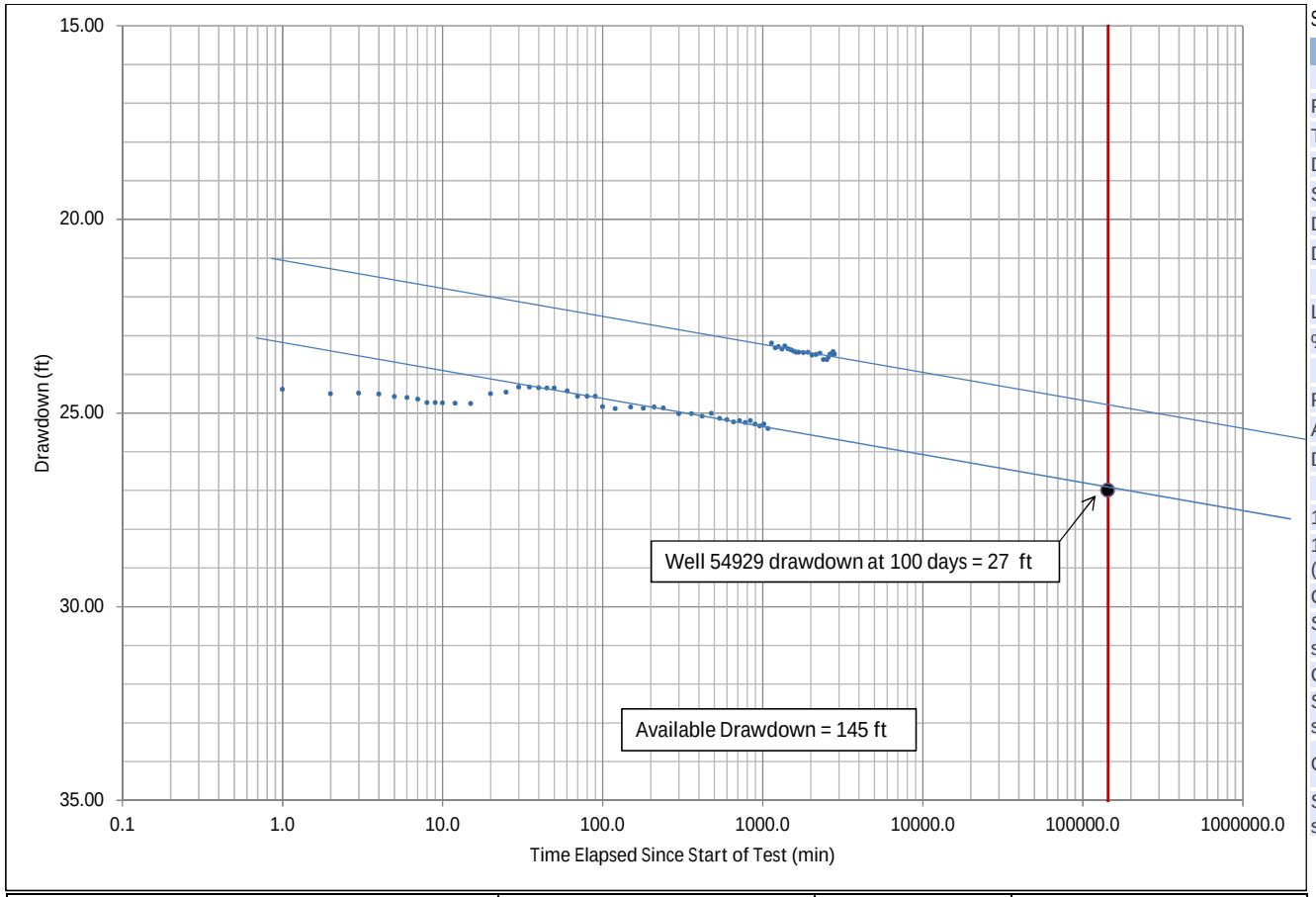
Well ID:	WIN 54929	Static Water Level (ftbtoc)	103.96
Start Date/Time	10/26/18 4:48 PM	Pre-Test Water Level (ftbtoc)	103.96
Client	SCRD	Total Well Depth (ft)	274.00
Project	2018-8152	Pump Intake Depth (ftbtoc)	218.00
Test	Constant Rate Test	Pump Used	Franklin Electric
Contractor	Monashee	Pumping Rate (L/s)	18.93

Clock Time	Time Elapsed (min)	Depth to Water (ft)	Drawdown (ft)	Comments
10/26/18 16:48:00	0	103.96	0.00	
10/26/18 16:49:00	1	128.35	24.39	
10/26/18 16:50:00	2	128.46	24.50	
10/26/18 16:51:00	3	128.45	24.49	
10/26/18 16:52:00	4	128.47	24.51	
10/26/18 16:53:00	5	128.54	24.58	
10/26/18 16:54:00	6	128.56	24.60	
10/26/18 16:55:00	7	128.6	24.64	
10/26/18 16:56:00	8	128.69	24.73	
10/26/18 16:57:00	9	128.69	24.73	
10/26/18 16:58:00	10	128.7	24.74	
10/26/18 17:00:00	12	128.71	24.75	
10/26/18 17:03:00	15	128.72	24.76	
10/26/18 17:08:00	20	128.46	24.50	
10/26/18 17:13:00	25	128.42	24.46	
10/26/18 17:18:00	30	128.29	24.33	
10/26/18 17:23:00	35	128.29	24.33	
10/26/18 17:28:00	40	128.31	24.35	
10/26/18 17:33:00	45	128.32	24.36	
10/26/18 17:38:00	50	128.32	24.36	
10/26/18 17:48:00	60	128.39	24.43	
10/26/18 17:58:00	70	128.53	24.57	
10/26/18 18:08:00	80	128.53	24.57	
10/26/18 18:18:00	90	128.53	24.57	
10/26/18 18:28:00	100	128.8	24.84	
10/26/18 18:48:00	120	128.85	24.89	
10/26/18 19:18:00	150	128.81	24.85	
10/26/18 19:48:00	180	128.84	24.88	
10/26/18 20:18:00	210	128.81	24.85	
10/26/18 20:48:00	240	128.83	24.87	
10/26/18 21:48:00	300	128.98	25.02	
10/26/18 22:48:00	360	128.98	25.02	
10/26/18 23:48:00	420	129.04	25.08	
10/27/18 0:48:00	480	128.97	25.01	
10/27/18 1:48:00	540	129.1	25.14	
10/27/18 2:48:00	600	129.13	25.17	
10/27/18 3:48:00	660	129.19	25.23	
10/27/18 4:48:00	720	129.16	25.20	
10/27/18 5:48:00	780	129.21	25.25	
10/27/18 6:48:00	840	129.16	25.20	
10/27/18 7:48:00	900	129.25	25.29	
10/27/18 8:48:00	960	129.3	25.34	

DUSTY ROAD
CONSTANT RATE TEST DATA

Associated Environmental

Clock Time	Time Elapsed (min)	Depth to Water (ft)	Drawdown (ft)	Comments
10/27/18 9:48:00	1020	129.25	25.29	
10/27/18 10:48:00	1080	129.36	25.40	
10/27/18 11:48:00	1140	127.16	23.20	
10/27/18 12:48:00	1200	127.28	23.32	
10/27/18 13:48:00	1260	127.25	23.29	
10/27/18 14:48:00	1320	127.31	23.35	
10/27/18 15:48:00	1380	127.23	23.27	
10/27/18 16:48:00	1440.0	127.30	23.34	
10/27/18 17:48:00	1500.0	127.33	23.37	
10/27/18 18:48:00	1560.0	127.36	23.40	
10/27/18 19:48:00	1620.0	127.39	23.43	
10/27/18 20:48:00	1680.0	127.39	23.43	
10/27/18 22:48:00	1800.0	127.40	23.44	
10/28/18 0:48:00	1920.0	127.39	23.43	
10/28/18 2:48:00	2040.0	127.47	23.51	
10/28/18 4:48:00	2160.0	127.45	23.49	
10/28/18 6:48:00	2280.0	127.42	23.46	
10/28/18 8:48:00	2400.0	127.58	23.62	
10/28/18 10:48:00	2520.0	127.58	23.62	
10/28/18 11:48:00	2580.0	127.52	23.56	
10/28/18 12:48:00	2640.0	127.44	23.48	
10/28/18 13:48:00	2700.0	127.43	23.47	
10/28/18 14:48:00	2760.0	127.38	23.42	
10/28/18 15:48:00	2820.0	127.44	23.48	



Summary Table

	WIN 54929
PUMPING SPECIFICATIONS	----------
Pumping rate (L/s)	18.93
Test duration (hours)	48
Depth of pump intake (ftbtoc)	218.00
Static water level (ftbtoc)	103.96
Depth to top of screen (ftbtoc)	261.00
Depth of well (ftbgl)	274.00
RECOVERY	----------
Length of recovery (min)	
% recovered	
CPCN INPUTS	----------
Pumping rate (L/s)	18.93
Available drawdown (ft)	130
Drawdown at 100 days (ft)	27
CPCN OUTPUTS	----------
100 day specific capacity (L/s/ft)	0.701
100 day specific capacity (USgpm/ft)	11.11
Calculated pumping rate (L/s)	91.16
Sustainable pumping rate with BC safety factor of 30% (L/s)	63.81
Calculated pumping rate (L/d)	7,876,055
Sustainable pumping rate with BC safety factor of 30% (L/d)	5,513,238
Calculated pumping rate (USGPM)	1,445
Sustainable pumping rate with BC safety factor of 30% (USGPM)	1,011.5

Associated Environmental	PROJECT: 2018-8152 DATE: 27-Nov-18 DRAWN BY:	PREPARED FOR SCRD	FIGURE D-1 Drawdown extrapolated to 100 days WIN 54929

MAHAN ROAD
STEP TEST DATA

Well ID:	WIN 54943	Static Water Level (ftbtoc)	276.30
Start Date/Time	10/29/18 8:46 AM	Pre-Test Water Level (ftbtoc)	276.30
Client	SCRD	Total Well Depth (ft)	390.00
Project	2018-8152	Pump Intake Depth (ftbtoc)	367.00
Test	Step Test	Pump Used	Franklin Electric (40 HP)
Contractor	Monashee	Pumping Rate (L/s)	Various

Clock Time	Time Elapsed (min)	Depth to Water (ft)	Drawdown (ft)	Comments
10/29/18 8:47:00	1	281.43	5.13	Step 1 (100 Usgpm)
10/29/18 8:48:00	2	287.9	11.60	
10/29/18 8:49:00	3	285.67	9.37	
10/29/18 8:50:00	4	283.53	7.23	
10/29/18 8:51:00	5	#N/A	#N/A	
10/29/18 8:52:00	6	286.31	10.01	
10/29/18 8:53:00	7	286.35	10.05	
10/29/18 8:54:00	8	286.37	10.07	
10/29/18 8:55:00	9	286.35	10.05	
10/29/18 8:56:00	10	286.35	10.05	
10/29/18 8:58:00	12	286.36	10.06	
10/29/18 9:01:00	15	286.4	10.10	
10/29/18 9:06:00	20	286.4	10.10	
10/29/18 9:11:00	25	286.38	10.08	
10/29/18 9:16:00	30	286.34	10.04	
10/29/18 9:21:00	35	286.31	10.01	
10/29/18 9:26:00	40	286.32	10.02	
10/29/18 9:31:00	45	286.28	9.98	
10/29/18 9:36:00	50	286.26	9.96	
10/29/18 9:46:00	60	286.28	9.98	
10/29/18 9:47:00	61	291.58	15.28	Step 2 (170 Usgpm)
10/29/18 9:48:00	62	291.7	15.40	
10/29/18 9:49:00	63	291.78	15.48	
10/29/18 9:50:00	64	291.32	15.02	
10/29/18 9:51:00	65	291.97	15.67	
10/29/18 9:52:00	66	291.94	15.64	
10/29/18 9:53:00	67	291.94	15.64	
10/29/18 9:54:00	68	291.95	15.65	
10/29/18 9:55:00	69	291.97	15.67	
10/29/18 9:56:00	70	291.96	15.66	
10/29/18 9:58:00	72	291.98	15.68	
10/29/18 10:01:00	75	292.01	15.71	
10/29/18 10:06:00	80	292.05	15.75	
10/29/18 10:11:00	85	292.05	15.75	
10/29/18 10:16:00	90	292.05	15.75	
10/29/18 10:21:00	95	292.02	15.72	
10/29/18 10:26:00	100	292.09	15.79	
10/29/18 10:31:00	105	292.09	15.79	
10/29/18 10:36:00	110	292.03	15.73	
10/29/18 10:46:00	120	292.02	15.72	Step 3 (240 Usgpm)
10/29/18 10:47:00	121	299.45	23.15	
10/29/18 10:48:00	122	299.72	23.42	
10/29/18 10:49:00	123	299.75	23.45	

MAHAN ROAD
STEP TEST DATA

Clock Time	Time Elapsed (min)	Depth to Water (ft)	Drawdown (ft)	Comments
10/29/18 10:50:00	124	299.79	23.49	
10/29/18 10:51:00	125	299.85	23.55	
10/29/18 10:52:00	126	299.89	23.59	
10/29/18 10:53:00	127	299.89	23.59	
10/29/18 10:54:00	128	299.95	23.65	
10/29/18 10:55:00	129	299.95	23.65	
10/29/18 10:56:00	130	299.93	23.63	
10/29/18 10:58:00	132	299.94	23.64	
10/29/18 11:01:00	135	299.98	23.68	
10/29/18 11:06:00	140	300.02	23.72	
10/29/18 11:11:00	145	300.04	23.74	
10/29/18 11:16:00	150	300.14	23.84	
10/29/18 11:21:00	155	300.09	23.79	
10/29/18 11:26:00	160	300.04	23.74	
10/29/18 11:31:00	165	300	23.70	
10/29/18 11:36:00	170	300	23.70	
10/29/18 11:46:00	180	299.98	23.68	Step 34 (300 Usgpm)
10/29/18 11:47:00	181	305.88	29.58	
10/29/18 11:48:00	182	306.02	29.72	
10/29/18 11:49:00	183	306.1	29.80	
10/29/18 11:50:00	184	306.08	29.78	
10/29/18 11:51:00	185	306.14	29.84	
10/29/18 11:52:00	186	306.12	29.82	
10/29/18 11:53:00	187	306.22	29.92	
10/29/18 11:54:00	188	306.22	29.92	
10/29/18 11:55:00	189	306.16	29.86	
10/29/18 11:56:00	190	306.14	29.84	
10/29/18 11:58:00	192	306.18	29.88	
10/29/18 12:01:00	195	306.18	29.88	
10/29/18 12:06:00	200	306.32	30.02	
10/29/18 12:11:00	205	306.34	30.04	
10/29/18 12:16:00	210	306.32	30.02	
10/29/18 12:21:00	215	306.34	30.04	
10/29/18 12:26:00	220	306.38	30.08	
10/29/18 12:31:00	225	306.29	29.99	
10/29/18 12:36:00	230	306.34	30.04	
10/29/18 12:46:00	240	306.32	30.02	

MAHAN ROAD
CONSTANT RATE TEST DATA

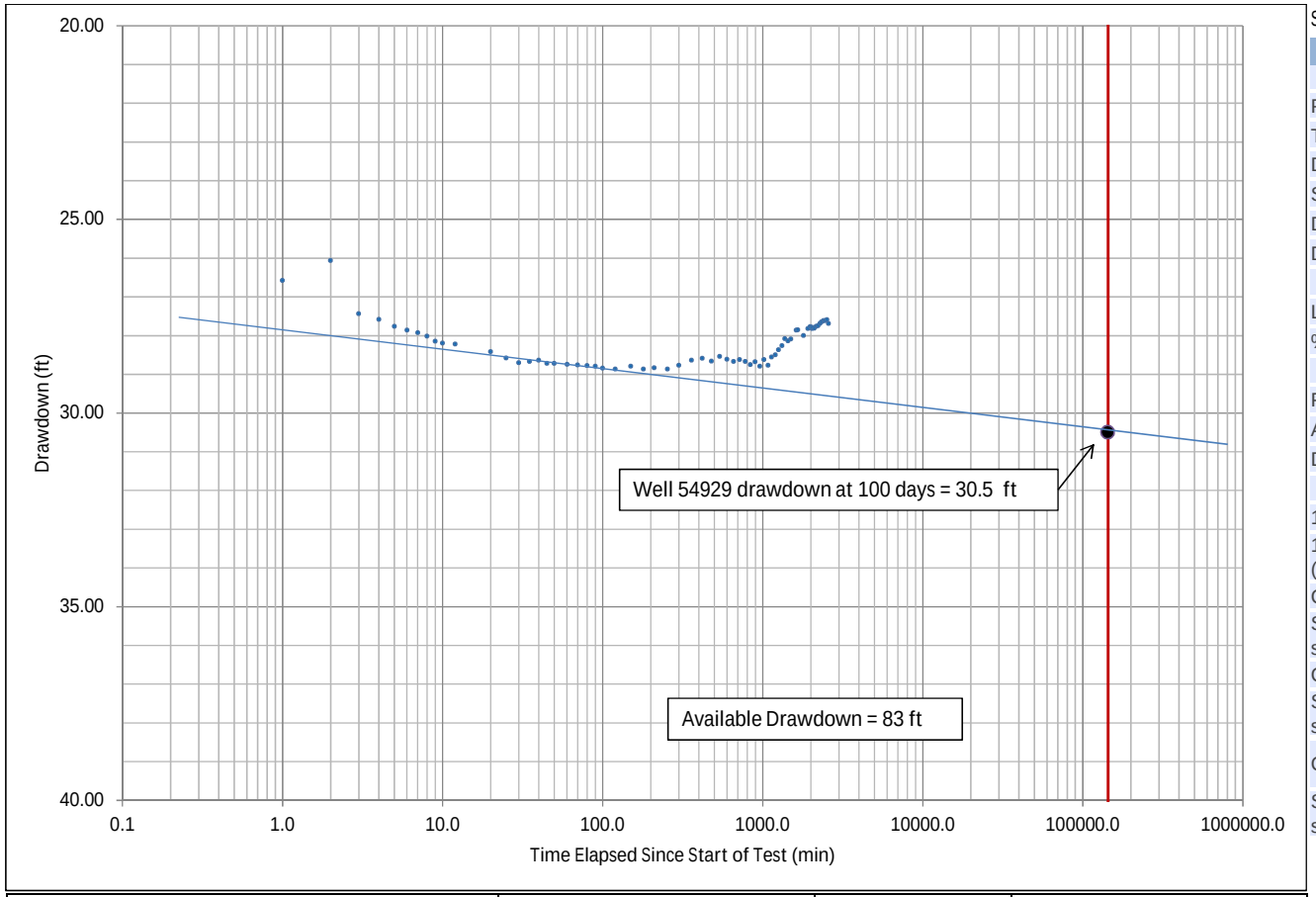
Well ID:	WIN 54943	Static Water Level (ftbtoc)	277.36
Start Date/Time	10/29/18 1:30 PM	Pre-Test Water Level (ftbtoc)	277.36
Client	SCRD	Total Well Depth (ft)	390.00
Project	2018-8152	Pump Intake Depth (ftbtoc)	367.00
Test	Constant Rate Test	Pump Used	Franklin Electric
Contractor	Monashee	Pumping Rate (L/s)	18.93

Clock Time	Time Elapsed (min)	Depth to Water (ft)	Drawdown (ft)	Comments
10/29/18 13:30:00	0	277.36	0.00	
10/29/18 13:31:00	1	303.94	26.58	
10/29/18 13:32:00	2	303.42	26.06	
10/29/18 13:33:00	3	304.8	27.44	
10/29/18 13:34:00	4	304.94	27.58	
10/29/18 13:35:00	5	305.12	27.76	
10/29/18 13:36:00	6	305.22	27.86	
10/29/18 13:37:00	7	305.29	27.93	
10/29/18 13:38:00	8	305.38	28.02	
10/29/18 13:39:00	9	305.51	28.15	
10/29/18 13:40:00	10	305.56	28.20	
10/29/18 13:42:00	12	305.58	28.22	
10/29/18 13:45:00	15	505.69	228.33	
10/29/18 13:50:00	20	305.78	28.42	
10/29/18 13:55:00	25	305.94	28.58	
10/29/18 14:00:00	30	306.06	28.70	
10/29/18 14:05:00	35	306.03	28.67	
10/29/18 14:10:00	40	306	28.64	
10/29/18 14:15:00	45	306.08	28.72	
10/29/18 14:20:00	50	306.08	28.72	
10/29/18 14:30:00	60	306.1	28.74	
10/29/18 14:40:00	70	306.12	28.76	
10/29/18 14:50:00	80	306.14	28.78	
10/29/18 15:00:00	90	306.15	28.79	
10/29/18 15:10:00	100	306.2	28.84	
10/29/18 15:30:00	120	306.23	28.87	
10/29/18 16:00:00	150	306.15	28.79	
10/29/18 16:30:00	180	306.23	28.87	
10/29/18 17:00:00	210	306.19	28.83	
10/29/18 17:45:00	255	306.23	28.87	
10/29/18 18:30:00	300	306.13	28.77	
10/29/18 19:30:00	360	306	28.64	
10/29/18 20:30:00	420	305.95	28.59	
10/29/18 21:30:00	480	306.02	28.66	
10/29/18 22:30:00	540	305.9	28.54	
10/29/18 23:30:00	600	305.97	28.61	
10/30/18 0:30:00	660	306.03	28.67	
10/30/18 1:30:00	720	305.98	28.62	
10/30/18 2:30:00	780	306.03	28.67	
10/30/18 3:30:00	840	306.11	28.75	
10/30/18 4:30:00	900	306.04	28.68	
10/30/18 5:30:00	960	306.15	28.79	

MAHAN ROAD
CONSTANT RATE TEST DATA

Associated Environmental

Clock Time	Time Elapsed (min)	Depth to Water (ft)	Drawdown (ft)	Comments
10/30/18 6:30:00	1020	305.98	28.62	
10/30/18 7:30:00	1080	306.13	28.77	
10/30/18 8:30:00	1140	305.92	28.56	
10/30/18 9:30:00	1200	305.86	28.50	
10/30/18 10:30:00	1260	305.73	28.37	
10/30/18 11:30:00	1320	305.62	28.26	
10/30/18 12:30:00	1380	305.44	28.08	
10/30/18 13:30:00	1440.0	305.50	28.14	
10/30/18 14:30:00	1500.0	305.45	28.09	
10/30/18 15:30:00	1560.0	#N/A	#N/A	
10/30/18 16:30:00	1620.0	305.22	27.86	
10/30/18 17:10:00	1660.0	305.21	27.85	
10/30/18 19:30:00	1800.0	305.36	28.00	
10/30/18 21:30:00	1920.0	305.18	27.82	
10/30/18 23:30:00	2040.0	305.18	27.82	
10/30/18 22:30:00	1980.0	305.13	27.77	
10/30/18 23:30:00	2040.0	305.15	27.79	
10/31/18 0:30:00	2100.0	305.17	27.81	
10/31/18 1:30:00	2160.0	305.12	27.76	
10/31/18 2:30:00	2220.0	305.11	27.75	
10/31/18 3:30:00	2280.0	305.05	27.69	
10/31/18 4:30:00	2340.0	305.01	27.65	
10/31/18 5:30:00	2400.0	304.98	27.62	
10/31/18 6:30:00	2460.0	304.98	27.62	
10/31/18 7:30:00	2520.0	304.95	27.59	
10/31/18 8:30:00	2580.0	305.05	27.69	
10/29/18 13:30:00				



Summary Table

	WIN 54943
PUMPING SPECIFICATIONS	----------
Pumping rate (L/s)	18.93
Test duration (hours)	48
Depth of pump intake (mftbtoc)	367.00
Static water level (ftbtoc)	277.36
Depth to top of screen (ftbtoc)	377.00
Depth of well (ftbgl)	390.00
RECOVERY	----------
Length of recovery (min)	120
% recovered	100
CPCN INPUTS	----------
Pumping rate (L/s)	18.93
Available drawdown (ft)	83.00
Drawdown at 100 days (ft)	30.5
CPCN OUTPUTS	----------
100 day specific capacity (L/s/ft)	0.621
100 day specific capacity (USgpm/ft)	9.84
Calculated pumping rate (L/s)	51.51
Sustainable pumping rate with BC safety factor of 30% (L/s)	36.05
Calculated pumping rate (L/d)	4,450,141
Sustainable pumping ate with BC safety factor of 30% (L/d)	3,115,099
Calculated pumping rate (USGPM)	816
Sustainable pumping rate with BC safety factor of 30% (USGPM)	571.5

Associated Environmental	PROJECT: 2018-8152 DATE: 27-Nov-18 DRAWN BY:	PREPARED FOR	FIGURE D-2
		SCRD	Drawdown extrapolated to 100 days WIN 54943

CHURCH ROAD
STEP TEST DATA

Well ID:	WIN 54928	Static Water Level (ftbtoc)	51.05
Start Date/Time	11/1/18 9:00 AM	Pre-Test Water Level (ftbtoc)	51.05
Client	SCRD	Total Well Depth (ft)	144.00
Project	2018-8152	Pump Intake Depth (ftbtoc)	134.00
Test	Step Test	Pump Used	Franklin Electric (40 HP)
Contractor	Monashee	Pumping Rate (L/s)	Various

Clock Time	Time Elapsed (min)	Depth to Water (ft)	Drawdown (ft)	Comments
11/1/18 9:01:00	1	62.37	11.32	Step 1 (100 Usgpm)
11/1/18 9:02:00	2	63.2	12.15	
11/1/18 9:03:00	3	63.91	12.86	
11/1/18 9:04:00	4	63.83	12.78	
11/1/18 9:05:00	5	63.77	12.72	
11/1/18 9:06:00	6	63.1	12.05	
11/1/18 9:07:00	7	62.87	11.82	
11/1/18 9:08:00	8	63.12	12.07	
11/1/18 9:09:00	9	63.15	12.10	
11/1/18 9:10:00	10	63.19	12.14	
11/1/18 9:12:00	12	62.82	11.77	
11/1/18 9:15:00	15	63	11.95	
11/1/18 9:20:00	20	62.96	11.91	
11/1/18 9:25:00	25	63.05	12.00	
11/1/18 9:30:00	30	62.87	11.82	
11/1/18 9:35:00	35	62.91	11.86	
11/1/18 9:40:00	40	62.91	11.86	
11/1/18 9:45:00	45	62.91	11.86	
11/1/18 9:50:00	50	62.9	11.85	
11/1/18 10:00:00	60	62.89	11.84	
11/1/18 10:01:00	61	69.93	18.88	Step 2 (170 Usgpm)
11/1/18 10:02:00	62	70.4	19.35	
11/1/18 10:03:00	63	70.43	19.38	
11/1/18 10:04:00	64	70.43	19.38	
11/1/18 10:05:00	65	70.43	19.38	
11/1/18 10:06:00	66	70.44	19.39	
11/1/18 10:07:00	67	70.47	19.42	
11/1/18 10:08:00	68	70.46	19.41	
11/1/18 10:09:00	69	70.49	19.44	
11/1/18 10:10:00	70	70.47	19.42	
11/1/18 10:12:00	72	70.46	19.41	
11/1/18 10:15:00	75	70.39	19.34	
11/1/18 10:20:00	80	70.26	19.21	
11/1/18 10:25:00	85	70.25	19.20	
11/1/18 10:30:00	90	70.18	19.13	
11/1/18 10:35:00	95	70.25	19.20	
11/1/18 10:40:00	100	70.18	19.13	
11/1/18 10:45:00	105	70.3	19.25	
11/1/18 10:50:00	110	70.2	19.15	

CHURCH ROAD
STEP TEST DATA

Associated Environmental

Clock Time	Time Elapsed (min)	Depth to Water (ft)	Drawdown (ft)	Comments
11/1/18 11:00:00	120	70.12	19.07	
11/1/18 11:10:00	130	70.37	19.32	
11/1/18 11:20:00	140	70.32	19.27	
11/1/18 11:33:00	153	70.09	19.04	
11/1/18 11:40:00	160	70.04	18.99	Step 3 (240 Usgpm)
11/1/18 11:41:00	161	78.25	27.20	
11/1/18 11:42:00	162	78.88	27.83	
11/1/18 11:43:00	163	78.85	27.80	
11/1/18 11:44:00	164	79.14	28.09	
11/1/18 11:45:00	165	79.1	28.05	
11/1/18 11:46:00	166	79.34	28.29	
11/1/18 11:47:00	167	79.33	28.28	
11/1/18 11:48:00	168	79.2	28.15	
11/1/18 11:49:00	169	79.02	27.97	
11/1/18 11:50:00	170	78.92	27.87	
11/1/18 11:52:00	172	78.54	27.49	
11/1/18 11:55:00	175	78.36	27.31	
11/1/18 12:00:00	180	78.56	27.51	
11/1/18 12:05:00	185	78.47	27.42	
11/1/18 12:10:00	190	71.18	20.13	Adjust back to 170 Usgpm
11/1/18 12:15:00	195	71	19.95	
11/1/18 12:20:00	200	71	19.95	
11/1/18 12:25:00	205	70.91	19.86	
11/1/18 12:30:00	210	70.82	19.77	
11/1/18 12:40:00	220	70.04	18.99	
11/1/18 12:53:00	233	70	18.95	
11/1/18 13:00:00	240	69.91	18.86	

CHURCH ROAD
CONSTANT RATE TEST DATA

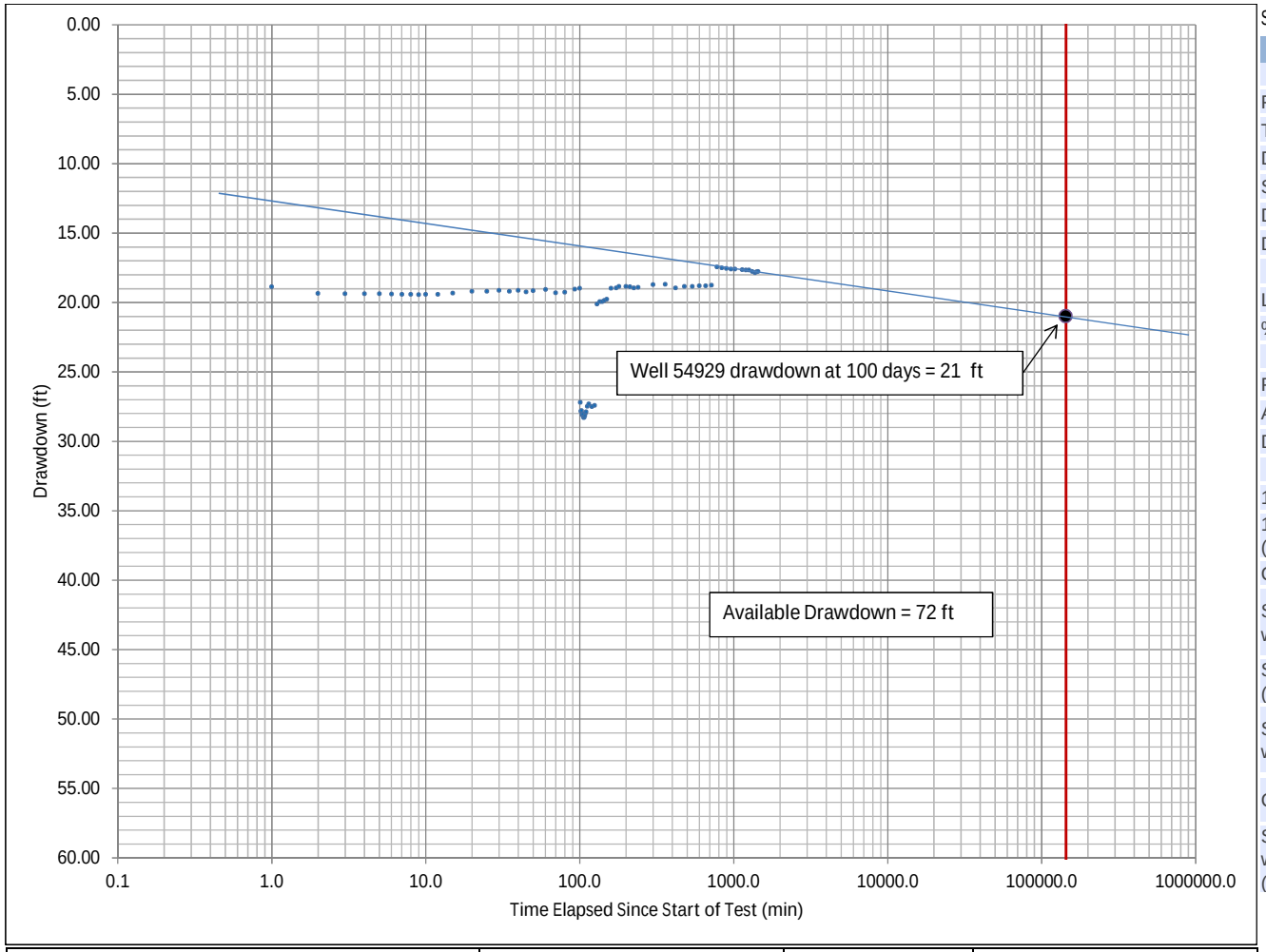
Well ID:	WIN 54928	Static Water Level (ftbtoc)	51.05
Start Date/Time	11/1/18 10:00 AM	Pre-Test Water Level (ftbtoc)	51.05
Client	SCRD	Total Well Depth (ft)	144.00
Project	2018-8152	Pump Intake Depth (ftbtoc)	134.00
Test	Constant Rate Test	Pump Used	Franklin Electric
Contractor	Monashee	Pumping Rate (L/s)	10.70

Clock Time	Time Elapsed (min)	Depth to Water (ft)	Drawdown (ft)	Comments
11/1/18 10:00:00	0	62.89	11.84	data starts at second step at 170 Usgpm
11/1/18 10:01:00	1	69.93	18.88	
11/1/18 10:02:00	2	70.4	19.35	
11/1/18 10:03:00	3	70.43	19.38	
11/1/18 10:04:00	4	70.43	19.38	
11/1/18 10:05:00	5	70.43	19.38	
11/1/18 10:06:00	6	70.44	19.39	
11/1/18 10:07:00	7	70.47	19.42	
11/1/18 10:08:00	8	70.46	19.41	
11/1/18 10:09:00	9	70.49	19.44	
11/1/18 10:10:00	10	70.47	19.42	
11/1/18 10:12:00	12	70.46	19.41	
11/1/18 10:15:00	15	70.39	19.34	
11/1/18 10:20:00	20	70.26	19.21	
11/1/18 10:25:00	25	70.25	19.20	
11/1/18 10:30:00	30	70.18	19.13	
11/1/18 10:35:00	35	70.25	19.20	
11/1/18 10:40:00	40	70.18	19.13	
11/1/18 10:45:00	45	70.3	19.25	
11/1/18 10:50:00	50	70.2	19.15	
11/1/18 11:00:00	60	70.12	19.07	
11/1/18 11:10:00	70	70.37	19.32	
11/1/18 11:20:00	80	70.32	19.27	
11/1/18 11:33:00	93	70.09	19.04	
11/1/18 11:40:00	100	70.04	18.99	
11/1/18 11:41:00	101	78.25	27.20	Upto 240 Usgpm
11/1/18 11:42:00	102	78.88	27.83	
11/1/18 11:43:00	103	78.85	27.80	
11/1/18 11:44:00	104	79.14	28.09	
11/1/18 11:45:00	105	79.1	28.05	
11/1/18 11:46:00	106	79.34	28.29	
11/1/18 11:47:00	107	79.33	28.28	
11/1/18 11:48:00	108	79.2	28.15	
11/1/18 11:49:00	109	79.02	27.97	
11/1/18 11:50:00	110	78.92	27.87	
11/1/18 11:52:00	112	78.54	27.49	
11/1/18 11:55:00	115	78.36	27.31	
11/1/18 12:00:00	120	78.56	27.51	
11/1/18 12:05:00	125	78.47	27.42	

CHURCH ROAD
CONSTANT RATE TEST DATA

Associated Environmental

Clock Time	Time Elapsed (min)	Depth to Water (ft)	Drawdown (ft)	Comments
11/1/18 12:10:00	130	71.18	20.13	Back to 170 Usgpm
11/1/18 12:15:00	135	71	19.95	
11/1/18 12:20:00	140	71	19.95	
11/1/18 12:25:00	145	70.91	19.86	
11/1/18 12:30:00	150	70.82	19.77	
11/1/18 12:40:00	160	70.04	18.99	
11/1/18 12:53:00	173	70	18.95	
11/1/18 13:00:00	180	69.91	18.86	
11/1/18 13:20:00	200	69.91	18.86	
11/1/18 13:32:00	212	69.93	18.88	
11/1/18 13:45:00	225	70.02	18.97	
11/1/18 14:00:00	240	69.97	18.92	
11/1/18 15:00:00	300	69.77	18.72	
11/1/18 16:00:00	360	69.75	18.70	
11/1/18 17:00:00	420	70	18.95	
11/1/18 18:00:00	480	69.9	18.85	
11/1/18 19:00:00	540	69.91	18.86	
11/1/18 20:00:00	600	69.85	18.80	
11/1/18 21:00:00	660	69.85	18.80	
11/1/18 22:00:00	720	69.82	18.77	
11/1/18 23:00:00	780	68.5	17.45	Flow meter ws broken. Got it working adjusted flow from 180 to 170
11/2/18 0:00:00	840	68.57	17.52	
11/2/18 1:00:00	900	68.6	17.55	
11/2/18 2:00:00	960	68.65	17.60	
11/2/18 3:00:00	1020	68.66	17.61	
11/2/18 4:00:00	1080	#N/A	#N/A	
11/2/18 5:00:00	1140	68.7	17.65	
11/2/18 6:00:00	1200	68.72	17.67	
11/2/18 7:00:00	1260	68.72	17.67	
11/2/18 8:00:00	1320	68.82	17.77	
11/2/18 9:00:00	1380	68.91	17.86	
11/2/18 9:30:00	1410	68.85	17.80	
11/2/18 10:00:00	1440	68.83	17.78	
11/1/18 10:00:00				



Summary Table

	WIN 54928
PUMPING SPECIFICATIONS	----------
Pumping rate (L/s)	10.70
Test duration (hours)	24
Depth of pump intake (ftbtoc)	134.00
Static water level (ftbtoc)	51.05
Depth to top of screen (ftbtoc)	135.50
Depth of well (ftbgl)	144.00
RECOVERY	----------
Length of recovery (min)	30
% recovered	100
CPCN INPUTS	----------
Pumping rate (L/s)	10.70
Available drawdown (ft)	72.00
Drawdown at 100 days (ft)	21
CPCN OUTPUTS	----------
100 day specific capacity (L/s/ft)	0.510
100 day specific capacity (USgpm/ft)	8.077
Calculated pumping rate (L/s)	36.69
Sustainable calculated pumping rate with BC safety factor of 30% (L/s)	25.68
Sustainable calculated pumping rate (L/d)	3,169,646
Sustainable calculated pumping rate with BC safety factor of 30% (L/d)	2,218,752
Calculated pumping rate (USGPM)	582
Sustainable calculated pumping rate with BC safety factor of 30% (USGPM)	407.1

Associated Environmental	PROJECT: 2018-8152 DATE: 27-Nov-18 DRAWN BY:	PREPARED FOR SCRD	FIGURE D-3 Drawdown extrapolated to 100 days WIN 54928

Appendix E - Hydrological Desk Study

Associated Environmental

Date:	December 18, 2018	**File:**	2018-8152
To:	Marta Green, P.Geo., Project Manager		
From:	Jordyn Carss, B.Sc. and Brian Guy, P.Geo.		
Project:	Phase 2 Groundwater Investigation		
Subject:	Desktop Surface Water Study for Soames and Charman Creeks		

MEMO

1 INTRODUCTION

To support investigations into the capacity of groundwater to supplement water supply on the Sunshine Coast, a study was performed to estimate relevant hydrologic properties of two unmonitored watercourses (i.e., Soames and Charman creeks). In areas where a hydraulic connection links groundwater and surface water, groundwater extraction can influence surface waterbodies by decreasing the amount of recharge that occurs during dry months, potentially decreasing or degrading aquatic habitat. The annual runoff, monthly distribution of annual runoff, and summer and annual low flows in Soames and Charman creeks was estimated using data from nearby monitored watercourses with similar runoff-generating mechanisms, climate, watershed size, and elevation.

The information contained in this memo can be used to inform decisions related to the development of production wells as part of the Phase 2 Groundwater Investigation Project.

2 METHODS

2.1 Spatial data analysis

Using GIS, the median elevation and drainage area for Soames and Charman creeks were calculated from a digital elevation model (Natural Resources Canada 2018) (Table 2).

2.2 Background research

Because very little data has been collected on the creeks of interest, data from similar nearby watercourses was used to estimate annual runoff and annual and summer low flows. The key background report used herein was Ahmed (2017): a study that summarizes Water Survey of Canada hydrologic data for watercourses located in the South Coast and West Coast regions. Additional background information was gathered from a study that estimated the monthly and annual water balance for Hotel Lake near Sechelt - situated at a similar elevation to Soames and Charman creeks (Summit 2004).

2.3 Selecting representative hydrometric stations

Soames and Charman Creeks are located in Hydrologic Zone 27, as defined by Ahmed (2017). Based on proximity, median elevation, and drainage area, several representative hydrometric stations from within Zone 27 were selected for analysis. Hydrologic data for the six watercourses is summarized in Table 1.

Table 1 – Hydrologic data of representative Zone 27 streams

Station Name	Location	Median Elevation (m)	Drainage area (km^2)	Annual Runoff (mm)	Jun-Sep 10-Year 7-Day Low Flow ($L/s/km^2$)	Annual 10-Year 7-Day Low Flow ($L/s/km^2$)
Lang	Saltery Bay	299	127.48	1011	0.643	0.643
Mahood-Newton	Surrey	84	17.95	1066	0.279	0.279
Nicomekl	Langley	55	71.18	896	2.065	2.023
Roberts	Sechelt	606	29.4	1089	1.599	1.599
Salmon River @ 72 Ave	Langley	92	46.22	975	2.813	2.726
West	Langley	86	11.53	1029	0.867	0.781

Notes:
Data from *Inventory of Streamflow in the South Coast and West Coast Regions* (Ahmed 2017)

2.4 Estimating annual runoff

Runoff data from the entire hydrologic zone (i.e. Zone 27) was graphed against median elevation to determine the overall trend for Zone 27 (Figure 1). Data outside the 95th percentile was discarded as it skewed the overall trend significantly. The trendline generated in Excel was manually adjusted to reflect a heavier weighting of the six key watercourses identified above (the red line in the figure). Annual runoff for Soames and Charman creeks was determined from this new trendline, then checked against results reported in Summit (2004).

2.5 Monthly distribution of annual runoff

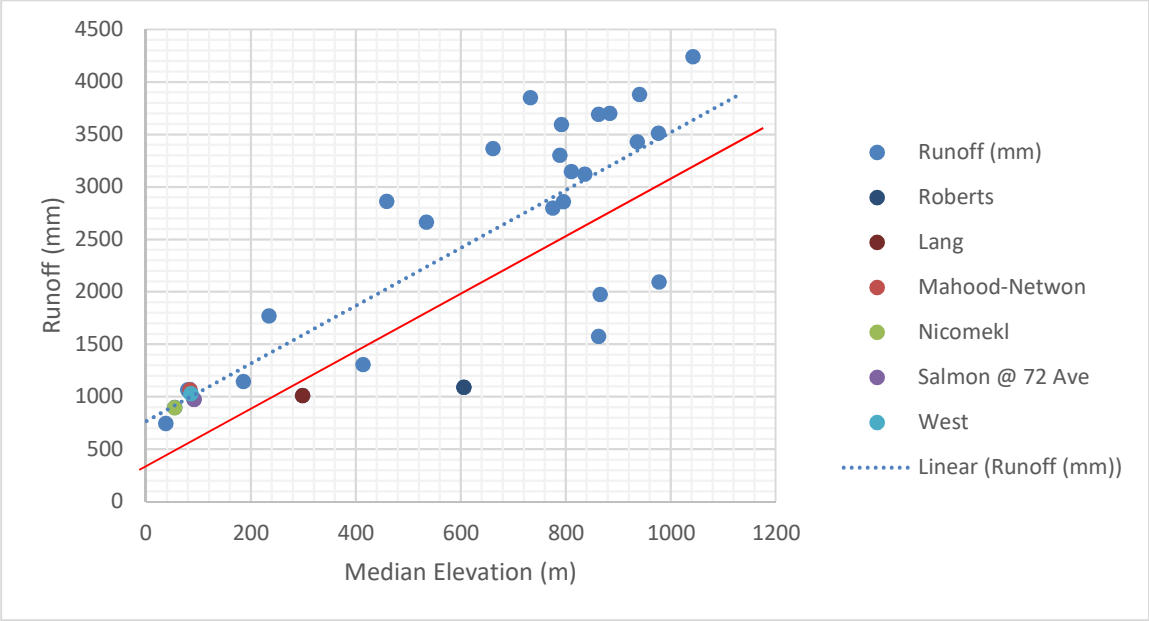
To create monthly hydrographs for Soames and Charman creeks, an average of the monthly distribution of the annual runoff was taken from the six representative hydrometric stations (Table 2). The average monthly distribution was then compared to the estimated monthly distribution of Hotel Lake (Summit 2004). In general, the average calculated from six representative stations in Zone 27 agrees with the estimated distribution at Hotel Lake. The Zone 27 average was then applied to the annual runoff for Soames and Charman creeks, as determined from the trendline in Figure 1.

Table 2 – Average monthly runoff distribution

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Zone 27 (%)	18	13	11	8	6	4	2	1	2	5	16	15

Notes:
Data from *Inventory of Streamflow in the South Coast and West Coast Regions* (Ahmed 2017)

Figure 1 – Annual runoff for stations in Zone 27



2.6 Estimating Low Flows

The 10-year return period 7-day low flow data, for both the entire year and the June-September period, from all stations in Zone 27 was graphed against drainage area (Figures 2 and 3). Even after discarding data outside of the 95th percentile, there is significant variability and a trendline could not be used to determine low flows at Soames and Charman creeks. Instead, an average was taken of low flow data from Roberts and Lang creeks as they are the closest in proximity and likely best represent the low flow regime of Soames and Charman creeks.

Figure 2 – 10-year return period 7-day annual low flow for stations in Zone 27

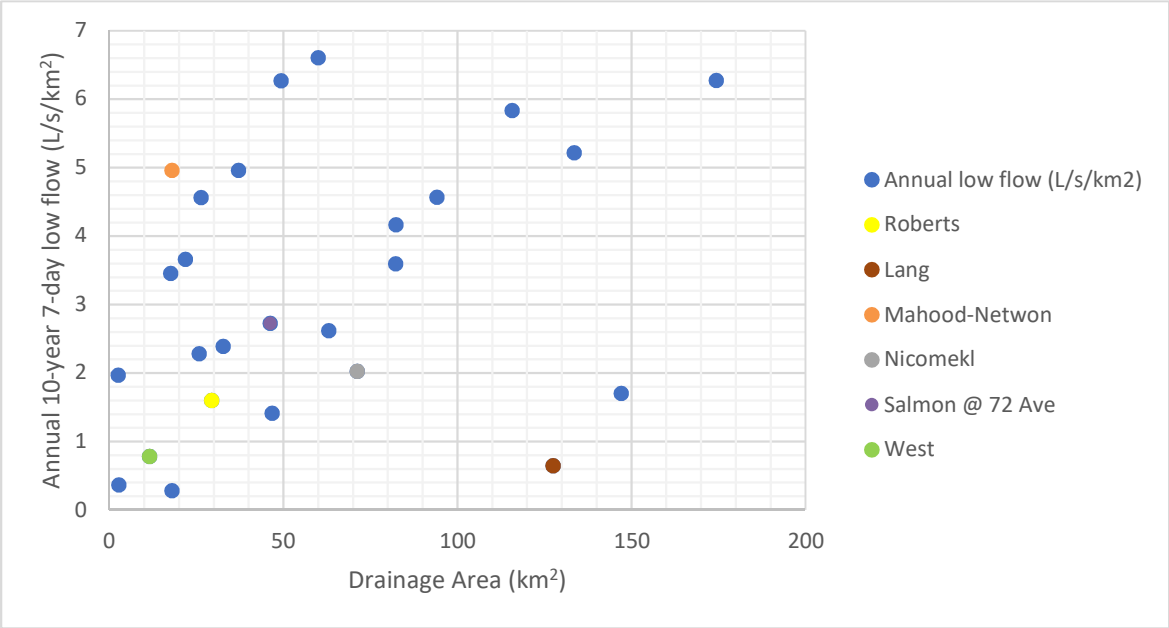
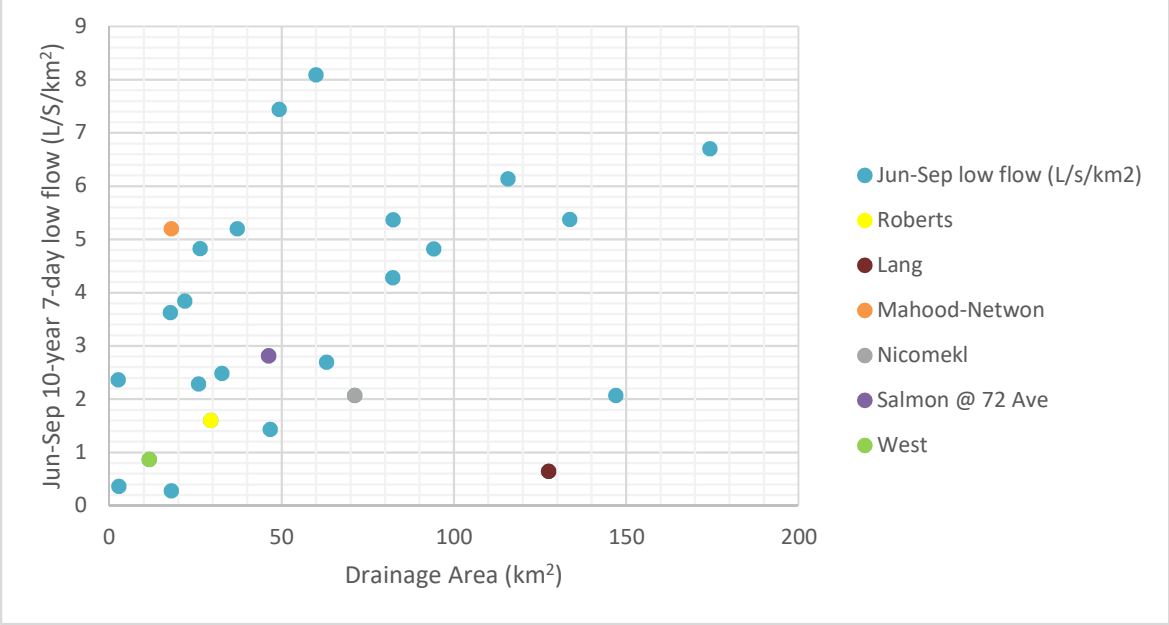


Figure 3 – 10-year return period 7-day June-September low flow for stations in Zone 27



3 RESULTS

Table 3 summarizes hydrologic data for Soames and Charman creeks.

Table 3 – Hydrologic data for Soames and Charman creeks

Creek Name	Median Elevation (m)[1]	Drainage Area (km^2)[1]	Annual Runoff (mm)	Average Annual Discharge (L/s)	Annual 10-Year 7-Day Low Flow ($L/s/km^2$)[2]	Annual 10-Year 7-Day Low Flow (L/s)	June-September 10-Year 7-Day Low Flow ($L/s/km^2$)[2]	June-September 10-Year 7-Day Low Flow ($L/s/km^2$)
Soames	161	1.76	730	41	1.12	1.97	1.12	1.97
Charman	122	1.39	610	27	1.12	1.56	1.12	1.56

Notes:
[1]Data from Canadian Digital Elevation Model (Natural Resources Canada 2018)
[2]Data from *Inventory of Streamflow in the South Coast and West Coast Regions* (Ahmed 2017)

3.1 Runoff

The annual runoff for Soames and Charman creeks is estimated to be 730 mm and 610 mm, respectively. In terms of volumetric flow rate, this is equal to 0.041 m^3/s (i.e., 41 L/s) for Soames Creek and 0.027 m^3/s (i.e., 27 L/s) for Charman Creek.

These results are consistent with those of Summit (2004) in which the average annual runoff to Hotel Lake was estimated to be 600 mm.

3.2 Monthly hydrographs

Monthly hydrographs for an average year for Soames and Charman creeks are presented in Figures 4 and 5, respectively. Table 4 contains the estimated monthly flow for each creek. Both creeks are typical of rain dominated catchments as they have the lowest flows in the summer when the weather is dry and peak flows in the winter when the coast experiences heavy rain.

Table 4 – Average monthly flows for Soames and Charman creeks

Creek	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Soames (L/s)	85.7	66.7	53.5	41.1	27.4	17.7	9.6	5.5	8.5	24.0	77.9	73.3
Charman (L/s)	56.5	44.0	35.3	27.1	18.1	11.7	6.3	3.6	5.6	15.8	51.4	48.4

Figure 4 – Soames Creek hydrograph

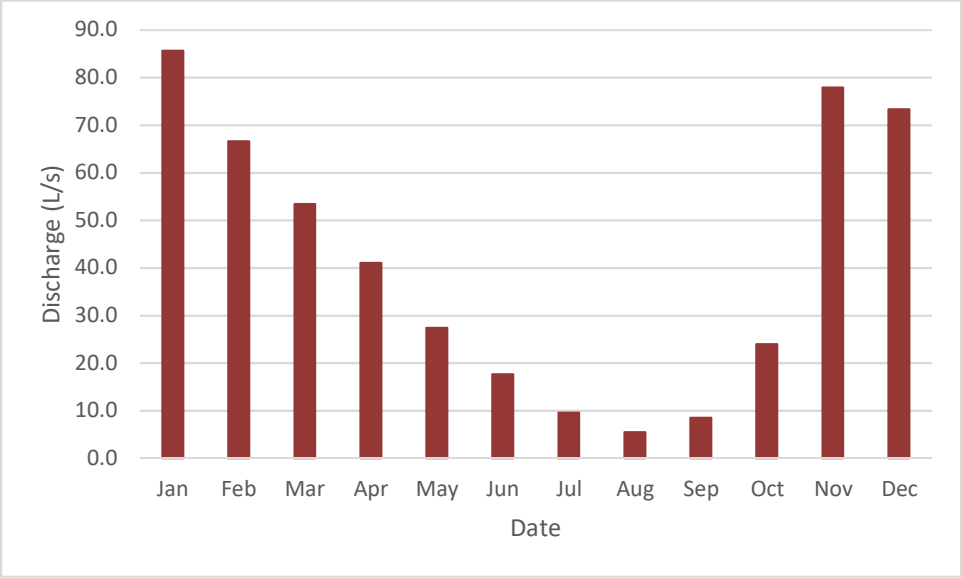
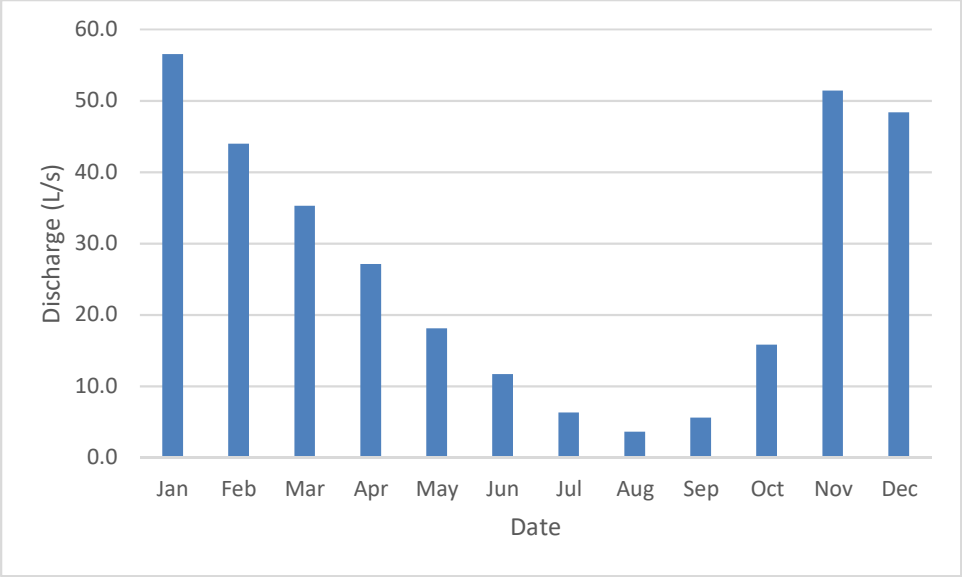


Figure 5 – Charman Creek hydrograph



3.3 10-year return period, 7-day low flow

The 10-year return period 7-day low flow for Soames and Charman creeks, both for the full year and for the June-September period is estimated as approximately 1.97 L/s and 1.56 L/s, respectively.

4 SUMMARY AND CONCLUSIONS

Associated completed a desktop hydrology study for Soames and Charman creeks. Based on this study, Associated concludes that:

- The annual runoff for Soames and Charman creeks are 41 L/s, and 27 L/s respectively.
- The 10-year return period 7-day low flow for Soames and Charman creeks are 1.97 and 1.56 L/s, respectively.

5 CLOSURE

This report was prepared for the SCRD to inform decision making during the Phase 2 Groundwater Investigation study. The services provided by Associated Environmental Consultants Inc. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

REFERENCES

Ahmed, A. (2017). Inventory of Streamflow in the South and West Coast Regions. Knowledge Management Branch, Ministry of Environment and Climate Change Strategy, Victoria, B.C.

Natural Resources Canada. (2018). Canadian Digital Elevation Model. Available at: https://open.canada.ca/data/en/dataset/7f245e4d-76c2-4caa-951a-45d1d2051333

Summit Environmental Consultants Ltd (Summit). (2004). Review of Hydrologic and Water Quality Information for Hotel Lake. Prepared for Area A Quality Water Association, Garden Bay, B.C.

