TECHNICAL MEMORANDUM

Issue Date:	September 21, 2020	**File:**	2019-8525.010.803
To:	**Frew Azene**	**Previous Issue Date:**	
From:	Marta Green, P.Geo.		
Client:	Sunshine Coast Regional District		
Project Name:	Phase 4a Detailed Design Church Road Well Field Project	**Project No.:**	2019-8525.010
Subject:	Supplemental Information to Support Licence Application Amendment		

1 INTRODUCTION

On behalf of the Sunshine Coast Regional District (the SCRD), Associated Environmental Consultants Inc. (Associated) request an update to the new groundwater use licence application for Church Road Wellfield that was previously submitted in September 2019 (Tracking No. 100292061) as described in this memo. This is the second supplemental information document submitted to the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD), with the first being the Environmental Flow Needs (EFN) Assessment[1], submitted to FLNRORD on August 11, 2020.

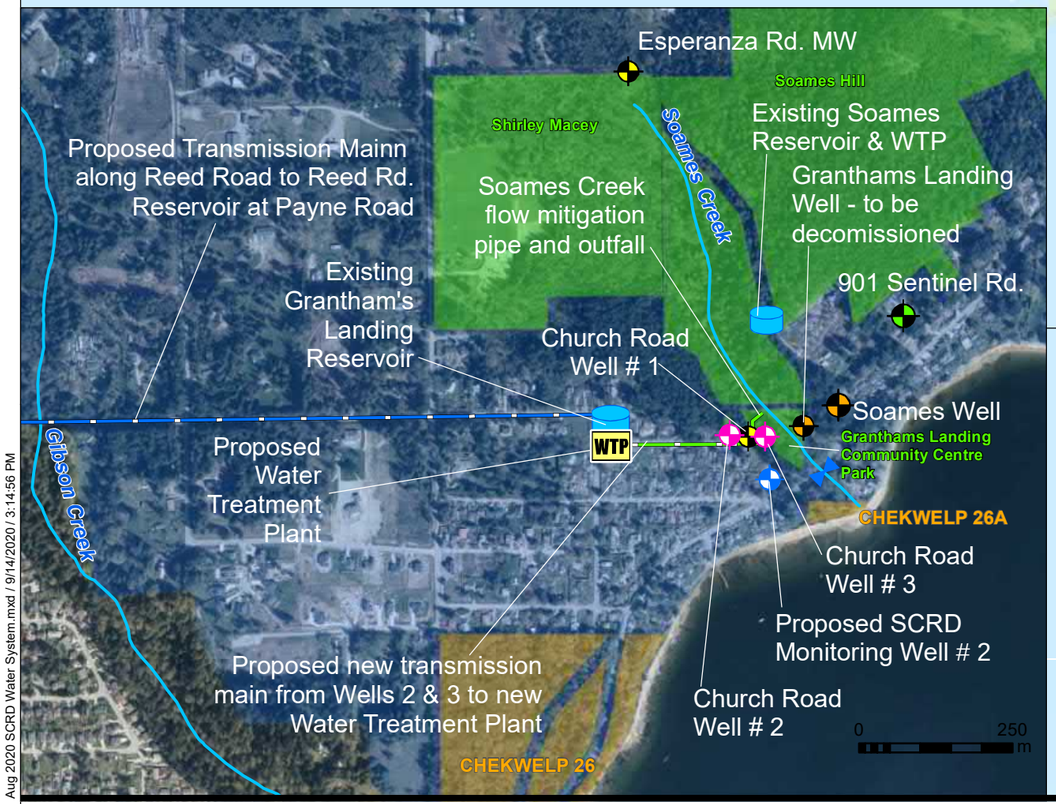
2 BACKGROUND

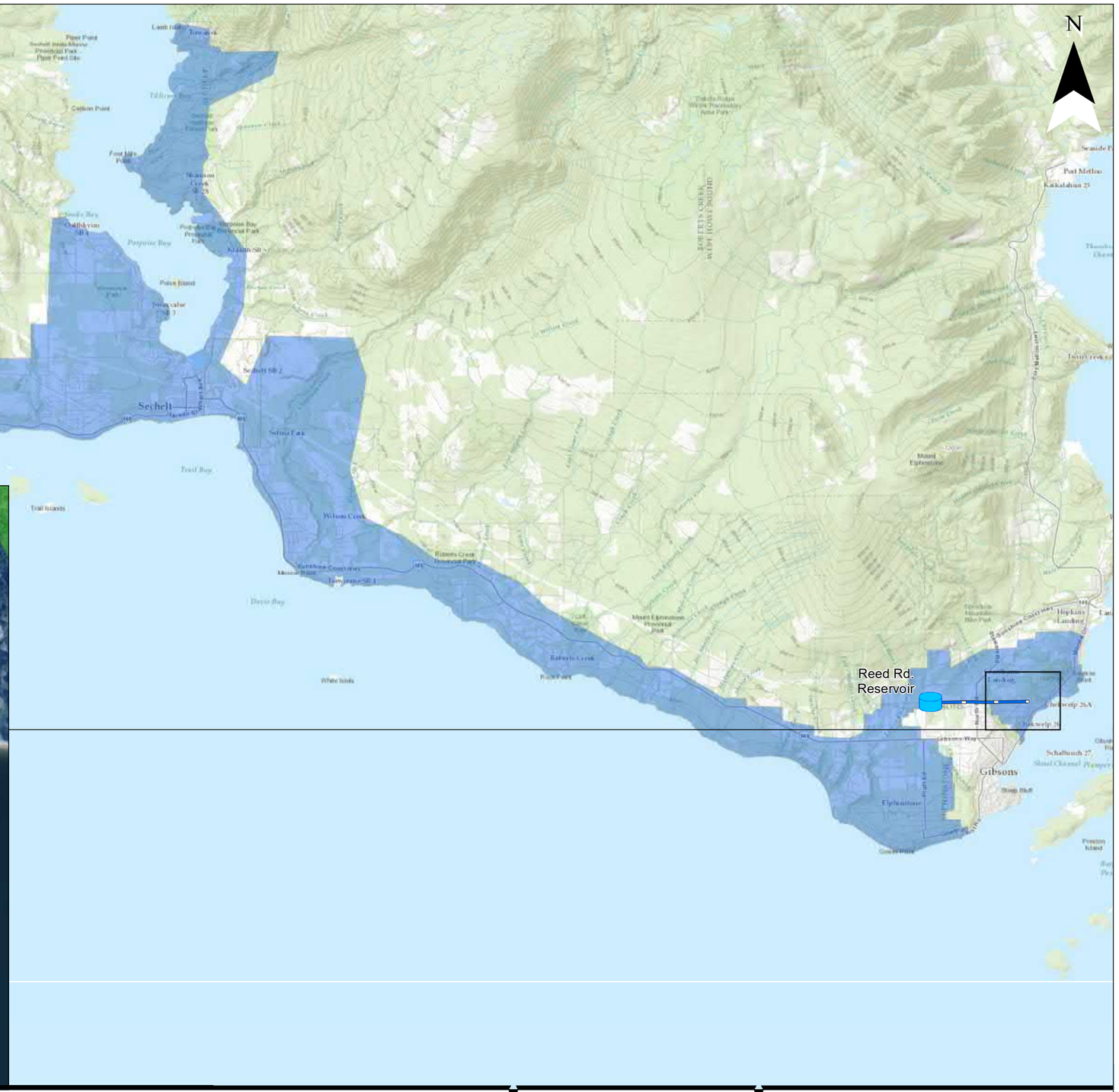
At the end of September 2019, the SCRD submitted a new groundwater use licence application and technical assessment report to FLNRORD for the future extraction of groundwater from two production wells located at Church Road/Elphinstone Avenue in Granthams Landing, Gibsons, BC, in what is now known as Aquifer 560[2]. At the time of the application submission, only one production well (Church Road Well 2) had been constructed and tested and the licence application was based on the results of this test. It was noted in the application that a second production well (Church Road Well 3) would be drilled and tested in 2020, the results of which would be provided as supplementary information (this memo) to the technical assessment report. Church Road Well 3 was constructed and tested in June/July 2020. The two Church Road production wells are together known as the Church Road Wellfield. Their location, together with all other nearby wells and features of interest are provided on Figure 2-1.

In addition to the new Church Road wells, the SCRD currently owns and operates two nearby existing groundwater sources, Soames Well and Granthams Landing Well. Both of these wells are constructed within the same aquifer as the Church Road wells, as follows:

- Soames Well is located approximately 170 m from the Church Road wells and is currently connected to an independent water distribution system (Soames distribution system) providing water to the local area via Soames Reservoir, but it can provide water into the Chapman distribution system if required. When in use, Soames Well operates at a pumping rate of 16.0 L/s, however, it is used intermittently based on demand, resulting in an average extraction rate equivalent to just over 1 L/s.

[1] Associated Environmental Consultants Inc. 2020. Environmental Flow Needs Assessment for Soames Creek. Memo. August 06, 2020.
[2] The Ministry of Environment has recently updated the aquifer numbers and the aquifer limits. Aquifer 553 has now been retired, and the wells are within the updated polygon boundaries for Aquifer 560.





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Associated Environmental

- New SCRD Production Well
- Existing SCRD Production Well
- SCRD Monitoring Well
- Proposed SCRD Monitoring Well
- Private Well
- Proposed Flow Monitoring Station
- Proposed Supply Main - Elphinstone Ave
- Proposed Transmission Main - to Reed Rd. Reservoir
- SCRD Park
- First Nation Reserve
- Chapman Water System

PROJECT NO.: 2019-8525.010.202
DATE: September 2020
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FIGURE 2-1: Church Road and Soames Well Location Plan and SCRD Distribution System

Sunshine Coast Regional District

SCRD Groundwater Investigation Phase 4

- Granthams Landing Well is an uncontrolled flowing artesian well that provides an average of just under 1 L/s water to the Granthams Landing community via the Granthams Landing Reservoir. One of the goals of developing Church Road Wells 2 and 3 is to allow the design and safe decommissioning of the Granthams Landing Well.

Hydraulic modelling and field testing by Associated and the SCRD in 2020 confirmed that the existing water distribution infrastructure is capable of transmitting a significantly higher quantity of water from Soames Well than is currently utilised. Therefore, a pumping test was conducted in August 2020 to assess the impact of increased extraction from Soames Well on aquifer water levels, nearby groundwater users and the environment. Following positive pumping test results, Associated's recommendation is to increase groundwater extraction from Soames Well and include extraction from this well in the licence application for the new Church Road Wellfield.

The total quantity of groundwater to be extracted from the two Church Road wells in the original licence application submission was higher than the amount that is proposed now (57.6 L/s originally compared to 54.4 L/s now). While Soames Well was not included as part of the original licence application (in terms of the water quantity applied for), in assessing the aquifer water availability for the Church Road wells it had been assumed that Soames Well would be used continuously at a constant rate of 16.7 L/s as part of the independent Soames water system. Consequently, while it is now proposed to include Soames Well under the same licence as the Church Road wells, the findings and recommendations of the technical assessment report remain valid.

This memo presents the supplemental information obtained from the 2020 drilling and testing of the second Church Road production well, the results of the testing of Soames Well, and provides a summary of the changes to be made to the licence application as a result of these recent investigations. This memo should be read in conjunction with the 2019 technical assessment report submitted with the licence application.

3 SUMMARY OF UPDATES

To simplify the licensing process, we recommend consolidating the groundwater extraction from the three wells (Church Road Wells 2 and 3, plus Soames Well) into a single new groundwater use licence and remove the supply from Granthams Landing Well. This will be achieved by withdrawing the existing use licence applications for Soames Well and Granthams Landing Well and adding Soames Well to the new groundwater use licence application. The main benefit of an existing use licence is to maintain 'first in time, first in right' use of groundwater. However, as the quantity of water that was historically and currently used (and applied for in the existing use licence applications) from Soames Well and Granthams Landing Well is very small - approximately 1 L/s from each well - it is not considered worthwhile to complicate the licensing process for such a small existing use quantity of water. In addition, there are no other large extractions from the same aquifer in the vicinity that would be given a right of use ahead of and affect the future use of the SCRD's Church Road and Soames wells.

A summary of the proposed updates to the licence application include:

- Adding Soames Well to this licence application (16.0 L/s based on recent pumping test results). The well log for Soames Well is provided in Appendix A and the well location is shown on Figure 2-1. The UTM coordinates for the well are: Zone 10 U; Easting: 464293.9; Northing: 5473657.5).
- Refining the annual volume for the two Church Road Wells from 57.6 L/s to 54.4 L/s, based on recent pumping test results.
- Increasing the total annual quantity of water to apply for to 2,221,654 m^3 equivalent to 70.4 L/s (54.4 L/s from Church Road wells plus 16.0 L from Soames Well) as indicated in Table 3-1.
- As a result of these updates, the SCRD will no longer require the existing use groundwater licence applications for Granthams Landing Well and Soames Well to be determined. In addition, the SCRD will no longer require their existing use surface water licence for Granthams Spring. The following will therefore occur:
    - The SCRD will withdraw their existing groundwater use licence applications for Granthams Landing Well (Tracking number 100195585) and Soames Well (Tracking number 100227262) after the Church Road Wellfield/Soames Well licence (this application) has been issued and before the start of the construction project, by emailing Lauren.Hunter.1@gov.bc.ca.
    - The SCRD will abandon their existing surface water licence, C025656 Granthams Spring. This licence will be abandoned at the beginning of the Church Road Wellfield construction project using the FrontCounterBC website via this link: https://portal.nrs.gov.bc.ca/web/client/-/complete-water-licence-abandonment.

Table 3-1: Proposed extraction quantities for the Church Road Wellfield and Soames Well

Well	Instantaneous Extraction Rate (L/s)	Maximum Annual Quantity (m^3) [1]	Comments and Anticipated Licence Conditions
Church Road Wellfield (Church Road Well 2 and Church Road Well 3)	54.4	1,716,733	The extraction rate has been updated based on recent pumping tests. Church Road Well 2 is 25.4 L/s and Church Road Well 3 is 29.0 L/s. If flow augmentation of Soames Creek is required, it will be taken from this quantity of water.
Granthams Landing Well	0	0	Granthams Landing Well will be taken offline as part of the development of the Church Road Wellfield, and then decommissioned after monitoring water levels in the aquifer in this vicinity for at least one year to allow for adequate decommissioning design time.
Soames Well	16.0	504,921	The well infrastructure is designed to be operated at up to 16.0 L/s but is currently only used intermittently. SCRD completed hydraulic modelling and a pumping test which confirmed that this well can be used to provide a significantly higher annual volume than it currently provides. Therefore, it is proposed to include extraction from this well with the licence for the Church Road wells.
Total	**70.4**	**2,221,654**	**Total instantaneous and annual quantities assuming wells are pumped at their maximum rates.**

Notes: [1] If the well is pumped continuously for one year (365.25 days) at the instantaneous extraction rate.

We request that the previously submitted licence application be amended to reflect the maximum annual groundwater quantities and instantaneous pumping rates detailed in Table 3-1.

4 UPDATE TO TECHNICAL ASSESSMENT SECTIONS

The following section provides a summary of the results of the 2020 groundwater investigations of Church Road Well 3 and Soames Well that have led to the proposed licence amendments. The detailed pumping test results and analysis for Church Road Well 3 and Soames Well is included as Appendix B.

4.1 Adequacy of Supply

Based on the 2020 pumping tests, the aquifer properties, well yields and well available drawdowns are similar to those described in the technical assessment report. The report (Appendix B) also includes an assessment of the combined impacts of pumping from the three wells simultaneously using the principle of superposition.

4.1.1 Church Road Well 3

The results of the 2020 pumping tests on Church Road Well 3 indicate a 100-day long term sustainable well yield (CPCN method[3]) of 29.5 L/s (467 USgpm) with a 30% margin of safety. This rate is based on maintaining a water level in the well above 2 masl in order to minimise the risk of saline intrusion and it takes into account drawdown in the well caused by well interference from operating Church Road Well 2 and Soames Well at their maximum pumping rates.

The well was tested at a constant rate of 29.0 L/s (460 USgpm). This is below the calculated 100-day sustainable yield of 29.5 L/s (467 USgpm) and also below the theoretical transmitting capacity of the well screen (29.5 L/s; 467 USgpm). As per the MOE 2007 guideline, wells should not be rated higher than the rate tested at; therefore, we recommend that this well be rated to extract groundwater at a maximum rate of 29.0 L/s (460 USgpm).

4.1.2 Soames Well

The results of the 2020 pumping test on Soames Well indicate a 100-day long term sustainable well yield of 29.6 L/s (470 USgpm) with a 30% margin of safety. Available drawdown in this well is restricted by the depth of the well and the depth of the pump. The maximum available drawdown available results in a water level of approximately 4 masl. The long-term sustainable yield takes into account drawdown in the well caused by well interference from operating Church Road Well 2 and Church Road Well 3 at their maximum pumping rates.

Soames Well has a theoretical long term sustainable yield of 29.6 L/s; however, the pumping rate is restricted by the existing in-situ pump and pipe infrastructure. As a result, we recommend that this well is rated to the maximum achievable pumping rate of 16.0 L/s (the rate it was tested at in 2020).

4.1.3 Groundwater Recharge

No additional information on recharge has been obtained from the 2020 investigations, therefore the recharge processes and best estimates provided in Section 6.3 of the technical assessment report remain valid and indicate that sufficient recharge is available to prevent 'mining' of the aquifer. A detailed monitoring plan will be developed prior to operation of the wells (see Sections 5 & 7). The data collected will be used to assess whether there is sufficient recharge to the aquifer.

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[3] Ministry of Environment. 2007. Guidelines for Evaluating Long-term Well Capacity for a Certification of Public Convenience and Necessity (CPCN).

4.2 Well Interference and Potential Impacts on Other Groundwater Users

Well interference has been assessed and was taken into consideration in assessing the maximum available drawdown and the adequacy of each supply well (see Section 4.1 of this memo and Appendix B).

Only one used private groundwater supply source constructed within the same aquifer is known located within 1 km of the Church Road and Soames wells: a well at 901 Sentinel Road, owned by The well is located approximately 320 metres northeast of the Church Road wells and 180 m northeast of Soames Well. Water levels in this private well were monitored during the pumping tests of the three production wells to assess the impact. The combined drawdown in this private well is estimated to be up to approximately 2.3 m and 2.4 m after 100 days and 180 days respectively of pumping from the three production wells at their maximum pumping rates. Based on the well water levels and the approximate pump depth, this leaves 10 m of available drawdown in the well at 901 Sentinel Road. Based on this assessment, the potential risk of impacts to this well is low.

The SCRD is committed to working with in developing a contingency plan and reaching an agreement if in the unlikely event extraction from the Church Road wells and Soames Well has a detrimental impact on well. This could include connecting to the mains supply (which runs next to his property, deepening his well, or lowering his pump to increase available drawdown. Now that the anticipated impacts have been determined, the next steps are for the SCRD to facilitate a meeting with to come up with an agreement.

It should be emphasised that based on evidence to date, there is unlikely to be a detrimental impact to water supply due to the groundwater extractions. If water level in the private well drops significantly, the water level in the SCRD's production wells will also have fallen and would likely be below their safe available drawdown levels. Consequently, operation of the SCRD's production wells would need to be managed to maintain well water levels above their safe available drawdown levels, resulting in less drawdown in well.

4.3 Potential Impact on Soames Creek

Groundwater extraction from Church Road Well 3 and Soames Well is from the same aquifer that springs supplying baseflow to Soames Creek emerge from. Extraction from these wells will have an impact on flow from these springs; however, a worst-case scenario that the springs will dry up had already been assumed in the technical assessment report and mitigation measures have been proposed to maintain the EFN threshold.

4.4 Potential Impacts on Fish and Fish Habitat

The EFN Assessment for Soames Creek was submitted separately to FLNRORD on August 11, 2020. The assessment recommended that due to the flashy nature of Soames Creek, the EFN threshold be set at 12.3 L/s across the year. There will be an impact to fish and fish habitat as a result of groundwater extraction causing a reduction in creek streamflow below the EFN during times of low flow. The SCRD will therefore mitigate this impact by discharging

groundwater into the creek to maintain a flow at or above the EFN threshold of 12.3 L/s when pumping of the Church Road Well Field causes an impact to the EFN (i.e., no mitigation will be provided if creek streamflow has naturally fallen below the EFN threshold without pumping occurring).

5 ANTICIPATED LICENCE CONDITIONS

Section 9.2 of the technical assessment report describes some anticipated licence conditions. Table 5-1 lists updated anticipated licenced conditions and replaces Section 9.2 of the technical assessment report.

Table 5-1: Anticipated Licence Conditions

Anticipated Licence Condition	Comments/Rationale
Maximum instantaneous pumping rates: • Church Road Well 2: 25.4 L/s • Church Road Well 3: 29.0 L/s • Soames Well: 16.0 L/s **Total: 70.4 L/s** Total annual water quantity: • Church Road Well 2: 801,563 m^3 • Church Road Well 3: 915,170 m^3 • Soames Well: 504,921 m^3 **Total: 2,221,654 m^3**	The maximum well pumping rates are the rates at which the wells were tested at. The rates are within the calculated 100-day long term sustainable well yields and are below the theoretical transmitting capacity of each wells' screen. All three wells could be pumped simultaneously for the entire year; however, we anticipate most use will occur between May 01 and October 31, based on the SCRD's needs, i.e., when there is insufficient water available from the SCRD's Chapman Creek and Edwards Lake sources to meet customer demand.
Maintain a water level in the production wells of greater than 2 masl.	To minimise the potential for saline intrusion. As part of well infrastructure design, water level sensors will be installed in the wells which will provide an alarm if the well water level approaches this depth.
Augment Soames Creek streamflow at or above the EFN threshold of 12.3 L/s when groundwater extraction from the Church Road Wellfield and Soames Well causes a reduction in creek streamflow. Commissioning of the production wells will not be allowed to commence until an acceptable flow monitoring station has been installed, commissioned and approved.	The flow monitoring station will be designed to alert the operators to start augmenting flow before the flow drops below 12.3 L/s. A low flow trigger value of 14 L/s is proposed. An appraisal of flow monitoring options is being prepared to determine the best flow monitoring and data communication methods.

Anticipated Licence Condition	Comments/Rationale
Install a sentinel monitoring well (Church Road Monitoring Well 2) located between the coast and the wellfield.	This monitoring well will be used to monitor groundwater salinity/conductivity for saline intrusion. It will also be used to monitor aquifer water levels. More details are provided in the Preliminary Monitoring Plan (Section 7).
Develop and maintain a Detailed Monitoring Plan. Commissioning of the wells cannot commence until a Detailed Monitoring Plan has been submitted and approved by FLNRORD. The Detailed Monitoring Plan must be submitted to FLNRORD at least 3 months before well commissioning is planned.	A Preliminary Monitoring Plan has been developed (Section 7 of this memo) for the first two years of monitoring, once operation of the wells commences.
Develop a source protection plan for the Church Road Wellfield and Soames Well.	A source protection plan will help to maintain the integrity of the water supply. The source protection plan should include long-term monitoring.

In addition to these anticipated licence conditions, we also recommend that the wells are used throughout the year (e.g., at a minimum once per week), even if at a reduced rate, to help prevent bio-fouling of the well.

6 PIPE CONFIGURATION

Figure 2-1 shows the proposed pipe configuration, together with the production wells and monitoring wells. It also shows the SCRD's distribution area where water from the wells could end up. In addition to Figure 2-1, kmz files will be provided to FLNRORD showing the location of the new infrastructure.

A new pipeline will transfer the extracted groundwater from the Church Road wells, west along Elphinstone Avenue to Granthams Landing Reservoir and Water Treatment Plant. From here it will go into the Chapman distribution system. When creek flow augmentation is required, raw groundwater will be transferred back down from the Granthams Landing Reservoir site along Elphinstone Avenue towards the wells and will then head in a northerly direction down the valley side to Soames Creek where it will discharge into the creek near the springhead via an outfall structure.

Soames Well is already connected to the SCRD's distribution system and will not require any new infrastructure.

7 PRELIMINARY MONITORING PLAN

Ongoing monitoring during operation of the wells is critical to confirm the anticipated impact to aquifer water levels, other groundwater users, and the environment (i.e., creek streamflow) is correct. Regular monitoring will provide an early warning of unexpected impacts from the groundwater extractions, such as increased drawdown of aquifer water level,

changes in water quality, saltwater intrusion, and insufficient aquifer recharge. Operational changes can be implemented to mitigate and manage any detrimental impacts.

The following parameters will be monitored: aquifer groundwater levels, pumping rates and the groundwater quantity extracted, groundwater quality, and Soames Creek streamflow and water quality. Table 7-1 presents a preliminary monitoring plan for the first year of wellfield operation listing the sites that will be monitored, the type and frequency of monitoring, and the rationale for monitoring.

Monitoring site locations are listed in Table 7-1 and shown on Figure 2-1. These sites all exist except for:

- Church Road Monitoring Well 2 – We are waiting for permits from the Ministry of Transportation and Infrastructure to allow drilling and construction of the well in their right of way.
- Soames Creek Flow Monitoring Station - An options appraisal is being prepared to determine the preferred flow monitoring method and location. Soames Creek Flow Monitoring Station is critical to ensuring that streamflow in Soames Creek can be monitored and will be used to inform when creek augmentation is required as a result of reduced streamflow caused by extraction of groundwater.

Commissioning of the Church Road wellfield and an increase in extraction from Soames Well will not commence until the Soames Creek Flow Monitoring Station has been installed, commissioned and approved.

The SCRD will be responsible for ensuring that the monitoring plan is implemented and followed, with the collection of data at the frequencies outlined in Table 7-1. During the first two years of operation we recommend that quarterly and annual monitoring reports are prepared by a Qualified Professional and submitted to the SCRD detailing the results of monitoring and making recommendations for any changes to the groundwater extraction and creek augmentation regime. We recommend that the SCRD retain these reports in their records for future inspection by FLNRORD should the information be requested. After two years of data collection and reporting, the monitoring sites, monitoring frequency and reporting frequency will be reassessed and can be reduced if no detrimental impacts have been identified or are anticipated in the future.

