Environment Act Proposal
Town of Beausejour Water Treatment Plant Upgrade

May 2020

The Manitoba Water Services Board

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Executive Summary

The Town of Beausejour has requested The Manitoba Water Services Board (MWSB) to prepare an Environment Act Proposal for a Class 2 Development Licence under the Manitoba Environment Act for an upgrade of the Water Treatment Plant (WTP). The expansion and upgrade involves the following:

1. Installation of a supply pipelines and two new raw water supply wells southwest of Beausejour;
2. Construction of a new Beausejour WTP and reservoir;
3. Construction of a dual-train membrane treatment unit with two blend greensand filters to supply the existing town distribution system, and;
4. Construction of a 2.8 km concentrate water pipeline from the WTP to the Brokenhead River at PR44, east of Beausejour.

The proposed upgrades will allow the Town to improve their water supply with a softened treated water, as the existing WTP at the end of its usable life span and is unable to meet the projected future 20-year demand. This EAP is submitted for the proposed infrastructure, and specifically for the new raw water supply wells and concentrate water discharge.

The Town of Beausejour with a population of 3,219 (Census 2016), is supplied potable water from the aging WTP which must be replaced to continue to supply a reliable and safe source of drinking water to the Town.

The proposed expansion includes the construction of a new dual-train 36 L/s WTP in Beausejour using groundwater wells as a water supply from the carbonate aquifer, and the construction of a new 2,900 m^3 reservoir to connect to the existing distribution system (Stantec, 2018).

The proposed treatment process consists of an integrated membrane system including a combination of reverse osmosis and nanofiltration elements, as well as greensand filtration bypass to provide blend water. Concentrate water will be discharged through a 2.8 km pipeline into the Brokenhead River. With the proposed expansion the operating capacity of the Beausejour WTP will increase from 23 to 36 L/s and provide a reliable water source for the public water system for the foreseeable future.

List of Acronyms

AO	Aesthetic Objective
CIP	Clean-in-Place
DBP	Disinfection By-Product
DWSA	Drinking Water Safety Act
EAP	Environment Act Proposal
GCDWQ	Guidelines for Canadian Drinking Water Quality
GUDI	Groundwater Under Direct Influence of Surface Water
MWSB	Manitoba Water Services Board
NF	Nanofiltration
ODW	Office of Drinking Water
OS	Operational Statements
PR	Public Road
RM	Rural Municipality
RO	Reverse Osmosis
TDS	Total Dissolved Solids
THM	Trihalomethane
TOC	Total Organic Carbon
UV	Ultraviolet
WTP	Water Treatment Plant

1.0 Introduction

The Town of Beausejour requested The Manitoba Water Services Board (MWSB) to prepare an Environment Act Proposal for a Class 2 Development Licence under the Manitoba Environment Act for an upgrade of the Water Treatment Plant (WTP) in the Town of Beausejour. This document provides the compiled information required on Manitoba Conservation's Environment Act Proposal Report Guidelines and Supplementary Guidelines for Municipal Water Supply Systems. This Environment Act Proposal includes components of the raw water wells and concentrate disposal and pipeline.

1.1 Background Information

The Town of Beausejour is located approximately 50 km northeast of Winnipeg with a population of 3,219 in the 2016 census. The Town of Beausejour receives raw water from a fractured limestone aquifer, which supplies water to the public water system from an aging WTP. Raw water is currently pumped from one of three wells. Well 1 is 34.4m deep and is located inside of the existing WTP building with a maximum capacity of 9.5 L/s, but it is no longer in use. Well 2 is 25.9 m deep, and located south of the existing reservoir with a maximum capacity of 15 L/s. Well 3 is 36.5 m deep and serves as the regular production well located east of the existing reservoir with a maximum capacity of 22.5 L/s (JRCC, 2017). The WTP was originally constructed in 1957, and currently has a rated treatment capacity of 22.5 L/s (Beausejour, 2017). In 2016, the maximum day demand from the Town was 942.5 m^3 (JRCC, 2017). Two distribution pumps supply water to the distribution system and/or the water tower depending on pressure and demand.

The water treatment process involves sand pressure filtration to remove iron and manganese, prior to disinfection with chlorine gas. Raw water is pumped to the WTP building, where compressed air is injected to oxidize dissolved iron. Raw water is filtered in three parallel 1.68 m diameter filters in series to remove the oxidized iron. Water is chlorinated for disinfection before it is stored in a round 2,500 m^3 concrete treated water reservoir. A water tower with a capacity of 285 m^3 maintains distribution system pressure near 44 psi, though areas of insufficient pressure exist in the system. The distribution pumping system comprises of two duty pumps and a fire pump, which are controlled by the water level in the water tower. The two duty pumps have a capacity of 22.7 L/s and the natural gas fire pump has a capacity of 44.2 L/s which is also used to supply the system during power outages (JRCC, 2016).

The existing WTP was constructed in 1957 with upgrades in 1962, 1976 and 1995, and has limited capacity to supply the needs of the Town into the future, as a steady growth rate is currently experienced and is projected to further increase. The plant does not include a water softening process, resulting in a large number of residential water softeners in the community (JRCC, 2017). The *Town of Beausejour Public Water System Assessment* (KGS Group, 2009) notes the filters have exceeded their typical service life. Considering the significant challenges presented by operating and maintaining a 56 year old WTP, the aging water plant requires an immediate upgrade.

1.1.1 Previous Studies

The following previous reports have been reviewed in preparation of this Environment Act Proposal.

Beausejour Water & Wastewater Assessment Study, **JR Cousin Consultants Ltd., 2016**

In 2016, JR Cousin Consultants Ltd. (JRCC) was retained by MWSB to examine the Town of Beausejour Water and Wastewater System and presented options and alternatives for upgrading the existing infrastructure and treatment process.

Hydrogeological Assessment of the Carbonate Aquifer as a Municipal Water Supply for the Town of Beausejour, **Friesen Drillers Ltd., 2016**

In August 2016, Friesen Drillers Ltd. was retained by the Town of Beausejour to study the geology and hydrogeology of the region including the Town of Beausejour. Through aquifer pumping tests on each well, it was determined that drawing water from the same aquifer that is currently in use will be sufficient for the proposed WTP. This conclusion was based upon the aquifer water levels and the groundwater quality.

- The report recommended that continued monitoring of the aquifer should be undertaken. The pumping test determined that increasing groundwater withdrawal to 575 acre feet/year is possible, but will require a new Water Rights Licence (WRL). The Town will also be required to properly abandon the existing wells.
- Although aquifer conditions proved to be sufficient, test drilling at the test wells were unable to develop an appropriate installation that could supply water for the proposed development.

Town of Beausejour – Water Distribution Model Study, **JR Cousin Consultants, 2017**

In December 2017, JRCC was retained by MWSB on behalf of the Town to prepare a Water Distribution Model Study for the Town of Beausejour that used a hydraulic model to determine the best options for upgrading the existing infrastructure.

- The existing water treatment plant (WTP) in Beausejour was constructed in 1957 with upgrades in 1962, 1976, and 1995, and though it currently meets requirements, the aging infrastructure needs to be updated to avoid failure. JRCC states that currently only a single aging pipe leaves the WTP, so any leaks that occur will shut down the Town's entire water system. Of the three wells, only two are currently operational. Therefore, further development will add additional stress to the aged system and eventually exceed the plant's capacity. It was also noted that according to the *Town of Beausejour Public Water System Assessment* by KGS in 2009 that the existing filters are past their intended service life, distribution pumps and motors are now obsolete, and the electrical system is outdated and difficult to maintain given the inability to find replacement parts.

- Water is treated through a pressure filtration process prior to being disinfected with chlorine and stored in the treated reservoir and water tower. The reservoir is a two-cell concrete reservoir with a 2,500 m^3 capacity, and the 285 m^3 water tower is proposed to be taken down upon completion of the upgrade.

***Town of Beausejour Water Treatment Plant Design – Preliminary Design Report,* Stantec Consulting Ltd., 2018**

In August 2018, MWSB on behalf of the Town of Beausejour retained Stantec Consulting Ltd. (Stantec) to complete functional and detailed design including tender drawings and specifications for the proposed project. A technical memorandum developed treatment processes and reservoir configuration. A desired future peak raw water pumping rate of 42 L/s is proposed to allow for future demand.