Appendix F - CARO water quality results

					Sampling Location	WIN 54928	WIN 54929	WIN 54943
					Date Sampled	01-Nov-18	26-Oct-18	30-Oct-18
					Well Name	CHURCH RD	DUSTY RD	MAHAN RD
					Lab Sample ID	8110123-01	8102454-01	8102785-01
					Sample Type			
Analyte	**Unit**	**Guideline**						
		GCDWQ MAC	GCDWQ AO	BC SDWQG MAC	BC SDWQG AO			
Lab Results								
General								
Alkalinity (bicarbonate, as CaCO3)	mg/L	NG	NG	NG	NG	40.6	52.2	52.0
Alkalinity (carbonate, as CaCO3)	mg/L	NG	NG	NG	NG	<1.0	<1.0	<1.0
Alkalinity (hydroxide, as CaCO3)	mg/L	NG	NG	NG	NG	<1.0	<1.0	<1.0
Alkalinity (phenolphthalein, as CaCO3)	mg/L	NG	NG	NG	NG	<1.0	<1.0	<1.0
Alkalinity (total, as CaCO3)	mg/L	NG	NG	NG	NG	40.6	52.2	52.0
Chloride	mg/L	NG	250	NG	250	2.24	21.5	26.8
Colour	CU	NG	15	NG	15	<5.0	<5.0	<5.0
Conductivity	µS/cm	NG	NG	NG	NG	105	181	192
Fluoride	mg/L	1.5	NG	1.5	NG	<0.10	<0.10	<0.10
Hardness, Total (dissolved as CaCO3)	mg/L	NG	NG	NG	NG	38.3	66.8	77.6
Langelier Index		NG	NG	NG	NG	0.6	-1.6	1.2
pH		NG	7.0 - 10.5 [2.1]	NG	NG	7.51	7.01	7.71
Sulphate	mg/L	NG	500 [2.2]	NG	500	7.8	2.2	4.6
Total dissolved solids	mg/L	NG	500	NG	NG	103	131	174
Total organic carbon	mg/L	NG	NG	4.0	NG	0.91	<0.50	<0.50
Turbidity	NTU	N [1.1]	NG	N [3.1]	NG	10.2	<0.10	0.95
UV transmittance at 254 nm	%	NG	NG	NG	NG	98.7	99.6	98.3
Nutrients								
Ammonia (total, as N)	mg/L	NG	NG	NG	NG	<0.020	0.021	<0.020
Nitrate + Nitrite (as N)	mg/L	10 [1.2]	NG	NG	NG	0.502	0.242	0.796
Organic nitrogen	mg/L	NG	NG	NG	NG	<0.0500	<0.0500	<0.0500
Total nitrogen	mg/L	NG	NG	NG	NG	0.502	0.242	0.796
Total kjeldahl nitrogen	mg/L	NG	NG	NG	NG	<0.050	<0.050	<0.050
Phosphorus (dissolved, by ICPMS/ICPOES)	mg/L	NG	NG	NG	N [4.1]	0.072	<0.050	0.077
Phosphorus (total, by ICPMS/ICPOES)	mg/L	NG	NG	NG	N [4.2]	0.105	<0.050	0.080
Potassium (dissolved)	mg/L	NG	NG	NG	NG	2.32	1.55	3.32
Potassium (total)	mg/L	NG	NG	NG	NG	2.32	1.29	3.30
Microbiological								
E. coli (counts)	CFU/100 mL	0 [1.3]	NG	10 [3.2]	NG	<1	<1	<1
Heterotrophic Plate Count (counts)	CFU/mL	N [1.4]	NG	NG	NG	<1	<1	<1
Iron Bacteria (counts)	CFU/mL	NG	NG	NG	NG	35300	8820	8820
Sulfate-reducing bacteria (counts)	CFU/100 mL	NG	NG	NG	NG	<800	<800	22600
Total coliforms (counts)	CFU/100 mL	0 [1.5]	NG	NG	NG	<1	<1	<1
Total Metals								
Aluminum (total)	mg/L	NG	N [2.3]	9.5	NG	0.575	0.0068	<0.0050
Antimony (total)	mg/L	0.006	NG	NG	NG	<0.00020	<0.00020	<0.00020
Arsenic (total)	mg/L	0.010 [1.6]	NG	0.01	NG	0.00188	<0.00050	0.00256
Barium (total)	mg/L	1.0	NG	NG	NG	0.0084	<0.0050	<0.0050
Beryllium (total)	mg/L	NG	NG	NG	NG	<0.00010	<0.00010	<0.00010
Bismuth (total)	mg/L	NG	NG	NG	NG	0.00093	<0.00010	<0.00010
Boron (total)	mg/L	5	NG	5.0	NG	0.0115	0.0374	0.0059
Cadmium (total)	mg/L	0.005	NG	0.005	NG	<0.000010	<0.000010	<0.000010
Calcium (total)	mg/L	NG	NG	NG	NG	8.53	17.7	16.5
Chromium (total)	mg/L	0.05	NG	NG	NG	0.00148	<0.00050	<0.00050
Cobalt (total)	mg/L	NG	NG	NG	NG	0.00039	<0.00010	<0.00010
Copper (total)	mg/L	NG	1.0	NG	1.0	0.0432	0.00308	0.00112
Iron (total)	mg/L	NG	0.3	NG	0.3	0.441	0.011	<0.010
Lead (total)	mg/L	0.010	NG	0.01	NG	0.00089	<0.00020	<0.00020
Lithium (total)	mg/L	NG	NG	NG	NG	0.00085	0.00079	0.00078
Magnesium (total)	mg/L	NG	NG	NG	NG	4.43	5.78	9.28
Manganese (total)	mg/L	NG	0.05	NG	0.05	0.00811	0.00074	0.00033
Mercury (total)	mg/L	0.001	NG	0.001	NG	<0.000010	<0.000010	<0.000010
Molybdenum (total)	mg/L	NG	NG	0.25	NG	0.00120	0.00050	0.00093
Nickel (total)	mg/L	NG	NG	NG	NG	0.00113	<0.00040	<0.00040
Selenium (total)	mg/L	0.05	NG	0.01	NG	<0.00050	<0.00050	<0.00050
Silicon (total, as Si)	mg/L	NG	NG	NG	NG	19.8	9.7	20.5
Silver (total)	mg/L	NG	NG	NG	NG	<0.000050	<0.000050	<0.000050
Sodium (total)	mg/L	NG	200	NG	NG	5.96	6.79	9.83
Strontium (total)	mg/L	NG	NG	NG	NG	0.0244	0.0533	0.0628
Sulphide (total, as S)	mg/L	NG	0.047 [2.4]	NG	NG	<0.020	<0.020	<0.020
Sulphur (total)	mg/L	NG	NG	NG	NG	<3.0	<3.0	<3.0
Tellurium (total)	mg/L	NG	NG	NG	NG	<0.00050	<0.00050	<0.00050
Thallium (total)	mg/L	NG	NG	NG	NG	<0.000020	<0.000020	<0.000020
Thorium (total)	mg/L	NG	NG	NG	NG	<0.00010	<0.00010	<0.00010
Tin (total)	mg/L	NG	NG	NG	NG	0.00207	<0.00020	<0.00020
Titanium (total)	mg/L	NG	NG	NG	NG	0.0224	<0.0050	<0.0050
Tungsten (total)	mg/L	NG	NG	NG	NG	<0.0010	<0.0010	<0.0010
Uranium (total)	mg/L	0.02	NG	NG	NG	0.000133	0.000091	0.000215
Vanadium (total)	mg/L	NG	NG	NG	NG	0.0079	0.0015	0.0098
Zinc (total)	mg/L	NG	5.0	NG	5.0	0.0284	0.0205	0.0328
Zirconium (total)	mg/L	NG	NG	NG	NG	0.00072	<0.00010	<0.00010
Dissolved Metals								
Aluminum (dissolved)	mg/L	NG	N [2.5]	9.5	NG	<0.0050	<0.0050	<0.0050
Antimony (dissolved)	mg/L	0.006	NG	NG	NG	<0.00020	<0.00020	<0.00020
Arsenic (dissolved)	mg/L	0.010 [1.7]	NG	0.01	NG	0.00176	<0.00050	0.00277
Barium (dissolved)	mg/L	1.0	NG	NG	NG	<0.0050	<0.0050	<0.0050
Beryllium (dissolved)	mg/L	NG	NG	NG	NG	<0.00010	<0.00010	<0.00010
Bismuth (dissolved)	mg/L	NG	NG	NG	NG	<0.00010	<0.00010	<0.00010
Boron (dissolved)	mg/L	5	NG	5.0	NG	0.0063	0.0107	0.0053
Cadmium (dissolved)	mg/L	0.005	NG	0.005	NG	0.000014	<0.000010	<0.000010
Calcium (dissolved)	mg/L	NG	NG	NG	NG	8.22	17.9	16.1
Chromium (dissolved)	mg/L	0.05	NG	NG	NG	0.00052	<0.00050	<0.00050
Cobalt (dissolved)	mg/L	NG	NG	NG	NG	<0.00010	<0.00010	<0.00010
Copper (dissolved)	mg/L	NG	1.0	NG	1.0	0.00153	0.00288	0.00073
Iron (dissolved)	mg/L	NG	0.3	NG	0.3	0.016	0.013	<0.010
Lead (dissolved)	mg/L	0.010	NG	0.01	NG	<0.00020	<0.00020	<0.00020
Lithium (dissolved)	mg/L	NG	NG	NG	NG	0.00059	0.00108	0.00067
Magnesium (dissolved)	mg/L	NG	NG	NG	NG	4.32	5.37	9.10
Manganese (dissolved)	mg/L	NG	0.05	NG	0.05	0.00109	0.00076	0.00035
Mercury (dissolved)	mg/L	0.001	NG	0.001	NG	<0.000010	<0.000010	<0.000010
Molybdenum (dissolved)	mg/L	NG	NG	0.25	NG	0.00252	0.00037	0.00094
Nickel (dissolved)	mg/L	NG	NG	NG	NG	0.00061	<0.00040	<0.00040
Selenium (dissolved)	mg/L	0.05	NG	0.01	NG	<0.00050	<0.00050	<0.00050
Silicon (dissolved, as Si)	mg/L	NG	NG	NG	NG	18.1	11.0	20.3

					Sampling Location	WIN 54928	WIN 54929	WIN 54943
					Date Sampled	01-Nov-18	26-Oct-18	30-Oct-18
					Well Name	CHURCH RD	DUSTY RD	MAHAN RD
					Lab Sample ID	8110123-01	8102454-01	8102785-01
					Sample Type			
Analyte	**Unit**	**Guideline**						
		GCDWQ MAC	GCDWQ AO	BC SDWQG MAC	BC SDWQG AO			
Silver (dissolved)	mg/L	NG	NG	NG	NG	<0.000050	<0.000050	<0.000050
Sodium (dissolved)	mg/L	NG	200	NG	NG	5.64	6.66	9.45
Strontium (dissolved)	mg/L	NG	NG	NG	NG	0.0228	0.0508	0.0614
Sulphur (dissolved)	mg/L	NG	NG	NG	NG	<3.0	<3.0	<3.0
Tellurium (dissolved)	mg/L	NG	NG	NG	NG	<0.00050	<0.00050	<0.00050
Thallium (dissolved)	mg/L	NG	NG	NG	NG	<0.000020	<0.000020	<0.000020
Thorium (dissolved)	mg/L	NG	NG	NG	NG	<0.00010	<0.00010	<0.00010
Tin (dissolved)	mg/L	NG	NG	NG	NG	<0.00020	<0.00020	<0.00020
Titanium (dissolved)	mg/L	NG	NG	NG	NG	<0.0050	<0.0050	<0.0050
Tungsten (dissolved)	mg/L	NG	NG	NG	NG	<0.0010	<0.0010	<0.0010
Uranium (dissolved)	mg/L	0.02	NG	NG	NG	0.000094	0.000091	0.000208
Vanadium (dissolved)	mg/L	NG	NG	NG	NG	0.0069	0.0012	0.0093
Zinc (dissolved)	mg/L	NG	5.0	NG	5.0	0.0186	0.0205	0.0182
Zirconium (dissolved)	mg/L	NG	NG	NG	NG	<0.00010	<0.00010	<0.00010

Guideline Notes for Reports for 2018-8152 SCRD GW Investigation Water Quality Results

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

Note 1.1 for Turbidity:

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

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

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

Note 1.2 for Nitrate + Nitrite (as N):

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

Note 1.3 for E. coli (counts):

MAC is none detectable per 100 mL

Note 1.4 for Heterotrophic Plate Count (counts):

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

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

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

Note 1.5 for Total coliforms (counts):

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

Total coliforms should be monitored in the distribution system because they are used to indicate changes in water quality. Detection of total coliforms from consecutive samples from the same site or from more than 10% of the samples collected in a given sampling period should be investigated.

Note 1.6 for Arsenic (total):

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

Note 1.7 for Arsenic (dissolved):

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

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

Note 2.1 for pH:

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

Note 2.2 for Sulphate:

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

Note 2.3 for Aluminum (total):

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

Note 2.4 for Sulphide (total, as S):

The aesthetic objective for sulphide (as H2S) is 0.05 mg/L. This is equivalent to 0.047 mg/L sulphide (as S).

Note 2.5 for Aluminum (dissolved):

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

3. Notes for BC Source Drinking Water Quality Guidelines - Maximum Acceptable Concentrations (2017 and updates) (BC SDWQG MAC)

General Notes:

The source drinking water quality guidelines presented in this document apply to the ambient water before it is treated and distributed for domestic use. The guidelines apply to drinking water sources from surface water and groundwater.

Metal guidelines are based on total concentrations.

Note 3.1 for Turbidity:

For raw drinking water with treatment for particulates, the guideline is:
Change from background of 5 NTU at any time when background is ≤ 50 NTU; and change from background of 10% when background is > 50 NTU.
For raw drinking water without treatment for particulates, the guideline is:
Change from background of 1 NTU at any time when background is ≤ 5 NTU; and change from background of 5 NTU at any time.
If natural background turbidity is > 50 NTU, the guideline is:
Induced turbidity should not exceed 10% of the background turbidity.

Note 3.2 for E. coli (counts):

The MAC is ≤ 10 E. coli /100 mL; 90th percentile (minimum of 5 samples).

4. Notes for BC Source Drinking Water Quality Guidelines - Aesthetic Objectives (2017 and updates) (BC SDWQG AO)

General Notes:

The source drinking water quality guidelines presented in this document apply to the ambient water before it is treated and distributed for domestic use. The guidelines apply to drinking water sources from surface water and groundwater.
Metal guidelines are based on total concentrations.

Note 4.1 for Phosphorus (dissolved, by ICPMS/ICPOES):

The AO for lakes is 0.01 mg/L. For lakes with residence time > 6 months, measure total P during spring overturn. For lakes with residence time < 6 months, measure mean epilimnetic total P during the growing season (ENV 1985).

Note 4.2 for Phosphorus (total, by ICPMS/ICPOES):

The AO for lakes is 0.01 mg/L. For lakes with residence time > 6 months, measure total P during spring overturn. For lakes with residence time < 6 months, measure mean epilimnetic total P during the growing season (ENV 1985).

LOGIN NOTICE (Work Order 8102454)

CLIENT	Associated Environmental Consultants Inc. (Vernon)		
PO NUMBER		**QUOTATION ID**	AE Master Bid (BC)
PROJECT	2018-8152.000.003	**SUBMITTED BY**	
PROJECT INFO	SCRD GW Investigation	**COC NO.**	

Receipt Details:

RECEIVED	2018-10-26 15:29	**LOGGED IN**	2018-10-26 16:26
LOCATION	Richmond Lab	**ACCOUNT MGR**	Eilish St.Clair, B.Sc., C.I.T.

Sample Condition Summary: Quantity of Transport Vessels Received: 1

Receipt Temperature = 9°C

Broken Container(s)	No	Sampling Date(s) Missing	No	Incorrect Cont./Pres.	No
Cooling Initiated	Yes	Sample(s) Frozen	No	Missing/Extra Samples	No

Note: *Sample transport temperatures of less than 8°C for microbiological parameters and less than or equal to 10°C for environmental parameters is recommended. Samples that exceed these values will still be processed. However, please note that the analytical results may be affected, especially for samples collected prior to the day of receipt.*

REPORT TO	Nicole Penner Associated Environmental Consultants Inc. (Vernon) #200 - 2800 29th Street Vernon, BC V1T 9P9 Tel: (250) 545-3672	**INCLUDE QC** **INCLUDE COC** **EXTRAS**	Yes No Guidelines
INVOICE TO	Nicole Penner Associated Environmental Consultants Inc. (Vernon) #200 - 2800 29th Street Vernon, BC V1T 9P9 Tel: (250) 545-3672	**FREQUENCY** **GST EXEMPT** **PAYMENT TERMS** **MIN AMOUNT**	With Report No Upon Receipt N/A

Delivery Plan:

REPORT DUE 2018-11-06 17:00 (5-7 day TAT)

Contact Name	Email / Fax / Cellular	Login Notice	Report	Invoice	EDD	EDD Format	CC to	Fax	Text	Mail
Nicole Penner	pennern@ae.ca	✓	✓		✓	CARO Excel	support@wirelesswater.com			
Nicole Penner	pennern@ae.ca			✓			anzej@ae.ca			
Wireless H2O v2 EDD Uploaded by CARO on behalf of Client										

Analysis Schedule:

Analysis / Version	Due	Expires [1]	Status	Comments

WIN 54929 (8102454-01) | Matrix: Water | Sampled: 2018-10-26 09:30

LOGIN NOTICE (Work Order 8102454)

Analysis Schedule, Continued:

Analysis / Version	Due	Expires [1]	Status	Comments
WIN 54929 (8102454-01) | Matrix: Water | Sampled: 2018-10-26 09:30, Continued				
Container(s) Submitted:				
A = C05_125 mL Plastic (Metals)	*B = C06_40 mL Vial (Mercury)*	*C = S05_125 mL Plastic (Metals-F)*		
D = S06_40 mL Vial (Mercury-F)	*E = C23_125 mL Plastic (Sulfide)*	*F = C13_500 mL Plastic (General)*		
G = C13_500 mL Plastic (General)	*H = C13_500 mL Plastic (General)*	*I = C22_125 mL Plastic (General)*		
J = C04_40 mL Vial (VOC Water)	*K = C04_40 mL Vial (VOC Water)*	*L = C07_300 mL Plastic (Micro-S)*		
M = C07_300 mL Plastic (Micro-S)	*N = C14_40 mL Vial (TOC)*	*O = C14_40 mL Vial (TOC)*		
P = S14_40 mL Vial (DOC-F)	*Q = S14_40 mL Vial (DOC-F)*	*R = C10_125 mL Plastic (H2SO4)*		
S = C10_125 mL Plastic (H2SO4)				
Alkalinity	2018-11-06	2018-11-09	Available	
Anions by IC (3) Pkg	2018-11-06	2018-11-23	Available	
Carbon, Total Organic	2018-11-06	2018-11-23	Available	
Coliforms, Total (MPN)	2018-11-06	2018-10-27	Subcontracted	Subcontracted
Colour, True	2018-11-06	2018-10-29	Batched	
Conductivity	2018-11-06	2018-11-23	Analyzed	
E. coli (MPN)	2018-11-06	2018-10-27	Subcontracted	Subcontracted
Heterotrophic Plate Count	2018-11-06	2018-10-27	Subcontracted	Subcontracted
Iron Related Bacteria (Count)	2018-11-06	2018-10-28	Available	
Langelier Index	2018-11-06	2018-11-23	Available	
Mercury, dissolved by CVAFS	2018-11-06	2018-11-23	Available	
Mercury, total by CVAFS	2018-11-06	2018-11-23	Available	
Metals, Dissolved by ICPMS (All) Pkg	2018-11-06	2019-04-24	Available	
Metals, Total by ICPMS (All) Pkg	2018-11-06	2019-04-24	Available	
Nitrogen, Organic (Calc TKN, NH3)	2018-11-06	2018-11-23	Available	
Nitrogen, Total (TKN, NO2+NO3 by colour)	2018-11-06	2018-10-29	Available	
pH	2018-11-06	2018-10-26	Available	
Solids, Total Dissolved	2018-11-06	2018-11-02	Available	
Sulfate Reducing Bacteria (Count)	2018-11-06	2018-10-28	Available	
Sulfide, Total	2018-11-06	2018-11-02	Available	
Transmittance at 254 nm	2018-11-06	2018-10-29	Available	
Turbidity	2018-11-06	2018-10-29	Analyzed	

1 *Red font indicates that the analysis has already or is about to expire. In order to guarantee that your samples will be analyzed within the recommended holding time, they must be received at least one day prior to the expiry date (3 hours for microbiological testing). Note that all pH in water / Chlorine / Temperature / Dissolved Oxygen results will be automatically be qualified as they should be analyzed in the field for greatest accuracy.*

LOGIN NOTICE (Work Order 8102454)

Packages and their respective Analyses included in this Work Order:

Anions by IC (3) Pkg

Chloride by IC	Fluoride by IC	Sulfate by IC

Metals, Dissolved by ICPMS (All) Pkg

Aluminum, dissolved by ICPMS	Antimony, dissolved by ICPMS	Arsenic, dissolved by ICPMS
Barium, dissolved by ICPMS	Beryllium, dissolved by ICPMS	Bismuth, dissolved by ICPMS
Boron, dissolved by ICPMS	Cadmium, dissolved by ICPMS	Calcium, dissolved by ICPMS
Chromium, dissolved by ICPMS	Cobalt, dissolved by ICPMS	Copper, dissolved by ICPMS
Hardness, Total (as CaCO3) (Calc)	Iron, dissolved by ICPMS	Lead, dissolved by ICPMS
Lithium, dissolved by ICPMS	Magnesium, dissolved by ICPMS	Manganese, dissolved by ICPMS
Molybdenum, dissolved by ICPMS	Nickel, dissolved by ICPMS	Phosphorus, dissolved by ICPMS
Potassium, dissolved by ICPMS	Selenium, dissolved by ICPMS	Silicon, dissolved by ICPMS
Silver, dissolved by ICPMS	Sodium, dissolved by ICPMS	Strontium, dissolved by ICPMS
Sulfur, dissolved by ICPMS	Tellurium, dissolved by ICPMS	Thallium, dissolved by ICPMS
Thorium, dissolved by ICPMS	Tin, dissolved by ICPMS	Titanium, dissolved by ICPMS
Tungsten, dissolved by ICPMS	Uranium, dissolved by ICPMS	Vanadium, dissolved by ICPMS
Zinc, dissolved by ICPMS	Zirconium, dissolved by ICPMS	

Metals, Total by ICPMS (All) Pkg

Aluminum, total by ICPMS	Antimony, total by ICPMS	Arsenic, total by ICPMS
Barium, total by ICPMS	Beryllium, total by ICPMS	Bismuth, total by ICPMS
Boron, total by ICPMS	Cadmium, total by ICPMS	Calcium, total by ICPMS
Chromium, total by ICPMS	Cobalt, total by ICPMS	Copper, total by ICPMS
Hardness, Total (as CaCO3) (Calc)	Iron, total by ICPMS	Lead, total by ICPMS
Lithium, total by ICPMS	Magnesium, total by ICPMS	Manganese, total by ICPMS
Molybedenum, total by ICPMS	Nickel, total by ICPMS	Phosphorus, total by ICPMS
Potassium, total by ICPMS	Selenium, total by ICPMS	Silicon, total by ICPMS
Silver, total by ICPMS	Sodium, total by ICPMS	Strontium, total by ICPMS
Sulfur, total by ICPMS	Tellurium, total by ICPMS	Thallium, total by ICPMS
Thorium, total by ICPMS	Tin, total by ICPMS	Titanium, total by ICPMS
Tungsten, total by ICPMS	Uranium, total by ICPMS	Vanadium, total by ICPMS
Zinc, total by ICPMS	Zirconium, total by ICPMS	

Nitrogen, Organic (Calc TKN, NH3)

Ammonia, Total	Nitrogen, Organic (Calc)

Nitrogen, Total (TKN, NO2+NO3 by colour)

Nitrate+Nitrite by Colorimetry	Nitrogen, Total (Calc)	Nitrogen, Total Kjeldahl

LOGIN NOTICE (Work Order 8102454)

Each Analysis includes the following Analytes and their respective Reporting Limits [RLs]:			
Alkalinity in Water	*Reference Method: SM 2320 B* (2011)*		*Units: mg/L*
Alkalinity, Total (as CaCO3) [1]	Alkalinity, Phenolphthalein (as CaCO3) [1]	Alkalinity, Bicarbonate (as CaCO3) [1]	Alkalinity, Carbonate (as CaCO3) [1]
Alkalinity, Hydroxide (as CaCO3) [1]			
Ammonia, Total in Water	*Reference Method: SM 4500-NH3 G* (2011)*		*Units: mg/L*
Ammonia, Total (as N) [0.02]			
Anions by IC in Water	*Reference Method: SM 4110 B (2011)*		*Units: mg/L*
Chloride [0.1]	Fluoride [0.1]	Sulfate [1]	
Carbon, Total Organic in Water	*Reference Method: SM 5310 B (2011)*		*Units: mg/L*
Carbon, Total Organic [0.5]			
Coliforms, Total (MPN) in Water	*Reference Method: SM 9221 (2006)*		*Units: MPN/100 mL*
Coliforms, Total [2]			
Colour, True in Water	*Reference Method: SM 2120 C (2011)*		*Units: CU*
Colour, True [5]			
Conductivity in Water	*Reference Method: SM 2510 B (2011)*		*Units: uS/cm*
Conductivity (EC) [2]			
Dissolved Metals by ICPMS in Water	*Reference Method: EPA 200.8 / EPA 6020B*		*Units: mg/L*
Aluminum, dissolved [0.005]	Antimony, dissolved [0.0002]	Arsenic, dissolved [0.0005]	Barium, dissolved [0.005]
Beryllium, dissolved [0.0001]	Bismuth, dissolved [0.0001]	Boron, dissolved [0.005]	Cadmium, dissolved [1e-005]
Calcium, dissolved [0.2]	Chromium, dissolved [0.0005]	Cobalt, dissolved [0.0001]	Copper, dissolved [0.0004]
Iron, dissolved [0.01]	Lead, dissolved [0.0002]	Lithium, dissolved [0.0001]	Magnesium, dissolved [0.01]
Manganese, dissolved [0.0002]	Molybdenum, dissolved [0.0001]	Nickel, dissolved [0.0004]	Phosphorus, dissolved [0.05]
Potassium, dissolved [0.1]	Selenium, dissolved [0.0005]	Silicon, dissolved [1]	Silver, dissolved [5e-005]
Sodium, dissolved [0.1]	Strontium, dissolved [0.001]	Sulfur, dissolved [3]	Tellurium, dissolved [0.0005]
Thallium, dissolved [2e-005]	Thorium, dissolved [0.0001]	Tin, dissolved [0.0002]	Titanium, dissolved [0.005]
Tungsten, dissolved [0.001]	Uranium, dissolved [2e-005]	Vanadium, dissolved [0.001]	Zinc, dissolved [0.004]
Zirconium, dissolved [0.0001]			
E. coli (MPN) in Water	*Reference Method: SM 9221 (2006)*		*Units: MPN/100 mL*
E. coli (MPN) [2]			
Heterotrophic Plate Count in Water	*Reference Method: SM 9215 B (2004)*		*Units: CFU/mL*
Heterotrophic Plate Count [1]			
Iron Related Bacteria (Count) in Water	*Reference Method: DBI DBISOP06*		*Units: CFU/mL*
Iron Related Bacteria [2]			

LOGIN NOTICE (Work Order 8102454)

Langelier Index in Water	*Reference Method: SM 2330 B (2010)*	*Units: -*
Langelier Index [-5]		
Mercury by CVAFS in Water	*Reference Method: EPA 245.7**	*Units: mg/L*
Mercury, dissolved [1e-005]	Mercury, total [1e-005]	
Nitrate+Nitrite by Colorimetry in Water	*Reference Method: SM 4500-NO3- F (2011)*	*Units: mg/L*
Nitrate+Nitrite (as N) [0.005]		
Nitrogen, Total Kjeldahl in Water	*Reference Method: SM 4500-Norg D* (2011)*	*Units: mg/L*
Nitrogen, Total Kjeldahl [0.05]		
pH in Water	*Reference Method: SM 4500-H+ B (2011)*	*Units: pH units*
pH [0.1]		
Solids, Total Dissolved in Water	*Reference Method: SM 2540 C* (2011)*	*Units: mg/L*
Solids, Total Dissolved [15]		
Sulfate Reducing Bacteria (Count) in Water	*Reference Method: DBI DBSLW05*	*Units: CFU/mL*
Sulfate Reducing Bacteria [8]		
Sulfide, Total in Water	*Reference Method: SM 4500-S2 D* (2011)*	*Units: mg/L*
Sulfide, Total [0.02]		
Total Metals by ICPMS in Water	*Reference Method: EPA 200.2* / EPA 6020B*	*Units: mg/L*
Aluminum, total [0.005]	Antimony, total [0.0002]	Arsenic, total [0.0005]
Barium, total [0.005]	Beryllium, total [0.0001]	Bismuth, total [0.0001]
Boron, total [0.005]	Cadmium, total [1e-005]	Calcium, total [0.2]
Chromium, total [0.0005]	Cobalt, total [0.0001]	Copper, total [0.0004]
Iron, total [0.01]	Lead, total [0.0002]	Lithium, total [0.0001]
Magnesium, total [0.01]	Manganese, total [0.0002]	Molybdenum, total [0.0001]
Nickel, total [0.0004]	Phosphorus, total [0.05]	Potassium, total [0.1]
Selenium, total [0.0005]	Silicon, total [1]	Silver, total [5e-005]
Sodium, total [0.1]	Strontium, total [0.001]	Sulfur, total [3]
Tellurium, total [0.0005]	Thallium, total [2e-005]	Thorium, total [0.0001]
Tin, total [0.0002]	Titanium, total [0.005]	Tungsten, total [0.001]
Uranium, total [2e-005]	Vanadium, total [0.001]	Zinc, total [0.004]
Zirconium, total [0.0001]		
Transmittance at 254 nm in Water	*Reference Method: SM 5910 B* (2013)*	*Units: % T*
UV Transmittance @ 254nm [0.1]		
Turbidity in Water	*Reference Method: SM 2130 B (2011)*	*Units: NTU*
Turbidity [0.1]		

Note: RLs on Final Report may be higher than expected due to: 1) limited sample volume, 2) high moisture, 3) analytical interferences

LOGIN NOTICE (Work Order 8102454)

Please verify that all of the information included in this Login Notice is correct. If there are any errors, omissions, or concerns, please contact us at 1-888-311-8846.

You can expect to receive the analytical report via email on or after the due date shown above.

Thank you for using CARO!

☒ 110-4011 Viking Way, Richmond, BC V6V 2K9
Tel: (604) 279-1499 Fax: (604) 279-1599

☐ 102-3677 Highway 97N, Kelowna, BC V1X 5C3
Tel: (250) 765-9646 Fax: (250) 765-3893

☐ 17225 109 Avenue NW, Edmonton, AB T5S 1H7
Tel: (780) 489-9100 Fax: (780) 489-9700

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CHAIN OF CUSTODY RECORD

COC# | PAGE 1 OF 1

RELINQUISHED BY:	DATE: Oct 26/18	RECEIVED BY:	DATE: Oct 26
	TIME: 1:00	Nabc MOVEd	TIME: 3:30 pm

PROJECT: SCRD GW Investigation

PROJECT INFO: 2018-8152.000.003

REPORT TO:

COMPANY: Associated Environmental
ADDRESS: 200-2800 29th Street
Vernon, BC V1T 9P9
CONTACT: Nicole Penner
TEL/FAX: 250-545-3672 250-938-5537
EMAIL PDF ☒ EDD ☒
EMAIL 1: pennern@ae.ca; friesent@ae.ca
EMAIL 2: support@ wirelesswater.com
MAIL HARDCOPY ☐ HOLD FOR P/U ☐ FAX ☐

INVOICE TO: SAME AS REPORT TO ☒

COMPANY:
ADDRESS:
CONTACT:
TEL/FAX:
EMAIL PDF ☒
EMAIL 1: pennern@ae.ca
EMAIL 2: anzej@ae.ca
MAIL HARDCOPY ☐ HOLD FOR P/U ☐

SAMLPLED BY: Tony Friesen

PO #:

TURNAROUND TIME REQUESTED:
Routine: (5-7 Days) ☒
Rush: 1 Day* ☐ 2 Day* ☐ 3 Day* ☐
Other* ☐
*Contact Lab To Confirm. Surcharge May Apply

REGULATORY APPLICATION:
Canadian Drinking Water Quality Guidelines ☒ CCME ☐
BC Drinking Water Protection Act / Reg. ☐ ALBERTA TIER 1 ☐
BC CSR ☐ AL ☐ RL ☐ CL ☐ IL ☐ AW ☐
OTHER:

ANALYSES REQUESTED:

	CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	MATRIX: OTHER WATER	MATRIX: SOIL	MATRIX: OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	SAMPLING: TIME HH:MM	COMMENTS: CHLORINATED	COMMENTS: FILTERED	COMMENTS: PRESERVED	COMMENTS: (i.e. flow/volume media ID/notes)	BTEX ☐ VPH ☐ PHC F1 ☐	VOC ☐ VPH ☐	EPH ☐ PHC F2-F4 ☐	PAH ☐ L/HEPH ☐	PHENOLS Chlorinated ☐ Non-Chlor. ☐	PCB ☐ GLYCOLS ☐ HAA ☐	PESTICIDES ☐ ACID HERBICIDES ☐	METALS - WATER TOTAL Hg ☒	METALS - WATER DISSOLVED Hg ☒	METALS - SOIL (SALM) ☐ inc. pH ☐	pH ☒ EC ☒ ALK ☒	TSS ☐ VSS ☐ TDS ☒	BOD ☐ COD ☐	TOG ☐ MOG ☐	FECAL COLIFORMS ☐ HPC ☒	TOTAL COLIFORMS ☒ E.coli ☒	ASBESTOS	Iron & sulphate reducing bacteria	Total and organic nitrogen package	Chloride, fluoride, sulphate	Corrosivity (Langelier index)	Sulphide	Total organic carbon	Colour, turbidity, UV transmittance	HOLD
	WIN 54929		✓				26-10-18	09:30				300 USgpm								✓	✓		✓	✓			✓	✓		✓	✓	✓	✓	✓	✓		

SHIPPING INSTRUCTIONS: Return Cooler(s) ☐
Supplies Needed:

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will Apply):

OTHER INSTRUCTIONS:
Low-level DL for metals. Upload to Wireless Water. Ensure E. coli & total coliform DL of < 1 CFU/100 mL.

PAYMENT:
CHEQUE ☐
CREDIT ☐
DEBIT ☐
CASH ☐
INVOICE ☐

SAMPLE RECEIPT TEMP (°C): 9.4°C
Work Order #
CUSTODY SEAL INTACT Y ☐ N ☐ NA ☐

☒ 110-4011 Viking Way, Richmond, BC V6V 2K9
Tel: (604) 279-1499 Fax: (604) 279-1599
☐ 102-3677 Highway 97N, Kelowna, BC V1X 5C3
Tel: (250) 765-9646 Fax: (250) 765-3893
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CHAIN OF CUSTODY RECORD

COC# | PAGE 1 OF 1

RELINQUISHED BY:	DATE: Oct 26/18	RECEIVED BY:	DATE: Oct 26
	TIME: 1:00	Nabc MOVER	TIME: 3:30 pm

PROJECT: SCRD GW Investigation

PROJECT INFO: 2018-8152.000.003

REPORT TO:
COMPANY: Associated Environmental
ADDRESS: 200-2800 29th Street
Vernon, BC V1T 9P9
CONTACT: Nicole Penner 270
TEL/FAX: 250-545-3672 250-938-5537
EMAIL PDF ☒ EDD ☒
EMAIL 1: pennern@ae.ca; friesent@ae.ca
EMAIL 2: support@ wirelesswater.com
MAIL HARDCOPY ☐ HOLD FOR P/U ☐ FAX ☐

INVOICE TO: SAME AS REPORT TO ☒
COMPANY:
ADDRESS:
CONTACT:
TEL/FAX:
EMAIL PDF ☒
EMAIL 1: pennern@ae.ca
EMAIL 2: anzej@ae.ca
MAIL HARDCOPY ☐ HOLD FOR P/U ☐

SAMLPLED BY: Tony Friesen

PO #:

TURNAROUND TIME REQUESTED:
Routine: (5-7 Days) ☒
Rush: 1 Day* ☐ 2 Day* ☐ 3 Day* ☐
Other*
*Contact Lab To Confirm. Surcharge May Apply

REGULATORY APPLICATION:
Canadian Drinking Water Quality Guidelines ☒ CCME ☐
BC Drinking Water Protection Act / Reg. ☐ ALBERTA TIER 1 ☐
BC CSR ☐ AL ☐ RL ☐ CL ☐ IL ☐ AW ☐
OTHER:

ANALYSES REQUESTED:

CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	MATRIX: OTHER WATER	MATRIX: SOIL	MATRIX: OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	SAMPLING: TIME HH:MM	COMMENTS: CHLORINATED	COMMENTS: FILTERED	COMMENTS: PRESERVED	COMMENTS: (i.e. flow/volume media ID/notes)	BTEX ☐ VPH ☐ PHC F1 ☐	VOC ☐ VPH ☐	EPH ☐ PHC F2-F4 ☐	PAH ☐ L/HEPH ☐	PHENOLS ☐ Chlorinated ☐ Non-Chlor.	PCB ☐ GLYCOLS ☐ HAA ☐	PESTICIDES ☐ ACID HERBICIDES ☐	METALS - WATER TOTAL ☒ Hg	METALS - WATER DISSOLVED ☒ Hg	METALS - SOIL (SALM) ☐ inc. pH	pH ☒ EC ☒ ALK ☒	TSS ☐ VSS ☐ TDS ☒	BOD ☐ COD ☐	TOG ☐ MOG ☐	FECAL COLIFORMS ☐ HPC ☒	TOTAL COLIFORMS ☒ E.coli ☒	ASBESTOS	Iron & sulphate reducing bacteria	Total and organic nitrogen package	Chloride, fluoride, sulphate	Corrosivity (Langelier index)	Sulphide	Total organic carbon	Colour, turbidity, UV transmittance	HOLD
WIN 54929		✓				26-10-18	09:30				300 USgpm								✓	✓		✓	✓			✓	✓		✓	✓	✓	✓	✓	✓		

SHIPPING INSTRUCTIONS: Return Cooler(s) ☐
Supplies Needed:

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will Apply):

OTHER INSTRUCTIONS:
Low-level DL for metals. Upload to Wireless Water. Ensure E. coli & total coliform DL of < 1 CFU/100 mL.

PAYMENT:
CHEQUE ☐
CREDIT ☐
DEBIT ☐
CASH ☐
INVOICE ☐

SAMPLE RECEIPT TEMP (°C): 9.4°C
Work Order #
CUSTODY SEAL INTACT Y ☐ N ☐ NA ☐

CERTIFICATE OF ANALYSIS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon) #200 - 2800 29th Street Vernon, BC V1T 9P9		
ATTENTION	Nicole Penner	**WORK ORDER**	8102454
PO NUMBER		**RECEIVED / TEMP**	2018-10-26 15:29 / 9°C
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54
PROJECT INFO	SCRD GW Investigation		

Introduction:

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

Big Picture Sidekicks

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

We've Got Chemistry

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

Ahead of the Curve

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

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

Authorized By:

Eilish St.Clair, B.Sc., C.I.T.
Client Service Representative

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102454
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
WIN 54929 (8102454-01) | Matrix: Water | Sampled: 2018-10-26 09:30						
Anions						
Chloride	**21.5**	AO ≤ 250	0.10	mg/L	2018-11-01	
Fluoride	< 0.10	MAC = 1.5	0.10	mg/L	2018-11-01	
Nitrate+Nitrite (as N)	**0.242**	N/A	0.0050	mg/L	2018-10-31	
Sulfate	**2.2**	AO ≤ 500	1.0	mg/L	2018-11-01	
Biological Activity Reaction Tests						
Iron Related Bacteria	**8820**	N/A	2	CFU/mL	2018-10-30	HT1
Sulfate Reducing Bacteria	< 8	N/A	8	CFU/mL	2018-10-30	HT1
Calculated Parameters						
Hardness, Total (as CaCO3)	**66.8**	None Required	0.500	mg/L	N/A	
Langelier Index	**-1.6**	N/A	-5.0	-	2018-11-05	
Nitrogen, Total	**0.242**	N/A	0.0500	mg/L	N/A	
Nitrogen, Organic	< 0.0500	N/A	0.0500	mg/L	N/A	
Dissolved Metals						
Aluminum, dissolved	< 0.0050	N/A	0.0050	mg/L	2018-11-04	
Antimony, dissolved	< 0.00020	N/A	0.00020	mg/L	2018-11-04	
Arsenic, dissolved	< 0.00050	N/A	0.00050	mg/L	2018-11-04	
Barium, dissolved	< 0.0050	N/A	0.0050	mg/L	2018-11-04	
Beryllium, dissolved	< 0.00010	N/A	0.00010	mg/L	2018-11-04	
Bismuth, dissolved	< 0.00010	N/A	0.00010	mg/L	2018-11-04	
Boron, dissolved	**0.0107**	N/A	0.0050	mg/L	2018-11-04	
Cadmium, dissolved	< 0.000010	N/A	0.000010	mg/L	2018-11-04	
Calcium, dissolved	**17.9**	N/A	0.20	mg/L	2018-11-04	
Chromium, dissolved	< 0.00050	N/A	0.00050	mg/L	2018-11-04	
Cobalt, dissolved	< 0.00010	N/A	0.00010	mg/L	2018-11-04	
Copper, dissolved	**0.00288**	N/A	0.00040	mg/L	2018-11-04	
Iron, dissolved	**0.013**	N/A	0.010	mg/L	2018-11-04	
Lead, dissolved	< 0.00020	N/A	0.00020	mg/L	2018-11-04	
Lithium, dissolved	**0.00108**	N/A	0.00010	mg/L	2018-11-04	
Magnesium, dissolved	**5.37**	N/A	0.010	mg/L	2018-11-04	
Manganese, dissolved	**0.00076**	N/A	0.00020	mg/L	2018-11-04	
Mercury, dissolved	< 0.000010	N/A	0.000010	mg/L	2018-11-01	
Molybdenum, dissolved	**0.00037**	N/A	0.00010	mg/L	2018-11-04	
Nickel, dissolved	< 0.00040	N/A	0.00040	mg/L	2018-11-04	
Phosphorus, dissolved	< 0.050	N/A	0.050	mg/L	2018-11-04	
Potassium, dissolved	**1.55**	N/A	0.10	mg/L	2018-11-04	
Selenium, dissolved	< 0.00050	N/A	0.00050	mg/L	2018-11-04	
Silicon, dissolved	**11.0**	N/A	1.0	mg/L	2018-11-04	
Silver, dissolved	< 0.000050	N/A	0.000050	mg/L	2018-11-04	
Sodium, dissolved	**6.66**	N/A	0.10	mg/L	2018-11-04	
Strontium, dissolved	**0.0508**	N/A	0.0010	mg/L	2018-11-04	

TEST RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102454
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
WIN 54929 (8102454-01) | Matrix: Water | Sampled: 2018-10-26 09:30, Continued						
Dissolved Metals, Continued						
Sulfur, dissolved	< 3.0	N/A	3.0	mg/L	2018-11-04	
Tellurium, dissolved	< 0.00050	N/A	0.00050	mg/L	2018-11-04	
Thallium, dissolved	< 0.000020	N/A	0.000020	mg/L	2018-11-04	
Thorium, dissolved	< 0.00010	N/A	0.00010	mg/L	2018-11-04	
Tin, dissolved	< 0.00020	N/A	0.00020	mg/L	2018-11-04	
Titanium, dissolved	< 0.0050	N/A	0.0050	mg/L	2018-11-04	
Tungsten, dissolved	< 0.0010	N/A	0.0010	mg/L	2018-11-04	
Uranium, dissolved	**0.000091**	N/A	0.000020	mg/L	2018-11-04	
Vanadium, dissolved	**0.0012**	N/A	0.0010	mg/L	2018-11-04	
Zinc, dissolved	**0.0205**	N/A	0.0040	mg/L	2018-11-04	
Zirconium, dissolved	< 0.00010	N/A	0.00010	mg/L	2018-11-04	
General Parameters						
Alkalinity, Total (as CaCO3)	**52.2**	N/A	1.0	mg/L	2018-10-31	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2018-10-31	
Alkalinity, Bicarbonate (as CaCO3)	**52.2**	N/A	1.0	mg/L	2018-10-31	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2018-10-31	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2018-10-31	
Ammonia, Total (as N)	**0.021**	None Required	0.020	mg/L	2018-11-01	
Carbon, Total Organic	< 0.50	N/A	0.50	mg/L	2018-11-05	
Colour, True	< 5.0	AO ≤ 15	5.0	CU	2018-10-29	
Conductivity (EC)	**181**	N/A	2.0	µS/cm	2018-10-29	
Nitrogen, Total Kjeldahl	< 0.050	N/A	0.050	mg/L	2018-11-01	
pH	**7.01**	7.0-10.5	0.10	pH units	2018-10-30	HT2
Solids, Total Dissolved	**131**	AO ≤ 500	15	mg/L	2018-11-02	
Sulfide, Total	< 0.020	AO ≤ 0.05	0.020	mg/L	2018-11-01	
Turbidity	< 0.10	OG < 1	0.10	NTU	2018-10-29	
UV Transmittance @ 254nm	**99.6**	N/A	0.10	% T	2018-10-30	HT1
Total Metals						
Aluminum, total	**0.0068**	OG < 0.1	0.0050	mg/L	2018-11-03	
Antimony, total	< 0.00020	MAC = 0.006	0.00020	mg/L	2018-11-03	
Arsenic, total	< 0.00050	MAC = 0.01	0.00050	mg/L	2018-11-03	
Barium, total	< 0.0050	MAC = 1	0.0050	mg/L	2018-11-03	
Beryllium, total	< 0.00010	N/A	0.00010	mg/L	2018-11-03	
Bismuth, total	< 0.00010	N/A	0.00010	mg/L	2018-11-03	
Boron, total	**0.0374**	MAC = 5	0.0050	mg/L	2018-11-03	
Cadmium, total	< 0.000010	MAC = 0.005	0.000010	mg/L	2018-11-03	
Calcium, total	**17.7**	None Required	0.20	mg/L	2018-11-03	
Chromium, total	< 0.00050	MAC = 0.05	0.00050	mg/L	2018-11-03	
Cobalt, total	< 0.00010	N/A	0.00010	mg/L	2018-11-03	
Copper, total	**0.00308**	AO ≤ 1	0.00040	mg/L	2018-11-03	
Iron, total	**0.011**	AO ≤ 0.3	0.010	mg/L	2018-11-03	

TEST RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102454
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
WIN 54929 (8102454-01) | Matrix: Water | Sampled: 2018-10-26 09:30, Continued						
Total Metals, Continued						
Lead, total	< 0.00020	MAC = 0.01	0.00020	mg/L	2018-11-03	
Lithium, total	**0.00079**	N/A	0.00010	mg/L	2018-11-03	
Magnesium, total	**5.78**	None Required	0.010	mg/L	2018-11-03	
Manganese, total	**0.00074**	AO ≤ 0.05	0.00020	mg/L	2018-11-03	
Mercury, total	< 0.000010	MAC = 0.001	0.000010	mg/L	2018-11-01	
Molybdenum, total	**0.00050**	N/A	0.00010	mg/L	2018-11-03	
Nickel, total	< 0.00040	N/A	0.00040	mg/L	2018-11-03	
Phosphorus, total	< 0.050	N/A	0.050	mg/L	2018-11-03	
Potassium, total	**1.29**	N/A	0.10	mg/L	2018-11-03	
Selenium, total	< 0.00050	MAC = 0.05	0.00050	mg/L	2018-11-03	
Silicon, total	**9.7**	N/A	1.0	mg/L	2018-11-03	
Silver, total	< 0.000050	None Required	0.000050	mg/L	2018-11-03	
Sodium, total	**6.79**	AO ≤ 200	0.10	mg/L	2018-11-03	
Strontium, total	**0.0533**	N/A	0.0010	mg/L	2018-11-03	
Sulfur, total	< 3.0	N/A	3.0	mg/L	2018-11-03	
Tellurium, total	< 0.00050	N/A	0.00050	mg/L	2018-11-03	
Thallium, total	< 0.000020	N/A	0.000020	mg/L	2018-11-03	
Thorium, total	< 0.00010	N/A	0.00010	mg/L	2018-11-03	
Tin, total	< 0.00020	N/A	0.00020	mg/L	2018-11-03	
Titanium, total	< 0.0050	N/A	0.0050	mg/L	2018-11-03	
Tungsten, total	< 0.0010	N/A	0.0010	mg/L	2018-11-03	
Uranium, total	**0.000091**	MAC = 0.02	0.000020	mg/L	2018-11-03	
Vanadium, total	**0.0015**	N/A	0.0010	mg/L	2018-11-03	
Zinc, total	**0.0205**	AO ≤ 5	0.0040	mg/L	2018-11-03	
Zirconium, total	< 0.00010	N/A	0.00010	mg/L	2018-11-03	
Microbiological Parameters						
Coliforms, Total	<1	MAC = 0	1	CFU/100 mL	2018-10-27	
Heterotrophic Plate Count	<1	N/A	1	CFU/mL	2018-10-27	
E. coli (MF)	<1	N/A	1	CFU/100 mL	2018-10-27	

Sample Qualifiers:

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

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

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102454
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54

Analysis Description	Method Ref.	Technique	Location
Alkalinity in Water	SM 2320 B* (2011)	Titration with H2SO4	Kelowna
Ammonia, Total in Water	SM 4500-NH3 G* (2011)	Automated Colorimetry (Phenate)	Kelowna
Anions in Water	SM 4110 B (2011)	Ion Chromatography	Kelowna
Carbon, Total Organic in Water	SM 5310 B (2011)	Combustion, Infrared CO2 Detection	Kelowna
Coliforms, Total in Water	SM 9222 (2006)	Membrane Filtration	Sublet
Colour, True in Water	SM 2120 C (2011)	Spectrophotometry (456 nm)	Kelowna
Conductivity in Water	SM 2510 B (2011)	Conductivity Meter	Richmond
Dissolved Metals in Water	EPA 200.8 / EPA 6020B	0.45 µm Filtration / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	Richmond
E. coli in Water	SM 9223 B (2004)	Enzyme Substrate Endo Agar	Sublet
Hardness in Water	SM 2340 B (2011)	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	N/A
Heterotrophic Plate Count in Water	SM 9215 B (2004)	Pour Plate	Sublet
Iron Related Bacteria in Water	DBI DBISOP06	Biological Activity Reaction Test	Kelowna
Langelier Index in Water	SM 2330 B (2010)	Calculation	N/A
Mercury, dissolved in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Nitrate+Nitrite in Water	SM 4500-NO3- F (2011)	Automated Colorimetry (Cadmium Reduction)	Kelowna
Nitrogen, Total Kjeldahl in Water	SM 4500-Norg D* (2011)	Block Digestion and Flow Injection Analysis	Kelowna
pH in Water	SM 4500-H+ B (2011)	Electrometry	Richmond
Solids, Total Dissolved in Water	SM 2540 C* (2011)	Gravimetry (Dried at 103-105C)	Kelowna
Sulfate Reducing Bacteria in Water	DBI DBSLW05	Biological Activity Reaction Test	Kelowna
Sulfide, Total in Water	SM 4500-S2 D* (2011)	Colorimetry (Methylene Blue)	Edmonton
Total Metals in Water	EPA 200.2* / EPA 6020B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	Richmond
Transmittance at 254 nm in Water	SM 5910 B* (2013)	Ultraviolet Absorption	Kelowna
Turbidity in Water	SM 2130 B (2011)	Nephelometry	Richmond

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

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PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54

Glossary of Terms:

RL	Reporting Limit (default)
% T	Percent Transmittance
<	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
<1	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
AO	Aesthetic Objective
CFU/100 mL	Colony Forming Units per 100 millilitres
CFU/mL	Colony Forming Units per millilitre
CU	Colour Units (referenced against a platinum cobalt standard)
MAC	Maximum Acceptable Concentration (health based)
mg/L	Milligrams per litre
NTU	Nephelometric Turbidity Units
OG	Operational Guideline (treated water)
pH units	pH < 7 = acidic, ph > 7 = basic
µS/cm	Microsiemens per centimetre
DBI	Drycon Bioconcepts Inc. Biological Activity Reaction Tests
EPA	United States Environmental Protection Agency Test Methods
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

General Comments:

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

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102454
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54

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

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

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

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Anions, Batch B8J2128										
Blank (B8J2128-BLK1)				Prepared: 2018-10-31, Analyzed: 2018-10-31						
Nitrate+Nitrite (as N)	< 0.0100	0.0100	mg/L							
Blank (B8J2128-BLK2)				Prepared: 2018-10-31, Analyzed: 2018-10-31						
Nitrate+Nitrite (as N)	< 0.0100	0.0100	mg/L							
LCS (B8J2128-BS1)				Prepared: 2018-10-31, Analyzed: 2018-10-31						
Nitrate+Nitrite (as N)	0.483	0.0100	mg/L	0.500		97	91-108			
LCS (B8J2128-BS2)				Prepared: 2018-10-31, Analyzed: 2018-10-31						
Nitrate+Nitrite (as N)	0.496	0.0100	mg/L	0.500		99	91-108			
Duplicate (B8J2128-DUP2)		**Source: 8102454-01**		Prepared: 2018-10-31, Analyzed: 2018-10-31						
Nitrate+Nitrite (as N)	0.242	0.0050	mg/L		0.242			< 1	10	
Matrix Spike (B8J2128-MS2)		**Source: 8102454-01**		Prepared: 2018-10-31, Analyzed: 2018-10-31						
Nitrate+Nitrite (as N)	0.373	0.0100	mg/L	0.125	0.242	105	80-120			
Anions, Batch B8J2373										
Blank (B8J2373-BLK1)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Chloride	< 0.10	0.10	mg/L							
Fluoride	< 0.10	0.10	mg/L							
Sulfate	< 1.0	1.0	mg/L							
Blank (B8J2373-BLK2)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Chloride	< 0.10	0.10	mg/L							
Fluoride	< 0.10	0.10	mg/L							
Sulfate	< 1.0	1.0	mg/L							
LCS (B8J2373-BS1)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Chloride	16.2	0.10	mg/L	16.0		101	90-110			
Fluoride	4.15	0.10	mg/L	4.00		104	88-108			
Sulfate	16.4	1.0	mg/L	16.0		103	91-109			
LCS (B8J2373-BS2)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Chloride	16.1	0.10	mg/L	16.0		101	90-110			

APPENDIX 2: QUALITY CONTROL RESULTS

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PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Anions, Batch B8J2373, Continued										
LCS (B8J2373-BS2), Continued				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Fluoride	4.08	0.10	mg/L	4.00		102	88-108			
Sulfate	16.5	1.0	mg/L	16.0		103	91-109			
Biological Activity Reaction Tests, Batch B8J2286										
Blank (B8J2286-BLK1)				Prepared: 2018-10-30, Analyzed: 2018-10-30						
Iron Related Bacteria	< 2	2	CFU/mL							
Duplicate (B8J2286-DUP1)		**Source: 8102454-01**		Prepared: 2018-10-30, Analyzed: 2018-10-30						
Iron Related Bacteria	8820	2	CFU/mL		8820			< 1	171	
Biological Activity Reaction Tests, Batch B8J2288										
Blank (B8J2288-BLK1)				Prepared: 2018-10-30, Analyzed: 2018-10-30						
Sulfate Reducing Bacteria	< 8	8	CFU/mL							
Duplicate (B8J2288-DUP1)		**Source: 8102454-01**		Prepared: 2018-10-30, Analyzed: 2018-10-30						
Sulfate Reducing Bacteria	< 8	8	CFU/mL		< 8				121	
Dissolved Metals, Batch B8K0096										
Blank (B8K0096-BLK1)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Mercury, dissolved	< 0.000010	0.000010	mg/L							
Blank (B8K0096-BLK2)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Mercury, dissolved	< 0.000010	0.000010	mg/L							
Reference (B8K0096-SRM1)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Mercury, dissolved	0.00502	0.000010	mg/L	0.00489		103	80-120			
Reference (B8K0096-SRM2)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Mercury, dissolved	0.00468	0.000010	mg/L	0.00489		96	80-120			
Dissolved Metals, Batch B8K0199										
Blank (B8K0199-BLK1)				Prepared: 2018-11-04, Analyzed: 2018-11-04						
Aluminum, dissolved	< 0.0050	0.0050	mg/L							
Antimony, dissolved	< 0.00020	0.00020	mg/L							
Arsenic, dissolved	< 0.00050	0.00050	mg/L							
Barium, dissolved	< 0.0050	0.0050	mg/L							
Beryllium, dissolved	< 0.00010	0.00010	mg/L							
Bismuth, dissolved	< 0.00010	0.00010	mg/L							
Boron, dissolved	< 0.0050	0.0050	mg/L							
Cadmium, dissolved	< 0.000010	0.000010	mg/L							
Calcium, dissolved	< 0.20	0.20	mg/L							
Chromium, dissolved	< 0.00050	0.00050	mg/L							
Cobalt, dissolved	< 0.00010	0.00010	mg/L							
Copper, dissolved	< 0.00040	0.00040	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.00020	0.00020	mg/L							
Lithium, dissolved	< 0.00010	0.00010	mg/L							
Magnesium, dissolved	< 0.010	0.010	mg/L							
Manganese, dissolved	< 0.00020	0.00020	mg/L							
Molybdenum, dissolved	< 0.00010	0.00010	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102454
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Dissolved Metals, Batch B8K0199, Continued										
Blank (B8K0199-BLK1), Continued				Prepared: 2018-11-04, Analyzed: 2018-11-04						
Nickel, dissolved	< 0.00040	0.00040	mg/L							
Phosphorus, dissolved	< 0.050	0.050	mg/L							
Potassium, dissolved	< 0.10	0.10	mg/L							
Selenium, dissolved	< 0.00050	0.00050	mg/L							
Silicon, dissolved	< 1.0	1.0	mg/L							
Silver, dissolved	< 0.000050	0.000050	mg/L							
Sodium, dissolved	< 0.10	0.10	mg/L							
Strontium, dissolved	< 0.0010	0.0010	mg/L							
Sulfur, dissolved	< 3.0	3.0	mg/L							
Tellurium, dissolved	< 0.00050	0.00050	mg/L							
Thallium, dissolved	< 0.000020	0.000020	mg/L							
Thorium, dissolved	< 0.00010	0.00010	mg/L							
Tin, dissolved	< 0.00020	0.00020	mg/L							
Titanium, dissolved	< 0.0050	0.0050	mg/L							
Tungsten, dissolved	< 0.0010	0.0010	mg/L							
Uranium, dissolved	< 0.000020	0.000020	mg/L							
Vanadium, dissolved	< 0.0010	0.0010	mg/L							
Zinc, dissolved	< 0.0040	0.0040	mg/L							
Zirconium, dissolved	< 0.00010	0.00010	mg/L							
Blank (B8K0199-BLK2)				Prepared: 2018-11-04, Analyzed: 2018-11-04						
Aluminum, dissolved	< 0.0050	0.0050	mg/L							
Antimony, dissolved	< 0.00020	0.00020	mg/L							
Arsenic, dissolved	< 0.00050	0.00050	mg/L							
Barium, dissolved	< 0.0050	0.0050	mg/L							
Beryllium, dissolved	< 0.00010	0.00010	mg/L							
Bismuth, dissolved	< 0.00010	0.00010	mg/L							
Boron, dissolved	< 0.0050	0.0050	mg/L							
Cadmium, dissolved	< 0.000010	0.000010	mg/L							
Calcium, dissolved	< 0.20	0.20	mg/L							
Chromium, dissolved	< 0.00050	0.00050	mg/L							
Cobalt, dissolved	< 0.00010	0.00010	mg/L							
Copper, dissolved	< 0.00040	0.00040	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.00020	0.00020	mg/L							
Lithium, dissolved	< 0.00010	0.00010	mg/L							
Magnesium, dissolved	< 0.010	0.010	mg/L							
Manganese, dissolved	< 0.00020	0.00020	mg/L							
Molybdenum, dissolved	< 0.00010	0.00010	mg/L							
Nickel, dissolved	< 0.00040	0.00040	mg/L							
Phosphorus, dissolved	< 0.050	0.050	mg/L							
Potassium, dissolved	< 0.10	0.10	mg/L							
Selenium, dissolved	< 0.00050	0.00050	mg/L							
Silicon, dissolved	< 1.0	1.0	mg/L							
Silver, dissolved	< 0.000050	0.000050	mg/L							
Sodium, dissolved	< 0.10	0.10	mg/L							
Strontium, dissolved	< 0.0010	0.0010	mg/L							
Sulfur, dissolved	< 3.0	3.0	mg/L							
Tellurium, dissolved	< 0.00050	0.00050	mg/L							
Thallium, dissolved	< 0.000020	0.000020	mg/L							
Thorium, dissolved	< 0.00010	0.00010	mg/L							
Tin, dissolved	< 0.00020	0.00020	mg/L							
Titanium, dissolved	< 0.0050	0.0050	mg/L							
Tungsten, dissolved	< 0.0010	0.0010	mg/L							
Uranium, dissolved	< 0.000020	0.000020	mg/L							
Vanadium, dissolved	< 0.0010	0.0010	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102454
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Dissolved Metals, Batch B8K0199, Continued										
Blank (B8K0199-BLK2), Continued				Prepared: 2018-11-04, Analyzed: 2018-11-04						
Zinc, dissolved	< 0.0040	0.0040	mg/L							
Zirconium, dissolved	< 0.00010	0.00010	mg/L							
Blank (B8K0199-BLK3)				Prepared: 2018-11-04, Analyzed: 2018-11-04						
Aluminum, dissolved	< 0.0050	0.0050	mg/L							
Antimony, dissolved	< 0.00020	0.00020	mg/L							
Arsenic, dissolved	< 0.00050	0.00050	mg/L							
Barium, dissolved	< 0.0050	0.0050	mg/L							
Beryllium, dissolved	< 0.00010	0.00010	mg/L							
Bismuth, dissolved	< 0.00010	0.00010	mg/L							
Boron, dissolved	< 0.0050	0.0050	mg/L							
Cadmium, dissolved	< 0.000010	0.000010	mg/L							
Calcium, dissolved	< 0.20	0.20	mg/L							
Chromium, dissolved	< 0.00050	0.00050	mg/L							
Cobalt, dissolved	< 0.00010	0.00010	mg/L							
Copper, dissolved	< 0.00040	0.00040	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.00020	0.00020	mg/L							
Lithium, dissolved	< 0.00010	0.00010	mg/L							
Magnesium, dissolved	< 0.010	0.010	mg/L							
Manganese, dissolved	< 0.00020	0.00020	mg/L							
Molybdenum, dissolved	< 0.00010	0.00010	mg/L							
Nickel, dissolved	< 0.00040	0.00040	mg/L							
Phosphorus, dissolved	< 0.050	0.050	mg/L							
Potassium, dissolved	< 0.10	0.10	mg/L							
Selenium, dissolved	< 0.00050	0.00050	mg/L							
Silicon, dissolved	< 1.0	1.0	mg/L							
Silver, dissolved	< 0.000050	0.000050	mg/L							
Sodium, dissolved	< 0.10	0.10	mg/L							
Strontium, dissolved	< 0.0010	0.0010	mg/L							
Sulfur, dissolved	< 3.0	3.0	mg/L							
Tellurium, dissolved	< 0.00050	0.00050	mg/L							
Thallium, dissolved	< 0.000020	0.000020	mg/L							
Thorium, dissolved	< 0.00010	0.00010	mg/L							
Tin, dissolved	< 0.00020	0.00020	mg/L							
Titanium, dissolved	< 0.0050	0.0050	mg/L							
Tungsten, dissolved	< 0.0010	0.0010	mg/L							
Uranium, dissolved	< 0.000020	0.000020	mg/L							
Vanadium, dissolved	< 0.0010	0.0010	mg/L							
Zinc, dissolved	< 0.0040	0.0040	mg/L							
Zirconium, dissolved	< 0.00010	0.00010	mg/L							
LCS (B8K0199-BS1)				Prepared: 2018-11-04, Analyzed: 2018-11-04						
Aluminum, dissolved	0.0223	0.0050	mg/L	0.0200		111	80-120			
Antimony, dissolved	0.0198	0.00020	mg/L	0.0200		99	80-120			
Arsenic, dissolved	0.0204	0.00050	mg/L	0.0200		102	80-120			
Barium, dissolved	0.0185	0.0050	mg/L	0.0200		93	80-120			
Beryllium, dissolved	0.0200	0.00010	mg/L	0.0200		100	80-120			
Bismuth, dissolved	0.0192	0.00010	mg/L	0.0200		96	80-120			
Boron, dissolved	0.0194	0.0050	mg/L	0.0200		97	80-120			
Cadmium, dissolved	0.0194	0.000010	mg/L	0.0200		97	80-120			
Calcium, dissolved	2.10	0.20	mg/L	2.00		105	80-120			
Chromium, dissolved	0.0198	0.00050	mg/L	0.0200		99	80-120			
Cobalt, dissolved	0.0198	0.00010	mg/L	0.0200		99	80-120			
Copper, dissolved	0.0188	0.00040	mg/L	0.0200		94	80-120			
Iron, dissolved	2.00	0.010	mg/L	2.00		100	80-120			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102454
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Dissolved Metals, Batch B8K0199, Continued										
LCS (B8K0199-BS1), Continued				Prepared: 2018-11-04, Analyzed: 2018-11-04						
Lead, dissolved	0.0197	0.00020	mg/L	0.0200		98	80-120			
Lithium, dissolved	0.0206	0.00010	mg/L	0.0200		103	80-120			
Magnesium, dissolved	2.03	0.010	mg/L	2.00		102	80-120			
Manganese, dissolved	0.0184	0.00020	mg/L	0.0200		92	80-120			
Molybdenum, dissolved	0.0191	0.00010	mg/L	0.0200		95	80-120			
Nickel, dissolved	0.0205	0.00040	mg/L	0.0200		103	80-120			
Phosphorus, dissolved	2.06	0.050	mg/L	2.00		103	80-120			
Potassium, dissolved	1.97	0.10	mg/L	2.00		98	80-120			
Selenium, dissolved	0.0206	0.00050	mg/L	0.0200		103	80-120			
Silicon, dissolved	2.3	1.0	mg/L	2.00		113	80-120			
Silver, dissolved	0.0183	0.000050	mg/L	0.0200		92	80-120			
Sodium, dissolved	1.97	0.10	mg/L	2.00		98	80-120			
Strontium, dissolved	0.0175	0.0010	mg/L	0.0200		88	80-120			
Sulfur, dissolved	4.4	3.0	mg/L	5.00		88	80-120			
Tellurium, dissolved	0.0201	0.00050	mg/L	0.0200		101	80-120			
Thallium, dissolved	0.0199	0.000020	mg/L	0.0200		99	80-120			
Thorium, dissolved	0.0177	0.00010	mg/L	0.0200		88	80-120			
Tin, dissolved	0.0204	0.00020	mg/L	0.0200		102	80-120			
Titanium, dissolved	0.0222	0.0050	mg/L	0.0200		111	80-120			
Tungsten, dissolved	0.0173	0.0010	mg/L	0.0200		86	80-120			
Uranium, dissolved	0.0184	0.000020	mg/L	0.0200		92	80-120			
Vanadium, dissolved	0.0198	0.0010	mg/L	0.0200		99	80-120			
Zinc, dissolved	0.0181	0.0040	mg/L	0.0200		91	80-120			
Zirconium, dissolved	0.0222	0.00010	mg/L	0.0200		111	80-120			
Reference (B8K0199-SRM1)				Prepared: 2018-11-04, Analyzed: 2018-11-04						
Aluminum, dissolved	0.237	0.0050	mg/L	0.233		102	79-114			
Antimony, dissolved	0.0458	0.00020	mg/L	0.0430		106	89-123			
Arsenic, dissolved	0.446	0.00050	mg/L	0.438		102	87-113			
Barium, dissolved	3.54	0.0050	mg/L	3.35		106	85-114			
Beryllium, dissolved	0.232	0.00010	mg/L	0.213		109	79-122			
Boron, dissolved	1.80	0.0050	mg/L	1.74		103	79-117			
Cadmium, dissolved	0.216	0.000010	mg/L	0.224		96	89-112			
Calcium, dissolved	7.57	0.20	mg/L	7.69		98	85-120			
Chromium, dissolved	0.460	0.00050	mg/L	0.437		105	87-113			
Cobalt, dissolved	0.124	0.00010	mg/L	0.128		97	90-117			
Copper, dissolved	0.876	0.00040	mg/L	0.844		104	90-115			
Iron, dissolved	1.30	0.010	mg/L	1.29		101	86-112			
Lead, dissolved	0.113	0.00020	mg/L	0.112		101	90-113			
Lithium, dissolved	0.106	0.00010	mg/L	0.104		102	77-127			
Magnesium, dissolved	6.65	0.010	mg/L	6.92		96	84-116			
Manganese, dissolved	0.307	0.00020	mg/L	0.345		89	85-113			
Molybdenum, dissolved	0.401	0.00010	mg/L	0.426		94	87-112			
Nickel, dissolved	0.936	0.00040	mg/L	0.840		111	90-114			
Phosphorus, dissolved	0.523	0.050	mg/L	0.495		106	74-119			
Potassium, dissolved	3.23	0.10	mg/L	3.19		101	78-119			
Selenium, dissolved	0.0360	0.00050	mg/L	0.0331		109	89-123			
Sodium, dissolved	19.3	0.10	mg/L	19.1		101	81-117			
Strontium, dissolved	0.866	0.0010	mg/L	0.916		95	82-111			
Thallium, dissolved	0.0383	0.000020	mg/L	0.0393		97	90-113			
Uranium, dissolved	0.254	0.000020	mg/L	0.266		95	87-113			
Vanadium, dissolved	0.932	0.0010	mg/L	0.869		107	85-110			
Zinc, dissolved	0.771	0.0040	mg/L	0.881		88	88-114			