We also recommend that any data collected for the private supply well at 901 Sentinel Road is provided to the owner.

A back-up generator is included as part of the new water system design and will provide power to the wells' pumps in the event of a mains power outage. This will ensure that extraction from the wells remain active and can continue to provide water to the community as well as providing flow to the creek, when required. In addition, the use of two production wells (Church Road Well 2 and Well 3) that can both provide augmentation water to the creek provides a measure of safety for the operation of the creek augmentation scheme should there be a pump failure in one of the wells, or if a well and/or pump needs to undergo maintenance.

Table 7-1: Proposed monitoring plan for first two years of Church Road Wellfield and Soames Well operation

Monitoring	Site Name	Source/Type	Monitoring Type	Monitoring Frequency	Rationale
Groundwater Level	Church Road Well 2	Production Well	Pressure transducer data logger& manual measurements	Instantaneous readout Logging data at 15-minute intervals Monthly manual measurements	Monitor water level in production well to ensure water level remains above the maximum safe drawdown as well as above the pump intake and motor. Manual dip measurements to confirm.
	Church Road Well 3	Production Well	Pressure transducer data logger& manual measurements	Instantaneous readout Logging data at 15-minute intervals Monthly manual measurements	Monitor water level in production well to ensure water level remains above the maximum safe drawdown as well as above the pump intake and motor. Manual dip measurements to confirm.
	Soames Well	Production Well	Pressure transducer data logger& manual measurements	Instantaneous readout Logging data at 15-minute intervals Monthly manual measurements	Monitor water level in production well to ensure water level remains above the maximum safe drawdown as well as above the pump intake and motor. Manual dip measurements to confirm.
	Church Road Well 1	Observation	Pressure transducer data logger & manual measurements	Logging data at 15-minute intervals Monthly data download and manual measurements	To observe the impact on aquifer water level between the two Church Road Wells.
	Church Rd Monitoring Well 2*	Observation	Pressure transducer data logger & manual measurements	Logging data at 15-minute intervals Monthly data download and manual measurements	To observe the impact on aquifer water level between the wellfield and the sea.
	901 Sentinel Road	Private water	Pressure transducer data logger & manual measurements	Logging data at 15-minute intervals Monthly data download and manual measurements	To observe the impact of groundwater extraction on this private well.
	Esperanza Road Monitoring Well	Observation	Manual measurements	Monthly manual measurements	To observe upgradient impacts on aquifer water level.
	Granthams Landing Well	Observation	Pressure gauge	Monthly readings	To observe the impact on the artesian pressure head in this well to help in design of future well decommissioning.
Groundwater Quantity	Church Road well 2	Production	Inline flow meter	Logging data at 15-minute intervals with totaliser	To ensure the abstraction rate does not exceed the maximum instantaneous rate and complies with licensed quantity.
	Church Road Well 3	Production	Inline flow meter	Logging data at 15-minute intervals with totaliser	To ensure the abstraction rate does not exceed the maximum instantaneous rate and complies with licensed quantity.
	Soames Well	Production	Inline flow meter	Logging data at 15-minute intervals with totaliser	To ensure the abstraction rate does not exceed the maximum instantaneous rate and complies with licensed quantity.
Groundwater Quality	Church Road Well 2	Production	Conductivity data logger Water samples	Monthly sampling	Ensure that groundwater quality does not deteriorate over time and meets the Guidelines for Canadian Drinking Water Quality and the BC Water Quality Guidelines for Aquatic Life (for augmentation water).
	Church Road Well 3	Production	Conductivity data logger Water samples	Monthly sampling	Ensure that groundwater quality does not deteriorate over time and meets the guidelines for Canadian drinking Water Quality and the BC Water Quality Guidelines for Aquatic Life (for augmentation water).
	Soames Well	Production	Conductivity data logger Water sample	Monthly sampling	Ensure that groundwater quality does not deteriorate over time.
	Church Road Monitoring Well 2 [1]	Observation	Conductivity data logger Water sample	Logging conductivity data at hourly intervals Monthly data download and manual measurements Water sample if conductivity increases	To ensure saline intrusion is not occurring and provide an early warning if it does.
Soames Creek Streamflow	Soames Creek Flow Monitoring Station [2]	Creek	Area Velocity Flow Meter	Instantaneous readout Logging data at 15-minute intervals Telemetry system with alarms	To monitor creek streamflow and inform the need for creek augmentation at a prescribed trigger flow rate of 14 L/s to maintain an EFN of 12.3 L/s.
Soames Creek Water Quality	Soames Creek	Creek	Dissolved oxygen field measurements	Monthly	Monitor dissolved oxygen in creek at locations downstream of creek augmentation discharge to ensure dissolved oxygen content is high enough.

[1] Monitoring well to be drilled; [2] Location and monitoring station type to be confirmed.

8 SUMMARY

The 2020 groundwater investigations included the successful drilling and testing of a second production well: Church Road Well 3. The results of pumping tests have shown this well to be just as productive as the Church Road Well 2 and suggest it is capable of pumping at a rate of 29.0 L/s without having a detrimental impact on aquifer water levels and existing groundwater users. A reduction in streamflow in Soames Creek was identified during the pumping tests, however, the creek augmentation scheme already outlined in the technical assessment report (Associated 2019) submitted with the licence application will mitigate this impact.

In addition to drilling a second production well at Church Road, the SCRD's existing groundwater well, Soames Well was identified as having the potential to provide a greater quantity of water to the community than it currently does. Hydraulic modelling and field testing of the SCRD's water distribution system showed that water from Soames Well, which feeds the SCRD's Soames supply zone, could be diverted and used in the SCRD's Chapman supply zone. Consequently, a pumping test was conducted on Soames Well to assess the impact that pumping continuously from this well will have on groundwater levels. The results of this pumping test showed that the well can be used to provide significantly more water to the SCRD's water supply system at a rate of up to 16.0 L/s.

The combined impacts of pumping from Church Road Well 2 (pumping test completed in 2019), Church Road Well 3, and Soames Well was also assessed. The results indicate that all three wells can be used simultaneously without having a significant effect on aquifer water levels or a nearby groundwater user's private well located at 901 Sentinel Road. An impact on Soames Creek will occur with a reduction in streamflow; however, a creek augmentation scheme has already been proposed to mitigate this, assuming the worst-case impact (i.e., drying up spring seepages and the uncontrolled artesian flow discharging from the Granthams Landing Well).

As a result of the 2020 investigations the following amendments are requested to the original licence application (Tracking No. 100292061) submitted in September 2019:

- Adding **Soames Well** to the licence application for the extraction of groundwater up to a maximum instantaneous pumping rate of **16.0 L/s**.
- Amending the maximum instantaneous pumping rates for Church Road Well 2 and Church Road Well 3 to the following, based on recent pumping test data:
  - **Church Road Well 2**: From 28.8 L/s to **25.4 L/s**
  - **Church Road Well 3**: From 28.8 L/s to **29.0 L/s**
- Amending the **total annual quantity** of water that can be extracted from the aquifer from 1,817,718 m^3 to **2,221,654 m^3**. This annual quantity is based on using the three wells at their maximum rates continuously.

In addition to changes to the licence application, the SCRD will:

- Abandon their existing use surface water licence for Granthams Springs (Licence No. C025656).
- Withdraw their existing groundwater use licence applications for Granthams Landing Well and Soames Well (after the Church Road Wellfield/Soames Well licence (this application) has been issued and before the start of the construction project).

- Develop a detailed monitoring plan to be submitted to and approved by FLNRORD prior to the wells being commissioned.
- Liaise with the owner of the private supply well at 901 Sentinel Rd and develop a contingency plan for in the unlikely event that this private well is detrimentally impacted as a result of the SCRD extractions.

9 CLOSURE

We trust this meets your needs at this time. Please feel free to contact Marta Green, at 250-545-3672, if you have any questions or require any additional information.

Steve Colebrook, M.Sc.
Environmental Scientist

Marta Green, P.Geo.
Senior Hydrogeologist

SC/MG

List of Attachments:
Appendix A: Soames Well Log
Appendix B: Church Road Well 3 and Soames Well 2020 Groundwater Investigation Report

APPENDIX A – SOAMES WELL LOG

AESL SOAMES PT.

November 20, 1979

Soames Point Waterworks District,
Grantham's Landing, B.C.
VON 1XO

Attention: Mr. E.D. Grout,
Secretary-Treasurer

Dear Sirs,

Re: Construction and Testing of 8" Well

The purpose of this letter is to report on the construction and testing of the 8" diameter well recently completed for the District by Rural Well Drillers. Background information is contained in our letter of December 11, 1978 to the District.

Tenderss were called on the drilling of an 8" diameter test-production well in late April, 1979. The project was awarded to Rural Well Drillers Ltd., on the basis of having submitted the tenders resulting in the lowest estimated total cost. Three of the four tenders submitted were very competitive. Because of difficulties associated with arranging a site for the well, the drilling did not get underway until October 5th. Testing of the successful well was carried out on October 16th and 17th.

Test Drilling and Well Construction

Rural Well Drillers used an air rotary drill equipped with a casing hammer to construct the well. The log of the well located on the north side of the valley of the unnamed creek is as follows:

0	-	3 ft.	sandy gravel
3	-	7 ft.	fine dry sand
7	-	10 ft.	boulders and compact gravel
10	-	17 ft.	compact silty sand and coarse gravel, few boulders
17	-	26 ft.	medium sand, compact
26	-	83 ft.	compact sandy gravel with some silt, occasional boulders

83	-	94 ft.	very compact silty coarse gravel
94	-	97 ft.	compact clayey gravel, possibly till, very little water
97	-	101 ft.	loose coarse clean sandy gravel, very high yield water, came clear in a few minutes
101	-	121 ft.	very coarse clean sandy gravel, very productive water-bearing capacity, coarse material heaves up pipe; yield by blowing in excess of 100 gpm.

The static water level is about 31½ ft. below ground.

Twenty feet of 10" diameter casing was installed at surface. Drilling was continued as 8" to 121 ft. The exact thickness of the loose water-bearing aquifer is unknown, as drilling was terminated before reaching the bottom. The well is completed with 15 ft. of 0.050" slot 8" nominal Johnson's stainless steel well screen set with the bottom at 121 ft. The top of the riser is at 102 ft. below ground. Development of the well was carved out by blowing air and bailing and was completed quite quickly. During completion of the well head installation the annular space between the two casings should be sealed off to prevent any movement of water down between the two casings.

Pump Test and Well Capacity

Following completion of the well a 24 hour pump test was carried out by a subcontractor, Aqua-Flo Testing and Equipment Ltd., of Langley. A 20 h.p. submersible pump powered by a diesel engine was used for the test. The discharge rate during the test was measured by means of a standard 2" diameter orifice on 4" diameter pipe set up at the end of 350 ft. of discharge pipe which conveyed the water into the creek. Datum for water level measurements during testing was approximately 2.35 ft. above ground. Water levels were measured by means of an electric water level indicator.

Data collected during the pump test are appended to this letter along with standard straight line plots of the data. The data have been plotted in the usual way with drawdown vs. log of minutes since the start of pumping and residual drawdown vs. log of the ratio $\frac{\text{minutes since start of pumping}}{\text{minutes since pumping stopped}}$. Testing was started at a rate of 51 USgpm. and increased in a series of steps to 74 USgpm, 157 USgpm and finally to 240 USgpm at 250 minutes after the start of pumping.

cont'd... 3

Pumping continued at a rate of 240 USgpm until the test was terminated at the end of the 24 hours.

The performance of the well during the test may be summarized as follows:

Duration of pumping (minutes)	Pumping Rate (USgpm)	Drawdown (ft)	Specific Capacity (USgpm/ft. of drawdown)
0 to 25	51	4.67	10.92
25 to 50	74	4.97	14.89
50 to 350	157	10.87	14.44
350 to 1440	240	17.41	13.78

Other than for the initial pumping rate the well performs in a normal way with a decrease in specific capacity with an increased pumping rate. The fact that the specific capactty increases for a corresponding increase in pumping rate near the start of pumping may be related to well development; that is, the initial pumping may serve to stabilize the natural pack around the well screen.

The transmissibility of the aquifer (that is, the capability of the aquifer to yield water to wells constructed in it), calculated from recovery data is 1.4×10^5 US gal. per day per ft. of aquifer width. This is moderately high and indicates that better well performance should be possible. The plot of the drawdown data shows that at each increased rate of pumping the water level draws down quite rapidly but becomes stable quite quickly. This fits in with the fairly high transmissibity indicated. It would be a mistake however, to attempt to draw too many conclusions from only the recovery data following pumping of a single well. Since drilling did not reach the bottom of the aquifer, it is quite likely that apparent well inefficiency is a result of well loss due to partial penetration. Any further drilling in this aquifer should be continued to the bottom.

Calculated in the normal way, by assuming use of 70% of the available drawdown and by using the specific capacity obtained from pump testing, the capacity of the well is in the order of 650 US gpm. This is more than twice the rate at which pump testing was carried out and if future demand requires the well to be used in excess of 400 US gpm additional pump testing at a higher rate should be carried out to assess well and aquifer response to the increased rate. We understand

cont'd

Can Test ltd.

1650 PANDORA STREET, VANCOUVER, B.C. V5L 1L6 • TELEPHONE 254-7278 • TELEX 04-54210

Report On ANALYSIS OF WATER SAMPLES File No. 2913D

Report No.

Reported To Pacific Hydrology Consultants Ltd. P.O. #

1401 West Broadway Date Nov.14/79

Vancouver, B. C. V6H 1H6

Attention:

We have tested the samples of water submitted by Aqua-Flo Testing and Equipment Ltd. on October 18, 1979, and report as follows:-

SAMPLE IDENTIFICATION

The sample was submitted in a plastic bottle labelled:-

SOAMES POINT WATER WORKS
10/17/79
E. LIVINGSTON
TIME OF TEST
0900-1300 MIN

METHOD OF TESTING

The analysis was carried out in accordance with procedures described in "Standard Methods for the Examination of Water and Wastewater", (14th Edition), published by the American Public Health Association - 1975.

RESULTS OF TESTING

See Page 2.

REMARKS

The water represented by the sample submitted can be characterized as a moderately soft water, moderate with respect to dissolved mineralization. For all parameters tested, the sample met the limits set by the Canadian Drinking Water Standards and Objectives, 1968, with the exception of dissolved phosphates.

Phosphates are limited for aesthetic reasons, and are not considered a health hazard.

File No: 2913D
Page No: 2
Date: Nov.14/79

RESULTS OF TESTING

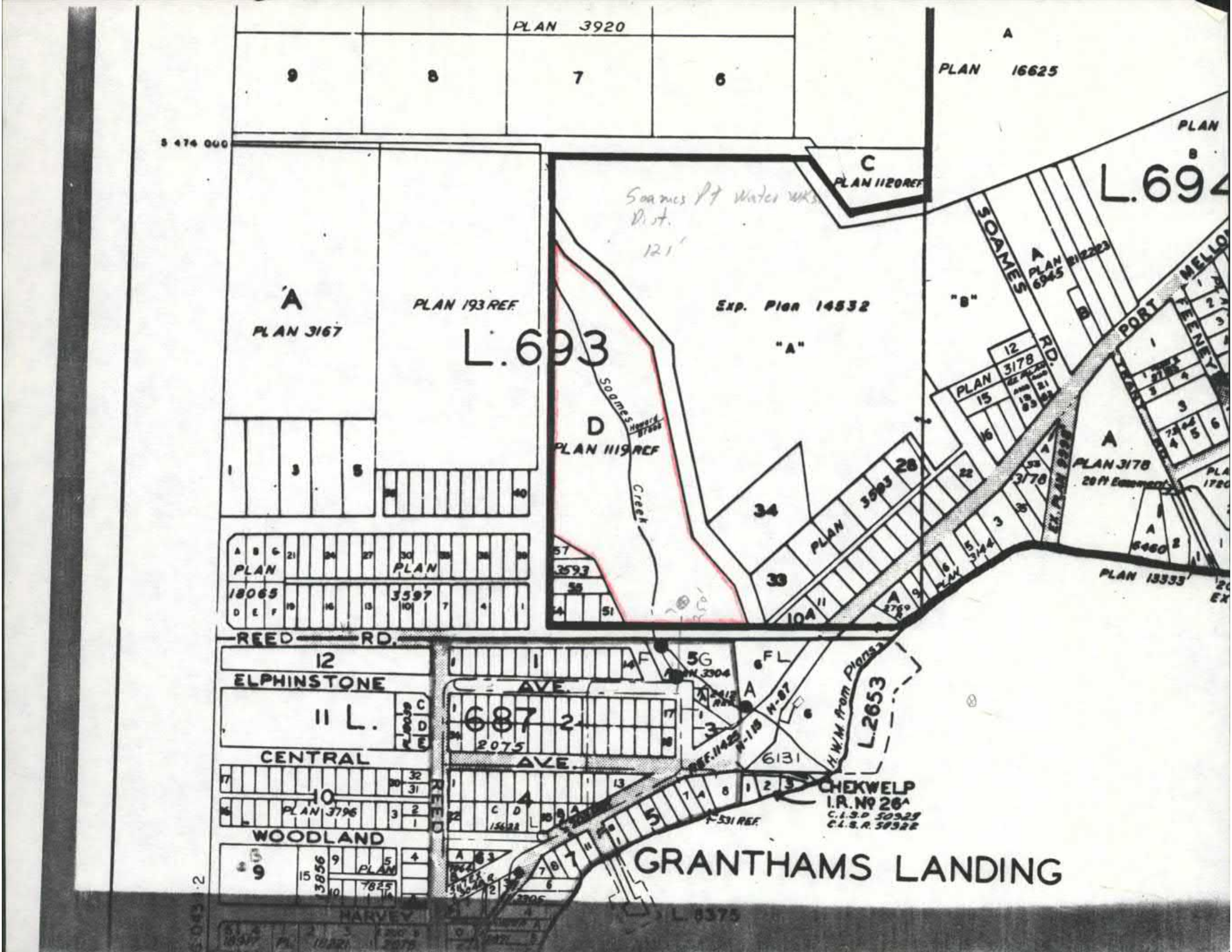
TEST		Sample Identification Soams Point
Physical Tests		
pH		7.60
Conductance (umhos/cm)		111.
Color (CU)		L 5.
Turbidity (JTU)		0.18
Total Dissolved Solids (mg/L)		110.
Total Suspended Solids (mg/L)		L 0.2
Dissolved Anions (mg/L)		
Alkalinity		
Bicarbonate	HCO_3	50.0
Carbonate	CO_3	Nil
Chloride	Cl	2.0
Sulfate	SO_4	L 5.
Nitrate & Nitrite	N	0.078
Phosphate	PO_4	0.31
Fluoride	F	0.098
Silica	SiO_2	40.1
Dissolved Cations (mg/L)		
Total Hardness	$CaCO_3$	34.1
Calcium	Ca	6.37
Magnesium	Mg	4.43
Sodium	Na	5.50
Potassium	K	2.28
Iron	Fe	L 0.030
Manganese	Mn	L 0.003
Cadmium	Cd	L 0.001
Copper	Cu	0.002
Lead	Pb	L 0.001
Zinc	Zn	L 0.001
Others (mg/L)		
Total Iron	Fe	0.049
Total Manganese	Mn	L 0.003

L - less than

mg/L - milligrams per litre (or parts per million for drinking water)

Judi M. Mitchell, B.Sc.
Chemist

JMM:vb


PLAN 3920
9
8
7
6
A
PLAN 16625
PLAN
L.694
C
PLAN 1120 REF
Soames Pt Water Wks Dist.
121'
SOAMES
A
PLAN 6945
"B"
RD.
PORT
MELLON
KEENEY
A
PLAN 193 REF
PLAN 3167
L.693
Exp. Plan 14832
"A"
D
PLAN 1119 REF
Creek
PLAN 3178
20 ft Easement
A
6460
PLAN 13333
PLAN 3593
PLAN 18065
PLAN 3597
REED RD.
12
ELPHINSTONE
11 L.
CENTRAL
10
PLAN 3796
WOODLAND
9
PLAN 7825
HARVEY
687
2075
AVE.
4
6131
H.W.M. from Plan 53
L.2653
CHEKWELP
I.R. No 26A
C.L.S.D. 509.28
C.L.S.R. 509.22
531 REF.
GRANTHAMS LANDING
L.8375

92 G/6 092G043213 PID 015972356 Sechelt / Gibsons Phonsi (1)

WATER WELL RECORD

WTN 65967

DEPT. OF ENVIRONMENT, WATER RESOURCES SERVICE, WATER INVESTIGATIONS BRANCH VICTORIA, BRITISH COLUMBIA

LEGAL DESCRIPTION: LOT RKD SEC. ____ TP. ____ R. ____ D.L. 693 LAND DISTRICT New Westminstr PLAN ____

DESCRIPTIVE LOCATION ____ LICENCE NO. ____ DATE ____

Z 10 WELL NO. 9

4641352 E

5476368 N

Z X Y NO.

NAT. TOPO. SHEET NO. 92 G/6

OWNER'S NAME: Scames Point Water Works Dist. ADDRESS Granthams Landing, B.C., VON-1X0

DRILLER'S NAME Rural Well Drilling ADDRESS Surrey DATE COMPLETED 10-17-79

DEPTH 121' ELEVATION OF ____ ☐ ESTIMATED ☐ SURVEYED CASING DIAM. 10" LENGTH 20'

METHOD OF CONSTRUCTION air rotary CASING DIAM 8" LENGTH ____

SCREEN LOCATION 106'-121' SCREEN ☑ SIZE 0.050" LENGTH 15 TYPE Johnsons SS

SANITARY SEAL YES ☐ NO ☐ SCREEN ☐ SIZE ____ LENGTH ____ TYPE ____

PERFORATED CASING ☐ LENGTH ____ PERFORATIONS FROM ____ TO ____

GRAVEL PACK ☐ LENGTH ____ DIAM. ____ SIZE GRAVEL, ETC. ____

DISTANCE TO WATER 31.5' ☐ ESTIMATED WATER LEVEL

FROM ____ ☐ MEASURED ELEVATION ____ ARTESIAN PRESSURE ____

DATE OF WATER LEVEL MEASUREMENT ____ WATER USE ____

PRODUCTION TEST SUMMARY

DATE ____

TEST BY Aqua-Flo Testing + Equipment

BAIL TEST ☐ PUMP TEST ☐ DURATION OF TEST 24 hrs.

RATE 51-24 USgpm DRAWDOWN 17.41'

WATER LEVEL AT COMPLETION OF TEST 51.39'

AVAILABLE DRAWDOWN ____ SPECIFIC CAPACITY ____

PERMEABILITY ____ STORAGE COEFF. ____

TRANSMISSIVITY ____

RECOMMENDED PUMPING RATE ____

RECOMMENDED PUMP SETTING ____

CHEMISTRY

TEST BY Can Test. DATE 10/17/79

TOTAL DISSOLVED SOLIDS 110 mg/l TEMPERATURE ____ °C pH 7.60 SILICA (SiO_2) 40.1 mg/l

CONDUCTANCE 111 μmhos/cm AT 25°C TOTAL IRON (Fe) 0.049 mg/l TOTAL HARDNESS ($CaCO_3$) 34.1 mg/l

TOTAL ALKALINITY ($CaCO_3$) ____ mg/l PHEN. ALKALINITY ($Ca CO_3$) ____ mg/l MANGANESE (Mn) <0.003 mg/l

COLOUR <5 ODOUR ____ TURBIDITY 0.18

ANIONS	mg/l	epm
CARBONATE (CO_3)	0	40-<5
BICARBONATE (HCO_3)	50.0	PO_4 - 0.31
SULPHATE (SO_4)		F - 0.008
CHLORIDE (Cl)	20	
$NO_2 + NO_3$ (NITROGEN)	0.078	
* TKN. (NITROGEN)		
PHOSPHORUS (P)		

CATIONS	mg/l	epm
CALCIUM (Ca)	6.37	Pb - <0.001
MAGNESIUM (Mg)	4.43	Zn - <0.001
SODIUM (Na)	5.5	
POTASSIUM (K)	2.28	
IRON (DISSOLVED)	<0.030	
	Cd - <0.001	
	Cu - 0.002	

* TKN = TOTAL KJELDAHL NITROGEN CHEMISTRY SITE NO. ____

NO_2 = NITRITE NO_3 = NITRATE

CHEMISTRY FIELD TESTS

TEST BY ____ DATE ____ EQUIPMENT USED 002617

LITHOLOGY

FROM	TO	DESCRIPTION
0	3'	sandy gravel
3'	7'	Fine dry sand.
7'	10'	boulders + compact gravel
10'	17'	compact silty sand + coarse gravel, Few boulders.
17'	26'	medium sand, compact.
26'	83'	compact sandy gravel with some silt, occasional boulders.
83'	94'	very compact silty coarse gravel.
94'	97'	compact clayey gravel, possibly till, very little water
97'	101'	loose coarse clean sandy gravel, very high yield water, cleared in minutes
101'	121'	very coarse clean sandy gravel, very productive water bearing capacity, coarse material heaves up pipe; yield by blowing greater than 100 gpm

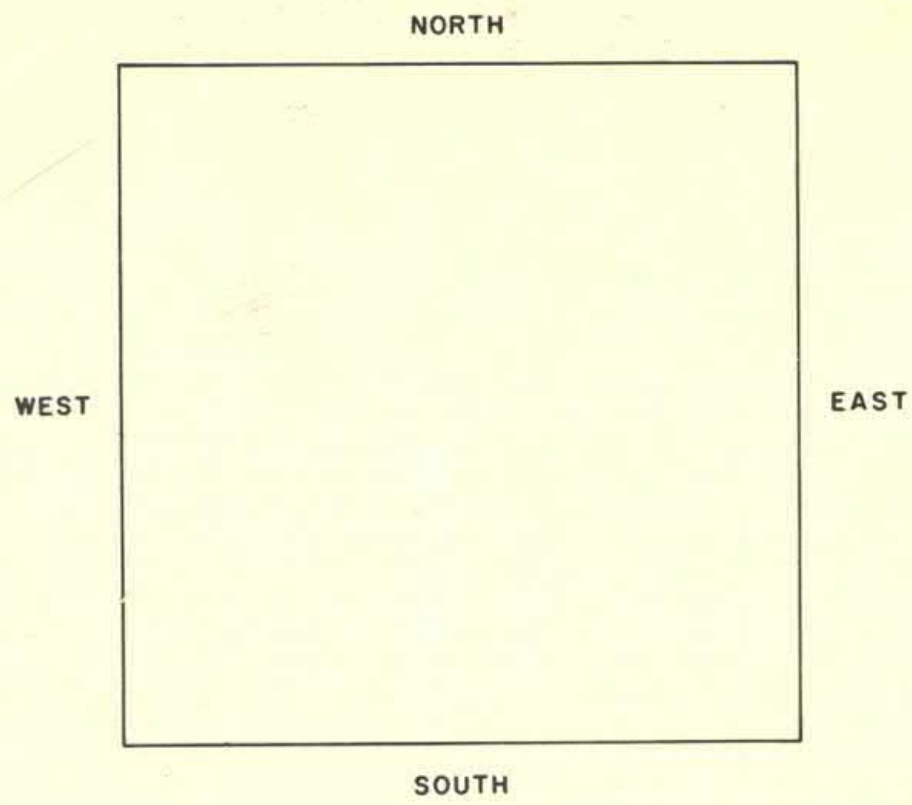
CONTENTS OF FOLDER

☑ DRILL LOG ☑ PUMP TEST DATA ☑ CHEMICAL ANALYSIS

☐ SIEVE ANALYSIS ☐ GEOPHYSICAL LOGS ☐ REPORT

OTHER ____

SOURCES OF INFORMATION Livingston Report #92 G/6-#11



CARD BY _____ DATE _____

ADDITIONAL DATA ADDED BY _____

REMARKS

located in Creek bed in Ravine - spring water. Good water - a little hard (unsure if this is actually well site) could see pump houses.