- The proposed treatment system is a dual train nanofiltration/reverse osmosis membrane treatment process with bypass manganese greensand filters. A 27.5 L/s permeate treatment rate with 8.5 L/s manganese greensand filtrate was determined to be the most effective option to meet treated water quality objectives.
- The proposed method of dealing with produced waste streams is to discharge the membrane concentrate water to the Brokenhead River via forcemain, and the greensand backwash to be discharged to the sewer.
- Upon assessment, it was determined that it is not ideal to re-use the existing reservoir due to its age and outdated standards of construction, along with significant capital investment to connect the existing reservoir to the new WTP.

***Hydrogeological Test Work – Town of Beausejour Groundwater Supply Secondary Test Site,* Friesen Drillers Ltd., 2019**

In 2018, Friesen drillers was retained by MWSB to undertake test drilling for additional municipal wells. The test wells were drilled within the Town near the existing WTP site. The results were unfavourable for the development of additional municipal production wells, and significant additional drilling and reconciliation of past drilling and reports concluded that sufficient water was not available in the Town. Friesen Drillers recommended additional test work be conducted at a secondary location just southwest of the Town. The test results indicate favourable hydrogeological conditions for the development of additional municipal use wells. Further testing at the Pescitelli Road location is recommended.

Hydrogeological Test Work – Supplemental Municipal Groundwater Supply – Town of Beausejour, **Friesen Drillers Ltd., 2020**

In 2019, Friesen drillers was retained by MWSB on behalf of the Town to complete a well inventory, installation of two production wells, and a hydrogeological report of their findings to supply the new WTP. In early 2020, two production wells were installed on Pescitelli Road south and west of the Town. A 72-hour pump test was completed on the west well, and a shorter confirmatory pump test was completed on the east well, with results demonstrating the feasibility of utilizing the new wells as a sustainable source to supply the new Beausejour WTP. The report is appended as part of the submission for the requirements for the Environmental Approvals for the raw water withdrawal.

1.1.2 Population

Based on the 2016 Census, the Town of Beausejour has a population of 3,219, a 2.9% increase from 3,126 in 2011. Based on discussion with the Town and MWSB, Stantec projected that the population in the Town will increase over the next few years at an annual population growth rate factor of 1.6% per year. A 20-year population of approximately 4,640 is projected for the Town (Stantec, 2018) as shown in *Figure 1.1* below.

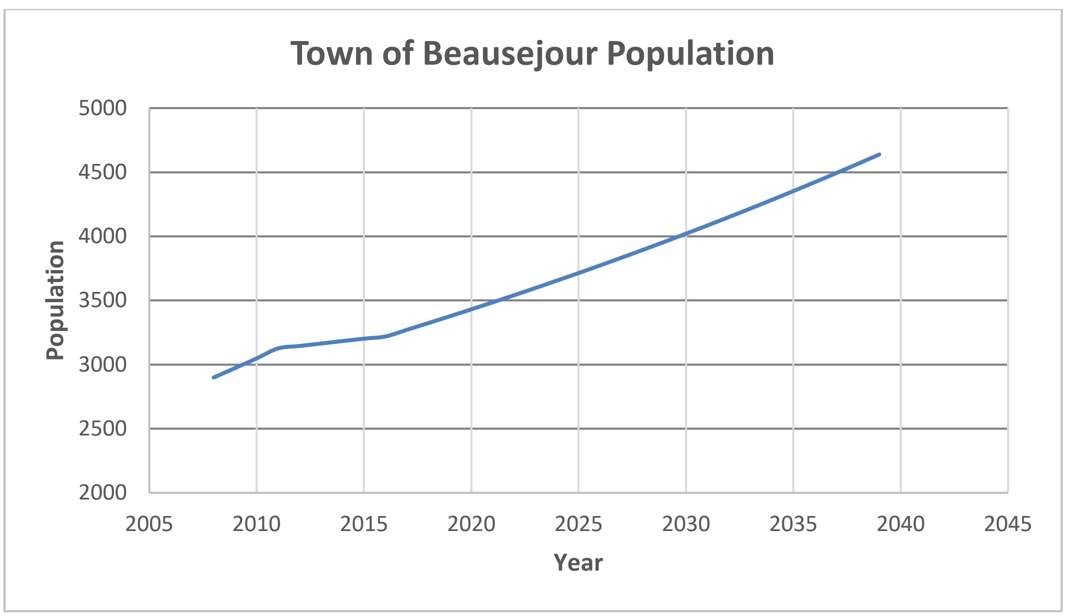

FIGURE 1.1 – TOWN OF BEAUSEJOUR POPULATION PROJECTION

1.1.3 Current and Projected Water Use

A WTP is designed based on peak-day demand. When calculating water consumption, typical average daily water usage ranges from 250 L/person/day to 300 L/person/day and peak day usage (peak day factor) is typically 1.5 to 2.0 times greater. Based on historical water consumption records, a 260 L/capita/day water usage and a peak day factor of 2.0 were utilized (Stantec, 2018).

The average day 20-year projected demand for the system is 1,206,400 L/day (Stantec, 2018). The current peak day treated water demand for Beausejour is 17.5 L/s (JRCC, 2016). The projected 2038 peak-day demand for the system is 33.5 L/s (Stantec, 2018). The new WTP will provide a reservoir which satisfies the required water storage, chlorine contact disinfection time, and emergency fire storage for a Class 5 WTP (240 L/s) with a total storage capacity of 2,900 m^3. The projected treated water demands are summarized in *Table 1.1* below.

TABLE 1.1 – PROJECTED TREATED WATER DEMAND FOR THE TOWN OF BEAUSEJOUR

Projected Treated Water Demand for the Town of Beausejour Water System		
	Quantity	**Units**
2016 Population	3,219	Capita
2038 Population (@1.6% Growth/yr)	4,640	Capita
Consumption/Capita/Day	260.0	L/c/day
2038 Average Day Consumption	1,206,400	L/day
2038 Average Day Demand	16.8	L/s
Peak Day factor	2.0	-
2038 Peak Day Consumption	2,412,800	L/day
2038 Peak Day Demand (20-hour operating day)	33.5	L/s

1.1.4 Raw Water Source

Three wells provide the raw water supply for the Town of Beausejour from a fractured limestone aquifer, the Lower Carbonate Aquifer. The water-bearing zone interface varies, but lies approximately 23 m below the ground surface. The major recharge area for this aquifer is located within the Sandilands sand and gravel moraine complex east of Beausejour (Friesens, 2020). The three existing wells were drilled in 1957, 1962, and 1995 and are located in the WTP, just south of the existing reservoir, and just east of the existing reservoir respectively on the WTP property. The operation of the wells is activated by the water level in the water tower, and the original well is no longer in use. The well screens are approximately 23-26 m below the ground level in the fractured limestone. Based on the analysis, the wells are classified as non-GUDI wells (Friesen Drillers, 2016).

The new well site located on Pescitelli Road consists of two wells located 800m apart on the south side of the municipal road right-of-way. The East well is located to the west of Road 41E and 71N (Pescitelli Road) and the West well is located 800m west.

The East well was constructed utilizing a 305mm casing to a depth of 21.3m and the well reached a total depth of 36.3m into the carbonate aquifer. The well was grouted with concrete and sealed with bentonite and included a well cap and seal until the final installation is completed during construction which will include a pitless unit, bollards to protect the well-head, and mounding to ensure surface runoff from the surrounding area does not approach to the pitless unit and casing.

The West well was constructed utilizing a 305mm casing to a depth of 27.1m and the well reached a total depth of 44.2m into the carbonate aquifer. The well was grouted with concrete and sealed with bentonite and included a well cap and seal until the final installation is completed during construction which will include a pitless unit, bollards to protect the well-head, and mounding to ensure surface runoff from the surrounding area does not approach to the pitless unit and casing.

Both wells were noted to be producing clean water and located in the aquifer where clean factures existed, and produced significant yields sufficient to supply the proposed WTP project. Complete details are provided in the appended report.

1.1.5 Water Rights Act

The Town of Beausejour utilizes Water Rights License No. 2005-023 (previously License No. 95-08). The Licence allows the maximum instantaneous rate of withdrawal to be 22.8 L/s and a maximum annual usage of 450 dam^3/yr from the aquifer.