General Parameters, Batch B8J2184

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102454
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B8J2184, Continued										
Blank (B8J2184-BLK1)				Prepared: 2018-10-29, Analyzed: 2018-10-29						
Colour, True	< 5.0	5.0	CU							
Blank (B8J2184-BLK2)				Prepared: 2018-10-29, Analyzed: 2018-10-29						
Colour, True	< 5.0	5.0	CU							
LCS (B8J2184-BS1)				Prepared: 2018-10-29, Analyzed: 2018-10-29						
Colour, True	11	5.0	CU	10.0		109	85-115			
LCS (B8J2184-BS2)				Prepared: 2018-10-29, Analyzed: 2018-10-29						
Colour, True	11	5.0	CU	10.0		105	85-115			
General Parameters, Batch B8J2212										
Blank (B8J2212-BLK1)				Prepared: 2018-10-29, Analyzed: 2018-10-29						
Conductivity (EC)	< 2.0	2.0	µS/cm							
LCS (B8J2212-BS1)				Prepared: 2018-10-29, Analyzed: 2018-10-29						
Conductivity (EC)	148	2.0	µS/cm	147		101	90-110			
Reference (B8J2212-SRM1)				Prepared: 2018-10-29, Analyzed: 2018-10-29						
Conductivity (EC)	1020	2.0	µS/cm	1000		102	95-105			
General Parameters, Batch B8J2221										
Blank (B8J2221-BLK1)				Prepared: 2018-11-05, Analyzed: 2018-11-05						
Carbon, Total Organic	< 0.50	0.50	mg/L							
Blank (B8J2221-BLK2)				Prepared: 2018-11-05, Analyzed: 2018-11-05						
Carbon, Total Organic	< 0.50	0.50	mg/L							
Blank (B8J2221-BLK3)				Prepared: 2018-11-05, Analyzed: 2018-11-05						
Carbon, Total Organic	< 0.50	0.50	mg/L							
Blank (B8J2221-BLK4)				Prepared: 2018-11-05, Analyzed: 2018-11-05						
Carbon, Total Organic	< 0.50	0.50	mg/L							
LCS (B8J2221-BS1)				Prepared: 2018-11-05, Analyzed: 2018-11-05						
Carbon, Total Organic	9.59	0.50	mg/L	10.0		96	78-116			
LCS (B8J2221-BS2)				Prepared: 2018-11-05, Analyzed: 2018-11-05						
Carbon, Total Organic	9.05	0.50	mg/L	10.0		90	78-116			
LCS (B8J2221-BS3)				Prepared: 2018-11-05, Analyzed: 2018-11-05						
Carbon, Total Organic	9.07	0.50	mg/L	10.0		91	78-116			
LCS (B8J2221-BS4)				Prepared: 2018-11-05, Analyzed: 2018-11-05						
Carbon, Total Organic	9.94	0.50	mg/L	10.0		99	78-116			
General Parameters, Batch B8J2269										
Blank (B8J2269-BLK1)				Prepared: 2018-10-29, Analyzed: 2018-10-29						
Turbidity	< 0.10	0.10	NTU							
Duplicate (B8J2269-DUP1)		**Source: 8102454-01**		Prepared: 2018-10-29, Analyzed: 2018-10-29						
Turbidity	< 0.10	0.10	NTU		< 0.10				18	

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102454
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B8J2295										
Reference (B8J2295-SRM1)				Prepared: 2018-10-30, Analyzed: 2018-10-30						
pH	6.18	0.10	pH units	6.20		100	97.5-102.5			
Reference (B8J2295-SRM2)				Prepared: 2018-10-30, Analyzed: 2018-10-30						
pH	6.23	0.10	pH units	6.20		100	97.5-102.5			
General Parameters, Batch B8J2304										
Blank (B8J2304-BLK1)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Ammonia, Total (as N)	< 0.020	0.020	mg/L							
Blank (B8J2304-BLK2)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Ammonia, Total (as N)	< 0.020	0.020	mg/L							
Blank (B8J2304-BLK3)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Ammonia, Total (as N)	< 0.020	0.020	mg/L							
LCS (B8J2304-BS1)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Ammonia, Total (as N)	1.02	0.020	mg/L	1.00		102	90-115			
LCS (B8J2304-BS2)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Ammonia, Total (as N)	1.02	0.020	mg/L	1.00		102	90-115			
LCS (B8J2304-BS3)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Ammonia, Total (as N)	0.992	0.020	mg/L	1.00		99	90-115			
Duplicate (B8J2304-DUP3)		**Source: 8102454-01**		Prepared: 2018-11-01, Analyzed: 2018-11-01						
Ammonia, Total (as N)	0.022	0.020	mg/L		0.021				15	
Matrix Spike (B8J2304-MS3)		**Source: 8102454-01**		Prepared: 2018-11-01, Analyzed: 2018-11-01						
Ammonia, Total (as N)	0.264	0.020	mg/L	0.250	0.021	97	75-125			
General Parameters, Batch B8J2315										
Blank (B8J2315-BLK1)				Prepared: 2018-10-30, Analyzed: 2018-10-30						
UV Transmittance @ 254nm	< 0.10	0.10	% T							
LCS (B8J2315-BS1)				Prepared: 2018-10-30, Analyzed: 2018-10-30						
UV Transmittance @ 254nm	46.7	0.10	% T	46.5		100	98-103			
General Parameters, Batch B8J2381										
Blank (B8J2381-BLK1)				Prepared: 2018-10-31, Analyzed: 2018-11-01						
Nitrogen, Total Kjeldahl	< 0.050	0.050	mg/L							
Blank (B8J2381-BLK2)				Prepared: 2018-10-31, Analyzed: 2018-11-01						
Nitrogen, Total Kjeldahl	< 0.050	0.050	mg/L							
LCS (B8J2381-BS1)				Prepared: 2018-10-31, Analyzed: 2018-11-01						
Nitrogen, Total Kjeldahl	1.07	0.050	mg/L	1.00		107	84-121			
LCS (B8J2381-BS2)				Prepared: 2018-10-31, Analyzed: 2018-11-01						
Nitrogen, Total Kjeldahl	1.07	0.050	mg/L	1.00		107	84-121			
General Parameters, Batch B8J2383										

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102454
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B8J2383, Continued										
Blank (B8J2383-BLK1)				Prepared: 2018-10-31, Analyzed: 2018-10-31						
Alkalinity, Total (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1.0	1.0	mg/L							
Blank (B8J2383-BLK2)				Prepared: 2018-10-31, Analyzed: 2018-10-31						
Alkalinity, Total (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1.0	1.0	mg/L							
LCS (B8J2383-BS1)				Prepared: 2018-10-31, Analyzed: 2018-10-31						
Alkalinity, Total (as CaCO3)	103	1.0	mg/L	100		103	92-106			
LCS (B8J2383-BS2)				Prepared: 2018-10-31, Analyzed: 2018-10-31						
Alkalinity, Total (as CaCO3)	105	1.0	mg/L	100		105	92-106			
Duplicate (B8J2383-DUP2)		**Source: 8102454-01**		Prepared: 2018-10-31, Analyzed: 2018-10-31						
Alkalinity, Total (as CaCO3)	53.5	1.0	mg/L		52.2			2	10	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	1.0	mg/L		< 1.0				10	
Alkalinity, Bicarbonate (as CaCO3)	53.5	1.0	mg/L		52.2			2	10	
Alkalinity, Carbonate (as CaCO3)	< 1.0	1.0	mg/L		< 1.0				10	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	1.0	mg/L		< 1.0				10	
General Parameters, Batch B8K0090										
Blank (B8K0090-BLK1)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Sulfide, Total	< 0.020	0.020	mg/L							
LCS (B8K0090-BS1)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Sulfide, Total	0.461	0.020	mg/L	0.500		92	82-116			
General Parameters, Batch B8K0138										
Blank (B8K0138-BLK1)				Prepared: 2018-11-02, Analyzed: 2018-11-02						
Solids, Total Dissolved	< 15	15	mg/L							
LCS (B8K0138-BS1)				Prepared: 2018-11-02, Analyzed: 2018-11-02						
Solids, Total Dissolved	234	15	mg/L	240		98	85-115			
Total Metals, Batch B8K0005										
Blank (B8K0005-BLK1)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Mercury, total	< 0.000010	0.000010	mg/L							
Blank (B8K0005-BLK2)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Mercury, total	< 0.000010	0.000010	mg/L							
Reference (B8K0005-SRM1)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Mercury, total	0.00534	0.000010	mg/L	0.00489		109	80-120			
Reference (B8K0005-SRM2)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Mercury, total	0.00502	0.000010	mg/L	0.00489		103	80-120			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102454
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Total Metals, Batch B8K0113										
Blank (B8K0113-BLK1)				Prepared: 2018-11-01, Analyzed: 2018-11-03						
Aluminum, total	< 0.0050	0.0050	mg/L							
Antimony, total	< 0.00020	0.00020	mg/L							
Arsenic, total	< 0.00050	0.00050	mg/L							
Barium, total	< 0.0050	0.0050	mg/L							
Beryllium, total	< 0.00010	0.00010	mg/L							
Bismuth, total	< 0.00010	0.00010	mg/L							
Boron, total	< 0.0050	0.0050	mg/L							
Cadmium, total	< 0.000010	0.000010	mg/L							
Calcium, total	< 0.20	0.20	mg/L							
Chromium, total	< 0.00050	0.00050	mg/L							
Cobalt, total	< 0.00010	0.00010	mg/L							
Copper, total	< 0.00040	0.00040	mg/L							
Iron, total	< 0.010	0.010	mg/L							
Lead, total	< 0.00020	0.00020	mg/L							
Lithium, total	< 0.00010	0.00010	mg/L							
Magnesium, total	< 0.010	0.010	mg/L							
Manganese, total	< 0.00020	0.00020	mg/L							
Molybdenum, total	< 0.00010	0.00010	mg/L							
Nickel, total	< 0.00040	0.00040	mg/L							
Phosphorus, total	< 0.050	0.050	mg/L							
Potassium, total	< 0.10	0.10	mg/L							
Selenium, total	< 0.00050	0.00050	mg/L							
Silicon, total	< 1.0	1.0	mg/L							
Silver, total	< 0.000050	0.000050	mg/L							
Sodium, total	< 0.10	0.10	mg/L							
Strontium, total	< 0.0010	0.0010	mg/L							
Sulfur, total	< 3.0	3.0	mg/L							
Tellurium, total	< 0.00050	0.00050	mg/L							
Thallium, total	< 0.000020	0.000020	mg/L							
Thorium, total	< 0.00010	0.00010	mg/L							
Tin, total	< 0.00020	0.00020	mg/L							
Titanium, total	< 0.0050	0.0050	mg/L							
Tungsten, total	< 0.0010	0.0010	mg/L							
Uranium, total	< 0.000020	0.000020	mg/L							
Vanadium, total	< 0.0010	0.0010	mg/L							
Zinc, total	< 0.0040	0.0040	mg/L							
Zirconium, total	< 0.00010	0.00010	mg/L							
Blank (B8K0113-BLK2)				Prepared: 2018-11-01, Analyzed: 2018-11-03						
Aluminum, total	< 0.0050	0.0050	mg/L							
Antimony, total	< 0.00020	0.00020	mg/L							
Arsenic, total	< 0.00050	0.00050	mg/L							
Barium, total	< 0.0050	0.0050	mg/L							
Beryllium, total	< 0.00010	0.00010	mg/L							
Bismuth, total	< 0.00010	0.00010	mg/L							
Boron, total	< 0.0050	0.0050	mg/L							
Cadmium, total	< 0.000010	0.000010	mg/L							
Calcium, total	< 0.20	0.20	mg/L							
Chromium, total	< 0.00050	0.00050	mg/L							
Cobalt, total	< 0.00010	0.00010	mg/L							
Copper, total	< 0.00040	0.00040	mg/L							
Iron, total	< 0.010	0.010	mg/L							
Lead, total	< 0.00020	0.00020	mg/L							
Lithium, total	< 0.00010	0.00010	mg/L							
Magnesium, total	< 0.010	0.010	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102454
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Total Metals, Batch B8K0113, Continued										
Blank (B8K0113-BLK2), Continued				Prepared: 2018-11-01, Analyzed: 2018-11-03						
Manganese, total	< 0.00020	0.00020	mg/L							
Molybdenum, total	< 0.00010	0.00010	mg/L							
Nickel, total	< 0.00040	0.00040	mg/L							
Phosphorus, total	< 0.050	0.050	mg/L							
Potassium, total	< 0.10	0.10	mg/L							
Selenium, total	< 0.00050	0.00050	mg/L							
Silicon, total	< 1.0	1.0	mg/L							
Silver, total	< 0.000050	0.000050	mg/L							
Sodium, total	< 0.10	0.10	mg/L							
Strontium, total	< 0.0010	0.0010	mg/L							
Sulfur, total	< 3.0	3.0	mg/L							
Tellurium, total	< 0.00050	0.00050	mg/L							
Thallium, total	< 0.000020	0.000020	mg/L							
Thorium, total	< 0.00010	0.00010	mg/L							
Tin, total	< 0.00020	0.00020	mg/L							
Titanium, total	< 0.0050	0.0050	mg/L							
Tungsten, total	< 0.0010	0.0010	mg/L							
Uranium, total	< 0.000020	0.000020	mg/L							
Vanadium, total	< 0.0010	0.0010	mg/L							
Zinc, total	< 0.0040	0.0040	mg/L							
Zirconium, total	< 0.00010	0.00010	mg/L							
Blank (B8K0113-BLK3)				Prepared: 2018-11-01, Analyzed: 2018-11-03						
Aluminum, total	< 0.0050	0.0050	mg/L							
Antimony, total	< 0.00020	0.00020	mg/L							
Arsenic, total	< 0.00050	0.00050	mg/L							
Barium, total	< 0.0050	0.0050	mg/L							
Beryllium, total	< 0.00010	0.00010	mg/L							
Bismuth, total	< 0.00010	0.00010	mg/L							
Boron, total	< 0.0050	0.0050	mg/L							
Cadmium, total	< 0.000010	0.000010	mg/L							
Calcium, total	< 0.20	0.20	mg/L							
Chromium, total	< 0.00050	0.00050	mg/L							
Cobalt, total	< 0.00010	0.00010	mg/L							
Copper, total	< 0.00040	0.00040	mg/L							
Iron, total	< 0.010	0.010	mg/L							
Lead, total	< 0.00020	0.00020	mg/L							
Lithium, total	< 0.00010	0.00010	mg/L							
Magnesium, total	< 0.010	0.010	mg/L							
Manganese, total	< 0.00020	0.00020	mg/L							
Molybdenum, total	< 0.00010	0.00010	mg/L							
Nickel, total	< 0.00040	0.00040	mg/L							
Phosphorus, total	< 0.050	0.050	mg/L							
Potassium, total	< 0.10	0.10	mg/L							
Selenium, total	< 0.00050	0.00050	mg/L							
Silicon, total	< 1.0	1.0	mg/L							
Silver, total	< 0.000050	0.000050	mg/L							
Sodium, total	< 0.10	0.10	mg/L							
Strontium, total	< 0.0010	0.0010	mg/L							
Sulfur, total	< 3.0	3.0	mg/L							
Tellurium, total	< 0.00050	0.00050	mg/L							
Thallium, total	< 0.000020	0.000020	mg/L							
Thorium, total	< 0.00010	0.00010	mg/L							
Tin, total	< 0.00020	0.00020	mg/L							
Titanium, total	< 0.0050	0.0050	mg/L							
Tungsten, total	< 0.0010	0.0010	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102454
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Total Metals, Batch B8K0113, Continued										
Blank (B8K0113-BLK3), Continued				Prepared: 2018-11-01, Analyzed: 2018-11-03						
Uranium, total	< 0.000020	0.000020	mg/L							
Vanadium, total	< 0.0010	0.0010	mg/L							
Zinc, total	< 0.0040	0.0040	mg/L							
Zirconium, total	< 0.00010	0.00010	mg/L							
LCS (B8K0113-BS1)				Prepared: 2018-11-01, Analyzed: 2018-11-03						
Aluminum, total	0.0230	0.0050	mg/L	0.0200		115	80-120			
Antimony, total	0.0219	0.00020	mg/L	0.0200		110	80-120			
Arsenic, total	0.0193	0.00050	mg/L	0.0200		97	80-120			
Barium, total	0.0210	0.0050	mg/L	0.0200		105	80-120			
Beryllium, total	0.0183	0.00010	mg/L	0.0200		92	80-120			
Bismuth, total	0.0195	0.00010	mg/L	0.0200		98	80-120			
Boron, total	0.0194	0.0050	mg/L	0.0200		97	80-120			
Cadmium, total	0.0200	0.000010	mg/L	0.0200		100	80-120			
Calcium, total	2.06	0.20	mg/L	2.00		103	80-120			
Chromium, total	0.0189	0.00050	mg/L	0.0200		95	80-120			
Cobalt, total	0.0187	0.00010	mg/L	0.0200		94	80-120			
Copper, total	0.0196	0.00040	mg/L	0.0200		98	80-120			
Iron, total	1.80	0.010	mg/L	2.00		90	80-120			
Lead, total	0.0191	0.00020	mg/L	0.0200		95	80-120			
Lithium, total	0.0193	0.00010	mg/L	0.0200		97	80-120			
Magnesium, total	1.99	0.010	mg/L	2.00		99	80-120			
Manganese, total	0.0200	0.00020	mg/L	0.0200		100	80-120			
Molybdenum, total	0.0192	0.00010	mg/L	0.0200		96	80-120			
Nickel, total	0.0191	0.00040	mg/L	0.0200		96	80-120			
Phosphorus, total	1.84	0.050	mg/L	2.00		92	80-120			
Potassium, total	1.77	0.10	mg/L	2.00		88	80-120			
Selenium, total	0.0196	0.00050	mg/L	0.0200		98	80-120			
Silicon, total	1.9	1.0	mg/L	2.00		95	80-120			
Silver, total	0.0179	0.000050	mg/L	0.0200		89	80-120			
Sodium, total	2.12	0.10	mg/L	2.00		106	80-120			
Strontium, total	0.0182	0.0010	mg/L	0.0200		91	80-120			
Sulfur, total	4.6	3.0	mg/L	5.00		91	80-120			
Tellurium, total	0.0218	0.00050	mg/L	0.0200		109	80-120			
Thallium, total	0.0189	0.000020	mg/L	0.0200		95	80-120			
Thorium, total	0.0184	0.00010	mg/L	0.0200		92	80-120			
Tin, total	0.0218	0.00020	mg/L	0.0200		109	80-120			
Titanium, total	0.0196	0.0050	mg/L	0.0200		98	80-120			
Tungsten, total	0.0211	0.0010	mg/L	0.0200		105	80-120			
Uranium, total	0.0189	0.000020	mg/L	0.0200		95	80-120			
Vanadium, total	0.0192	0.0010	mg/L	0.0200		96	80-120			
Zinc, total	0.0238	0.0040	mg/L	0.0200		119	80-120			
Zirconium, total	0.0221	0.00010	mg/L	0.0200		111	80-120			
Reference (B8K0113-SRM1)				Prepared: 2018-11-01, Analyzed: 2018-11-03						
Aluminum, total	0.298	0.0050	mg/L	0.303		98	82-114			
Antimony, total	0.0561	0.00020	mg/L	0.0511		110	88-115			
Arsenic, total	0.118	0.00050	mg/L	0.118		100	88-111			
Barium, total	0.839	0.0050	mg/L	0.823		102	83-110			
Beryllium, total	0.0465	0.00010	mg/L	0.0496		94	80-119			
Boron, total	3.38	0.0050	mg/L	3.45		98	80-118			
Cadmium, total	0.0500	0.000010	mg/L	0.0495		101	90-110			
Calcium, total	10.8	0.20	mg/L	11.6		93	85-113			
Chromium, total	0.247	0.00050	mg/L	0.250		99	88-111			
Cobalt, total	0.0369	0.00010	mg/L	0.0377		98	90-114			
Copper, total	0.539	0.00040	mg/L	0.486		111	90-117			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102454
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 15:54

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Total Metals, Batch B8K0113, Continued										
Reference (B8K0113-SRM1), Continued				Prepared: 2018-11-01, Analyzed: 2018-11-03						
Iron, total	0.483	0.010	mg/L	0.488		99	90-116			
Lead, total	0.205	0.00020	mg/L	0.204		101	90-110			
Lithium, total	0.403	0.00010	mg/L	0.403		100	79-118			
Magnesium, total	4.06	0.010	mg/L	3.79		107	88-116			
Manganese, total	0.109	0.00020	mg/L	0.109		100	88-108			
Molybdenum, total	0.197	0.00010	mg/L	0.198		100	88-110			
Nickel, total	0.243	0.00040	mg/L	0.249		98	90-112			
Phosphorus, total	0.216	0.050	mg/L	0.227		95	72-118			
Potassium, total	7.11	0.10	mg/L	7.21		99	87-116			
Selenium, total	0.125	0.00050	mg/L	0.121		104	90-122			
Sodium, total	7.83	0.10	mg/L	7.54		104	86-118			
Strontium, total	0.347	0.0010	mg/L	0.375		92	86-110			
Thallium, total	0.0789	0.000020	mg/L	0.0805		98	90-113			
Uranium, total	0.0288	0.000020	mg/L	0.0306		94	88-112			
Vanadium, total	0.382	0.0010	mg/L	0.386		99	87-110			
Zinc, total	2.53	0.0040	mg/L	2.49		102	90-113			

LOGIN NOTICE (Work Order 8102785)

CLIENT	Associated Environmental Consultants Inc. (Vernon)		
PO NUMBER		**QUOTATION ID**	AE Master Bid (BC)
PROJECT	2018-8152.000.003	**SUBMITTED BY**	
PROJECT INFO	SCRD GW Investigation	**COC NO.**	

Receipt Details:

RECEIVED	2018-10-31 12:30	**LOGGED IN**	2018-10-31 13:30
LOCATION	Richmond Lab	**ACCOUNT MGR**	Eilish St.Clair, B.Sc., C.I.T.

Sample Condition Summary: Quantity of Transport Vessels Received: 1

Receipt Temperature = 2°C

Broken Container(s)	No	Sampling Date(s) Missing	No	Incorrect Cont./Pres.	No
Cooling Initiated	Yes	Sample(s) Frozen	No	Missing/Extra Samples	No

Note: *Sample transport temperatures of less than 8°C for microbiological parameters and less than or equal to 10°C for environmental parameters is recommended. Samples that exceed these values will still be processed. However, please note that the analytical results may be affected, especially for samples collected prior to the day of receipt.*

REPORT TO	Nicole Penner Associated Environmental Consultants Inc. (Vernon) #200 - 2800 29th Street Vernon, BC V1T 9P9 Tel: (250) 545-3672	**INCLUDE QC** **INCLUDE COC** **EXTRAS**	Yes No Guidelines
INVOICE TO	Nicole Penner Associated Environmental Consultants Inc. (Vernon) #200 - 2800 29th Street Vernon, BC V1T 9P9 Tel: (250) 545-3672	**FREQUENCY** **GST EXEMPT** **PAYMENT TERMS** **MIN AMOUNT**	With Report No Upon Receipt N/A

Delivery Plan:

REPORT DUE Draft: 2018-11-07 15:30 (5 day TAT) | Final: 2018-11-19 15:30 (12 day TAT)

Contact Name	Email / Fax / Cellular	Login Notice	Report	Invoice	EDD	EDD Format	CC to	Fax	Text	Mail
Nicole Penner	pennern@ae.ca	✓	✓		✓	CARO Excel	support@wirelesswater.com			
Nicole Penner	pennern@ae.ca			✓			anzej@ae.ca			
Wireless H2O v2 EDD Uploaded by CARO on behalf of Client										

Analysis Schedule:

Analysis / Version	Due	Expires [1]	Status	Comments

WIN 54943 (8102785-01) | Matrix: Water | Sampled: 2018-10-30 10:30

Container(s) Submitted:

A = C13_500 mL Plastic (General)	*B = C13_500 mL Plastic (General)*	*C = C13_500 mL Plastic (General)*
D = C07_300 mL Plastic (Micro-S)	*E = C07_300 mL Plastic (Micro-S)*	*F = C10_125 mL Plastic (H2SO4)*
G = C10_125 mL Plastic (H2SO4)	*H = C23_125 mL Plastic (Sulfide)*	*I = C05_125 mL Plastic (Metals)*
J = C06_40 mL Vial (Mercury)	*K = S05_125 mL Plastic (Metals-F)*	*L = S06_40 mL Vial (Mercury-F)*
M = C14_40 mL Vial (TOC)	*N = C14_40 mL Vial (TOC)*	*O = S14_40 mL Vial (DOC-F)*
P = S14_40 mL Vial (DOC-F)	*Q = C04_40 mL Vial (VOC Water)*	*R = C04_40 mL Vial (VOC Water)*

LOGIN NOTICE (Work Order 8102785)

Analysis Schedule, Continued:

Analysis / Version	Due	Expires [1]	Status	Comments
WIN 54943 (8102785-01) | Matrix: Water | Sampled: 2018-10-30 10:30, Continued				
Alkalinity	2018-11-07	2018-11-13	Available	
Anions by IC (3) Pkg	2018-11-07	2018-11-27	Available	
Carbon, Total Organic	2018-11-07	2018-11-27	Available	
Coliforms, Total & E. coli (MF) Pkg	2018-11-07	2018-10-31	Subcontracted	
Colour, True	2018-11-07	2018-11-02	Available	
Conductivity	2018-11-07	2018-11-27	Available	
Heterotrophic Plate Count	2018-11-07	2018-10-31	Subcontracted	Subcontracted
Iron Related Bacteria (Count)	2018-11-19	2018-11-01	Available	
Langelier Index	2018-11-07	2018-11-27	Available	
Mercury, dissolved by CVAFS	2018-11-07	2018-11-27	Available	
Mercury, total by CVAFS	2018-11-07	2018-11-27	Available	
Metals, Dissolved by ICPMS (All) Pkg	2018-11-07	2019-04-28	Available	
Metals, Total by ICPMS (All) Pkg	2018-11-07	2019-04-28	Available	
Nitrogen, Organic (Calc TKN, NH3)	2018-11-07	2018-11-27	Available	
Nitrogen, Total (TKN, NO2+NO3 by colour)	2018-11-07	2018-11-02	Available	
pH	2018-11-07	2018-10-30	Available	
Solids, Total Dissolved	2018-11-07	2018-11-06	Available	
Sulfate Reducing Bacteria (Count)	2018-11-19	2018-11-01	Available	
Sulfide, Total	2018-11-07	2018-11-06	Available	
Transmittance at 254 nm	2018-11-07	2018-11-02	Available	
Turbidity	2018-11-07	2018-11-02	Available	

1 *Red font indicates that the analysis has already or is about to expire. In order to guarantee that your samples will be analyzed within the recommended holding time, they must be received at least one day prior to the expiry date (3 hours for microbiological testing). Note that all pH in water / Chlorine / Temperature / Dissolved Oxygen results will be automatically be qualified as they should be analyzed in the field for greatest accuracy.*

LOGIN NOTICE (Work Order 8102785)

Packages and their respective Analyses included in this Work Order:

Anions by IC (3) Pkg

Chloride by IC	Fluoride by IC	Sulfate by IC

Coliforms, Total & E. coli (MF) Pkg

Coliforms, Total (MF)	E. coli (MF)

Metals, Dissolved by ICPMS (All) Pkg

Aluminum, dissolved by ICPMS	Antimony, dissolved by ICPMS	Arsenic, dissolved by ICPMS
Barium, dissolved by ICPMS	Beryllium, dissolved by ICPMS	Bismuth, dissolved by ICPMS
Boron, dissolved by ICPMS	Cadmium, dissolved by ICPMS	Calcium, dissolved by ICPMS
Chromium, dissolved by ICPMS	Cobalt, dissolved by ICPMS	Copper, dissolved by ICPMS
Hardness, Total (as CaCO3) (Calc)	Iron, dissolved by ICPMS	Lead, dissolved by ICPMS
Lithium, dissolved by ICPMS	Magnesium, dissolved by ICPMS	Manganese, dissolved by ICPMS
Molybdenum, dissolved by ICPMS	Nickel, dissolved by ICPMS	Phosphorus, dissolved by ICPMS
Potassium, dissolved by ICPMS	Selenium, dissolved by ICPMS	Silicon, dissolved by ICPMS
Silver, dissolved by ICPMS	Sodium, dissolved by ICPMS	Strontium, dissolved by ICPMS
Sulfur, dissolved by ICPMS	Tellurium, dissolved by ICPMS	Thallium, dissolved by ICPMS
Thorium, dissolved by ICPMS	Tin, dissolved by ICPMS	Titanium, dissolved by ICPMS
Tungsten, dissolved by ICPMS	Uranium, dissolved by ICPMS	Vanadium, dissolved by ICPMS
Zinc, dissolved by ICPMS	Zirconium, dissolved by ICPMS	

Metals, Total by ICPMS (All) Pkg

Aluminum, total by ICPMS	Antimony, total by ICPMS	Arsenic, total by ICPMS
Barium, total by ICPMS	Beryllium, total by ICPMS	Bismuth, total by ICPMS
Boron, total by ICPMS	Cadmium, total by ICPMS	Calcium, total by ICPMS
Chromium, total by ICPMS	Cobalt, total by ICPMS	Copper, total by ICPMS
Hardness, Total (as CaCO3) (Calc)	Iron, total by ICPMS	Lead, total by ICPMS
Lithium, total by ICPMS	Magnesium, total by ICPMS	Manganese, total by ICPMS
Molybedenum, total by ICPMS	Nickel, total by ICPMS	Phosphorus, total by ICPMS
Potassium, total by ICPMS	Selenium, total by ICPMS	Silicon, total by ICPMS
Silver, total by ICPMS	Sodium, total by ICPMS	Strontium, total by ICPMS
Sulfur, total by ICPMS	Tellurium, total by ICPMS	Thallium, total by ICPMS
Thorium, total by ICPMS	Tin, total by ICPMS	Titanium, total by ICPMS
Tungsten, total by ICPMS	Uranium, total by ICPMS	Vanadium, total by ICPMS
Zinc, total by ICPMS	Zirconium, total by ICPMS	

Nitrogen, Organic (Calc TKN, NH3)

Ammonia, Total	Nitrogen, Organic (Calc)

Nitrogen, Total (TKN, NO2+NO3 by colour)

Nitrate+Nitrite by Colorimetry	Nitrogen, Total (Calc)	Nitrogen, Total Kjeldahl

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Each Analysis includes the following Analytes and their respective Reporting Limits [RLs]:			
Alkalinity in Water	*Reference Method: SM 2320 B* (2011)*		*Units: mg/L*
Alkalinity, Total (as CaCO3) [1]	Alkalinity, Phenolphthalein (as CaCO3) [1]	Alkalinity, Bicarbonate (as CaCO3) [1]	Alkalinity, Carbonate (as CaCO3) [1]
Alkalinity, Hydroxide (as CaCO3) [1]			
Ammonia, Total in Water	*Reference Method: SM 4500-NH3 G* (2011)*		*Units: mg/L*
Ammonia, Total (as N) [0.02]			
Anions by IC in Water	*Reference Method: SM 4110 B (2011)*		*Units: mg/L*
Chloride [0.1]	Fluoride [0.1]	Sulfate [1]	
Carbon, Total Organic in Water	*Reference Method: SM 5310 B (2011)*		*Units: mg/L*
Carbon, Total Organic [0.5]			
Coliforms, Total (MF) in Water	*Reference Method: SM 9222 (2006)*		*Units: CFU/100 mL*
Coliforms, Total [1]			
Colour, True in Water	*Reference Method: SM 2120 C (2011)*		*Units: CU*
Colour, True [5]			
Conductivity in Water	*Reference Method: SM 2510 B (2011)*		*Units: uS/cm*
Conductivity (EC) [2]			
Dissolved Metals by ICPMS in Water	*Reference Method: EPA 200.8 / EPA 6020B*		*Units: mg/L*
Aluminum, dissolved [0.005]	Antimony, dissolved [0.0002]	Arsenic, dissolved [0.0005]	Barium, dissolved [0.005]
Beryllium, dissolved [0.0001]	Bismuth, dissolved [0.0001]	Boron, dissolved [0.005]	Cadmium, dissolved [1e-005]
Calcium, dissolved [0.2]	Chromium, dissolved [0.0005]	Cobalt, dissolved [0.0001]	Copper, dissolved [0.0004]
Iron, dissolved [0.01]	Lead, dissolved [0.0002]	Lithium, dissolved [0.0001]	Magnesium, dissolved [0.01]
Manganese, dissolved [0.0002]	Molybdenum, dissolved [0.0001]	Nickel, dissolved [0.0004]	Phosphorus, dissolved [0.05]
Potassium, dissolved [0.1]	Selenium, dissolved [0.0005]	Silicon, dissolved [1]	Silver, dissolved [5e-005]
Sodium, dissolved [0.1]	Strontium, dissolved [0.001]	Sulfur, dissolved [3]	Tellurium, dissolved [0.0005]
Thallium, dissolved [2e-005]	Thorium, dissolved [0.0001]	Tin, dissolved [0.0002]	Titanium, dissolved [0.005]
Tungsten, dissolved [0.001]	Uranium, dissolved [2e-005]	Vanadium, dissolved [0.001]	Zinc, dissolved [0.004]
Zirconium, dissolved [0.0001]			
E. coli (MF) in Water	*Reference Method: SM 9223 B (2004)*		*Units: CFU/100 mL*
E. coli [1]			
Heterotrophic Plate Count in Water	*Reference Method: SM 9215 B (2004)*		*Units: CFU/mL*
Heterotrophic Plate Count [1]			
Iron Related Bacteria (Count) in Water	*Reference Method: DBI DBISOP06*		*Units: CFU/mL*
Iron Related Bacteria [2]			

LOGIN NOTICE (Work Order 8102785)

Langelier Index in Water	*Reference Method: SM 2330 B (2010)*		*Units: -*
Langelier Index [-5]			
Mercury by CVAFS in Water	*Reference Method: EPA 245.7**		*Units: mg/L*
Mercury, dissolved [1e-005]	Mercury, total [1e-005]		
Nitrate+Nitrite by Colorimetry in Water	*Reference Method: SM 4500-NO3- F (2011)*		*Units: mg/L*
Nitrate+Nitrite (as N) [0.005]			
Nitrogen, Total Kjeldahl in Water	*Reference Method: SM 4500-Norg D* (2011)*		*Units: mg/L*
Nitrogen, Total Kjeldahl [0.05]			
pH in Water	*Reference Method: SM 4500-H+ B (2011)*		*Units: pH units*
pH [0.1]			
Solids, Total Dissolved in Water	*Reference Method: SM 2540 C* (2011)*		*Units: mg/L*
Solids, Total Dissolved [15]			
Sulfate Reducing Bacteria (Count) in Water	*Reference Method: DBI DBSLW05*		*Units: CFU/mL*
Sulfate Reducing Bacteria [8]			
Sulfide, Total in Water	*Reference Method: SM 4500-S2 D* (2011)*		*Units: mg/L*
Sulfide, Total [0.02]			
Total Metals by ICPMS in Water	*Reference Method: EPA 200.2* / EPA 6020B*		*Units: mg/L*
Aluminum, total [0.005]	Antimony, total [0.0002]	Arsenic, total [0.0005]	Barium, total [0.005]
Beryllium, total [0.0001]	Bismuth, total [0.0001]	Boron, total [0.005]	Cadmium, total [1e-005]
Calcium, total [0.2]	Chromium, total [0.0005]	Cobalt, total [0.0001]	Copper, total [0.0004]
Iron, total [0.01]	Lead, total [0.0002]	Lithium, total [0.0001]	Magnesium, total [0.01]
Manganese, total [0.0002]	Molybdenum, total [0.0001]	Nickel, total [0.0004]	Phosphorus, total [0.05]
Potassium, total [0.1]	Selenium, total [0.0005]	Silicon, total [1]	Silver, total [5e-005]
Sodium, total [0.1]	Strontium, total [0.001]	Sulfur, total [3]	Tellurium, total [0.0005]
Thallium, total [2e-005]	Thorium, total [0.0001]	Tin, total [0.0002]	Titanium, total [0.005]
Tungsten, total [0.001]	Uranium, total [2e-005]	Vanadium, total [0.001]	Zinc, total [0.004]
Zirconium, total [0.0001]			
Transmittance at 254 nm in Water	*Reference Method: SM 5910 B* (2013)*		*Units: % T*
UV Transmittance @ 254nm [0.1]			
Turbidity in Water	*Reference Method: SM 2130 B (2011)*		*Units: NTU*
Turbidity [0.1]			

Note: RLs on Final Report may be higher than expected due to: 1) limited sample volume, 2) high moisture, 3) analytical interferences

LOGIN NOTICE (Work Order 8102785)

Please verify that all of the information included in this Login Notice is correct. If there are any errors, omissions, or concerns, please contact us at 1-888-311-8846.

You can expect to receive the analytical report via email on or after the due date shown above.

Thank you for using CARO!

CARO ANALYTICAL SERVICES

8102785

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CHAIN OF CUSTODY RECORD

COC# | PAGE 1 OF 1

RELINQUISHED BY:	DATE: Oct 30/18	RECEIVED BY:	DATE: 10/31
	TIME: 11:00	NJY Loomis	TIME: 12:30

PROJECT: SCRD GW Investigation

PROJECT INFO: 2018-8152.000.003

REPORT TO:

COMPANY: Associated Environmental
ADDRESS: 200-2800 29th Street, Vernon, BC V1T 9P9
CONTACT: Nicole Penner
TEL/FAX: 250-545-3672 250-938-5537
EMAIL PDF ☒ EDD ☒
EMAIL 1: pennern@ae.ca; friesent@ae.ca
EMAIL 2: support@ wirelesswater.com
MAIL HARDCOPY ☐ HOLD FOR P/U ☐ FAX ☐

INVOICE TO: SAME AS REPORT TO ☒

COMPANY:
ADDRESS:
CONTACT:
TEL/FAX:
EMAIL PDF ☒
EMAIL 1: pennern@ae.ca
EMAIL 2: anzej@ae.ca
MAIL HARDCOPY ☐ HOLD FOR P/U ☐

SAMLPLED BY: Tony Friesen

PO #:

TURNAROUND TIME REQUESTED:
Routine: (5-7 Days) ☒
Rush: 1 Day* ☐ 2 Day* ☐ 3 Day* ☐
Other* ☐
*Contact Lab To Confirm. Surcharge May Apply

REGULATORY APPLICATION:
Canadian Drinking Water Quality Guidelines ☒ CCME ☐
BC Drinking Water Protection Act / Reg. ☐ ALBERTA TIER 1 ☐
BC CSR ☐ AL ☐ RL ☐ CL ☐ IL ☐ AW ☐
OTHER:

ANALYSES REQUESTED:

CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	MATRIX: OTHER WATER	MATRIX: SOIL	MATRIX: OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	SAMPLING: TIME HH:MM	COMMENTS: CHLORINATED	COMMENTS: FILTERED	COMMENTS: PRESERVED	COMMENTS: (i.e. flow/volume media ID/notes)	BTEX ☐ VPH ☐ PHC F1 ☐	VOC ☐ VPH ☐	EPH ☐ PHC F2-F4 ☐	PAH ☐ L/HEPH ☐	PHENOLS Chlorinated ☐ Non-Chlor. ☐	PCB ☐ GLYCOLS ☐ HAA ☐	PESTICIDES ☐ ACID HERBICIDES ☐	METALS - WATER TOTAL Hg ☒	METALS - WATER DISSOLVED Hg ☒	METALS - SOIL (SALM) ☐ inc. pH ☐	pH ☒ EC ☒ ALK ☒	TSS ☐ VSS ☐ TDS ☒	BOD ☐ COD ☐	TOG ☐ MOG ☐	FECAL COLIFORMS ☐ HPC ☒	TOTAL COLIFORMS ☒ E.coli ☒	ASBESTOS	Iron & sulphate reducing bacteria	Total and organic nitrogen package	Chloride, fluoride, sulphate	Corrosivity (Langelier index)	Sulphide	Total organic carbon	Colour, turbidity, UV transmittance	HOLD
WIN 54943		✔				30-10-18	1030												✔	✔		✔	✔			✔	✔		✔	✔	✔	✔	✔	✔		

SHIPPING INSTRUCTIONS: Return Cooler(s) ☐
Supplies Needed:

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will Apply):

OTHER INSTRUCTIONS:
Low-level DL for metals. Upload to Wireless Water. Ensure E. coli & total coliform DL of < 1 CFU/100 mL.

PAYMENT:
CHEQUE ☐
CREDIT ☐
DEBIT ☐
CASH ☐
INVOICE ☐

SAMPLE RECEIPT TEMP (°C): 21
Work Order #
CUSTODY SEAL INTACT Y ☐ N ☐ NA ☐

CERTIFICATE OF ANALYSIS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon) #200 - 2800 29th Street Vernon, BC V1T 9P9		
ATTENTION	Nicole Penner	**WORK ORDER**	8102785
PO NUMBER		**RECEIVED / TEMP**	2018-10-31 12:30 / 2°C
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 11:16
PROJECT INFO	SCRD GW Investigation		

Introduction:

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

Big Picture Sidekicks

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

We've Got Chemistry

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

Ahead of the Curve

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

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

Authorized By:

Eilish St.Clair, B.Sc., C.I.T.
Client Service Representative

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102785
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 11:16

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
WIN 54943 (8102785-01) | Matrix: Water | Sampled: 2018-10-30 10:30						
Anions						
Chloride	**26.8**	AO ≤ 250	0.10	mg/L	2018-11-03	
Fluoride	< 0.10	MAC = 1.5	0.10	mg/L	2018-11-03	
Nitrate+Nitrite (as N)	**0.796**	N/A	0.0050	mg/L	2018-11-02	
Sulfate	**4.6**	AO ≤ 500	1.0	mg/L	2018-11-03	
Biological Activity Reaction Tests						
Iron Related Bacteria	**8820**	N/A	2	CFU/mL	2018-11-01	
Sulfate Reducing Bacteria	**226**	N/A	8	CFU/mL	2018-11-01	
Calculated Parameters						
Hardness, Total (as CaCO3)	**77.6**	None Required	0.500	mg/L	N/A	
Langelier Index	**1.2**	N/A	-5.0	-	2018-11-07	
Nitrogen, Total	**0.796**	N/A	0.0500	mg/L	N/A	
Nitrogen, Organic	< 0.0500	N/A	0.0500	mg/L	N/A	
Dissolved Metals						
Aluminum, dissolved	< 0.0050	N/A	0.0050	mg/L	2018-11-06	
Antimony, dissolved	< 0.00020	N/A	0.00020	mg/L	2018-11-06	
Arsenic, dissolved	**0.00277**	N/A	0.00050	mg/L	2018-11-06	
Barium, dissolved	< 0.0050	N/A	0.0050	mg/L	2018-11-06	
Beryllium, dissolved	< 0.00010	N/A	0.00010	mg/L	2018-11-06	
Bismuth, dissolved	< 0.00010	N/A	0.00010	mg/L	2018-11-06	
Boron, dissolved	**0.0053**	N/A	0.0050	mg/L	2018-11-06	
Cadmium, dissolved	< 0.000010	N/A	0.000010	mg/L	2018-11-06	
Calcium, dissolved	**16.1**	N/A	0.20	mg/L	2018-11-06	
Chromium, dissolved	< 0.00050	N/A	0.00050	mg/L	2018-11-06	
Cobalt, dissolved	< 0.00010	N/A	0.00010	mg/L	2018-11-06	
Copper, dissolved	**0.00073**	N/A	0.00040	mg/L	2018-11-06	
Iron, dissolved	< 0.010	N/A	0.010	mg/L	2018-11-06	
Lead, dissolved	< 0.00020	N/A	0.00020	mg/L	2018-11-06	
Lithium, dissolved	**0.00067**	N/A	0.00010	mg/L	2018-11-06	
Magnesium, dissolved	**9.10**	N/A	0.010	mg/L	2018-11-06	
Manganese, dissolved	**0.00035**	N/A	0.00020	mg/L	2018-11-06	
Mercury, dissolved	< 0.000010	N/A	0.000010	mg/L	2018-11-06	
Molybdenum, dissolved	**0.00094**	N/A	0.00010	mg/L	2018-11-06	
Nickel, dissolved	< 0.00040	N/A	0.00040	mg/L	2018-11-06	
Phosphorus, dissolved	**0.077**	N/A	0.050	mg/L	2018-11-06	
Potassium, dissolved	**3.32**	N/A	0.10	mg/L	2018-11-06	
Selenium, dissolved	< 0.00050	N/A	0.00050	mg/L	2018-11-06	
Silicon, dissolved	**20.3**	N/A	1.0	mg/L	2018-11-06	
Silver, dissolved	< 0.000050	N/A	0.000050	mg/L	2018-11-06	
Sodium, dissolved	**9.45**	N/A	0.10	mg/L	2018-11-06	
Strontium, dissolved	**0.0614**	N/A	0.0010	mg/L	2018-11-06	

TEST RESULTS

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PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 11:16

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
WIN 54943 (8102785-01) | Matrix: Water | Sampled: 2018-10-30 10:30, Continued						
Dissolved Metals, Continued						
Sulfur, dissolved	< 3.0	N/A	3.0	mg/L	2018-11-06	
Tellurium, dissolved	< 0.00050	N/A	0.00050	mg/L	2018-11-06	
Thallium, dissolved	< 0.000020	N/A	0.000020	mg/L	2018-11-06	
Thorium, dissolved	< 0.00010	N/A	0.00010	mg/L	2018-11-06	
Tin, dissolved	< 0.00020	N/A	0.00020	mg/L	2018-11-06	
Titanium, dissolved	< 0.0050	N/A	0.0050	mg/L	2018-11-06	
Tungsten, dissolved	< 0.0010	N/A	0.0010	mg/L	2018-11-06	
Uranium, dissolved	**0.000208**	N/A	0.000020	mg/L	2018-11-06	
Vanadium, dissolved	**0.0093**	N/A	0.0010	mg/L	2018-11-06	
Zinc, dissolved	**0.0182**	N/A	0.0040	mg/L	2018-11-06	
Zirconium, dissolved	< 0.00010	N/A	0.00010	mg/L	2018-11-06	
General Parameters						
Alkalinity, Total (as CaCO3)	**52.0**	N/A	1.0	mg/L	2018-11-02	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2018-11-02	
Alkalinity, Bicarbonate (as CaCO3)	**52.0**	N/A	1.0	mg/L	2018-11-02	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2018-11-02	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2018-11-02	
Ammonia, Total (as N)	< 0.020	None Required	0.020	mg/L	2018-11-06	
Carbon, Total Organic	< 0.50	N/A	0.50	mg/L	2018-11-07	
Colour, True	< 5.0	AO ≤ 15	5.0	CU	2018-11-02	
Conductivity (EC)	**192**	N/A	2.0	µS/cm	2018-11-07	
Nitrogen, Total Kjeldahl	< 0.050	N/A	0.050	mg/L	2018-11-05	
pH	**7.71**	7.0-10.5	0.10	pH units	2018-11-06	HT2
Solids, Total Dissolved	**174**	AO ≤ 500	15	mg/L	2018-11-06	
Sulfide, Total	< 0.020	AO ≤ 0.05	0.020	mg/L	2018-11-06	
Turbidity	**0.95**	OG < 1	0.10	NTU	2018-11-01	
UV Transmittance @ 254nm	**98.3**	N/A	0.10	% T	2018-11-01	
Total Metals						
Aluminum, total	< 0.0050	OG < 0.1	0.0050	mg/L	2018-11-06	
Antimony, total	< 0.00020	MAC = 0.006	0.00020	mg/L	2018-11-06	
Arsenic, total	**0.00256**	MAC = 0.01	0.00050	mg/L	2018-11-06	
Barium, total	< 0.0050	MAC = 1	0.0050	mg/L	2018-11-06	
Beryllium, total	< 0.00010	N/A	0.00010	mg/L	2018-11-06	
Bismuth, total	< 0.00010	N/A	0.00010	mg/L	2018-11-06	
Boron, total	**0.0059**	MAC = 5	0.0050	mg/L	2018-11-06	
Cadmium, total	< 0.000010	MAC = 0.005	0.000010	mg/L	2018-11-06	
Calcium, total	**16.5**	None Required	0.20	mg/L	2018-11-06	
Chromium, total	< 0.00050	MAC = 0.05	0.00050	mg/L	2018-11-06	
Cobalt, total	< 0.00010	N/A	0.00010	mg/L	2018-11-06	
Copper, total	**0.00112**	AO ≤ 1	0.00040	mg/L	2018-11-06	
Iron, total	< 0.010	AO ≤ 0.3	0.010	mg/L	2018-11-06	

TEST RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102785
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 11:16

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
WIN 54943 (8102785-01) | Matrix: Water | Sampled: 2018-10-30 10:30, Continued						
Total Metals, Continued						
Lead, total	< 0.00020	MAC = 0.01	0.00020	mg/L	2018-11-06	
Lithium, total	**0.00078**	N/A	0.00010	mg/L	2018-11-06	
Magnesium, total	**9.28**	None Required	0.010	mg/L	2018-11-06	
Manganese, total	**0.00033**	AO ≤ 0.05	0.00020	mg/L	2018-11-06	
Mercury, total	< 0.000010	MAC = 0.001	0.000010	mg/L	2018-11-07	
Molybdenum, total	**0.00093**	N/A	0.00010	mg/L	2018-11-06	
Nickel, total	< 0.00040	N/A	0.00040	mg/L	2018-11-06	
Phosphorus, total	**0.080**	N/A	0.050	mg/L	2018-11-06	
Potassium, total	**3.30**	N/A	0.10	mg/L	2018-11-06	
Selenium, total	< 0.00050	MAC = 0.05	0.00050	mg/L	2018-11-06	
Silicon, total	**20.5**	N/A	1.0	mg/L	2018-11-06	
Silver, total	< 0.000050	None Required	0.000050	mg/L	2018-11-06	
Sodium, total	**9.83**	AO ≤ 200	0.10	mg/L	2018-11-06	
Strontium, total	**0.0628**	N/A	0.0010	mg/L	2018-11-06	
Sulfur, total	< 3.0	N/A	3.0	mg/L	2018-11-06	
Tellurium, total	< 0.00050	N/A	0.00050	mg/L	2018-11-06	
Thallium, total	< 0.000020	N/A	0.000020	mg/L	2018-11-06	
Thorium, total	< 0.00010	N/A	0.00010	mg/L	2018-11-06	
Tin, total	< 0.00020	N/A	0.00020	mg/L	2018-11-06	
Titanium, total	< 0.0050	N/A	0.0050	mg/L	2018-11-06	
Tungsten, total	< 0.0010	N/A	0.0010	mg/L	2018-11-06	
Uranium, total	**0.000215**	MAC = 0.02	0.000020	mg/L	2018-11-06	
Vanadium, total	**0.0098**	N/A	0.0010	mg/L	2018-11-06	
Zinc, total	**0.0328**	AO ≤ 5	0.0040	mg/L	2018-11-06	
Zirconium, total	< 0.00010	N/A	0.00010	mg/L	2018-11-06	
Microbiological Parameters						
Coliforms, Total	<1	MAC = 0	1	CFU/100 mL	2018-10-31	
E. coli	<1	MAC = 0	1	CFU/100 mL	2018-10-31	
Heterotrophic Plate Count	<1	N/A	1	CFU/mL	2018-10-31	

Sample Qualifiers:

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

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102785
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 11:16

Analysis Description	Method Ref.	Technique	Location
Alkalinity in Water	SM 2320 B* (2011)	Titration with H2SO4	Kelowna
Ammonia, Total in Water	SM 4500-NH3 G* (2011)	Automated Colorimetry (Phenate)	Kelowna
Anions in Water	SM 4110 B (2011)	Ion Chromatography	Kelowna
Carbon, Total Organic in Water	SM 5310 B (2011)	Combustion, Infrared CO2 Detection	Kelowna
Coliforms, Total in Water	SM 9222 (2006)	Membrane Filtration	Sublet
Colour, True in Water	SM 2120 C (2011)	Spectrophotometry (456 nm)	Kelowna
Conductivity in Water	SM 2510 B (2011)	Conductivity Meter	Kelowna
Dissolved Metals in Water	EPA 200.8 / EPA 6020B	0.45 µm Filtration / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	Richmond
E. coli in Water	SM 9223 B (2004)	Enzyme Substrate Endo Agar	Sublet
Hardness in Water	SM 2340 B (2011)	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	N/A
Heterotrophic Plate Count in Water	SM 9215 B (2004)	Pour Plate	Sublet
Iron Related Bacteria in Water	DBI DBISOP06	Biological Activity Reaction Test	Kelowna
Langelier Index in Water	SM 2330 B (2010)	Calculation	N/A
Mercury, dissolved in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Nitrate+Nitrite in Water	SM 4500-NO3- F (2011)	Automated Colorimetry (Cadmium Reduction)	Kelowna
Nitrogen, Total Kjeldahl in Water	SM 4500-Norg D* (2011)	Block Digestion and Flow Injection Analysis	Kelowna
pH in Water	SM 4500-H+ B (2011)	Electrometry	Kelowna
Solids, Total Dissolved in Water	SM 2540 C* (2011)	Gravimetry (Dried at 103-105C)	Kelowna
Sulfate Reducing Bacteria in Water	DBI DBSLW05	Biological Activity Reaction Test	Kelowna
Sulfide, Total in Water	SM 4500-S2 D* (2011)	Colorimetry (Methylene Blue)	Edmonton
Total Metals in Water	EPA 200.2* / EPA 6020B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	Richmond
Transmittance at 254 nm in Water	SM 5910 B* (2013)	Ultraviolet Absorption	Kelowna
Turbidity in Water	SM 2130 B (2011)	Nephelometry	Richmond

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

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Glossary of Terms:

RL	Reporting Limit (default)
% T	Percent Transmittance
<	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
<1	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
AO	Aesthetic Objective
CFU/100 mL	Colony Forming Units per 100 millilitres
CFU/mL	Colony Forming Units per millilitre
CU	Colour Units (referenced against a platinum cobalt standard)
MAC	Maximum Acceptable Concentration (health based)
mg/L	Milligrams per litre
NTU	Nephelometric Turbidity Units
OG	Operational Guideline (treated water)
pH units	pH < 7 = acidic, ph > 7 = basic
µS/cm	Microsiemens per centimetre
DBI	Drycon Bioconcepts Inc. Biological Activity Reaction Tests
EPA	United States Environmental Protection Agency Test Methods
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

General Comments:

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

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102785
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 11:16