APPENDIX B – CHURCH ROAD WELL 3 AND SOAMES WELL 2020 GROUNDWATER INVESTIGATION REPORT

Associated Environmental

REPORT

Sunshine Coast Regional District

Groundwater Investigation
Phase 4a
Church Road Well 3 & Soames Well

SEPTEMBER 2020

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PAGE NO.

1 INTRODUCTION AND BACKGROUND

This memo has been prepared by Associated Environmental Consultants Inc. (Associated) on behalf of the Sunshine Coast Regional District (SCRD) to supplement the Technical Assessment Report (Associated 2019) submitted to the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) in 2019 to support a new groundwater use licence application for wells at the Church Road wellfield (Licence Application Tracking No. 100292061). This memo should be read in conjunction with the Technical Assessment Report.

The Technical Assessment Report was prepared following groundwater investigations in 2018 and 2019, including the drilling and aquifer testing of an 8" diameter production well at Church Road in 2019, known as Church Road Well 2. Following successful aquifer testing of this well, the licence application was submitted for two production wells at Church Road.

In June/July 2020 a second 8" production well, known as Church Road Well 3 was drilled and tested at the Church Road site to confirm the assumptions made in the Technical Assessment Report. In addition, following hydraulic modelling of SCRD's Soames water supply system, we found that extraction of groundwater from the SCRD's existing Soames Well can be increased to provide an additional quantity of water to the community when water demand exceeds the quantity available from the SCRD's Chapman Creek source, typically during the drier summer months. Consequently, Soames Well was tested in August 2020 to determine how much water can be extracted from this well without having a detrimental impact on the aquifer, existing water users, and the environment.

This memo presents the results of the drilling and aquifer testing in 2020 of Church Road Well 3 and the aquifer testing of Soames Well. It also combines the results of aquifer testing from all three production wells to determine the combined impact caused by simultaneous extraction of the three wells when pumped at their maximum pumping rates. The location of Church Road Well 3 and Soames Well, as well as all monitoring wells, are shown on Figure 1-1.

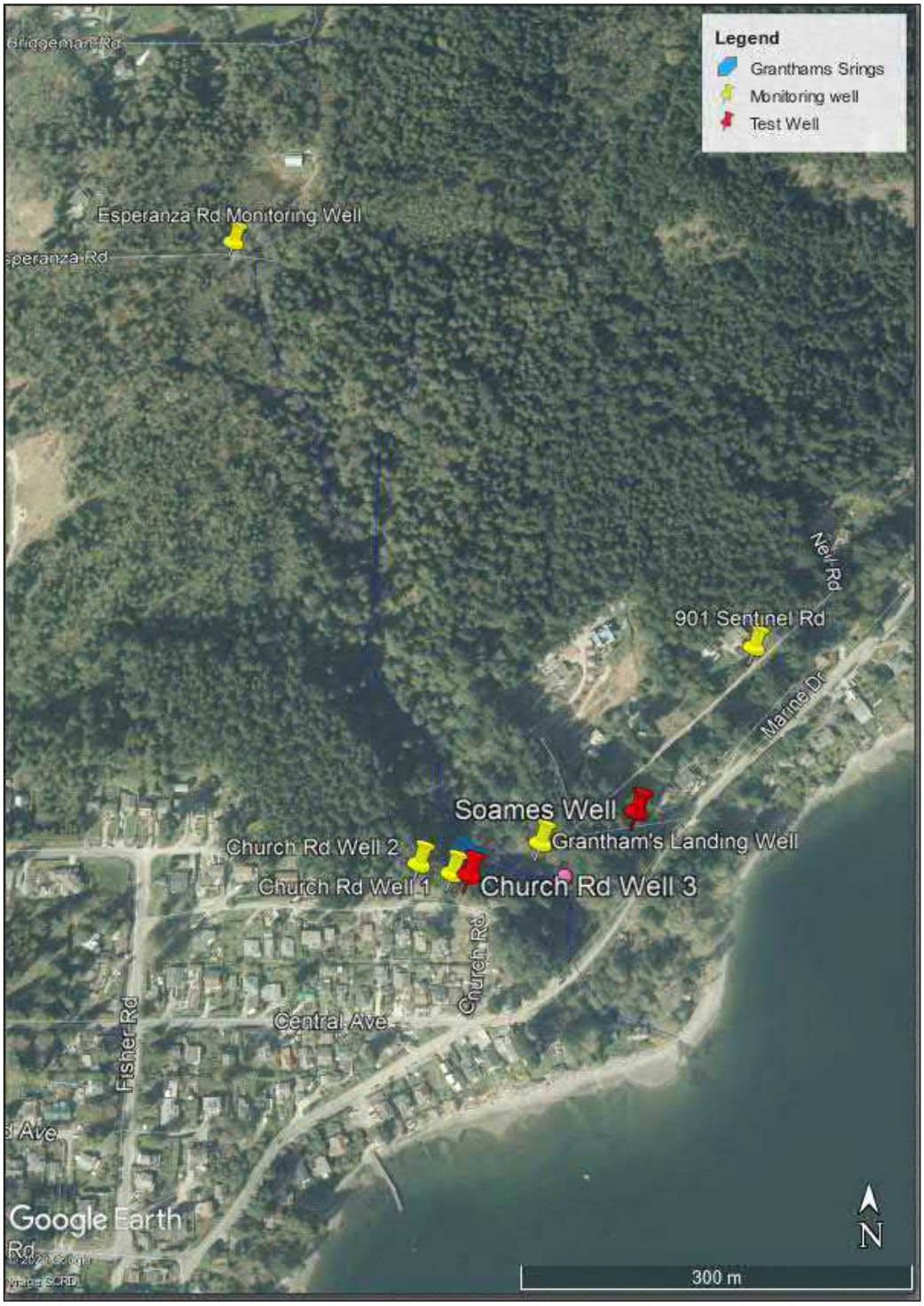


Figure 1-1
Well location Plan

2 CHURCH ROAD WELL 3

2.1 Well Construction – Church Road Well 3

Associated retained Drillwell Enterprises Ltd (Drillwell), operated by Registered Well Driller Cass Currie [WD 15052001] to drill and install an 8-inch diameter groundwater test well at the pre-determined site on the corner of Elphinstone Avenue and Church Road. Drilling commenced on 23 June 2020. Drillwell used a truck-mounted Foremost DR12 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 used 20-ft drill rods together with 8-inch casing, also 20 ft in length. As the well advanced, new sections of casing were 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 while the well was still being drilled within unsaturated material. Associated's Field Hydrogeologist, Steven Colebrook, M.Sc., was on site to supervise the drilling, collect samples, record lithology, sieve samples and design well construction. Marta Green, P.Geo., oversaw the field program.

Prior to advancing the 8-inch production casing, 12-inch casing was advanced to a depth of 18.6 m (61.0 ft). The 8-inch casing was then lowered into the hole and bentonite grout poured into the annulus via a tremie pipe between the 8 and 12-inch casing. The 12-inch casing was then removed to leave a 2-inch sanitary seal between the 8-inch casing and the ground material to meet the requirements of the Groundwater Protection Regulation (GWPR 2016) for water wells. The surface seal was installed into a till/clay layer to provide a sanitary seal around the 8-inch casing from the surface into the low permeability confining layer located above the target aquifer, preventing the creation of a preferential flow path down the side of the casing into the confined aquifer.

Drilling with production casing (8 inch) was then advanced until the base of the aquifer was identified at a depth of 57.9 m (190 ft). The final drilled depth of the well was 59.4 m (195 ft). Samples were collected at 1.5 m intervals in unsaturated material and at 0.6 m intervals within the aquifer, or whenever the lithology changed. 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. A total of 17 samples were sieved from a depth of 47.5 m bgl (156 ft bgl) to 57.9 m bgl (190 ft bgl). Based on the results of the sieve analysis, a telescopic 8-inch diameter bespoke Variperm screen was designed with an end cap at the base and a k-packer and riser above. A screen with a theoretical screen transmitting capacity of 29.5 L/s (467 USgpm) was designed for the well.

Following installation of the screen, the well was initially developed by mechanical dart bailing and removal of material from within the screen section. Development progressed to include airlifting and surging above the screen, airlifting within the screen, and airlift jetting throughout the screen interval. Development continued until virtually no sediment was being removed from the well during airlifting and the water ran clear; well development occurred for over 20 hours. The well was completed with 1.04 m (41 inches) casing stick-up to meet the GWPR guidelines and included a vermin and tamper proof well cap, and a well identifier number (WIN 61103).

Details of the final construction of Church Road Well 3 are provided in Table 2-1 and a well log is provided in Figure 2-1. The log shows the geological materials encountered match the geological stratigraphy detailed in Section 4.1 of the Technical Assessment Report: sand and gravel deposits (Capilano Sediments), overlying lower permeability till and

clay deposits (Vashon Till), overlying fining downwards layers of sand with some gravel (Pre-Vashon). Bedrock was not encountered during drilling.

During drilling, water was encountered at a depth of approximately 25.9 m bgl (85 ft bgl), increasing by 27.4 m bgl (90 ft bgl). This coincided with a change in geology to a light grey, loose, fine to medium sand. This depth is assumed to be the top of the aquifer. The base of the aquifer was at a depth of 57.9 m bgl where the geology changed from sand to a clay with minor sand and silt. The static water level in the well recorded on 22 July 2019 was 14.57 m bgl (15.61 m below top of well casing).

The geology encountered during drilling and the measured static water level are consistent with that observed in the previously drilled Church Road Well 1 and Church Road Well 2.

Table 2-1
Church Road Well 3 completion details

Specification	Details
Well ID Plate No.	61103
Date Constructed	10 July 2020
Approximate ground elevation (masl)	39
Drilled depth (m bgl)	59.4
Completed well depth (m bgl)	57.3
Casing diameter ID (m)	0.203
Static water level (m btoc)	15.6
Casing stick up (m)	1.04
Base of screen (m bgl)	57.3
Top of screen (m bgl)	48.2
Top of k-packer (m bgl)	47.5
Screen design (from base upwards)	8.5 m of 20-slot; 0.6 m of 15-slot
Theoretical screen transmitting capacity (L/s)	29.5 (467 USgpm)
Drillers estimated yield (L/s)	>31.5 (>500 USgpm)
Depth to top of confining layer (m bgl)	13.7
Depth to base of confining layer (m bgl)	24.4
Aquifer type	Confined sand and gravel
Aquifer thickness (m)	33.5

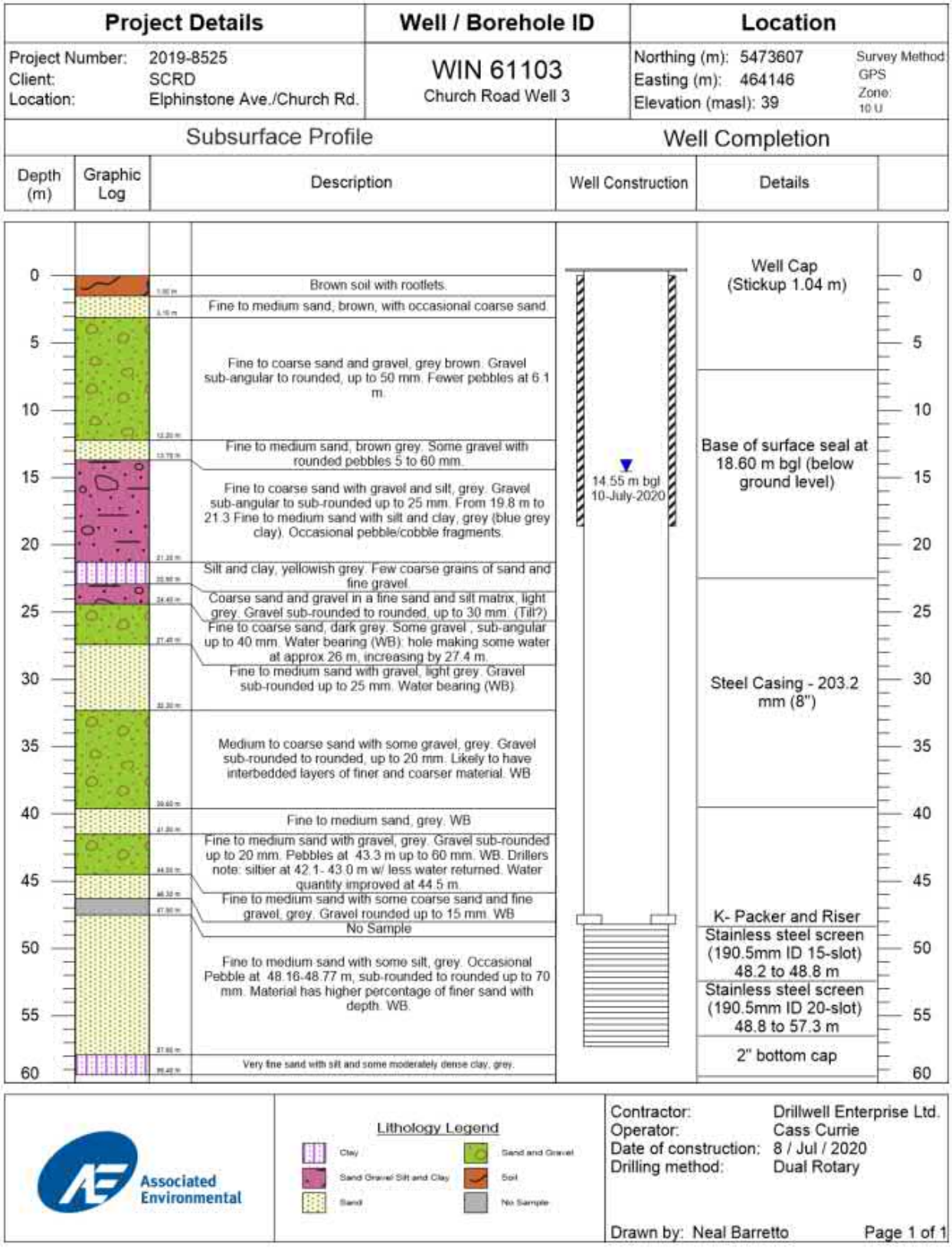


Figure 2-1
Well log for Church Road Well 3

3 ADEQUACY OF SUPPLY – CHURCH ROAD WELL 3

3.1 Pumping Test Methods

Following completion of well drilling, aquifer testing was undertaken to help determine aquifer characteristics, assess well interference on nearby wells, and determine the sustainable long-term pumping rate. Associated retained Monashee Aquifer Testing (Monashee) to supply, install, and operate the pump for the aquifer test. The test was conducted by registered well pump installers Max Schibli (WPI 05102905) and Ian Hames (WPI 19080601). A memo was provided to Monashee prior to the tests commencing. The memo set out the requirements of the pumping tests, 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 design of the pumping test had been discussed prior to the test commencing with Shirley Wang of FLNRORD, and was very similar to the test conducted on Church Road Well 2 undertaken in 2019, which was discussed prior to testing with Michele Lepitre of FLNRORD.

The tests commenced on 28 July 2020 and were completed on 31 July 2020. The preceding weather was sunny, which remained for the duration of the tests. Associated's Field Hydrogeologist was on site to oversee the testing, which included a 4-hour variable rate (step) test and a 48-hour constant rate test, with recovery monitoring following both types of test. Groundwater was allowed to recover to a minimum of 95% of it's static water level following the step test and prior to the constant rate test commencing from that well.

The submersible pump was installed to a depth of approximately 47 m, just above the top of the well screen and k-packer, providing a maximum available drawdown during testing of approximately 30 m. The well water discharge line was directed downgradient from the well into the Soames Creek valley to avoid water circulation and to prevent possible flooding of nearby property and roads. The pipe was extended past the downstream hydrometric monitoring location to allow any impacts on flow in Soames Creek due to pumping to be observed. The discharge water was not allowed to discharge directly into the creek.

The pumping flow rate was measured using an inline flow meter. Groundwater levels in the test well (Church Road Well 3) was measured with an electronic water level sounding tape at the frequency specified by the BC Ministry of Environment (2008) and a HOBO™ pressure transducer datalogger installed within a sounding tube. Nearby observation monitoring wells had previously been identified and, following agreement from the owners, these wells were also monitored as part of the pumping tests using, in most cases, HOBO™ pressure transducer dataloggers with manual measurements taken using either an electronic water level sounding tape or an acoustic sounder.

During the pumping tests, water quality field parameters (pH, temperature, conductivity, total dissolved solids) were monitored to observe for changes in chemistry. Water quality was also monitored within the creek, including for dissolved oxygen to ensure the discharge water was not having a detrimental impact once it made its way into the creek.

Table 3-1 provides a summary of the specifications of the aquifer pumping tests from Church Road Well 3.

Table 3-1
Church Road Well 3 pumping tests specifications

Step Test: 28 July 2020, started at 08:00		
Step 1	Rate (L/s)	12.6 (200 USgpm)
	Duration (min)	60
Step 2	Rate (L/s)	18.9 (300 USgpm)
	Duration (min)	60
Step 3	Rate (L/s)	25.2 (400 USgpm)
	Duration (min)	60
Step 4	Rate (L/s)	31.5 (500 USgpm)
	Duration (min)	60
Constant Rate Test: 28 July 2020, started at 14:00		
	Rate (L/s)	29.0 (460 USgpm)
	Duration (hours)	48

The step test was designed to assess the specific capacity of the well at various discharge rates to help determine the optimum rate at which to run the constant rate test.

Data from the constant rate pumping test were analyzed following the Guidelines for Evaluating Long-term Well Capacity for a Certification of Public Convenience and Necessity (CPCN) (MOE 2007). This method extrapolates drawdown in pumping wells and observation wells during pumping to 100 days[1] 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

Well interference on other wells plus factors such as well screen location, pump location, and sea level are taken into account when determining the available drawdown in the well.

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

3.2 Pumping Test Results and Discussion

3.2.1 Step Tests

Table 3-2 outlines the results of the step tests for Church Road Well 3. The water level at the start of the test was 16.28 metres below top of casing (mbtoc) (24.69 masl).

Table 3-2
Church Road Well 2 step test results

Step	Duration (mins)	Pumping Rate (m^3/d)	Drawdown (m)	Specific Capacity (m^3/day/m)
1	60	1090 (12.6 L/s)	5.04	216.3
2	60	1,635 (18.9 L/s)	7.81	209.4
3	60	2,180 (25.2 L/s)	10.48	208.0
4	60	2,725 (31.5 L/s)	12.79	213.1

Step testing commenced at 08:00 on 28 July 2020; each step was conducted for 60 minutes with a total of four steps. During each step an initial rapid drawdown in water level was recorded followed by relatively static water levels (Figure 3-1). Water levels recovered rapidly following the end of the step test with 90% recovery achieved within 15 minutes, and 95% recovery within 25 minutes. The results of the step test show a specific capacity of approximately 210 $m^3/d/m$ throughout the test, the final step was slightly higher than the two middle steps at 213 $m^3/d/m$, indicating no drop in well efficiency, even though the pumping rate was above the manufacturers theoretical screening capacity of the well screen installed. This increase in specific capacity may reflect additional well development caused by the step tests.

A rate of 29.0 L/s (460 USgpm) was selected for the constant rate test. This rate was chosen based on the drawdown observed during the step tests and because this rate is just below the manufacturers theoretical transmitting capacity of the well screen (467 USgpm).

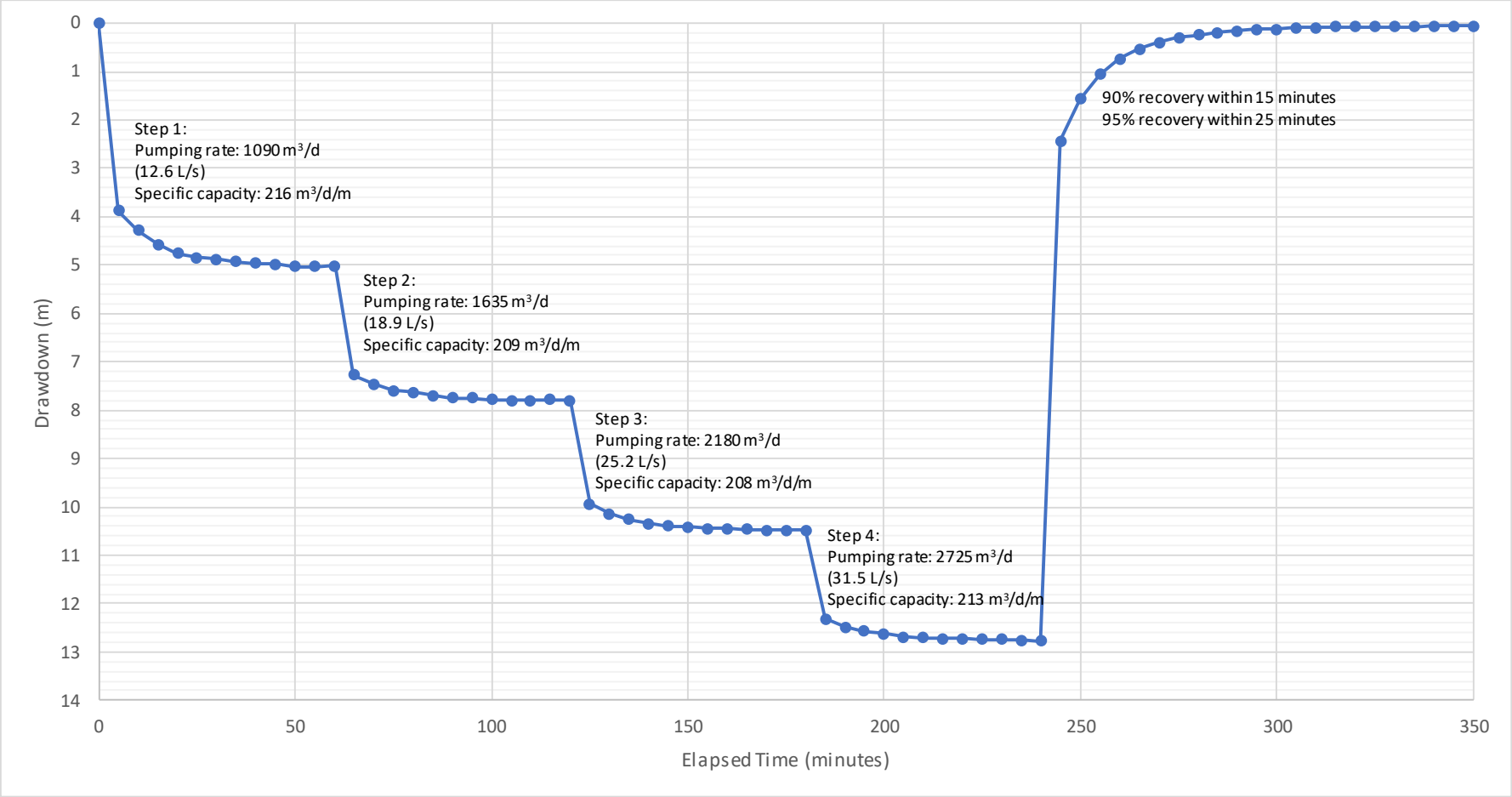


Figure 3-1
Results of the Church Road Well 3 step test

3.2.2 Constant Rate Test

The constant rate test commenced at 14:00 on 28 July 2020 and was maintained at a rate of 29.0 L/s (460 USgpm), throughout the test. The water level at the start of the test was 15.56 mbtoc (24.58 masl). The test was conducted for a period of 48 hours. The weather preceding and during the test was sunny. During the test water levels were monitored in the test well and six observation monitoring wells, details for each observation well are provided in Table 3-3 and their location shown on Figure 1-1.