In 2016, Friesen Drillers Ltd. completed a hydrogeological assessment of the carbonate aquifer as a municipal water supply for the Town of Beausejour. From water use records, the Town is currently using 80-100% of their annual allowance. An instantaneous pumping rate of 42 L/s is required for the proposed system to supply the projected maximum day demands. The estimated 20-year treated water demand is 16.8 L/s average day and 33.5 L/s peak day (Stantec, 2018). The WTP has been designed as a 36 L/s WTP. *Table 1.2* summarizes the projected raw and treated water demand for the Town of Beausejour.

TABLE 1.2 – PROJECTED TREATED WATER DEMAND FOR THE TOWN OF BEAUSEJOUR WTP

	Treated Demand	Raw Demand	Units
Instantaneous Withdrawal	36.0	42.0	L/s
Average Consumption	17.9	21.0	L/s
Annual Allocation	564,494,400	662,256,000	L/year
Annual Allocation	564,494.4	662,256.0	m^3/year
Annual Allocation	564.5	662.3	dam^3/year

According to the current Water Rights Act Licence, the maximum rate at which water may be diverted instantaneously shall not exceed 22.8 L/s and the total annual usage of water diverted in any one year shall not exceed 450 cubic decameters. As *Table 1.2* indicates, the demand will exceed the allowable withdrawal of the current Water Rights Licence, and a new licence will be required. In conjunction with the raw water exploration, Friesen's Drillers on behalf of the Town have applied for a Groundwater Exploration Permit (GEP) for the new sites. A new WRL will be applied for in conjunction with the installation of the new raw water supply system by Friesen Drillers to request an annual allocation of 540 acre-ft./year (667 dam3/year).

The Office of Drinking Water (ODW) currently conducts annual audits of all public water systems which includes sampling and chemistry analysis every three years for secure groundwater sources and once per year for surface water and GUDI supply systems. In addition, the operator tests chlorine residuals daily on the treated water. The water quality analysis can be found summarized in *Table 1.4* on the following page. Water from the new wells is within the range of parameters experienced in the existing raw water quality data.

No raw water quality parameters currently exceed the GCDWQ maximum acceptable concentration health requirements. However, hardness, iron, and manganese all exceed the current or proposed GCDWQ aesthetic objectives. Treated water quality parameters at the existing treatment plant exceeding the GCDWQ aesthetic objectives include hardness and total dissolved solids (TDS). The existing treatment system does not reduce hardness and TDS below the acceptable aesthetic objectives; hardness levels are described as 'poor, but tolerable'. The proposed treatment system upgrade will remove hardness, iron, manganese and ammonia levels to meet aesthetic requirements, and address the Langelier Saturation Index (LSI) and pH.

The proposed WTP upgrade will draw water from the same source as the existing plant, however the proposed treatment process will provide a softened water source to meet all current regulations under the DWSA and the GCDWQ.

TABLE 1.4 WATER QUALITY RESULTS (2018)

Parameter	Unit	GCDWQ	Existing Wells Raw Water	Existing Treated Water	New Wells Raw Water
Alkalinity (Total)	mg/L		308 - 330	327	318 – 435
Ammonia	mg/L		0.15 - 0.184	<0.010	0.146 – 0.228
Arsenic	mg/L	≤ 0.01 ALARA**	0.00276 - 0.00311	0.00044	0.00459 – 0.00509
Calcium	mg/L		69.4 - 77.8	74.0	63.2 – 94.9
Conductivity	umhos/cm		702 – 883	844	638 – 844
Fluoride	mg/L	≤ 1.5	0.19 - 0.4	0.265	0.221 – 0.266
Hardness (Total) $CaCO_3$	mg/L	200/500a	**339 – 374**	**356**	**353 – 497**
Iron	mg/L	≤ 0.3	**1.09 – 1.39**	0.019	**0.94 – 2.38**
Lead	mg/L	< 0.005 ALARA**			<0.000050 – 0.00107
Manganese	mg/L	≤ 0.05/ 0.02	**0.0224 – 0.0245**	0.0174	0.0155 – 0.0584
Nitrate-N	mg/L	≤ 10	< 0.005 – 0.016	0.170	<0.020
pH	pH units	6.5-8.5	7.52 – 8.26	7.72	7.52 – 7.81
Sodium	mg/L	200	20.6 – 36.5	43.4	17.2 – 25.4
Sulfate	mg/L	500	59.6 – 64	67.8	29.7 – 61.3
Total Dissolved Solids	mg/L	500	453 – 472	**507**	372 – 431
Total Organic Carbon	mg/L	-	< 1.0 – 2.0	1.73	1.96 – 2.84
True Color	CU	15	< 5.0 - 5.0	<5.0	<5.0
Turbidity	NTU	≤ 0.3 / 0.1[c]	14.9 – 18	0.14	3.86 – 92.0
Uranium	mg/L	≤ 0.02	0.0003 – 0.00051	0.00049	0.000548 – 0.000604

[a] Hardness levels greater than 200 are considered poor but tolerable. Hardness levels greater than 500 are generally considered unacceptable
[b] THM based on average of quarterly samples
[c] Turbidity limits as follows: 1.0 NTU for slow sand or diatomaceous earth filtration, 0.3 NTU for chemically assisted filtration, and 0.1 NTU for membrane filtration; Turbidity results measured in the lab may reflect oxidation of the sample during transit and field testing would be required to verify results.
*Turbidity is a physical property that must be measured on site. It is anticipated that on site testing would demonstrate that the high turbidity recorded is a result of the high iron content oxidizing and precipitating in the raw water during transit.
[DLA]Detected Limit Adjusted for required dilution
*Manganese MAC and AO levels proposed to become 0.05 and 0.02 respectively in future.
** ALARA: As Low As Reasonably Achievable

1.1.6 Compliance Plan

A compliance plan to address all outstanding regulatory issues has not been completed for the existing WTP. The proposed WTP project will satisfy all outstanding compliance issues.

2.0 Description of Proposed Development

2.1 Project Description

The proposed development includes:

- The construction of two new raw water production wells southwest of Beausejour including well mechanization and 300mm raw water supply pipeline;
- Construction of a new 36.0 L/s WTP and 2,900 m^3 reservoir including a dual–train membrane treatment process with side–stream manganese greensand filters;
- Connection to existing treated water distribution system;
- Construction of 2.8 km of 150mm diameter concentrate water discharge pipeline from the WTP to the Brokenhead River.

The existing WTP, wells, reservoir, and water tower will be decommissioned once the proposed membrane treatment system is operational. The treated water from the new WTP will connect to the existing treated water distribution system to distribute to residents throughout the Town.

Figure 2.1 below shows the location of the new WTP site with respect to the existing WTP. The development also requires approval to discharge concentrate water to the Brokenhead River, proximate to the PTH44 Bridge 2.0 km east of Beausejour. The proposed discharge route and location can be found in *Appendix A*.

FIGURE 2.1 – LOCATION OF WTP (GOOGLE EARTH, 2018)

2.1.1 Water Source

Water will be supplied from the carbonate groundwater aquifer which has supplied Beausejour since 1957. With the past operating history of the system, the quantity, quality, reliability and sustainability has been demonstrated for 63 years. Additional testing has been completed to demonstrate the efficacy of the system for the foreseeable future.

2.1.1.1 Well Installations

Friesen Drillers Ltd. completed pumping tests of each municipal supply well to determine the capacity of the carbonate aquifer. Since the existing well field will be abandoned, the significant work surrounding these wells and the search for new wells at the existing site is only covered more thoroughly in the appended report (See Section 3). It is important to note however, that pressure transducers monitoring the well activity during the exploratory pump tests showed a uniform pattern of groundwater drawdown and recovery. Analysis of the data provided a preliminary estimate of transmissivity for the aquifer of 25,000 usgpm/ft. (Friesen Drillers, 2016). Additional pump testing at the new well site has shown much higher transmissivity of 250,000 usgpm/ft. (Friesen Drillers, 2020).

The overlying geology of the area consists of interlayered clay and till with local deposits of sand and gravel. Boulders have also been encountered in numerous boreholes in the Beausejour region. The carbonate aquifer bedrock ranges from depth of 21.3 – 30.5m below grade, while the top of the Winnipeg Formation sandstone formation lies near 42.7m below grade.

As part of the upgrade there will be the installation of new production wells with adequate pumping capacity to satisfy the 42 L/s projected future demand. The new production wells will be equipped with pitless units, mechanized, and protected from surrounding runoff and vehicular traffic, and will operate similarly to the existing wells. The proposed location of the new production wells and proximity to the proposed WTP location is shown in *Figure 2.2* below.