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

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

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

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Anions, Batch B8K0036										
Blank (B8K0036-BLK1)				Prepared: 2018-11-02, Analyzed: 2018-11-02						
Nitrate+Nitrite (as N)	< 0.0100	0.0100	mg/L							
Blank (B8K0036-BLK2)				Prepared: 2018-11-02, Analyzed: 2018-11-02						
Nitrate+Nitrite (as N)	< 0.0100	0.0100	mg/L							
Blank (B8K0036-BLK3)				Prepared: 2018-11-02, Analyzed: 2018-11-02						
Nitrate+Nitrite (as N)	< 0.0100	0.0100	mg/L							
LCS (B8K0036-BS1)				Prepared: 2018-11-02, Analyzed: 2018-11-02						
Nitrate+Nitrite (as N)	0.493	0.0100	mg/L	0.500		99	91-108			
LCS (B8K0036-BS2)				Prepared: 2018-11-02, Analyzed: 2018-11-02						
Nitrate+Nitrite (as N)	0.521	0.0100	mg/L	0.500		104	91-108			
LCS (B8K0036-BS3)				Prepared: 2018-11-02, Analyzed: 2018-11-02						
Nitrate+Nitrite (as N)	0.511	0.0100	mg/L	0.500		102	91-108			
Duplicate (B8K0036-DUP1)		**Source: 8102785-01**		Prepared: 2018-11-02, Analyzed: 2018-11-02						
Nitrate+Nitrite (as N)	0.812	0.0050	mg/L		0.796			2	10	
Matrix Spike (B8K0036-MS1)		**Source: 8102785-01**		Prepared: 2018-11-02, Analyzed: 2018-11-02						
Nitrate+Nitrite (as N)	0.914	0.0100	mg/L	0.125	0.796	94	80-120			
Anions, Batch B8K0205										
Blank (B8K0205-BLK1)				Prepared: 2018-11-03, Analyzed: 2018-11-03						
Chloride	< 0.10	0.10	mg/L							
Fluoride	< 0.10	0.10	mg/L							
Sulfate	< 1.0	1.0	mg/L							
Blank (B8K0205-BLK2)				Prepared: 2018-11-03, Analyzed: 2018-11-03						
Chloride	< 0.10	0.10	mg/L							
Fluoride	< 0.10	0.10	mg/L							
Sulfate	< 1.0	1.0	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102785
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Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Anions, Batch B8K0205, Continued										
LCS (B8K0205-BS1)				Prepared: 2018-11-03, Analyzed: 2018-11-03						
Chloride	16.0	0.10	mg/L	16.0		100	90-110			
Fluoride	4.07	0.10	mg/L	4.00		102	88-108			
Sulfate	15.7	1.0	mg/L	16.0		98	91-109			
LCS (B8K0205-BS2)				Prepared: 2018-11-03, Analyzed: 2018-11-03						
Chloride	15.9	0.10	mg/L	16.0		99	90-110			
Fluoride	4.12	0.10	mg/L	4.00		103	88-108			
Sulfate	16.1	1.0	mg/L	16.0		100	91-109			
Biological Activity Reaction Tests, Batch B8K0044										
Blank (B8K0044-BLK1)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Iron Related Bacteria	< 2	2	CFU/mL							
Duplicate (B8K0044-DUP1)		**Source: 8102785-01**		Prepared: 2018-11-01, Analyzed: 2018-11-01						
Iron Related Bacteria	8820	2	CFU/mL		8820			< 1	171	
Biological Activity Reaction Tests, Batch B8K0046										
Blank (B8K0046-BLK1)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Sulfate Reducing Bacteria	< 8	8	CFU/mL							
Duplicate (B8K0046-DUP1)		**Source: 8102785-01**		Prepared: 2018-11-01, Analyzed: 2018-11-01						
Sulfate Reducing Bacteria	< 8	8	CFU/mL		226			200	121	MIC29
Dissolved Metals, Batch B8K0330										
Blank (B8K0330-BLK1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Aluminum, dissolved	< 0.0050	0.0050	mg/L							
Antimony, dissolved	< 0.00020	0.00020	mg/L							
Arsenic, dissolved	< 0.00050	0.00050	mg/L							
Barium, dissolved	< 0.0050	0.0050	mg/L							
Beryllium, dissolved	< 0.00010	0.00010	mg/L							
Bismuth, dissolved	< 0.00010	0.00010	mg/L							
Boron, dissolved	< 0.0050	0.0050	mg/L							
Cadmium, dissolved	< 0.000010	0.000010	mg/L							
Calcium, dissolved	< 0.20	0.20	mg/L							
Chromium, dissolved	< 0.00050	0.00050	mg/L							
Cobalt, dissolved	< 0.00010	0.00010	mg/L							
Copper, dissolved	< 0.00040	0.00040	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.00020	0.00020	mg/L							
Lithium, dissolved	< 0.00010	0.00010	mg/L							
Magnesium, dissolved	< 0.010	0.010	mg/L							
Manganese, dissolved	< 0.00020	0.00020	mg/L							
Molybdenum, dissolved	< 0.00010	0.00010	mg/L							
Nickel, dissolved	< 0.00040	0.00040	mg/L							
Phosphorus, dissolved	< 0.050	0.050	mg/L							
Potassium, dissolved	< 0.10	0.10	mg/L							
Selenium, dissolved	< 0.00050	0.00050	mg/L							
Silicon, dissolved	< 1.0	1.0	mg/L							
Silver, dissolved	< 0.000050	0.000050	mg/L							
Sodium, dissolved	< 0.10	0.10	mg/L							
Strontium, dissolved	< 0.0010	0.0010	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102785
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 11:16

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Dissolved Metals, Batch B8K0330, Continued										
Blank (B8K0330-BLK1), Continued				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Sulfur, dissolved	< 3.0	3.0	mg/L							
Tellurium, dissolved	< 0.00050	0.00050	mg/L							
Thallium, dissolved	< 0.000020	0.000020	mg/L							
Thorium, dissolved	< 0.00010	0.00010	mg/L							
Tin, dissolved	< 0.00020	0.00020	mg/L							
Titanium, dissolved	< 0.0050	0.0050	mg/L							
Tungsten, dissolved	< 0.0010	0.0010	mg/L							
Uranium, dissolved	< 0.000020	0.000020	mg/L							
Vanadium, dissolved	< 0.0010	0.0010	mg/L							
Zinc, dissolved	< 0.0040	0.0040	mg/L							
Zirconium, dissolved	< 0.00010	0.00010	mg/L							
Blank (B8K0330-BLK2)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Aluminum, dissolved	< 0.0050	0.0050	mg/L							
Antimony, dissolved	< 0.00020	0.00020	mg/L							
Arsenic, dissolved	< 0.00050	0.00050	mg/L							
Barium, dissolved	< 0.0050	0.0050	mg/L							
Beryllium, dissolved	< 0.00010	0.00010	mg/L							
Bismuth, dissolved	< 0.00010	0.00010	mg/L							
Boron, dissolved	< 0.0050	0.0050	mg/L							
Cadmium, dissolved	< 0.000010	0.000010	mg/L							
Calcium, dissolved	< 0.20	0.20	mg/L							
Chromium, dissolved	< 0.00050	0.00050	mg/L							
Cobalt, dissolved	< 0.00010	0.00010	mg/L							
Copper, dissolved	< 0.00040	0.00040	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.00020	0.00020	mg/L							
Lithium, dissolved	< 0.00010	0.00010	mg/L							
Magnesium, dissolved	< 0.010	0.010	mg/L							
Manganese, dissolved	< 0.00020	0.00020	mg/L							
Molybdenum, dissolved	< 0.00010	0.00010	mg/L							
Nickel, dissolved	< 0.00040	0.00040	mg/L							
Phosphorus, dissolved	< 0.050	0.050	mg/L							
Potassium, dissolved	< 0.10	0.10	mg/L							
Selenium, dissolved	< 0.00050	0.00050	mg/L							
Silicon, dissolved	< 1.0	1.0	mg/L							
Silver, dissolved	< 0.000050	0.000050	mg/L							
Sodium, dissolved	< 0.10	0.10	mg/L							
Strontium, dissolved	< 0.0010	0.0010	mg/L							
Sulfur, dissolved	< 3.0	3.0	mg/L							
Tellurium, dissolved	< 0.00050	0.00050	mg/L							
Thallium, dissolved	< 0.000020	0.000020	mg/L							
Thorium, dissolved	< 0.00010	0.00010	mg/L							
Tin, dissolved	< 0.00020	0.00020	mg/L							
Titanium, dissolved	< 0.0050	0.0050	mg/L							
Tungsten, dissolved	< 0.0010	0.0010	mg/L							
Uranium, dissolved	< 0.000020	0.000020	mg/L							
Vanadium, dissolved	< 0.0010	0.0010	mg/L							
Zinc, dissolved	< 0.0040	0.0040	mg/L							
Zirconium, dissolved	< 0.00010	0.00010	mg/L							
Blank (B8K0330-BLK3)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Aluminum, dissolved	< 0.0050	0.0050	mg/L							
Antimony, dissolved	< 0.00020	0.00020	mg/L							
Arsenic, dissolved	< 0.00050	0.00050	mg/L							
Barium, dissolved	< 0.0050	0.0050	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102785
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 11:16

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Dissolved Metals, Batch B8K0330, Continued										
Blank (B8K0330-BLK3), Continued				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Beryllium, dissolved	< 0.00010	0.00010	mg/L							
Bismuth, dissolved	< 0.00010	0.00010	mg/L							
Boron, dissolved	< 0.0050	0.0050	mg/L							
Cadmium, dissolved	< 0.000010	0.000010	mg/L							
Calcium, dissolved	< 0.20	0.20	mg/L							
Chromium, dissolved	< 0.00050	0.00050	mg/L							
Cobalt, dissolved	< 0.00010	0.00010	mg/L							
Copper, dissolved	< 0.00040	0.00040	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.00020	0.00020	mg/L							
Lithium, dissolved	< 0.00010	0.00010	mg/L							
Magnesium, dissolved	< 0.010	0.010	mg/L							
Manganese, dissolved	< 0.00020	0.00020	mg/L							
Molybdenum, dissolved	< 0.00010	0.00010	mg/L							
Nickel, dissolved	< 0.00040	0.00040	mg/L							
Phosphorus, dissolved	< 0.050	0.050	mg/L							
Potassium, dissolved	< 0.10	0.10	mg/L							
Selenium, dissolved	< 0.00050	0.00050	mg/L							
Silicon, dissolved	< 1.0	1.0	mg/L							
Silver, dissolved	< 0.000050	0.000050	mg/L							
Sodium, dissolved	< 0.10	0.10	mg/L							
Strontium, dissolved	< 0.0010	0.0010	mg/L							
Sulfur, dissolved	< 3.0	3.0	mg/L							
Tellurium, dissolved	< 0.00050	0.00050	mg/L							
Thallium, dissolved	< 0.000020	0.000020	mg/L							
Thorium, dissolved	< 0.00010	0.00010	mg/L							
Tin, dissolved	< 0.00020	0.00020	mg/L							
Titanium, dissolved	< 0.0050	0.0050	mg/L							
Tungsten, dissolved	< 0.0010	0.0010	mg/L							
Uranium, dissolved	< 0.000020	0.000020	mg/L							
Vanadium, dissolved	< 0.0010	0.0010	mg/L							
Zinc, dissolved	< 0.0040	0.0040	mg/L							
Zirconium, dissolved	< 0.00010	0.00010	mg/L							
LCS (B8K0330-BS1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Aluminum, dissolved	0.0208	0.0050	mg/L	0.0200		104	80-120			
Antimony, dissolved	0.0180	0.00020	mg/L	0.0200		90	80-120			
Arsenic, dissolved	0.0197	0.00050	mg/L	0.0200		99	80-120			
Barium, dissolved	0.0200	0.0050	mg/L	0.0200		100	80-120			
Beryllium, dissolved	0.0185	0.00010	mg/L	0.0200		93	80-120			
Bismuth, dissolved	0.0204	0.00010	mg/L	0.0200		102	80-120			
Boron, dissolved	0.0167	0.0050	mg/L	0.0200		84	80-120			
Cadmium, dissolved	0.0197	0.000010	mg/L	0.0200		98	80-120			
Calcium, dissolved	1.90	0.20	mg/L	2.00		95	80-120			
Chromium, dissolved	0.0210	0.00050	mg/L	0.0200		105	80-120			
Cobalt, dissolved	0.0205	0.00010	mg/L	0.0200		103	80-120			
Copper, dissolved	0.0194	0.00040	mg/L	0.0200		97	80-120			
Iron, dissolved	1.89	0.010	mg/L	2.00		95	80-120			
Lead, dissolved	0.0195	0.00020	mg/L	0.0200		97	80-120			
Lithium, dissolved	0.0188	0.00010	mg/L	0.0200		94	80-120			
Magnesium, dissolved	1.97	0.010	mg/L	2.00		98	80-120			
Manganese, dissolved	0.0189	0.00020	mg/L	0.0200		95	80-120			
Molybdenum, dissolved	0.0194	0.00010	mg/L	0.0200		97	80-120			
Nickel, dissolved	0.0199	0.00040	mg/L	0.0200		100	80-120			
Phosphorus, dissolved	1.87	0.050	mg/L	2.00		93	80-120			
Potassium, dissolved	1.79	0.10	mg/L	2.00		90	80-120			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102785
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 11:16

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Dissolved Metals, Batch B8K0330, Continued										
LCS (B8K0330-BS1), Continued				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Selenium, dissolved	0.0197	0.00050	mg/L	0.0200		99	80-120			
Silicon, dissolved	1.9	1.0	mg/L	2.00		97	80-120			
Silver, dissolved	0.0184	0.000050	mg/L	0.0200		92	80-120			
Sodium, dissolved	2.12	0.10	mg/L	2.00		106	80-120			
Strontium, dissolved	0.0191	0.0010	mg/L	0.0200		95	80-120			
Sulfur, dissolved	4.6	3.0	mg/L	5.00		93	80-120			
Tellurium, dissolved	0.0206	0.00050	mg/L	0.0200		103	80-120			
Thallium, dissolved	0.0198	0.000020	mg/L	0.0200		99	80-120			
Thorium, dissolved	0.0168	0.00010	mg/L	0.0200		84	80-120			
Tin, dissolved	0.0209	0.00020	mg/L	0.0200		105	80-120			
Titanium, dissolved	0.0201	0.0050	mg/L	0.0200		100	80-120			
Tungsten, dissolved	0.0186	0.0010	mg/L	0.0200		93	80-120			
Uranium, dissolved	0.0179	0.000020	mg/L	0.0200		90	80-120			
Vanadium, dissolved	0.0207	0.0010	mg/L	0.0200		103	80-120			
Zinc, dissolved	0.0204	0.0040	mg/L	0.0200		102	80-120			
Zirconium, dissolved	0.0224	0.00010	mg/L	0.0200		112	80-120			
Reference (B8K0330-SRM1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Aluminum, dissolved	0.226	0.0050	mg/L	0.233		97	79-114			
Antimony, dissolved	0.0476	0.00020	mg/L	0.0430		111	89-123			
Arsenic, dissolved	0.444	0.00050	mg/L	0.438		101	87-113			
Barium, dissolved	3.19	0.0050	mg/L	3.35		95	85-114			
Beryllium, dissolved	0.213	0.00010	mg/L	0.213		100	79-122			
Boron, dissolved	1.60	0.0050	mg/L	1.74		92	79-117			
Cadmium, dissolved	0.223	0.000010	mg/L	0.224		100	89-112			
Calcium, dissolved	7.95	0.20	mg/L	7.69		103	85-120			
Chromium, dissolved	0.494	0.00050	mg/L	0.437		113	87-113			
Cobalt, dissolved	0.130	0.00010	mg/L	0.128		101	90-117			
Copper, dissolved	0.855	0.00040	mg/L	0.844		101	90-115			
Iron, dissolved	1.29	0.010	mg/L	1.29		100	86-112			
Lead, dissolved	0.110	0.00020	mg/L	0.112		98	90-113			
Lithium, dissolved	0.102	0.00010	mg/L	0.104		98	77-127			
Magnesium, dissolved	6.97	0.010	mg/L	6.92		101	84-116			
Manganese, dissolved	0.317	0.00020	mg/L	0.345		92	85-113			
Molybdenum, dissolved	0.430	0.00010	mg/L	0.426		101	87-112			
Nickel, dissolved	0.830	0.00040	mg/L	0.840		99	90-114			
Phosphorus, dissolved	0.472	0.050	mg/L	0.495		95	74-119			
Potassium, dissolved	2.77	0.10	mg/L	3.19		87	78-119			
Selenium, dissolved	0.0347	0.00050	mg/L	0.0331		105	89-123			
Sodium, dissolved	18.6	0.10	mg/L	19.1		98	81-117			
Strontium, dissolved	0.885	0.0010	mg/L	0.916		97	82-111			
Thallium, dissolved	0.0383	0.000020	mg/L	0.0393		97	90-113			
Uranium, dissolved	0.255	0.000020	mg/L	0.266		96	87-113			
Vanadium, dissolved	0.860	0.0010	mg/L	0.869		99	85-110			
Zinc, dissolved	0.859	0.0040	mg/L	0.881		98	88-114			
Dissolved Metals, Batch B8K0395										
Blank (B8K0395-BLK1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Mercury, dissolved	< 0.000010	0.000010	mg/L							
Blank (B8K0395-BLK2)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Mercury, dissolved	< 0.000010	0.000010	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102785
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 11:16

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Dissolved Metals, Batch B8K0395, Continued										
Reference (B8K0395-SRM1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Mercury, dissolved	0.00523	0.000010	mg/L	0.00489		107	80-120			
Reference (B8K0395-SRM2)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Mercury, dissolved	0.00496	0.000010	mg/L	0.00489		101	80-120			
General Parameters, Batch B8K0081										
Blank (B8K0081-BLK1)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
Turbidity	< 0.10	0.10	NTU							
General Parameters, Batch B8K0093										
Blank (B8K0093-BLK1)				Prepared: 2018-11-02, Analyzed: 2018-11-02						
Colour, True	< 5.0	5.0	CU							
Blank (B8K0093-BLK2)				Prepared: 2018-11-02, Analyzed: 2018-11-02						
Colour, True	< 5.0	5.0	CU							
LCS (B8K0093-BS1)				Prepared: 2018-11-02, Analyzed: 2018-11-02						
Colour, True	11	5.0	CU	10.0		105	85-115			
LCS (B8K0093-BS2)				Prepared: 2018-11-02, Analyzed: 2018-11-02						
Colour, True	11	5.0	CU	10.0		109	85-115			
General Parameters, Batch B8K0097										
Blank (B8K0097-BLK1)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
UV Transmittance @ 254nm	< 0.10	0.10	% T							
LCS (B8K0097-BS1)				Prepared: 2018-11-01, Analyzed: 2018-11-01						
UV Transmittance @ 254nm	46.8	0.10	% T	46.5		101	98-103			
General Parameters, Batch B8K0141										
Blank (B8K0141-BLK1)				Prepared: 2018-11-02, Analyzed: 2018-11-02						
Alkalinity, Total (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1.0	1.0	mg/L							
Blank (B8K0141-BLK2)				Prepared: 2018-11-02, Analyzed: 2018-11-02						
Alkalinity, Total (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1.0	1.0	mg/L							
LCS (B8K0141-BS1)				Prepared: 2018-11-02, Analyzed: 2018-11-02						
Alkalinity, Total (as CaCO3)	103	1.0	mg/L	100		103	92-106			
LCS (B8K0141-BS2)				Prepared: 2018-11-02, Analyzed: 2018-11-02						
Alkalinity, Total (as CaCO3)	104	1.0	mg/L	100		104	92-106			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102785
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 11:16

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B8K0275										
Blank (B8K0275-BLK1)				Prepared: 2018-11-04, Analyzed: 2018-11-05						
Nitrogen, Total Kjeldahl	< 0.050	0.050	mg/L							
Blank (B8K0275-BLK2)				Prepared: 2018-11-04, Analyzed: 2018-11-05						
Nitrogen, Total Kjeldahl	< 0.050	0.050	mg/L							
LCS (B8K0275-BS1)				Prepared: 2018-11-04, Analyzed: 2018-11-05						
Nitrogen, Total Kjeldahl	1.09	0.050	mg/L	1.00		109	84-121			
LCS (B8K0275-BS2)				Prepared: 2018-11-04, Analyzed: 2018-11-05						
Nitrogen, Total Kjeldahl	1.06	0.050	mg/L	1.00		106	84-121			
General Parameters, Batch B8K0314										
Blank (B8K0314-BLK1)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Carbon, Total Organic	< 0.50	0.50	mg/L							
Blank (B8K0314-BLK2)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Carbon, Total Organic	< 0.50	0.50	mg/L							
Blank (B8K0314-BLK3)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Carbon, Total Organic	< 0.50	0.50	mg/L							
LCS (B8K0314-BS1)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Carbon, Total Organic	9.23	0.50	mg/L	10.0		92	78-116			
LCS (B8K0314-BS2)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Carbon, Total Organic	9.49	0.50	mg/L	10.0		95	78-116			
LCS (B8K0314-BS3)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Carbon, Total Organic	9.16	0.50	mg/L	10.0		92	78-116			
General Parameters, Batch B8K0373										
Blank (B8K0373-BLK1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Ammonia, Total (as N)	< 0.020	0.020	mg/L							
Blank (B8K0373-BLK2)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Ammonia, Total (as N)	< 0.020	0.020	mg/L							
Blank (B8K0373-BLK3)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Ammonia, Total (as N)	< 0.020	0.020	mg/L							
LCS (B8K0373-BS1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Ammonia, Total (as N)	0.989	0.020	mg/L	1.00		99	90-115			
LCS (B8K0373-BS2)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Ammonia, Total (as N)	0.989	0.020	mg/L	1.00		99	90-115			
LCS (B8K0373-BS3)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Ammonia, Total (as N)	1.00	0.020	mg/L	1.00		100	90-115			
General Parameters, Batch B8K0398										
Blank (B8K0398-BLK1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Solids, Total Dissolved	< 15	15	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102785
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 11:16

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B8K0398, Continued										
Blank (B8K0398-BLK2)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Solids, Total Dissolved	< 15	15	mg/L							
LCS (B8K0398-BS1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Solids, Total Dissolved	239	15	mg/L	240		100	85-115			
LCS (B8K0398-BS2)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Solids, Total Dissolved	232	15	mg/L	240		97	85-115			
General Parameters, Batch B8K0450										
Blank (B8K0450-BLK1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Sulfide, Total	< 0.020	0.020	mg/L							
Blank (B8K0450-BLK2)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Sulfide, Total	< 0.020	0.020	mg/L							
LCS (B8K0450-BS1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Sulfide, Total	0.478	0.020	mg/L	0.500		96	82-116			
LCS (B8K0450-BS2)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Sulfide, Total	0.463	0.020	mg/L	0.500		93	82-116			
General Parameters, Batch B8K0496										
Reference (B8K0496-SRM1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
pH	7.02	0.10	pH units	7.01		100	98-102			HT2
General Parameters, Batch B8K0601										
Blank (B8K0601-BLK1)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Conductivity (EC)	< 2.0	2.0	µS/cm							
Blank (B8K0601-BLK2)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Conductivity (EC)	< 2.0	2.0	µS/cm							
LCS (B8K0601-BS3)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Conductivity (EC)	1390	2.0	µS/cm	1410		98	95-104			
LCS (B8K0601-BS4)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Conductivity (EC)	1400	2.0	µS/cm	1410		99	95-104			
Total Metals, Batch B8K0321										
Blank (B8K0321-BLK1)				Prepared: 2018-11-05, Analyzed: 2018-11-06						
Aluminum, total	< 0.0050	0.0050	mg/L							
Antimony, total	< 0.00020	0.00020	mg/L							
Arsenic, total	< 0.00050	0.00050	mg/L							
Barium, total	< 0.0050	0.0050	mg/L							
Beryllium, total	< 0.00010	0.00010	mg/L							
Bismuth, total	< 0.00010	0.00010	mg/L							
Boron, total	< 0.0050	0.0050	mg/L							
Cadmium, total	< 0.000010	0.000010	mg/L							
Calcium, total	< 0.20	0.20	mg/L							
Chromium, total	< 0.00050	0.00050	mg/L							
Cobalt, total	< 0.00010	0.00010	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102785
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 11:16

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Total Metals, Batch B8K0321, Continued										
Blank (B8K0321-BLK1), Continued				Prepared: 2018-11-05, Analyzed: 2018-11-06						
Copper, total	< 0.00040	0.00040	mg/L							
Iron, total	< 0.010	0.010	mg/L							
Lead, total	< 0.00020	0.00020	mg/L							
Lithium, total	< 0.00010	0.00010	mg/L							
Magnesium, total	< 0.010	0.010	mg/L							
Manganese, total	< 0.00020	0.00020	mg/L							
Molybdenum, total	< 0.00010	0.00010	mg/L							
Nickel, total	< 0.00040	0.00040	mg/L							
Phosphorus, total	< 0.050	0.050	mg/L							
Potassium, total	< 0.10	0.10	mg/L							
Selenium, total	< 0.00050	0.00050	mg/L							
Silicon, total	< 1.0	1.0	mg/L							
Silver, total	< 0.000050	0.000050	mg/L							
Sodium, total	< 0.10	0.10	mg/L							
Strontium, total	< 0.0010	0.0010	mg/L							
Sulfur, total	< 3.0	3.0	mg/L							
Tellurium, total	< 0.00050	0.00050	mg/L							
Thallium, total	< 0.000020	0.000020	mg/L							
Thorium, total	< 0.00010	0.00010	mg/L							
Tin, total	< 0.00020	0.00020	mg/L							
Titanium, total	< 0.0050	0.0050	mg/L							
Tungsten, total	< 0.0010	0.0010	mg/L							
Uranium, total	< 0.000020	0.000020	mg/L							
Vanadium, total	< 0.0010	0.0010	mg/L							
Zinc, total	< 0.0040	0.0040	mg/L							
Zirconium, total	< 0.00010	0.00010	mg/L							
Blank (B8K0321-BLK2)				Prepared: 2018-11-05, Analyzed: 2018-11-06						
Aluminum, total	< 0.0050	0.0050	mg/L							
Antimony, total	< 0.00020	0.00020	mg/L							
Arsenic, total	< 0.00050	0.00050	mg/L							
Barium, total	< 0.0050	0.0050	mg/L							
Beryllium, total	< 0.00010	0.00010	mg/L							
Bismuth, total	< 0.00010	0.00010	mg/L							
Boron, total	< 0.0050	0.0050	mg/L							
Cadmium, total	< 0.000010	0.000010	mg/L							
Calcium, total	< 0.20	0.20	mg/L							
Chromium, total	< 0.00050	0.00050	mg/L							
Cobalt, total	< 0.00010	0.00010	mg/L							
Copper, total	< 0.00040	0.00040	mg/L							
Iron, total	< 0.010	0.010	mg/L							
Lead, total	< 0.00020	0.00020	mg/L							
Lithium, total	< 0.00010	0.00010	mg/L							
Magnesium, total	< 0.010	0.010	mg/L							
Manganese, total	< 0.00020	0.00020	mg/L							
Molybdenum, total	< 0.00010	0.00010	mg/L							
Nickel, total	< 0.00040	0.00040	mg/L							
Phosphorus, total	< 0.050	0.050	mg/L							
Potassium, total	< 0.10	0.10	mg/L							
Selenium, total	< 0.00050	0.00050	mg/L							
Silicon, total	< 1.0	1.0	mg/L							
Silver, total	< 0.000050	0.000050	mg/L							
Sodium, total	< 0.10	0.10	mg/L							
Strontium, total	< 0.0010	0.0010	mg/L							
Sulfur, total	< 3.0	3.0	mg/L							
Tellurium, total	< 0.00050	0.00050	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102785
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 11:16

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Total Metals, Batch B8K0321, Continued										
Blank (B8K0321-BLK2), Continued				Prepared: 2018-11-05, Analyzed: 2018-11-06						
Thallium, total	< 0.000020	0.000020	mg/L							
Thorium, total	< 0.00010	0.00010	mg/L							
Tin, total	< 0.00020	0.00020	mg/L							
Titanium, total	< 0.0050	0.0050	mg/L							
Tungsten, total	< 0.0010	0.0010	mg/L							
Uranium, total	< 0.000020	0.000020	mg/L							
Vanadium, total	< 0.0010	0.0010	mg/L							
Zinc, total	< 0.0040	0.0040	mg/L							
Zirconium, total	< 0.00010	0.00010	mg/L							
Blank (B8K0321-BLK3)				Prepared: 2018-11-05, Analyzed: 2018-11-06						
Aluminum, total	< 0.0050	0.0050	mg/L							
Antimony, total	< 0.00020	0.00020	mg/L							
Arsenic, total	< 0.00050	0.00050	mg/L							
Barium, total	< 0.0050	0.0050	mg/L							
Beryllium, total	< 0.00010	0.00010	mg/L							
Bismuth, total	< 0.00010	0.00010	mg/L							
Boron, total	< 0.0050	0.0050	mg/L							
Cadmium, total	< 0.000010	0.000010	mg/L							
Calcium, total	< 0.20	0.20	mg/L							
Chromium, total	< 0.00050	0.00050	mg/L							
Cobalt, total	< 0.00010	0.00010	mg/L							
Copper, total	< 0.00040	0.00040	mg/L							
Iron, total	< 0.010	0.010	mg/L							
Lead, total	< 0.00020	0.00020	mg/L							
Lithium, total	< 0.00010	0.00010	mg/L							
Magnesium, total	< 0.010	0.010	mg/L							
Manganese, total	< 0.00020	0.00020	mg/L							
Molybdenum, total	< 0.00010	0.00010	mg/L							
Nickel, total	< 0.00040	0.00040	mg/L							
Phosphorus, total	< 0.050	0.050	mg/L							
Potassium, total	< 0.10	0.10	mg/L							
Selenium, total	< 0.00050	0.00050	mg/L							
Silicon, total	< 1.0	1.0	mg/L							
Silver, total	< 0.000050	0.000050	mg/L							
Sodium, total	< 0.10	0.10	mg/L							
Strontium, total	< 0.0010	0.0010	mg/L							
Sulfur, total	< 3.0	3.0	mg/L							
Tellurium, total	< 0.00050	0.00050	mg/L							
Thallium, total	< 0.000020	0.000020	mg/L							
Thorium, total	< 0.00010	0.00010	mg/L							
Tin, total	< 0.00020	0.00020	mg/L							
Titanium, total	< 0.0050	0.0050	mg/L							
Tungsten, total	< 0.0010	0.0010	mg/L							
Uranium, total	< 0.000020	0.000020	mg/L							
Vanadium, total	< 0.0010	0.0010	mg/L							
Zinc, total	< 0.0040	0.0040	mg/L							
Zirconium, total	< 0.00010	0.00010	mg/L							
LCS (B8K0321-BS1)				Prepared: 2018-11-05, Analyzed: 2018-11-06						
Aluminum, total	0.0239	0.0050	mg/L	0.0200		119	80-120			
Antimony, total	0.0201	0.00020	mg/L	0.0200		100	80-120			
Arsenic, total	0.0201	0.00050	mg/L	0.0200		100	80-120			
Barium, total	0.0208	0.0050	mg/L	0.0200		104	80-120			
Beryllium, total	0.0197	0.00010	mg/L	0.0200		98	80-120			
Bismuth, total	0.0206	0.00010	mg/L	0.0200		103	80-120			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102785
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 11:16

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Total Metals, Batch B8K0321, Continued										
LCS (B8K0321-BS1), Continued				Prepared: 2018-11-05, Analyzed: 2018-11-06						
Boron, total	0.0181	0.0050	mg/L	0.0200		91	80-120			
Cadmium, total	0.0202	0.000010	mg/L	0.0200		101	80-120			
Calcium, total	2.00	0.20	mg/L	2.00		100	80-120			
Chromium, total	0.0218	0.00050	mg/L	0.0200		109	80-120			
Cobalt, total	0.0207	0.00010	mg/L	0.0200		104	80-120			
Copper, total	0.0218	0.00040	mg/L	0.0200		109	80-120			
Iron, total	1.94	0.010	mg/L	2.00		97	80-120			
Lead, total	0.0199	0.00020	mg/L	0.0200		99	80-120			
Lithium, total	0.0200	0.00010	mg/L	0.0200		100	80-120			
Magnesium, total	2.09	0.010	mg/L	2.00		104	80-120			
Manganese, total	0.0201	0.00020	mg/L	0.0200		101	80-120			
Molybdenum, total	0.0196	0.00010	mg/L	0.0200		98	80-120			
Nickel, total	0.0214	0.00040	mg/L	0.0200		107	80-120			
Phosphorus, total	2.03	0.050	mg/L	2.00		102	80-120			
Potassium, total	1.91	0.10	mg/L	2.00		95	80-120			
Selenium, total	0.0209	0.00050	mg/L	0.0200		105	80-120			
Silicon, total	2.1	1.0	mg/L	2.00		103	80-120			
Silver, total	0.0180	0.000050	mg/L	0.0200		90	80-120			
Sodium, total	2.28	0.10	mg/L	2.00		114	80-120			
Strontium, total	0.0221	0.0010	mg/L	0.0200		111	80-120			
Sulfur, total	4.0	3.0	mg/L	5.00		81	80-120			
Tellurium, total	0.0220	0.00050	mg/L	0.0200		110	80-120			
Thallium, total	0.0202	0.000020	mg/L	0.0200		101	80-120			
Thorium, total	0.0172	0.00010	mg/L	0.0200		86	80-120			
Tin, total	0.0209	0.00020	mg/L	0.0200		105	80-120			
Titanium, total	0.0196	0.0050	mg/L	0.0200		98	80-120			
Tungsten, total	0.0210	0.0010	mg/L	0.0200		105	80-120			
Uranium, total	0.0204	0.000020	mg/L	0.0200		102	80-120			
Vanadium, total	0.0217	0.0010	mg/L	0.0200		109	80-120			
Zinc, total	0.0211	0.0040	mg/L	0.0200		106	80-120			
Zirconium, total	0.0223	0.00010	mg/L	0.0200		111	80-120			
Reference (B8K0321-SRM1)				Prepared: 2018-11-05, Analyzed: 2018-11-06						
Aluminum, total	0.309	0.0050	mg/L	0.303		102	82-114			
Antimony, total	0.0527	0.00020	mg/L	0.0511		103	88-115			
Arsenic, total	0.117	0.00050	mg/L	0.118		100	88-111			
Barium, total	0.797	0.0050	mg/L	0.823		97	83-110			
Beryllium, total	0.0478	0.00010	mg/L	0.0496		96	80-119			
Boron, total	3.41	0.0050	mg/L	3.45		99	80-118			
Cadmium, total	0.0496	0.000010	mg/L	0.0495		100	90-110			
Calcium, total	11.9	0.20	mg/L	11.6		103	85-113			
Chromium, total	0.268	0.00050	mg/L	0.250		107	88-111			
Cobalt, total	0.0393	0.00010	mg/L	0.0377		104	90-114			
Copper, total	0.540	0.00040	mg/L	0.486		111	90-117			
Iron, total	0.525	0.010	mg/L	0.488		108	90-116			
Lead, total	0.199	0.00020	mg/L	0.204		98	90-110			
Lithium, total	0.425	0.00010	mg/L	0.403		105	79-118			
Magnesium, total	4.22	0.010	mg/L	3.79		111	88-116			
Manganese, total	0.105	0.00020	mg/L	0.109		96	88-108			
Molybdenum, total	0.203	0.00010	mg/L	0.198		102	88-110			
Nickel, total	0.259	0.00040	mg/L	0.249		104	90-112			
Phosphorus, total	0.213	0.050	mg/L	0.227		94	72-118			
Potassium, total	7.88	0.10	mg/L	7.21		109	87-116			
Selenium, total	0.120	0.00050	mg/L	0.121		99	90-122			
Sodium, total	8.28	0.10	mg/L	7.54		110	86-118			
Strontium, total	0.380	0.0010	mg/L	0.375		101	86-110			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8102785
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-13 11:16

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Total Metals, Batch B8K0321, Continued										
Reference (B8K0321-SRM1), Continued				Prepared: 2018-11-05, Analyzed: 2018-11-06						
Thallium, total	0.0872	0.000020	mg/L	0.0805		108	90-113			
Uranium, total	0.0305	0.000020	mg/L	0.0306		100	88-112			
Vanadium, total	0.407	0.0010	mg/L	0.386		105	87-110			
Zinc, total	2.54	0.0040	mg/L	2.49		102	90-113			
Total Metals, Batch B8K0397										
Blank (B8K0397-BLK1)				Prepared: 2018-11-06, Analyzed: 2018-11-07						
Mercury, total	< 0.000010	0.000010	mg/L							
Blank (B8K0397-BLK2)				Prepared: 2018-11-06, Analyzed: 2018-11-07						
Mercury, total	< 0.000010	0.000010	mg/L							
Reference (B8K0397-SRM1)				Prepared: 2018-11-06, Analyzed: 2018-11-07						
Mercury, total	0.00516	0.000010	mg/L	0.00489		106	80-120			
Reference (B8K0397-SRM2)				Prepared: 2018-11-06, Analyzed: 2018-11-07						
Mercury, total	0.00454	0.000010	mg/L	0.00489		93	80-120			

QC Qualifiers:

HT2	The 15 minute recommended holding time (from sampling to analysis) has been exceeded - field analysis is recommended.
MIC29	The difference in logs is less than the R value.

LOGIN NOTICE (Work Order 8110123)

CLIENT	Associated Environmental Consultants Inc. (Vernon)		
PO NUMBER		**QUOTATION ID**	AE Master Bid (BC)
PROJECT	2018-8152.000.003	**SUBMITTED BY**	
PROJECT INFO	SCRD GW Investigation	**COC NO.**	

Receipt Details:

RECEIVED	2018-11-02 08:30	**LOGGED IN**	2018-11-02 09:56
LOCATION	Richmond Lab	**ACCOUNT MGR**	Eilish St.Clair, B.Sc., C.I.T.

Sample Condition Summary: Quantity of Transport Vessels Received: 1

Receipt Temperature = 5°C

Broken Container(s)	No	Sampling Date(s) Missing	No	Incorrect Cont./Pres.	No
Cooling Initiated	Yes	Sample(s) Frozen	No	Missing/Extra Samples	No

Note: *Sample transport temperatures of less than 8°C for microbiological parameters and less than or equal to 10°C for environmental parameters is recommended. Samples that exceed these values will still be processed. However, please note that the analytical results may be affected, especially for samples collected prior to the day of receipt.*

REPORT TO	Nicole Penner Associated Environmental Consultants Inc. (Vernon) #200 - 2800 29th Street Vernon, BC V1T 9P9 Tel: (250) 545-3672	**INCLUDE QC** **INCLUDE COC** **EXTRAS**	Yes No Guidelines
INVOICE TO	Nicole Penner Associated Environmental Consultants Inc. (Vernon) #200 - 2800 29th Street Vernon, BC V1T 9P9 Tel: (250) 545-3672	**FREQUENCY** **GST EXEMPT** **PAYMENT TERMS** **MIN AMOUNT**	With Report No Upon Receipt N/A

Delivery Plan:

REPORT DUE Draft: 2018-11-09 15:30 (5 day TAT) | Final: 2018-11-21 15:30 (12 day TAT)

Contact Name	Email / Fax / Cellular	Login Notice	Report	Invoice	EDD	EDD Format	CC to	Fax	Text	Mail
Nicole Penner	pennern@ae.ca	✓	✓		✓	CARO Excel	support@wirelesswater.com			
Nicole Penner	pennern@ae.ca			✓			anzej@ae.ca			
Wireless H2O v2 EDD Uploaded by CARO on behalf of Client										

Analysis Schedule:

Analysis / Version	Due	Expires [1]	Status	Comments
WIN 54928 (8110123-01) | Matrix: Water | Sampled: 2018-11-01 11:30				

LOGIN NOTICE (Work Order 8110123)

Analysis Schedule, Continued:

Analysis / Version	Due	Expires [1]	Status	Comments
WIN 54928 (8110123-01) | Matrix: Water | Sampled: 2018-11-01 11:30, Continued				
Container(s) Submitted:				
A = C13_500 mL Plastic (General)	*B = C13_500 mL Plastic (General)*	*C = C13_500 mL Plastic (General)*		
D = C07_300 mL Plastic (Micro-S)	*E = C07_300 mL Plastic (Micro-S)*	*F = C10_125 mL Plastic (H2SO4)*		
G = C10_125 mL Plastic (H2SO4)	*H = C23_125 mL Plastic (Sulfide)*	*I = C05_125 mL Plastic (Metals)*		
J = C06_40 mL Vial (Mercury)	*K = S05_125 mL Plastic (Metals-F)*	*L = S06_40 mL Vial (Mercury-F)*		
M = C14_40 mL Vial (TOC)	*N = C14_40 mL Vial (TOC)*	*O = S14_40 mL Vial (DOC-F)*		
P = S14_40 mL Vial (DOC-F)	*Q = C04_40 mL Vial (VOC Water)*	*R = C04_40 mL Vial (VOC Water)*		
S = C22_125 mL Plastic (General)				
Alkalinity	2018-11-09	2018-11-15	Available	
Anions by IC (3) Pkg	2018-11-09	2018-11-29	Batched	
Carbon, Total Organic	2018-11-09	2018-11-29	Available	
Coliforms, Total & E. coli (MF) Pkg	2018-11-09	2018-11-02	Subcontracted	
Colour, True	2018-11-09	2018-11-04	Analyzed	
Conductivity	2018-11-09	2018-11-29	Available	
Heterotrophic Plate Count	2018-11-09	2018-11-02	Subcontracted	Subcontracted
Iron Related Bacteria (Count)	2018-11-21	2018-11-03	Batched	
Langelier Index	2018-11-09	2018-11-29	Available	
Mercury, dissolved by CVAFS	2018-11-09	2018-11-29	Available	
Mercury, total by CVAFS	2018-11-09	2018-11-29	Available	
Metals, Dissolved by ICPMS (All) Pkg	2018-11-09	2019-04-30	Available	
Metals, Total by ICPMS (All) Pkg	2018-11-09	2019-04-30	Available	
Nitrogen, Organic (Calc TKN, NH3)	2018-11-09	2018-11-29	Available	
Nitrogen, Total (TKN, NO2+NO3 by colour)	2018-11-09	2018-11-04	Available	
pH	2018-11-09	2018-11-01	Available	
Solids, Total Dissolved	2018-11-09	2018-11-08	Available	
Sulfate Reducing Bacteria (Count)	2018-11-21	2018-11-03	Batched	
Sulfide, Total	2018-11-09	2018-11-08	Available	
Transmittance at 254 nm	2018-11-09	2018-11-04	Analyzed	
Turbidity	2018-11-09	2018-11-04	Analyzed	

1 *Red font indicates that the analysis has already or is about to expire. In order to guarantee that your samples will be analyzed within the recommended holding time, they must be received at least one day prior to the expiry date (3 hours for microbiological testing). Note that all pH in water / Chlorine / Temperature / Dissolved Oxygen results will be automatically be qualified as they should be analyzed in the field for greatest accuracy.*

LOGIN NOTICE (Work Order 8110123)

Packages and their respective Analyses included in this Work Order:

Anions by IC (3) Pkg

Chloride by IC	Fluoride by IC	Sulfate by IC

Coliforms, Total & E. coli (MF) Pkg

Coliforms, Total (MF)	E. coli (MF)

Metals, Dissolved by ICPMS (All) Pkg

Aluminum, dissolved by ICPMS	Antimony, dissolved by ICPMS	Arsenic, dissolved by ICPMS
Barium, dissolved by ICPMS	Beryllium, dissolved by ICPMS	Bismuth, dissolved by ICPMS
Boron, dissolved by ICPMS	Cadmium, dissolved by ICPMS	Calcium, dissolved by ICPMS
Chromium, dissolved by ICPMS	Cobalt, dissolved by ICPMS	Copper, dissolved by ICPMS
Hardness, Total (as CaCO3) (Calc)	Iron, dissolved by ICPMS	Lead, dissolved by ICPMS
Lithium, dissolved by ICPMS	Magnesium, dissolved by ICPMS	Manganese, dissolved by ICPMS
Molybdenum, dissolved by ICPMS	Nickel, dissolved by ICPMS	Phosphorus, dissolved by ICPMS
Potassium, dissolved by ICPMS	Selenium, dissolved by ICPMS	Silicon, dissolved by ICPMS
Silver, dissolved by ICPMS	Sodium, dissolved by ICPMS	Strontium, dissolved by ICPMS
Sulfur, dissolved by ICPMS	Tellurium, dissolved by ICPMS	Thallium, dissolved by ICPMS
Thorium, dissolved by ICPMS	Tin, dissolved by ICPMS	Titanium, dissolved by ICPMS
Tungsten, dissolved by ICPMS	Uranium, dissolved by ICPMS	Vanadium, dissolved by ICPMS
Zinc, dissolved by ICPMS	Zirconium, dissolved by ICPMS	

Metals, Total by ICPMS (All) Pkg

Aluminum, total by ICPMS	Antimony, total by ICPMS	Arsenic, total by ICPMS
Barium, total by ICPMS	Beryllium, total by ICPMS	Bismuth, total by ICPMS
Boron, total by ICPMS	Cadmium, total by ICPMS	Calcium, total by ICPMS
Chromium, total by ICPMS	Cobalt, total by ICPMS	Copper, total by ICPMS
Hardness, Total (as CaCO3) (Calc)	Iron, total by ICPMS	Lead, total by ICPMS
Lithium, total by ICPMS	Magnesium, total by ICPMS	Manganese, total by ICPMS
Molybedenum, total by ICPMS	Nickel, total by ICPMS	Phosphorus, total by ICPMS
Potassium, total by ICPMS	Selenium, total by ICPMS	Silicon, total by ICPMS
Silver, total by ICPMS	Sodium, total by ICPMS	Strontium, total by ICPMS
Sulfur, total by ICPMS	Tellurium, total by ICPMS	Thallium, total by ICPMS
Thorium, total by ICPMS	Tin, total by ICPMS	Titanium, total by ICPMS
Tungsten, total by ICPMS	Uranium, total by ICPMS	Vanadium, total by ICPMS
Zinc, total by ICPMS	Zirconium, total by ICPMS	

Nitrogen, Organic (Calc TKN, NH3)

Ammonia, Total	Nitrogen, Organic (Calc)

Nitrogen, Total (TKN, NO2+NO3 by colour)

Nitrate+Nitrite by Colorimetry	Nitrogen, Total (Calc)	Nitrogen, Total Kjeldahl

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Each Analysis includes the following Analytes and their respective Reporting Limits [RLs]:			
Alkalinity in Water	*Reference Method: SM 2320 B* (2011)*		*Units: mg/L*
Alkalinity, Total (as CaCO3) [1]	Alkalinity, Phenolphthalein (as CaCO3) [1]	Alkalinity, Bicarbonate (as CaCO3) [1]	Alkalinity, Carbonate (as CaCO3) [1]
Alkalinity, Hydroxide (as CaCO3) [1]			
Ammonia, Total in Water	*Reference Method: SM 4500-NH3 G* (2011)*		*Units: mg/L*
Ammonia, Total (as N) [0.02]			
Anions by IC in Water	*Reference Method: SM 4110 B (2011)*		*Units: mg/L*
Chloride [0.1]	Fluoride [0.1]	Sulfate [1]	
Carbon, Total Organic in Water	*Reference Method: SM 5310 B (2011)*		*Units: mg/L*
Carbon, Total Organic [0.5]			
Coliforms, Total (MF) in Water	*Reference Method: SM 9222 (2006)*		*Units: CFU/100 mL*
Coliforms, Total [1]			
Colour, True in Water	*Reference Method: SM 2120 C (2011)*		*Units: CU*
Colour, True [5]			
Conductivity in Water	*Reference Method: SM 2510 B (2011)*		*Units: uS/cm*
Conductivity (EC) [2]			
Dissolved Metals by ICPMS in Water	*Reference Method: EPA 200.8 / EPA 6020B*		*Units: mg/L*
Aluminum, dissolved [0.005]	Antimony, dissolved [0.0002]	Arsenic, dissolved [0.0005]	Barium, dissolved [0.005]
Beryllium, dissolved [0.0001]	Bismuth, dissolved [0.0001]	Boron, dissolved [0.005]	Cadmium, dissolved [1e-005]
Calcium, dissolved [0.2]	Chromium, dissolved [0.0005]	Cobalt, dissolved [0.0001]	Copper, dissolved [0.0004]
Iron, dissolved [0.01]	Lead, dissolved [0.0002]	Lithium, dissolved [0.0001]	Magnesium, dissolved [0.01]
Manganese, dissolved [0.0002]	Molybdenum, dissolved [0.0001]	Nickel, dissolved [0.0004]	Phosphorus, dissolved [0.05]
Potassium, dissolved [0.1]	Selenium, dissolved [0.0005]	Silicon, dissolved [1]	Silver, dissolved [5e-005]
Sodium, dissolved [0.1]	Strontium, dissolved [0.001]	Sulfur, dissolved [3]	Tellurium, dissolved [0.0005]
Thallium, dissolved [2e-005]	Thorium, dissolved [0.0001]	Tin, dissolved [0.0002]	Titanium, dissolved [0.005]
Tungsten, dissolved [0.001]	Uranium, dissolved [2e-005]	Vanadium, dissolved [0.001]	Zinc, dissolved [0.004]
Zirconium, dissolved [0.0001]			
E. coli (MF) in Water	*Reference Method: SM 9223 B (2004)*		*Units: CFU/100 mL*
E. coli [1]			
Heterotrophic Plate Count in Water	*Reference Method: SM 9215 B (2004)*		*Units: CFU/mL*
Heterotrophic Plate Count [1]			
Iron Related Bacteria (Count) in Water	*Reference Method: DBI DBISOP06*		*Units: CFU/mL*
Iron Related Bacteria [2]			

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Langelier Index in Water	*Reference Method: SM 2330 B (2010)*	*Units: -*
Langelier Index [-5]		
Mercury by CVAFS in Water	*Reference Method: EPA 245.7**	*Units: mg/L*
Mercury, dissolved [1e-005]	Mercury, total [1e-005]	
Nitrate+Nitrite by Colorimetry in Water	*Reference Method: SM 4500-NO3- F (2011)*	*Units: mg/L*
Nitrate+Nitrite (as N) [0.005]		
Nitrogen, Total Kjeldahl in Water	*Reference Method: SM 4500-Norg D* (2011)*	*Units: mg/L*
Nitrogen, Total Kjeldahl [0.05]		
pH in Water	*Reference Method: SM 4500-H+ B (2011)*	*Units: pH units*
pH [0.1]		
Solids, Total Dissolved in Water	*Reference Method: SM 2540 C* (2011)*	*Units: mg/L*
Solids, Total Dissolved [15]		
Sulfate Reducing Bacteria (Count) in Water	*Reference Method: DBI DBSLW05*	*Units: CFU/mL*
Sulfate Reducing Bacteria [8]		
Sulfide, Total in Water	*Reference Method: SM 4500-S2 D* (2011)*	*Units: mg/L*
Sulfide, Total [0.02]		
Total Metals by ICPMS in Water	*Reference Method: EPA 200.2* / EPA 6020B*	*Units: mg/L*
Aluminum, total [0.005]	Antimony, total [0.0002]	Arsenic, total [0.0005]
Barium, total [0.005]	Beryllium, total [0.0001]	Bismuth, total [0.0001]
Boron, total [0.005]	Cadmium, total [1e-005]	Calcium, total [0.2]
Chromium, total [0.0005]	Cobalt, total [0.0001]	Copper, total [0.0004]
Iron, total [0.01]	Lead, total [0.0002]	Lithium, total [0.0001]
Magnesium, total [0.01]	Manganese, total [0.0002]	Molybdenum, total [0.0001]
Nickel, total [0.0004]	Phosphorus, total [0.05]	Potassium, total [0.1]
Selenium, total [0.0005]	Silicon, total [1]	Silver, total [5e-005]
Sodium, total [0.1]	Strontium, total [0.001]	Sulfur, total [3]
Tellurium, total [0.0005]	Thallium, total [2e-005]	Thorium, total [0.0001]
Tin, total [0.0002]	Titanium, total [0.005]	Tungsten, total [0.001]
Uranium, total [2e-005]	Vanadium, total [0.001]	Zinc, total [0.004]
Zirconium, total [0.0001]		
Transmittance at 254 nm in Water	*Reference Method: SM 5910 B* (2013)*	*Units: % T*
UV Transmittance @ 254nm [0.1]		
Turbidity in Water	*Reference Method: SM 2130 B (2011)*	*Units: NTU*
Turbidity [0.1]		

Note: RLs on Final Report may be higher than expected due to: 1) limited sample volume, 2) high moisture, 3) analytical interferences

LOGIN NOTICE (Work Order 8110123)

Please verify that all of the information included in this Login Notice is correct. If there are any errors, omissions, or concerns, please contact us at 1-888-311-8846.

You can expect to receive the analytical report via email on or after the due date shown above.

Thank you for using CARO!

CARO ANALYTICAL SERVICES

110-4011 Viking Way, Richmond, BC V6V 2K9
T5S 1H7

8110123

Clear Form | Print a Copy | Save a Copy | CARO Website | CARO BC COC, Rev 03/14

CHAIN OF CUSTODY RECORD

COC# | PAGE 1 OF 1

RELINQUISHED BY:	DATE:	RECEIVED BY:	DATE:
	TIME: 1:00	PURO TC	TIME: 830

PROJECT: SCRD GW Investigation

PROJECT INFO: 2018-8152.000.003

REPORT TO:

COMPANY: Associated Environmental
ADDRESS: 200-2800 29th Street, Vernon, BC V1T 9P9
CONTACT: Nicole Penner
TEL/FAX: 250-545-3672 250-938-5537
EMAIL PDF ☒ EDD ☒
EMAIL 1: pennern@ae.ca; friesent@ae.ca
EMAIL 2: support@ wirelesswater.com
MAIL HARDCOPY ☐ HOLD FOR P/U ☐ FAX ☐

SAME AS REPORT TO ☒

COMPANY:
ADDRESS:
CONTACT:
TEL/FAX:
EMAIL PDF ☒
EMAIL 1: pennern@ae.ca
EMAIL 2: anzej@ae.ca
MAIL HARDCOPY ☐ HOLD FOR P/U ☐

SAMLPLED BY: Tony Friesen

PO #:

TURNAROUND TIME REQUESTED:
Routine: (5-7 Days) ☒
Rush: 1 Day* ☐ 2 Day* ☐ 3 Day* ☐
Other* ☐
*Contact Lab To Confirm. Surcharge May Apply

REGULATORY APPLICATION:
Canadian Drinking Water Quality Guidelines ☒ CCME ☐
BC Drinking Water Protection Act / Reg. ☐ ALBERTA TIER 1 ☐
BC CSR ☐ AL ☐ RL ☐ CL ☐ IL ☐ AW ☐
OTHER:

ANALYSES REQUESTED:

CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	TIME HH:MM	COMMENTS: CHLORINATED	FILTERED	PRESERVED	(i.e. flow/volume media ID/notes)	BTEX ☐ VPH ☐ PHC F1 ☐	VOC ☐ VPH ☐	EPH ☐ PHC F2-F4 ☐	PAH ☐ L/HEPH ☐	PHENOLS Chlorinated ☐ Non-Chlor. ☐	PCB ☐ GLYCOLS ☐ HAA ☐	PESTICIDES ☐ ACID HERBICIDES ☐	METALS - WATER TOTAL Hg ☒	METALS - WATER DISSOLVED Hg ☒	METALS - SOIL (SALM) ☐ inc. pH ☐	pH ☒ EC ☒ ALK ☒	TSS ☐ VSS ☐ TDS ☒	BOD ☐ COD ☐	TOG ☐ MOG ☐	FECAL COLIFORMS ☐ HPC ☒	TOTAL COLIFORMS ☒ E.coli ☒	ASBESTOS	Iron & sulphate reducing bacteria	Total and organic nitrogen package	Chloride, fluoride, sulphate	Corrosivity (Langelier index)	Sulphide	Total organic carbon	Colour, turbidity, UV transmittance	HOLD
~~WIN 54929~~		✓				~~26-10-18~~	~~09:30~~				300 USgpm								✓	✓		✓	✓			✓	✓		✓	✓	✓	✓	✓	✓	
WIN 54928		✓				1/11/18	1030												✓	✓		✓	✓			✓	✓		✓	✓	✓	✓	✓	✓	

SHIPPING INSTRUCTIONS: Return Cooler(s) ☐
Supplies Needed:

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will Apply):

OTHER INSTRUCTIONS:
Low-level DL for metals. Upload to Wireless Water. Ensure E. coli & total coliform DL of < 1 CFU/100 mL.