Table 3-3
Monitoring well details

Common Well Name	Well ID	Owner	Datum (m asl)	Distance from Church Road Well 3 (m)	Static Water Level	Monitoring Method
Church Road Well 1	WIN 54928	SCRD	40.04 [1]	9	15.43mbtoc (24.61 masl)	Manual dip measurements
Church Road Well 2	WIN 53545	SCRD	40.98 [1]	38	16.55 mbtoc (24.43 masl)	Data logger and manual dip measurements
Granthams Landing Well	WTN 78231	SCRD	18.37 [2]	65	Flowing artesian	Data logger and pressure gauge readings
Soames Well	WTN 65967	SCRD	31.82 [3]	145	10.19 mbtoc (21.63 masl)	Manual dip measurements
901 Sentinel Road	WTN 70718	Private	45.5 [4]	315	24.26 mbtoc (21.2 masl)	Data logger and manual dip measurements
Esperanza Road MW (MW97-2)	-	SCRD	120.5 [4]	630	93.61 mbtoc (26.9 masl)	Manual dip measurements

Notes:
[1] Top of casing
[2] Ground level
[3] Edge of manhole cover rim (downgradient side)
[4] Approximate from SCRD Lidar data (1 m resolution)

During the constant rate test, no extraction occurred from the Granthams Landing Well and Soames Well Both of these sources were shut over 24 hrs before the start of the constant rate test.

At the end of the constant rate test, drawdown in the well was 12.08 m giving the well a specific capacity of 2.40 L/s/m. Following the end of the constant rate test, well water level recovered to 90% of the static water level within 15 minutes and 95% within 25 minutes.

A water sample was collected from the well towards the end of the constant rate pumping test and sent for potable water analysis at accredited CARO Laboratories. The results show no exceedances of the Guidelines for Canadian Drinking Water Quality (GCDWQ) (GC 2020) for any of the parameters tested. Water quality results are provided in Appendix A.

No significant difference was observed in the creek water quality upstream and downstream of the pumping test discharge. The largest difference observed was a reduction in the specific conductance of the water which measured approximately 210 µS/cm in the creek upstream of the discharge and 180 µS/cm 10 m downstream of the discharge. Dissolved oxygen was typically 1.0-0.5 mg/L lower downstream of the discharge but always above 10 mg/L, despite water from the well having a dissolved oxygen content of approximately 4.5 mg/L. This indicates that sufficient aeration was occurring prior to the discharge water entering the creek.

3.2.3 Aquifer Characteristics

Aquifer characteristics, hydraulic conductivity (K), transmissivity (T) and storativity (S) were calculated from the results of the pumping test. T and S were calculated using the Cooper-Jacob modification of Theis method using time-drawdown and recovery data from the production well and observation wells: Church Road Well 1, Church Road Well 2, Soames Well, and 901 Sentinel Road Well. Drawdown plots are provided in Appendix B. The drawdown data suggest a recharge boundary is reached after approximately 30-40 minutes of pumping. This is similar to the drawdown observed during previous pumping tests of wells in this aquifer and is discussed in further detail in Section 6.2.4 of the Technical Assessment Report (Associated 2019). Consequently, the early time drawdown data are more likely to be indicative of the aquifer characteristics. The transmissivity, hydraulic conductivity and storativity values calculated from the test data are presented in Table 3-4. These are within the range of values calculated from the Church Road Well 2 pumping test undertaken in 2019 and described in the Technical Assessment Report and for some of the wells in the area studied by Waterline (Waterline 2013). The hydraulic conductivity values match the book-values for clean sand (Freeze and Cherry 1979).

Table 3-4
Calculated aquifer characteristics

Method Used	Well used in Calculation	Transmissivity (m^2/d)	Hydraulic Conductivity (m/d) [1]	Storativity
Time-drawdown	Church Road Well 3	161	4.8	-
Time-drawdown	Church Road Well 2	255	7.6	0.0001
Time-drawdown	Church Road Well 1	275	8.2	0.007
Residual-drawdown	Church Rd Well 2	206	6.1	-
Time-recovery	Church Rd Well 2	218	6.5	-
	Average	**223**	**6.6**	**0.004**
	Median	**206**	**6.5**	**0.004**

Notes:
[1] Based on an aquifer thickness of 33.5 m.

3.2.4 Well Interference

Six observation wells were monitored during the Church Road Well 3 48-hour constant rate test. The impacts noted on each well are presented in Table 3-5. Figures showing the drawdown in each monitoring well during the test and extrapolated to 100 days and 184 days are provided in Appendix B. The 184-day drawdown values correspond to a possible 'worst-case' drought and was the period used in drought demand modelling for the SCRD by Integrated

Sustainability (2018). We noted that historical data (since 2012) shows that there has not been a period of water restrictions lasting longer than 100 days (Integrated Sustainability 2018), indicating that 184 is quite conservative, and 100 days may be more realistic.

Table 3-5
Drawdown in monitoring wells during Church Road Well 3 constant rate test

Observation Well	Distance from Church Rd Well 3 (m)	Water Level start constant rate test (mbdatum)	Drawdown at end of test (m)	Extrapolated 100-day drawdown (m)	Extrapolated 184-day drawdown (m)	Water level recovery
Church Road Well 1	9	15.43	2.55	2.85	2.90	90% after 40 minutes
Church Road Well 2	38	16.55	3.63	4.00	4.05	90% after 35 minutes
Granthams Landing Well [1]	65	4.26 [2]	0.8	1.03	1.06	85% after three hours
Soames Well	145	10.19	0.48	0.71	0.74	80% after three hours
901 Sentinel Rd	315	24.26	0.38	0.68	0.72	80% after three hours
Esperanza Rd MW	630	93.61	0	-	-	-

Notes:
[1] Granthams Landing Well is an artesian flowing well, which also has water flowing up the side of the casing, consequently the data obtained is of limited value. The pressure recorded and the reduction in pressure recorded during the test would have been greater if there was no leakage up the outside of the well casing.
[2] Artesian pressure (m above datum).

3.2.4.1 Discussion

The drawdown results of the pumping test were as anticipated and are similar to the results found during the 2019 pumping test of Church Road Well 2 with minor impact to aquifer water levels except in the immediate vicinity of the pumped well.

The exception is the drawdown noted in Church Road Well 1 compared to Church Road Well 2. Church Road Well 1 is located just 9 m from test well Church Road Well 3, however, drawdown in Church Road Well 1 was over 1 m less than that observed in Church Road Well 2 which is located 38 m away from the test well. This is likely a result of the different location of the well screens of these two wells in the aquifer. The well screen in Church Road Well 1 is located in the middle of the aquifer while the well screen for Church Road Well 2 is located at the bottom of the aquifer (the same as Church Road Well 3). A layer of finer grained material was noted during drilling of Church Road Well 3 and the location of this layer approximately corresponds to the location of the screen in Church Road Well 1. Based on this, it's reasonable to assume that the heterogeneity of the aquifer material with lower permeability layer(s) subdued the impact of pumping on Church Road Well 1. This aquifer heterogeneity is likely to have also subdued the impact observed in the other wells that are screened in the upper portion of the aquifer – Granthams Landing Well, Soames Well and 901 Sentinel Road Well.

In summary, aquifer drawdown as a result of pumping is minimal and will not have a detrimental impact on existing groundwater users.

3.2.5 Impact on Soames Creek

As described in sections 2.3 and 7.3 of the Technical Assessment Report (Associated 2019) and detailed in an environmental flow needs memo (Associated 2020), a temporary hydrometric station (herein referred to as D/S Soames Hydrometric Station) was installed on Soames Creek to measure streamflow downstream of all discharges into the creek. The hydrometric station comprises a staff gauge plate and stilling well installed with water level data logger. Field measurements have been taken of creek streamflow during 2020 and a preliminary stage-discharge relationship and flow rating curve has been developed based on creek stage and measured discharge. The new rating curve had to be developed for 2020 following damage to the hydrometric station in November 2019 and a change in creek morphology over the 2019/2020 winter.

During the pumping tests, creek flow was monitored to determine the impact on creek streamflow due to pumping from Church Road Well 3. Figure 3-2 presents the creek streamflow data prior to, during and after the pumping tests.

Figure 3-2 illustrates how pumping from Church Road Well 3 reduces streamflow in the creek. It should be noted that prior to the start of the tests, flow from the artesian flowing Granthams Landing Well to Granthams Pumphouse (from where it overflows into the creek) was stopped, so the only flow from this well discharging to the creek was from the flow emerging around the outside of the well casing. In other words, no flow from inside of the well casing was discharging to the creek via the Granthams Landing pumphouse during the pumping tests. This resulted in a reduction in streamflow in the creek of approximately 2.5 L/s. Following the start of the constant rate test, a further reduction in creek streamflow is recorded. At the start of the constant rate test creek streamflow was approximately 12 L/s but after 2 days of pumping the streamflow had reduced to approximately 8 L/s, a decrease of 4 L/s.

The data indicates that streamflow in the creek was higher in the days prior to the pumping test than it was in the days following the test. July was a very dry month with just 29 mm rain recorded at Gower Point rainfall station (4.7 km to the south-west of the wells), of which 27.6 mm was recorded before 12 July 2020. No additional rainfall was recorded until 05 August 2020. The reduction in flow observed before and after the pumping test could therefore be reflecting a natural seasonal decline in creek streamflow so the 4 L/s reduction in creek streamflow recorded during the pumping test may not all be attributed to the groundwater extraction. Streamflow recorded after the test are similar to the low flows observed in 2019.

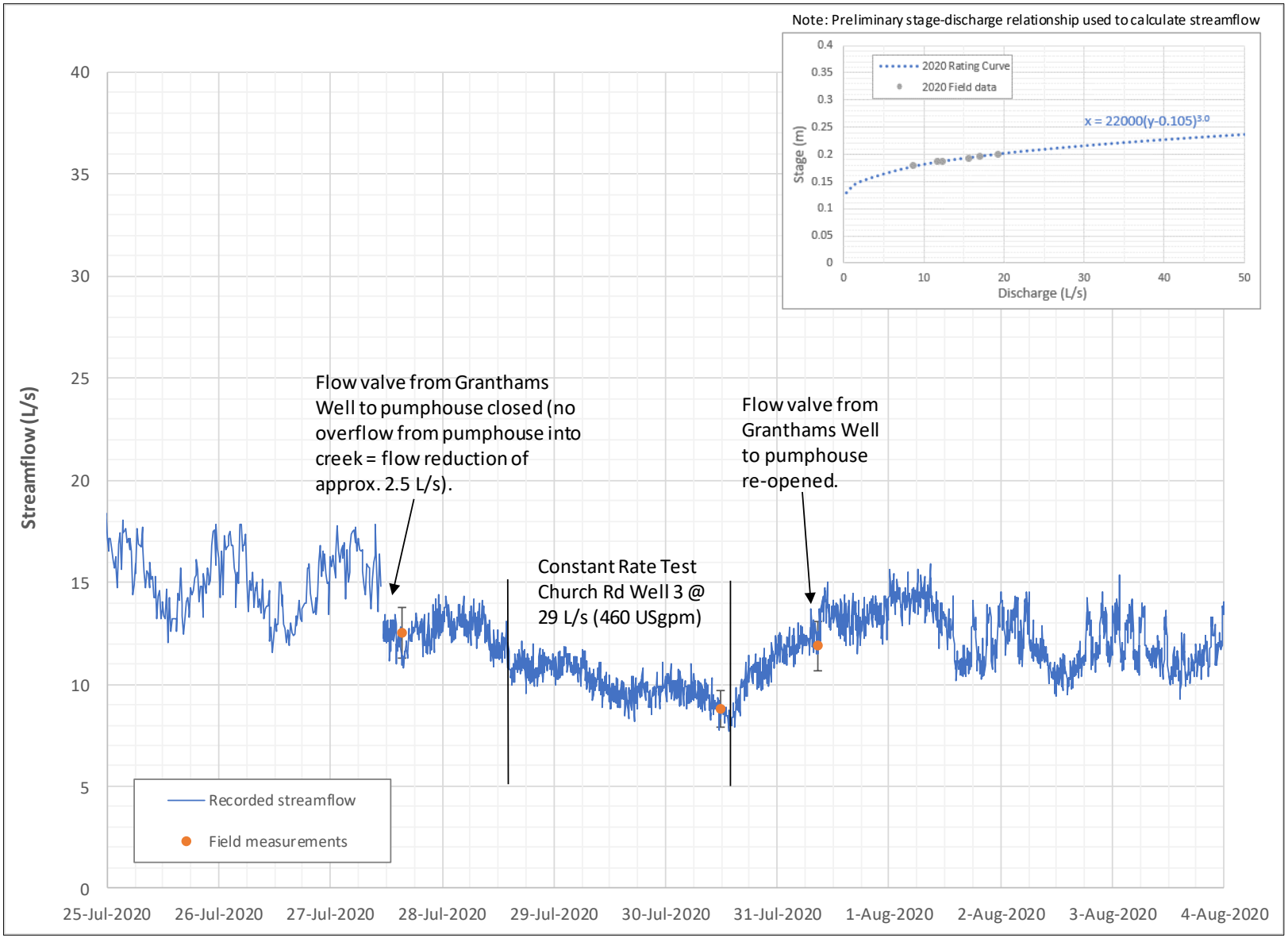


Figure 3-2
Soames Creek streamflow during Church Road Well 3 constant rate test

In addition to the continuous flow measurements recorded at the D/S Soames Creek hydrometric station, visual observations were made at the springheads, and field flow measurements were taken in the most southerly channel draining the springs. Based on these, the flow at the springheads had reduced and the head of the springs had moved a short distance downstream (Figure 3-3). Current meter flow gauging (using a Swoffer 2100 flow meter) on the southern channel, approximately 20 m downstream of the springhead also indicated a reduction in flow (from approximately 4 L/s before the pumping test started to 1.4 L/s near the end of the pumping test); although caution should be given to this data due to the low flow, narrow stream channel, and shallow depth of water, potentially decreasing the gauging accuracy. This reduction in flow is however relatively consistent with the reduction in flow recorded by the hydrometric station

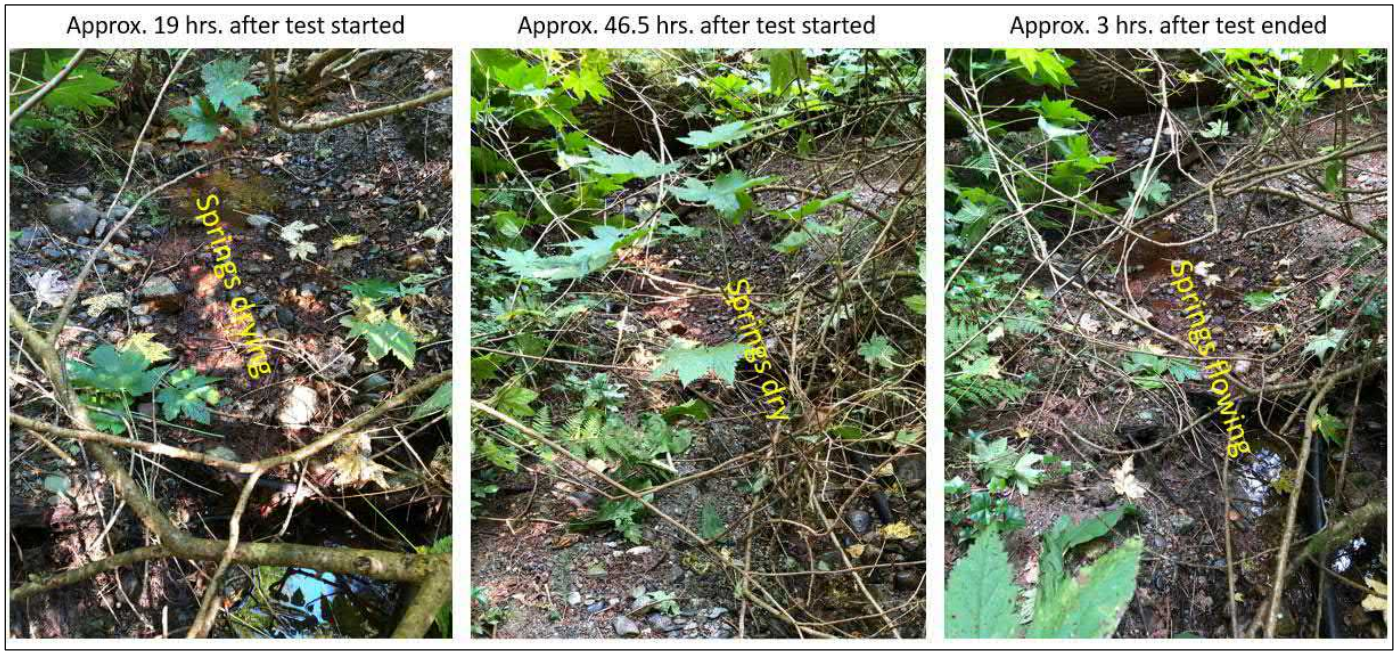
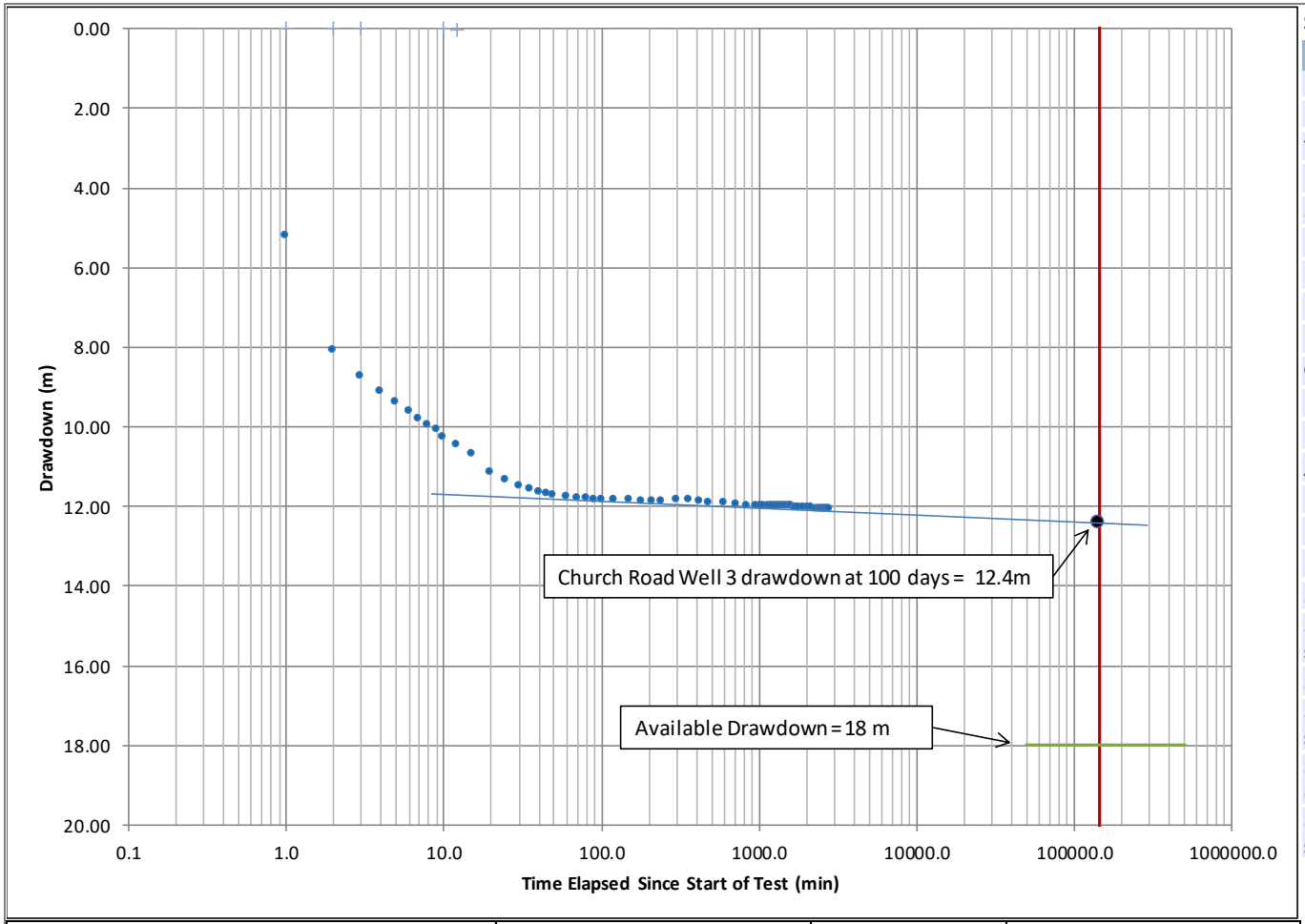


Figure 3-3
Visual spring observations

3.2.6 Long Term Sustainable Well Yield

The calculated sustainable long-term pumping rate for Church Road Well 3 using the CPCN 100-day method (MOE 2007) is 29.5 L/s (467.3 USgpm). Figure 3-4 shows the extrapolated drawdown curve on a linear-logarithmic chart and provides a summary of the calculation inputs and resulting 100-day sustainable well yield.



Summary Table

	61103
PUMPING SPECIFICATIONS	----------
Pumping rate (L/s)	29.01
Test duration (hours)	48
Depth of pump intake (mbtoc)	0.00
Static water level (mbtoc)	15.50
Depth to top of screen (mbtoc)	48.20
Depth of well (mbgl)	57.30
RECOVERY	----------
Length of recovery (min)	480
% recovered	99
CPCN INPUTS	----------
Pumping rate (L/s)	29.01
Available drawdown (m)	18.00
Drawdown at 100 days (m)	12.4
CPCN OUTPUTS	----------
100 day specific capacity (L/s/m)	2.340
Sustainable pumping rate (L/s)	42.11
Sustainable pumping rate with BC safety factor of 30% (L/s)	29.48
Sustainable pumping rate (L/d)	3,638,415
Sustainable pumping ate with BC safety factor of 30% (L/d)	2,546,891
Sustainable pumping rate (USGPM)	668
Sustainable pumping rate with BC safety factor of 30% (USGPM)	467.3

Associated Environmental	PROJECT: 2019-8525 DATE: 10-Sep-20 DRAWN BY: SC	PREPARED FOR	FIGURE 3-4
		SCRD	Drawdown extrapolated to 100 days 61103

Figure 3-4
Church Road Well 3: 100-day sustainable well yield

In determining the 18 m of available drawdown (i.e., which affects the 100-day sustainable well yield), the following was considered:

1. Although the well is technically confined under non-pumping conditions, pumping of the aquifer over time will locally at the well draw the water below the confining unit, therefore, we calculated available drawdown assuming it is an unconfined aquifer. Available drawdown in an unconfined aquifer is the distance from the static water level to the top of the screen. The static groundwater level is 24.5 masl. To maintain the aquifer water level above sea level and therefore maintain a hydraulic gradient to the ocean, we used a minimum allowable groundwater level of 2 masl, rather than using the elevation of the top of the screen (at an elevation of -8.5 masl). This equals 22.5 m of available drawdown.
2. Next, we extended the well interference observed on nearby wells during constant rate pumping tests to 100 days. Using the calculated aquifer characteristics and the extrapolated drawdown curves, we added 4 m of additional drawdown which could be expected from Church Road Well 2 pumping at a rate of 25.4 L/s (403 USgpm), plus 0.5 m well interference from Soames Well pumping at a rate of 16.0 L/s (254 USgpm) continuously.

The following assumptions were made in determining the 100-day sustainable well yield:

1. No no-flow boundary condition exists that will result in an increased rate of drawdown (no no-flow boundary conditions were observed during the pumping tests).
2. There is sufficient recharge to the aquifer that will allow water levels to return to typical high annual levels in winter. Aquifer recharge is discussed further in Sections 4.4.2 and 6.3 of the Technical Assessment Report (Associated 2019). As with most large groundwater supply projects, long-term monitoring of the aquifer water levels is recommended to confirm our assumptions. A detailed monitoring plan will be submitted separately.

As per the MOE 2007 guideline, wells should not be rated higher than the rate tested at; therefore, based on the results of the pumping test, we recommend that Church Road Well 3 be rated to operate at a maximum instantaneous pumping rate of 29.0 L/s (460 USgpm).

4 ADEQUACY OF SUPPLY – SOAMES WELL

4.1 Pumping Test Methods

Soames Well has been in operation by the SCRD and its predecessor Soames Point Waterworks District since 1979; however, no recent pumping tests have been conducted on the well. A constant rate pumping test was therefore undertaken to determine assess well interference on nearby wells and determine a sustainable long-term pumping rate. A step test was not conducted on this well as the maximum pumping capacity for the well was already known from existing use of this well. The maximum pumping rate and the rate at which the constant rate test was undertaken is 16.0 L/s (254 USgpm).

The test commenced on 13 August 2020 and was completed on 14 August 2020. The preceding weather was sunny, which remained for the duration of the tests. Associated's Field Hydrogeologist Tony Friesen, G.I.T. was on site to set up and conduct the testing, which consisted of a 24-hour constant rate test, with recovery monitoring to a minimum of 95% groundwater recovery.

The existing in-situ Soames Well pump was used to conduct the pumping test. The water was pumped from the well up to Soames Reservoir and allowed to overflow into 300 feet of 4" lay flat hose which ran down the valley side into the valley bottom of Soames Creek. The discharge water was not allowed to discharge directly into the creek but did eventually make its way into the creek. A smaller flow volume was also discharged from a 2" overflow pipe and was allowed to flow down the valley side into Soames Creek. Best practices and procedures to protect the environment and other receptors were followed during the pumping tests.

The pumping flow rate was measured using an inline flow meter. Groundwater level in the pumping well (Soames Well) was measured with an electronic water level sounding tape at the frequency specified by the BC Ministry of Environment[2]. Five nearby observation monitoring wells had previously been identified and, following agreement from the owners, these wells were also monitored as part of the pumping tests using HOBO™ pressure transducer dataloggers with manual measurements taken using an electronic water level sounding tape. Details for each observation well are provided in Table 4-1 and their location shown on Figure 1-1.

Data from the constant rate pumping test were analyzed following the Guidelines for Evaluating Long-term Well Capacity for a Certification of Public Convenience and Necessity (CPCN) (MOE 2007), as detailed in Section 3.1 for Church Road Well 3.