FIGURE 2.2 - NEW PRODUCTION WELLS LOCATION (GOOGLE EARTH, 2019)

2.1.1.2 Raw Water Quality

During the 72-hour pump test, water samples were collected and submitted for laboratory analysis to characterize the raw water quality of the aquifer. The results indicated that the aquifer is suitable water for membrane treatment which will produce high quality treated water. The water quality summary is as shown above in *Table 1.4.* The results of the water analysis are consistent with previous tests performed over the past few decades, indicating that the aquifer yields consistent water quality. The geochemistry of the groundwater suggests that it is non-GUDI as affirmed by Friesen's Drillers Ltd. (2020). The wells are also considered to be installed in a confined aquifer and is not in artesian condition. Development of groundwater at the test well site is therefore unlikely to induce significant changes to the water quality as the water demonstrates isotope characteristics of geologically-young water (Friesen Drillers, 2020). The complete raw water analysis can be found in *Appendix D*.

2.1.1.3 Water Treatment Plant

The Town of Beausejour WTP is classified as a Class 2 Water Treatment Facility. The existing 23 L/s pressure filtration treatment system will be replaced with a 36.0 L/s dual train membrane treatment process with a side-stream blend through manganese greensand filters. The proposed membrane filtration process with primary and secondary disinfection through gaseous chlorine is effective in protecting against viruses and cysts such as Cryptosporidium oocysts and Giardia lamblia cysts, and removing hardness, lead, arsenic, nitrates, total dissolved solids, iron, manganese and softening the water to acceptable concentrations. The process will effectively remove the aesthetic parameters of hardness, iron and manganese. The upgraded treatment system will supply the projected 20-year population demand of the Town while treating water that meets the GCDWQ and the Drinking Water Safety Act.

The detailed design of the proposed WTP has been completed with all anticipated requirements of environmental approval. Designs will be finalized for tender once the Environment Act Licence has been received and funding has been secured.

The existing treatment system will be decommissioned once the new system is fully operational and commissioned, and the old treatment equipment will be removed from the existing WTP building. Membrane concentrate accounts for 16% of the total raw water flow through the WTP. Using a 16% concentrate rate and a 20.4% by-pass through a pressure filter results in an instantaneous raw water demand of 41.8 L/s. *Figure 2.2* illustrates a schematic of the proposed treatment process producing 36.5 L/s of treated water to satisfy the projected 20-year demand.

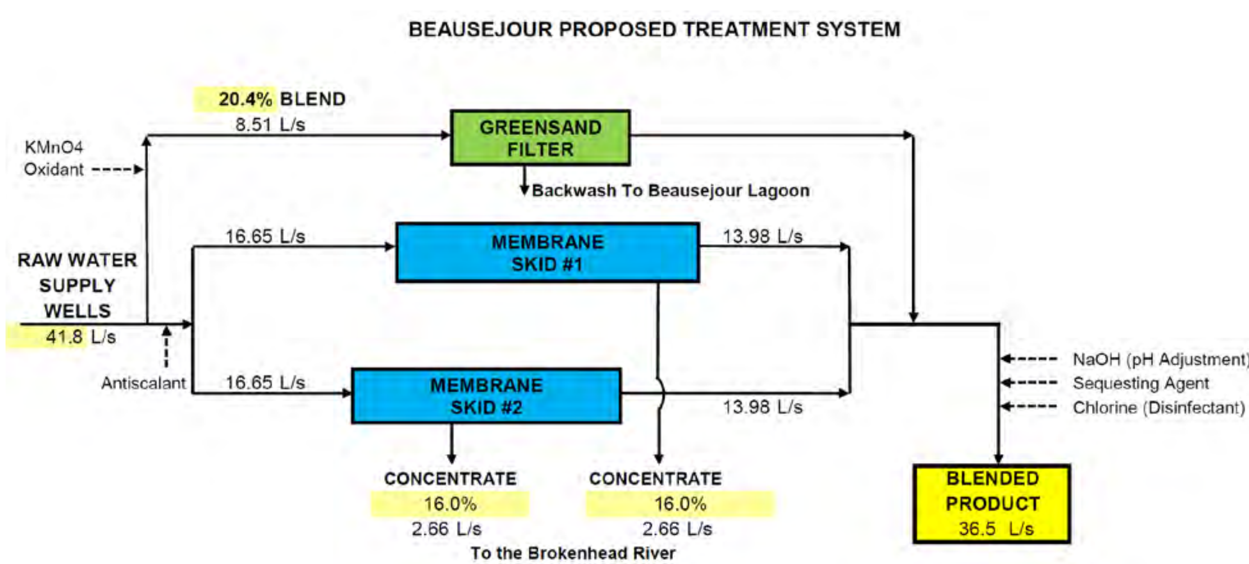

FIGURE 2.2 – PROPOSED TREATMENT PROCESS

The membrane system will be designed to reduce hardness ions to range between 80 – 120 mg/L $CaCO_3$). Membrane systems remove a significant portion of the dissolved minerals. In order to achieve an aesthetically–acceptable level of hardness, approximately 20% of the raw water flow will by-pass the membrane unit and receive treatment in a greensand pressure filter to be blended with treated membrane permeate following removal of iron and manganese. Alone, membrane permeate is generally chemically unstable and benefits from the addition of filtered greensand bypass water and/or caustic soda to adjust the pH to a suitable level within the distribution system. The blend flow will be set to increase the longevity of the membranes and decrease operational costs.

For design purposes, membrane system projections from Delco Water have been utilized to predict ion concentrations in the treated permeate, blended, and concentrate water. Raw water quality from the production well was used as inputs for the model. A detailed projected analysis is included in *Appendix E*.

2.1.1.4 Backwash and Concentrate Disposal

Membrane systems generate a mineralized concentrate stream. Concentrate streams vary between 10%-30% of the total flow from membrane systems depending on the arrangement and type of membranes selected. The proposed membrane system was modeled for an 85% recovery with 15% of the flow through the membrane unit being concentrated (Stantec, 2018).

It is proposed that membrane concentrate be discharged to the Brokenhead River through a 2.8 km 150 mm diameter pipeline.

2.1.1.5 Operation and Maintenance

The Town is responsible for operation and maintenance of the well site, WTP, and concentrate discharge. An operator is required to periodically inspect that system performance is maintained. In addition, the operators will be required to submit bi-weekly water samples for bacteriological testing in accordance with the Manitoba *Drinking Water Quality Standards Regulation*. Operators will read customer watermeters on a quarterly basis and respond to maintenance issues related to the system.

Operators will be required to operate the facility in a safe and efficient manner in accordance with relevant operations manuals and Drinking Water Safety Act regulations. Operation requirements will include measurements, monitoring, sampling, testing, record-keeping and reporting. Operators will be required to do Clean-In-Place (CIP) maintenance initiated on trans-membrane pressure drop and change Membrane Treatment Unit (MTU) pre-filters. In addition, operators must ensure the equipment is inspected and properly maintained. Operators will receive training during the commissioning phase by the selected equipment supplier, Delco Water.

Other typical operating costs include; chemicals, maintenance personnel, electricity costs, general repairs, water and bacteriological testing, and a reserve fund for future membrane replacement or expansion and staff certification and training. Operating and maintenance costs are recovered through the sale of water in the distribution system.

2.2 Certificate of Title

The WTP will be constructed on land owned by the Town of Beausejour. A Certificate of Title is attached in Appendix F.

The raw water wells and mechanization infrastructure will be installed in the municipal right-of-way (ROW) within the Rural Municipality of Brokenhead. The RM has been involved with discussions and is in favour of the proposed locations. Raw water supply pipeline will be installed along municipal ROW along Pescitelli Road and on land owned by the Town. Easements will be requested if necessary to facilitate the installation of the pipeline.

The concentrate water pipeline will be installed along provincial ROWs on Park Avenue and PTH 44. Approval from the Highways Department has been obtained. Easements will be requested if necessary to facilitate the installation of the pipeline.

2.3 Mineral rights

All mineral rights associated with lands for the existing and proposed new facilities belong to the Crown.

2.4 Existing and Adjacent Land Use

The proposed land for the development will be on municipal and provincially owned land in road right-of-ways. Existing and adjacent land use will not change as a result of this development.