PAYMENT:
CHEQUE ☐
CREDIT ☐
DEBIT ☐
CASH ☐
INVOICE ☐

SAMPLE RECEIPT TEMP (°C): 5.0
Work Order # 8110213
CUSTODY SEAL INTACT Y ☐ N ☐ NA ☐

CERTIFICATE OF ANALYSIS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon) #200 - 2800 29th Street Vernon, BC V1T 9P9		
ATTENTION	Nicole Penner	**WORK ORDER**	8110123
PO NUMBER		**RECEIVED / TEMP**	2018-11-02 08:30 / 5°C
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07
PROJECT INFO	SCRD GW Investigation		

Introduction:

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

Big Picture Sidekicks

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

We've Got Chemistry

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

Ahead of the Curve

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

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

Authorized By:

Eilish St.Clair, B.Sc., C.I.T.
Client Service Representative

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8110123
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
WIN 54928 (8110123-01) | Matrix: Water | Sampled: 2018-11-01 11:30						
Anions						
Chloride	**2.24**	AO ≤ 250	0.10	mg/L	2018-11-06	
Fluoride	< 0.10	MAC = 1.5	0.10	mg/L	2018-11-06	
Nitrate+Nitrite (as N)	**0.502**	N/A	0.0050	mg/L	2018-11-07	
Sulfate	**7.8**	AO ≤ 500	1.0	mg/L	2018-11-06	
Biological Activity Reaction Tests						
Iron Related Bacteria	**35300**	N/A	2	CFU/mL	2018-11-03	
Sulfate Reducing Bacteria	< 8	N/A	8	CFU/mL	2018-11-03	
Calculated Parameters						
Hardness, Total (as CaCO3)	**38.3**	None Required	0.500	mg/L	N/A	
Langelier Index	**0.6**	N/A	-5.0	-	2018-11-14	
Nitrogen, Total	**0.502**	N/A	0.0500	mg/L	N/A	
Nitrogen, Organic	< 0.0500	N/A	0.0500	mg/L	N/A	
Dissolved Metals						
Aluminum, dissolved	< 0.0050	N/A	0.0050	mg/L	2018-11-09	
Antimony, dissolved	< 0.00020	N/A	0.00020	mg/L	2018-11-09	
Arsenic, dissolved	**0.00176**	N/A	0.00050	mg/L	2018-11-09	
Barium, dissolved	< 0.0050	N/A	0.0050	mg/L	2018-11-09	
Beryllium, dissolved	< 0.00010	N/A	0.00010	mg/L	2018-11-09	
Bismuth, dissolved	< 0.00010	N/A	0.00010	mg/L	2018-11-09	
Boron, dissolved	**0.0063**	N/A	0.0050	mg/L	2018-11-09	
Cadmium, dissolved	**0.000014**	N/A	0.000010	mg/L	2018-11-09	
Calcium, dissolved	**8.22**	N/A	0.20	mg/L	2018-11-09	
Chromium, dissolved	**0.00052**	N/A	0.00050	mg/L	2018-11-09	
Cobalt, dissolved	< 0.00010	N/A	0.00010	mg/L	2018-11-09	
Copper, dissolved	**0.00153**	N/A	0.00040	mg/L	2018-11-09	
Iron, dissolved	**0.016**	N/A	0.010	mg/L	2018-11-09	
Lead, dissolved	< 0.00020	N/A	0.00020	mg/L	2018-11-09	
Lithium, dissolved	**0.00059**	N/A	0.00010	mg/L	2018-11-09	
Magnesium, dissolved	**4.32**	N/A	0.010	mg/L	2018-11-09	
Manganese, dissolved	**0.00109**	N/A	0.00020	mg/L	2018-11-09	
Mercury, dissolved	< 0.000010	N/A	0.000010	mg/L	2018-11-07	
Molybdenum, dissolved	**0.00252**	N/A	0.00010	mg/L	2018-11-09	
Nickel, dissolved	**0.00061**	N/A	0.00040	mg/L	2018-11-09	
Phosphorus, dissolved	**0.072**	N/A	0.050	mg/L	2018-11-09	
Potassium, dissolved	**2.32**	N/A	0.10	mg/L	2018-11-09	
Selenium, dissolved	< 0.00050	N/A	0.00050	mg/L	2018-11-09	
Silicon, dissolved	**18.1**	N/A	1.0	mg/L	2018-11-09	
Silver, dissolved	< 0.000050	N/A	0.000050	mg/L	2018-11-09	
Sodium, dissolved	**5.64**	N/A	0.10	mg/L	2018-11-09	
Strontium, dissolved	**0.0228**	N/A	0.0010	mg/L	2018-11-09	

TEST RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8110123
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
WIN 54928 (8110123-01) | Matrix: Water | Sampled: 2018-11-01 11:30, Continued						
Dissolved Metals, Continued						
Sulfur, dissolved	< 3.0	N/A	3.0	mg/L	2018-11-09	
Tellurium, dissolved	< 0.00050	N/A	0.00050	mg/L	2018-11-09	
Thallium, dissolved	< 0.000020	N/A	0.000020	mg/L	2018-11-09	
Thorium, dissolved	< 0.00010	N/A	0.00010	mg/L	2018-11-09	
Tin, dissolved	< 0.00020	N/A	0.00020	mg/L	2018-11-09	
Titanium, dissolved	< 0.0050	N/A	0.0050	mg/L	2018-11-09	
Tungsten, dissolved	< 0.0010	N/A	0.0010	mg/L	2018-11-09	
Uranium, dissolved	**0.000094**	N/A	0.000020	mg/L	2018-11-09	
Vanadium, dissolved	**0.0069**	N/A	0.0010	mg/L	2018-11-09	
Zinc, dissolved	**0.0186**	N/A	0.0040	mg/L	2018-11-09	
Zirconium, dissolved	< 0.00010	N/A	0.00010	mg/L	2018-11-09	
General Parameters						
Alkalinity, Total (as CaCO3)	**40.6**	N/A	1.0	mg/L	2018-11-05	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2018-11-05	
Alkalinity, Bicarbonate (as CaCO3)	**40.6**	N/A	1.0	mg/L	2018-11-05	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2018-11-05	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2018-11-05	
Ammonia, Total (as N)	< 0.020	None Required	0.020	mg/L	2018-11-06	
Carbon, Total Organic	**0.91**	N/A	0.50	mg/L	2018-11-08	
Colour, True	< 5.0	AO ≤ 15	5.0	CU	2018-11-03	
Conductivity (EC)	**105**	N/A	2.0	µS/cm	2018-11-06	
Nitrogen, Total Kjeldahl	< 0.050	N/A	0.050	mg/L	2018-11-07	
pH	**7.51**	7.0-10.5	0.10	pH units	2018-11-06	HT2
Solids, Total Dissolved	**103**	AO ≤ 500	15	mg/L	2018-11-08	
Sulfide, Total	< 0.020	AO ≤ 0.05	0.020	mg/L	2018-11-07	
Turbidity	**10.2**	OG < 1	0.10	NTU	2018-11-02	
UV Transmittance @ 254nm	**98.7**	N/A	0.10	% T	2018-11-03	
Total Metals						
Aluminum, total	**0.575**	OG < 0.1	0.0050	mg/L	2018-11-09	
Antimony, total	< 0.00020	MAC = 0.006	0.00020	mg/L	2018-11-09	
Arsenic, total	**0.00188**	MAC = 0.01	0.00050	mg/L	2018-11-09	
Barium, total	**0.0084**	MAC = 1	0.0050	mg/L	2018-11-09	
Beryllium, total	< 0.00010	N/A	0.00010	mg/L	2018-11-09	
Bismuth, total	**0.00093**	N/A	0.00010	mg/L	2018-11-09	
Boron, total	**0.0115**	MAC = 5	0.0050	mg/L	2018-11-09	
Cadmium, total	< 0.000010	MAC = 0.005	0.000010	mg/L	2018-11-09	
Calcium, total	**8.53**	None Required	0.20	mg/L	2018-11-09	
Chromium, total	**0.00148**	MAC = 0.05	0.00050	mg/L	2018-11-09	
Cobalt, total	**0.00039**	N/A	0.00010	mg/L	2018-11-09	
Copper, total	**0.0432**	AO ≤ 1	0.00040	mg/L	2018-11-09	
Iron, total	**0.441**	AO ≤ 0.3	0.010	mg/L	2018-11-09	

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8110123
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
WIN 54928 (8110123-01) | Matrix: Water | Sampled: 2018-11-01 11:30, Continued						
Total Metals, Continued						
Lead, total	**0.00089**	MAC = 0.01	0.00020	mg/L	2018-11-09	
Lithium, total	**0.00085**	N/A	0.00010	mg/L	2018-11-09	
Magnesium, total	**4.43**	None Required	0.010	mg/L	2018-11-09	
Manganese, total	**0.00811**	AO ≤ 0.05	0.00020	mg/L	2018-11-09	
Mercury, total	< 0.000010	MAC = 0.001	0.000010	mg/L	2018-11-08	
Molybdenum, total	**0.00120**	N/A	0.00010	mg/L	2018-11-09	
Nickel, total	**0.00113**	N/A	0.00040	mg/L	2018-11-09	
Phosphorus, total	**0.105**	N/A	0.050	mg/L	2018-11-09	
Potassium, total	**2.32**	N/A	0.10	mg/L	2018-11-09	
Selenium, total	< 0.00050	MAC = 0.05	0.00050	mg/L	2018-11-09	
Silicon, total	**19.8**	N/A	1.0	mg/L	2018-11-09	
Silver, total	< 0.000050	None Required	0.000050	mg/L	2018-11-09	
Sodium, total	**5.96**	AO ≤ 200	0.10	mg/L	2018-11-09	
Strontium, total	**0.0244**	N/A	0.0010	mg/L	2018-11-09	
Sulfur, total	< 3.0	N/A	3.0	mg/L	2018-11-09	
Tellurium, total	< 0.00050	N/A	0.00050	mg/L	2018-11-09	
Thallium, total	< 0.000020	N/A	0.000020	mg/L	2018-11-09	
Thorium, total	< 0.00010	N/A	0.00010	mg/L	2018-11-09	
Tin, total	**0.00207**	N/A	0.00020	mg/L	2018-11-09	
Titanium, total	**0.0224**	N/A	0.0050	mg/L	2018-11-09	
Tungsten, total	< 0.0010	N/A	0.0010	mg/L	2018-11-09	
Uranium, total	**0.000133**	MAC = 0.02	0.000020	mg/L	2018-11-09	
Vanadium, total	**0.0079**	N/A	0.0010	mg/L	2018-11-09	
Zinc, total	**0.0284**	AO ≤ 5	0.0040	mg/L	2018-11-09	
Zirconium, total	**0.00072**	N/A	0.00010	mg/L	2018-11-09	
Microbiological Parameters						
Coliforms, Total	<1	MAC = 0	1	CFU/100 mL	2018-11-02	
E. coli	<1	MAC = 0	1	CFU/100 mL	2018-11-02	
Heterotrophic Plate Count	<1	N/A	1	CFU/mL	2018-11-02	

Sample Qualifiers:

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

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8110123
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07

Analysis Description	Method Ref.	Technique	Location
Alkalinity in Water	SM 2320 B* (2011)	Titration with H2SO4	Kelowna
Ammonia, Total in Water	SM 4500-NH3 G* (2011)	Automated Colorimetry (Phenate)	Kelowna
Anions in Water	SM 4110 B (2011)	Ion Chromatography	Kelowna
Carbon, Total Organic in Water	SM 5310 B (2011)	Combustion, Infrared CO2 Detection	Kelowna
Coliforms, Total in Water	SM 9222 (2006)	Membrane Filtration	Sublet
Colour, True in Water	SM 2120 C (2011)	Spectrophotometry (456 nm)	Kelowna
Conductivity in Water	SM 2510 B (2011)	Conductivity Meter	Richmond
Dissolved Metals in Water	EPA 200.8 / EPA 6020B	0.45 µm Filtration / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	Richmond
E. coli in Water	SM 9223 B (2004)	Enzyme Substrate Endo Agar	Sublet
Hardness in Water	SM 2340 B (2011)	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	N/A
Heterotrophic Plate Count in Water	SM 9215 B (2004)	Pour Plate	Sublet
Iron Related Bacteria in Water	DBI DBISOP06	Biological Activity Reaction Test	Kelowna
Langelier Index in Water	SM 2330 B (2010)	Calculation	N/A
Mercury, dissolved in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Nitrate+Nitrite in Water	SM 4500-NO3- F (2011)	Automated Colorimetry (Cadmium Reduction)	Kelowna
Nitrogen, Total Kjeldahl in Water	SM 4500-Norg D* (2011)	Block Digestion and Flow Injection Analysis	Kelowna
pH in Water	SM 4500-H+ B (2011)	Electrometry	Richmond
Solids, Total Dissolved in Water	SM 2540 C* (2011)	Gravimetry (Dried at 103-105C)	Kelowna
Sulfate Reducing Bacteria in Water	DBI DBSLW05	Biological Activity Reaction Test	Kelowna
Sulfide, Total in Water	SM 4500-S2 D* (2011)	Colorimetry (Methylene Blue)	Edmonton
Total Metals in Water	EPA 200.2* / EPA 6020B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	Richmond
Transmittance at 254 nm in Water	SM 5910 B* (2013)	Ultraviolet Absorption	Kelowna
Turbidity in Water	SM 2130 B (2011)	Nephelometry	Richmond

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

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PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07

Glossary of Terms:

RL	Reporting Limit (default)
% T	Percent Transmittance
<	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
<1	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
AO	Aesthetic Objective
CFU/100 mL	Colony Forming Units per 100 millilitres
CFU/mL	Colony Forming Units per millilitre
CU	Colour Units (referenced against a platinum cobalt standard)
MAC	Maximum Acceptable Concentration (health based)
mg/L	Milligrams per litre
NTU	Nephelometric Turbidity Units
OG	Operational Guideline (treated water)
pH units	pH < 7 = acidic, ph > 7 = basic
µS/cm	Microsiemens per centimetre
DBI	Drycon Bioconcepts Inc. Biological Activity Reaction Tests
EPA	United States Environmental Protection Agency Test Methods
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

General Comments:

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

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8110123
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07

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

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

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

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Anions, Batch B8K0263										
Blank (B8K0263-BLK1)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Nitrate+Nitrite (as N)	< 0.0100	0.0100	mg/L							
Blank (B8K0263-BLK2)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Nitrate+Nitrite (as N)	< 0.0100	0.0100	mg/L							
Blank (B8K0263-BLK3)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Nitrate+Nitrite (as N)	< 0.0100	0.0100	mg/L							
LCS (B8K0263-BS1)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Nitrate+Nitrite (as N)	0.505	0.0100	mg/L	0.500		101	91-108			
LCS (B8K0263-BS2)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Nitrate+Nitrite (as N)	0.501	0.0100	mg/L	0.500		100	91-108			
LCS (B8K0263-BS3)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Nitrate+Nitrite (as N)	0.505	0.0100	mg/L	0.500		101	91-108			
Anions, Batch B8K0271										
Blank (B8K0271-BLK1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Chloride	< 0.10	0.10	mg/L							
Fluoride	< 0.10	0.10	mg/L							
Sulfate	< 1.0	1.0	mg/L							
LCS (B8K0271-BS1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Chloride	16.0	0.10	mg/L	16.0		100	90-110			
Fluoride	4.09	0.10	mg/L	4.00		102	88-108			
Sulfate	16.1	1.0	mg/L	16.0		100	91-109			
Biological Activity Reaction Tests, Batch B8K0243										
Blank (B8K0243-BLK1)				Prepared: 2018-11-03, Analyzed: 2018-11-03						
Iron Related Bacteria	< 2	2	CFU/mL							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8110123
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Biological Activity Reaction Tests, Batch B8K0243, Continued										
Duplicate (B8K0243-DUP1)		**Source: 8110123-01**		Prepared: 2018-11-03, Analyzed: 2018-11-03						
Iron Related Bacteria	35300	2	CFU/mL		35300			< 1	171	
Biological Activity Reaction Tests, Batch B8K0244										
Blank (B8K0244-BLK1)				Prepared: 2018-11-03, Analyzed: 2018-11-03						
Sulfate Reducing Bacteria	< 8	8	CFU/mL							
Duplicate (B8K0244-DUP1)		**Source: 8110123-01**		Prepared: 2018-11-03, Analyzed: 2018-11-03						
Sulfate Reducing Bacteria	< 8	8	CFU/mL		< 8				121	
Dissolved Metals, Batch B8K0507										
Blank (B8K0507-BLK1)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Mercury, dissolved	< 0.000010	0.000010	mg/L							
Blank (B8K0507-BLK2)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Mercury, dissolved	< 0.000010	0.000010	mg/L							
Reference (B8K0507-SRM1)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Mercury, dissolved	0.00526	0.000010	mg/L	0.00489		108	80-120			
Reference (B8K0507-SRM2)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Mercury, dissolved	0.00475	0.000010	mg/L	0.00489		97	80-120			
Dissolved Metals, Batch B8K0583										
Blank (B8K0583-BLK1)				Prepared: 2018-11-09, Analyzed: 2018-11-09						
Aluminum, dissolved	< 0.0050	0.0050	mg/L							
Antimony, dissolved	< 0.00020	0.00020	mg/L							
Arsenic, dissolved	< 0.00050	0.00050	mg/L							
Barium, dissolved	< 0.0050	0.0050	mg/L							
Beryllium, dissolved	< 0.00010	0.00010	mg/L							
Bismuth, dissolved	< 0.00010	0.00010	mg/L							
Boron, dissolved	< 0.0050	0.0050	mg/L							
Cadmium, dissolved	< 0.000010	0.000010	mg/L							
Calcium, dissolved	< 0.20	0.20	mg/L							
Chromium, dissolved	< 0.00050	0.00050	mg/L							
Cobalt, dissolved	< 0.00010	0.00010	mg/L							
Copper, dissolved	< 0.00040	0.00040	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.00020	0.00020	mg/L							
Lithium, dissolved	< 0.00010	0.00010	mg/L							
Magnesium, dissolved	< 0.010	0.010	mg/L							
Manganese, dissolved	< 0.00020	0.00020	mg/L							
Molybdenum, dissolved	< 0.00010	0.00010	mg/L							
Nickel, dissolved	< 0.00040	0.00040	mg/L							
Phosphorus, dissolved	< 0.050	0.050	mg/L							
Potassium, dissolved	< 0.10	0.10	mg/L							
Selenium, dissolved	< 0.00050	0.00050	mg/L							
Silicon, dissolved	< 1.0	1.0	mg/L							
Silver, dissolved	< 0.000050	0.000050	mg/L							
Sodium, dissolved	< 0.10	0.10	mg/L							
Strontium, dissolved	< 0.0010	0.0010	mg/L							
Sulfur, dissolved	< 3.0	3.0	mg/L							
Tellurium, dissolved	< 0.00050	0.00050	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8110123
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Dissolved Metals, Batch B8K0583, Continued										
Blank (B8K0583-BLK1), Continued				Prepared: 2018-11-09, Analyzed: 2018-11-09						
Thallium, dissolved	< 0.000020	0.000020	mg/L							
Thorium, dissolved	< 0.00010	0.00010	mg/L							
Tin, dissolved	< 0.00020	0.00020	mg/L							
Titanium, dissolved	< 0.0050	0.0050	mg/L							
Tungsten, dissolved	< 0.0010	0.0010	mg/L							
Uranium, dissolved	< 0.000020	0.000020	mg/L							
Vanadium, dissolved	< 0.0010	0.0010	mg/L							
Zinc, dissolved	< 0.0040	0.0040	mg/L							
Zirconium, dissolved	< 0.00010	0.00010	mg/L							
Blank (B8K0583-BLK2)				Prepared: 2018-11-09, Analyzed: 2018-11-09						
Aluminum, dissolved	< 0.0050	0.0050	mg/L							
Antimony, dissolved	< 0.00020	0.00020	mg/L							
Arsenic, dissolved	< 0.00050	0.00050	mg/L							
Barium, dissolved	< 0.0050	0.0050	mg/L							
Beryllium, dissolved	< 0.00010	0.00010	mg/L							
Bismuth, dissolved	< 0.00010	0.00010	mg/L							
Boron, dissolved	< 0.0050	0.0050	mg/L							
Cadmium, dissolved	< 0.000010	0.000010	mg/L							
Calcium, dissolved	< 0.20	0.20	mg/L							
Chromium, dissolved	< 0.00050	0.00050	mg/L							
Cobalt, dissolved	< 0.00010	0.00010	mg/L							
Copper, dissolved	< 0.00040	0.00040	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.00020	0.00020	mg/L							
Lithium, dissolved	< 0.00010	0.00010	mg/L							
Magnesium, dissolved	< 0.010	0.010	mg/L							
Manganese, dissolved	< 0.00020	0.00020	mg/L							
Molybdenum, dissolved	< 0.00010	0.00010	mg/L							
Nickel, dissolved	< 0.00040	0.00040	mg/L							
Phosphorus, dissolved	< 0.050	0.050	mg/L							
Potassium, dissolved	< 0.10	0.10	mg/L							
Selenium, dissolved	< 0.00050	0.00050	mg/L							
Silicon, dissolved	< 1.0	1.0	mg/L							
Silver, dissolved	< 0.000050	0.000050	mg/L							
Sodium, dissolved	< 0.10	0.10	mg/L							
Strontium, dissolved	< 0.0010	0.0010	mg/L							
Sulfur, dissolved	< 3.0	3.0	mg/L							
Tellurium, dissolved	< 0.00050	0.00050	mg/L							
Thallium, dissolved	< 0.000020	0.000020	mg/L							
Thorium, dissolved	< 0.00010	0.00010	mg/L							
Tin, dissolved	< 0.00020	0.00020	mg/L							
Titanium, dissolved	< 0.0050	0.0050	mg/L							
Tungsten, dissolved	< 0.0010	0.0010	mg/L							
Uranium, dissolved	< 0.000020	0.000020	mg/L							
Vanadium, dissolved	< 0.0010	0.0010	mg/L							
Zinc, dissolved	< 0.0040	0.0040	mg/L							
Zirconium, dissolved	< 0.00010	0.00010	mg/L							
Blank (B8K0583-BLK3)				Prepared: 2018-11-09, Analyzed: 2018-11-09						
Aluminum, dissolved	< 0.0050	0.0050	mg/L							
Antimony, dissolved	< 0.00020	0.00020	mg/L							
Arsenic, dissolved	< 0.00050	0.00050	mg/L							
Barium, dissolved	< 0.0050	0.0050	mg/L							
Beryllium, dissolved	< 0.00010	0.00010	mg/L							
Bismuth, dissolved	< 0.00010	0.00010	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8110123
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Dissolved Metals, Batch B8K0583, Continued										
Blank (B8K0583-BLK3), Continued				Prepared: 2018-11-09, Analyzed: 2018-11-09						
Boron, dissolved	< 0.0050	0.0050	mg/L							
Cadmium, dissolved	< 0.000010	0.000010	mg/L							
Calcium, dissolved	< 0.20	0.20	mg/L							
Chromium, dissolved	< 0.00050	0.00050	mg/L							
Cobalt, dissolved	< 0.00010	0.00010	mg/L							
Copper, dissolved	< 0.00040	0.00040	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.00020	0.00020	mg/L							
Lithium, dissolved	< 0.00010	0.00010	mg/L							
Magnesium, dissolved	< 0.010	0.010	mg/L							
Manganese, dissolved	< 0.00020	0.00020	mg/L							
Molybdenum, dissolved	< 0.00010	0.00010	mg/L							
Nickel, dissolved	< 0.00040	0.00040	mg/L							
Phosphorus, dissolved	< 0.050	0.050	mg/L							
Potassium, dissolved	< 0.10	0.10	mg/L							
Selenium, dissolved	< 0.00050	0.00050	mg/L							
Silicon, dissolved	< 1.0	1.0	mg/L							
Silver, dissolved	< 0.000050	0.000050	mg/L							
Sodium, dissolved	< 0.10	0.10	mg/L							
Strontium, dissolved	< 0.0010	0.0010	mg/L							
Sulfur, dissolved	< 3.0	3.0	mg/L							
Tellurium, dissolved	< 0.00050	0.00050	mg/L							
Thallium, dissolved	< 0.000020	0.000020	mg/L							
Thorium, dissolved	< 0.00010	0.00010	mg/L							
Tin, dissolved	< 0.00020	0.00020	mg/L							
Titanium, dissolved	< 0.0050	0.0050	mg/L							
Tungsten, dissolved	< 0.0010	0.0010	mg/L							
Uranium, dissolved	< 0.000020	0.000020	mg/L							
Vanadium, dissolved	< 0.0010	0.0010	mg/L							
Zinc, dissolved	< 0.0040	0.0040	mg/L							
Zirconium, dissolved	< 0.00010	0.00010	mg/L							
LCS (B8K0583-BS1)				Prepared: 2018-11-09, Analyzed: 2018-11-09						
Aluminum, dissolved	0.0182	0.0050	mg/L	0.0200		91	80-120			
Antimony, dissolved	0.0180	0.00020	mg/L	0.0200		90	80-120			
Arsenic, dissolved	0.0197	0.00050	mg/L	0.0200		99	80-120			
Barium, dissolved	0.0201	0.0050	mg/L	0.0200		101	80-120			
Beryllium, dissolved	0.0199	0.00010	mg/L	0.0200		99	80-120			
Bismuth, dissolved	0.0195	0.00010	mg/L	0.0200		98	80-120			
Boron, dissolved	0.0188	0.0050	mg/L	0.0200		94	80-120			
Cadmium, dissolved	0.0202	0.000010	mg/L	0.0200		101	80-120			
Calcium, dissolved	1.91	0.20	mg/L	2.00		96	80-120			
Chromium, dissolved	0.0180	0.00050	mg/L	0.0200		90	80-120			
Cobalt, dissolved	0.0191	0.00010	mg/L	0.0200		96	80-120			
Copper, dissolved	0.0194	0.00040	mg/L	0.0200		97	80-120			
Iron, dissolved	1.84	0.010	mg/L	2.00		92	80-120			
Lead, dissolved	0.0199	0.00020	mg/L	0.0200		99	80-120			
Lithium, dissolved	0.0203	0.00010	mg/L	0.0200		101	80-120			
Magnesium, dissolved	1.93	0.010	mg/L	2.00		97	80-120			
Manganese, dissolved	0.0193	0.00020	mg/L	0.0200		96	80-120			
Molybdenum, dissolved	0.0179	0.00010	mg/L	0.0200		89	80-120			
Nickel, dissolved	0.0188	0.00040	mg/L	0.0200		94	80-120			
Phosphorus, dissolved	1.93	0.050	mg/L	2.00		97	80-120			
Potassium, dissolved	1.75	0.10	mg/L	2.00		88	80-120			
Selenium, dissolved	0.0205	0.00050	mg/L	0.0200		103	80-120			
Silicon, dissolved	1.8	1.0	mg/L	2.00		90	80-120			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8110123
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Dissolved Metals, Batch B8K0583, Continued										
LCS (B8K0583-BS1), Continued				Prepared: 2018-11-09, Analyzed: 2018-11-09						
Silver, dissolved	0.0190	0.000050	mg/L	0.0200		95	80-120			
Sodium, dissolved	2.13	0.10	mg/L	2.00		107	80-120			
Strontium, dissolved	0.0179	0.0010	mg/L	0.0200		90	80-120			
Sulfur, dissolved	4.2	3.0	mg/L	5.00		84	80-120			
Tellurium, dissolved	0.0203	0.00050	mg/L	0.0200		102	80-120			
Thallium, dissolved	0.0201	0.000020	mg/L	0.0200		101	80-120			
Thorium, dissolved	0.0173	0.00010	mg/L	0.0200		86	80-120			
Tin, dissolved	0.0192	0.00020	mg/L	0.0200		96	80-120			
Titanium, dissolved	0.0197	0.0050	mg/L	0.0200		98	80-120			
Tungsten, dissolved	0.0180	0.0010	mg/L	0.0200		90	80-120			
Uranium, dissolved	0.0184	0.000020	mg/L	0.0200		92	80-120			
Vanadium, dissolved	0.0170	0.0010	mg/L	0.0200		85	80-120			
Zinc, dissolved	0.0221	0.0040	mg/L	0.0200		110	80-120			
Zirconium, dissolved	0.0192	0.00010	mg/L	0.0200		96	80-120			
Duplicate (B8K0583-DUP1)			**Source: 8110123-01**	Prepared: 2018-11-09, Analyzed: 2018-11-09						
Aluminum, dissolved	< 0.0050	0.0050	mg/L		< 0.0050				11	
Antimony, dissolved	< 0.00020	0.00020	mg/L		< 0.00020				20	
Arsenic, dissolved	0.00171	0.00050	mg/L		0.00176				8	
Barium, dissolved	< 0.0050	0.0050	mg/L		< 0.0050				7	
Beryllium, dissolved	< 0.00010	0.00010	mg/L		< 0.00010				14	
Bismuth, dissolved	< 0.00010	0.00010	mg/L		< 0.00010				20	
Boron, dissolved	0.0063	0.0050	mg/L		0.0063				13	
Cadmium, dissolved	0.000013	0.000010	mg/L		0.000014				20	
Calcium, dissolved	8.18	0.20	mg/L		8.22			< 1	8	
Chromium, dissolved	< 0.00050	0.00050	mg/L		0.00052				14	
Cobalt, dissolved	< 0.00010	0.00010	mg/L		< 0.00010				10	
Copper, dissolved	0.00141	0.00040	mg/L		0.00153				20	
Iron, dissolved	0.014	0.010	mg/L		0.016				14	
Lead, dissolved	< 0.00020	0.00020	mg/L		< 0.00020				20	
Lithium, dissolved	0.00058	0.00010	mg/L		0.00059			2	14	
Magnesium, dissolved	4.17	0.010	mg/L		4.32			3	6	
Manganese, dissolved	0.00104	0.00020	mg/L		0.00109			5	9	
Molybdenum, dissolved	0.00239	0.00010	mg/L		0.00252			5	19	
Nickel, dissolved	< 0.00040	0.00040	mg/L		0.00061				20	
Phosphorus, dissolved	0.075	0.050	mg/L		0.072				14	
Potassium, dissolved	2.29	0.10	mg/L		2.32			1	8	
Selenium, dissolved	< 0.00050	0.00050	mg/L		< 0.00050				20	
Silicon, dissolved	17.8	1.0	mg/L		18.1			1	12	
Silver, dissolved	< 0.000050	0.000050	mg/L		< 0.000050				20	
Sodium, dissolved	5.59	0.10	mg/L		5.64			< 1	6	
Strontium, dissolved	0.0225	0.0010	mg/L		0.0228			1	6	
Sulfur, dissolved	< 3.0	3.0	mg/L		< 3.0				20	
Tellurium, dissolved	< 0.00050	0.00050	mg/L		< 0.00050				20	
Thallium, dissolved	< 0.000020	0.000020	mg/L		< 0.000020				13	
Thorium, dissolved	< 0.00010	0.00010	mg/L		< 0.00010				20	
Tin, dissolved	< 0.00020	0.00020	mg/L		< 0.00020				20	
Titanium, dissolved	< 0.0050	0.0050	mg/L		< 0.0050				20	
Tungsten, dissolved	< 0.0010	0.0010	mg/L		< 0.0010				20	
Uranium, dissolved	0.000094	0.000020	mg/L		0.000094				14	
Vanadium, dissolved	0.0068	0.0010	mg/L		0.0069			1	20	
Zinc, dissolved	0.0197	0.0040	mg/L		0.0186				11	
Zirconium, dissolved	< 0.00010	0.00010	mg/L		< 0.00010				20	
Reference (B8K0583-SRM1)				Prepared: 2018-11-09, Analyzed: 2018-11-09						
Aluminum, dissolved	0.196	0.0050	mg/L	0.233		84	79-114			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8110123
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Dissolved Metals, Batch B8K0583, Continued										
Reference (B8K0583-SRM1), Continued				Prepared: 2018-11-09, Analyzed: 2018-11-09						
Antimony, dissolved	0.0470	0.00020	mg/L	0.0430		109	89-123			
Arsenic, dissolved	0.443	0.00050	mg/L	0.438		101	87-113			
Barium, dissolved	3.20	0.0050	mg/L	3.35		96	85-114			
Beryllium, dissolved	0.225	0.00010	mg/L	0.213		106	79-122			
Boron, dissolved	1.74	0.0050	mg/L	1.74		100	79-117			
Cadmium, dissolved	0.224	0.000010	mg/L	0.224		100	89-112			
Calcium, dissolved	7.98	0.20	mg/L	7.69		104	85-120			
Chromium, dissolved	0.440	0.00050	mg/L	0.437		101	87-113			
Cobalt, dissolved	0.121	0.00010	mg/L	0.128		94	90-117			
Copper, dissolved	0.868	0.00040	mg/L	0.844		103	90-115			
Iron, dissolved	1.26	0.010	mg/L	1.29		98	86-112			
Lead, dissolved	0.114	0.00020	mg/L	0.112		102	90-113			
Lithium, dissolved	0.105	0.00010	mg/L	0.104		101	77-127			
Magnesium, dissolved	6.99	0.010	mg/L	6.92		101	84-116			
Manganese, dissolved	0.326	0.00020	mg/L	0.345		95	85-113			
Molybdenum, dissolved	0.396	0.00010	mg/L	0.426		93	87-112			
Nickel, dissolved	0.801	0.00040	mg/L	0.840		95	90-114			
Phosphorus, dissolved	0.507	0.050	mg/L	0.495		102	74-119			
Potassium, dissolved	2.75	0.10	mg/L	3.19		86	78-119			
Selenium, dissolved	0.0349	0.00050	mg/L	0.0331		105	89-123			
Sodium, dissolved	19.2	0.10	mg/L	19.1		100	81-117			
Strontium, dissolved	0.841	0.0010	mg/L	0.916		92	82-111			
Thallium, dissolved	0.0384	0.000020	mg/L	0.0393		98	90-113			
Uranium, dissolved	0.261	0.000020	mg/L	0.266		98	87-113			
Vanadium, dissolved	0.858	0.0010	mg/L	0.869		99	85-110			
Zinc, dissolved	0.898	0.0040	mg/L	0.881		102	88-114			
General Parameters, Batch B8K0215										
Blank (B8K0215-BLK1)				Prepared: 2018-11-02, Analyzed: 2018-11-02						
Turbidity	< 0.10	0.10	NTU							
Duplicate (B8K0215-DUP1)			**Source: 8110123-01**	Prepared: 2018-11-02, Analyzed: 2018-11-02						
Turbidity	10.8	0.10	NTU		10.2			5	18	
General Parameters, Batch B8K0239										
Blank (B8K0239-BLK1)				Prepared: 2018-11-03, Analyzed: 2018-11-03						
Colour, True	< 5.0	5.0	CU							
Blank (B8K0239-BLK2)				Prepared: 2018-11-03, Analyzed: 2018-11-03						
Colour, True	< 5.0	5.0	CU							
LCS (B8K0239-BS1)				Prepared: 2018-11-03, Analyzed: 2018-11-03						
Colour, True	10	5.0	CU	10.0		100	85-115			
LCS (B8K0239-BS2)				Prepared: 2018-11-03, Analyzed: 2018-11-03						
Colour, True	11	5.0	CU	10.0		105	85-115			
General Parameters, Batch B8K0240										
Blank (B8K0240-BLK1)				Prepared: 2018-11-03, Analyzed: 2018-11-03						
UV Transmittance @ 254nm	< 0.10	0.10	% T							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8110123
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B8K0240, Continued										
LCS (B8K0240-BS1)				Prepared: 2018-11-03, Analyzed: 2018-11-03						
UV Transmittance @ 254nm	46.6	0.10	% T	46.5		100	98-103			
Duplicate (B8K0240-DUP1)		**Source: 8110123-01**		Prepared: 2018-11-03, Analyzed: 2018-11-03						
UV Transmittance @ 254nm	98.9	0.10	% T		98.7			< 1	6	
General Parameters, Batch B8K0373										
Blank (B8K0373-BLK1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Ammonia, Total (as N)	< 0.020	0.020	mg/L							
Blank (B8K0373-BLK2)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Ammonia, Total (as N)	< 0.020	0.020	mg/L							
Blank (B8K0373-BLK3)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Ammonia, Total (as N)	< 0.020	0.020	mg/L							
LCS (B8K0373-BS1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Ammonia, Total (as N)	0.989	0.020	mg/L	1.00		99	90-115			
LCS (B8K0373-BS2)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Ammonia, Total (as N)	0.989	0.020	mg/L	1.00		99	90-115			
LCS (B8K0373-BS3)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Ammonia, Total (as N)	1.00	0.020	mg/L	1.00		100	90-115			
General Parameters, Batch B8K0387										
Blank (B8K0387-BLK1)				Prepared: 2018-11-05, Analyzed: 2018-11-05						
Alkalinity, Total (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1.0	1.0	mg/L							
Blank (B8K0387-BLK2)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Alkalinity, Total (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1.0	1.0	mg/L							
Blank (B8K0387-BLK3)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Alkalinity, Total (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1.0	1.0	mg/L							
LCS (B8K0387-BS1)				Prepared: 2018-11-05, Analyzed: 2018-11-05						
Alkalinity, Total (as CaCO3)	104	1.0	mg/L	100		104	92-106			
LCS (B8K0387-BS2)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Alkalinity, Total (as CaCO3)	106	1.0	mg/L	100		106	92-106			
LCS (B8K0387-BS3)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Alkalinity, Total (as CaCO3)	105	1.0	mg/L	100		105	92-106			

APPENDIX 2: QUALITY CONTROL RESULTS

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PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B8K0451										
General Parameters, Batch B8K0460										
Blank (B8K0460-BLK1)				Prepared: 2018-11-06, Analyzed: 2018-11-07						
Nitrogen, Total Kjeldahl	< 0.050	0.050	mg/L							
Blank (B8K0460-BLK2)				Prepared: 2018-11-06, Analyzed: 2018-11-07						
Nitrogen, Total Kjeldahl	< 0.050	0.050	mg/L							
LCS (B8K0460-BS1)				Prepared: 2018-11-06, Analyzed: 2018-11-07						
Nitrogen, Total Kjeldahl	1.10	0.050	mg/L	1.00		110	84-121			
LCS (B8K0460-BS2)				Prepared: 2018-11-06, Analyzed: 2018-11-07						
Nitrogen, Total Kjeldahl	1.06	0.050	mg/L	1.00		106	84-121			
General Parameters, Batch B8K0464										
Blank (B8K0464-BLK1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Conductivity (EC)	< 2.0	2.0	µS/cm							
LCS (B8K0464-BS1)				Prepared: 2018-11-06, Analyzed: 2018-11-06						
Conductivity (EC)	148	2.0	µS/cm	147		101	90-110			
General Parameters, Batch B8K0576										
Blank (B8K0576-BLK1)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Sulfide, Total	< 0.020	0.020	mg/L							
Blank (B8K0576-BLK2)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Sulfide, Total	< 0.020	0.020	mg/L							
LCS (B8K0576-BS1)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Sulfide, Total	0.469	0.020	mg/L	0.500		94	82-116			
LCS (B8K0576-BS2)				Prepared: 2018-11-07, Analyzed: 2018-11-07						
Sulfide, Total	0.459	0.020	mg/L	0.500		92	82-116			
Duplicate (B8K0576-DUP2)		**Source: 8110123-01**		Prepared: 2018-11-07, Analyzed: 2018-11-07						
Sulfide, Total	< 0.020	0.020	mg/L		< 0.020				15	
General Parameters, Batch B8K0629										
Blank (B8K0629-BLK1)				Prepared: 2018-11-08, Analyzed: 2018-11-08						
Carbon, Total Organic	< 0.50	0.50	mg/L							
Blank (B8K0629-BLK2)				Prepared: 2018-11-08, Analyzed: 2018-11-08						
Carbon, Total Organic	< 0.50	0.50	mg/L							
Blank (B8K0629-BLK3)				Prepared: 2018-11-08, Analyzed: 2018-11-08						
Carbon, Total Organic	< 0.50	0.50	mg/L							
LCS (B8K0629-BS1)				Prepared: 2018-11-08, Analyzed: 2018-11-08						
Carbon, Total Organic	9.75	0.50	mg/L	10.0		98	78-116			
LCS (B8K0629-BS2)				Prepared: 2018-11-08, Analyzed: 2018-11-08						
Carbon, Total Organic	9.45	0.50	mg/L	10.0		94	78-116			

APPENDIX 2: QUALITY CONTROL RESULTS

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PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B8K0629, Continued										
LCS (B8K0629-BS3)				Prepared: 2018-11-08, Analyzed: 2018-11-08						
Carbon, Total Organic	9.45	0.50	mg/L	10.0		94	78-116			
General Parameters, Batch B8K0665										
Blank (B8K0665-BLK1)				Prepared: 2018-11-08, Analyzed: 2018-11-08						
Solids, Total Dissolved	< 15	15	mg/L							
Blank (B8K0665-BLK2)				Prepared: 2018-11-08, Analyzed: 2018-11-08						
Solids, Total Dissolved	< 15	15	mg/L							
LCS (B8K0665-BS1)				Prepared: 2018-11-08, Analyzed: 2018-11-08						
Solids, Total Dissolved	232	15	mg/L	240		97	85-115			
LCS (B8K0665-BS2)				Prepared: 2018-11-08, Analyzed: 2018-11-08						
Solids, Total Dissolved	231	15	mg/L	240		96	85-115			
Total Metals, Batch B8K0590										
Blank (B8K0590-BLK1)				Prepared: 2018-11-07, Analyzed: 2018-11-09						
Aluminum, total	< 0.0050	0.0050	mg/L							
Antimony, total	< 0.00020	0.00020	mg/L							
Arsenic, total	< 0.00050	0.00050	mg/L							
Barium, total	< 0.0050	0.0050	mg/L							
Beryllium, total	< 0.00010	0.00010	mg/L							
Bismuth, total	< 0.00010	0.00010	mg/L							
Boron, total	< 0.0050	0.0050	mg/L							
Cadmium, total	< 0.000010	0.000010	mg/L							
Calcium, total	< 0.20	0.20	mg/L							
Chromium, total	< 0.00050	0.00050	mg/L							
Cobalt, total	< 0.00010	0.00010	mg/L							
Copper, total	< 0.00040	0.00040	mg/L							
Iron, total	< 0.010	0.010	mg/L							
Lead, total	< 0.00020	0.00020	mg/L							
Lithium, total	< 0.00010	0.00010	mg/L							
Magnesium, total	< 0.010	0.010	mg/L							
Manganese, total	< 0.00020	0.00020	mg/L							
Molybdenum, total	< 0.00010	0.00010	mg/L							
Nickel, total	< 0.00040	0.00040	mg/L							
Phosphorus, total	< 0.050	0.050	mg/L							
Potassium, total	< 0.10	0.10	mg/L							
Selenium, total	< 0.00050	0.00050	mg/L							
Silicon, total	< 1.0	1.0	mg/L							
Silver, total	< 0.000050	0.000050	mg/L							
Sodium, total	< 0.10	0.10	mg/L							
Strontium, total	< 0.0010	0.0010	mg/L							
Sulfur, total	< 3.0	3.0	mg/L							
Tellurium, total	< 0.00050	0.00050	mg/L							
Thallium, total	< 0.000020	0.000020	mg/L							
Thorium, total	< 0.00010	0.00010	mg/L							
Tin, total	< 0.00020	0.00020	mg/L							
Titanium, total	< 0.0050	0.0050	mg/L							
Tungsten, total	< 0.0010	0.0010	mg/L							
Uranium, total	< 0.000020	0.000020	mg/L							
Vanadium, total	< 0.0010	0.0010	mg/L							
Zinc, total	< 0.0040	0.0040	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

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PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Total Metals, Batch B8K0590, Continued										
Blank (B8K0590-BLK1), Continued				Prepared: 2018-11-07, Analyzed: 2018-11-09						
Zirconium, total	< 0.00010	0.00010	mg/L							
Blank (B8K0590-BLK2)				Prepared: 2018-11-07, Analyzed: 2018-11-09						
Aluminum, total	< 0.0050	0.0050	mg/L							
Antimony, total	< 0.00020	0.00020	mg/L							
Arsenic, total	< 0.00050	0.00050	mg/L							
Barium, total	< 0.0050	0.0050	mg/L							
Beryllium, total	< 0.00010	0.00010	mg/L							
Bismuth, total	< 0.00010	0.00010	mg/L							
Boron, total	< 0.0050	0.0050	mg/L							
Cadmium, total	< 0.000010	0.000010	mg/L							
Calcium, total	< 0.20	0.20	mg/L							
Chromium, total	< 0.00050	0.00050	mg/L							
Cobalt, total	< 0.00010	0.00010	mg/L							
Copper, total	< 0.00040	0.00040	mg/L							
Iron, total	< 0.010	0.010	mg/L							
Lead, total	< 0.00020	0.00020	mg/L							
Lithium, total	< 0.00010	0.00010	mg/L							
Magnesium, total	< 0.010	0.010	mg/L							
Manganese, total	< 0.00020	0.00020	mg/L							
Molybdenum, total	< 0.00010	0.00010	mg/L							
Nickel, total	< 0.00040	0.00040	mg/L							
Phosphorus, total	< 0.050	0.050	mg/L							
Potassium, total	< 0.10	0.10	mg/L							
Selenium, total	< 0.00050	0.00050	mg/L							
Silicon, total	< 1.0	1.0	mg/L							
Silver, total	< 0.000050	0.000050	mg/L							
Sodium, total	< 0.10	0.10	mg/L							
Strontium, total	< 0.0010	0.0010	mg/L							
Sulfur, total	< 3.0	3.0	mg/L							
Tellurium, total	< 0.00050	0.00050	mg/L							
Thallium, total	< 0.000020	0.000020	mg/L							
Thorium, total	< 0.00010	0.00010	mg/L							
Tin, total	< 0.00020	0.00020	mg/L							
Titanium, total	< 0.0050	0.0050	mg/L							
Tungsten, total	< 0.0010	0.0010	mg/L							
Uranium, total	< 0.000020	0.000020	mg/L							
Vanadium, total	< 0.0010	0.0010	mg/L							
Zinc, total	< 0.0040	0.0040	mg/L							
Zirconium, total	< 0.00010	0.00010	mg/L							
Blank (B8K0590-BLK3)				Prepared: 2018-11-07, Analyzed: 2018-11-09						
Aluminum, total	< 0.0050	0.0050	mg/L							
Antimony, total	< 0.00020	0.00020	mg/L							
Arsenic, total	< 0.00050	0.00050	mg/L							
Barium, total	< 0.0050	0.0050	mg/L							
Beryllium, total	< 0.00010	0.00010	mg/L							
Bismuth, total	< 0.00010	0.00010	mg/L							
Boron, total	< 0.0050	0.0050	mg/L							
Cadmium, total	< 0.000010	0.000010	mg/L							
Calcium, total	< 0.20	0.20	mg/L							
Chromium, total	< 0.00050	0.00050	mg/L							
Cobalt, total	< 0.00010	0.00010	mg/L							
Copper, total	< 0.00040	0.00040	mg/L							
Iron, total	< 0.010	0.010	mg/L							
Lead, total	< 0.00020	0.00020	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8110123
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Total Metals, Batch B8K0590, Continued										
Blank (B8K0590-BLK3), Continued				Prepared: 2018-11-07, Analyzed: 2018-11-09						
Lithium, total	< 0.00010	0.00010	mg/L							
Magnesium, total	< 0.010	0.010	mg/L							
Manganese, total	< 0.00020	0.00020	mg/L							
Molybdenum, total	< 0.00010	0.00010	mg/L							
Nickel, total	< 0.00040	0.00040	mg/L							
Phosphorus, total	< 0.050	0.050	mg/L							
Potassium, total	< 0.10	0.10	mg/L							
Selenium, total	< 0.00050	0.00050	mg/L							
Silicon, total	< 1.0	1.0	mg/L							
Silver, total	< 0.000050	0.000050	mg/L							
Sodium, total	< 0.10	0.10	mg/L							
Strontium, total	< 0.0010	0.0010	mg/L							
Sulfur, total	< 3.0	3.0	mg/L							
Tellurium, total	< 0.00050	0.00050	mg/L							
Thallium, total	< 0.000020	0.000020	mg/L							
Thorium, total	< 0.00010	0.00010	mg/L							
Tin, total	< 0.00020	0.00020	mg/L							
Titanium, total	< 0.0050	0.0050	mg/L							
Tungsten, total	< 0.0010	0.0010	mg/L							
Uranium, total	< 0.000020	0.000020	mg/L							
Vanadium, total	< 0.0010	0.0010	mg/L							
Zinc, total	< 0.0040	0.0040	mg/L							
Zirconium, total	< 0.00010	0.00010	mg/L							
LCS (B8K0590-BS1)				Prepared: 2018-11-07, Analyzed: 2018-11-09						
Aluminum, total	0.0223	0.0050	mg/L	0.0200		111	80-120			
Antimony, total	0.0219	0.00020	mg/L	0.0200		109	80-120			
Arsenic, total	0.0207	0.00050	mg/L	0.0200		104	80-120			
Barium, total	0.0222	0.0050	mg/L	0.0200		111	80-120			
Beryllium, total	0.0213	0.00010	mg/L	0.0200		106	80-120			
Bismuth, total	0.0241	0.00010	mg/L	0.0200		120	80-120			
Boron, total	0.0233	0.0050	mg/L	0.0200		117	80-120			
Cadmium, total	0.0227	0.000010	mg/L	0.0200		113	80-120			
Calcium, total	2.12	0.20	mg/L	2.00		106	80-120			
Chromium, total	0.0185	0.00050	mg/L	0.0200		93	80-120			
Cobalt, total	0.0202	0.00010	mg/L	0.0200		101	80-120			
Copper, total	0.0207	0.00040	mg/L	0.0200		104	80-120			
Iron, total	1.75	0.010	mg/L	2.00		87	80-120			
Lead, total	0.0205	0.00020	mg/L	0.0200		102	80-120			
Lithium, total	0.0217	0.00010	mg/L	0.0200		108	80-120			
Magnesium, total	1.99	0.010	mg/L	2.00		100	80-120			
Manganese, total	0.0206	0.00020	mg/L	0.0200		103	80-120			
Molybdenum, total	0.0200	0.00010	mg/L	0.0200		100	80-120			
Nickel, total	0.0203	0.00040	mg/L	0.0200		101	80-120			
Phosphorus, total	1.89	0.050	mg/L	2.00		95	80-120			
Potassium, total	1.72	0.10	mg/L	2.00		86	80-120			
Selenium, total	0.0228	0.00050	mg/L	0.0200		114	80-120			
Silicon, total	1.6	1.0	mg/L	2.00		82	80-120			
Silver, total	0.0234	0.000050	mg/L	0.0200		117	80-120			
Sodium, total	2.00	0.10	mg/L	2.00		100	80-120			
Strontium, total	0.0184	0.0010	mg/L	0.0200		92	80-120			
Sulfur, total	4.0	3.0	mg/L	5.00		80	80-120			
Tellurium, total	0.0214	0.00050	mg/L	0.0200		107	80-120			
Thallium, total	0.0203	0.000020	mg/L	0.0200		101	80-120			
Thorium, total	0.0234	0.00010	mg/L	0.0200		117	80-120			
Tin, total	0.0218	0.00020	mg/L	0.0200		109	80-120			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	8110123
PROJECT	2018-8152.000.003	**REPORTED**	2018-11-14 22:07

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Total Metals, Batch B8K0590, Continued										
LCS (B8K0590-BS1), Continued				Prepared: 2018-11-07, Analyzed: 2018-11-09						
Titanium, total	0.0166	0.0050	mg/L	0.0200		83	80-120			
Tungsten, total	0.0207	0.0010	mg/L	0.0200		103	80-120			
Uranium, total	0.0206	0.000020	mg/L	0.0200		103	80-120			
Vanadium, total	0.0182	0.0010	mg/L	0.0200		91	80-120			
Zinc, total	0.0200	0.0040	mg/L	0.0200		100	80-120			
Zirconium, total	0.0213	0.00010	mg/L	0.0200		106	80-120			
Reference (B8K0590-SRM1)				Prepared: 2018-11-07, Analyzed: 2018-11-09						
Aluminum, total	0.340	0.0050	mg/L	0.303		112	82-114			
Antimony, total	0.0549	0.00020	mg/L	0.0511		107	88-115			
Arsenic, total	0.120	0.00050	mg/L	0.118		102	88-111			
Barium, total	0.853	0.0050	mg/L	0.823		104	83-110			
Beryllium, total	0.0510	0.00010	mg/L	0.0496		103	80-119			
Boron, total	3.94	0.0050	mg/L	3.45		114	80-118			
Cadmium, total	0.0538	0.000010	mg/L	0.0495		109	90-110			
Calcium, total	11.8	0.20	mg/L	11.6		102	85-113			
Chromium, total	0.225	0.00050	mg/L	0.250		90	88-111			
Cobalt, total	0.0376	0.00010	mg/L	0.0377		100	90-114			
Copper, total	0.514	0.00040	mg/L	0.486		106	90-117			
Iron, total	0.439	0.010	mg/L	0.488		90	90-116			
Lead, total	0.197	0.00020	mg/L	0.204		97	90-110			
Lithium, total	0.418	0.00010	mg/L	0.403		104	79-118			
Magnesium, total	4.04	0.010	mg/L	3.79		107	88-116			
Manganese, total	0.108	0.00020	mg/L	0.109		99	88-108			
Molybdenum, total	0.200	0.00010	mg/L	0.198		101	88-110			
Nickel, total	0.246	0.00040	mg/L	0.249		99	90-112			
Phosphorus, total	0.211	0.050	mg/L	0.227		93	72-118			
Potassium, total	6.61	0.10	mg/L	7.21		92	87-116			
Selenium, total	0.135	0.00050	mg/L	0.121		111	90-122			
Sodium, total	7.64	0.10	mg/L	7.54		101	86-118			
Strontium, total	0.338	0.0010	mg/L	0.375		90	86-110			
Thallium, total	0.0806	0.000020	mg/L	0.0805		100	90-113			
Uranium, total	0.0300	0.000020	mg/L	0.0306		98	88-112			
Vanadium, total	0.355	0.0010	mg/L	0.386		92	87-110			
Zinc, total	2.38	0.0040	mg/L	2.49		96	90-113			
Total Metals, Batch B8K0642										
Blank (B8K0642-BLK1)				Prepared: 2018-11-08, Analyzed: 2018-11-08						
Mercury, total	< 0.000010	0.000010	mg/L							
Blank (B8K0642-BLK2)				Prepared: 2018-11-08, Analyzed: 2018-11-08						
Mercury, total	< 0.000010	0.000010	mg/L							
Reference (B8K0642-SRM1)				Prepared: 2018-11-08, Analyzed: 2018-11-08						
Mercury, total	0.00501	0.000010	mg/L	0.00489		102	80-120			
Reference (B8K0642-SRM2)				Prepared: 2018-11-08, Analyzed: 2018-11-08						
Mercury, total	0.00477	0.000010	mg/L	0.00489		98	80-120			

Appendix G - GARP screening and assessment checklists

HAZARDS	SCREENING		ASSESSMENT		NOTES
Water Supply System Well	NOT PRESENT	PRESENT (complete Assessment)	AT RISK (Water source potentially GARP)	AT LOW RISK	
A. Water Quality Results					
A1: Exhibits recurring presence of total coliform bacteria, fecal coliform bacteria, or Escherichia coli (E. coli).	☑	☐	☐	☑	There have been no detections of total coliforms, fecal coliforms, or E. coli ; however the dataset (1 samples) is too small to provide much confidence. We recommend collecting weekly raw samples for first year of operation.
A2: Has reported intermittent turbidity or has a history of consistent turbidity greater than 1 NTU.	☑	☐	☐	☑	The dataset is small (1 sample) to provide much confidence. Recommend installing a turbidity meter and regularly (every 4 hours at a minimum) monitor turbidity for first year of operation.
B. Well Location					
B1: Situated inside setback distances from possible sources of contamination as per section 8 of the HHR[1]	☑	☐	☐	☐	No dumping grounds or cemetries within 120m of the well, no private dwellings within 6m (closest is 120 m away), no sources of contamination identified within 30m although the well is on the edge of Sechelt Public Works Yard so potential contamination sources cannot be ruled out in the furture
B2: Has an intake depth <15 m below ground surface that is located within a natural boundary of surface water or a flood prone area.	☑	☐	☐	☐	Top of the well intake is 79.5 mbgl
B3: Has an intake depth between the high-water mark and surface water bottom (or <15 m below the normal water level if surface water depth is unknown), and located within, or less than 150 m from the natural boundary of any surface water.	☑	☐	☐	☑	Intake level is significantly below the level of the closest surface water feature (Irgens Creek) which is 160m away at it's closest point.

1. HHR - Health Hazard Regulation
2. GWPR - Groundwater Protection Regulation
3. Reworded from original version to provide clarity.

B4: Located within 300 m of a source of probable enteric viral contamination without a barrier to viral transport.	☐	☑	☑	☐	Irgens Creek is located approximately 160m away. Homes within 300m of the site that will have septic tanks or connected to mains sewer. Additional assessment would be needed to further assess this risk.
C. Well Construction					
C1: Does not meet GWPR[2] (Part 3 Div 3) for surface sealing.	☑	☐	☐	☐	Surrface seal to a depth of 5 mbgl meets the requirements of GWPR.
C2: Does not meet GWPR (Part 4) and WSA (Section 54) for well caps and covers.	☑	☐	☐	☐	Well cap is tamper and vermin proof.
C3: Does not meet GWPR (Section 63) and DWPA (Section 16) for floodproofing.	☑	☐	☐	☐	The well is not located in a flood risk area. Well stick-up of 0.85m above ground level.
C4: Does not meet GWPR (Part 3 and Part 7) for wellhead protection.	☑	☐	☐	☐	See C1 for surface sealing and C3 for casing stick-up.
D. Aquifer Type and Setting					
D1: Has an intake depth <15 m below ground surface	☑	☐	☐	☐	The top of the intake of the well is 79.5 mbgl.
D2: Is situated in an [unconfined, unconsolidated, or fractured bedrock aquifer that is highly vulnerable]. [3]	☐	☑	☑	☐	The sand and gravel aquifer that the well is completed in is likely to be vulnerable to pathogens as there are no low permeabilty layers to provide protection. However the depth to groundwater may allow sub-surface filtration to remove or inactivate any pathogens prior to them reaching groundwater - would need to be assessed to confirm.
D3: Is completed in a karst bedrock aquifer, regardless of depth.	☑	☐	☐	☑	The well is completed in an unconsolidated sand and gravel aquifer; therefore, no karst bedrock aquifer is present.

Stage 2: GARP Determination

☐ At Risk (GARP) ☑ At Risk (GARP-viruses only) ☐ At Low Risk

Stage 3: Risk Mitigation

1. HHR - Health Hazard Regulation
2. GWPR - Groundwater Protection Regulation
3. Reworded from original version to provide clarity.

Recommended Options:

- [ ] Treatment to meet provincial drinking water objectives
- [x] Treatment to meet only the provincial drinking water objectives for viruses
- [ ] Provide alternate source of water
- [ ] Well Alteration / correct significant deficiencies in well construction
- [ ] Relocate the well
- [ ] Eliminate source(s) of contamination
- [ ] Level 2 or 3 investigation (additional investigation)
- [x] Move to Stage 4: Long-term Monitoring
- [ ] Other:

Comments: Explotarory test well at this time. Treatment would require 4-log removal for viruses, or further assessment of aquifer filtration capacity for virsues. Also recommend as part of long term (stage 4) monitoring: raw coliforms and regular turbidity readings (see notes for Hazard A1 and A2)

1. HHR - Health Hazard Regulation
2. GWPR - Groundwater Protection Regulation
3. Reworded from original version to provide clarity.

HAZARDS	SCREENING		ASSESSMENT		NOTES
Water Supply System Well	NOT PRESENT	PRESENT (complete Assessment)	AT RISK (Water source potentially GARP)	AT LOW RISK	
A. Water Quality Results					
A1: Exhibits recurring presence of total coliform bacteria, fecal coliform bacteria, or Escherichia coli (E. coli).	☑	☐	☐	☑	There have been no detections of total coliforms, fecal coliforms, or E. coli ; however the dataset (1 samples) is too small to provide confidence.
A2: Has reported intermittent turbidity or has a history of consistent turbidity greater than 1 NTU.	☑	☐	☐	☑	Not enough data available to determine.
B. Well Location					
B1: Situated inside setback distances from possible sources of contamination as per section 8 of the HHR[1]	☑	☐	☐	☐	No dumping grounds or cemetries identified within 120m of the well, no private dwellings within 6m (closest is 35m away), no sources of contamination identified within 30m of the well.
B2: Has an intake depth <15 m below ground surface that is located within a natural boundary of surface water or a flood prone area.	☑	☐	☐	☐	Top of the well intake is 114.9 mbgl
B3: Has an intake depth between the high-water mark and surface water bottom (or <15 m below the normal water level if surface water depth is unknown), and located within, or less than 150 m from the natural boundary of any surface water.	☑	☐	☐	☐	Intake level is significantly below the level of the closest surface water feature (Charmans Creek) which is 225m away at it's closest point.
B4: Located within 300 m of a source of probable enteric viral contamination without a barrier to viral transport.	☐	☑	☑	☐	Charmans Creek is located approximately 225m away. There are a number of properties within 300m of the site which will have septic tanks or other seawge disposal methods.
C. Well Construction					
C1: Does not meet GWPR[2] (Part 3 Div 3) for surface sealing.	☑	☐	☐	☐	Surrface seal to a depth of 5 mbgl meets the requirements of GWPR.
C2: Does not meet GWPR (Part 4) and WSA (Section 54) for well caps and covers.	☑	☐	☐	☐	Well cap is tamper and vermin proof.

1. HHR - Health Hazard Regulation
2. GWPR - Groundwater Protection Regulation
3. Reworded from original version to provide clarity.

C3: Does not meet GWPR (Section 63) and DWPA (Section 16) for floodproofing.	☑	☐	☐	☐	The well is not located in a flood risk area. A surface seal to meet GWPR requirements was installed. The well casing extends above ground level by 0.66m
C4: Does not meet GWPR (Part 3 and Part 7) for wellhead protection.	☑	☐	☐	☐	See C1 for surface sealing.
D. Aquifer Type and Setting					
D1: Has an intake depth <15 m below ground surface	☑	☐	☐	☐	The top of the intake of the well is 114.9 mbgl.
D2: Is situated in an [unconfined, unconsolidated, or fractured bedrock aquifer that is highly vulnerable]. [3]	☑	☐	☐	☐	The sand and gravel aquifer that the well is completed is protected by the overlying low permeability clay and till layer.
D3: Is completed in a karst bedrock aquifer, regardless of depth.	☑	☐	☐	☐	The well is completed in an unconsolidated sand and gravel aquifer with overlying low permeability strata. No karst bedrock aquifer is present.

Stage 2: GARP Determination

☐ At Risk (GARP) ☑ At Risk (GARP-viruses only) ☐ At Low Risk

Stage 3: Risk Mitigation

Recommended Options:

- ☐ Treatment to meet provincial drinking water objectives
- ☐ Treatment to meet only the provincial drinking water objectives for viruses
- ☐ Provide alternate source of water
- ☐ Well Alteration / correct significant deficiencies in well construction
- ☐ Relocate the well
- ☐ Eliminate source(s) of contamination
- ☐ Level 2 or 3 investigation (additional investigation)
- ☐ Move to Stage 4: Long-term Monitoring
- ☐ Other:

Comments: This is an exporatory test well and is not intended to be used as a production well at this stage. Treatment would require 4-log removal for viruses

1. HHR - Health Hazard Regulation
2. GWPR - Groundwater Protection Regulation
3. Reworded from original version to provide clarity.

HAZARDS	SCREENING		ASSESSMENT		NOTES
Water Supply System Well	NOT PRESENT	PRESENT (complete Assessment)	AT RISK (Water source potentially GARP)	AT LOW RISK	
A. Water Quality Results					
A1: Exhibits recurring presence of total coliform bacteria, fecal coliform bacteria, or Escherichia coli (E. coli).	☑	☐	☐	☑	There have been no detections of total coliforms, fecal coliforms, or E. coli ; however the dataset (1 samples) is too small to provide confidence. Recommend sampling weekly from raw tap for first year of operation.
A2: Has reported intermittent turbidity or has a history of consistent turbidity greater than 1 NTU.	☐	☑	☐	☑	High turbidity from silt and sand being drawn into well during pumping. Likely at low risk, but recommend long term monitoring of turbidity (every 4 hours for at least first year of operation)
B. Well Location					
B1: Situated inside setback distances from possible sources of contamination as per section 8 of the HHR[1]	☑	☐	☐	☐	No dumping grounds or cemetries were identified within 120m of the well, no private dwellings within 6m (closest is 35 m away), no sources of contamination identified within 30m although there could be septic tanks for nearby properties.
B2: Has an intake depth <15 m below ground surface that is located within a natural boundary of surface water or a flood prone area.	☑	☐	☐	☐	Top of the well intake is 41.9 mbgl
B3: Has an intake depth between the high-water mark and surface water bottom (or <15 m below the normal water level if surface water depth is unknown), and located within, or less than 150 m from the natural boundary of any surface water.	☑	☐	☐	☐	Intake level is c.20m below the level of the bed-level of the closest surface water feature (Soames Creek) which is <50m away.

1. HHR - Health Hazard Regulation
2. GWPR - Groundwater Protection Regulation
3. Reworded from original version to provide clarity.