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

Table 4-1
Monitoring well details

Common Well Name	Well ID	Owner	Datum (masl)	Distance from Soames Well (m)	Static Water Level	Monitoring Method
Church Road Well 1	WIN 54928	SCRD	40.04 [1]	155	15.47mbtoc (24.57 masl)	Data logger (15 minute intervals) and manual dip measurements
Church Road Well 2	WIN 53545	SCRD	40.98 [1]	185	16.31 mbtoc (24.67 masl)	Data logger (15 minute intervals) and manual dip measurements
Church Road Well 3	WIN 61103	SCRD	40.14 [1]	150	15.60 mbtoc (24.54 masl)	Data logger (15 minute intervals) and manual dip measurements
Granthams Landing Well	WTN 78231	SCRD	18.37 [2]	85	Flowing artesian	Data logger (15 minute intervals)
901 Sentinel Road	WTN 70718	Private Well	45.5 [3]	180	24.35 mbtoc (21.2 masl)	Data logger (15 minute intervals) and manual dip measurements

Notes:
[1] Top of casing;
[2] Ground level;
[3] Approximate level from SCRD Lidar data (1 m resolution)

During the constant rate test, no extraction occurred from the Granthams Landing or Church Road wells.

4.2 Pumping Test Results and Discussion

The constant rate test commenced at 15:30 on 13 August 2020 and was maintained at a rate of 16.0 L/s (254 USgpm), throughout the test. The weather preceding and during the test was sunny. The well water level at the start of the test was 10.31 mbtoc (21.51 masl). The test was conducted for a period of 24 hours.

At the end of the constant rate test, drawdown in the well was 5.89 m giving the well a specific capacity of 2.71 L/s/m. Following the end of the constant rate test, well water level recovered to 90% of the static water level after 30 minutes and 95% after 45 minutes.

4.2.1 Well Interference

As detailed in Section 4-1 and Table 4-1, five observation wells were monitored during the Soames Well 24-hour constant rate test. The impacts noted on each well are presented in Table 4-2. Figures showing the drawdown in each monitoring well during the test and extrapolated to 100 days and 184 days are provided in Appendix C. The findings are discussed below in Section 4.2.1.1.

Table 4-2
Drawdown in monitoring wells during Soames Well constant rate test

Observation Well	Distance from Church Rd Well 3 (m)	Water Level start constant rate test (mbdatum)	Drawdown at end of test (m)	Extrapolated 100-day drawdown (m)	Extrapolated 184-day drawdown (m)	Water level recovery [3]
Church Road Well 1	155	15.47	0.19	0.31	0.33	70% after 105 minutes
Church Road Well 2	185	16.31	0.22	0.36	0.38	75% after 105 minutes
Church Road Well 3	150	15.60	0.25	0.40	0.42	75% after 105 minutes
Granthams Landing Well [1]	85	4.21 [2]	0.15	0.27	0.28	64% after 105 minutes
901 Sentinel Rd	180	24.35	0.65	1.05	1.10	70% after 90 minutes

Notes:
[1] Granthams Landing Well is an artesian flowing well, which also has water flowing up the side of the casing, consequently the data obtained is of limited value. The pressure recorded and the reduction in pressure recorded during the test would have been greater if there was no leakage up the outside of the well casing.
[2] Artesian pressure (m above datum).
[3] Water level recovery in the pumping well reached 90% after 30 minutes and 95% after 45 minutes.

4.2.1.1 Discussion

The drawdown data indicates that there is a minor impact on aquifer water levels as a result of pumping from Soames Well. The results do however show that there is a larger impact on water levels at 901 Sentinel Road than on other wells which are located a similar distance away or closer, i.e. the Church Road wells. This disparity could be explained by two scenarios:

1) Soames Well and 901 Sentinel Well are both constructed and screened in the top 7.5 metres of the aquifer, while the Church Road wells are constructed and screened deeper in the aquifer: Church Road Wells 2 and 3 fully penetrate the 33.5 m thick aquifer with screens set at the bottom (25-33.5 m below the top of the aquifer), while at Church Road Well 1 the screen is set approximately 18-22 m below the top of the aquifer. During drilling of Church Rd Well 3 a lower permeability siltier layer was encountered approximately 17.5-18.5 m below the top of the aquifer with a corresponding reduction in water produced during drilling (Figure 3-1). This lower permeability layer may be present throughout the area resulting in a layered aquifer. As Soames Well is completed in the top of the aquifer this may explain the more subdued response to pumping observed in the wells with screens located below this lower permeability layer (Church Road Wells 2 and 3) compared to those wells which are screened in the top of the aquifer (901 Sentinel Road).
2) A no-flow boundary has been reached to the north east (could be bedrock related to Soames Hill) which results in greater drawdown of water levels to the northeast. However, there is no evidence of this boundary in the drawdown data from any of the pumping tests undertaken, so the first scenario is considered the more likely.

In summary, the results show that aquifer drawdown as a result of pumping from Soames Well is minimal and is unlikely to have a detrimental impact on existing groundwater users.

4.2.2 Impact on Soames Creek

A pumping impact on Soames Creek could not be observed during the Soames Well pumping test as water from the test was discharged upstream of the hydrometric station via two discharge lines (Section 4.1). Consequently, an increase rather than reduction in flow was observed in the creek at the hydrometric station because of the pumping test. The results from the Church Road Well 2 and Church Road Well 3 pumping tests did show a reduction in creek flows as a result of groundwater extraction decreasing spring seepage, consequently it is anticipated that there would also be an impact on spring seepage due to pumping from Soames Well. However, Soames Well is located further from the springs (approximately 130 m away) than the Church Road wells (30 m away) and the pumping test rate was less so the impact on spring flow would not have been as large. In any case, for the purpose of the licence application a worst-case assumption has been made that extraction from the SCRD's wells will dry the springs up. Creek flow augmentation is proposed to mitigate this.

4.2.3 Long Term Sustainable Well Yield

The calculated sustainable long-term pumping rate for Soames Well using the CPCN 100-day method (MOE 2007) is 29.6 L/s (469.6 USgpm). Figure 4-1 shows the extrapolated drawdown curve on a linear-logarithmic chart and provides a summary of the calculation inputs and resulting 100-day sustainable well yield.

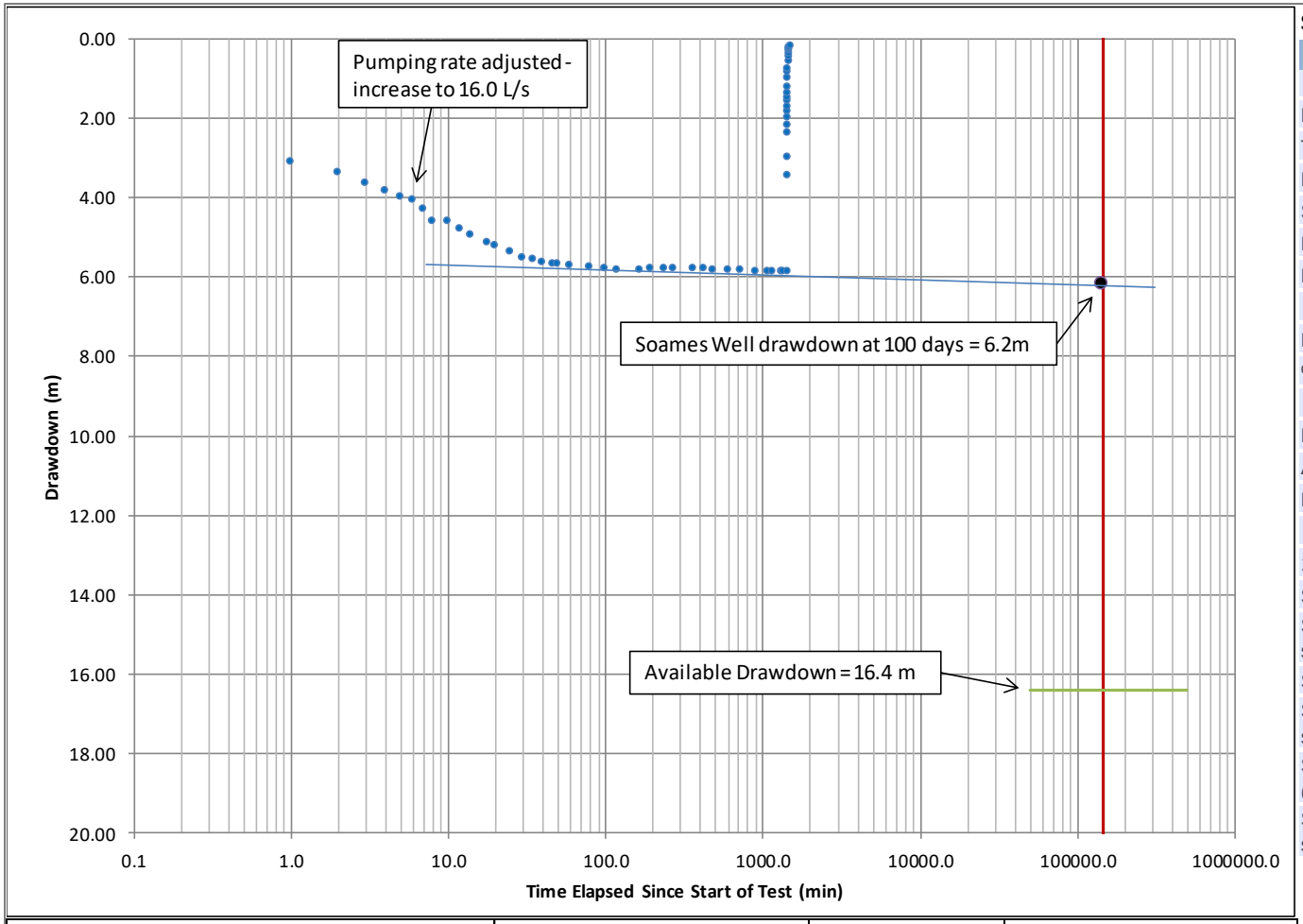
In determining the 16.4 m of available drawdown (i.e., which affects calculation of the 100-day sustainable well yield), the following was considered:

1. We calculated the available drawdown by comparing the static water level against the pump level. The static water level is at 10.3 mbgl and the pump is at approximately 28 mbgl leaving 17.7 m available drawdown.
2. Next, we subtracted the 100-day well interference observed on Soames Well during the Church Road Well 2 and 3 constant rate pumping tests (0.6 m drawdown from Church Road Well 2 and 0.7 m drawdown from Church Road Well 3). This left an available drawdown in Soames Well of 16.4 m.

The following assumptions were made in determining the 100-day sustainable well yield:

1. No no-flow boundary condition exists that will result in an increased rate of drawdown (no no-flow boundary conditions were observed during the pumping tests).
2. There is sufficient recharge to the aquifer that will allow water levels to return to typical high annual levels in winter. Aquifer recharge is discussed further in Sections 4.4.2 and 6.3 of the Technical Assessment Report (Associated 2019). As with most large groundwater supply projects, long-term monitoring of the aquifer water levels is recommended to confirm our assumptions. A detailed monitoring plan will be submitted separately.

However, as per the MOE 2007 guideline, wells should not be rated higher than the rate tested at; therefore, based on the results of the pumping test, we recommend that Soames Well be rated to operate at a maximum instantaneous pumping rate of 16.0 L/s (460 USgpm).



Summary Table

	Soames Well
PUMPING SPECIFICATIONS	----------
Pumping rate (L/s)	16.00
Test duration (hours)	24
Depth of pump intake (mbtoc)	28.00
Static water level (mbtoc)	10.30
Depth to top of screen (mbtoc)	31.00
Depth of well (mbgl)	36.90
RECOVERY	----------
Length of recovery (min)	60
% recovered	97
CPCN INPUTS	----------
Pumping rate (L/s)	16.00
Available drawdown (m)	16.40
Drawdown at 100 days (m)	6.2
CPCN OUTPUTS	----------
100 day specific capacity (L/s/m)	2.581
Sustainable pumping rate (L/s)	42.32
Sustainable pumping rate with BC safety factor of 30% (L/s)	29.63
Sustainable pumping rate (L/d)	3,656,671
Sustainable pumping ate with BC safety factor of 30% (L/d)	2,559,670
Sustainable pumping rate (USGPM)	671
Sustainable pumping rate with BC safety factor of 30% (USGPM)	469.6

Associated Environmental	PROJECT: 2019-8525 DATE: 11-Sep-20 DRAWN BY: SC	PREPARED FOR SCRD	Figure 4-1 Drawdown extrapolated to 100 days Soames Well

Figure 4-1
Soames Well: 100-day sustainable well yield

5 COMBINED PUMPING IMPACT

The groundwater use licence application is for three production wells that will be used simultaneously during times of the year when the SCRD's Chapman Lake supply source is insufficient to meet demand. The three production wells consist of Church Road Well 2, Church Road Well 3 and Soames Well[3]. Pumping tests have been undertaken on all three wells to determine the specific capacity of the wells, their long term sustainable yields, well interference effects, and impact to the environment, i.e., impact on streamflow in Soames Creek.

5.1 Combined Impact of Pumping on Groundwater Levels

No pumping test has been undertaken on all three wells simultaneously; however, the principle of superposition allows the combined water level drawdown to be calculated. The principle of superposition applies to linear systems, therefore by doubling a stress (e.g., the pumping rate) will double the impact (e.g., double the amount of drawdown). Confined aquifers such as this one are linear systems, therefore well interference can be calculated using the principle of superposition, i.e., the drawdown at any point in the area of influence caused by the pumping of several wells is equal to the sum of the individual drawdowns caused by each pumping well (Todd and Mays, 2005).

Based on the pumping test results, Table 5-1 presents the extrapolated 100-day and 184-day individual and combined groundwater drawdown for the three production wells and the nearby private well, located at 901 Sentinel Road.

Table 5-1
100-day and 184-day drawdown in the three production wells and 901 Sentinel Road

Production Well	Pumping rate (L/s)	100-day drawdown (m)			
		Church Road Well 2	Church Road Well 3	Soames Well	901 Sentinel Road
Church Road Well 2	25.4	11.65	3.50 [1]	0.60	0.55
Church Road Well 3	29.0	4.00	12.40	0.71	0.68
Soames Well	16.0	0.36	0.40	6.20	1.05
Combined Total	**70.4**	**16.01**	**16.30**	**7.51**	**2.28**
Production Well	**Pumping rate (L/s)**	**184-day drawdown (m)**			
		Church Road Well 2	**Church Road Well 3**	**Soames Well**	**901 Sentinel Road**
Church Road Well 2	25.4	11.70	3.55 [1]	0.63	0.58
Church Road Well 3	29.0	4.05	12.45	0.74	0.72
Soames Well	16.0	0.38	0.42	6.22	1.10
Combined Total	**70.4**	**16.13**	**16.42**	**7.59**	**2.40**
Safe available drawdown (m)		**22.5**	**22.5**	**17.7**	**12.6**

Notes: [1] Church Road Well 3 had not been constructed when Church Road Well 2 was tested. The drawdown is therefore estimated based on the drawdown observed in Church Road Well 2 during the Church Road Well 3 pumping test, taking into account the lower pumping rate at Church Road Well 2.

[3] Granthams Landing Well will be closed at the start of construction of the Church Road Well Field project, and a section of pipe removed so that this well can not be operational at the same time as the Church Road wells.

The combined total 100-day and 184-day drawdown values are within the safe maximum available drawdown for each of the three production wells. The impact on water level in the private well at 901 Sentinel Road is presented visually in Figure 5-1. It shows the individual drawdown values, combined drawdown values, approximate location of the pump (based on communication with the well owner and neighbouring former owner), and the depth of the well. This shows that there remains a water column of approximately 10 m above the pump level, even in the worst-case scenario of after 184 days of continuous pumping of the three production wells simultaneously.

5.2 Combined Impact of Pumping on Soames Creek

We cannot quantify the combined impact of pumping on streamflow in Soames Creek as the exact location of the spring discharges are not fully understood. Two scenarios are described further:

- If the discharge is confined to the springhead area then it is probable that the combined impact from pumping all three wells simultaneously will lower the groundwater piezometric head below the elevation of the springs, thus stopping all flow.
- If spring seeps emerge as far downstream as Granthams Pumphouse, some discharge may still occur if the piezometric head is above ground elevation at this point. If this is the case, uncontrolled discharge from Granthams Landing Well will also continue but at a reduced quantity.

Field measurements indicate that there are no additional springs (or other discharges) downstream of where the uncontrolled flow from Granthams Landing Well discharges into the creek, approximately 10 m downstream of Granthams Pumphouse. In all situations, pumping will result in a reduction in creek streamflow below the calculated environmental flow need of 12.3 L/s during periods of low flow. Therefore, to mitigate the reduction in creek streamflow, flow augmentation is proposed up to a maximum of 12.3 L/s (Associated 2020).

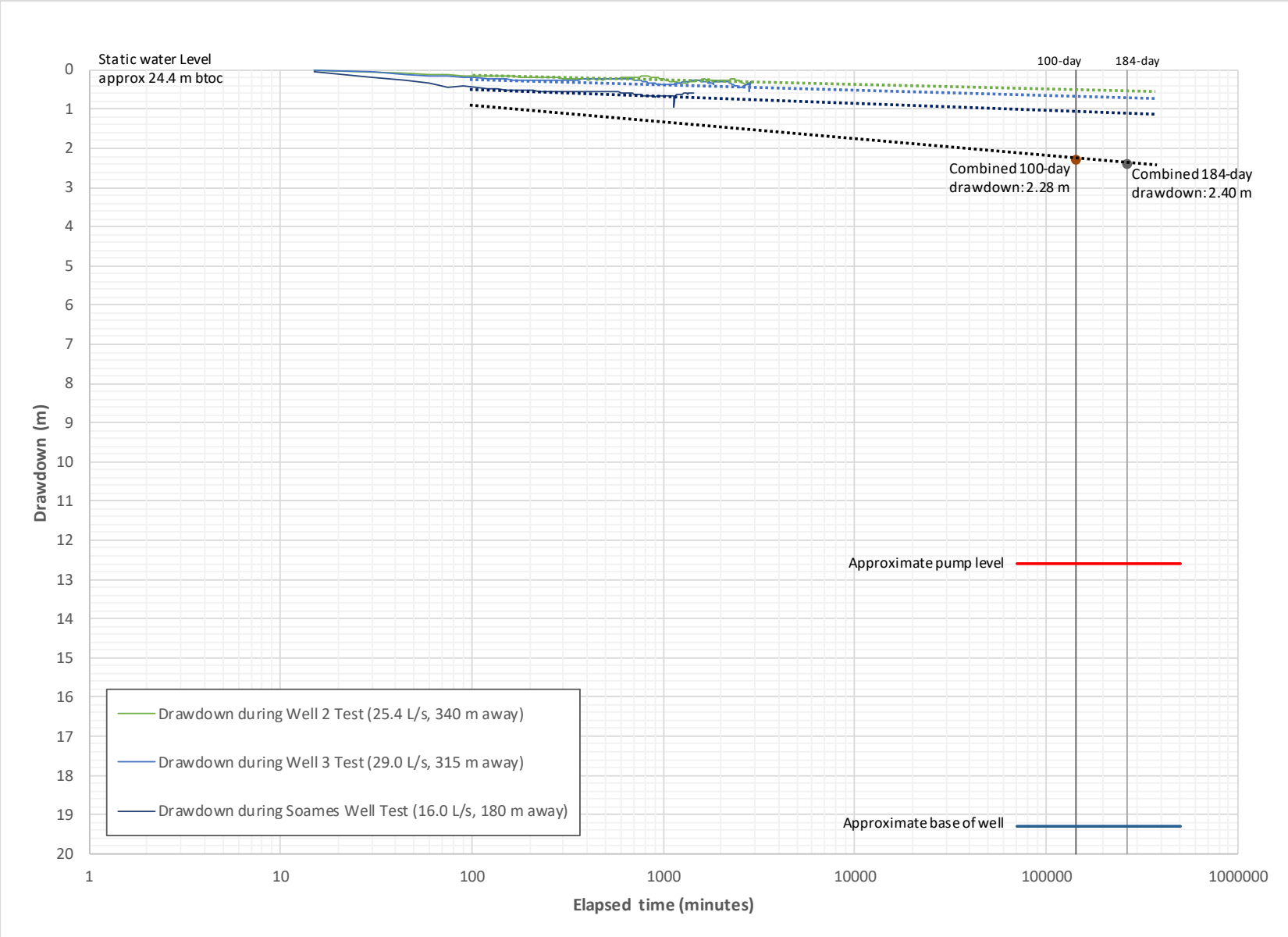


Figure 5-1
901 Sentinel Road 100-day and 184-day extrapolated drawdown

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

We make the following conclusions based on the results of the construction and aquifer testing of Church Road Well 3, the aquifer testing of Soames Well, and assessment of the combined impact from pumping all production wells simultaneously.

6.1.1 Church Road Well 3

We conclude the following related to the construction and aquifer testing of Church Road Well 3:

- Church Road Well 3 was successfully drilled and tested during June and July 2020.
- The well was completed to a depth of 58 mbgl.
- A 33.5 m thick confined sand and gravel aquifer was found.
- The aquifer is confined by a 10.5 m thick till and clay layer which is overlain by 14 m of dry sand and gravel.
- 9.1 m of 15- and 20-slot stainless steel screen was installed in the well from the base of the aquifer.
- Results from step tests and a 48-hour pumping test show that the well can be pumped at 29.0 L/s (460 USgpm), the rate at which the constant rate test was undertaken, without having a detrimental impact on aquifer water levels. This is below the theoretical transmitting capacity of the well screen (29.5 L/s, 460 USgpm) and below the calculated long term sustainable pumping rate of 29.5 L/s (467 USgpm). The recommended maximum instantaneous pumping rate for this well is therefore 29.0 L/s (460 USgpm)
- Extraction from Church Road Well 3 does have an impact on streamflow in Soames Creek caused by a reduction in spring seepages, consequently mitigation will be required.

6.1.2 Soames Well

We conclude the following related to aquifer testing of Soames Well:

- Soames Well is an existing SCRD operated well that was identified as having potential to increase the volume of groundwater extraction.
- A 24-hour pumping test was successfully completed on Soames Well in August 2020 at a rate of 16.0 L/s (254 USgpm).
- Soames Well is screened in the upper part of the aquifer and appears to be partially separated to the lower part of the aquifer by lower permeability layers within the aquifer.
- Results of the pumping test show that Soames well can be pumped at a rate of 16.0 L/s (254 USgpm) without having a detrimental impact on aquifer water levels or nearby groundwater users. The recommended maximum instantaneous pumping rate for this well is therefore 16.0 L/s (254 USgpm)
- No impact on Soames Creek was observed during the pumping test, however it is likely that extraction from this well will result in a reduction in spring seepage into Soames Creek, based on evidence from the Church Road Well 2 and Church Road Well 3 pumping tests.

6.1.3 Combined (Church Road Wells 2 and 3 and Soames Well)

We conclude the following related to the assessment of the combined impacts of pumping from the three production wells:

- Using the principle of superposition, the combined drawdown from all three production wells pumping simultaneously shows there is sufficient water available for extraction from the aquifer without causing a detrimental impact to aquifer water levels and nearby existing groundwater users.
- Drawdown in the nearby private well at 901 Sentinel Road may increase by over 2 m as a result of simultaneous pumping; however, there will remain approximately 10 m of available drawdown in the well.
- The combined impact of groundwater extraction will reduce flow in Soames Creek and cause a reduction in streamflow quicker than if just one well is in use; however, a worst case scenario of completely drying the creek up (a reduction of 7 L/s caused by stopping spring flow and a reduction of up to 6.5 L/s from the overflowing artesian Granthams Landing Well) has already been considered in the Technical Assessment Report previously submitted, and mitigation has been proposed (creek augmentation) up to the EFN when the pumping of the SCRD-owned wells in the area cause the flow in Soames Creek to go below the EFN.

6.2 Recommendations

The following recommendations are made as a result of the investigations undertaken in 2020 on Church Road Well 3 and Soames Well:

- Church Road Well 3 be rated to operate at a maximum instantaneous pumping rate of 29.0 L/s.
- Soames Well be rated to operate at a maximum instantaneous pumping rate of 16.0 L/s.
- Amend the previously submitted new groundwater use licence application (Tracking No. 100292061) to take into account:
    - a maximum instantaneous pumping rate of 29.0 L/s for Church Road Well 3 (a pumping rate of 28.8 L/s was originally applied for in the licence based on results from the Church Road Well 2 pumping test); and
    - the addition of groundwater extraction from Soames Well at a maximum instantaneous pumping rate of 16.0 L/s.
- Develop a detailed monitoring plan (groundwater and surface water) prior to operation of the Church Road Wellfield and Soames Well to confirm the anticipated extraction impacts from all three wells being used simultaneously and to provide early warning of any unexpected impacts.
- Liaise with the owner of the private water supply well at 901 Sentinel Road that in the unlikely event of groundwater extraction having a detrimental impact to their water supply, the SCRD will provide mitigation, such as connecting the property to mains water, lowering the pump, or drilling a deeper well.

CLOSURE

This report was prepared for the Sunshine Coast Regional District to present the results and findings of the 2020 groundwater investigations at Church Road Well 3 and Soames Well, as part of the Phase 4a Groundwater Investigation.

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.

Steven Colebrook, M.Sc.
Environmental Scientist

Marta Green, P.Geo.
Project Manager and Senior Hydrogeologist

SC/MG

REFERENCES

Associated Environmental Consultants Inc. 2019. Technical Assessment, Groundwater Use Licence Application, Tracking No. 100292061.

Associated Environmental Consultants Inc. 2020. Environmental Flow Needs Assessment for Soames Creek. Memo. August 06, 2020.

Freeze, R.A., and Cherry, J.A., 1979, Groundwater: Englewood Cliffs, NJ, Prentice-Hall, 604 p.

Government of Canada (GC). 2020. Guidelines for Canadian Drinking Water Quality. Health Canada. Available at https://www.canada.ca/en/health-canada/services/environmental-workplace-health/water-quality/drinking-water/canadian-drinking-water-guidelines.html

Groundwater Protection Regulation (GWPR). B.C. Reg 39/2016. *Water Sustainability Act*. Available at: https://www.bclaws.ca/civix/document/id/complete/statreg/39_2016

Integrated Sustainability. 2018. Water Demand Analysis. Prepared for Sunshine Coast Regional District. Report Ref: VP19-SCR-01-00-LET-WW-WaterDemandAnalysis_Rev2. 6 December 2018.