2.5 Land Use Designation and Zoning

The proposed land for development will be government road allowances and land adjacent to the development is predominately agricultural. Zoning designation for this development is not applicable.

2.6 Project Schedule

The development of the water treatment plant project is anticipated to occur as a single phase project. The project is scheduled to commence in 2020 or 2021 depending on the availability of funding and the receipt of all approvals.

2.7 Project Funding

Funding has not yet been secured for this project. Funding from the Federal and Provincial governments will be required to proceed with the works.

2.8 Regulatory Approvals

The following branches/departments will be provided with copies of plans and specifications for information purposes and for the purposes of approvals and agreements:

Manitoba Conservation and Water Stewardship (if required for a drain crossing)
Office of Drinking Water
Manitoba Infrastructure and Transportation

The contractor will be required to contact telephone, Hydro, gas, and telecom utilities for utility locations and approvals.

2.9 Public Consultation

A public consultation, and borrowing bylaw hearing has been held to present information and discuss the proposed WTP upgrade to the residents of the Town of Beausejour as a part of the Borrowing Bylaw. Resident's concerns were heard and responses were provided to their questions.

2.10 Storage of Petroleum Products and Other Chemicals

Fuel will not be stored on-site at any time or location along the proposed construction route or near any well. Fuel will be supplied by fuelling trucks which are regulated under The Storage and Handling of Petroleum Products and Allied Products Regulation. Records of fuel volumes and an emergency response plan which includes spill prevention, notification and response will be implemented. No fuelling activities will be permitted within 100m of watercourses during construction. During construction, the contractors will be required to ensure that all equipment is properly maintained to prevent leaks of fuel and motor fluids.

There will be no storage of petroleum products or other chemicals at any of the well sites during operation of the proposed development. Maintenance activities for the wells do not require refuelling on-site. Chemicals associated with the operation of the existing plant (alum, hypochlorite and potassium permanganate) and new plant (antiscalant, hypochlorite, cleaning chemicals, sequestering agent, and sodium hydroxide) will be stored in designated areas within the plant complete with spill containment. General household cleaning products will also be stored at this site.

2.11 Duty to Consult

The proposed project does not involve any federally owned or Reserve lands. The Brokenhead Ojibway Nation (Brokenhead 4 Indian Reserve) is 32 km north of the Town and is the nearest First Nation to the site.

3.0 Physical Environment

3.1 Physiographic Setting and Climate

The Town of Beausejour is located in southeastern Manitoba, about 50 km northeast of Winnipeg. The topography of the area has some slight elevation changes varying between 248 and 237 m geodetic elevation.

Based on Environment Canada climate data, the mean annual temperature in the area is approximately 3 degrees Celsius with below zero average daily temperatures from November through March. Although the station closest to Beausejour has no recorded data since 2005, precipitation records over the past decade for Oakbank and Pinawa (approximately 50 km west and east of Beausejour respectively) are presented in *Figure 3.1* below. Mean annual precipitation was found to be 590 mm/year during this period (Environment Canada, 2018).

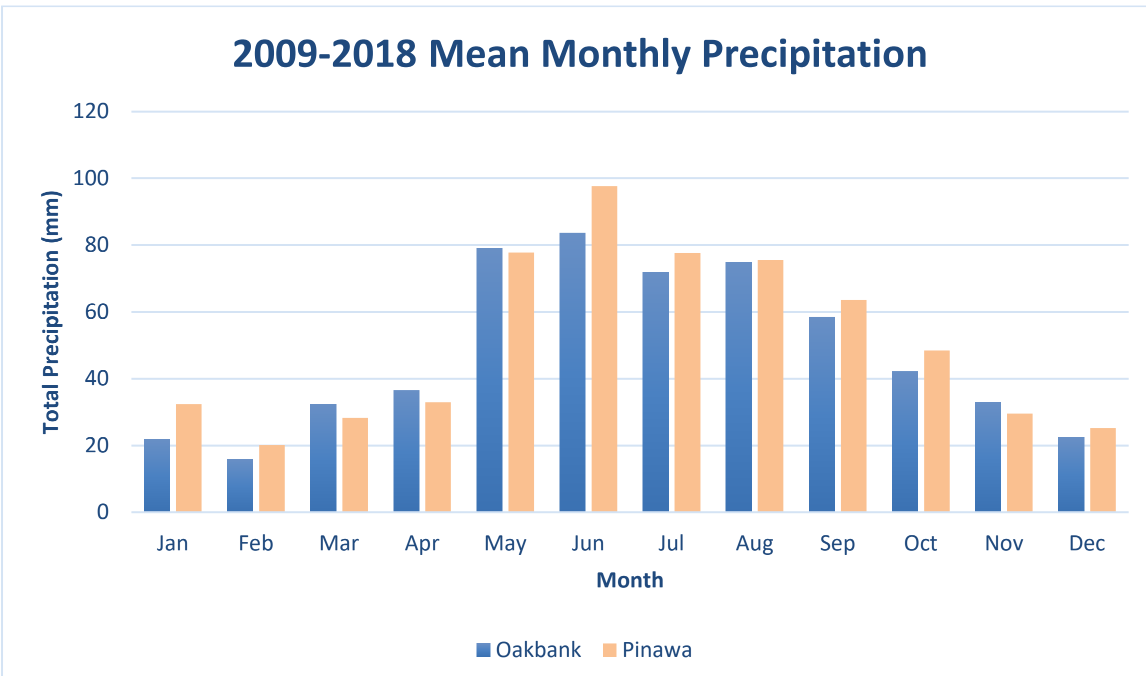

FIGURE 3.1 - 2009-2018 MEAN MONTHLY PRECIPITATION

3.2 Hydrogeology

Early investigations of the hydrogeology of the area have identified the area to be under the Western Canadian Sedimentary Basin hydrogeological region of Canada, in southeastern Manitoba. The bedrock beneath the Town of Beausejour consists of basal Winnipeg Formation shale and sandstone, with overlying Red River Formation dolomitic limestone, deposited upon Precambrian granites. The key aquifer in this area is the Red River Formation Aquifer (Friesen Drillers, 2016).

The Red River Formation Aquifer is the current water source for the existing three groundwater wells and the new wells also withdraw water from the same zone. An investigation by Friesen Drillers Ltd. was completed to determine the effects of further development within this aquifer. A diagram of the regional hydrogeology and local recharge zones can be found in *Appendix B*.

Investigations of this aquifer through pumping the existing wells have provided an estimate of the transmissivity of the aquifer as 250,000 USGPD/ft. The full range of the aquifer's transmissivity, its storativity value, project pumping rate, recharge mechanism, discharge mechanism, drawdown and sustainability of the well has been determined through the full scale pumping tests completed by Friesen Drillers in 2020. The complete report is included in *Appendix G*. The report recommended that the wellfield is able to supply the requested 667 dam^3/year of annual allocation at a pumping rate of 42 L/s. It also noted that the drawdown of the proposed wells will be within the historical natural groundwater fluctuation and no impacts on surrounding users is anticipated.

The carbonate aquifer which the proposed wells have been installed into receives recharge from the Sandilands sand and gravel moraine complex located to the east of Beausejour. The report demonstrated that the groundwater levels are influenced by the precipitation received, and that interconnectivity of the major aquifers has not been observed. On-going testing in the future is recommended to affirm the effectiveness of the aquitards at preventing surface water intrusion into the aquifer. The report concluded that due to the 400 km^2 recharge area of the aquifer and given the precipitation, annual usage, and high transmissivity, the aquifer is able to sustainably supply the proposed development for Beausejour.

3.3 Hydrology

The Brokenhead River is a major tributary that runs through the Town of Beausejour, discharging into Lake Winnipeg.

The land within the immediate area of the Town of Beausejour is generally of low relief (Friesen Drillers, 2016). The available information indicates that the likely natural discharge point for groundwater flowing through the Town of Beausejour in the shallow surface geology is the Brokenhead River, leading to Lake Winnipeg. Flows on the Brokenhead River are monitored by the Water Survey of Canada at Station 05SA002, with data up to 2018, with 2017 data missing. Flow data is not recorded when ice covers the river. The Brokenhead River has a gross drainage area of 1580 km^2. Mean monthly flows varied from 2.724 m^3/s to 16.146 m^3/s over the 2006-2018 period (2724 – 16146 L/s). Mean discharge data for the Brokenhead River can be found summarized below in *Table 3.1* (Environment Canada, 2020).