B4: Located within 300 m of a source of probable enteric viral contamination without a barrier to viral transport.	☐	☑	☑	☐	Soames Creek is located <50 away. Viruses can be present even where a confining layer is present. There will be nearby septic sewage disposal/sewer pipeline given the proximity of the well to a residential area . Either treat to 4-log inactivation of viruses or complete additional assessment of a barrier to viral transport.
C. Well Construction					
C1: Does not meet GWPR[2] (Part 3 Div 3) for surface sealing.	☑	☐	☐	☐	Surface seal to a depth of 5 mbgl meets the requirements of GWPR.
C2: Does not meet GWPR (Part 4) and WSA (Section 54) for well caps and covers.	☑	☐	☐	☐	Well cap is tamper and vermin proof.
C3: Does not meet GWPR (Section 63) and DWPA (Section 16) for floodproofing.	☑	☐	☐	☐	The well is not located in a flood risk area. Casing stick-up of 0.61m above ground level
C4: Does not meet GWPR (Part 3 and Part 7) for wellhead protection.	☑	☐	☐	☐	See C1.
D. Aquifer Type and Setting					
D1: Has an intake depth <15 m below ground surface	☑	☐	☐	☐	The top of the intake of the well is 41.9 mbgl.
D2: Is situated in an [unconfined, unconsolidated, or fractured bedrock aquifer that is highly vulnerable]. [3]	☑	☐	☐	☐	The aquifer that the well is completed in is a confined sand and gravel aquifer protected by a low permeability till layer.
D3: Is completed in a karst bedrock aquifer, regardless of depth.	☑	☐	☐	☐	The well is completed in an unconsolidated sand and gravel aquifer; therefore, no karst bedrock aquifer is present.

Stage 2: GARP Determination

☐ At Risk (GARP) ☑ At Risk (GARP-viruses only) ☐ At Low Risk

Stage 3: Risk Mitigation

Recommended Options:

☐ Treatment to meet provincial drinking water objectives

☑ Treatment to meet only the provincial drinking water objectives for viruses

☐ Provide alternate source of water

1. HHR - Health Hazard Regulation
2. GWPR - Groundwater Protection Regulation
3. Reworded from original version to provide clarity.

- ☐ Well Alteration / correct significant deficiencies in well construction
- ☐ Relocate the well
- ☐ Eliminate source(s) of contamination
- ☐ Level 2 or 3 investigation (additional investigation)
- ☑ Move to Stage 4: Long-term Monitoring
- ☐ Other:

Comments: This is an exporatory test well and is not intended to be used as a production well at this stage. However, to support designing of the production well, treatment would require 4-log removal for viruses, and long term monitoring would include regular (every four hours) monitoring of turbidity and weekly sampling of raw water during first year of operation for E.coli and total coliforms. Additional assessment could be completed to further explore barriers to viral transport, and a non-GARP determination may be possible.

1. HHR - Health Hazard Regulation
2. GWPR - Groundwater Protection Regulation
3. Reworded from original version to provide clarity.

Appendix H - Preliminary production well design

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

Project No.: 20188152 File:

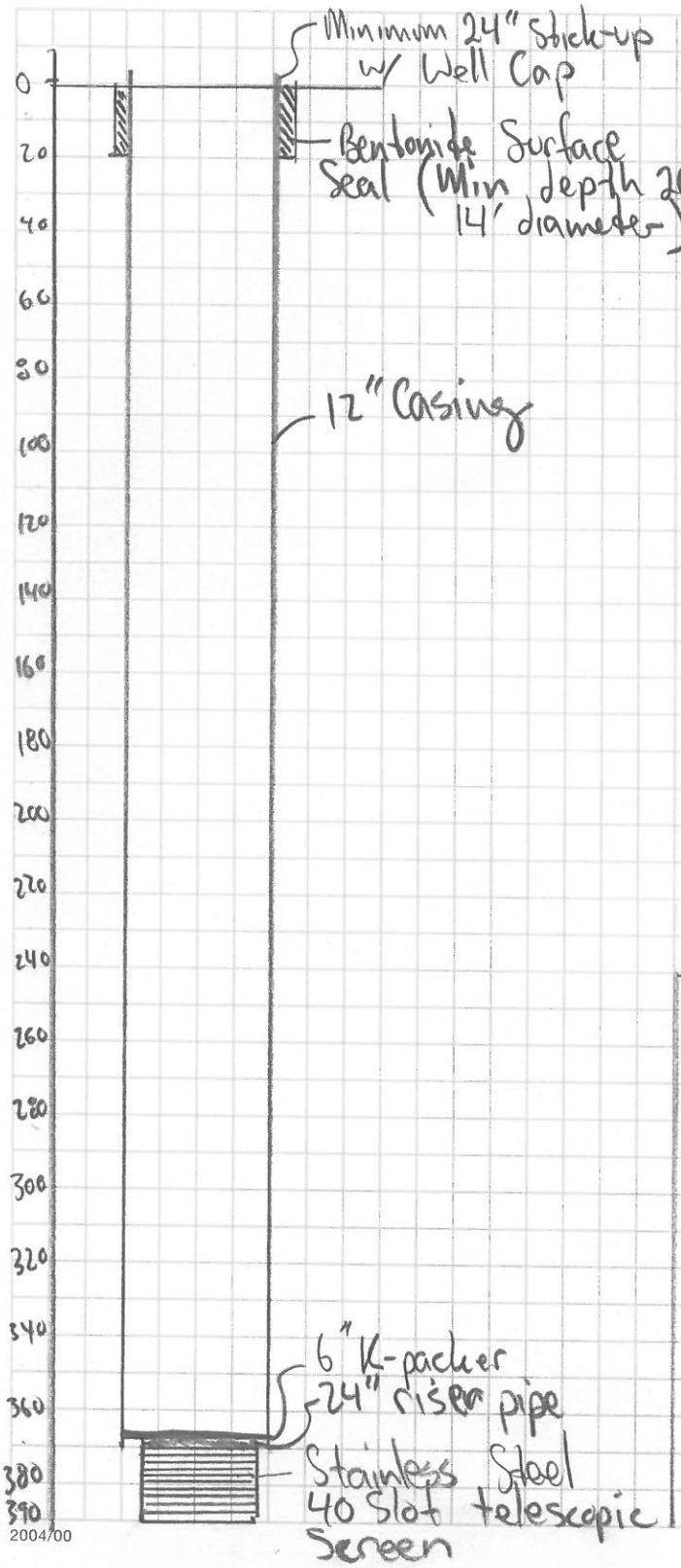
Client: SCRD

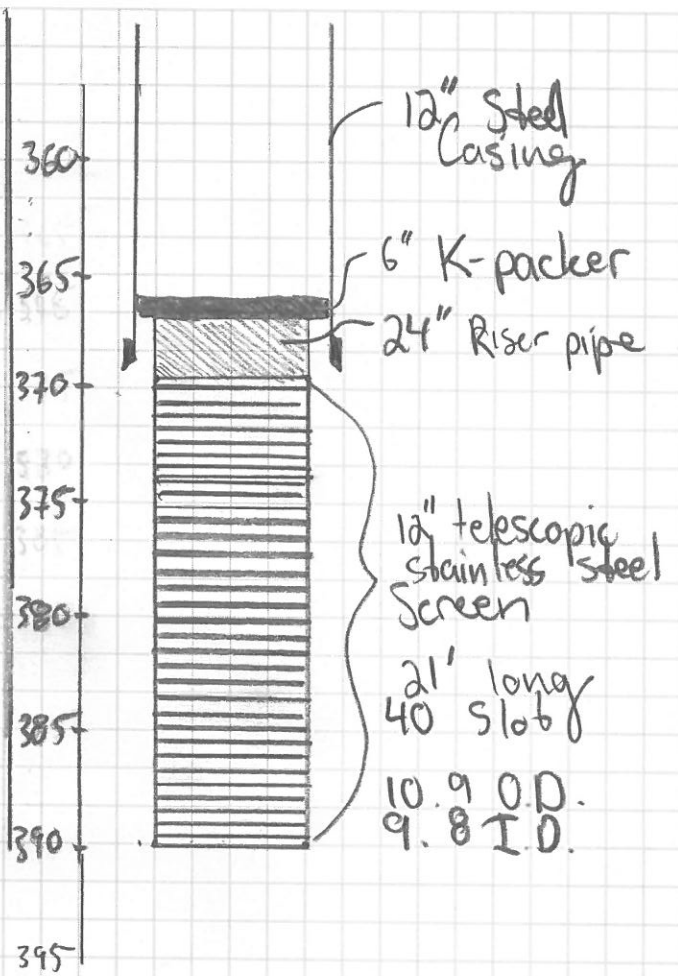
Subject: Mahan Rd Well Design

By: Tony Friesen Date: Nov 23/2018

Sheet of Chk'd: Date:

DESIGN NOTES





* Well design based on a Calculated Sustainable yield of 592 US gpm

Screen Specs based on Johnson Screens

40 slot = 90 in^2/ft open space

90 in^2/ft x 0.31 = 27.9 US g/ft

592 USgpm / 27.9 US g/ft

= 21.22 ft of 40 Slot screen needed

2004/00

207

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

Project No.: 20188152 File:

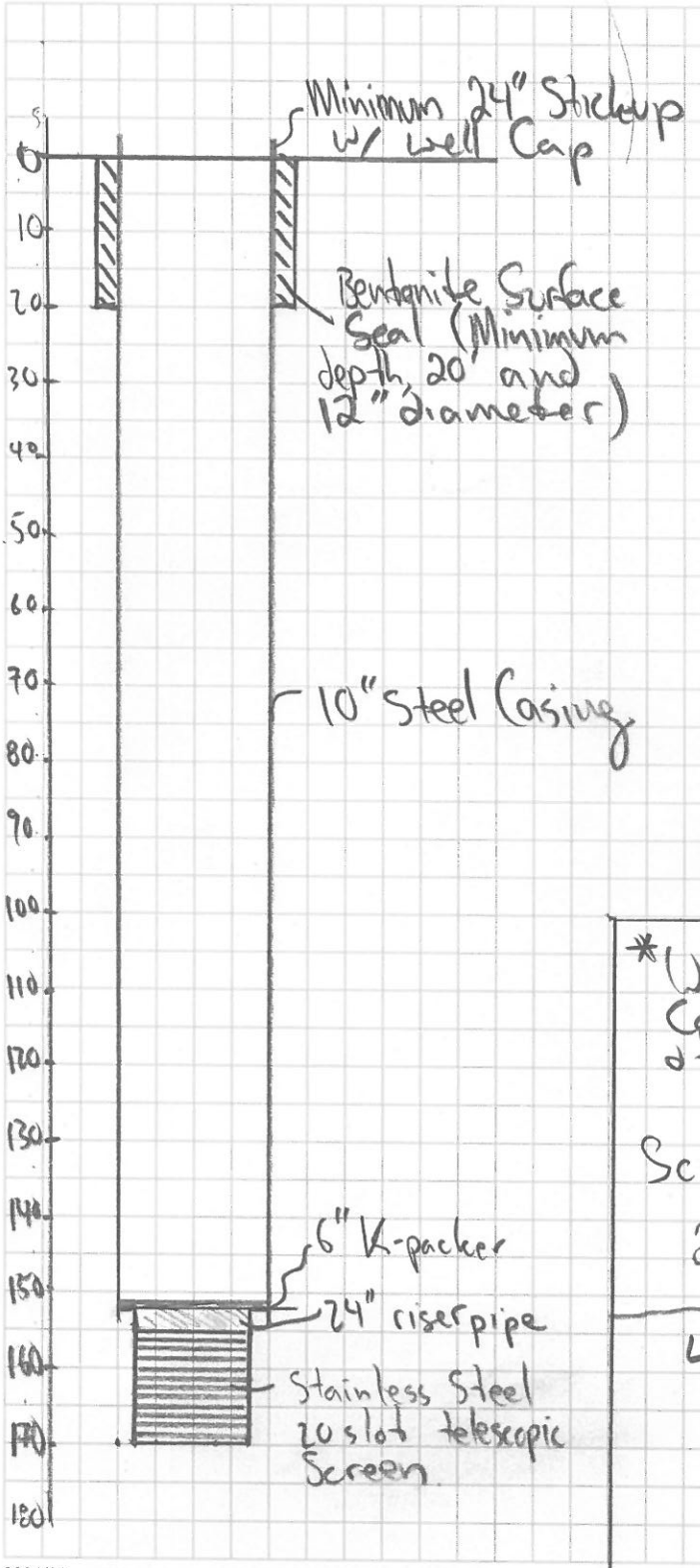
Client: SCRD

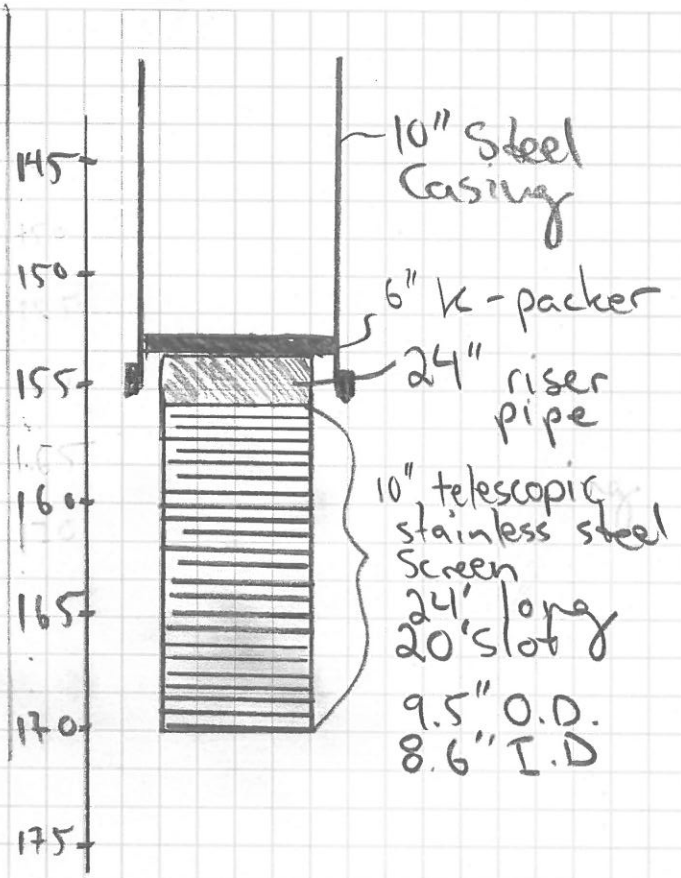
Subject: Elphinstone Well Design

By: Tony Friesen Date: Nov 23/2018

Sheet ____ of ____ Chk'd: ____ Date: ____

DESIGN NOTES





208

*Well design based on a calculated sustainable yield of 407 US gpm

Screen Specs based on Johnson Screens.

20 slot = 53 in²/ft open space
53 × 0.31 = 16.43 US gpm/ft

407 US gpm / 16.43 US gpm/ft
= 24.4 ft of 20 slot screen needed.

Associated Engineering | GLOBAL PERSPECTIVE. LOCAL FOCUS.

Project No.: 20188152 File:

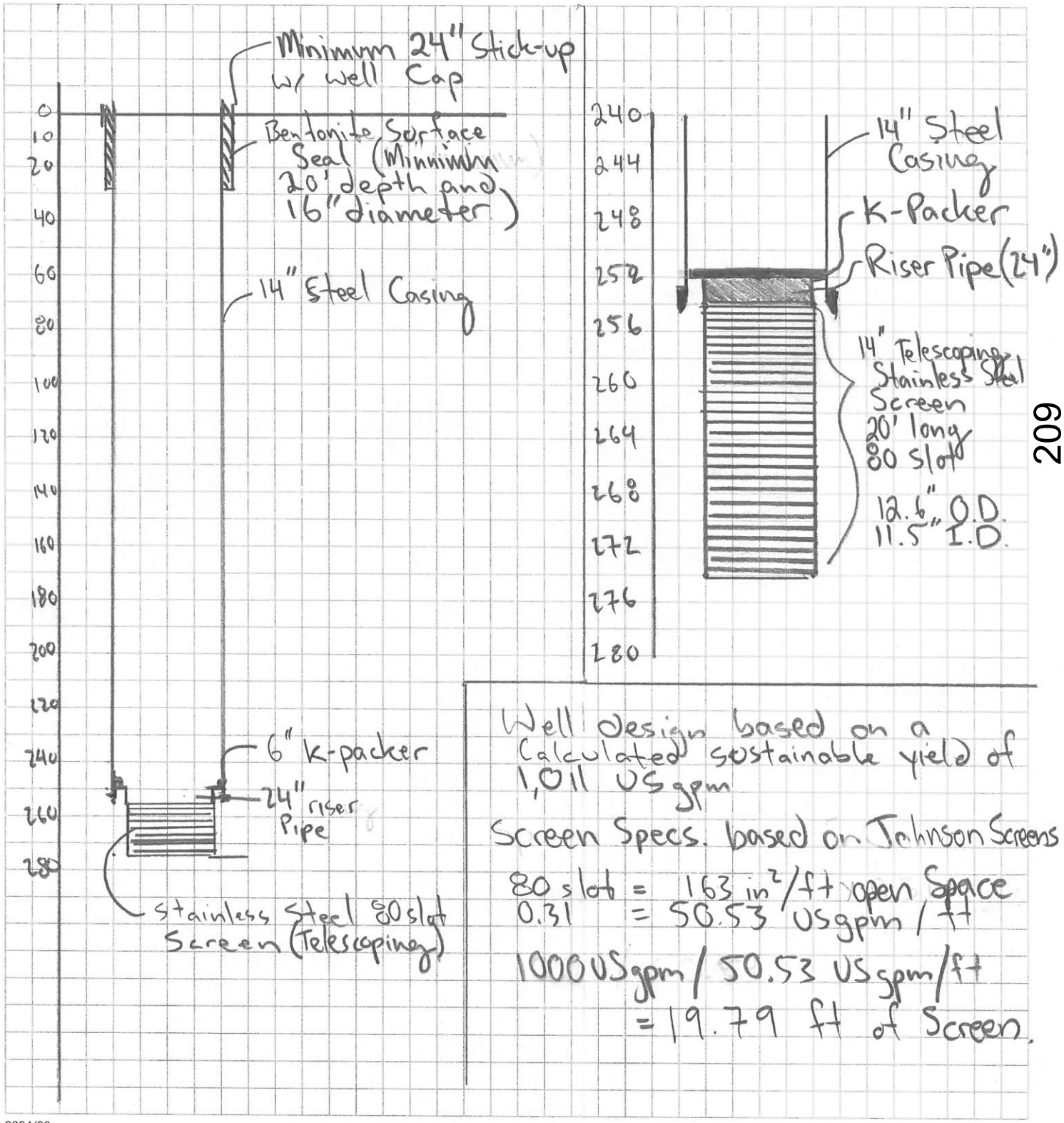
Client: SCRD

Subject: Dusty Rd Well Design

By: Tony Friesen Date: Nov 23, 2018

Sheet of Chk'd: Date:

DESIGN NOTES



Well design based on a calculated sustainable yield of 1,011 US gpm

Screen Specs. based on Johnson Screens

80 slot = 163 in²/ft open Space
0.31 = 50.53 USgpm / ft

1000 USgpm / 50.53 USgpm/ft
= 19.79 ft of Screen.

209

Appendix I - Well evaluation methodology and minutes of well evaluation meeting

Associated Environmental

Date:	November 26, 2018	**File:**	2018-8152.000 Task 6
To:	Remko Rosenboom, SCRD		
From:	Marta Green, P.Geo.		
Project:	Phase 2 Groundwater Investigation		
Subject:	Draft well site grading criteria		

MEMO

1 INTRODUCTION

The Sunshine Coast Regional District (SCRD) has a water supply shortage of 2.3 million m^3 from May to October. This is equivalent to 175 L/s (2775 USgpm) for 153 days. One of the projects to look into making up this shortage is the Phase 2 Groundwater Investigation Project, and Associated Environmental (AE) has been retained to support this project. A total of four boreholes were drilled, and three were completed as exploratory water supply wells. Pumping tests were completed, and sustainable well capacities were estimated. At the same time, treatment and storage requirements to bring the wells into the SCRD water supply system was assessed and a desktop assessment of potential environmental concerns and impacts on nearby users and environmental flow needs (important for understanding level of effort needed for a new groundwater use license application) was also completed.

The next step is to evaluate the three well sites based on multiple criteria and assess the feasibility of developing a production well at each site. This will be completed by setting up the multiple criteria, and then discussing and agreeing on the criteria during a meeting facilitated by AE, and finally by ranking the wells as a project team.

This memorandum proposes well evaluation criteria to be used by the project team to identify and recommend the most appropriate wells to move forward with into production wells. The draft evaluation criteria presented herein are to be reviewed, and then discussed and used during the evaluation meeting to be held on November 28, 2018.

2 WELL SITE EVALUATION CRITERIA

Table 1 summarizes the draft evaluation criteria and importance weighting to be used to identify and recommend the most appropriate well site. Examples of poor and excellent scores of the grading is provided and definitions will be further discussed during the meeting.

3 EVALUATION USING THE CRITERIA

During the meeting, we will fill in Table 2. Background information to help with the evaluation is found in the interim report and the engineering memo submitted to SCRD separately. This table will be filled out in excel during the meeting.

Table 1: Draft well site evaluation criteria

General Category	Grading Criterion	Importance Weighting	Poor Score (1) Definition	Excellent Score (5) Definition
Well Supply	Long term sustainable well yield	0.1	*Low yielding*	*Meets or exceeds nearby SCRD pipe infrastructure capacity*
	Well interference (drawdown) with other wells	0.1	*Moderate to high risk that the subject well may impact other wells (existing or future) (e.g.: Town of Gibsons, Gravel Pit Owners). This may cause additional operational challenges*	*Low risk that the subject well may impact other wells (existing or future) (e.g.: Town of Gibsons, Gravel Pit Owners). This may cause additional operational challenges in future.*
Engineering	Pipe Size	0.1	*Small diameter (low flow) pipes in area only.*	*Large diameter (high flow) pipes exist nearby.*
	Production Well Costs, Treatment and Storage (Capital)	0.1	*High cost capital investment (e.g.: advanced treatment needed)*	*Low cost capital investment (e.g.: chlorine and minimal storage needed)*
	O&M and Energy Costs	0.1	*High cost O&M. Difficult to operate.*	*Low cost O&M. Easy to operate.*
Access Issues	Room for Production Well and Storage	0.1	*No room for production well and storage. Would need to purchase land.*	*Lots of room for production well and storage, and land owned by SCRD.*
	Land Use Fit	0.1	*Doesn't fit in well with surrounding land use. May result in complaints during construction and operation.*	*Fits in well with surrounding land use.*
Environmental	Source Protection	0.1	*The well is in a vulnerable aquifer with significant hazards nearby. This well will require a high level of management and the well will always be exposed to a certain amount of risk of loss of well due to contamination.*	*The well is in a protected aquifer with low risk hazards nearby. This well should be able to last a long time with low level of management and is at low risk of being lost due to contamination*
	Hydraulic Connection and Impacts to Environmental Flow Needs	0.1	*The aquifer is hydraulically connected, which will require the Province to consider impacts to Environmental Flow Needs when considering licensing decisions. Possible mitigation to augment EFNs in streams may be needed.*	*The aquifer is definitely not hydraulically connected, and the Province won't need to consider impacts to Environmental Flow Needs when considering licensing decisions. Mitigation will not be needed.*
	Environmental Assessment Act	0.1	*The "Project" would trigger an environmental assessment under the Environmental Assessment Act (75 L/s).*	*The "Project" would not trigger an environmental assessment under the Environmental Assessment Act (75 L/s).*

Table 2: Evaluation of the well sites using the selected evaluation criteria

General Category	Grading Criterion	Score			Importance Weighting	Notes
		Dusty Road Well	Mahan Road Well	Elphinstone Road Well		
Well Supply	Long term sustainable well yield					
	Well interference (drawdown) with other wells					
Engineering	Pipe Size					
	Production Well Development, Treatment and Storage (Capital)					
	O&M and Energy Costs					
Access Issues	Room for Production Well and Storage					
	Geotech					
Environmental	Source Protection					
	Hydraulic Connection and Impacts to Environmental Flow Needs					
	Environmental Assessment Act					Trigger is 75 L/s but yield for each is less.
Total score with importance weighting		*0*	*0*	*0*		

Date:	November 28, 2018	**File:**	2018-8152
Time:	10:00 – 12:00	**Page:**	1 of 5
Project:	GW Investigation Phase 2		
Subject:	Well Site Evaluation Meeting		
Client:	Sunshine Coast Regional District		
Location:	SCRD offices, Sechelt		
Present:	SCRD: Remko Rosenboom – RR Andrew Kraus – AR Shane Walkey – SW Codie Abbott – CA Associated Engineering/Environmental: Marta Green – MG Matt Lozie – ML (via Skype) Matt Henney – MH (via Skype) Steve Colebrook – SC		
Distribution:	Those Present		

This Record of Meeting is considered to be complete and correct. Please advise the writer within one week of any errors or omissions, otherwise this Record of Meeting will be considered to be an accurate record of the discussions

Discussion:

1 INTRODUCTIONS AND AGENDA

Brief round table and phone introductions plus a run through of the proposed agenda, essentially following the grading criterion of the evaluation matrix (see appended matrix table).

2 WELL SUPPLY

SC gave a brief overview of the site hydrogeology, geology, any difficulties encountered during drilling, pumped well yields, estimated sustainable well yields and well interference observed. Key details below:

2.1 GRAY CREEK

- Well not completed due to relatively shallow depth of aquifer at apex of alluvial fan.
- Discussed possibility for a well to be located further west in land owned by the fish farm, given the good well yields that the farm yields from their wells.
- SCRD currently have a surface water licence on Gray Creek which allows 3 ML/d to be abstracted.
- Potential to transfer this surface water licence to a groundwater licence.

2.2 DUSTY ROAD

- Unconfined sand and gravel aquifer.

Discussion:

- Good sustainable yield of 1011 USgpm.
- No well interference observed at two monitoring wells, one located near Sechelt Inlet Rd, the other at Lehigh Quarry. However, insufficient data to assess impact on quarry well water levels due to access issues during pumping test.

2.3 MAHAN ROAD

- Unconfined sand and gravel aquifer with a low permeability layer above which provides some protection from contaminants. Deep aquifer with water levels approx. 85 mbgl.
- Sustainable yield of 572 USgpm calculated.
- Tidal influence observed on water levels.
- Impact of pumping observed at the monitoring wells located approx. 250 and 400m away, with measured drawdowns of 0.7 and 0.5 m respectively.
- RR noted that we will need to assess what the impact might be on the Town of Gibsons wells.
- Will also need to conduct a survey to find all private groundwater users in the area that could be affected by abstraction from a production well here – SW noted that a number of properties in the area are not connected to mains water supply so likely to have their own well. Any negative impact on these wells would need to be mitigated against, e.g. lowering pumps, drill new wells, put on mains supply.
- MG suggested undertaking an independent aquifer mapping study, particularly given the existing users of this aquifer (Town of Gibsons, private supplies). Study could partner with BC FLNR Surrey office and Town of Gibsons.

2.4 ELPHINSTONE AVENUE (CHURCH ROAD)

- Confined sand and gravel aquifer.
- Difficult installation of screen due to drilling technique not providing a true reflection of ground conditions.
- Sustainable yield of 407 USgpm from pumping test results, however noted that pumping test was impacted by silts and sands being pulled into well.
- Would need to drill using cable tool technique to get true representative samples of the aquifer material to allow suitable screen design.
- Impact of pumping observed at Granthams Well but not observed at Sentinel Rd or Soames Well (although very limited data collected to assess Soames Well – access difficulties).

3 ENGINEERING

ML ran through the proposed engineering requirements (pipe sizes, tie-ins, treatment) at each site together with a look at capital costs. Assumed that all sites will require treatment for 4-log inactivation (all wells assessed as GARP for viruses only). Key details below:

3.1 DUSTY ROAD

- A 300 mm pipe would be run from the well to tie in with existing mains at Sechelt Inlet Rd. This pipe would allow sufficient chlorine contact time for 4-log virus inactivation.
- Need to confirm water flow direction in main along Sechelt Inlet Rd. Gray Creek surface water source not used apart from during the summer when flow in mains is to the south. Otherwise flow typically to north. Assume system is fed south to north.
- System has a closed head until pumps are on at Sandy North pumping station.

3.2 MAHAN ROAD

- Propose dedicated 250 mm main along Kearton Rd to Pratt Rd.
- Reed Road Reservoir will control pumping – Mahan Rd would only be ‘on’ when Reed Road Reservoir falls to a certain level.
- The pipe capacity of 94 L/s is based on capacity of pipe along Pratt Rd.
- Due to the depth to aquifer and significant lift of water, 3-phase power is required – this would require a new 600m power line to be brought in to the site from the north – expensive.

3.3 ELPHINSTONE AVENUE (CHURCH ROAD)

- 300mm pipe to existing reservoir at the west end of Elphinstone Ave. (Granthams Landing Reservoir).
- 4-log virus inactivation with chlorine. Pipe to reservoir plus residence time in reservoir will provide sufficient contact time..
- Power requirements are just at the limit of single phase which is available in this area. A booster may be sufficient to generate power requirements.
- Filtration added to costs of treatment system due to high total Fe in water sample. However, thought that this is due to the well screen being oversized and sand and silt pulled into well and water sample. Will remove these costs for final report.

All three sites need the production well drilling and testing costs added to the capital costs. Mahan most expensive to drill due to depth to aquifer.

Envisage a two-room building at each site (electrical room and chlorination dosing room). Example at Roberts Creek.

All likely to have similar O&M costs, unless filtration is required at Elphinstone. O&M pumping costs might be seasonal, dependent on use of groundwater source.

Discussion:

Elphinstone and Mahan considered better locations for supply purposes than Dusty. Both could feed into Reed Road Reservoir

4 ACCESS ISSUES

- No major access issues at Dusty Road, although it was noted that the quarry is likely to expand in the area and would likely surround production well(s).
- MOTI own land at Mahan and along Kearton Rd; historically they have been ok with development on their land, but SCRD want security of land ownership.
- SCRD own small park next to the Elphinstone test well. Potential to develop wellfield at Shirley Macey Park to the north west? Although would require further investigation. SCRD own land here as well.
- Any future well(s) at Gray Creek would require land agreement with fish farm.

5 ENVIRONMENTAL ISSUES

MG ran through some of the environmental issues at each of the sites, including source protection, hydraulic connection and impact to environmental flow needs (EFN). Key details below:

5.1 DUSTY ROAD

- Dusty at very high risk from source protection perspective.
- Located next to one of the largest sand and gravel quarries in North America with plans for extensive quarry expansion around the well.
- It is an unconfined aquifer so any spills or leaks from oil and gas for quarry machinery could make its way to the aquifer and drawdown cone of the well. This could result in the aquifer and well becoming contaminated and unusable in the future.
- Aquifer likely to be hydraulically connected to Irgens Creek so may require mitigation to augment EFN.

5.2 MAHAN ROAD

- Low permeability clay and till layer overlying the aquifer provides protection from contamination migrating down to the aquifer.
- Aquifer much less likely to be hydraulically connected to local creeks due to geological setting and previous creek flow observations. Further work currently being undertaken by Associated to help determine the likelihood of connection.
- Aquatic values of the creeks are very important to community.

Discussion:

5.3 ELPHINSTONE AVENUE (CHURCH ROAD)

- Low permeability till layer overlying the confined aquifer provides protection from contamination migrating down to aquifer.
- Extent of low permeability cover being further examined to help assess whether the aquifer is hydraulically connected to Soames Creek.
- To comply with Groundwater Protection Regulations (GWPR) a well at this location would allow Granthams to be closed (currently an uncontrolled flowing artesian well not in compliance with GWPR).

All wells are below 75 L/s so as long as each well is considered a separate 'project' they are below the flow rate threshold of 75 L/s that automatically require an Environmental Assessment as required by the Environmental Assessment Act.

- **EVALUATION OF SITES USING WEIGHTED EVALUATION CRITERIA**

The completed evaluation matrix is appended to these minutes.

- All agreed that source protection should have highest importance weighting.
- Long term sustainable yield, CAPEX and hydraulic connection also considered of more importance.
- All agreed to remove Land Use Fit criteria from matrix (give it 0% weighting in matrix). There will be minimal disturbance and sufficient room at each site. Community is used to seeing wells in parks and residential areas.

Scores were assigned for each well based on findings and discussions during the meeting. Elphinstone Avenue has highest score with Dusty Road the lowest.

6 FINAL COMMENTS

- More work required for Elphinstone and Mahan with Elphinstone identified as the best option to move forward with.
- Need to consider where development would occur at Elphinstone and also explore potential for wellfield at Shirley Macey Park.
- Mahan has potential but first do mapping/aquifer study
- Dusty Road not considered an option at this stage due to the high source protection risk given its location next to Lehigh Quarry which is expected to expand around the area of the well.
- Gray Creek is still an option – need to maintain communications with the fish farm. There may be potential to transfer the current Gray Creek surface licence (3 ML/d) to a groundwater licence in the future.
- Change name of Elphinstone Avenue well to Church Rd well.

Table 2: Evaluation of the well sites using the selected evaluation criteria

General Category	Grading Criterion	Score			Importance Weighting	Notes
		Dusty Road Well	Mahan Road Well	Elphinstone Road Well		
Well Supply	Long term sustainable well yield	5	4	3	15%	Dusty Road: unconfined aquifer. Sand and Gravel: 64 L/s. Mahan Road: deep well, 400 ft deep well. Also unconfined although there is a local confining unit which provides protection. Yields: pumped 300 USgpm: rated at 570 USgpm. Elphinstone: Confined aquifer (confining layer: till) and sand and gravel below that. Issues with drilling. DR didn't give clear picture of what's down there. Screen got lost first time. Put another screen in and then pumping test started pulling in sands and silts at 240 USgpm. Dialed back to 170 USgpm. Rated at 407 USgpm.
	Well interference (drawdown) with other wells	3	3	5	5%	Dusty: inconclusive due to lack of data. Mahan: monitored two wells: 300m to North (private well): 70 cm drawdown. MOE's observation well: 400 m away 50 cm drawdown (difficult to interpret with tidal influence). Gibsons wells farther away so negligible interference is expected but could use 50 cm as worst case scenario. Also will need a detailed (door to door) survey to confirm water users (every house near the border but in the Town of Gibsons can be assumed to have a well). Everyone ok with ongoing monitoring and discussion with other well owners. An independent aquifer mapping study across entire study may be useful. See if can partner with BC FLNR Surrey office and Town of Gibsons. Soames: monitored pressure changes in Granthams, and Soames well minimal interference observed but data was limited. Also private well: no interference.
Engineering	Interconnecting Pipe Size	3	5	4	10%	Limiting factor in bold: Dusty: well 64 L/s and pipe **47**. Mahan: well **37**, pipe 94 (pipe along Pratt Road, and could flow in other direction). Elphinstone: well **26**, pipe 59. Lots of pipe room in Mahan.
	Production Wells, Treatment, Storage, Tie-In and Energy Costs (Capital)	5	3	4	15%	All sites designed with 4-log treatment (chlorination). Expensive to connect Mahan to 3-phase power as will come from Gibsons Way, approx 600m to north. Elphinstone may be able to use single phase with booster.
	O&M and Long term Energy Costs	5	4	3	5%	Generally the same per well except for energy costs (Mahan has highest drilling costs due to depth). O&M for pumps may be seasonal.
Access Issues	Room for Production Well, Treatment Plant, and Storage, Land ownership/agreement	4	3	5	10%	SCRD staff will look into this further. Board may wish to have ownership vs right of way only from MOTI, so Mahan scores lower. Elphinstone is also on right of way but there is room owned by SCRD.
	Land Use Fit	5	5	5	0%	Everyone agreed there will be minimal disturbance and sufficient room at each site. Community is used to wells in parks and in residential areas.
Environmental	Source Protection	1	4	5	20%	Dusty has a very high risk: one of largest gravel extraction mines in North America. Plans for expansion all around this well. Unconfined aquifer so any spills or leaks from oil or gas for machines could make it's way to aquifer and drawdown cone of well.
	Hydraulic Connection and Impacts to Environmental Flow Needs (needed to support new Groundwater Use Licence Application)	2	5	5	15%	Aquifer at Dusty Road site is likely connected to Irgins Creek so could require mitigation to augment EFNs. Mahan and Elphinstone not likely connected to Charman and Soames Creek, respectively. Will know more by final report because AE is doing more hydrology work. Aquatic values are very important for community.
	Other regulations (e.g.: Environmental Assessment Act and Ground Water Protection Regulation)	3	3	5	5%	EAA: All wells below 75 L/s as long as each well considered a different "project". If in separate watersheds should be ok. For GWPR, Elphinstone would allow Granthams to be closed (uncontrolled flowing artesian well) to be be in compliance with GWPR.
Total score with importance weighting		3.25	3.9	4.35	100%	

Appendix J - Preliminary Class D capital cost estimates and proposed infrastructure for each well site

Sunshine Coast Regional District Date: **11/26/2018**
Groundwater Investigation Phase 2
Interim Cost Estimate

Proposed Well Site - Dusty Road

ID	Description	Unit	Quantity	Unit Price	Amount
0.0	**General**				
0.1	Mobilization/Demobilization	LS	1	$ 25,000.00	$ 25,000.00
0.2	Survey	LS	1	$ 10,000.00	$ 10,000.00
1.0	**Civil**				
1.1	300mm Diameter Water Main	m	300	$ 500.00	$ 150,000.00
1.2	Pavement R&R	m	300	$ 240.00	$ 72,000.00
2.0	**Structural**				
2.1	WTP Building	LS	1	$ 170,000.00	$ 170,000.00
3.0	**Process Mechanical**				
3.1	WTP Process Piping and Equipment	LS	1	$ 120,000.00	$ 120,000.00
3.2	Well drilling and test pumping	LS	1	$ 160,000.00	$ 160,000.00
3.3	Well Completion	LS	1	$ 100,000.00	$ 100,000.00
4.0	**Building Mechanical**				
4.1	WTP HVAC	LS	1	$ 45,000.00	$ 45,000.00
4.2	WTP Floor Drains and Plumbing	LS	1	$ 40,000.00	$ 40,000.00
5.0	**EI&C**				
5.1	WTP Electrical Works	LS	1	$ 35,000.00	$ 35,000.00
5.2	WTP Instrumentation and SCADA	LS	1	$ 35,000.00	$ 35,000.00
5.3	Service Connection (3 Phase)	LS	1	$ 20,000.00	$ 20,000.00
				Sub-Total	**$ 982,000.00**
				Contingency (40%)	**$ 392,800.00**
				Total	**$ 1,374,800.00**

Does Not Include any Property Acquisition Costs

N

W E

S

0 20 40 Meters

INFRASTRUCTURE SERVICES
SUNSHINE COAST REGIONAL DISTRICT

This information has been compiled by the Sunshine Coast Regional District using data derived from a number of sources with varying levels of accuracy. The Sunshine Coast Regional District disclaims all responsibility for the accuracy or completeness of this information.

LEGEND

- 3.5 m — Offset (Service)
- 3.5 m — Offset (Pipe/Structure)
- @PIN — Connection at Property Pin
- Y — Yoke
- SP — Fire Hydrant
- Standpipe
- PS — Pump Station
- Power Pole
- W — Man Hole
- Air Relief Valve
- Blow Off Valve
- Check Valve
- Gate Valve
- Pressure Reducing Valve
- Cap
- Cross
- Elbow
- Tee
- Reducer
- W — Connection
- W — Meter
- Meter Setter

- 750mm Ø
- 600mm Ø
- 450mm Ø
- 400mm Ø
- 350mm Ø
- 300mm Ø
- 250mm Ø
- 200mm Ø
- 150mm Ø
- 100mm Ø
- 75mm Ø
- 50mm Ø
- 37.5mm Ø
- 25mm Ø
- Abandoned Water Main

Dusty Rd Well Site

2018-11-01

1

6117 ####

1.0 m TO PIN

6111

6109

@PIN

6109

Sechelt Inlet Rd

19.3m

6100

5426

6075

Allen Rd

Allen Rd

Sechelt Inlet Rd

3.0m

10.3m

0.9 m TO PIN

6088

6090

5490A
5490B
5435

9.6m

6.8m

3.2m

10.3m

4 ####

5510

Dusty Rd

2@ 2.0 m TO PIN

6120

Tie In

Sechelt Inlet Rd

13.4m

6053

11.3m

5474

New dedicated 300mm main

6045

6041

66.5m

5456

DUSTY RD WELL

New WTP Adjacent to Well

6037

6040

Dusty Rd

Dusty Rd

6100

Dusty Rd

Dusty Road Well
Proposed Infrastructure

Sechelt Inlet Rd

####

Sunshine Coast Regional District Date: **11/26/2018**
Groundwater Investigation Phase 2
Interim Cost Estimate

Proposed Well Site - Mahan Road

ID	Description	Unit	Quantity	Unit Price	Amount
0.0	**General**				
0.1	Mobilization/Demobilization	LS	1	$ 25,000.00	$ 25,000.00
0.2	Survey	LS	1	$ 10,000.00	$ 10,000.00
1.0	**Civil**				
1.1	250mm Diameter Water Main	m	410	$ 440.00	$ 180,400.00
2.0	**Structural**				
2.1	WTP Building	LS	1	$ 170,000.00	$ 170,000.00
3.0	**Process Mechanical**				
3.1	WTP Process Piping and Equipment	LS	1	$ 110,000.00	$ 110,000.00
3.2	Well drilling and test pumping	LS	1	$ 250,000.00	$ 250,000.00
3.3	Well Completion	LS	1	$ 100,000.00	$ 100,000.00
4.0	**Building Mechanical**				
4.1	WTP HVAC	LS	1	$ 45,000.00	$ 45,000.00
4.2	WTP Floor Drains and Plumbing	LS	1	$ 40,000.00	$ 40,000.00
5.0	**EI&C**				
5.1	WTP Electrical Works	LS	1	$ 35,000.00	$ 35,000.00
5.2	WTP Instrumentation and SCADA	LS	1	$ 35,000.00	$ 35,000.00
5.3	Service Connection (3 Phase from Gibsons Way)	LS	1	$ 250,000.00	$ 250,000.00
				Sub-Total	**$ 1,250,400.00**
				Contingency (40%)	**$ 500,160.00**
				Total	**$ 1,750,560.00**

Does Not Include any Property Acquisition Costs

N
W E
S

0 20 40 Meters

INFRASTRUCTURE SERVICES
SUNSHINE COAST REGIONAL DISTRICT

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LEGEND

- Pressure Zone 4 (240m)
- Pressure Zone 3 (170m)
- Pressure Zone 2 (120m)
- Pressure Zone 1 (60m)
- 3.5 m — Offset (Service)
- 3.5 m — Offset (Pipe/Structure)
- @PIN — Connection at Property Pin
- Y — Yoke
- Fire Hydrant
- SP — Standpipe
- PS — Pump Station
- Power Pole
- W — Man Hole
- Air Relief Valve
- Blow Off Valve
- Check Valve
- Gate Valve
- Pressure Reducing Valve
- Cap
- Cross
- Elbow
- Tee
- Reducer
- W — Connection
- W — Meter
- Meter Setter

- 750mm Ø
- 600mm Ø
- 450mm Ø
- 400mm Ø
- 350mm Ø
- 300mm Ø
- 250mm Ø
- 200mm Ø
- 150mm Ø
- 100mm Ø
- 75mm Ø
- 50mm Ø
- 37.5mm Ø
- 25mm Ø
- Abandoned Water Main

Mahan Rd Well Site

2018-11-01

1

491 487 477 463 464 451 450 441 440 420 394 387 956 460 453 404

INGLIS

MATHEW RD

KEARTON ROAD

FIRCREST ROAD

Tie In

Dedicated 250mm main

New WTP Adjacent to Well

MAHAN RD WELL

Mahan Road Well
Proposed Infrastructure

Sunshine Coast Regional District Date: **11/26/2018**
Groundwater Investigation Phase 2
Interim Cost Estimate

Proposed Well Site - Church Road

ID	Description	Unit	Quantity	Unit Price	Amount
0.0	**General**				
0.1	Mobilization/Demobilization	LS	1	$ 25,000.00	$ 25,000.00
0.2	Survey	LS	1	$ 10,000.00	$ 10,000.00
1.0	**Civil**				
1.1	150mm Diameter Water Main	m	600	$ 340.00	$ 204,000.00
1.2	Pavement R&R	m	600	$ 240.00	$ 144,000.00
1.3	Site Works	LS	1	$ 20,000.00	$ 20,000.00
2.0	**Structural**				
2.1	WTP Building	LS	1	$ 215,000.00	$ 215,000.00
2.2	Grantham Reservoir Tie In and Baffles	LS	1	$ 100,000.00	$ 100,000.00
3.0	**Process Mechanical**				
3.1	WTP Process Piping and Equipment	LS	1	$ 90,000.00	$ 90,000.00
3.2	WTP Distribution Pumping	LS	1	$ 80,000.00	$ 80,000.00
3.3	Well drilling and test pumping	LS	1	$ 145,000.00	$ 145,000.00
3.4	Well Completion	LS	1	$ 90,000.00	$ 90,000.00
4.0	**Building Mechanical**				
4.1	WTP HVAC	LS	1	$ 45,000.00	$ 45,000.00
4.2	WTP Floor Drains and Plumbing	LS	1	$ 40,000.00	$ 40,000.00
5.0	**EI&C**				
5.1	WTP Electrical Works	LS	1	$ 35,000.00	$ 35,000.00
5.2	WTP Instrumentation and SCADA	LS	1	$ 35,000.00	$ 35,000.00
5.3	Service Connection and 3 Phase Power (350m)	LS	1	$ 150,000.00	$ 150,000.00
6.3	Power and Control Cable from WTP to Well (220m)	LS	1	$ 10,000.00	$ 10,000.00
				Sub-Total	**$ 1,438,000.00**
				Contingency (40%)	**$ 575,200.00**
				Total	**$ 2,013,200.00**

Does Not Include any Property Acquisition Costs
Does not include back up generator

N

W E

S

0 20 40 Meters

INFRASTRUCTURE SERVICES
SUNSHINE COAST REGIONAL DISTRICT

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LEGEND

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- Standpipe
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- Power Pole
- W — Man Hole
- Air Relief Valve
- Blow Off Valve
- Check Valve
- Gate Valve
- Pressure Reducing Valve
- Cap
- Cross
- Elbow
- Tee
- Reducer
- Connection
- Meter
- Meter Setter

- 750mm Ø
- 600mm Ø
- 450mm Ø
- 400mm Ø
- 350mm Ø
- 300mm Ø
- 250mm Ø
- 200mm Ø
- 150mm Ø
- 100mm Ø
- 75mm Ø
- 50mm Ø
- 37.5mm Ø
- 25mm Ø
- Abandoned Water Main

Tie into 210m PZ at Chamberlin Road

New 150mm dedicated main

Upgrade reservoir with baffles and separate inlet pipe

Tie In to Existing Reservoir

New WTP and PS Adjacent to Existing Reservoir

New raw water main 150mm

GRANTHAMS RESERVOIR
113,650 LITRES (25,000 IMPERIAL GAL.)
TWL = 80.0 m
GEODETIC DATUM

Church Road Well
Proposed Infrastructure

Elphinstone Ave Well Site

2018-11-01

1

Associated Engineering comments in red boxes, marked up on Opus DaytonKnight (2013) drawing

PRESSURE ZONES	RESERVOIRS	TOTAL VOLUME (CU.M)
Zone 1	Selma Park 1, Geddes	3,487
Zone 2	Trout Lake, Selma Zone 2, Reed Road, Welcome Woods	22,979
Zone 3	Henry Road	1,137
Zone 4	Cemetary Road	227
Sandy Hook	Mount Richardson, Gray Creek	857
Zone 1 West	Secret Cove	2,281
Zone 2 Granthams	-	-

CONTINUED ON FIGURE 3-2A

Chapman WTP

Selma Zone 2 Reservoir (Clearwell)

Selma Zone 1 Reservoir

SELMA PARK

WILSON CREEK

TRANSMISSION SUPPLY

DAVIS BAY

ROBERTS CREEK

TRANSMISSION SUPPLY

Geddes Reservoir

Reed Road pump station has a transmission line to the Henry Road reservoir. So we can to connect to this trans-mission line (it has capacity for more flow)

162m HGL

Reed Rd - HGL of 210m

closed valve to isolate pressure zones at Chamberlain Rd

location of Church Rd Well

PZ 210m

Cemetary Road Reservoir

210m HGL

Henry Road Reservoir

Reed Road Reservoirs (2)

PZ 162m

LANGDALE

POINT

GRANTHAMS LANDING

GIBSONS

GOWER POINT

OPUS DAYTONKNIGHT

PROJ NO: D-02820.00
DRAWN BY: CL
DATE: APR 2013

0 500 1,000 2,000 3,000 4,000 Meters

SCALE 1:50,000

SUNSHINE COAST REGIONAL DISTRICT

CHAPMAN WATER SYSTEM
TRANSMISSION MAINS AND PRESSURE ZONES

FIGURE 3-2B

Path: H:\Projects\000\028 SCRD\3-2\00\Figure 3-2B - System and Zones.mxd

SCRD WELL OPERATIONAL COSTS

ANNUAL ELECTRICITY COSTS

Dusty (one well)

1	Electricity Demands	Est Monthly Demand (kWh)	Est Annual Demand (kWh)	
1.1	Well Pump	25200	100800	
1.2	Distribution Pumps			
1.3	Building Lighting, Heating	1500	18000	

2	Annual power Costs	Annual kWh Usage	Rate ($/kWh)	Annual Cost
2.1	Base Cost	0	n/a	$45
2.2	Blended Tier Rate kWh/month	118800	$0.160	$19,008
2.6	Max Demand Charge	35	$9.090	$318
	Annual Electricity Costs			**$19,372**

Mahan (one well)

1	Electricity Demands	Est Monthly Demand (kWh)	Est Annual Demand (kWh)	
1.1	Well Pump	39600	158400	
1.2	Distribution Pumps			
1.3	Building Lighting, Heating	1500	18000	

2	Annual power Costs	Annual kWh Usage	Rate ($/kWh)	Annual Cost
2.1	Base Cost	0	n/a	$45
2.2	Blended Tier Rate kWh/month	176400	$0.160	$28,224
2.6	Max Demand Charge	55	$9.090	$500
	Annual Electricity Costs			**$28,769**

Church Road (one well)

1	Electricity Demands	Est Monthly Demand (kWh)	Est Annual Demand (kWh)	
1.1	Well Pump	14400	57600	
1.2	Distribution Pumps	36000	144000	
1.3	Building Lighting, Heating	2000	24000	

2	Annual power Costs	Annual kWh Usage	Rate ($/kWh)	Annual Cost
2.1	Base Cost	0	n/a	$45
2.2	Blended Tier Rate kWh/month	225600	$0.160	$36,096
2.6	Max Demand Charge	100	$9.090	$909
	Annual Electricity Costs			**$37,050**

Assumptions:
These costs are for comparion purposes and based on approximate motor sizes for each well
Replacement costs not included
Miscellaneous costs like SCADA network, water sampling, insurance, operator wages, engineering support, tech support not included since this is for comparison purposes
Wells operate for 4 months a year

ANNUAL HYPOCHLORITE COSTS

Well site	Pumping Rate L/s	L/d	m3/d	Daily cost ($)	Annual cost ($)
Dusty Road	64	5529600	5530	$111	$13,271
Mahan Road	37	3196800	3197	$64	$7,672
Church Road	26	2246400	2246	$45	$5,391

Assumptions:
Wells operate for 4 months a year
Hypochlorite costs are $0.02 per m3 water for each well, based on current SCRD chlorine costs for existing wells

Appendix K - Class D capital cost estimates for Church Road Options

Sunshine Coast Regional District Date: **1/7/2018**
Groundwater Investigation Phase 2
Final Cost Estimate

Proposed Well Site - Church Road (Option A)

ID	Description	Unit	Quantity	Unit Price	Amount
2019-2020 Water Licence and Fisher Road Pilot Hole and MW					
0.0	**General**				
0.1	Technical Assessment and Water Licence Application	LS	1	$ 80,000.00	$ 80,000.00
				Sub-Total	**$ 80,000.00**
				Contingency (40%)	**$ 112,000.00**
2021-2022 Detailed Design and Construction (assumes water licence received March 2021)					
0.0	**General**				
0.1	Mobilization/Demobilization	LS	1	$ 25,000.00	$ 25,000.00
0.2	Survey	LS	1	$ 10,000.00	$ 10,000.00
1.0	**Civil**				
1.1	Water Supply Mains (150 mm)	m	600	$ 340.00	$ 204,000.00
1.2	Pavement R&R	m	600	$ 240.00	$ 144,000.00
1.3	Site Works	LS	1	$ 20,000.00	$ 20,000.00
2.0	**Structural**				
2.1	WTP Building	LS	1	$ 215,000.00	$ 215,000.00
2.2	Grantham Reservoir Tie In and Baffles	LS	1	$ 100,000.00	$ 100,000.00
3.0	**Process Mechanical**				
3.1	WTP Process Piping and Equipment	LS	1	$ 90,000.00	$ 90,000.00
3.2	WTP Distribution Pumping	LS	1	$ 80,000.00	$ 80,000.00
3.3	Church Road Production Well drilling and test pumping	LS	1	$ 145,000.00	$ 145,000.00
3.5	Hydrogeology for well drilling and test pumping	LS	1	$ 40,000.00	$ 40,000.00
3.6	Well Completion	LS	1	$ 90,000.00	$ 90,000.00
4.0	**Building Mechanical**				
4.1	WTP HVAC	LS	1	$ 45,000.00	$ 45,000.00
4.2	WTP Floor Drains and Plumbing	LS	1	$ 40,000.00	$ 40,000.00
5.0	**EI&C**				
5.1	WTP Electrical Works	LS	1	$ 35,000.00	$ 35,000.00
5.2	WTP Instrumentation and SCADA	LS	1	$ 35,000.00	$ 35,000.00
5.3	Service Connection and 3 Phase Power (350m)	LS	1	$ 150,000.00	$ 150,000.00
5.4	Power and Control Cable from WTP to Well (220m)	LS	1	$ 10,000.00	$ 10,000.00
				Sub-Total	**$ 1,478,000.00**
				Engineering for design (8%)	**$ 118,240.00**
				Engineering for construction (7%)	**$ 103,460.00**
				Contingency for construction (40%)	**$ 591,200.00**
				Total 2021 -2022	**$ 2,290,900.00**
				Total (2019-2022)	**$ 2,402,900.00**

Sunshine Coast Regional District Date: **1/7/2018**
Groundwater Investigation Phase 2
Final Cost Estimate

Proposed Well Site - Church Road & Fisher Road (Option B)

ID	Description	Unit	Quantity	Unit Price	Amount
2019-2020 Water Licence and Fisher Road Pilot Hole and MW					
0.0	**General**				
0.1	Technical Assessment and Water Licence Application	LS	1	$ 80,000.00	$ 80,000.00
0.2	Drilling Fisher Road pilot well	LS	1	$ 44,000.00	$ 44,000.00
0.3	Testing Fisher Road pilot well	LS	1	$ 11,000.00	$ 11,000.00
0.4	Hydrogeology	LS	1	$ 40,000.00	$ 40,000.00
				Sub-Total	**$ 175,000.00**
				Contingency (40%)	**$ 245,000.00**
2021-2022 Detailed Design and Construction (assumes water licence received March 2021)					
0.0	**General**				
0.1	Mobilization/Demobilization	LS	1	$ 25,000.00	$ 25,000.00
0.2	Survey	LS	1	$ 10,000.00	$ 10,000.00
1.0	**Civil**				
1.1	Water Supply Mains (assume 150 mm)	m	300	$ 340.00	$ 102,000.00
1.2	Water Supply Mains (assume 200 mm)	m	300	$ 370.00	$ 111,000.00
1.3	Pavement R&R	m	600	$ 240.00	$ 144,000.00
1.4	Site Works	LS	1	$ 20,000.00	$ 20,000.00
2.0	**Structural**				
2.1	WTP Building	LS	1	$ 215,000.00	$ 215,000.00
2.2	Grantham Reservoir Tie In and Baffles	LS	1	$ 100,000.00	$ 100,000.00
3.0	**Process Mechanical**				
3.1	WTP Process Piping and Equipment	LS	1	$ 100,000.00	$ 100,000.00
3.2	WTP Distribution Pumping	LS	1	$ 100,000.00	$ 100,000.00
3.3	Church Road Production Well drilling and test pumping	LS	1	$ 145,000.00	$ 145,000.00
3.4	Fisher Road Production Well drilling and test pumping	LS	1	$ 170,000.00	$ 170,000.00
3.5	Hydrogeology for well drilling and test pumping	LS	1	$ 75,000.00	$ 75,000.00
3.6	Well Completion	LS	2	$ 90,000.00	$ 180,000.00
4.0	**Building Mechanical**				
4.1	WTP HVAC	LS	1	$ 45,000.00	$ 45,000.00
4.2	WTP Floor Drains and Plumbing	LS	1	$ 40,000.00	$ 40,000.00
5.0	**EI&C**				
5.1	WTP Electrical Works	LS	1	$ 35,000.00	$ 35,000.00
5.2	WTP Instrumentation and SCADA	LS	1	$ 35,000.00	$ 35,000.00
5.3	Service Connection and 3 Phase Power (350m)	LS	1	$ 150,000.00	$ 150,000.00
5.4	Power and Control Cable from WTP to Well (220m)	LS	1	$ 10,000.00	$ 10,000.00
				Sub-Total	**$ 1,812,000.00**
				Engineering for design (8%)	**$ 144,960.00**
				Engineering for construction (7%)	**$ 126,840.00**
				Contingency for construction (40%)	**$ 724,800.00**
				Total 2021 -2022	**$ 2,808,600.00**
				Total (2019-2022)	**$ 3,053,600.00**

Reduction in Water Supply Deficit by well development Church Road

Table 1 and 2 presents the percentage by which the Water Supply Deficit would be reduced with the development of a single well or well field in the Church Road area.

Table 1: Reduction in Water Supply Deficit by developing single well in Church Road Area

Effectiveness of water conservation initiatives (per capita, compared to 2010)	**2025**	**2035**	**2050**
Service Area Population	26,000	32,000	43,000
10% reduction	20%	14%	9%
20% reduction	25%	17%	11%
33% reduction	33%	22	14%

Table 2: Reduction in Water Supply Deficit by development of well field in Church Road Area

Effectiveness of water conservation initiatives (per capita, compared to 2010)	**2025**	**2035**	**2050**
Service Area Population	26,000	32,000	43,000
10% reduction	41%	29%	19%
20% reduction	50%	35%	22%
33% reduction	68%	45%	28%

SUNSHINE COAST REGIONAL DISTRICT STAFF REPORT

TO: Infrastructure Services Committee – January 24, 2019

AUTHOR: Tina Perreault, Chief Financial Officer / General Manager, Corporate Services

SUBJECT: **REGIONAL WATER SERVICE AREA 2019 RATE BYLAW AMENDMENT**

RECOMMENDATION(S)

THAT the report titled Regional Water Service Area 2019 Rate Bylaw Amendment be received;

AND THAT the Water Rates Bylaw 422, Schedule B be amended to increase the Regional Water Service Area Land Charges (Parcel Taxes) by 2.0%, User Fees by 5.0%, and Metered Usage Fees by 5.0% in 2019;

AND THAT the Water Rates Bylaw 422 be amended to include:

- **Invoicing details relating to pro-rated service;**
- **Invoices are due on the due date specified on the invoice and payments must be received by 4:30pm PST;**
- **Parameters around applying for a parcel tax reduction on properties with farm classification;**
- **Any amounts unpaid on the 31st of December will be deemed to be taxes in arrears and will be recovered in the manner provided in the *Local Government Act*;**
- **No rebate, refund or credit on any fees collected in error after two years from the date of payment will be issued;**

AND THAT the Water Rates Bylaw 422, Schedule B be amended to include the Manual Water Meter Readings fee of $25 up to a maximum of $300 per annum;

AND THAT the Water Rates Bylaw 422, Schedule B be forwarded to the January 31, 2019 for three readings and adoption;

AND FURTHER THAT the 2019-2023 Financial Plan be amended accordingly.

BACKGROUND

The Sunshine Coast Regional District (SCRD) Board adopted the 2013 Comprehensive Regional Water Plan (CRWP) in June 2013. The Plan outlines how to sustain desired service levels through

a balance of demand management (conservation) initiatives, supply-side development (infrastructure expansion), asset replacement and rehabilitation.

The Regional Water Service Area (RWSA) consists of approximately 11,000 parcels and 10,450 billable water users. The current parcel tax and user rates per single family residential dwelling are $257.84 and $273.63, respectively.