Ministry of Environment (MOE). 2007. Guidelines for Evaluating Long-term Well Capacity for a Certification of Public Convenience and Necessity (CPCN).

Ministry of Environment (MOE). 2008. Pumping Test Report Form January 2008.

Todd, D.K., and Mays, L.W. 2005. Groundwater Hydrology. Third Edition. Wiley, 656p.

Waterline Resources Inc. 2013. Aquifer Mapping Study, Town of Gibsons, British Columbia. Report Ref: WL09-1578

APPENDIX A - CHURCH ROAD WELL 3 - WATER QUALITY RESULTS

CERTIFICATE OF ANALYSIS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon) #200 - 2800 29th Street Vernon, BC V1T 9P9		
ATTENTION	Nicole Penner	**WORK ORDER**	0072931
PO NUMBER		**RECEIVED / TEMP**	2020-07-30 11:40 / 8°C
PROJECT	SCRD Phase 4A GW Investigation	**REPORTED**	2020-08-10 15:30
PROJECT INFO	2019-8525.010.203	**COC NUMBER**	No Number

Introduction:

CARO Analytical Services is a testing laboratory full of smart, engaged scientists driven to make the world a safer and healthier place. Through our clients' projects we become an essential element for a better world. We employ methods conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts. CARO is accredited by the Canadian Association for Laboratories Accreditation (CALA) to ISO/IEC 17025:2017 for specific tests listed in the scope of accreditation approved by CALA.

Big Picture Sidekicks

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

We've Got Chemistry

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

Ahead of the Curve

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

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

Authorized By:

Alana Crump
Team Lead, Client Service

CARO ANALYTICAL SERVICES

TEST RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	0072931
PROJECT	SCRD Phase 4A GW Investigation	**REPORTED**	2020-08-10 15:30

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
61103 (0072931-01) | Matrix: Water | Sampled: 2020-07-30 07:30						
Anions						
Chloride	**1.85**	AO ≤ 250	0.10	mg/L	2020-07-31	
Fluoride	< 0.10	MAC = 1.5	0.10	mg/L	2020-07-31	
Nitrate (as N)	**0.322**	MAC = 10	0.010	mg/L	2020-07-31	
Nitrite (as N)	< 0.010	MAC = 1	0.010	mg/L	2020-07-31	
Sulfate	**7.6**	AO ≤ 500	1.0	mg/L	2020-07-31	
Biological Activity Reaction Tests						
Iron Related Bacteria	**35000**	N/A	1	CFU/mL	2020-07-31	
Sulfate Reducing Bacteria	**1400**	N/A	5	CFU/mL	2020-07-31	
Calculated Parameters						
Hardness, Total (as CaCO3)	**32.1**	None Required	0.500	mg/L	N/A	
Langelier Index	**0.6**	N/A	-5.0		2020-08-06	
Nitrate+Nitrite (as N)	**0.322**	N/A	0.0100	mg/L	N/A	
Nitrogen, Total	**0.416**	N/A	0.0500	mg/L	N/A	
Nitrogen, Organic	**0.0940**	N/A	0.0500	mg/L	N/A	
Dissolved Metals						
Lithium, dissolved	**0.00068**	N/A	0.00010	mg/L	2020-08-05	
Aluminum, dissolved	**0.283**	N/A	0.0050	mg/L	2020-08-05	
Antimony, dissolved	< 0.00020	N/A	0.00020	mg/L	2020-08-05	
Arsenic, dissolved	**0.00153**	N/A	0.00050	mg/L	2020-08-05	
Barium, dissolved	< 0.0050	N/A	0.0050	mg/L	2020-08-05	
Beryllium, dissolved	< 0.00010	N/A	0.00010	mg/L	2020-08-05	
Bismuth, dissolved	< 0.00010	N/A	0.00010	mg/L	2020-08-05	
Boron, dissolved	< 0.0500	N/A	0.0500	mg/L	2020-08-05	
Cadmium, dissolved	< 0.000010	N/A	0.000010	mg/L	2020-08-05	
Calcium, dissolved	**6.86**	N/A	0.20	mg/L	2020-08-05	
Chromium, dissolved	< 0.00050	N/A	0.00050	mg/L	2020-08-05	
Cobalt, dissolved	< 0.00010	N/A	0.00010	mg/L	2020-08-05	
Copper, dissolved	**0.00136**	N/A	0.00040	mg/L	2020-08-05	
Iron, dissolved	**0.076**	N/A	0.010	mg/L	2020-08-05	
Lead, dissolved	< 0.00020	N/A	0.00020	mg/L	2020-08-05	
Magnesium, dissolved	**3.64**	N/A	0.010	mg/L	2020-08-05	
Manganese, dissolved	**0.00595**	N/A	0.00020	mg/L	2020-08-05	
Mercury, dissolved	< 0.000010	N/A	0.000010	mg/L	2020-07-31	
Molybdenum, dissolved	**0.00132**	N/A	0.00010	mg/L	2020-08-05	
Nickel, dissolved	< 0.00040	N/A	0.00040	mg/L	2020-08-05	
Phosphorus, dissolved	**0.077**	N/A	0.050	mg/L	2020-08-05	
Potassium, dissolved	**2.70**	N/A	0.10	mg/L	2020-08-05	
Selenium, dissolved	< 0.00050	N/A	0.00050	mg/L	2020-08-05	
Silicon, dissolved	**18.9**	N/A	1.0	mg/L	2020-08-05	
Silver, dissolved	< 0.000050	N/A	0.000050	mg/L	2020-08-05	
Sodium, dissolved	**5.56**	N/A	0.10	mg/L	2020-08-05	

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TEST RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	0072931
PROJECT	SCRD Phase 4A GW Investigation	**REPORTED**	2020-08-10 15:30

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
61103 (0072931-01) | Matrix: Water | Sampled: 2020-07-30 07:30, Continued						
Dissolved Metals, Continued						
Strontium, dissolved	**0.0251**	N/A	0.0010	mg/L	2020-08-05	
Sulfur, dissolved	< 3.0	N/A	3.0	mg/L	2020-08-05	
Tellurium, dissolved	< 0.00050	N/A	0.00050	mg/L	2020-08-05	
Thallium, dissolved	< 0.000020	N/A	0.000020	mg/L	2020-08-05	
Thorium, dissolved	< 0.00010	N/A	0.00010	mg/L	2020-08-05	
Tin, dissolved	< 0.00020	N/A	0.00020	mg/L	2020-08-05	
Titanium, dissolved	< 0.0050	N/A	0.0050	mg/L	2020-08-05	
Tungsten, dissolved	< 0.0010	N/A	0.0010	mg/L	2020-08-05	
Uranium, dissolved	**0.000092**	N/A	0.000020	mg/L	2020-08-05	
Vanadium, dissolved	**0.0080**	N/A	0.0010	mg/L	2020-08-05	
Zinc, dissolved	**0.0092**	N/A	0.0040	mg/L	2020-08-05	
Zirconium, dissolved	< 0.00010	N/A	0.00010	mg/L	2020-08-05	
General Parameters						
Alkalinity, Total (as CaCO3)	**37.4**	N/A	1.0	mg/L	2020-07-31	
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	N/A	1.0	mg/L	2020-07-31	
Alkalinity, Bicarbonate (as CaCO3)	**37.4**	N/A	1.0	mg/L	2020-07-31	
Alkalinity, Carbonate (as CaCO3)	< 1.0	N/A	1.0	mg/L	2020-07-31	
Alkalinity, Hydroxide (as CaCO3)	< 1.0	N/A	1.0	mg/L	2020-07-31	
Ammonia, Total (as N)	< 0.050	None Required	0.050	mg/L	2020-08-04	
Carbon, Total Organic	< 0.50	N/A	0.50	mg/L	2020-08-06	
Colour, True	< 5.0	AO ≤ 15	5.0	CU	2020-08-01	
Conductivity (EC)	**97.6**	N/A	2.0	µS/cm	2020-07-31	
Nitrogen, Total Kjeldahl	**0.094**	N/A	0.050	mg/L	2020-08-05	
pH	**7.63**	7.0-10.5	0.10	pH units	2020-07-31	HT2
Solids, Total Dissolved	**94**	AO ≤ 500	15	mg/L	2020-08-04	
Sulfide, Total	< 0.020	AO ≤ 0.05	0.020	mg/L	2020-07-31	
Turbidity	**0.14**	OG < 1	0.10	NTU	2020-07-31	
UV Transmittance @ 254 nm - Unfiltered	**98.6**	N/A	0.10	% T	2020-07-31	
Total Metals						
Aluminum, total	**0.0625**	OG < 0.1	0.0050	mg/L	2020-08-06	
Antimony, total	< 0.00020	MAC = 0.006	0.00020	mg/L	2020-08-06	
Arsenic, total	**0.00160**	MAC = 0.01	0.00050	mg/L	2020-08-06	
Barium, total	< 0.0050	MAC = 2	0.0050	mg/L	2020-08-06	
Beryllium, total	< 0.00010	N/A	0.00010	mg/L	2020-08-06	
Bismuth, total	< 0.00010	N/A	0.00010	mg/L	2020-08-06	
Boron, total	**0.0640**	MAC = 5	0.0500	mg/L	2020-08-06	
Cadmium, total	< 0.000010	MAC = 0.005	0.000010	mg/L	2020-08-06	
Calcium, total	**10.9**	None Required	0.20	mg/L	2020-08-06	
Chromium, total	< 0.00050	MAC = 0.05	0.00050	mg/L	2020-08-06	
Cobalt, total	< 0.00010	N/A	0.00010	mg/L	2020-08-06	
Copper, total	**0.00233**	MAC = 2	0.00040	mg/L	2020-08-06	
Iron, total	**0.092**	AO ≤ 0.3	0.010	mg/L	2020-08-06	

TEST RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	0072931
PROJECT	SCRD Phase 4A GW Investigation	**REPORTED**	2020-08-10 15:30

Analyte	Result	Guideline	RL	Units	Analyzed	Qualifier
61103 (0072931-01) | Matrix: Water | Sampled: 2020-07-30 07:30, Continued						
Total Metals, Continued						
Lead, total	**0.00024**	MAC = 0.005	0.00020	mg/L	2020-08-06	
Lithium, total	**0.00072**	N/A	0.00010	mg/L	2020-08-06	
Magnesium, total	**3.51**	None Required	0.010	mg/L	2020-08-06	
Manganese, total	**0.0101**	MAC = 0.12	0.00020	mg/L	2020-08-06	
Mercury, total	< 0.000010	MAC = 0.001	0.000010	mg/L	2020-07-31	
Molybdenum, total	**0.00144**	N/A	0.00010	mg/L	2020-08-06	
Nickel, total	< 0.00040	N/A	0.00040	mg/L	2020-08-06	
Phosphorus, total	**0.115**	N/A	0.050	mg/L	2020-08-06	
Potassium, total	**2.64**	N/A	0.10	mg/L	2020-08-06	
Selenium, total	< 0.00050	MAC = 0.05	0.00050	mg/L	2020-08-06	
Silicon, total	**21.4**	N/A	1.0	mg/L	2020-08-06	
Silver, total	< 0.000050	None Required	0.000050	mg/L	2020-08-06	
Sodium, total	**5.09**	AO ≤ 200	0.10	mg/L	2020-08-06	
Strontium, total	**0.0319**	7	0.0010	mg/L	2020-08-06	
Sulfur, total	**3.3**	N/A	3.0	mg/L	2020-08-06	
Tellurium, total	< 0.00050	N/A	0.00050	mg/L	2020-08-06	
Thallium, total	< 0.000020	N/A	0.000020	mg/L	2020-08-06	
Thorium, total	< 0.00010	N/A	0.00010	mg/L	2020-08-06	
Tin, total	< 0.00020	N/A	0.00020	mg/L	2020-08-06	
Titanium, total	< 0.0050	N/A	0.0050	mg/L	2020-08-06	
Tungsten, total	< 0.0010	N/A	0.0010	mg/L	2020-08-06	
Uranium, total	**0.000113**	MAC = 0.02	0.000020	mg/L	2020-08-06	
Vanadium, total	**0.0082**	N/A	0.0010	mg/L	2020-08-06	
Zinc, total	**0.0098**	AO ≤ 5	0.0040	mg/L	2020-08-06	
Zirconium, total	< 0.00010	N/A	0.00010	mg/L	2020-08-06	
Microbiological Parameters						
Coliforms, Total	<1	MAC = 0	1	CFU/100 mL	2020-07-30	
Heterotrophic Plate Count	<1	N/A	1	CFU/mL	2020-07-30	
E. coli	<1	MAC = 0	1	CFU/100 mL	2020-07-30	

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**	0072931
PROJECT	SCRD Phase 4A GW Investigation	**REPORTED**	2020-08-10 15:30

Analysis Description	Method Ref.	Technique	Accredited	Location
Alkalinity in Water	SM 2320 B* (2017)	Titration with H2SO4	✓	Kelowna
Ammonia, Total in Water	SM 4500-NH3 G* (2017)	Automated Colorimetry (Phenate)	✓	Kelowna
Anions in Water	SM 4110 B (2017)	Ion Chromatography	✓	Kelowna
Carbon, Total Organic in Water	SM 5310 B (2017)	Combustion, Infrared CO2 Detection	✓	Kelowna
Coliforms, Total in Water	SM 9222* (2017)	Membrane Filtration / Chromocult Agar	✓	Kelowna
Colour, True in Water	SM 2120 C (2017)	Spectrophotometry (456 nm)	✓	Kelowna
Conductivity in Water	SM 2510 B (2017)	Conductivity Meter	✓	Kelowna
Dissolved Metals in Water	EPA 200.8 / EPA 6020B	0.45 µm Filtration / Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS)	✓	Richmond
E. coli in Water	SM 9222* (2017)	Membrane Filtration / Chromocult Agar	✓	Kelowna
Hardness in Water	SM 2340 B (2017)	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	✓	N/A
Heterotrophic Plate Count in Water	SM 9215 B (2017)	Pour Plate		Sublet
Iron Related Bacteria in Water	DBI DBISOP06	Biological Activity Reaction Test		Kelowna
Langelier Index in Water	SM 2330 B (2017)	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
Nitrogen, Total Kjeldahl in Water	SM 4500-Norg D* (2017)	Block Digestion and Flow Injection Analysis	✓	Kelowna
pH in Water	SM 4500-H+ B (2017)	Electrometry	✓	Kelowna
Solids, Total Dissolved in Water	SM 2540 C* (2017)	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* (2017)	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 - Unfiltered in Water	SM 5910 B* (2017)	Ultraviolet Absorption	✓	Kelowna
Turbidity in Water	SM 2130 B (2017)	Nephelometry	✓	Kelowna

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

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	0072931
PROJECT	SCRD Phase 4A GW Investigation	**REPORTED**	2020-08-10 15:30

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.

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

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

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	0072931
PROJECT	SCRD Phase 4A GW Investigation	**REPORTED**	2020-08-10 15:30

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

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

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

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Anions, Batch B0G2773										
Blank (B0G2773-BLK1)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Chloride	< 0.10	0.10	mg/L							
Fluoride	< 0.10	0.10	mg/L							
Nitrate (as N)	< 0.010	0.010	mg/L							
Nitrite (as N)	< 0.010	0.010	mg/L							
Sulfate	< 1.0	1.0	mg/L							
Blank (B0G2773-BLK2)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Chloride	< 0.10	0.10	mg/L							
Fluoride	< 0.10	0.10	mg/L							
Nitrate (as N)	< 0.010	0.010	mg/L							
Nitrite (as N)	< 0.010	0.010	mg/L							
Sulfate	< 1.0	1.0	mg/L							
LCS (B0G2773-BS1)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Chloride	16.0	0.10	mg/L	16.0		100	90-110			
Fluoride	4.01	0.10	mg/L	4.00		100	88-108			
Nitrate (as N)	4.01	0.010	mg/L	4.00		100	90-110			
Nitrite (as N)	2.01	0.010	mg/L	2.00		101	85-115			
Sulfate	16.0	1.0	mg/L	16.0		100	90-110			
LCS (B0G2773-BS2)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Chloride	16.1	0.10	mg/L	16.0		101	90-110			
Fluoride	4.02	0.10	mg/L	4.00		100	88-108			
Nitrate (as N)	4.02	0.010	mg/L	4.00		100	90-110			
Nitrite (as N)	2.05	0.010	mg/L	2.00		103	85-115			
Sulfate	16.0	1.0	mg/L	16.0		100	90-110			
Biological Activity Reaction Tests, Batch B0G2793										
Blank (B0G2793-BLK1)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Iron Related Bacteria	< 1	1	CFU/mL							
Duplicate (B0G2793-DUP1)			**Source: 0072931-01**	Prepared: 2020-07-31, Analyzed: 2020-07-31						
Iron Related Bacteria	35000	1	CFU/mL		35000			< 1	171	

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Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Biological Activity Reaction Tests, Batch B0G2794										
Blank (B0G2794-BLK1)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Sulfate Reducing Bacteria	< 5	5	CFU/mL							
Duplicate (B0G2794-DUP1)		**Source: 0072931-01**		Prepared: 2020-07-31, Analyzed: 2020-07-31						
Sulfate Reducing Bacteria	6000	5	CFU/mL		1400			124	121	MIC29
Dissolved Metals, Batch B0G2743										
Blank (B0G2743-BLK1)				Prepared: 2020-07-30, Analyzed: 2020-07-31						
Mercury, dissolved	< 0.000010	0.000010	mg/L							
Reference (B0G2743-SRM1)				Prepared: 2020-07-30, Analyzed: 2020-07-31						
Mercury, dissolved	0.00535	0.000010	mg/L	0.00581		92	80-120			
Dissolved Metals, Batch B0H0241										
Blank (B0H0241-BLK1)				Prepared: 2020-08-05, Analyzed: 2020-08-05						
Lithium, dissolved	< 0.00010	0.00010	mg/L							
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	< 0.0500	0.0500	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							
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 (B0H0241-BLK2)				Prepared: 2020-08-05, Analyzed: 2020-08-05						
Lithium, dissolved	< 0.00010	0.00010	mg/L							

APPENDIX 2: QUALITY CONTROL RESULTS

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PROJECT	SCRD Phase 4A GW Investigation	**REPORTED**	2020-08-10 15:30

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Dissolved Metals, Batch B0H0241, Continued										
Blank (B0H0241-BLK2), Continued				Prepared: 2020-08-05, Analyzed: 2020-08-05						
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	< 0.0500	0.0500	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							
Magnesium, dissolved	< 0.010	0.010	mg/L							
Manganese, dissolved	0.113	0.00020	mg/L							BLK
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							
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 (B0H0241-BS1)				Prepared: 2020-08-05, Analyzed: 2020-08-05						
Lithium, dissolved	0.0213	0.00010	mg/L	0.0200		106	80-120			
Aluminum, dissolved	0.0234	0.0050	mg/L	0.0199		118	80-120			
Antimony, dissolved	0.0185	0.00020	mg/L	0.0200		92	80-120			
Arsenic, dissolved	0.0216	0.00050	mg/L	0.0200		108	80-120			
Barium, dissolved	0.0200	0.0050	mg/L	0.0198		101	80-120			
Beryllium, dissolved	0.0213	0.00010	mg/L	0.0198		108	80-120			
Bismuth, dissolved	0.0211	0.00010	mg/L	0.0200		105	80-120			
Boron, dissolved	< 0.0500	0.0500	mg/L	0.0200		95	80-120			
Cadmium, dissolved	0.0205	0.000010	mg/L	0.0199		103	80-120			
Calcium, dissolved	1.98	0.20	mg/L	2.02		98	80-120			
Chromium, dissolved	0.0208	0.00050	mg/L	0.0198		105	80-120			
Cobalt, dissolved	0.0202	0.00010	mg/L	0.0199		102	80-120			
Copper, dissolved	0.0213	0.00040	mg/L	0.0200		107	80-120			
Iron, dissolved	2.22	0.010	mg/L	2.02		110	80-120			
Lead, dissolved	0.0204	0.00020	mg/L	0.0199		102	80-120			
Magnesium, dissolved	2.05	0.010	mg/L	2.02		101	80-120			
Manganese, dissolved	0.0201	0.00020	mg/L	0.0199		101	80-120			
Molybdenum, dissolved	0.0204	0.00010	mg/L	0.0200		102	80-120			
Nickel, dissolved	0.0205	0.00040	mg/L	0.0200		102	80-120			

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PROJECT	SCRD Phase 4A GW Investigation	**REPORTED**	2020-08-10 15:30

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Dissolved Metals, Batch B0H0241, Continued										
LCS (B0H0241-BS1), Continued				Prepared: 2020-08-05, Analyzed: 2020-08-05						
Phosphorus, dissolved	2.04	0.050	mg/L	2.00		102	80-120			
Potassium, dissolved	2.14	0.10	mg/L	2.02		106	80-120			
Selenium, dissolved	0.0222	0.00050	mg/L	0.0200		111	80-120			
Silicon, dissolved	2.1	1.0	mg/L	2.00		106	80-120			
Silver, dissolved	0.0200	0.000050	mg/L	0.0200		100	80-120			
Sodium, dissolved	2.18	0.10	mg/L	2.02		108	80-120			
Strontium, dissolved	0.0207	0.0010	mg/L	0.0200		103	80-120			
Sulfur, dissolved	5.8	3.0	mg/L	5.00		115	80-120			
Tellurium, dissolved	0.0218	0.00050	mg/L	0.0200		109	80-120			
Thallium, dissolved	0.0202	0.000020	mg/L	0.0199		102	80-120			
Thorium, dissolved	0.0199	0.00010	mg/L	0.0200		99	80-120			
Tin, dissolved	0.0209	0.00020	mg/L	0.0200		105	80-120			
Titanium, dissolved	0.0217	0.0050	mg/L	0.0200		108	80-120			
Tungsten, dissolved	0.0204	0.0010	mg/L	0.0200		102	80-120			
Uranium, dissolved	0.0208	0.000020	mg/L	0.0200		104	80-120			
Vanadium, dissolved	0.0209	0.0010	mg/L	0.0200		105	80-120			
Zinc, dissolved	0.0213	0.0040	mg/L	0.0200		107	80-120			
Zirconium, dissolved	0.0202	0.00010	mg/L	0.0200		101	80-120			
Reference (B0H0241-SRM1)				Prepared: 2020-08-05, Analyzed: 2020-08-05						
Lithium, dissolved	0.113	0.00010	mg/L	0.100		113	70-130			
Aluminum, dissolved	0.265	0.0050	mg/L	0.235		113	70-130			
Antimony, dissolved	0.0485	0.00020	mg/L	0.0431		113	70-130			
Arsenic, dissolved	0.485	0.00050	mg/L	0.423		115	70-130			
Barium, dissolved	3.23	0.0050	mg/L	3.30		98	70-130			
Beryllium, dissolved	0.236	0.00010	mg/L	0.209		113	70-130			
Boron, dissolved	1.53	0.0500	mg/L	1.65		93	70-130			
Cadmium, dissolved	0.238	0.000010	mg/L	0.221		108	70-130			
Calcium, dissolved	8.36	0.20	mg/L	7.72		108	70-130			
Chromium, dissolved	0.456	0.00050	mg/L	0.434		105	70-130			
Cobalt, dissolved	0.132	0.00010	mg/L	0.124		106	70-130			
Copper, dissolved	0.882	0.00040	mg/L	0.815		108	70-130			
Iron, dissolved	1.44	0.010	mg/L	1.27		113	70-130			
Lead, dissolved	0.119	0.00020	mg/L	0.110		108	70-130			
Magnesium, dissolved	7.16	0.010	mg/L	6.59		109	70-130			
Manganese, dissolved	0.366	0.00020	mg/L	0.342		107	70-130			
Molybdenum, dissolved	0.430	0.00010	mg/L	0.404		106	70-130			
Nickel, dissolved	0.898	0.00040	mg/L	0.835		108	70-130			
Phosphorus, dissolved	0.562	0.050	mg/L	0.499		113	70-130			
Potassium, dissolved	3.36	0.10	mg/L	2.88		117	70-130			
Selenium, dissolved	0.0388	0.00050	mg/L	0.0324		120	70-130			
Sodium, dissolved	20.9	0.10	mg/L	18.0		116	70-130			
Strontium, dissolved	0.964	0.0010	mg/L	0.935		103	70-130			
Thallium, dissolved	0.0411	0.000020	mg/L	0.0385		107	70-130			
Uranium, dissolved	0.264	0.000020	mg/L	0.258		102	70-130			
Vanadium, dissolved	0.906	0.0010	mg/L	0.873		104	70-130			
Zinc, dissolved	0.963	0.0040	mg/L	0.848		114	70-130			
General Parameters, Batch B0G2763										
Blank (B0G2763-BLK1)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Turbidity	< 0.10	0.10	NTU							
Blank (B0G2763-BLK2)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Turbidity	< 0.10	0.10	NTU							