Table 3.1 – BROKENHEAD RIVER – 2006-2018 MEAN MONTHLY DISCHARGE

	March	April	May	June	July	August	September	October
2006	0.374	28.8	9.46	3.88	0.506	0.089	0.053	0.566
2007	3.18	11.9	15.8	41.9	14.1	1.04	0.387	6.06
2008	0.151	9.93	8.1	8.87	2.97	0.989	1.26	2.98
2009	4.41	26.5	21.1	21.4	22.4	19.1	14.4	4.24
2010	5.41	6	17.2	38.5	21	5.37	19.1	14
2011	1.59	44.1	28.4	18.7	2.73	0.117	0.194	0.116
2012	1.61	2.56	2.85	3.39	0.442	0.229	0.078	0.69
2013	0.419	3.62	18.6	10.1	1.55	0.158	0.030	0.073
2014	-	8.33	21.4	14.4	12.2	1.72	0.927	1.01
2015	2.81	2.51	10.2	8.7	8.79	8.86	11.3	4.07
2016	9.82	19.9	11.5	19.1	19.7	7.19	13.3	8.18
2018	0.194	0.772	1.08	4.81	4.06	0.156	0.159	1.51
Average (m^3/s)	2.724	13.744	13.808	16.146	9.204	3.752	5.099	3.625
Minimum (m^3/s)	0.151	0.772	1.080	3.390	0.442	0.089	0.030	0.073
Maximum (m^3/s)	9.820	44.100	28.400	41.900	22.400	19.100	19.100	14.000

**Note: 2017 flow data missing from database.*

The projected discharge concentrate flow rate from the membrane unit is 5.3 L/s. The Brokenhead River experiences high seasonal mean monthly flows that range between 2,700 L/s in March and 17,200 L/s in June with a recorded maximum as high as 163,000 L/s in March 1974 during partially dry conditions (Environment Canada, 2016). The proposed 5.3 L/s concentrate represents 0.19% of the flow on the month with the lowest average flow of 2,724 L/s. During the months of November to February flows are not recorded as the ice prevents measurement of the flow. It is anticipated however, that generally there will be a low-flow period during the months of December-February. The discharge of the concentrate is through a discharge pipe with orifice holes installed on the bottom of the river to allow for an even discharge into the receiving waters. While some ice cover will surround the discharge point, open water may persist into the winter depending on flow, however, no detrimental effects are anticipated from the discharge of membrane concentrate.

The concentrate flow from the WTP will undergo significant mixing upon entering the Brokenhead River. The contributions of the concentrate at low flow are of the most concern. Though the concentrate can be considered to be a minor contributor to the overall base flow of the Brokenhead River during average flow, discharge must be acceptable during the periods of lowest flow. Water from the Brokenhead River was sampled, and chemistry from the river was used to determine the concentrate blend effects on the receiving body of water as shown in *Table 3.2* below. The minimum mean monthly flow during 2006-2018 was 30 L/s (0.030 m^3/s), however, a 7Q10 or 4-day average, 3-year minimum flow as required by the *Manitoba Water Quality Standards, Objectives, and Guidelines* of 20.75 L/s which was utilized as the governing Brokenhead River flow rate for this analysis. The filter backwash with higher iron concentrations will be discharged to the sewer collection system into the Town of Beausejour lagoon.

Figure 3.2 below shows daily discharge characteristics for the Brokenhead River near Beausejour (Station 05SA002).

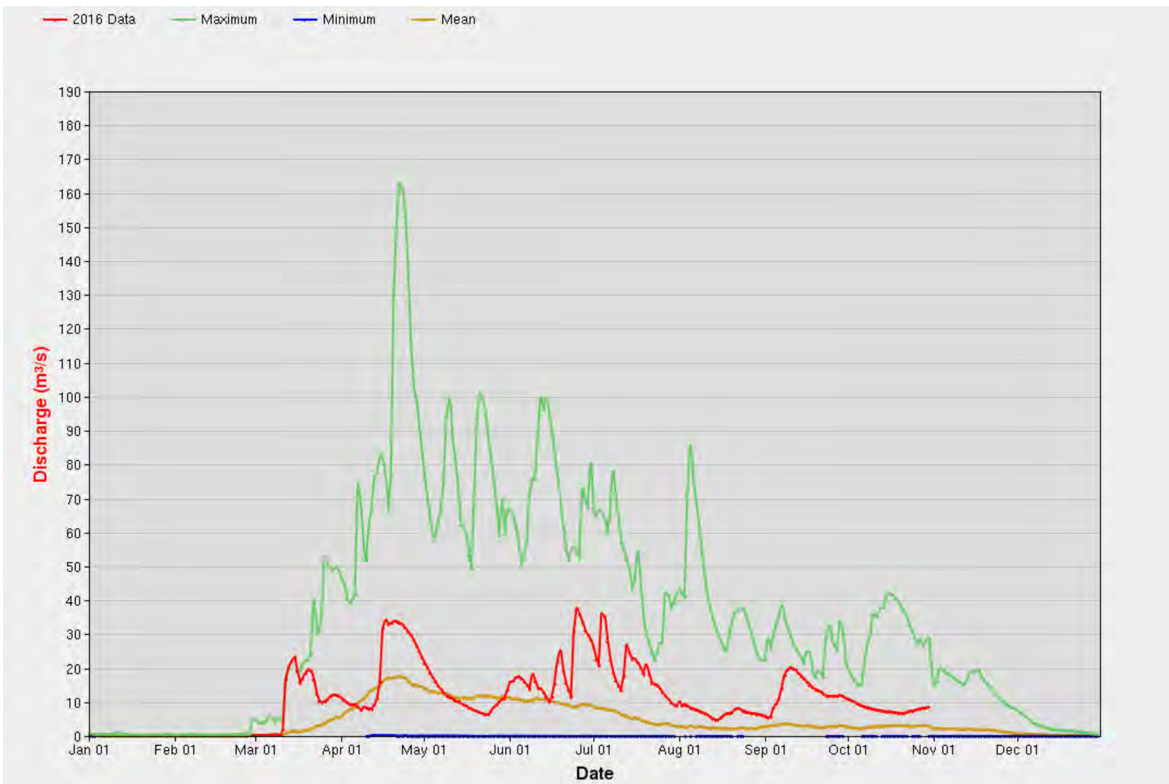

FIGURE 3.2 WATER SURVEY OF CANADA STATISTICS CORRESPONDING TO 75 YEARS OF DATA RECORDED FROM 1942 TO 2016

Concentrate effluent from the WTP must be able to pass the LC_{50} acute lethality testing on appropriate species. To accomplish this, the concentrate water quality must meet all effluent requirements stipulated in the *Manitoba Water Quality Standards, Objectives, and Guidelines*. Table 3.2 presents the *Tier 2 Water Quality Objectives* which apply to the Beausejour WTP project. For simplicity, parameters that resulted in the most stringent guidelines have been assumed.

Table 3.2 – *TIER 2 WATER QUALITY OBJECTIVES*

Effluent Parameter	Period	Duration	Allowable Exceedance	Design Flow	Objective
Ammonia	Water >5°C or Early Life Stages Present	30 Days	<1 in 3 years	30Q10	1.52 mg/L
	Water >5°C or Early Life Stages Present	4 Days	<1 in 3 years	7Q10	2.73 mg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	4.71 mg/L
	Water ≤5°C or Early Life Stages Absent	30 Days	<1 in 3 years	30Q10	1.09 mg/L
	Water ≤5°C or Early Life Stages Absent	4 Days	<1 in 3 years	7Q10	2.73 mg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	4.71 mg/L
	Early Life Stages Present	30 Days	<1 in 3 years	30Q10	1.09 mg/L
	Early Life Stages Present	4 Days	<1 in 3 years	7Q10	2.73 mg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	3.15 mg/L
	Early Life Stages Absent	30 Days	<1 in 3 years	30Q10	1.09 mg/L
	Early Life Stages Absent	4 Days	<1 in 3 years	7Q10	2.73 mg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	3.15 mg/L
Arsenic	All Periods	4 Days	<1 in 3 years	7Q10	150 μg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	340 μg/L
Cadmium	All Periods	4 Days	<1 in 3 years	7Q10	< 0.64 μg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	< 7.74 μg/L
Chlorine	All Periods	4 Days	<1 in 3 years	7Q10	11 μg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	19 μg/L
Chromium III	All Periods	4 Days	<1 in 3 years	7Q10	< 230.67 μg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	< 1773.3 μg/L
Chromium IV	All Periods	4 Days	<1 in 3 years	7Q10	11 μg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	16 μg/L
Copper	All Periods	4 Days	<1 in 3 years	7Q10	< 29.28 μg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	< 49.62 μg/L
Lead	All Periods	4 Days	<1 in 3 years	7Q10	< 10.94 μg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	< 280.85 μg/L
Nickel	All Periods	4 Days	<1 in 3 years	7Q10	< 168.04 μg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	< 1512.89 μg/L