The bylaw to regulate the rates and operation of the water supply and distribution system for the Sunshine Coast Regional District (SCRD) is done through Bylaw No. 422 - Water Rates and Regulations. Each year as part of the Financial Planning and Parcel Tax process, the rates are reviewed for each water service and the respective rate schedules are amended. Copy of the consolidated Bylaw can be found on our website at: Bylaws: Infrastructure. Schedule B of the Bylaw apply to the RWSA as established under Bylaw No. 1002. The purpose of this report is to recommend 2019 rate increases for the RWSA which aligns with the current model.

DISCUSSION

User Fees and Parcel Taxes

The primary objective in rate determination is setting appropriate, sustainable and equitable charges and fees that help the utility achieve full cost recovery by determining the funding envelope required to service RWSA customers over the long term while maintaining financial sustainability.

The two primary sources of revenue for the RWSA are parcel taxes and user fees. Parcel taxes are calculated as a function of parcel size and levied against all parcels within the RWSA. User fees are composed of flat rate water user fees, which are levied on all residential water users within the RWSA, as well as metered water rates that are levied on ICI (industrial, commercial and institutional) water users.

The best practice methodology for the allocation of expenditures and revenues within the RWSA is based on the principle that parcel tax revenues fund capital expenditures (and associated debt) and that user fee revenues fund operating related expenditures. Under the current rate structure, parcel taxes are subsidizing user fees, which requires a revenue adjustment period that will result in user fees increasing at a faster rate than parcel taxes in order to ensure that revenues are equitably aligned over time.

Staff utilize a financial modelling tool designed by Opus DaytonKnight to determine water rates on an annual basis which incorporates numerous variables, in order to set required revenues to support the operating and capital expenditure requirements of the service area in the short and long term.

As part of the Comprehensive Regional Water Plan, there are several significant projects that are currently in progress:

1. Universal Water Metering – Phase 3
2. Chapman Lake Infrastructure Improvement
3. Groundwater Investigation

4. Raw Water Reservoirs

These projects and associated funding, if applicable, will have a significant impact on the financial modelling tool that has historically been used in the rate setting process. Once the scope and funding of these projects is determined, staff will review and update the financial modelling tool.

In the meantime, staff recommend that parcel taxes be increased annually to account for Canadian inflationary cost of construction at minimum. The current five year moving average for infrastructure construction price index (2012 to 2107) indicates a 2.0% inflation rate for infrastructure costs. Therefore, parcel taxes should be increased by 2%.

Consistent with prior years and in order to maintain moderate user fee increases, staff recommend a 5% user rate increase.

Other Administrative Updates

As part of a review of invoicing processes, staff identified a few areas where clarity is needed within the Bylaw.

Section 4.6

The current Water Rates and Regulations Bylaw does not specify how charges are applied in the case of a connection being installed or disconnected (i.e. turned off until further notice) throughout the year. It is recommended that the Bylaw be amended to specify that properties who receive a water connection during the year will be charged on a pro-rated basis commencing on the first of the month following the date of connection install. This aligns with the terms and conditions set out on the water service application. In the case of a water service being turned off for an indefinite period, a credit will be returned to the customer for the remainder of the year in which they have prepaid for service.

Section 24.3

The current Water Rates and Regulations Bylaw specifies that invoices (other than annual invoices) are due within 30 days of the date of billing. It is recommended that the Bylaw be amended to specify that the invoice is due on the due date as specified which is generally thirty days from the date of billing. Additionally, it is recommended that the Bylaw specify that payments must be received by 4:30 pm PST.

Section 24.7

The current Water Rates and Regulations Bylaw does not include a deadline or a process for advising the Regional District of farm land classification. This impacts whether a reduced land charge is applied for properties classified as farm land under the British Columbia Assessment Authority Act. It is recommended that the Bylaw be amended to include that notification must be made in writing to the Chief Financial Officer by January 5 of each year. If the notification is not received before the deadline, the reduced land charge rate would be forfeited and the customer would be required to pay the applicable parcel tax land charge.

Section 24.8 [*new proposed section*]

The current Water Rates and Regulations Bylaw does not specify the treatment of amounts outstanding as of December 31st. As legislated by the *Local Government Act* the SCRD transfers outstanding utility amounts to taxes. It is recommended that the Bylaw be amended to include this practice. This also correlates with other SCRD utility Bylaws.

Section 26.1

The current Water Rates and Regulations Bylaw states that no rebates, refunds or credit will be applied; however, in reality, there are billing adjustments required periodically. It is recommended that the Bylaw be amended to include that refunds or adjustments on any fees collected in error will only be issued up to two years from the payment date.

Schedule B

The current Water Rates and Regulations Bylaw Schedule B does not include a fee for manual water meter readings. It is recommended that the Bylaw be amended to include a fee of $25 per reading up to a maximum of $300 per annum. This is consistent with Schedule D and Schedule E.

Financial Implications

It is recommended that user fees and meter rates be increased by 5% for 2019 and parcel taxes be increased by 2% for 2019. The proposed rate increase will amount to an annual increase of $13.68 per single family dwelling for user fees and $5.16 per residential parcel.

Historical rate increases for the preceding five years are detailed in the table below:

Historical Rates							
	2013	2014	2015	2016	2017	2018	2019
Parcel Tax	244.29	249.27	252.46	255.41	255.41	257.84	263.00
User Fee	215.36	231.79	246.62	255.77	266.00	273.63	287.31
Total	459.65	481.06	499.08	511.18	521.41	531.47	550.31
Total $ Increase		$21.41	$18.02	$12.10	$10.23	$10.06	$18.84
Total % Increase		4.66%	3.75%	2.42%	2.00%	1.93%	3.54%

Timeline for next steps or estimated completion date

Once approval is received to amend the user rates and parcel taxes the Water Rates Bylaw 422, Schedule B will be amended to increase the Regional Water Service Area User Fees and Parcel Taxes and forwarded to the January 31, 2019 Board Meeting for three reading and adoption.

Communications Strategy

A Communication Plan has been developed to inform homeowners of the rate increases. Information regarding rate changes will be communicated via print advertising, social media and

on utility invoices sent to customers. The rate changes are also included in the public presentations for the budget process.

STRATEGIC PLAN AND RELATED POLICIES

Annual reviews and adjustments of fees and charges is consistent with Section 4.2.2 of the Financial Sustainability Policy.

CONCLUSION

In order to maintain current service levels, meet future operational expenses, proceed with the RWSA Capital Plan and fund future asset replacement and rehabilitation, it is recommended that the Regional Water Rates Bylaw 422, Schedule B be amended to incorporate a 5% increase in user fee rates and a 2% increase in parcel tax rates.

To increase clarity on the Utility Services administration of Utility Invoicing, it is recommended that the Regional Water Rates Bylaw 422 be amended to incorporate the administrative changes outlined in the report.

Reviewed by:			
Manager		Finance	X–S. Zacharias
GM	X–R. Rosenboom	Legislative	X–A. Legault
CAO	X–J. Loveys	Other	X–B. Smale

SUNSHINE COAST REGIONAL DISTRICT STAFF REPORT

TO: Infrastructure Services Committee – January 24, 2019

AUTHOR: Tina Perreault, General Manager, Corporate Services / Chief Financial Officer

SUBJECT: **SOUTH PENDER HARBOUR WATER SERVICE AREA 2019 RATE BYLAW AMENDMENT**

RECOMMENDATION(S)

THAT the report titled South Pender Harbour Water Service Area 2019 Rate Bylaw Amendment be received;

AND THAT the Water Rates Bylaw 422, Schedule E be amended to increase the South Pender Harbour Water Service Area User Fees and Metered Usage Fees by 5.5% in 2019;

AND THAT the Water Rates Bylaw 422, Schedule E be amended to increase the South Pender Harbour Water Service Area Parcel Taxes by 2.0% in 2019 and forwarded to the January 31, 2019 Board Meeting for three reading and adoption;

AND FURTHER THAT the 2019-2023 Financial Plan be amended accordingly.

BACKGROUND

The bylaw to regulate the rates and operation of the water supply and distribution system for the Sunshine Coast Regional District (SCRD) is done through Bylaw No. 422- Water Rates and Regulations. Each year as part of the Financial Planning and Parcel Tax process, the rates are reviewed for each water service and the respective rate schedules are amended. Copy of the consolidated Bylaw can be found on our website at: Bylaws: Infrastructure. Schedule E of the Bylaw apply to the North Pender Harbour Water Service Area as established under Bylaw No. 1074.

The South Pender Harbour Water Service Area (SPHWSA) consists of approximately 1,045 parcels and 981 billable water users. The current parcel tax and user rates per single family residential dwelling are $324.38 and $393.37, respectively.

In the SPHWSA, parcel taxes are intended to fund capital expenditures (acquiring or maintaining fixed assets) and user fees are intended to fund operational expenditures (ongoing costs of running the service).

Currently, a portion of parcel taxes are being used to fund operating expenditures, only recently have rate increases begun to address this imbalance through larger increases to user rates.

Water rate reviews are performed on an annual basis. The review typically involves a comparison of the previous year's budget to actual value spent, and a review of the future project initiatives to

forecast operational costs. Last year, the results of this review provided a recommendation for a user fee rate increase of 5.5% and no change to the parcel tax rate.

Staff have continued the practice of reviewing operational costs to evaluate the sustainability of user rates for 2019. Additionally, this year has included a high level review of the approximate capital replacement costs of the SPHWSA to evaluate the sustainability of parcel tax rates.

DISCUSSION

Options and Analysis

User Fees

Under the historical rate schedules for SPHWSA, a portion of parcel tax revenue has been required to fund operating expenditures. To address this imbalance, user fees need to be increased at a rate greater than the increase in operating expenditures.

Consistent with prior years and in order to maintain moderate user fee increases, staff recommend a 5.5% user rate increase.

With an annual increase of 5.5%, the SPHWSA is expected to reach a balanced operational fund in 2024. After that point, user rates should be increased annually to account for inflationary increases to operational expenditures.

Parcel Taxes

For 2019, a high level review of the parcel tax rates was conducted. To determine the overall replacement value of the SPHWSA, staff utilized the original cost of the assets, in conjunction with engineering judgement (in accordance with the *Engineers and Geoscientist of BC Budget Guidelines*), to estimate the present value of costs.

Based on the above analysis, staff identified a need to conduct an in-depth review of asset management in SPHWSA as was conducted for the SCRD's waste water service areas. The results of this review will provide a more detailed strategy for ensuring sufficient capital funding. Staff look to initiate this review in 2019 or 2020.

Until that time, staff recommend that parcel taxes be increased annually to account for Canadian inflationary cost of construction, at minimum. The current five year moving average for infrastructure construction price index (2012 to 2017) indicates a 2.0% inflation rate for infrastructure costs. Therefore, parcel taxes should be increased by 2.0%.

Financial Implications

It is recommended that user fees and meter rates be increased by 5.5% for 2019 and parcel taxes be increased by 2.0% for 2019. The proposed rate increase will amount to an annual increase of $21.64 per single family dwelling for user fees and $6.49 per parcel under 2 acres for parcel taxes.

Historical rate increases for the preceding five years are detailed in the table below:

Historical Rates							
	2013	2014	2015	2016	2017	2018	Proposed 2019
Parcel Tax	277.62	297.05	311.90	324.38	324.38	324.38	330.87
User Fee	306.83	328.31	344.73	358.52	372.86	393.37	415.01
Total	584.45	625.36	656.63	682.90	697.24	717.75	745.88
Total $ Increase		$40.91	$31.27	$26.27	$14.34	$20.51	$28.13
Total % Increase		7.00%	5.00%	4.00%	2.10%	2.94%	3.92%

Timeline for next steps or estimated completion date

Once approval is received to amend the user rates and parcel taxes the Water Rates Bylaw 422, Schedule D will be amended to increase the South Pender Harbour Water Service Area User Fees and Parcel Taxes and forwarded to the January 31, 2019 Board Meeting for three reading and adoption.

Communications Strategy

A Communication Plan is being developed to inform homeowners of the rate increases. Information regarding rate changes will be communicated via print advertising, social media and on the on utility invoices sent to customers. The rate changes are also included in the public presentations for the budget process.

STRATEGIC PLAN AND RELATED POLICIES

Annual reviews and adjustments of fees and charges are consistent with Section 4.2.2 of the Financial Sustainability Policy.

CONCLUSION

In the SPHWSA, parcel taxes are intended to fund capital expenditures (acquiring or maintaining fixed assets) and user fees are intended to fund operational expenditures (ongoing costs of running the service).

Under the historical rate schedules for SPHWSA, a portion of parcel tax revenue has been required to fund operating expenditures. To address this imbalance, user fees need to be increased at a rate greater than the increase in operating expenditures. In order to maintain current service levels and meet future operational and capital expenditures, a 5.5% increase to water user fees and meter rates.

Until a review of asset management is completed and due to inflationary cost of construction, staff also recommend that parcel taxes be increased by 2% annually.

Once approval is received to amend the user rates and parcel taxes the Water Rates Bylaw 422, Schedule D will be amended to increase the South Pender Harbour Water Service Area User

Fees and Parcel Taxes and forwarded to the January 31, 2019 Board Meeting for three readings and adoption.

Reviewed by:			
Manager		CFO/Finance	
GM	X-R. Rosenboom	Legislative	X- A. Legault
CAO	X-J. Loveys	Other	X-S. Zacharias X-B. Smale

SUNSHINE COAST REGIONAL DISTRICT STAFF REPORT

TO: Infrastructure Services Committee – January 24, 2019

AUTHOR: Tina Perreault, General Manager, Corporate Services / Chief Financial Officer

SUBJECT: **NORTH PENDER HARBOUR WATER SERVICE AREA 2019 RATE BYLAW AMENDMENT**

RECOMMENDATIONS

THAT the report titled North Pender Harbour Water Service Area 2019 Rate Bylaw Amendment be received;

AND THAT the Water Rates Bylaw 422, Schedule D be amended to increase the North Pender Harbour Water Service Area User Fees and Metered Usage Fees by 8.5% in 2019;

AND THAT the Water Rates Bylaw 422, Schedule D be amended to increase the North Pender Harbour Water Service Area Parcel Taxes by 2.0% in 2019;

AND THAT the revised Water Rates Bylaw 422, Schedule D be forwarded to the January 31, 2019 Board Meeting for three readings and adoption;

AND FURTHER THAT the 2019-2023 Financial Plan be amended accordingly.

BACKGROUND

The bylaw to regulate the rates and operation of the water supply and distribution system for the Sunshine Coast Regional District (SCRD) is done through Bylaw No. 422 - Water Rates and Regulations. Each year as part of the Financial Planning and Parcel Tax process, the rates are reviewed for each water service and the respective rate schedules are amended. Copy of the consolidated Bylaw can be found on our website at: Bylaws: Infrastructure. Schedule D of the Bylaw apply to the North Pender Harbour Water Service Area as established under Bylaw No. 1070.

The North Pender Harbour Water Service Area (NPHWSA) consists of approximately 770 parcels and 517 billable water users. The current parcel tax and user rates per single family residential dwelling are $320.23 and $255.98, respectively.

In the NPHWSA, parcel taxes are intended to fund capital expenditures (acquiring or maintaining fixed assets) and user fees are intended to fund operational expenditures (ongoing costs of running the service).

Currently, a portion of parcel taxes are being used to fund operating expenditures, only recently have rate increases begun to address this imbalance through larger increases to user rates.

Water rate reviews are performed on an annual basis. The review typically involves a comparison of the previous year's budget to actual value spent, and a review of the future project initiatives to

forecast operational costs. Last year, the results of this review provided a recommendation for a user fee rate increase of 8.5% and no change to the parcel tax rate.

Staff have continued the practice of reviewing operational costs to evaluate the sustainability of user rates for 2019. Additionally, this year has included a high level review of the approximate capital replacement costs of the NPHWSA to evaluate the sustainability of parcel tax rates.

DISCUSSION

Options and Analysis

User Fees

Under the historical rate schedules for NPHWSA, a portion of parcel tax revenue has been required to fund operating expenditures. To address this imbalance, user fees need to be increased at a rate greater than the increase in operating expenditures.

Consistent with prior years and in order to maintain moderate user fee increases, staff recommend an 8.5% user rate increase.

With an annual increase of 8.5%, the NPHWSA is expected to reach a balanced operational fund in 2032. After that point, user rates should be increased annually to account for inflationary increases to operational expenditures.

Parcel Taxes

For 2019, a high level review of the parcel tax rates was conducted. To determine the overall replacement value of the NPHWSA, staff utilized the original cost of the assets, in conjunction with engineering judgement (in accordance with the *Engineers and Geoscientist of BC Budget Guidelines*), to estimate the present value of costs.

Based on the above analysis, staff identified a need to conduct an in-depth review of asset management in NPHWSA as was conducted for the SCRD's waste water service areas. The results of this review will provide a more detailed strategy for ensuring sufficient capital funding. Staff look to initiate this review in late 2019 or 2020.

Until that time, staff recommend that parcel taxes be increased annually to account for Canadian inflationary cost of construction, at minimum. The current five year moving average for infrastructure construction price index (2012 to 2017) indicates a 2.0% inflation rate for infrastructure costs. Therefore, parcel taxes should be increased by 2.0%.

Financial Implications

It is recommended that user fees and meter rates be increased by 8.5% for 2019 and parcel taxes be increased by 2.0% for 2019. The proposed rate increase will amount to an annual increase of $21.76 per single family dwelling for user fees and $6.40 per residential parcel.

Historical rate increases for the preceding five years are detailed in the table below:

Historical Rates							
	2013	2014	2015	2016	2017	2018	Proposed 2019
Parcel Tax	274.07	293.25	307.91	320.23	320.23	320.23	326.63
User Fee	194.15	207.74	218.13	226.86	235.93	255.98	277.74
Total	468.22	500.99	526.04	547.09	556.16	576.21	604.37
Total $ Increase		$32.77	$25.05	$21.05	$9.07	$20.05	$28.16
Total % Increase		7.00%	5.00%	4.00%	1.66%	3.61%	4.89%

Timeline for next steps or estimated completion date

Once approval is received to amend the user rates and parcel taxes the Water Rates Bylaw 422, Schedule D will be amended to increase the South Pender Harbour Water Service Area User Fees and Parcel Taxes and forwarded to the January 31, 2019 Board Meeting for three reading and adoption.

Communications Strategy

A Communication Plan is being developed to inform homeowners of the rate increases. Information regarding rate changes will be communicated via print advertising, social media and on the utility invoices sent to customers. The rate changes are also included in public presentations for the budget process.

STRATEGIC PLAN AND RELATED POLICIES

Annual reviews and adjustments of fees and charges are consistent with Section 4.2.2 of the Financial Sustainability Policy.

CONCLUSION

In the NPHWSA, parcel taxes are intended to fund capital expenditures (acquiring or maintaining fixed assets) and user fees are intended to fund operational expenditures (ongoing costs of running the service).

Under the historical rate schedules for NPHWSA, a portion of parcel tax revenue has been required to fund operating expenditures. To address this imbalance, user fees need to be increased at a rate greater than the increase in operating expenditures.

Consistent with prior years and in order to maintain moderate user fee increases, staff recommend an 8.5% user rate increase.

Until a review of asset management is completed and due to inflationary cost of construction, staff also recommend that parcel taxes be increased by 2% annually.

Once approval is received to amend the user rates and parcel taxes the Water Rates Bylaw 422, Schedule D will be amended to increase the South Pender Harbour Water Service Area User

Fees and Parcel Taxes and forwarded to the January 31, 2019 Board Meeting for three reading and adoption

Reviewed by:			
Manager		CFO/Finance	
GM	X-R. Rosenboom	Legislative	X-A. Legault
CAO	X-J.Loveys	Other	X-S. Zacharias X-B. Smale

SUNSHINE COAST REGIONAL DISTRICT STAFF REPORT

TO: Infrastructure Services Committee – January 24, 2019

AUTHOR: Sara Zacharias, Manager, Financial Services

SUBJECT: **BYLAW 627 ADMINISTRATIVE FEES AND CHARGES**

RECOMMENDATION(S)

THAT the report titled Bylaw 627 Administrative Fees and Charges be received;

AND THAT *Sunshine Coast Regional District Administrative Fees and Charges Amendment Bylaw No. 627.3, 2019 be forwarded to the Board for three readings and adoption.*

BACKGROUND

Section 397 of the *Local Government Act* provides that a Board may, by bylaw, impose a fee or charge payable in respect of a service or the use of regional district property. The bylaw to establish general fees and charges associated with the cost of providing various administrative services is Bylaw 627 – Administrative Fees and Charges. As part of a review of fees and charges, areas where updates to administrative fees and charges could be considered to offset costs incurred by the Sunshine Coast Regional District (SCRD) and to remove fees that are no longer relevant were identified.

DISCUSSION

The attached bylaw has been prepared to add the following administrative fees and charges:

- Conveyance requests: $25 per request, per property

  When a conveyance request is received by the Utilities Division, staff time and resources are required to respond to the request. The proposed fee is consistent with similar sized Regional Districts and Municipalities.

- Payment Transfer (first time – fee waived): $10 per transfer

  A payment transfer occurs primarily when an owner submits a payment to an incorrect utility account. The first time this happens, a letter is sent to the homeowner and no charge is applied. All subsequent payment transfers would incur a charge.

- Processing Fee for Foreign Currency Payments: $10 per payment

  A handling fee is charged by the bank on every transaction that is not in Canadian dollars. The payment also requires additional staff time and resources to process.

With the launch of the open data portal, various Mapping service fees (3.4 and 3.5), are no longer needed and could therefore be removed from the fee schedule.

Financial Implications

The proposed changes to administrative fees and charges are expected to generate approximately $25,000 per year, depending on the volume of transactions.

Timeline for next steps or estimated completion date

An updated Sunshine Coast Regional District Administrative Fees and Charges Amendment Bylaw No. 627.3, 2019 could be brought forward for three readings and adoption at the January 31, 2019 Regular Board Meeting.

Communications Strategy

A Communication Plan has been developed to inform homeowners of the rate increases. Information regarding rate changes will be communicated via print advertising, social media and on the on utility invoices sent to customers. The rate changes are also included in the public presentations for the budget process.

STRATEGIC PLAN AND RELATED POLICIES

An annual review of fees and charges is consistent with the Financial Sustainability Policy.

CONCLUSION

Section 397 of the *Local Government Act* provides that a Board may, by bylaw, impose a fee or charge payable in respect of a service or the use of regional district property.

The attached bylaw adds three (3) administrative fees for utility accounts. Services no longer relevant are proposed to be removed from the fee schedule.

If the recommended changes are approved, staff will present the Sunshine Coast Regional District Administrative Fees and Charges Bylaw No. 627.3, 2019 for three readings and adoption at the January 31, 2019 Regular Board Meeting.

Attachment A: Proposed SCRD Administrative Fees and Charges Amendment Bylaw No. 627.3

Reviewed by:			
Manager		CFO/Finance	X-T. Perreault
GM	X–R. Rosenboom	Legislative	X-A. Legault
CAO	X-J. Loveys	Other	

SUNSHINE COAST REGIONAL DISTRICT

BYLAW NO. 627.3

A bylaw to amend *Sunshine Coast Regional District Administrative Fees and Charges Bylaw No. 627, 2010*

WHEREAS the Board wishes to amend *Sunshine Coast Regional District Administrative Fees and Charges Bylaw No. 627, 2010*;

NOW THEREFORE the Board of the Sunshine Coast Regional District in open meeting assembled enacts as follows:

1. This bylaw may be cited for all purposes as *Sunshine Coast Regional District Administrative Fees and Charges Bylaw No. 627.3, 2019.*

2. *Sunshine Coast Regional District Administrative Fees and Charges Bylaw No. 627, 2010* is hereby amended as follows:

    a. Delete Schedule A in its entirety and replace with the revised Schedule A attached hereto.

READ A FIRST TIME	this	day of
READ A SECOND TIME	this	day of
READ A THIRD TIME	this	day of
ADOPTED	this	day of

_____
CORPORATE OFFICER

_____
CHAIR

SCHEDULE A

Administrative Fees and Charges

Prices are exclusive of any applicable tax.

1. PRINTED INFORMATION

1.1	Photocopies – single sided, black and white	
	a. 8.5”x11” or 8.5”x14”	$0.25 per page
	b. 11”x17”	$0.30 per page
1.2	Microfiche hard copy prints	
	a. 8.5”x11”	$1.00 per page
	b. 8.5”x14”	$1.50 per page
	c. 11”x17”	$2.00 per page
1.3	Planning and Development Publications	
	a. Zoning Bylaw	$ 5.00
	b. Planning & Development Procedures Bylaw	$ 5.00
	c. Subdivision Servicing Bylaw	$ 5.00
	d. Subdivision Servicing Standards (Water & Sewer Manual)	$20.00
	e. Tree Cutting Permit Bylaw	$ 5.00
	f. Official Community Plan (Egmont/Pender Harbour, Halfmoon Bay, Roberts Creek, Elphinstone, West Howe Sound, Hillside-Port Mellon or Twin Creeks Area)	$20.00
	g. Reconnaissance Study of Geotechnical Hazards	$20.00
1.4	Statement of Financial Information	$ 5.00
1.5	Copy of BCLS site survey (to registered owner or agent only)	$15.00
1.6	Lamination of Building Permit Card	$ 2.00

2. INFORMATION REQUIRING RESEARCH

2.1 Requests for information requiring research into the Regional District’s archival records; or for information dating back over two (2) years; or for information requiring more than fifteen (15) minutes to locate, will be charged at the hourly rate of $30.00 per hour (billable in 15-minute increments after the first hour), plus the applicable photocopying rate if copies are made.

3. MAPPING

3.1	Scan / print to PDF	
	Per page	$ 2.00
3.2	Scan to paper copy	
	Line drawing per square foot of paper	$ 1.20
	Full colour drawing per square foot of paper	$ 4.90
3.3	Plot / print paper copy	
	Line drawing per square foot of paper	$ 0.85
	Full colour drawing per square foot of paper	$ 4.20
3.4	Repealed	
3.5	Repealed	
3.6	Custom requests and mapping, not including printing	$ 75.00 per hour

3.7 Shipping and handling fees are charged at cost and are in addition to the fees quoted above.

4. FINANCIAL PROCESSING CHARGES

4.1	Cheques returned for not sufficient funds	$25.00
4.2	Payment transfer (no charge for first transaction)	$10.00
4.3	Foreign currency processing	$10.00
4.4	Property conveyance utility account information check	$25.00

5. INTEREST RATES

5.1 Late payment(s) will be subject to an interest penalty charge of 1.5% per month (19.56% annually) compounded monthly.

5.2 Latecomer agreements will be subject to an interest rate equivalent to the Bank of Canada prime rate.

SUNSHINE COAST REGIONAL DISTRICT STAFF REPORT

TO: **Infrastructure Services Committee – January 24, 2019**

AUTHOR: **Remko Rosenboom – General Manager, Infrastructure Services**

SUBJECT: **2018 WILDSAFEBC PROGRAM**

RECOMMENDATION(S)

THAT the report titled 2018 WildSafeBC Program be received for information;

AND THAT the appropriate applications be submitted to the British Columbia Conservation Foundation for 2019 WildSafeBC Program Funding with the SCRD as the host organization;

AND FURTHER THAT a budget proposal in support of the $7,500 funding request for 2019 WildSafeBC Program be brought forward to Round 1 Budget.

BACKGROUND

The Sunshine Coast Regional District has been the host organization of a WildSafeBC (formerly Bear Aware) Program for 2006-2008 and 2012-2018. The WildSafeBC program aims to reduce human-wildlife conflict throughout British Columbia. Program delivery by a Community Coordinator focuses on engaging the Sunshine Coast community through educational campaigns and a variety of outreach methodologies. Specific details of the 2018 program are included in the WildSafeBC Sunshine Coast Annual Report (Attachment A). Infrastructure Services Staff and the Community Coordinator met to discuss the 2018 season and what can be learned and carried forward to next season.

WildSafeBC provided expert knowledge to targeted communities including:

- District of Sechelt
- Town of Gibsons
- Sechelt Indian Government District
- Langdale
- Roberts Creek
- Halfmoon Bay
- Pender Harbour
- Egmont

When SCRD staff and the Community Coordinator met it was expressed that the program was successful in reaching out and connecting with the community. There are long-standing behaviours that take time to change, increasing interactions with wildlife, gaps in understanding appropriate behaviour and challenges from this season that provide goals and opportunities to reduce community conflict with wildlife for 2019.

The WildSafeBC Program provides great value to the community to raise awareness of and take action to decrease human-wildlife conflict. The SCRD provided funding in 2018 of $5,500.

This allowed for sharing of information from SCRD staff (Infrastructure Services and Bylaw Departments) with the Community Coordinator about neighbourhoods experiencing conflict, residents requiring education and proactively connecting with the community on best practices. The SCRD also continued to provide in-kind support including desk space, computer, internet, printer, and office supplies. The BC Ministry of Environment and Climate Change Strategy shares the cost and provides for the rest of the Community Coordinator's wages and expenses.

The amount of funding determines the number of hours allocated for the Community Coordinator to deliver the program. With the 2018 funding and carry over of $1,600 from the 2017 program, the SCRD received 510 dedicated hours which started at the beginning of June.

In speaking with a WildSafeBC Program representative the SCRD was informed that the $5,500 provided in 2018 would cover 430 hours in 2019 due to changes in Employer Health Tax as well as an annual wage increase. This would still provide a program but, with less outreach and less face to face contact with residents. In order to maintain the similar level of support as 2018 funding needs to be increased by $2,000 to $7,500 (510 hours).

It was also confirmed that because the Town of Gibsons and District of Sechelt have expanded curbside collection and potentially SCRD expansion in 2019 the community could benefit from more hours for community outreach. This would allow for assistance on reaching out to residents on proper storage, use of animal resistant containers, mitigating wildlife interactions and education with regards to garbage or organic collection. An additional $2,500 would result in approximately 100 extra hours for public outreach.

DISCUSSION

Supporting this program requires minimum coordination from SCRD staff. Email communication is used to inform of human-wildlife conflicts and to share information about outreach events that may be beneficial for either party to attend.

The continued partnership as host to the WildSafeBC Community Coordinator will require funding and in-kind support from the SCRD. The rest is provided by the Ministry of Environment and Climate Change Strategy via WildSafeBC.

Options:

1) The SCRD not be the host organization and not provide base funding. Another organization may take on the role and funding. However, the WildSafeBC Program may not proceed.

2) The SCRD be the host organization, provide funding of $7,500 and in kind support, and receive approximately 510 hours of outreach.

3) The SCRD be the host organization and provide the funding of $10,000 and in-kind support, to ensure a higher number of hours are allocated for the delivery of the WildSafeBC Program on the Sunshine Coast given the expansion of curbside collection programs.

STRATEGIC PLAN AND RELATED POLICIES

The Regional Organics Diversion Strategy acknowledges that residents are largely concerned with wildlife interactions with their waste and that community support is needed.

CONCLUSION

To ensure that the 2019 WildSafeBC Program is delivered on the Sunshine Coast, it is recommended to adopt option 3 or 4. If there is expansion in curbside collection, option 4 is recommended. If options 2, 3 or 4 are adopted then the SCRD shall submit the appropriate applications to the British Columbia Conservation Foundation by the February 1, 2019 deadline. A WildSafeBC Community Coordinator allows for expertise to support the community and to build on positive behaviours that were introduced to the community in the past year.

Reviewed by:			
Manager		CFO	X-T. Perreault
GM		Legislative	
CAO	X-J. Loveys	Other	

Attachment A: WildSafeBC Sunshine Coast Annual Report

WildSafeBC Annual Report 2018

Sunshine Coast

Prepared by: Jen Callaghan, WildSafeBC Community Coordinator

BRITISH COLUMBIA Ministry of Environment and Climate Change Strategy

WILD SAFE BC
British Columbia Conservation Foundation

SUNSHINE COAST REGIONAL DISTRICT

Executive Summary

The WildSafeBC program continues to build on successes from previous seasons. The program supported and interacted with residents from Egmont to Langdale and connected with a variety of community members, from chicken enthusiasts to bow hunters. Many residents on the Sunshine Coast practice habits that keep wildlife wild and communities safe. Garbage is stored indoors, fruit trees are picked, bird feeders are replaced by bird baths, and electric fencing is used to protect livestock. However, there are still Sunshine Coast residents learning lessons in human-wildlife conflict. Visiting the WildSafeBC booth at community events, residents share stories of encounters with wildlife. Most often, the item that attracted wildlife to a home or yard is secured after contact with wildlife has occurred. The freezer is emptied, the bird feeder is taken down, the BBQ is cleaned, only after the wildlife has had a meal.

The WildSafeBC Community Coordinator (WCC) works with the community to promote proactive behaviours and solutions to reduce human-wildlife conflicts. Between May and November, the WCC communicated directly with over 1,200 residents and reached thousands more through Facebook, radio and print media. The WCC gave 18 presentations to over 420 participants and attended 9 community events and connected with 443 people. Door-to-door campaigns reached 201 residents and 111 garbage bins were tagged with warning stickers. Social media Facebook 'likes' grew 12.5% since the beginning of 2018 while print and media reached over 24,000 people.

Some of the challenges include the large geographic area to cover and the intentional feeding of wildlife. Black bears accessing garbage is an ongoing issue that requires development of additional strategies in 2019. Some of the innovative initiatives developed this season included the development of guidelines for restaurants, resorts and vacation rental properties owners in order to reach short-term visitors to the area.

Table of Contents

Table of Figures

Highlights from the 2018 Season

Wildlife Activity

Human-wildlife reports to the Conservation Officer Service (COS) identify species, locations and timing trends for the Sunshine Coast. Using data from 2014 to 2017, the WildSafeBC Community Coordinator (WCC) was able to plan outreach messaging and activities. Reporting statistics in 2018 show patterns consistent with past years, with high levels of conflict occurring from May through October (fig. 1).

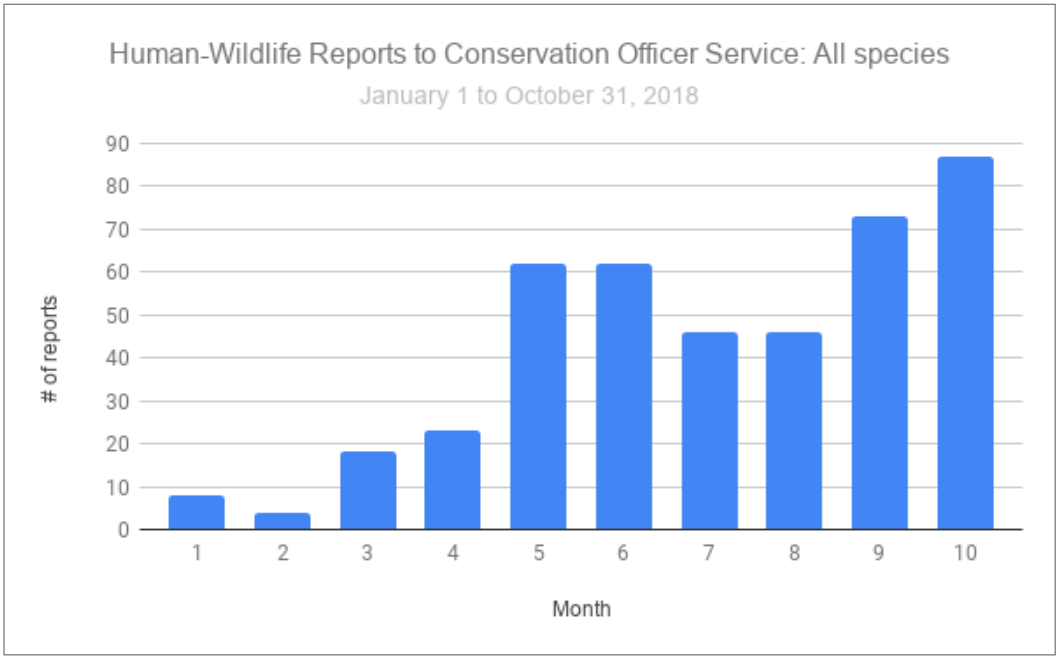


Figure 1. Human-wildlife reports by month from January 1 to October 31, 2018.

WildSafeBC (WSBC) conflict reduction strategies focused on the black bears, black-tailed deer, and cougars, the top three species in conflict with humans on the Sunshine Coast. Moreover, the majority of efforts focused on reducing conflict with black bears, as interactions with the species consistently accounts for 61% of reports (Table 1).

Table 1. Reports to the COS by species from January 1 to October 31, 2018.

Species	# of reports
Black bear	257
Black-tailed deer	76
Cougar	61
Elk	10
Coyote	9
Raptor	6
Bobcat	4
Wolf	4

257

The top three attractants that bring black bears into conflict with humans continue to be: garbage, fruit trees and bird feeders (fig. 3). In 2018, WSBC programming addressed these attractant issues through garbage tagging, door-to-door visits, social media posts, event outreach, and presentations for youth. These activities are discussed in more detail below.

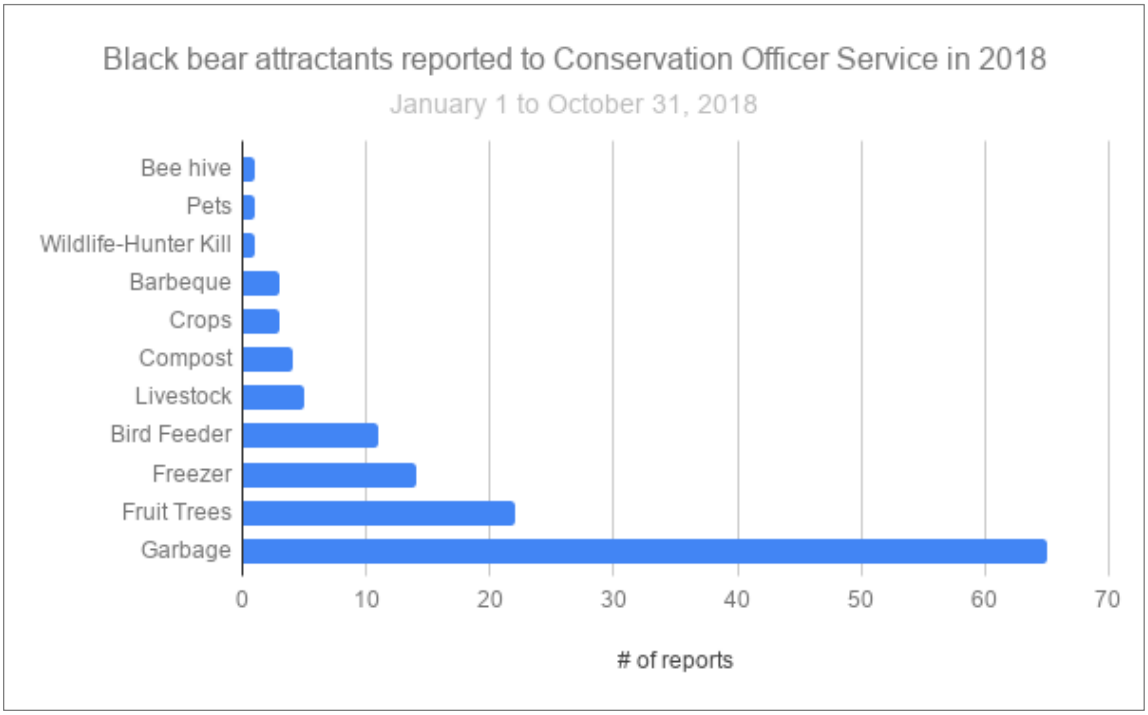


Figure 2. Black bear attractants in 2018 from January 1 to October 31.

Presentations to Schools and Community Groups

The WCC for the Sunshine Coast gave a total of 18 presentations to over 420 participants including:

- Scouts at Camp Byng – One presentation
- Halfmoon Bay Elementary – Two assembly presentations
- Langdale Elementary – Six classroom presentations (fig. 4)
- Explore the Wild Summer Camp at Chapman Creek Hatchery – Five camp presentations (fig. 5)
- SPIDER Elementary – Two classroom presentations and one outdoor activity
- Chapman Creek Hatchery Staff – Bear Spray Training (fig. 6)
- Ladies Ride Mountain Bikers – Bear Spray Demonstration

Figure 3. Junior Ranger Program presentation at Langdale Elementary.

Figure 4. Cougar Leap Challenge during Explore the Wild Summer Camp Presentation

Figure 5. Bear Spray Training at Chapman Creek Hatchery.

Door-to-Door Education and Garbage Tagging

Door-to-door visits allowed the WCC to engage with residents experiencing conflict with wildlife, hear further details and accounts, and gauge solutions that may work best for an area. Door hangers were left at homes, if residents were away, to provide an avenue for further conversation and share WSBC's top tips. Door-to-door activity was carried out 24 times and reached 328 residents.

Garbage tagging activity was targeted in areas outside of bylaw enforcement resources. Three evenings were spent checking 5 neighbourhoods: Bonniebrook, Lower Roberts Creek, Wilson Creek, Davis Bay and Selma Park. Garbage tag reminders, left on bins placed out early, reached 111 residents.

Figure 6. Garbage tagging in Roberts Creek.

Public Displays and Events

The WildSafeBC Community Coordinator attended 9 community events in 2018 (Table 2), connecting with 493 people (fig. 7).

Table 2. WildSafeBC attendance at community events on the Sunshine Coast.

Date	Event	Location
July 1	Canada Day at Hackett Park	Sechelt
July 7	Catch a Trout Day at Chapman Creek Hatchery	Sechelt
August 3	Friday Night Market at Gibsons Public Market	Gibsons
August 25	Poultry Swap at Roberts Creek Hall	Roberts Creek
August 25	Family Day at Rod and Gun Club	Sechelt
September 2	Harvest Festival at Botanical Garden	Sechelt
September 15	BC Goes Wild Weekend & SCRD Backroad Trash Bash	Pender Harbour
October 28	Halfmoon Bay Apple Festival	Halfmoon Bay
November 23	Banff Centre Mountain Film Festival World Tour	Gibsons

Figure 7. WildSafeBC Booth at the Sunshine Coast Botanical Garden Harvest Festival.

WildSafeBC provided 1500 brochures to the following organizations to support additional outreach and education:

- Gibsons Visitor Center
- Sechelt Visitor Center
- Madeira Park Visitor Center
- District of Sechelt Bylaw Officers
- Camp Olave
- Sunshine Coast Welcome Wagon

Social Media and Press

Facebook was utilized to regularly engage with followers, sharing reminders about seasonal attractants and trends, as well as updates on wildlife presence in neighbourhoods. The WildSafeBC Sunshine Coast Facebook page grew from 960 likes at the beginning of the year to 1,080. Individual posts on Facebook this year have reached anywhere from 90 to 6,700 people, with a total reach of 48,075 during the course of the season. Additional Facebook activity, like following local Facebook FYI groups, allowed further insights into neighbourhood trends that do not get reported to the COS or WildSafeBC.

Facebook posts also serve to stimulate conversation with local media. A post highlighting the results of garbage tagging resulted in a call from Mountain FM (fig. 8). Coast FM called after viewing an aggressive bear post in the summer and elevated bear activity posts in the fall.

Coast Reporter published an article in the June 7th edition to highlight increased wildlife activity and the restart of the WildSafeBC program. Print and radio media reach for 2018 is estimated at 23,930.

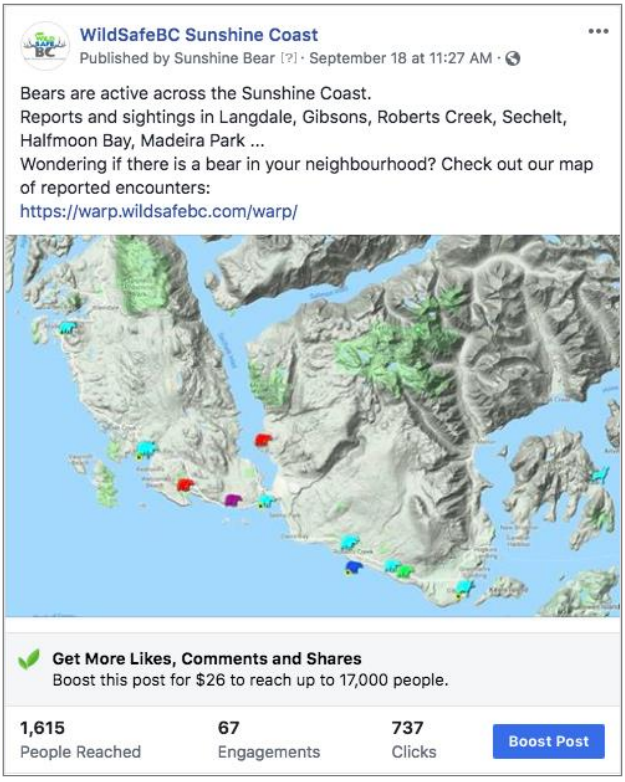


Figure 8. A Facebook post used to keep the community and media engaged in wildlife activity.

Bear in Area Signs

WildSafeBC has a variety of signs to alert the community with regards to specific wildlife activity (fig. 9). Bear in Area signs were utilized in 18 neighbourhoods over the course of the season. Signage was placed in response to the following:

- Request from COS
- Request from neighbourhood group
- Reports of activity via WARP, email, phone, or Facebook.

Smaller signs (8.5” x 11”) were utilized on neighbourhood message boards, parks and trail heads, and large dumpsters. “Cougar in Area” signs (8.5” x 11”) were placed on trail heads and near playgrounds in response to sightings. This included Franklin Street and Soames Hill in Gibsons, Chatelech Secondary and Hackett Park in Sechelt, and Halfmoon Bay Elementary and Conner Park in Halfmoon Bay. An “Aggressive Deer in Area” sign (8.5x11) was placed at the Inglis trail head at the end of Shaw Road in Gibsons.

Figure 9. Wildlife in Area signs used on the Sunshine Coast in 2018.

Fruit Tree Outreach and Education

Proactive harvesting of fruit trees was included in event booth, presentation, and Facebook messaging. Sharing of harvest was also promoted in the Farm and Garden Swap Facebook group. One individual was supported directly in picking. A total of 4 hours was dedicated solely to fruit tree outreach.

Unfortunately, the Sunshine Coast Fruit Tree Project, a volunteer harvest group, was on hiatus in 2018. Finding a partner, or additional strategies, to support fruit tree harvest should be explored in 2019.

Development of Guidelines

In 2018, the WCC guidelines for a WildSafe Restaurant which addressed common attractant issues by suggesting best practices for operating in bear country (fig. 10). These guidelines can be further distributed in 2019 and also support WildSafe routines at resorts.

Guidelines for WildSafe Properties are also in development. These guidelines will be shared with vacation and short term rental property owners, to ensure systems for managing wildlife attractants are in place and guests are provided with wildlife information.

Figure 10. Guidelines for a WildSafe Restaurant.

Partnerships

Sunshine Coast Regional District (SCRD) Solid Waste team helped the new WCC get established in 2018, by sharing details of the approach to solid waste in the SCRD, local event options for outreach, and connections to other SCRD departments. Throughout the season, the SCRD provided support for inquiries from the WCC and relayed messages from residents experiencing human-wildlife conflict. WildSafeBC joined the SCRD for the annual Backroads Trash Bash event on September 15, 2018.

The COS provided valuable information on current human-wildlife conflict areas as well as historical knowledge of trends in neighbourhoods. The COS worked with WildSafeBC by requesting visits to areas in need of outreach. In turn, the WCC provided feedback on conflicts resulting in safety issues as well as information on Provincial Wildlife Act violations (eg. results of garbage tagging).

The bylaw departments in the District of Sechelt and the Town of Gibsons worked with the WCC to share information on neighbourhoods experiencing human-wildlife conflict and ensure a representative was able to connect with residents. WildSafeBC shared results of garbage and fruit tree issues for bylaw to enforce or have on record.

The visitor centres in Gibsons, Sechelt and Madeira Park were great advocates of WildSafeBC information. Visitor centre staff shared they are often asked “where do we go to see wildlife?” and they are able to respond with WildSafeBC brochures and tips, as the wildlife is everywhere!

Challenges for the 2018 Season

1. Geography provides a challenge to the program on the Sunshine Coast, resulting in a slightly uneven distribution of service. The communities further afield from the population centres, like Egmont, Pender Harbour, or Keats Island, are less likely to see a “Bear in Area” sign or have face time with the WCC.

2. Long-standing behaviours and habits are taking time to shift. Feeding wildlife can take many forms such as feeders for birds or intentional feeding of raccoons or deer (fig.11). Bears that access fruit trees are also unintentionally being fed human foods. This can lead to human-wildlife conflicts which include safety concerns or property damage. This can be frustrating for neighbours in a community. In many cases dangerous wildlife, such as bears in urban areas, are not reported or reporting is delayed. As conflict behaviours escalate it can be challenging to address them and options become reduced.

Figure 11. Example of a Facebook post about feeding deer in September 2018.

3. Garbage continues to be an area of concern on the Sunshine Coast. Challenges with garbage include:
    - Garbage stored outdoors as many residents do not have a garages.
    - Limited access to bear resistant bin options.
    - Garbage placed out early prior to collection; sometimes days in advance when people head out of town.

4. As a new WCC, the program start in late May lead to a busy beginning. Learning community relationships and the role, while receiving daily emails and calls of human-wildlife conflict, was a challenge.

Goals and Opportunities for 2019

Many opportunities still exist for the WildSafeBC program on the Sunshine Coast. Below are recommended areas of focus for the 2019 program.

The WCC should plan to attend events in Egmont, Pender Harbour and Halfmoon Bay early in the 2019 season, to establish connections and encourage proactive approaches to conflict management.

The Sunshine Coast sees an influx of visitors and part-time residents during the summer months. It is best to connect with the businesses that support these visitors, and their waste, at the start of the season to ensure WildSafe practices are in place. These include:

- Marinas
- Resorts
- Hotels, Guest Houses, Short Term Rentals, Vacation Rentals

Proactive outreach to new property owners and renters may help to reduce any hiccups in wildlife interactions. This can include connecting with rental or real estate agencies and the Welcome Wagon. The District of Sechelt and the SCRD can support by distributing information to registered vacation properties.

Exploring options to support waste management by property owners has the potential for significant reductions in human-wildlife conflict on the Sunshine Coast. Over 60% of black bear conflict reports involve garbage. Working with the SCRD, the WCC can investigate options such as:

- Subsidy program for bear resistant containers
- Bin locks
- Community bins for residents departing before garbage day

Finally, the WCC should continue to connect with community members who successfully manage attractants like fruit trees and livestock. Sharing these local best practices, such as electric fencing and safe bear spray use, will help gain more acceptance and adoption from residents.

Acknowledgements

The WildSafeBC Sunshine Coast program gratefully acknowledges its 2018 funders:

- Sunshine Coast Regional District
- Ministry of Environment and Climate Change Strategy

Thank you to the Conservation Officer Service for providing insights into neighbourhood trends and wildlife biology over the course of the season. Support and communication in-person and by email were instrumental in program success.

Thank you to the following organizations for your support in sharing WildSafeBC information:

> Sunshine Coast Regional District; Solid Waste Services and Communications Department; Town of Gibsons Bylaw Office; District of Sechelt Bylaw Office; Visitor Information Centers in Gibsons, Sechelt and Madeira Park; Pender Harbour and District; neighbourhood associations and their representatives; Coast FM; Mountain FM; Coast Reporter; organizations that had WildSafeBC at their events and teachers who shared WildSafeBC with their classrooms.

Thank you to the BC Conservation Foundation team for their operational support and for all the work that keeps the program going.

Lastly, a big thank you the diligent and dedicated residents of the Sunshine Coast who work to “keep wildlife wild and their community safe”.

SUNSHINE COAST REGIONAL DISTRICT STAFF REPORT

TO: Infrastructure Services Committee - January 24, 2019

AUTHOR: Tina Perreault, General Manager, Corporate Services / Chief Financial Officer
Remko Rosenboom, General Manager, Infrastructure Services

SUBJECT: **TRANSIT SERVICE OVERVIEW**

RECOMMENDATION(S)

THAT the report titled Transit Service Overview be received for information.

BACKGROUND

The purpose of this report is to provide an overview to the Committee with respect to the history, current status and funding for transit services on the Sunshine Coast.

SCRD Transit History

Authority to provide transit service to the Sunshine Coast Regional District (SCRD) was provided on February 25, 1982. This authority was subsequently updated to remove Electoral Area A as a contributor to transit funding and include a provision that transit serving one area only, be fully funded by that area. In March 2007, Bylaw 1073 was passed converting the transit function to a service, and defining the participating areas as the Town of Gibsons, District of Sechelt, Sechelt Indian Government District and Electoral Areas B, D, E, and F, an arrangement which has remained in place since that time.

Initially the service was provided with small para-transit buses. In 1989 larger conventional buses were introduced, raising the vehicle total from four to seven. The following timeline highlights key events in the history of Sunshine Coast Transit.

1982 – Formal para-transit service begins on the Sunshine Coast
1989 – Larger buses introduced
1994 – HandyDART shifts to BC Transit from Community Services Society
1997 – Transit fare zone system removed, fare set at $1.50
2000 – Pender Harbour Transit study produced, area service not recommended
2005 – Transit fares increase from $1.75 to $2.00
2006 – Transit Business Plan developed and fares increased to $2.25
2009 – Per-passenger fare subsidy reviewed
2010 – Transit Fare Structure Review; Family Pass feature added to Monthly Pass
2011 – BC Transit introduces 3-year budgeting process
2013 – Transit Future Plan community consultation begins
2013 – September: Memorandum of Understanding (MOU) signed for initial implementation of “Service Priority 1”
2014 – January: Transit Future Plan completed and adopted by SCRD Board
2014 – July: MOU signed for continued implementation of “Service Priority 1”
2015 – March: Province freezes transit funding for two years and any further expansion plans stalled
2015 – November: Transit fare structure reviewed, single-payer structure in May 2016

2016 – March: Province announces 12.7 million in additional transit funding over 3 years
2016 – April: Community Bus service review, October implementation
2016 – April: Renewed expansion approved in principle by SCRD Board; "Service Priority 1" is collapsed into a single year
2017– March: "Service Priority 1" is approved and included into the 2017-2021 Financial Plan; provides 30 minute service on Route 90 and hourly on Route 1.
2018 – First full year of Transit Expansion service hours in place.
2019 – September: Planned shift of Route 2 from Highway 101 and Cowrie St., with service to Chatelech School.

DISCUSSION

Transit Operating Model

In a typical BC Municipality or Regional District, outside the lower mainland, public transit is a three-way partnership between BC Transit, a local partner (governing body or community association), and an operating partner. BC Transit provides partial operating funding, capital equipment, service support (planning, scheduling, training, safety and security) and administrative support (accounting, contract management and marketing).

The local partner provides further operating funding and acts as signatory to the Operating Agreement. The local partner also provides fare product sales, bus stops and at times roadway maintenance and negotiates routes and service levels with BC Transit.

The operating partner is selected to provide driver hiring, training and supervision, vehicle maintenance staff and services, direct customer service (phone support, lost and found) and fare revenue collection.

BC Transit functions as the Contract Manager for operating expenses, crediting the local partner for fare revenue deposited and invoicing the local partner for their remaining share of service costs. On the Sunshine Coast, the SCRD functions as both the local and operating partner. There are four local governments in BC having this type of partnership with BC Transit: Nanaimo, Powell River, Nelson and the SCRD.

The current breakdown of shared responsibility for funding is shown in the table below.

Service	SCRD Portion	BC Transit Portion
Conventional (big bus)	53.31%	46.69%
HandyDART	33.31%	66.69%

Note: in some systems, a blended rate based on these ratios is used for routes that provide both Conventional and HandyDART service using the same vehicle for both services.

Normally, an operating partner would be selected using a Request for Proposal (RFP) process, providing a market-based confirmation of value for the amount spent. BC Transit reimburses the operating partner for services provided, and recovers a portion of costs from the local partner using the cost-sharing formula. Having the SCRD as the both local and operating partner bypasses the standard RFP process. As a consequence, certain maintenance costs are capped by BC Transit to limit their exposure and increase budget control. As an example, mechanical repair costs are set by BC Transit at $53.46 per hour, and cost-shared with the SCRD at this rate. SCRD Fleet Maintenance department invoices its services at $73.00 per hour. The difference between these two rates ($19.54) is not cost-shared with BC Transit, but rather paid fully by the

SCRD. This increases the actual percentage of the hourly mechanical fleet maintenance costs paid by the SCRD to approximately 65 percent.

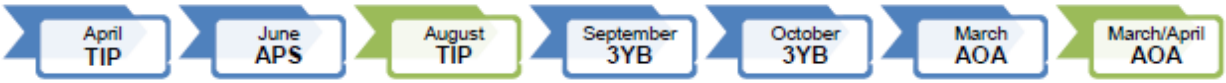
Current Transit Service Level

The Sunshine Coast provides both Conventional and Custom Transit service. As defined by BC Transit: *conventional transit serves the general population in more urban settings and offers scheduled service that operates on fixed routes; and custom transit offers door-to-door service for passengers who are unable to use the conventional transit system.* The custom service is also known as HandyDART.

For 2018 the SCRD delivered and funded approximately 31,600 of conventional service hours and 3,600 for the custom service.

Sunshine Coast Transit Planning History

BC Transit has a clearly defined process which outlines the steps required prior to implementing transit service changes (Transit Improvement Program-TIPS), performance reviews (Annual Performance Summary-APS), Budgeting (Three Year Budgets-3YB), and the Annual Operating Agreement-AOA. Details of the process and timelines are summarized below and attached for reference (Attachment A).



The 2006 BC Transit business plan for transit service on the Sunshine Coast noted that "*Increased frequency was the most requested service improvement, with more frequent service between the Langdale-Gibsons-Sechelt as the obvious candidate for this improvement*."

In 2012 a second round major of transit planning began, continuing well into 2013.This process resulted in the January 2014 Transit Future Plan (TFP). The Plan was developed to provide a staged approach to increasing transit to provide an attractive alternative to the automobile. The Transit Future Plan involved a comprehensive program of public consultation: a "Listening" stage, a "Checking" stage and a "Choices" stage. Official Community Plans and other local plans were referenced, and ridership data was collected to complement public input.

The result was an implementation strategy, beginning with "Quick Wins" and moving through Short Term (1-3 years), Medium Term (4-6 years) and Long Term (7+ years) priorities. The TFP was adopted by the SCRD Board in January 2014 and outlined the following phases.

TFP Service Priority 1		
Phase 1 (14/15)	2,500 hrs.	Split Route 1 into local (Rte 1) and Express (Rte 90) service
Phase 2 (15/16)	2,000 hrs.	Additional trips added to the Rte 90
Phase 3 (16/17)	4,370 hrs.	Route 90 to 30 min peak, Rte 1 to hourly all day
	8,870 hrs.	

The Phase 1 implementation of Service Priority 1 (2,500 hours) was agreed to in a Memorandum of Understanding signed in September, 2013. This confirmation allowed BC Transit to proceed with their request for expansion funding; the expansion itself was implemented in 2014. Phase 2 implementation was outlined in an MOU signed in July 2014, and carried the three-year expansion plan forward another year to 2017-18. This phase was not implemented due to a provincial funding freeze announced in early 2015.

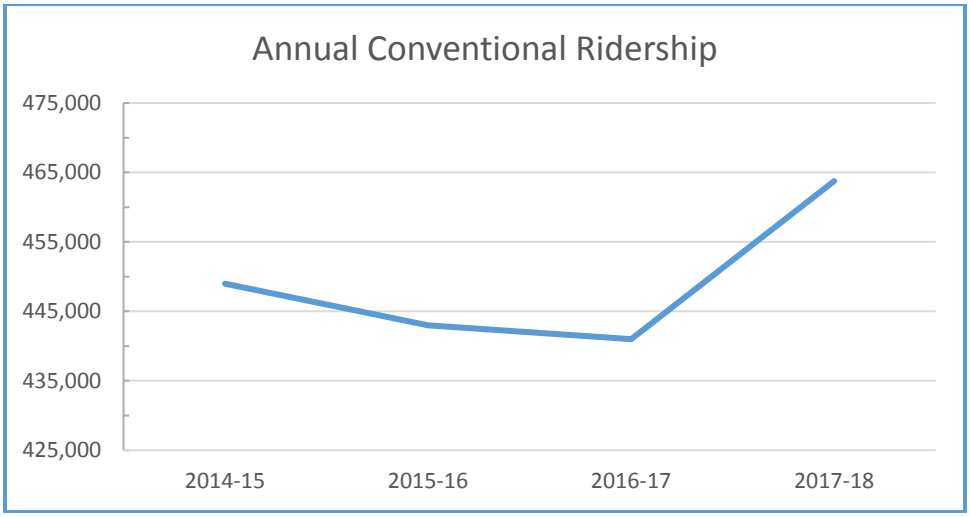
In early 2016, the Province announced additional funding for transit expansion which would form part of their 2017-18 budget. This resulted in renewed discussions with BC Transit and an updated MOU, signed in May 2016. The 2014 expansion plan had included 2,000 service hours and a single heavy-duty bus in 2015-16 (for the Rte 90), to be followed by an additional 4,370 service hours and six medium duty buses for 2016-17. In the MOU updated for 2016, these two phases were combined into one resulting in the remaining 6,370 hours from in Service Priority 1 being adopted as part of the SCRD's 2017-2021 Financial Plan. Service and funding began in October 2017 with the full service and cost implications occurring in 2018.