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Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B0G2763, Continued										
LCS (B0G2763-BS1)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Turbidity	39.4	0.10	NTU	40.0		98	90-110			
LCS (B0G2763-BS2)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Turbidity	39.3	0.10	NTU	40.0		98	90-110			
General Parameters, Batch B0G2771										
Blank (B0G2771-BLK1)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
UV Transmittance @ 254 nm - Unfiltered	< 0.10	0.10	% T							
LCS (B0G2771-BS1)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
UV Transmittance @ 254 nm - Unfiltered	43.4	0.10	% T	45.2		96	95-105			
General Parameters, Batch B0G2779										
Blank (B0G2779-BLK1)				Prepared: 2020-08-06, Analyzed: 2020-08-06						
Carbon, Total Organic	< 0.50	0.50	mg/L							
Blank (B0G2779-BLK2)				Prepared: 2020-08-06, Analyzed: 2020-08-06						
Carbon, Total Organic	< 0.50	0.50	mg/L							
Blank (B0G2779-BLK3)				Prepared: 2020-08-06, Analyzed: 2020-08-06						
Carbon, Total Organic	< 0.50	0.50	mg/L							
LCS (B0G2779-BS1)				Prepared: 2020-08-06, Analyzed: 2020-08-06						
Carbon, Total Organic	9.33	0.50	mg/L	10.0		93	78-116			
LCS (B0G2779-BS2)				Prepared: 2020-08-06, Analyzed: 2020-08-06						
Carbon, Total Organic	10.3	0.50	mg/L	10.0		103	78-116			
LCS (B0G2779-BS3)				Prepared: 2020-08-06, Analyzed: 2020-08-06						
Carbon, Total Organic	10.3	0.50	mg/L	10.0		103	78-116			
General Parameters, Batch B0G2788										
Blank (B0G2788-BLK1)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Sulfide, Total	< 0.020	0.020	mg/L							
LCS (B0G2788-BS1)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Sulfide, Total	0.481	0.020	mg/L	0.490		98	80-120			
Duplicate (B0G2788-DUP1)		**Source: 0072931-01**		Prepared: 2020-07-31, Analyzed: 2020-07-31						
Sulfide, Total	< 0.020	0.020	mg/L		< 0.020				15	
General Parameters, Batch B0G2842										
Blank (B0G2842-BLK1)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
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							
Conductivity (EC)	< 2.0	2.0	µS/cm							
Blank (B0G2842-BLK2)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Alkalinity, Total (as CaCO3)	< 1.0	1.0	mg/L							

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Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B0G2842, Continued										
Blank (B0G2842-BLK2), Continued				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Alkalinity, Phenolphthalein (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1.0	1.0	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1.0	1.0	mg/L							
Conductivity (EC)	< 2.0	2.0	µS/cm							
Blank (B0G2842-BLK3)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
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							
Conductivity (EC)	< 2.0	2.0	µS/cm							
LCS (B0G2842-BS1)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Alkalinity, Total (as CaCO3)	103	1.0	mg/L	100		103	80-120			
LCS (B0G2842-BS2)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Alkalinity, Total (as CaCO3)	104	1.0	mg/L	100		104	80-120			
LCS (B0G2842-BS3)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Alkalinity, Total (as CaCO3)	103	1.0	mg/L	100		103	80-120			
LCS (B0G2842-BS4)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Conductivity (EC)	1390	2.0	µS/cm	1410		99	95-104			
LCS (B0G2842-BS5)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Conductivity (EC)	1460	2.0	µS/cm	1410		104	95-104			
LCS (B0G2842-BS6)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
Conductivity (EC)	1410	2.0	µS/cm	1410		100	95-104			
Reference (B0G2842-SRM1)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
pH	6.99	0.10	pH units	7.01		100	98-102			
Reference (B0G2842-SRM2)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
pH	6.99	0.10	pH units	7.01		100	98-102			
Reference (B0G2842-SRM3)				Prepared: 2020-07-31, Analyzed: 2020-07-31						
pH	6.98	0.10	pH units	7.01		100	98-102			
General Parameters, Batch B0H0005										
Blank (B0H0005-BLK1)				Prepared: 2020-08-01, Analyzed: 2020-08-01						
Colour, True	< 5.0	5.0	CU							
Blank (B0H0005-BLK2)				Prepared: 2020-08-01, Analyzed: 2020-08-01						
Colour, True	< 5.0	5.0	CU							
LCS (B0H0005-BS1)				Prepared: 2020-08-01, Analyzed: 2020-08-01						
Colour, True	20	5.0	CU	20.0		102	85-115			
LCS (B0H0005-BS2)				Prepared: 2020-08-01, Analyzed: 2020-08-01						
Colour, True	20	5.0	CU	20.0		102	85-115			
General Parameters, Batch B0H0092										

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	0072931
PROJECT	SCRD Phase 4A GW Investigation	**REPORTED**	2020-08-10 15:30

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
General Parameters, Batch B0H0092, Continued										
Blank (B0H0092-BLK1)				Prepared: 2020-08-04, Analyzed: 2020-08-04						
Ammonia, Total (as N)	< 0.050	0.050	mg/L							
Blank (B0H0092-BLK2)				Prepared: 2020-08-04, Analyzed: 2020-08-04						
Ammonia, Total (as N)	< 0.050	0.050	mg/L							
Blank (B0H0092-BLK3)				Prepared: 2020-08-04, Analyzed: 2020-08-04						
Ammonia, Total (as N)	< 0.050	0.050	mg/L							
Blank (B0H0092-BLK4)				Prepared: 2020-08-04, Analyzed: 2020-08-04						
Ammonia, Total (as N)	< 0.050	0.050	mg/L							
LCS (B0H0092-BS1)				Prepared: 2020-08-04, Analyzed: 2020-08-04						
Ammonia, Total (as N)	1.00	0.050	mg/L	1.00		100	90-115			
LCS (B0H0092-BS2)				Prepared: 2020-08-04, Analyzed: 2020-08-04						
Ammonia, Total (as N)	0.981	0.050	mg/L	1.00		98	90-115			
LCS (B0H0092-BS3)				Prepared: 2020-08-04, Analyzed: 2020-08-04						
Ammonia, Total (as N)	0.987	0.050	mg/L	1.00		99	90-115			
LCS (B0H0092-BS4)				Prepared: 2020-08-04, Analyzed: 2020-08-04						
Ammonia, Total (as N)	0.962	0.050	mg/L	1.00		96	90-115			
General Parameters, Batch B0H0105										
Blank (B0H0105-BLK1)				Prepared: 2020-08-04, Analyzed: 2020-08-04						
Solids, Total Dissolved	< 15	15	mg/L							
LCS (B0H0105-BS1)				Prepared: 2020-08-04, Analyzed: 2020-08-04						
Solids, Total Dissolved	229	15	mg/L	240		95	85-115			
General Parameters, Batch B0H0147										
Blank (B0H0147-BLK1)				Prepared: 2020-08-04, Analyzed: 2020-08-05						
Nitrogen, Total Kjeldahl	< 0.050	0.050	mg/L							
Blank (B0H0147-BLK2)				Prepared: 2020-08-04, Analyzed: 2020-08-05						
Nitrogen, Total Kjeldahl	< 0.050	0.050	mg/L							
LCS (B0H0147-BS1)				Prepared: 2020-08-04, Analyzed: 2020-08-05						
Nitrogen, Total Kjeldahl	0.981	0.050	mg/L	1.00		98	85-115			
LCS (B0H0147-BS2)				Prepared: 2020-08-04, Analyzed: 2020-08-05						
Nitrogen, Total Kjeldahl	0.978	0.050	mg/L	1.00		98	85-115			
Microbiological Parameters, Batch '[none]'										
BLK (BATCH-BLK1 (Water))				Prepared: , Analyzed:						
Background Colonies	ND	200	CFU/100 mL				0-0			
Coliforms, Total	ND	1	CFU/100 mL				0-0			
E. coli	ND	1	CFU/100 mL				0-0			
DUP (BATCH-DUP1 (Water))				Prepared: , Analyzed:						
Background Colonies	ND	200	CFU/100 mL				0-0		82	
Coliforms, Total	ND	1	CFU/100 mL				0-0		82	
E. coli	ND	1	CFU/100 mL				0-0		104	

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	0072931
PROJECT	SCRD Phase 4A GW Investigation	**REPORTED**	2020-08-10 15:30

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Total Metals, Batch B0G2744										
Blank (B0G2744-BLK1)				Prepared: 2020-07-30, Analyzed: 2020-07-31						
Mercury, total	< 0.000010	0.000010	mg/L							
Reference (B0G2744-SRM1)				Prepared: 2020-07-30, Analyzed: 2020-07-31						
Mercury, total	0.00490	0.000010	mg/L	0.00581		84	80-120			
Total Metals, Batch B0H0214										
Blank (B0H0214-BLK1)				Prepared: 2020-08-05, Analyzed: 2020-08-06						
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	< 0.0500	0.0500	mg/L							
Cadmium, total	< 0.000010	0.000010	mg/L							
Calcium, total	< 0.20	0.20	mg/L							
Chromium, total	< 0.00050	0.00050	mg/L							
Cobalt, total	< 0.00010	0.00010	mg/L							
Copper, total	< 0.00040	0.00040	mg/L							
Iron, total	< 0.010	0.010	mg/L							
Lead, total	< 0.00020	0.00020	mg/L							
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 (B0H0214-BS1)				Prepared: 2020-08-05, Analyzed: 2020-08-06						
Aluminum, total	0.0230	0.0050	mg/L	0.0199		116	80-120			
Antimony, total	0.0239	0.00020	mg/L	0.0200		120	80-120			
Arsenic, total	0.0239	0.00050	mg/L	0.0200		119	80-120			
Barium, total	0.0225	0.0050	mg/L	0.0198		114	80-120			
Beryllium, total	0.0198	0.00010	mg/L	0.0198		100	80-120			
Bismuth, total	0.0227	0.00010	mg/L	0.0200		114	80-120			
Boron, total	< 0.0500	0.0500	mg/L	0.0200		111	80-120			
Cadmium, total	0.0214	0.000010	mg/L	0.0199		107	80-120			
Calcium, total	2.39	0.20	mg/L	2.02		118	80-120			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	0072931
PROJECT	SCRD Phase 4A GW Investigation	**REPORTED**	2020-08-10 15:30

Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Total Metals, Batch B0H0214, Continued										
LCS (B0H0214-BS1), Continued				Prepared: 2020-08-05, Analyzed: 2020-08-06						
Chromium, total	0.0224	0.00050	mg/L	0.0198		113	80-120			
Cobalt, total	0.0226	0.00010	mg/L	0.0199		114	80-120			
Copper, total	0.0209	0.00040	mg/L	0.0200		105	80-120			
Iron, total	2.17	0.010	mg/L	2.02		108	80-120			
Lead, total	0.0219	0.00020	mg/L	0.0199		110	80-120			
Lithium, total	0.0198	0.00010	mg/L	0.0200		99	80-120			
Magnesium, total	1.85	0.010	mg/L	2.02		91	80-120			
Manganese, total	0.0211	0.00020	mg/L	0.0199		106	80-120			
Molybdenum, total	0.0216	0.00010	mg/L	0.0200		108	80-120			
Nickel, total	0.0209	0.00040	mg/L	0.0200		105	80-120			
Phosphorus, total	1.98	0.050	mg/L	2.00		99	80-120			
Potassium, total	2.01	0.10	mg/L	2.02		100	80-120			
Selenium, total	0.0203	0.00050	mg/L	0.0200		102	80-120			
Silicon, total	2.2	1.0	mg/L	2.00		110	80-120			
Silver, total	0.0223	0.000050	mg/L	0.0200		112	80-120			
Sodium, total	1.85	0.10	mg/L	2.02		92	80-120			
Strontium, total	0.0236	0.0010	mg/L	0.0200		118	80-120			
Sulfur, total	5.5	3.0	mg/L	5.00		109	80-120			
Tellurium, total	0.0221	0.00050	mg/L	0.0200		110	80-120			
Thallium, total	0.0222	0.000020	mg/L	0.0199		112	80-120			
Thorium, total	0.0224	0.00010	mg/L	0.0200		112	80-120			
Tin, total	0.0226	0.00020	mg/L	0.0200		113	80-120			
Titanium, total	0.0200	0.0050	mg/L	0.0200		100	80-120			
Tungsten, total	0.0222	0.0010	mg/L	0.0200		111	80-120			
Uranium, total	0.0230	0.000020	mg/L	0.0200		115	80-120			
Vanadium, total	0.0225	0.0010	mg/L	0.0200		113	80-120			
Zinc, total	0.0215	0.0040	mg/L	0.0200		108	80-120			
Zirconium, total	0.0209	0.00010	mg/L	0.0200		104	80-120			
Reference (B0H0214-SRM1)				Prepared: 2020-08-05, Analyzed: 2020-08-06						
Aluminum, total	0.325	0.0050	mg/L	0.299		109	70-130			
Antimony, total	0.0606	0.00020	mg/L	0.0517		117	70-130			
Arsenic, total	0.146	0.00050	mg/L	0.119		123	70-130			
Barium, total	0.891	0.0050	mg/L	0.801		111	70-130			
Beryllium, total	0.0531	0.00010	mg/L	0.0501		106	70-130			
Boron, total	3.41	0.0500	mg/L	4.11		83	70-130			
Cadmium, total	0.0541	0.000010	mg/L	0.0503		108	70-130			
Calcium, total	10.7	0.20	mg/L	10.7		100	70-130			
Chromium, total	0.286	0.00050	mg/L	0.250		114	70-130			
Cobalt, total	0.0445	0.00010	mg/L	0.0384		116	70-130			
Copper, total	0.514	0.00040	mg/L	0.487		105	70-130			
Iron, total	0.540	0.010	mg/L	0.504		107	70-130			
Lead, total	0.317	0.00020	mg/L	0.278		114	70-130			
Lithium, total	0.426	0.00010	mg/L	0.398		107	70-130			
Magnesium, total	3.58	0.010	mg/L	3.59		100	70-130			
Manganese, total	0.121	0.00020	mg/L	0.111		109	70-130			
Molybdenum, total	0.218	0.00010	mg/L	0.196		111	70-130			
Nickel, total	0.265	0.00040	mg/L	0.248		107	70-130			
Phosphorus, total	0.261	0.050	mg/L	0.213		123	70-130			
Potassium, total	6.43	0.10	mg/L	5.89		109	70-130			
Selenium, total	0.135	0.00050	mg/L	0.120		112	70-130			
Sodium, total	8.75	0.10	mg/L	8.71		100	70-130			
Strontium, total	0.470	0.0010	mg/L	0.393		120	70-130			
Thallium, total	0.0930	0.000020	mg/L	0.0787		118	70-130			
Uranium, total	0.0385	0.000020	mg/L	0.0344		112	70-130			
Vanadium, total	0.449	0.0010	mg/L	0.391		115	70-130			

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO	Associated Environmental Consultants Inc. (Vernon)	**WORK ORDER**	0072931
PROJECT	SCRD Phase 4A GW Investigation	**REPORTED**	2020-08-10 15:30

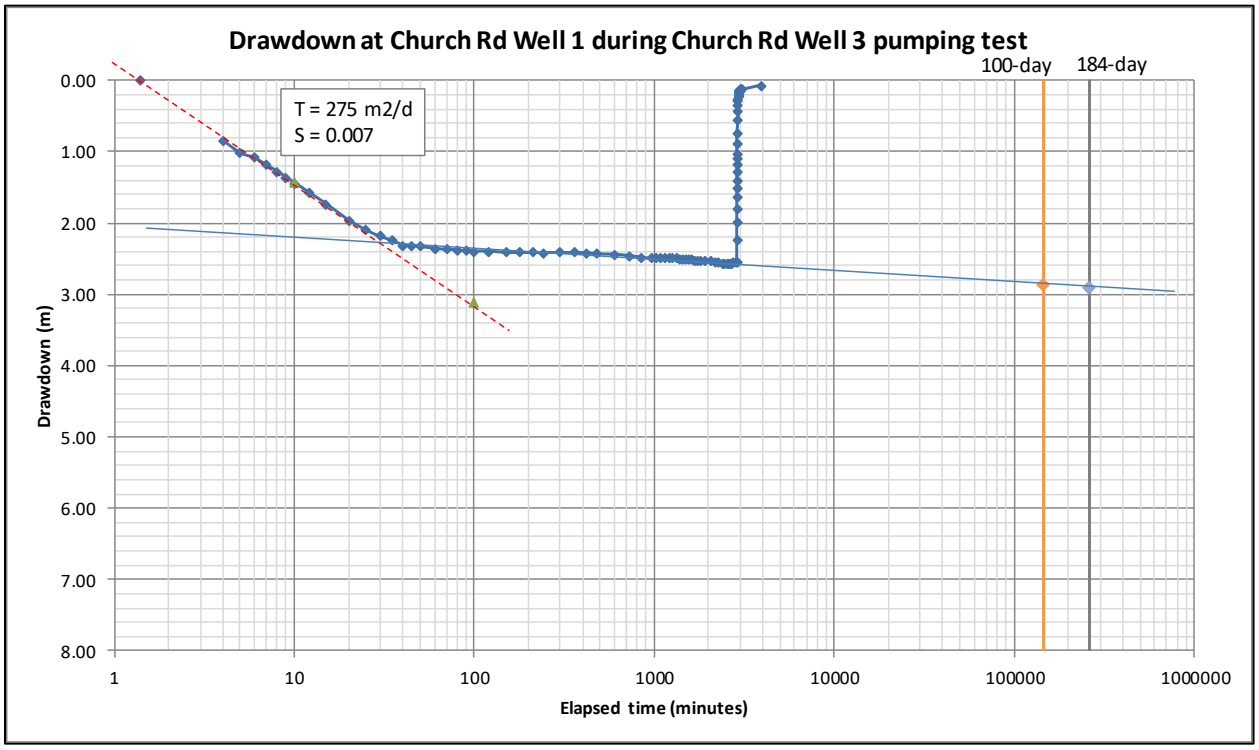
Analyte	Result	RL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Total Metals, Batch B0H0214, Continued										
Reference (B0H0214-SRM1), Continued				Prepared: 2020-08-05, Analyzed: 2020-08-06						
Zinc, total	2.64	0.0040	mg/L	2.50		106	70-130			

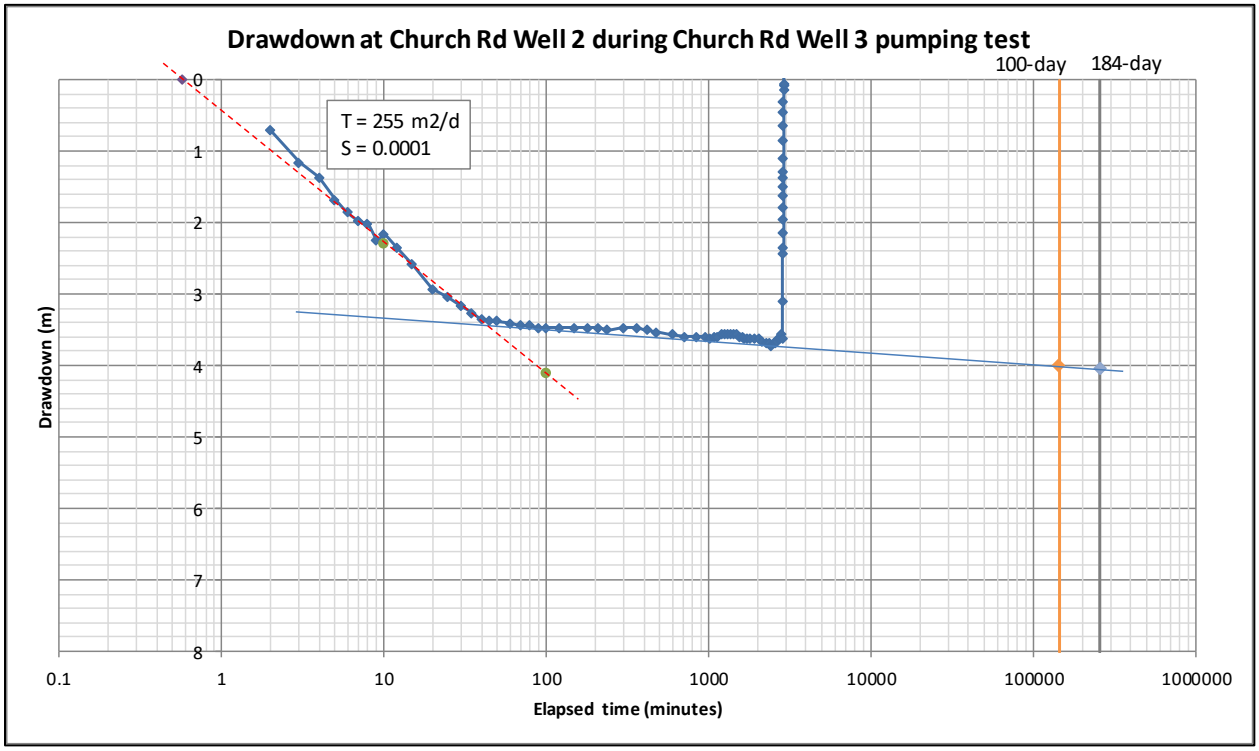
QC Qualifiers:

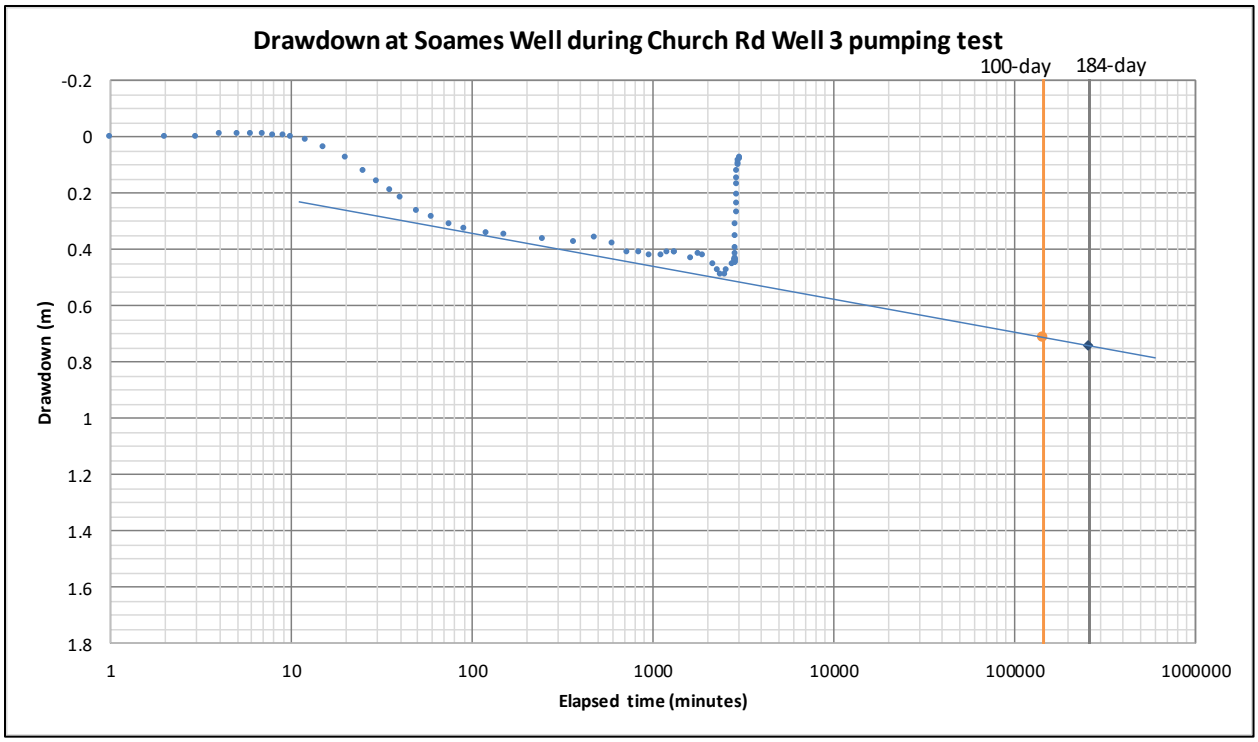
BLK	Analyte concentration in the Method Blank is above the Reporting Limit (RL).
MIC29	The difference in logs is less than the R value.