Nitrate – Nitrate Nitrogen	All Periods	Not to be Exceeded	Not to be Exceeded	N/A	10 mg/L
Total Dissolved Solids	All Periods For Greenhouses	7 Days	N/A	7Q10	700 mg/L
	All Periods Irrigation	7 Days	N/A	7Q10	500-3500 mg/L
Conductivity	All Periods For Greenhouses	7 Days	N/A	7Q10	1000 µS/cm
	All Periods Irrigation	7 Days	N/A	7Q10	1500 µS/cm
Total Suspended Sediment	All Periods Irrigation	7 Days	N/A	7Q10	10% change
Zinc	All Periods	4 Days	<1 in 3 years	7Q10	< 382.40 µg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	< 379.30 µg/L

Tier 1 Water Quality Objectives include objectives for Municipal Wastewater Effluents, all of which are satisfied by the proposed project:

Table 3.3 – *TIER 1 WATER QUALITY OBJECTIVES*

Effluent Parameter	Regulation Limit	Concentrate Discharge
Phosphorus, Total (mg/L)	1.0	<0.030
Ammonia (mg/L)	Site Specific	0.60
Nitrogen, Total (mg/L)	15	<0.020
Fecal Coliform	200	<200
Carbonaceous Biochemical Oxygen Demand (CBOD) (mg/L)	25	<25
Biochemical Oxygen Demand (mg/L)	25	<25
Total Suspended Solids (mg/L)	25	0

Tier 2 Water Quality Objectives provide objective water quality standards as a water-quality based approach to effluents which do not conform to the specific categories provided in *Tier 1 Objectives*. Targets and projected effluent characteristics are presented in *Table 3.4* below.

TABLE 3.4 – COMBINED FLOW CONCENTRATIONS

Parameter	Raw Water (mg/L)	Membrane Concentrate (mg/L)	Brokenhead River (mg/L)	Combined Flow	Discharge Regulation Limit
Hardness CaCO3 (mg/L)	376	2348.9	220	652.31	
Ammonia (mg/L)	0.146	0.6	0.033	0.1481	0.78
Arsenic (mg/L)	0.00459	0.024	0.00162	0.0062	0.15
Barium (mg/L)	0.107	0.7	0.0563	0.19	
Cadmium (mg/L)	<0.0000050	<0.0000050	0.000007	0.000007	0.00064
Calcium (mg/L)	64.1	401.1	59	128.47	
Chloride (mg/L)	32.2	175.4	3.01	38.02	
Chromium, Total (mg/L)	<0.00010	<0.00010	0.00022	0.00022	0.23067
Conductivity (µS/cm)	750	3666	384	**1050.46**	1000*
Cooper	<0.00050	<0.00050	<0.00050	<0.00050	0.02928
CO3 (mg/L)	<0.60	43.1	2.88	11.05	
Fluoride (mg/L)	0.28	1.1	0.144	0.338	
Iron (mg/L)	1.19	7.93	0.191	1.76	
Lead (mg/L)	<0.000050	<0.000050	0.000106	0.000106	0.01094
Magnesium (mg/L)	52.5	328.5	17.5	80.65	
Manganese (mg/L)	0.0158	0.2	0.044	0.076	
Nickel (mg/L)	0.00071	0.0035	0.00062	0.00120	
NO3 (mg/L)	<0.020	<0.020	<0.020	<0.020	10
Potassium (mg/L)	4.02	16.1	1.05	4.11	
pH	7.61	8.33	8.31	8.31	
Sodium (mg/L)	30.3	145.9	5.25	33.81	
Strontium (mg/L)	0.287	1.7	0.107	0.43	
SO4 (mg/L)	39	252.6	0.99	52.08	
SiO2 (mg/L)	16.4	87.3	24	36.85	
TDS (mg/L)	421	4012.48	281	**1038.73**	700*
Zinc (mg/L)	0.0069	0.046	0.0043	0.0128	0.3793

*See discussion below for clarification.

Two parameters above are conditionally exceed the limits of the *Tier 2* guidelines: conductivity and total dissolved solids (TDS). The *Water Quality Guidelines* stipulate that discharge must be below a conductivity of 1000 µS/cm for periods where greenhouse irrigation is likely to occur and below 1500 µS/cm for periods when field, park, or garden irrigation is likely to occur. These guidelines also correlate to require a TDS of below 700 mg/L for greenhouse irrigation, or 500 –

3500 mg/L crop dependant for field, park, or garden irrigation. Since irrigation is only likely to occur in the months of June, July or August, additional calculations are required to determine the minimum concentration which apply at the minimum flows observed in these conditions. A 7Q10 or 4-Day Average, 3-Year flow is 45.25 L/s, with a combined flow of 50.6 L/s.

TABLE 3.5 – COMBINED SUMMER FLOW CONCENTRATIONS

Parameter	Raw Water (mg/L)	Membrane Concentrate (mg/L)	Brokenhead River (mg/L)	Combined Flow (mg/L)	Discharge Regulation Limit
Conductivity (µS/cm)	750	3666	384	728.11	1000-1500
TDS (mg/L)	431	4012.48	281	672.23	700

An aerial survey of the surrounding water uses was completed. A greenhouse operation is located upstream of the proposed discharge location, but none are located immediately downstream so no irrigation of the manner is anticipated in the influence zone. A campground and golf course are located 100m and 200m downstream respectively. If the golf course does irrigate their grass, the combined concentrations during the summer months utilizing the respective minimum 4-Day Average, 3-Year flow, are below the limits and no adverse impacts from the concentrate discharge are anticipated. All other parameters are under the discharge regulation limit in the *Water Quality Guidelines*, and no detrimental effects are anticipated from the proposed concentrate discharge.

3.4 Fish and Fish Habitat

Fish species found in the Brokenhead River have been provided from the Department of Sustainable Development – Wildlife and Fisheries Branch. It was noted that the list of species provided include all that have been found in the waterbody and does not pertain to a site specific area. Brokenhead River provides year round habitat for many species varying in size, including:

- Stone Cat (*Noturus flavus*)
- Northern Redbelly Dace (*Chrosomus eos*)
- Black Bullhead (*Ameiurus melas*)
- Blacknose Shiner (*Notropis heterolepis*)
- Blacksided Darter (*Percina maculata*)
- Brook Stickleback (*Culaea inconstans*)
- Brown Bullhead (*Ameiurus nebulosus*)
- Burbot (*Lota lota*)
- Carp (*Cyprinus carpio*)
- Central Midminnow (*Umbra limi*)
- Chestnut Lamprey (*Ichthyomyzon castaneus*)

- Common Shiner (*Luxilus cornutus*)
- Fathead Minnow (*Pimephales promelas*)
- Finescale Dace (*Phoxinus neogaeus*)
- Freshwater Drum (*Aplodinotus grunniens*)
- Hornyhead Chub (*Nocomis biguttatus*)
- Johnny Darter (*Etheostoma nigrum*)
- Longnose Dace (*Rhinichthys cataractae*)
- Mimic Shiner (*Notropis volucellus*)
- Northern Pike (*Esox Lucius*)
- Pearl Dace (*Margariscus nachtriebi*)
- Rock Bass (*Ambloplites rupestris*)
- Shorthead Redhorse (*Moxostoma macrolepidotum*)
- Smallmouth Bass (*Micropterus dolomieu*)
- Tadpole Madtom (*Notorus gyrinus*)
- Walleye (*Sander vitreus*)
- White Sucker (*Catostomus commersonii*)
- Yellow Perch (*Perca flavescens*)

Recreational angling and commercial net have been identified as general uses.