For 2018-2019, the SCRD Board approved that service from Cowrie Street through to Derby Road in Sechelt be implemented as of September 2019. This service priority is to be funded through the reallocation of the existing service.

Staff continue to work with BCT as well as internally to understand costs and impacts of the current service levels. Therefore, staff also recommended deferring any decisions on future expansion of service until this work is complete.

Historical Ridership

Annual conventional transit ridership peaked in 2011-12 at 510,412 trips and in 2015-16 declined approximately 13% at 443,000 trips. With fare adjustments the decline stopped, and with expansion an increase in ridership is being seen. BC Transit ridership figures show 2017-2018 conventional ridership of 463,764, and 2018 ridership also showed an increase, with final stats for 2018 to be determined. Transit fare product sales in 2018 have also seen a 10 percent increase over 2017 sales.



Financial Overview

The SCRD's existing service establishing Bylaw No. 1073 provides that costs may be recovered by:

(a) property value tax;
(b) parcel taxes;
(c) fees and charges;
(d) revenues raised by other means authorized by the *Local Government Act* or another Act;
(e) revenues received by way of agreement, enterprises, gift, grant or otherwise.

The service is currently funded through a combination of user fees, a property value tax based on land and improvements within the service area and contributions under agreement from BC Transit.

The maximum amount of money that may be requisitioned for the service is $0.35/$1000 of assessed value.

The tax funded portion of the SCRD transit service is apportioned on the basis of the converted value of land and improvements within the service area.

Below is the preliminary Tax by Area for Transit [310] as presented at the November 30th, 2018 Pre-Budget Deliberations. These do not include the preliminary impacts of the 2019 BC Assessment impacts, which will be presented at the Round 1 Budget Deliberations on February 4, 2019.

	Area B	Area D	Area E	Area F	SIGD	DoS	ToG	Preliminary 2019 Taxation
Transit	420,378	299,405	232,948	417,399	67,398	868,097	389,775	2,695,400

Transit Reserve Fund

In 2016 BC Transit implemented a Reserve Fund in the Province's budgeting and cost-sharing process. The fund is financed by invoicing local partners for budgeted costs and "banking" any difference if actual costs are lower than budget.

In the past, any surplus between budgeted and actual costs would reduce invoiced costs for the local partner. The SCRD would be invoiced for actual service costs and any savings relative to budget were used to balance deficits or contribute to the SCRD transit Operating Reserve.

The primary source of Reserve Fund revenue has been fuel savings. Due to a current drop in fuel prices in combination with conservative (high) fuel cost estimates by BC Transit, the Reserve Fund has been increasing quickly in value. Funds are deposited using the shared-cost ratio.

Transit Fare Pricing

Transit fares have seen minor changes over the years. In 1997 the service moved from a zone fare at $1.75 maximum to a flat rate of $1.50; additional changes are detailed in the table below. The last fare review by BC Transit concluded in 2016, where it was recommended that some fares be adjust downward what out of a concern for financial pressure on youth and seniors with the goal of remaining "revenue neutral".

Product	2016	2015	2008	2006	2005	2004
Cash	$2.00	$2.25	$2.25	$2.25	$2.00	$1.75
***Concession* Cash**		*$1.75*	*$1.75*	*$1.75*	*$1.50*	*$1.25*
Day Pass	$5.00	$5.50	$5.50	n/a	n/a	n/a
***Concession* Day Pass**		*$4.00*	*$4.00*	*n/a*	*n/a*	*n/a*
General 10 Ticket Sheet	$18.00	$20.00	$20.00	$20.00	$17.50	$15.00
***Concession* 10 Ticket Sheet**		*$15.00*	*$15.00*	*$15.00*	*$12.50*	*$10.00*
General Monthly Pass	$60.00	$60.00	$55.00	$55.00	$55.00	$50.00
***Concession* Monthly Pass**	*$42.00*	*$38.00*	*$35.00*	*$35.00*	*$35.00*	*$35.00*

The next fare review is scheduled for 2020 by BC Transit, however, the SCRD could request an earlier review if desired.

STRATEGIC PLAN AND RELATED POLICIES

The Transit service aligns with past Strategic Priorities such as Embedding Environmental Leadership, Community Development and Supporting Economic Development.

CONCLUSION

The purpose of this report is to provide an overview with respect to the history, current status and funding for transit services on the Sunshine Coast, prior to the 2019-2023 Budget Deliberations.

Transit services on the Sunshine Coast was first introduces in 1982 and has steadily increased to where for 2018 the SCRD delivered and funded approximately 31,600 of conventional service hours and 3,600 for the custom service, which translated to 463,764 rides for 2017-18.

Typically, public transit is a three-way partnership between BC Transit, a local partner, and an operating partner. On the Sunshine Coast, the SCRD functions as both the local and operating partner. BC Transit has a clearly defined process which outlines the steps required prior to implementing transit service, which the SCRD follows.

The service is currently funded through a combination of user fees, a property value tax, and contributions under agreement from BC Transit. In 2016 BC Transit implemented a Reserve Fund which is financed by invoicing local partners for budgeted costs and "banking" any difference if actual costs are lower than budget. Pre-Budget estimates projected taxation requirements of approximately $2.7 million for 2019, with transit fares scheduled to be reviewed in 2020.

Reviewed by:			
Manager	X – G. Dykstra	CFO	
GM		Legislative	
CAO	X – J. Loveys	Other	

Attachment A: BC Transit- Annual Partner Communication Calendar

BCTransit
Connecting People and Communities

Annual
Partner Communications
Calendar

April **TIP** | June **APS** | August **TIP** | September **3YB** | October **3YB** | March **AOA** | March/April **AOA**

Annual Partner Communication Key Processes		
Process	**Description and Deliverables**	
Transit Improvement Program (TIP)	The TIP communicates to local government (LG) the expansion initiatives proposed for the next three years. It seeks the commitment to the expansion initiatives from LG which thereby allows BC Transit to proceed with securing sufficient funding within the Provincial Budget. This includes the allocation process and results of expansion priorites from Transit Future Plans, other Service Plans, local initiatives as well as major capital initiatives necessary for the development of the transit system.	
	April	BCT to send out Expansion Initiatives to LG
	August	LG to confirm Expansion Initiatives by way of sign-off and return to RTM
	March	BCT to provide confirmation to LG of the intent to fund expansion initiatives
Annual Performance Summary (APS)	The APS offers a high level analysis of the system's performance, in comparison to prior years, and where established, the opportunity to measure against service standards established by the local government. The intent is to inform council prior to decision on expansion initiatives for future years and subsequent budgeting. This document also serves as an opportunity to present results to council and to engage in discussion on decisions aimed at future year initiatives.	
	June	BCT to send out APS to LG
	On Request	LG to extend invitation, if desired, to RTM to present APS to council
Three Year Budgets (3YB)	The 3YB provides LG with budget expectations for the coming year and two year projections for base service levels. Additionally, a calendar year budget estimate is provided for the convenience of LGs. Where the LG has confirmed their desire to pursue expansion initiatives, a separate budget will follow with expansion budget projections.	
	September	BCT to send out 3YB based on existing, or known, service levels to LG
	October	BCT to send out 3YB based on calendar year estimates to LG; and,
		BCT to send out 3YB based on expansion initiatives confirmed by the LG in August
	December	LG to advise RTM of any budget concerns to expedite the execution of the AOA
Annual Operating Agreement (AOA)	Defines the service to be delivered, the provincial and municipal funding contributions, and the tariff schedule. Any changes to services defined in the AOA require the establishment of a Memorandum of Understanding which defines the objectives and scope of the service change. The intent is to ensure that all parties are in agreement to changes to the defined service in the AOA. Additionally, it defines the appropriate timeline, from the time of this agreement, necessary for the provision of service including planning, scheduling, operator training, shift changes, and fleet procurement if necessary.	
	March	BCT to send out 3 copies of AOA to LG for signature
	March/April	LG to ensure timely approval of AOA and forward all copies to operating company

SUNSHINE COAST REGIONAL DISTRICT STAFF REPORT

TO: Infrastructure Services Committee - January 24, 2019

AUTHOR: Tina Perreault, General Manger, Corporate Services / Chief Financial Officer

SUBJECT: **2019-20 BC TRANSIT ANNUAL OPERATING AGREEMENT DRAFT BUDGET**

RECOMMENDATION(S)

THAT the report titled 2019-20 BC Transit Annual Operating Agreement Draft Budget be received;

AND THAT the 2019-2023 Financial Plan be updated to reflect the draft Annual Operating Agreement budget.

BACKGROUND

Each year BC Transit and the Sunshine Coast Regional District (SCRD) enter into an Annual Operating Agreement (AOA) which governs transit service costs and funding for the BC Transit fiscal year from April 1 to March 31.

In support of the AOA process, BC Transit provides a draft budget reflective of general industry trends, location-based operations and maintenance activities, and any specific initiatives planned for the transit system over the next three years. The draft budget becomes the basis for the AOA.

The purpose of this report is to highlight anticipated changes in the 2019-20 AOA based on the draft budget and the associated financial impact to the SCRD as a cost sharing partner.

DISCUSSION

The draft budget projections are prepared based on the most current information available; however, there is some risk associated with cost volatility. According to BC Transit, if there are material changes between the release of the draft budget and February 2019, these changes will be reflected in the final budget which accompanies the AOA in March.

As the SCRD budget process usually concludes prior to receipt of the final budget from BC Transit, it is not always possible to incorporate any changes into the annual SCRD Financial Plan. This can result in funding surpluses or shortfalls. Historically, such changes have not had a material financial impact. Staff will report on any discrepancies when the final budget and AOA is presented to the Board.

2019-20 System Specific Budget Notes

The following system specific budget notes have been provided by BC Transit:

- **Revenue**
  - Assumptions for revenues related to Farebox Cash and Tickets & Passes are based on the most current information and trends.
  - BC Bus Pass revenue directly reflects information provided by the Ministry of Social Development and Social Innovation.

- **Operations**
  - **Fuel Costs** – A fuel price of $1.34 per litre has been projected for 2019/20.
  - **Information Systems** – Reflects costs associated with maintaining SMART Bus AVL (Automated Vehicle Location), APC (Automated Passenger Counters), and AVA (Automated Voice Annunciator) systems.
  - **BCT Management Services** – With advances and improvements made to fleet, operations, and ERP processes, adjustments have been made to reflect actual costs associated with maintaining and expanding services that supports your system within the Shared Services Model. The Shared Services Model allows BC Transit to advise your community on planning efforts, provide administrative functions pertaining to finance, fleet, and infrastructure, works with the province to assess funding, arranges and manages operations, and turns municipal priorities into transit operating and capital plans.
  - **Custom Registration Program** – Costs associated with the implementation of the BC Transit custom registration program have been reflected in 2019/20. This reflects the costs for mobility assessments and occupational therapist expenses via a third party (RFP).

- **Maintenance**
  - Maintenance reflects the most current information available and is based on recent trends and projected activity for the 2019/20 period.

- **Lease Fees**
  - Your lease fee summary reflects a budget credit for vehicle replacements covered under the Public Transit Infrastructure Fund (PTIF).

- **Reserve**
  - Where available, operating reserves have been utilized

Note that the BC Transit AOA budget outlines cost-shared expenses only, as per the operating agreement between BC Transit and the SCRD. It does not include SCRD expenses that are not cost shared with BC Transit.

Financial Implications

Revenue and Cost Summary

The tables below summarize the changes between the 2018-19 AOA and the 2019-20 Draft budget for the Custom and Conventional services:

Custom Service	2018-2019 AOA Budget	2019-2020 Draft AOA Budget	Net Change	% Change
Total Revenue	9,931	9,931	-	-
Total Operating Costs	391,306	413,565	22,259	5.69%
Total Costs	461,319	481,593	20,274	4.39%
SCRD Net Share of Costs	**172,534**	**189,843**	**17,309**	**10.03%**

Conventional Service	2018-2019 AOA Budget (amended)	2019-2020 Draft AOA Budget	Net Change	% Change
Total Revenue	774,599	772,882	(1,717)	(0.22%)
Total Operating Costs	3,139,724	3,427,991	288,267	9.18%
Total Costs	3,667,029	3,945,091	278,061	7.58%
SCRD Net Share of Costs	**1,261,915**	**1,489,290**	**227,376**	**18.02%**

The figures above are based on the BC Transit fiscal year and are not reflective of actual SCRD budget values which incorporate pro-rated portions of both AOAs as well as non-shareable costs. Further information on each line item is detailed below.

Revenues

AOA revenues include fares and advertising and are applied against the local share of operating costs. 2019-20 AOA values are consistent with current trends and show no increase over 2018-19. A conservative approach is preferred when budgeting for fare revenue as any deficit has a direct impact on taxation.

Operating Costs

The 2019-20 AOA includes approximately $146,000 in scheduled service costs which were previously considered non-shareable and funded 100% by the SCRD. This explains the significant increase in conventional service operating costs and a portion of the increase to the SCRD net share of costs; however, as these were existing expenditures, the SCRD's share of funding for these particular items in the financial plan actually decreases with their inclusion in the AOA.

Other material increases in operating costs include a 35% increase for BC Transit Management Services, an 11% increase for ICBC insurance and information systems and a 7% increase for maintenance.

Total Costs

Total costs are reflective of operating costs plus the local share of lease fees for buses, equipment, land and buildings. Lease fees in the draft budget have decreased by 2%.

SCRD Net Share of Costs

The SCRD net share of costs is the portion of shareable costs funded from taxation. It is calculated as the SCRD share of total shareable operating costs less fare and advertising revenue and reserve fund adjustment if applicable.

The net share of costs in the 2019-20 draft budget increases significantly more than total operating costs due to a 67% decrease in the reserve fund adjustment as compared to the previous year.

In 2015 the Provincial Government, through an Order in Council (OIC) began using operating savings to fund future inflationary increases through the establishment of a reserve fund. Past reports have highlighted that this model is not sustainable and would result in significant taxation increases once the reserve fund has been depleted.

Analysis of the 2018-19 AOA estimated that a taxation increase of up to $150,000 could be required in 2019-20. Based on the draft budgets, the impact will be $95,204 which is reflected in the SCRD Net Share of Costs.

A summary of the items increase to SCRD net shareable costs is detailed below:

	Custom	Conventional	**Total**
Decrease in Revenue	$0	$1,717	**$1,717**
Increase in Total Operating Costs	7,239	152,716	**159,995**
Decrease in Lease Fees	(1,985)	(10,206)	**(12,191)**
Decreased Reserve Adjustment	12,055	83,149	**95,204**
Total	**$17,309**	**$227,376**	**$244,685**

2019 Taxation Impact

Due to the difference in fiscal years between the SCRD budget and the BC Transit AOA budget, pro-rated values from both the 2018-19 and 2019-20 AOAs are used to calculate the budget values for the SCRD financial plan.

As a result, only a portion of the increase to the SCRD's net shareable costs identified in the 2019 -20 AOA will require funding from 2019 taxation with the remainder applied in 2020.

The calculated taxation increase required to fund the 2019-20 AOA in 2019 is $204,511. Of this amount, $147,222 was included in the preliminary budget based on known increases for wages and benefits. An additional $57,289 in taxation is required to fund the service in 2019 and will be incorporated into the Round 1 budget.

Timeline for next steps or estimated completion date

Staff will continue to liaise with BC Transit to identify any potential material changes between the draft and final budgets and will report back, as necessary, through the budget process and upon receipt of the final AOA targeted for April or May 2019.

STRATEGIC PLAN AND RELATED POLICIES

Providing transit services aligns with the SCRD Boards 2015-2018 Strategic value and priority of *Embedding Environmental Leadership*, as well as the priorities of *Facilitating Community Development, Ensure Fiscal Sustainability*, and *Supporting Sustainable Economic Development*.

CONCLUSION

Each year, BC Transit and the SCRD enter into an AOA that governs transit service costs and funding for the fiscal year from April 1 to March 31. In support of the AOA process, BC Transit provides a draft budget that becomes the basis for the AOA.

The 2019-20 draft AOA budget projects a $244,685 increase in the SCRD net share of costs as a result of increased operating costs and a decrease in the reserve fund adjustment. A portion of the increase is for operating costs which were not previously cost-shared.

After pro-rating the 2018-19 and 2019-20 AOAs to align with the SCRD fiscal year, a taxation increase of $204,511 is required. Of this, $147,222 was included in the preliminary budget based on known increases for wages and benefits. An additional $57,289 in taxation funding is required to fund the service in 2019.

Reviewed by:			
Manager	X-G. Dykstra	Finance	
GM	X-R. Rosenboom	Legislative	
CAO	X-J. Loveys	Other	X-B.Wing

SUNSHINE COAST REGIONAL DISTRICT STAFF REPORT

TO: Infrastructure Services Committee – January 24, 2019

AUTHOR: Sherry Reid, Deputy Corporate Officer

SUBJECT: **2019 RESOLUTIONS TO THE ASSOCIATION OF VANCOUVER ISLAND AND COASTAL COMMUNITIES (AVICC)**

RECOMMENDATIONS

THAT the report titled 2019 Resolutions to the Association of Vancouver Island and Coastal Communities (AVICC) be received;

AND THAT the Infrastructure Services Committee identify resolutions for staff to draft and present to the January 31st Corporate and Administrative Services Committee meeting for consideration.

BACKGROUND

The Association of Vancouver Island and Coastal Communities (AVICC) 2019 annual convention will be held on April 12th to 14th in Powell River. The convention provides members with the opportunity to bring forward issues and concerns from their communities through resolutions and debate.

AVICC is one of five area associations of local governments operating under the umbrella of the Union of BC Municipalities. AVICC represents the interests of the various local governments of Vancouver Island, Sunshine Coast, Powell River and the Central Coast.

DISCUSSION

Options and Analysis

The Union of BC Municipalities (UBCM) urges members to submit resolutions through their Area Associations for consideration. Resolutions endorsed at AVICC will be automatically submitted to UBCM for consideration at the 2019 Fall Convention. Issues that arise after the AVICC annual meeting may be submitted directly to UBCM.

AVICC encourages members to focus resolutions on new issues of provincial or AVICC-wide interest.

Timeline for next steps or estimated completion date

The deadline for submission of resolutions for consideration at the AVICC Annual General Meeting is February 7, 2019. Resolutions must be adopted by the Board no later than the January 31st Board meeting in order to meet AVICC's submission deadline.

AVICC will consider late resolution submissions up to noon on April 10, 2019. Late resolutions will only be considered when the topic was not known prior to the regular deadline date or if it is considered an emergency.

STRATEGIC PLAN AND RELATED POLICIES

Submission of resolutions to AVICC is in alignment with SCRD's strategic value of Collaboration and also supports SCRD's mission to provide leadership and quality services to our community through effective and responsive government.

CONCLUSION

Staff recommend that the Committee identify topics for potential AVICC resolutions to be drafted and brought forward for consideration at the January 31st Corporate and Administrative Services Committee.

Reviewed by:			
Manager		Finance	
GM		Legislative	X – A. Legault
CAO	X – J. Loveys	Other	

SUNSHINE COAST REGIONAL DISTRICT STAFF REPORT

TO: Infrastructure Services Committee – January 24, 2019

AUTHOR: Remko Rosenboom, General Manager, Infrastructure Services

SUBJECT: **INFRASTRUCTURE SERVICES DEPARTMENT – 2018 Q4 REPORT**

RECOMMENDATION(S)

THAT the report titled Infrastructure Services Department – 2018 Q4 Report be received.

BACKGROUND

The purpose of this report is to provide an update on activities in the Infrastructures Services Department for the Fourth Quarter (Q4) of 2018: October 1 – December 31.

The report provides information from the following divisions: Water, Wastewater, Transit and Fleet, Solid Waste Programs and Solid Waste Landfill Operations.

Utilities Division [365, 366, 370]

The Utilities Division serves three water service areas, the North Pender Water Service Area [365], the South Pender Water Service Area [366], and the Regional Water Service Area [370]. The Regional Water Service Area includes the Chapman water system as well as the smaller systems of Egmont, Cove Cay, Granthams, Soames Point, Langdale, and Eastbourne. The Utilities Division is also responsible for 18 wastewater facilities in Areas A, B, D, E, and F.

The SCRD water systems supply potable water to approximately 23,000 residents between Egmont and Langdale. This includes operations and maintenance of the Langdale, Soames Point, Granthams Landing, Eastbourne (Keats Island), Chapman/Gray Creek including the Chapman Creek Water Treatment Plant, the South Pender Harbour Water Treatment Plant, Cove Cay, Egmont and the North Pender Harbour Water Systems. In addition to water for drinking, these water systems supply potable water used for fire protection, recreation (pools and ice rinks), industrial use and irrigation.

Combined, the SCRD Water Systems consist of over 379 km of watermains, 16 storage reservoirs, 15 pump stations, 29 pressure reducing valve stations, 1145+ fire hydrants, 10 chlorination stations and approximately 11,475 water connections.

The quarterly report includes information about larger capital works and projects, and noteworthy program developments. As well as, monthly water treatment volumes from the Chapman Creek Water Treatment Plant and the South Pender Water Treatment Plant, and a summary of work orders.

PROJECTS - CAPITAL WORKS

- **Watermain Replacement Program**

    - North and South Pender Harbour Watermain Replacement
        - Construction is underway including blasting, roadworks and watermain construction. 50% of the North Pender and 25% of the South Pender watermains have been installed. The deadline for the Clean Water and Wastewater Fund (CWWF) grant for these projects is March 31, 2019 and these projects will be completed at that time and on budget.
    - Chapman Creek Bridge Watermain Replacement
        - The watermain attached to the Chapman Creek Bridge is in need of replacement due to age and corrosion. Tendering for construction is underway with project completion expected by May 2019.
    - Exposed Watermain Rehabilitation
        - A condition assessment of exposed sections of watermains was completed and identified numerous sections of pipe that require remediation work to prevent further deterioration. The first tender process was unsuccessful, one bid was received and over budget. Project review is underway and will be retendered in Q1 2019.

- Eastbourne Watermain Replacement
  - The replacement of a 400 metre section of the Eastbourne watermain was completed in January 2019. The work included replacement of a 25 mm diameter surface-laid polyvinyl chloride (PVC) waterline with a buried 50 mm high-density polyethylene (HDPE) watermain.
- Henry Road Watermain Replacement
  - Design and permitting is underway to replace 480 metres of 150 mm asbestos cement watermain with 200 mm ductile iron watermain on Henry Road between Russell and Reed Roads. The goal is to have this project completed by the summer of 2019.

- **Water Projects**

  - Soames Chlorination Project
    - The chlorination station has now been completed and put into service. Security fencing and site remediation is also complete.
  - Chapman Lake Infrastructure Improvement Project
    - A decision on the Tetrahedron Park boundary amendment is expected from the BC Legislature during the spring 2019 session. Construction is projected to begin in June or July 2019.
  - Groundwater Investigation– Phase 2
    - A report on the findings of this study is part of the January 24, 2019 Infrastructure Services Committee agenda.
  - Raw Water Reservoir(s)
    - The Project Team has completed the water demand analysis and are determining the feasibility of several concepts of Raw Water Reservoir(s). As per the April 2018 Infrastructure Services Committee staff report, the timeline for a first report on project outcomes is expected for the February Infrastructure Service Committee meeting.
  - Universal Metering Program
    - Phase 2 is complete. A total of 4765 meters have now been installed in the Electoral Areas of the regional water system. Options for implementation and funding of Phase 3 will be brought forward to the February Infrastructure Service Committee meeting.
  - Town of Gibsons Zone 3 uncoupling
    - The SCRD and the Town of Gibsons staff continue to meet and discuss process, impacts and infrastructure upgrades required to facilitate the Town of Gibsons taking over the primary water supply to Zone 3. A report on this process will be brought to a future committee meeting.
  - Review Bulk Water Agreement Town of Gibsons
    - In 2018 staff had four meetings with the Town of Gibsons staff and additional meetings are required to finalize this review.

- Chapman Water Treatment Plant Chlorination Project
  - The existing chlorination system at the Chapman WTP is nearing the end of its useful life and an alternative disinfection system to mitigate safety hazards is required. The results of a 2017 feasibility study recommended an On-Site Generation system to replace the existing chlorine gas disinfection system. The RFP document for engineering of an On-Site Generation system will be issued in Q1 2019. The plan is to have this project completed by Q4 2019.
- Langdale Well Upgrade
  - The pump and motor at the Langdale well was installed in the early 1970s and is in need of replacement. The preliminary design of interior piping and pump station shutdown planning is underway. Assessment of the well casing and other required building maintenance is in progress. The projected completion is expect in Q4 2019.

- **Wastewater**
  - Square Bay Wastewater Plant
    - Construction of a new wastewater plant at Square Bay is nearing completion with commissioning underway. The old wastewater plant has been removed and site clean-up and landscaping will be completed by early spring. Staff are working with the contractor to address the neighbours' concerns regarding lighting.
  - Canoe Road Wastewater Field and Collection System Replacement
    - This project is to design and construct a replacement treatment system and drainage field for a community wastewater system in Pender Harbour. Detailed design is complete and a Request for Quotation (RFQ) documents have been completed.
  - Merrill Crescent Wastewater Field Replacement
    - This project is to design and construct a replacement septic field for a community wastewater system in Pender Harbour. Detailed design is complete and a construction and installation contract has been awarded. Construction is scheduled to begin on January 21, 2019 with a projected completion in February 2019.
  - Curran Road
    - The outfall weights on the Curran Road outfall pipe are failing and need replacement. A proposal to replace all of the aging outfall pipe weights on the Curran Road outfall was presented at the November 29, 2018 Special Corporate and Administrative Services (Pre-Budget) Committee Meeting and approved to be incorporated into the 2019 Budget as Categorized Mandatory. The RFQ document for construction will be issued upon budget adoption in March 2019.

- Woodcreek Wastewater Plant
  - A proposal for a condition review of the existing system and evaluation of replacement solution options will be presented at the February 2019 Round 1 Budget meetings.

- **Demand Reduction Rebate Programs**

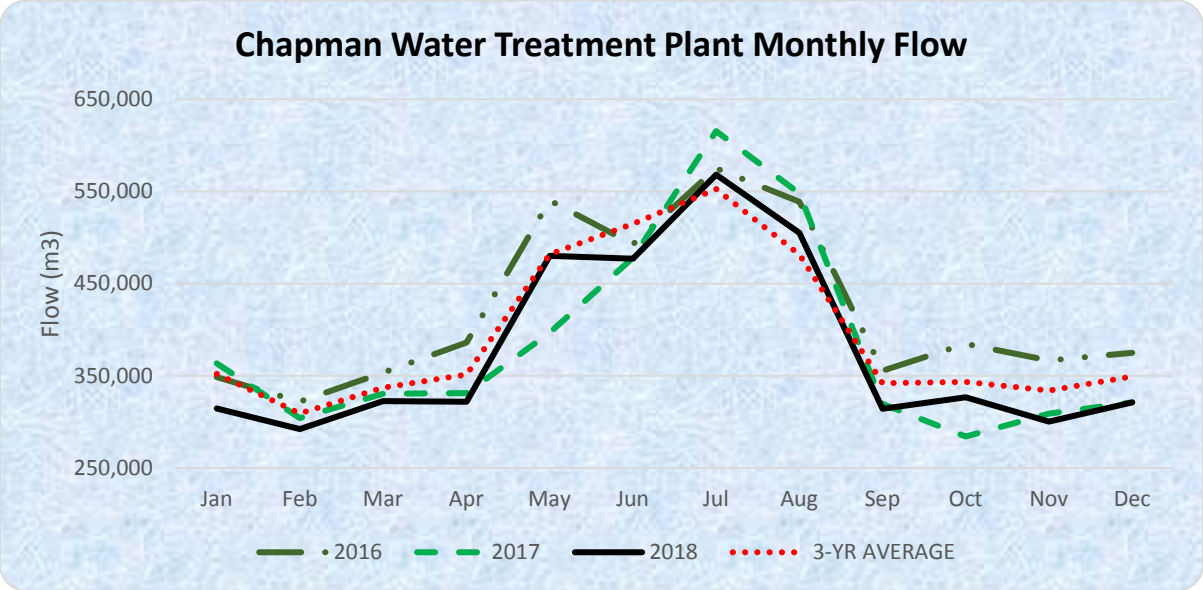
  - The new Rainwater Harvesting Rebate Program was launched November 1, 2018. Applications for 2018 closed on December 14. Forty-seven of the 50 rebates available in the Regional Water Service Area were awarded. One application was denied for not meeting program criteria and two applications were withdrawn. No applications were received for the four rebates available in the South Pender Water Service Area and no applications were received for the three rebates available in the North Pender Water Service Area. Applicants have 90 days to complete the installation.

    A report evaluating the Rainwater Harvesting Rebate Program will be brought forward to the February Infrastructure Services Committee meeting. The 2019 program will launch in April.

OPERATIONS - WATER DISTRIBUTION SYSTEM

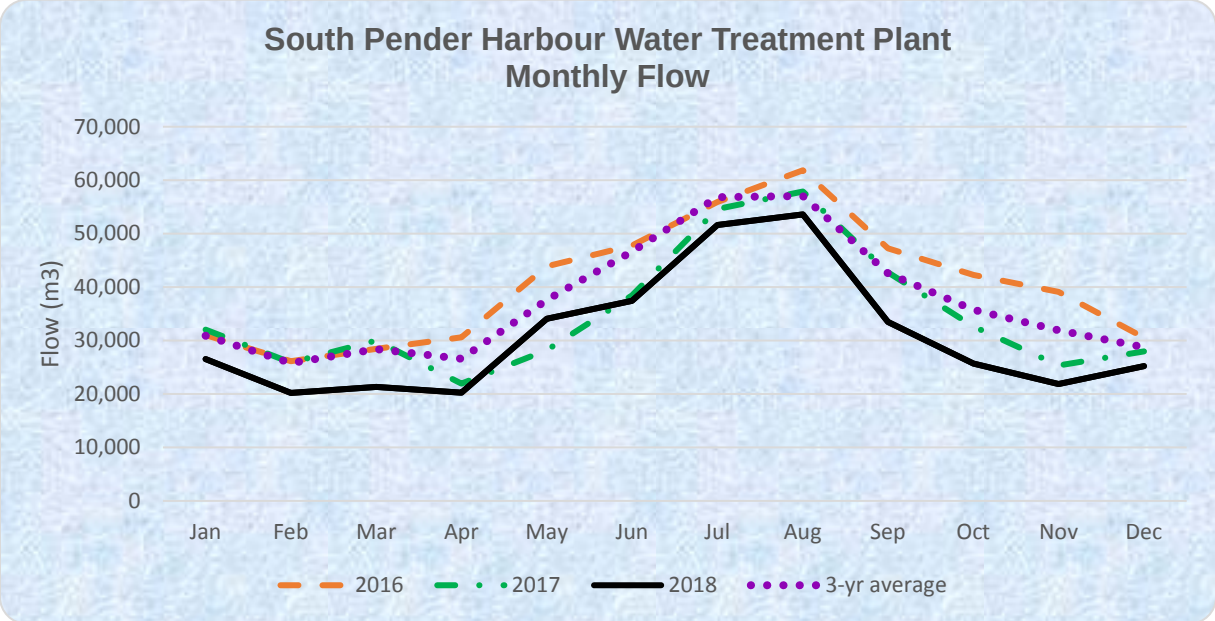
CHAPMAN WATER TREATMENT PLANT

In the Q4 2018, the Chapman Creek Water Treatment Plant produced and supplied 948,034 m^3 of potable water to residents, a 7% decrease over the three year average. The decrease is related to leaks on private properties that have been found and repaired.



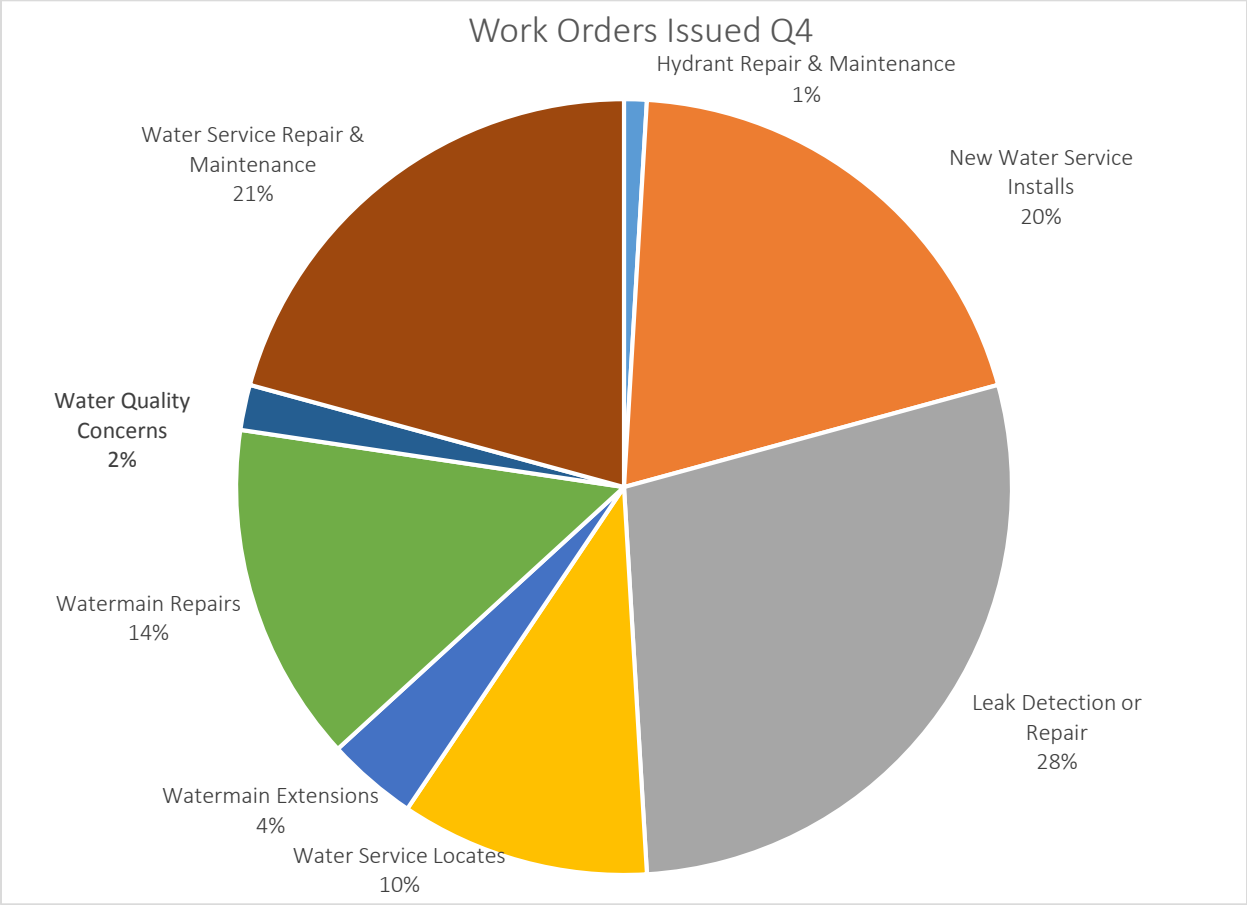
SOUTH PENDER WATER TREATMENT PLANT

In the Q4 2018, the South Pender Water Treatment Plant produced and supplied 72,756 m^3 of potable water to approximately 2,300 full and part-time residents of Madeira Park, Francis Peninsula and the surrounding area. This is an 18.1% decrease over the three year average and is related to leaks on private properties that have been found and repaired.



Work Orders Issued in Q4 2018

Work performed by SCRD Utility Services is tracked through the department's work order management system. Work may include scheduled or reactive maintenance and/repairs, service locates or capital asset work.



Transportation and Facilities [310, 312, 345, 350]

In contrast to most BC Transit systems, the SCRD functions as both the Local Government partner and the service contractor in relationship with BC Transit. This provides a clearer picture of costs than would otherwise be the case. Service expansion in October 2017 added approximately 6,300 annual hours or a 26% service increase.

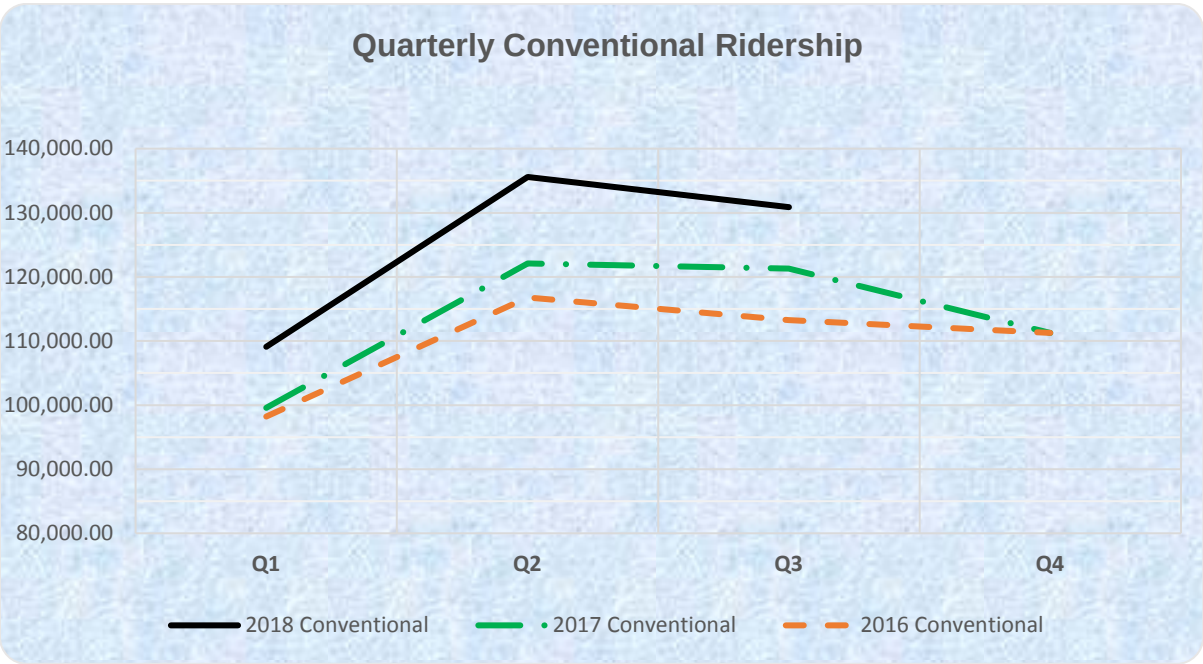
PROJECTS

Transit

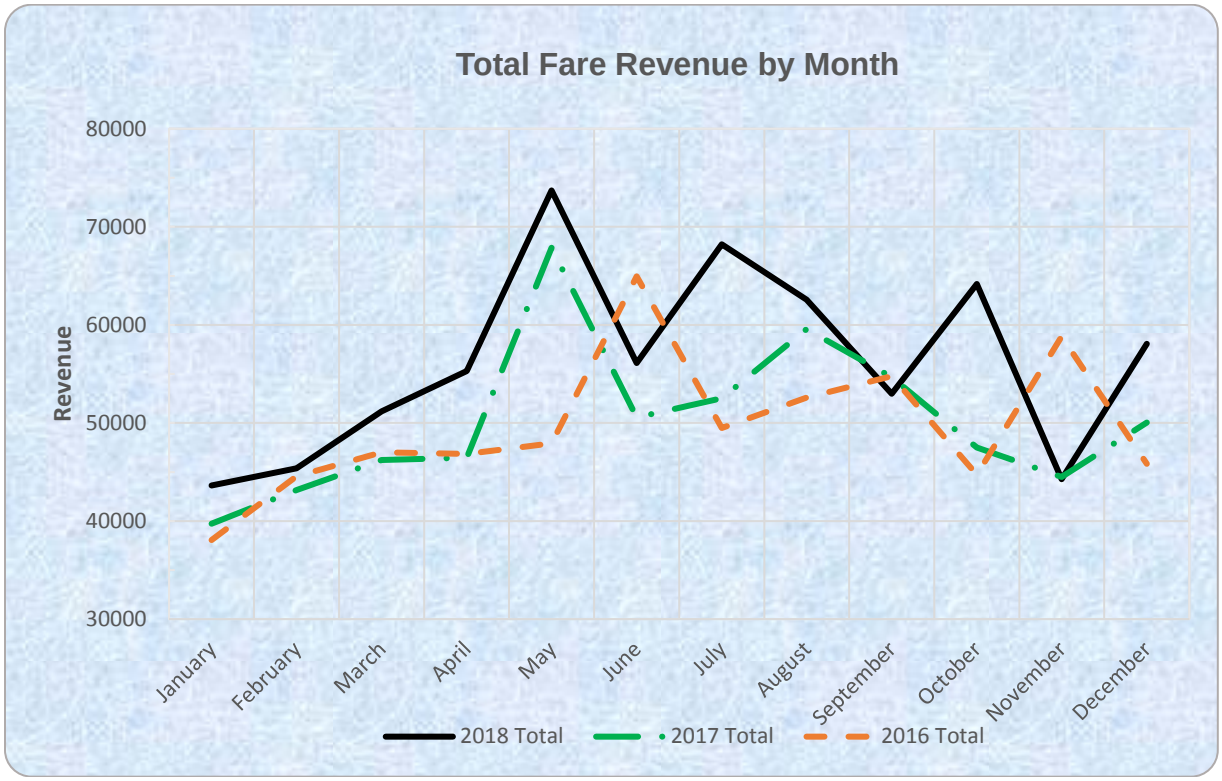
As of November 30, 2018 fare are currently at 11.6% over November 2017. In particular, consistently higher Monthly Pass sales are being seen averaging 15%, alongside a reduced proportion of cash fare. This reverses the trend prior to 2016, which saw steady ridership decreases and a shift toward cash fare. While cash fare does not offer the relative discount of a monthly pass (and therefore creates more revenue for the SCRD), monthly pass sales reflect a commitment to longer-term transit use.

On-time performance has improved with the shift into fall and winter. Maintaining on-time performance was a challenge this summer, with additional passenger and traffic loads and smaller buses contributing to the schedule impact. A schedule review has been initiated to identify budget neutral opportunities to improve on-time performance for next summer.

A new schedule aligning with winter ferry service went into effect in early October, with the next significant change occurring in mid-May 2019, pending ferry schedule changes.



*Q4 data is not yet available from BC Transit


Total Fare Revenue by Month
Revenue
80000
70000
60000
50000
40000
30000
January
February
March
April
May
June
July
August
September
October
November
December
2018 Total
2017 Total
2016 Total

Fleet Services

Annual fire truck Commercial Vehicle Inspection Program (CVIP) inspections were completed in December. This placed additional work pressure on the ongoing maintenance of the entire SCRD fleet with older buses accumulating extra mileage and new buses requiring more maintenance than anticipated. The CCTV camera installation recently completed on all conventional buses will provide reliable data regarding bus incidents and safety concerns; Automated Passenger Counters (APC's) were also installed in late summer. The APC's should allow for more detailed ridership data to become available in 2019.

Solid Waste [350, 351, 352, 355]

The Solid Waste Division provides solid waste management for the Sunshine Coast. In British Columbia, Regional Districts are mandated by the Provincial *Environmental Management Act* to develop Solid Waste Management Plans. The SCRD's Solid Waste Management Plan 2011(SWMP) guides how the SCRD manages its solid waste including waste diversion programs, services and disposal activities.

The division oversees the operation and maintenance of the Sechelt Landfill and the Pender Harbour Transfer Station. The division also maintains the contracts for curbside garbage collection services for Electoral Areas B, D, E and F, three recycling depots and green waste drop off locations.

In January 2018, the SCRD adopted the Regional Organics Diversion Strategy. The goal of the Strategy is to develop a financially sustainable roadmap that will lead to a robust, region-wide organics diversion program.

The quarterly report provides an update on current projects, diversion programs, services and monthly statistics.

SOLID WASTE PROGRAMS

Regional Organics Diversion Strategy

The planning work continues for the commercial sector ban on organics and recyclables, including an implementation plan for the landfill disposal bans.

Collaboration with Member Municipalities on Curbside Collection Services

The SCRD, the District of Sechelt and the Sechelt Indian Government District staff have collaborated on a combined tendering process for curbside collection services for garbage, recycling and organics (food waste and green waste). A report will be provided to committee with the results of this tendering process.

AVICC Special Committee on Solid Waste Management: Communications Group

On November 5, 2018, the Solid Waste Programs Coordinator participated in the AVICC Solid Waste Communications Group meeting by conference call. The meeting was a dedicated discussion of a proposal to develop a collaborative education campaign about "Recycle Right at Home" which targets the main misconceptions about recycling for residents.

The proposal was presented at the AVICC Administration Group meeting later that day and it was approved for campaign launch in spring 2019.

Love Food Hate Waste 2019 Provincial Campaign

The Province of British Columbia has invited local governments to join a provincial partnership to promote food waste reduction across the province. Solid Waste Services staff will work with the province to deliver coordinated education campaigns and raise awareness of food waste in households. The campaign provides digital materials, outreach resources and supports information sharing about best practices from other local governments. The education campaign will make use of the SCRD social media outlets and updates to solid waste webpages will include images and infographics to support the campaign.

Good Samaritan Program

The Good Samaritan Program pays the tipping fees for materials collected from illegal dump sites cleaned up by volunteers throughout the year. For 2018, approximately 20 tonnes of material was accepted at the Sechelt landfill and Pender Harbour Transfer Station under the Good Samaritan Program.

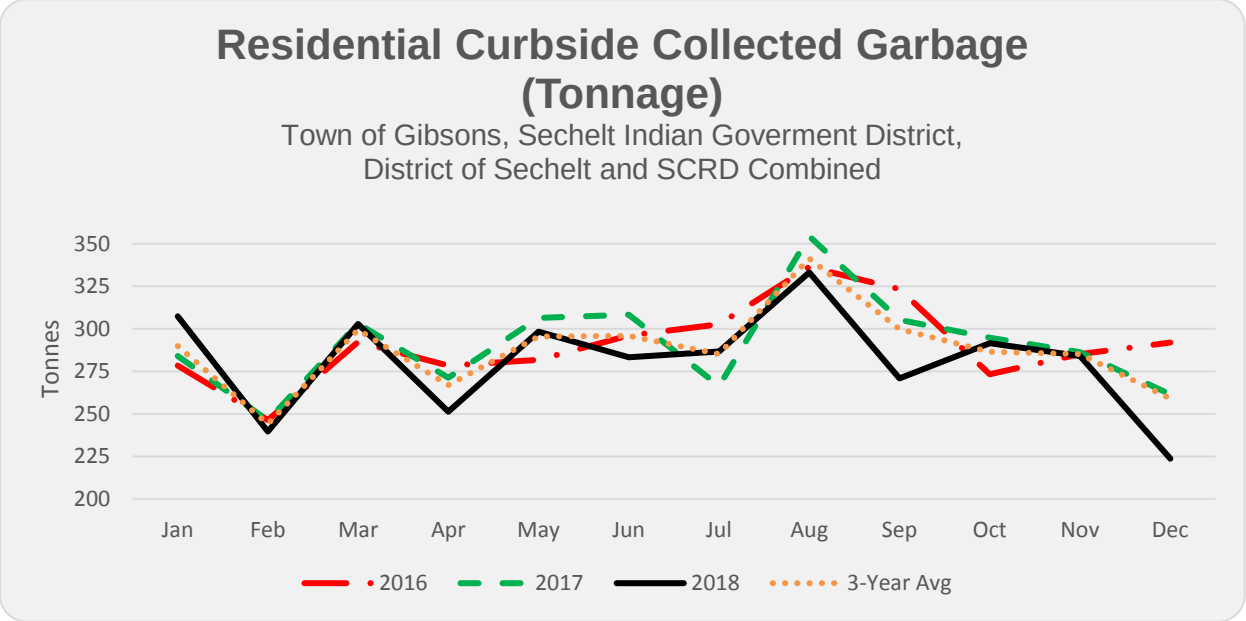
Sechelt Inlet Clean Up – Eel Grass Project

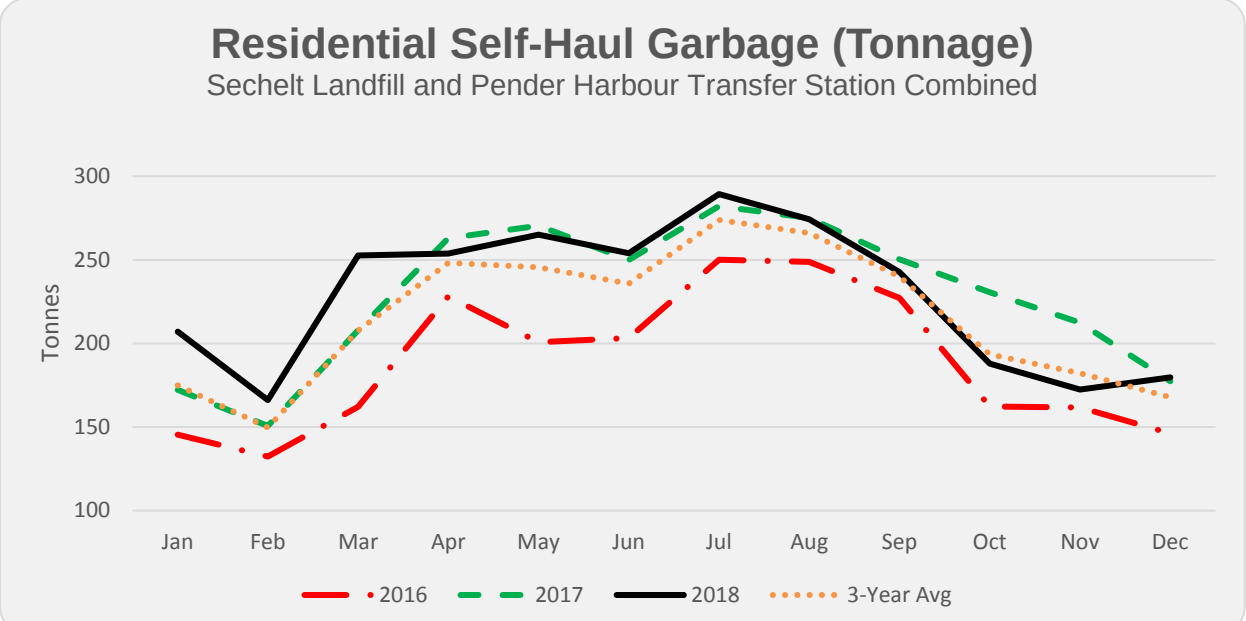
In collaboration with Salish Sea Nearshore Habitat Recovery Project, the District of Sechelt and the SCRD, 5.23 tonnes of material including nets, scrap metal, tires and furniture was cleaned up from the Sechelt Inlet. The SCRD charged the tipping fees to the SCRD Shoreline Clean-up program.

SOLID WASTE OPERATIONS

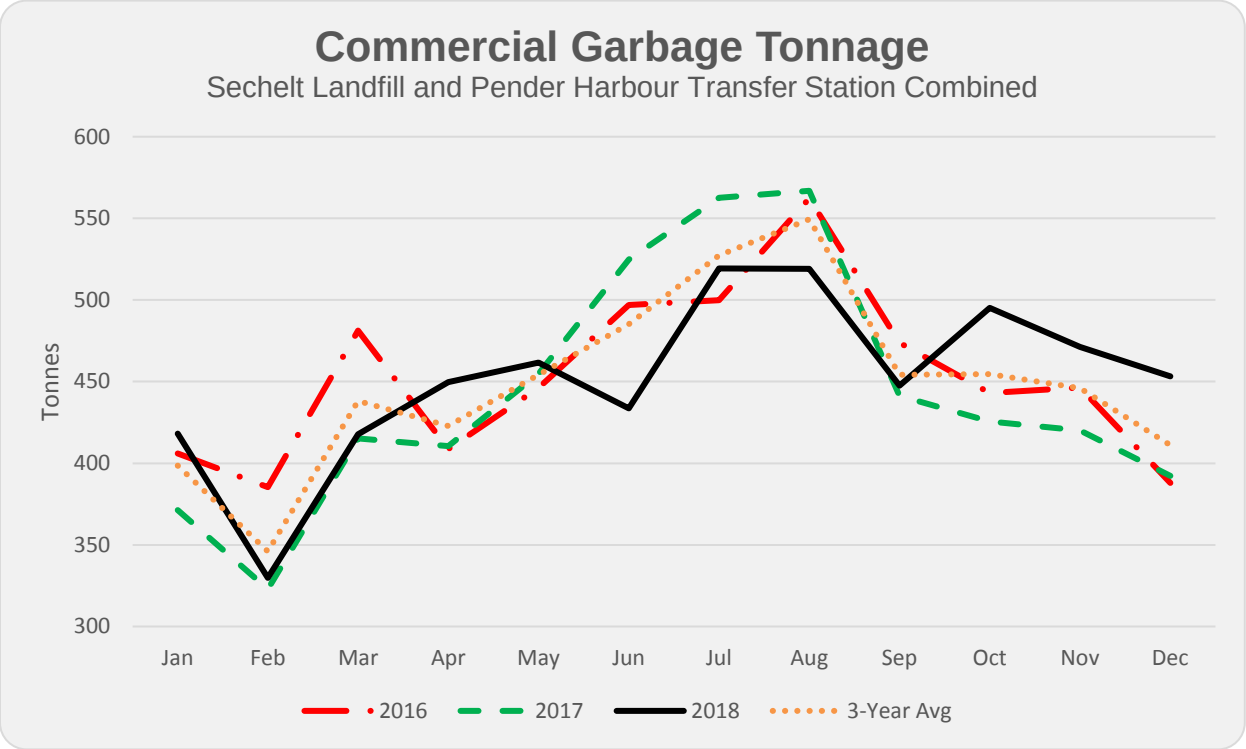
Statistics – Landfill

Residential garbage consists of both garbage collected curbside and garbage self-hauled by residents to the Pender Harbour Transfer Station and Sechelt Landfill. The residential curbside garbage tonnage presented includes a combined total of garbage collected curbside from residential dwellings in the Town of Gibsons, Sechelt Indian Government District, District of Sechelt and Sunshine Coast Regional District. Curbside residential garbage is then delivered to the Sechelt landfill and buried. The residential self-haul garbage presented includes a combined total of garbage self-hauled by residents to the Sechelt landfill or the Pender Harbour Transfer Station.





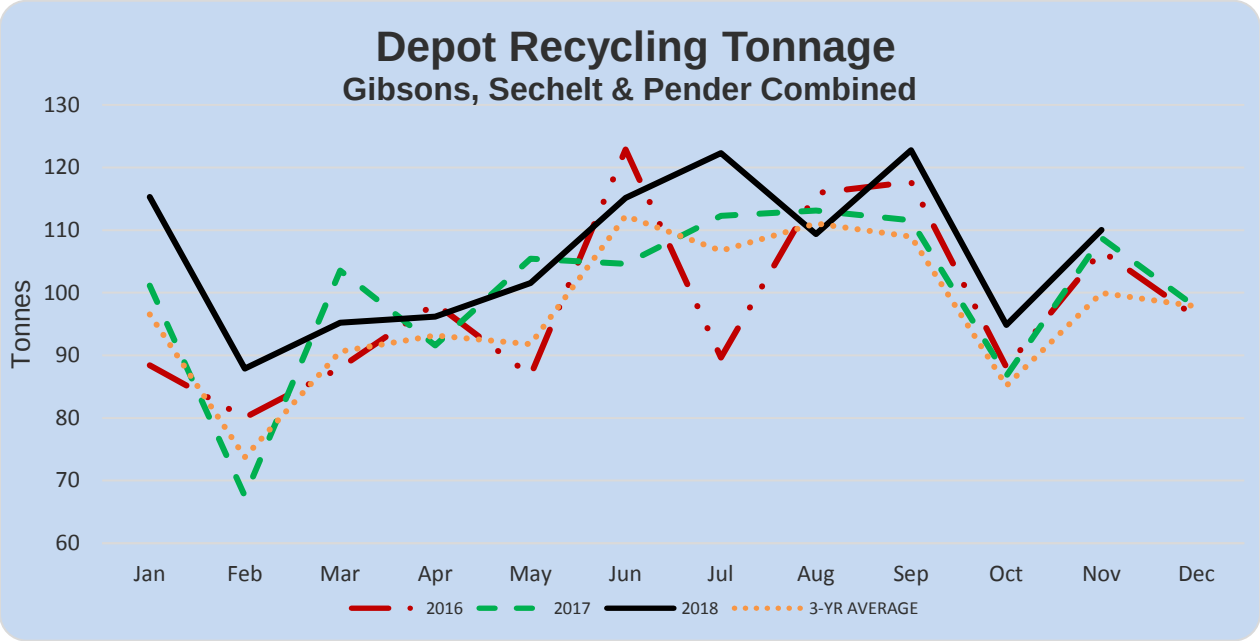
The commercial garbage tonnage presented includes garbage generated by commercial activity picked up from businesses and multi-family dwellings (SCRD) or dropped off at the Sechelt landfill and Pender Harbour Transfer Station. This does not include other landfilled items such as construction/demolition waste, asbestos or furniture.



Statistics – Recycling

In October 2018, the SCRD renewed its agreement with Recycle BC to provide PPP Depot Recycling Services in Gibsons, Pender Harbour and Sechelt for 5 years. The SCRD contracts these services to Gibsons Recycling, GRIPS and Salish Soils respectively and all three depot contracts were also extended at that time.

The data presented is provided by RecycleBC and is updated as it is received. The data represents the combined monthly weight (by tonne) of the materials dropped off at the three recycling depots.

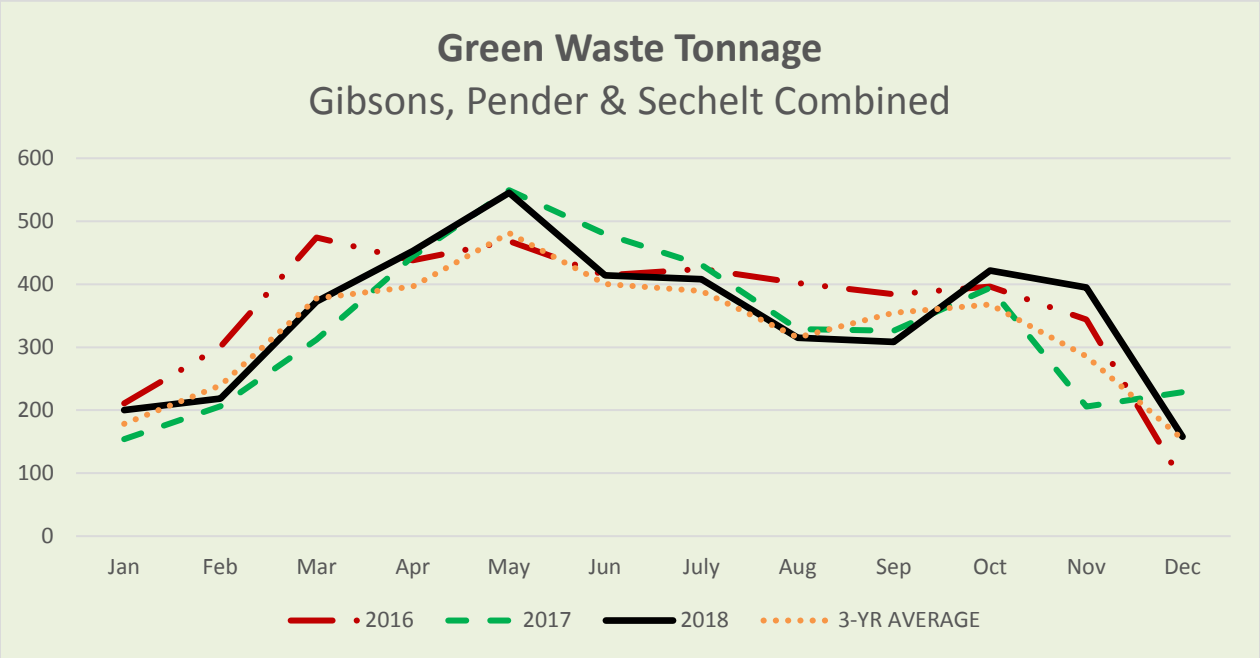


*December data is not yet available from RecycleBC

Statistics - Green Waste

The SCRD green waste recycling program provides collection locations for residents to self-haul and drop off yard and garden green waste at the Town of Gibsons Green Waste Facility, Pender Harbour Transfer Station, Sechelt Landfill and residential self-haul at Salish Soils. The collected green waste is then processed in Sechelt for composting.

The data presented provides the combined monthly weight (by tonne) of green waste dropped off at the collection locations.



Infrastructure Community Events/Outreach

Date	Community Event	Topic
Nov 23, 2018	Banff Centre Film Festival	Water / Solid Waste

The 2019 Solid Waste Communications Plan and the 2019 Water Communications Plan are in progress.

Reviewed by:			
Manager	X – S. Walkey X – G. Dykstra	Finance	
GM		Legislative	
CAO	X – J. Loveys	Other	X – A. Patrao X – A. Ridgeley X – B. Rebner X – C. Abbott X – R. Shay X – T. Ohlson