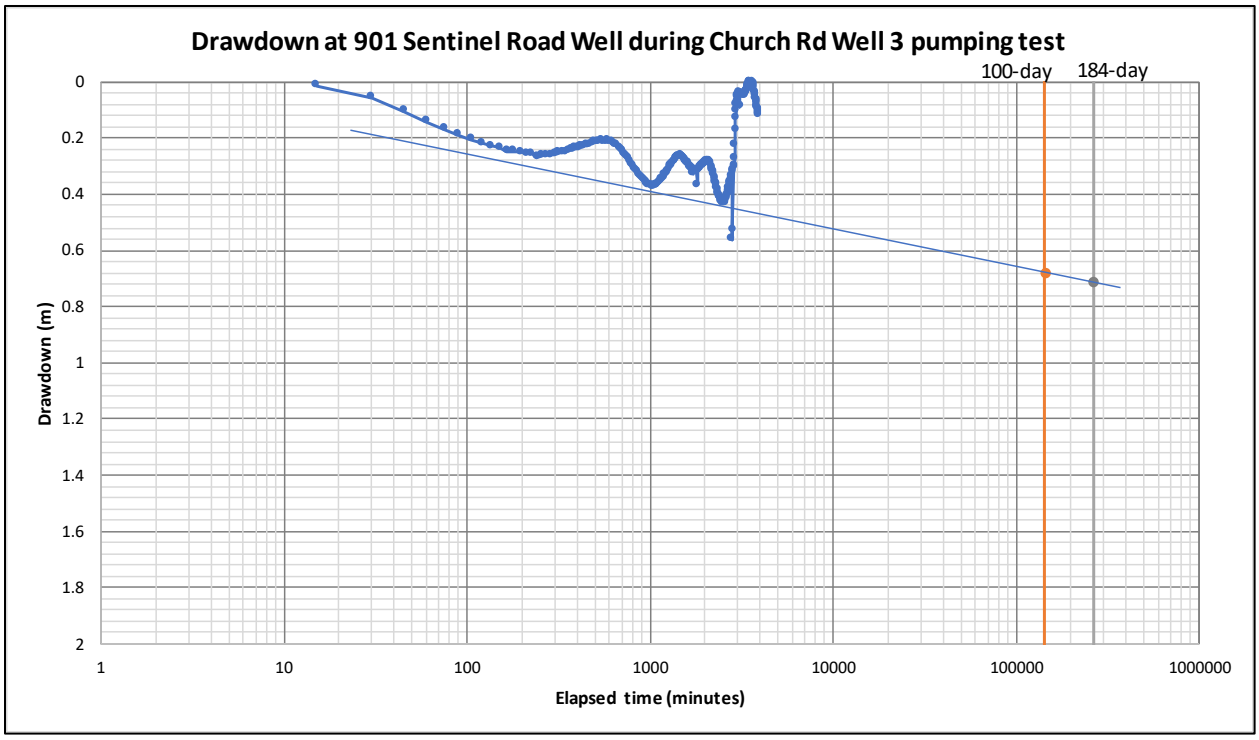
APPENDIX B - CHURCH ROAD WELL 3 - PUMPING TEST FIGURES

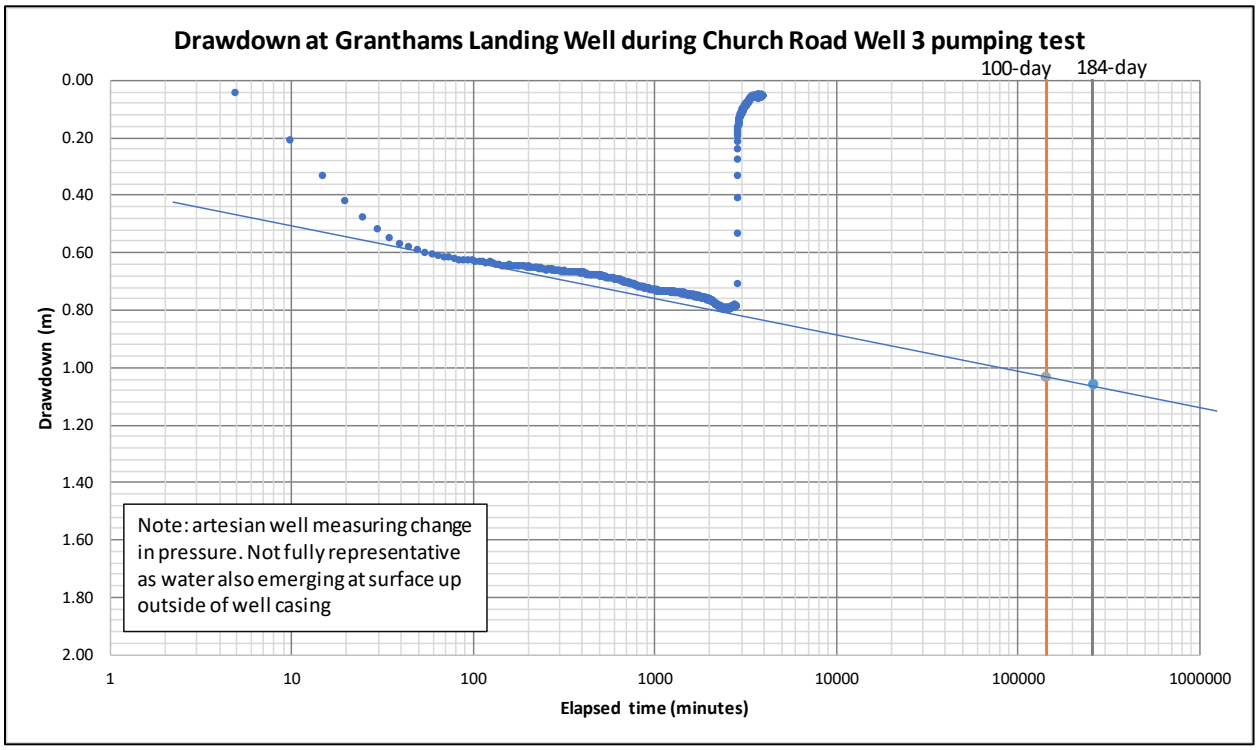
APPENDIX B – Observation well water drawdown during Church Road Well 3 Pumping Tests

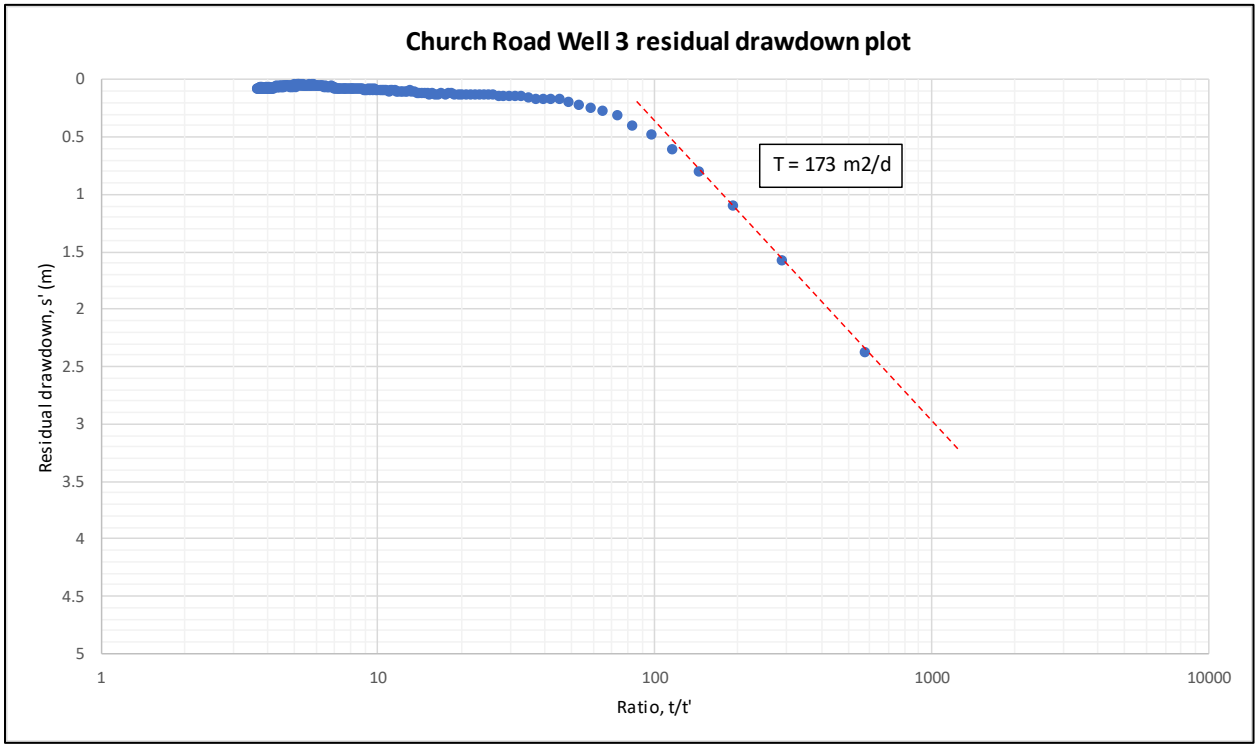


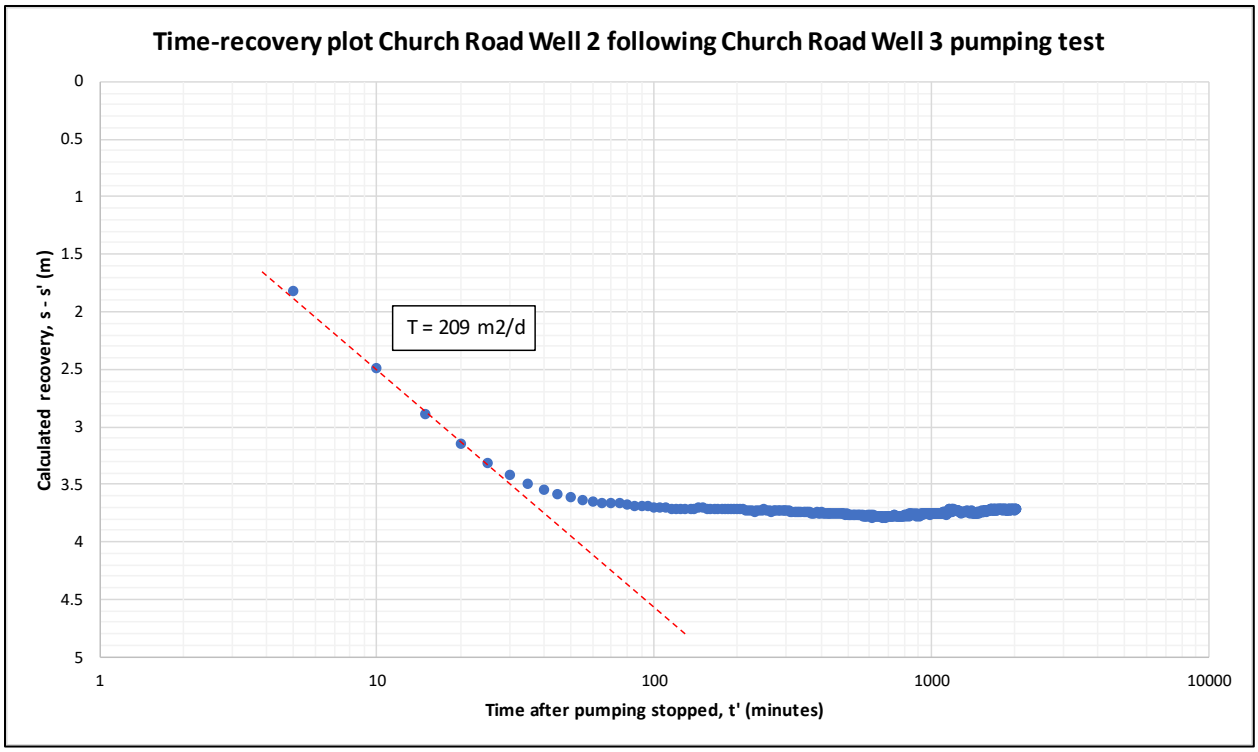



Drawdown at Soames Well during Church Rd Well 3 pumping test
100-day
184-day
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
Drawdown (m)
1
10
100
1000
10000
100000
1000000
Elapsed time (minutes)


Drawdown at 901 Sentinel Road Well during Church Rd Well 3 pumping test
100-day
184-day
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Drawdown (m)
1
10
100
1000
10000
100000
1000000
Elapsed time (minutes)

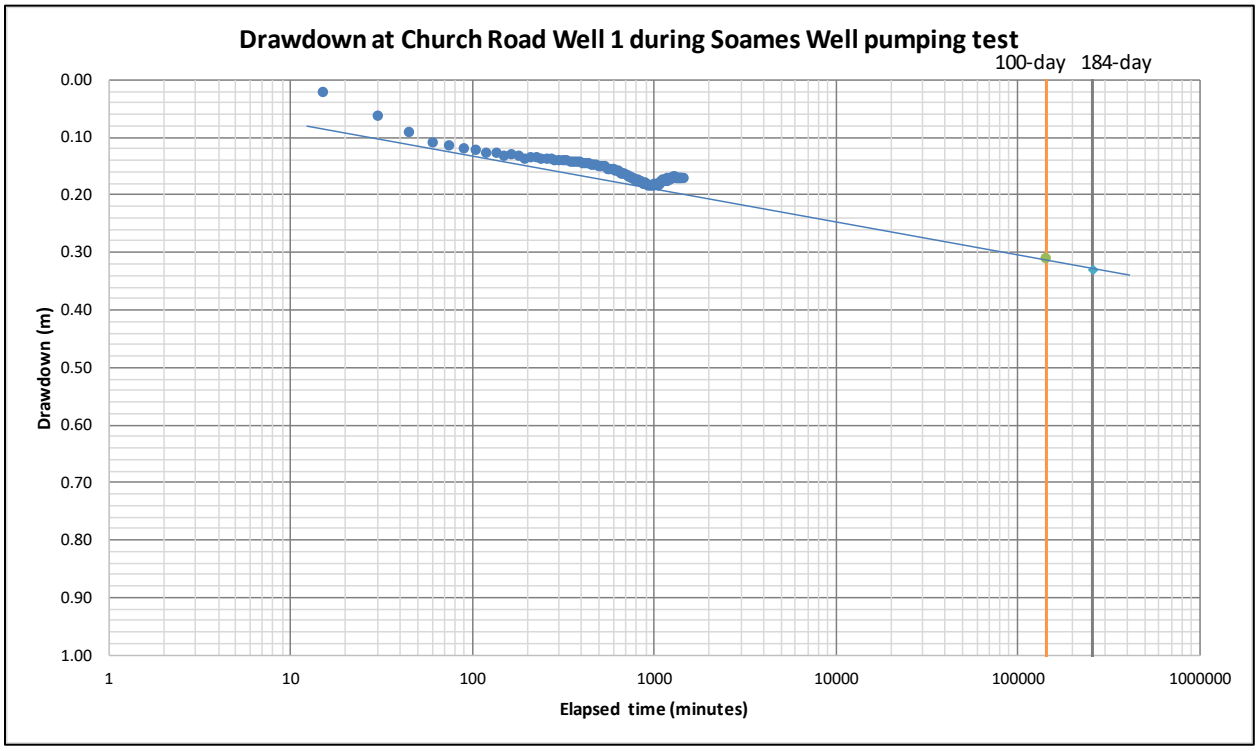

Drawdown at Granthams Landing Well during Church Road Well 3 pumping test
100-day
184-day
Drawdown (m)
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1.80
2.00
Note: artesian well measuring change in pressure. Not fully representative as water also emerging at surface up outside of well casing
1
10
100
1000
10000
100000
1000000
Elapsed time (minutes)

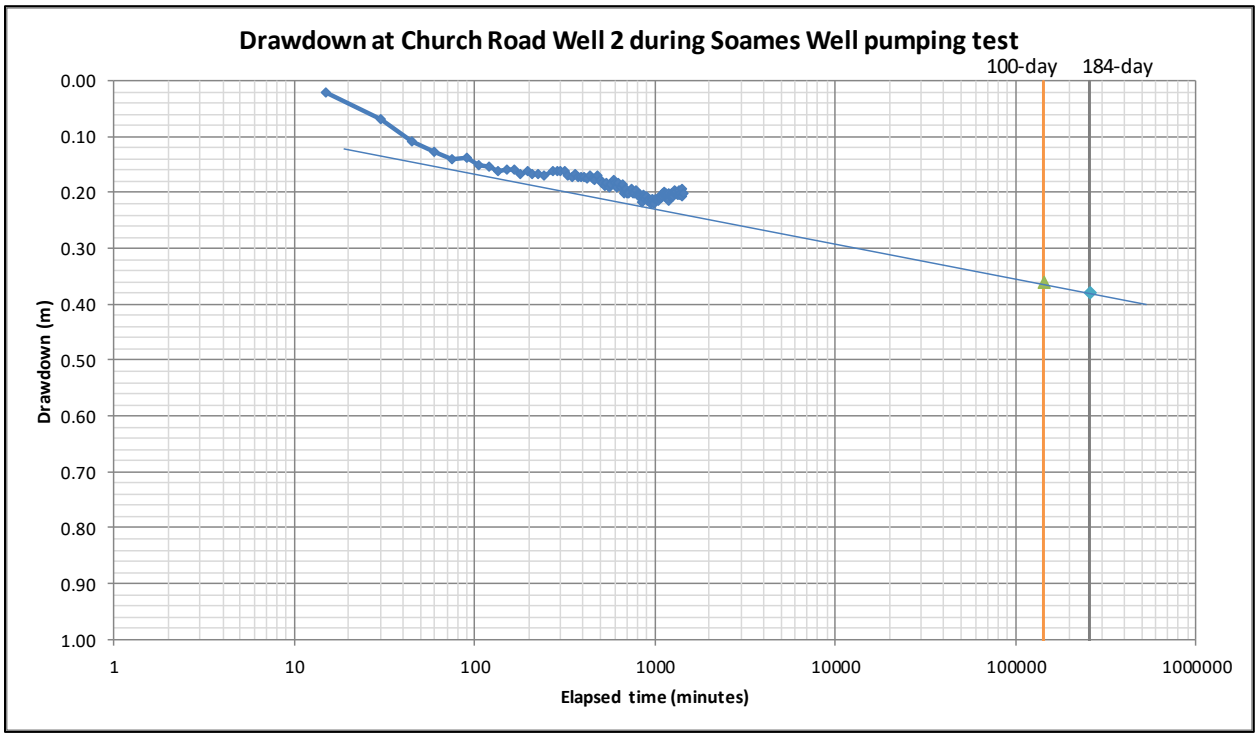

Church Road Well 3 residual drawdown plot
Residual drawdown, s' (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
T = 173 m2/d
1
10
100
1000
10000
Ratio, t/t'

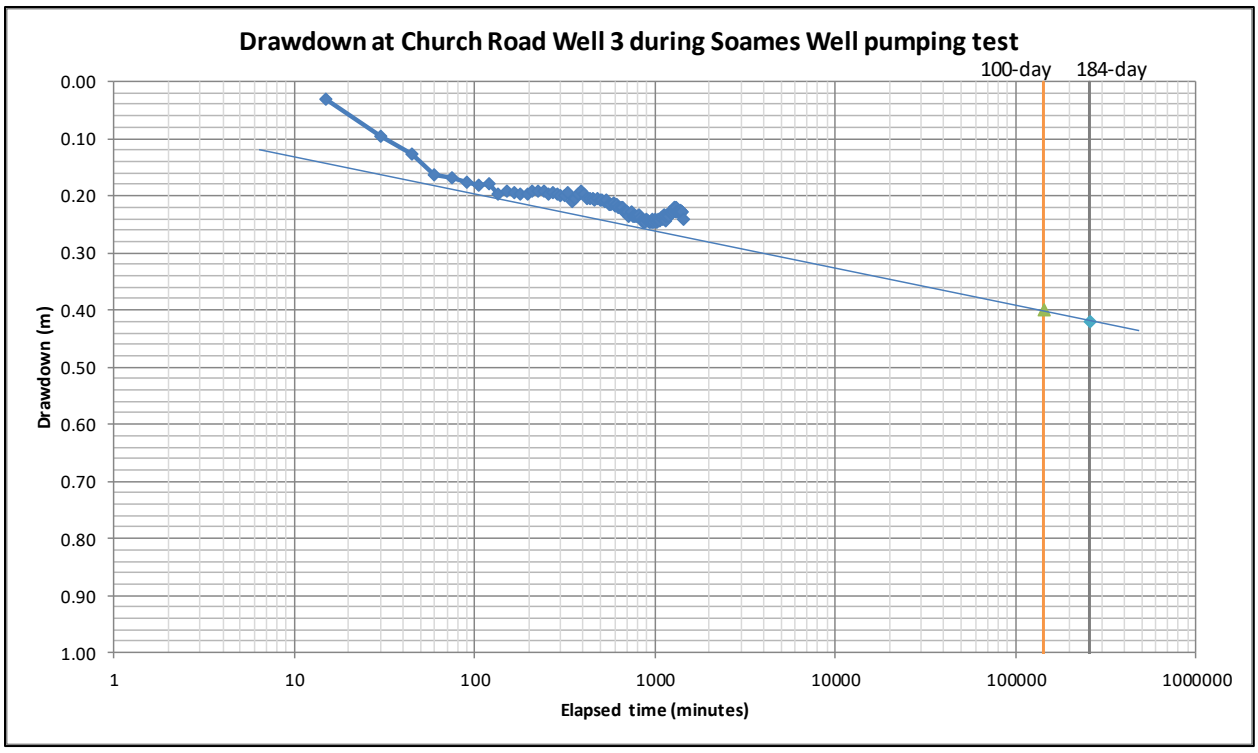

Time-recovery plot Church Road Well 2 following Church Road Well 3 pumping test
Calculated recovery, s - s' (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
T = 209 m2/d
1
10
100
1000
10000
Time after pumping stopped, t' (minutes)

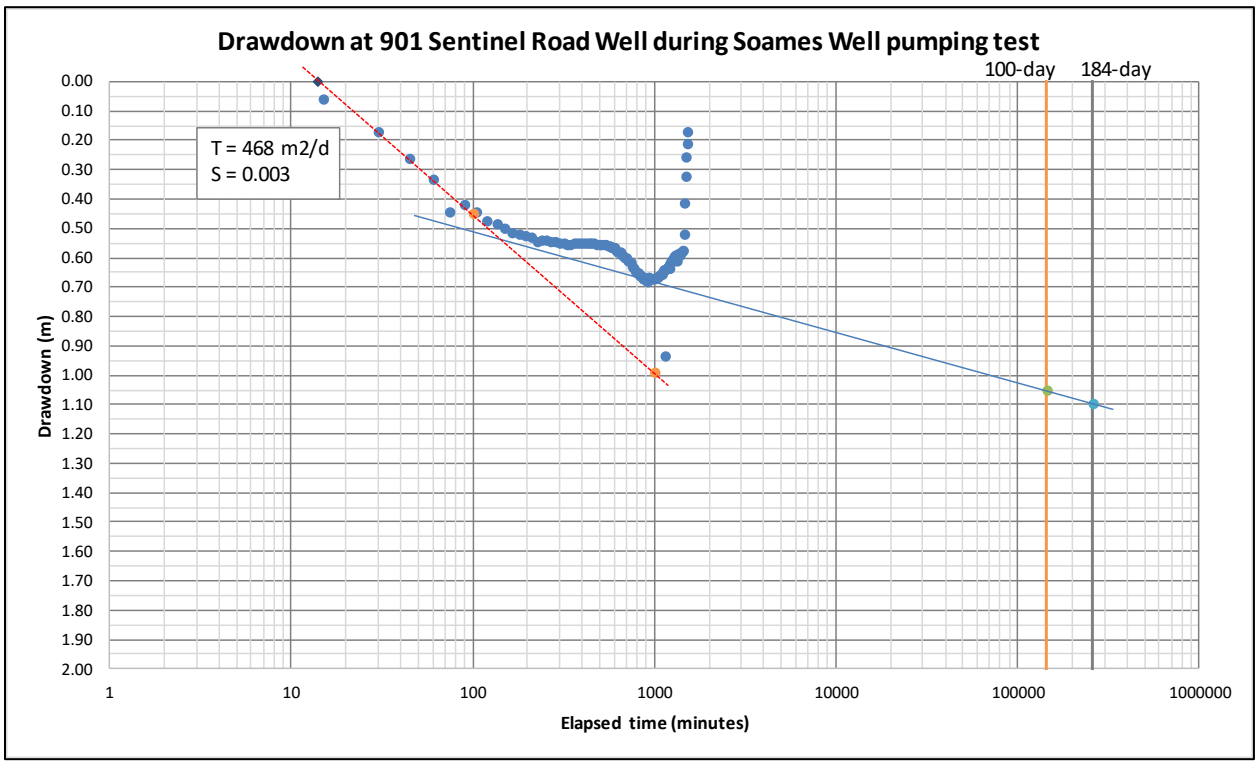
APPENDIX C - SOAMES WELL - PUMPING TEST FIGURES

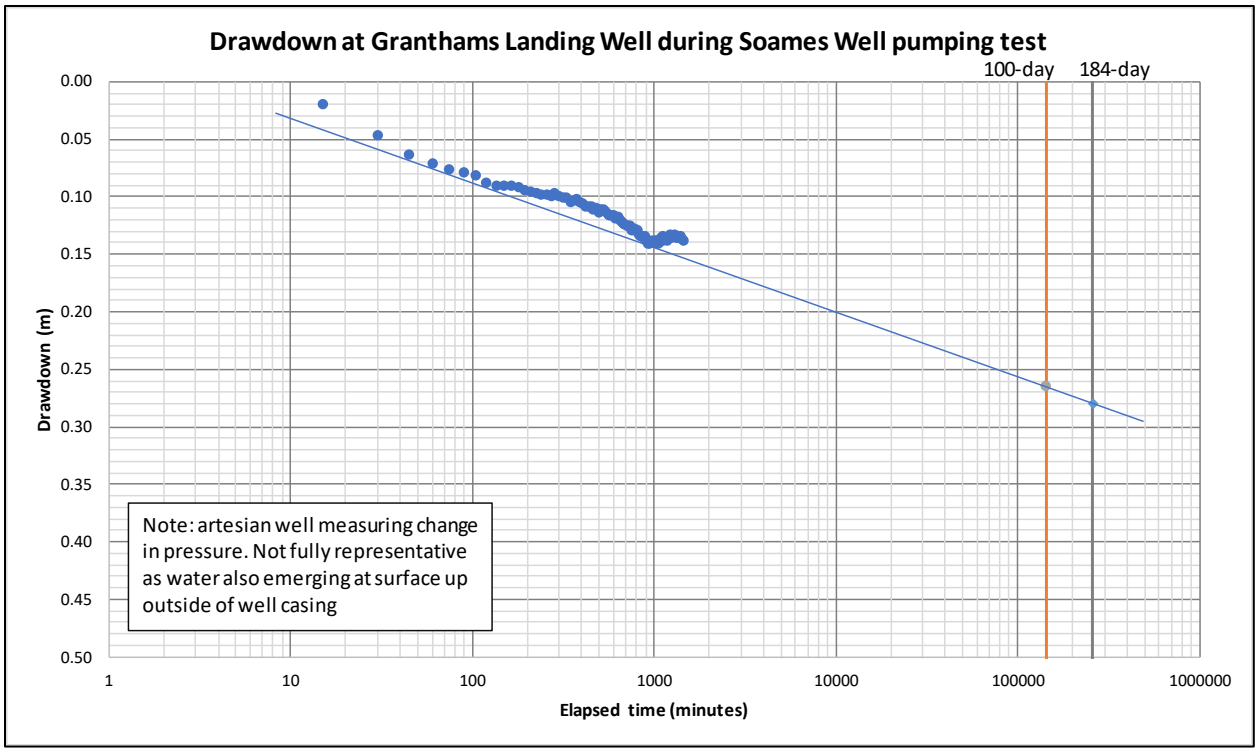
APPENDIX C – Observation well water drawdown during Soames Well Pumping Tests






Drawdown at Church Road Well 3 during Soames Well pumping test
100-day
184-day
Drawdown (m)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1
10
100
1000
10000
100000
1000000
Elapsed time (minutes)


Drawdown at 901 Sentinel Road Well during Soames Well pumping test
100-day
184-day
T = 468 m2/d
S = 0.003
Drawdown (m)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
1.40
1.50
1.60
1.70
1.80
1.90
2.00
1
10
100
1000
10000
100000
1000000
Elapsed time (minutes)


Drawdown at Granthams Landing Well during Soames Well pumping test
100-day
184-day
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45
0.50
Drawdown (m)
Note: artesian well measuring change in pressure. Not fully representative as water also emerging at surface up outside of well casing
1
10
100
1000
10000
100000
1000000
Elapsed time (minutes)