3.5 Wildlife Habitat and Vegetation

The Town of Beausejour is located in the Lake of the Woods Ecoregion within the Boreal Shield Ecozone. The Ecological Framework of Canada website contains information on the wildlife and vegetation within this region (Ecological Framework of Canada, 1995).

Characteristic Wildlife:

- Moose (*Alces alces*)
- Black Bear (*Ursus americanus*)
- Wolf (*Canis lupus*)
- Lynx (*Lynx canadensis*)
- Snowshoe Hare (*Lepus americanus*)
- Woodchuck (*Marmota monax*)
- Ruffed Grouse (*Bonasa umbellus*)
- Hooded Merganser (*Lophodytes cucullatus*)
- Pileated Woodpecker (*Dryocopus pileatus*)
- Bald Eagle (*Haliaeetus leucocephalus*)
- Turkey Vulture (*Cathartes aura*)
- Herring Gull (*Larus argentatus*)

- Waterfowl (*Anseriformes*)

Characteristic Vegetation:

- Trembling Aspen (*Populus tremuloides*)
- Paper Birch (*Betula papyrifera*)
- Jack Pine (*Pinus banksiana*)
- White Spruce (*Picea glauca*)
- Black Spruce (*Picea mariana*)
- Balsam Fir (*Abies balsamea*)
- White Pine (*Pinus strobus*)
- Tamarack (*Larix laricina*)

3.6 Socioeconomic

The project area is located within the Town of Beausejour and the Rural Municipality of Brokenhead. The Town has an area of approximately 5.35 km^2 and a population of approximately 3,219 (2016 Census). The RM of Brokenhead had a population of 5,122 in the 2016 Census and is one of the quickest growing municipalities in Manitoba with a 10.5% growth rate from 2011 to 2016. The main economic base of the area is agriculture and various local quarries.

3.7 Heritage Resources

Most project activities will occur in previously disturbed municipal and provincial right-of-ways. The proponent will work with Heritage Resources Branch to mitigate any concerns as required.

4.0 Potential Environmental Effects

An environmental effect includes any change that the project may cause to the environment. Environmental effects were identified from interactions between proposed project activities and environmental components. Mitigation measures and follow-up activities were identified for environmental effects determined to be adverse.

4.1 Air Quality

During construction, dust will be raised by construction equipment and there will be gaseous and particulate emissions from the construction equipment. Water spraying is an important, common and practical procedure that would be applied as required to alleviate potential dust problems. Emissions of gases and particulates would be minimized by keeping machinery in good working order. Any effects would be localized, temporary and insignificant. During operation of the development there will be no releases of pollutants to the air.

4.2 Soils

During construction, there is a risk of fuel or lubricant spills from heavy equipment and vehicle operation. The storage of fuel or lubricants within the area of the well construction site will not be allowed. Therefore, the potential spills will be very small in size and standard construction spill clean-up procedures, including the removal of any impacted soil, will be used to prevent impact.

During operation, project activities are limited to regular monitoring and maintenance activities that have a negligible effect on soil disturbance and compaction because of low vehicle traffic and the use of established routes to access the wells and WTP. Regular monitoring and maintenance activities will have a negligible effect on soil contamination since fuel trucks and other hazardous substances will not be brought on-site on a regular basis. The potential adverse effect on soil quality is assessed to be minor.

4.3 Surface Water, Fish and Fish Habitat

Minor and short term impacts on surface water may occur as a result of construction activity in road allowance ditches during runoff events. The impact on surface water would include sediment that may be eroded from excavation activities, minor engine leaks and potential fuel spills should runoff events occur during construction. Horizontal directional drilling will be conducted to install the concentrate water pipeline to the river outlet. This will eliminate excavation within the riparian zone and minimize impacts. There is potential for some loss of drilling mud to surface water. Impacts to fisheries and fish habitat are considered minor.

Water quality samples were taken from Brokenhead River, the waterway to be used for the concentrate disposal. The results were analyzed and impacts on wildlife habitat are considered negligible.

4.4 Groundwater Quality

Groundwater quality can be impacted by surface activities and surface water quality. Mitigation measures are necessary to protect groundwater quality during construction activities. The proposed activities are unlikely to result in adverse changes to water quality.

Nevertheless, the potential still exists and monitoring of the raw water quality will be required to identify any such adverse effects and allow the appropriate adjustments in the system operation to be made.

4.5 Groundwater Levels

A new WRL will be applied for related to the installation of the new production wells. The available information indicates that the proposed withdrawal of groundwater is unlikely to result in adverse changes to groundwater levels outside of normal seasonal variation. Nevertheless, the potential still exists and monitoring of the groundwater levels will be required to identify any such adverse effects and allow the appropriate adjustments in the system operation to be made.

4.6 Vegetation

Construction will occur primarily within municipal right of ways or easements that are previously disturbed, regularly managed, and comprised primarily of grasses. As the areas are already disturbed, they are unlikely to contain rare plant species, and the amount of vegetation disturbance is expected to be minimal.

During operation, monitoring and maintenance activities including access to the well sites will be restricted to designated and previously disturbed areas. Potential effects to vegetation are considered to be negligible.

4.7 Wildlife Habitat and Vegetation

The construction and operation activities associated with this project will be limited to areas already developed for hydro lines or urban or agricultural uses. The potential adverse effects of wildlife habitat loss were assessed to be negligible to minor.

4.8 Noise and Vibration

During the construction phase of the project, there will be several sources of sound emissions including equipment used for construction. The types of noises heard due to construction are dominated by equipment engines. However, miscellaneous short term impact noises (ie: dump truck gates, excavator buckets) are often heard. The noise will be in addition to regular community and highway activities, and the effects are considered minor.

Scheduling of various site activities can minimize the impact of noise. This would include scheduling construction for day-time hours to avoid sleep disturbance and the disruption of evening domestic activities. All equipment used on site will be fitted with appropriate mufflers and will be maintained in good working order to minimize noise levels.

4.9 Employment/Economy

Socio-economic implications are not expected as a result of environmental impacts as they are considered minor and short-term. Some economic implications may exist for the Town due to the costs of developing the water system; however, the Town will have a sustainable potable water supply to meet future demands. There will be some local economic benefit during construction. The proposed project will address an issue of water quality for the Town and address the issue of limited treatment capacity of treated water and a hard water which increases fixture replacement. The potential effects of the project on employment and the economy are assessed to be positive.

4.10 Human Health and Well Being

The potential adverse effects of the project on human health are assessed to be negligible to minor. Short term temporary increases in noise and dust emissions will occur during construction that is considered to be minor effects. During operation, there will be a minor increase in vehicular traffic associated with monitoring and maintenance activities. The potential effects are considered minor.

The project will result in the construction of a water treatment plant designed and operated to produce a treated water supply to meet current water quality standards. This will produce a higher standard of living in Beausejour. The effects of this on human health and wellbeing are considered positive.

4.11 Climate Change

There are no predicted impacts to climate as a result of the project activities.

5.0 Environmental Management Measures

Environmental management practices proposed to prevent or mitigate environmental effects that were determined to be adverse are identified and described below.

5.1 Air Quality

Emissions resulting from construction and transportation equipment may be mitigated by the utilization of well maintained vehicles and operating to reduce unnecessary idling.

The impact of dust may be mitigated by the use of an approved dust suppressant, limiting construction during high wind periods, and re-establishment of vegetation as soon as possible.

Burning of shrubs etc. will only occur on days and times where wind conditions are favorable. Burning could be limited to days permitted for burning according to the Manitoba Crop Residual Burning Program.

5.2 Soils

Mitigation to potential soil impacts through contamination from petroleum products include preparation of an emergency response plan for potential spills, use of spill clean-up equipment and materials, using properly maintained equipment, and using appropriate fuelling equipment.

Re-establishment of vegetation as soon as possible after disturbance will limit loss of soil due to wind or water erosion. Backfilling with soil stockpiles as soon as possible and minimizing the amount of soil disturbance can be implemented.

5.3 Surface Water

Mitigation of surface water issues may be achieved by limiting open cut trenching to within 30 m ahead or behind the pipe laying, redirecting surface water runoff, pumping accumulated water to adjacent ditches and providing erosion control practices as required.

Petroleum leaks or spills will be mitigated by use of properly maintained equipment, use of spill clean-up equipment and materials, and use of appropriate fuelling equipment. A prepared emergency response plan can be implemented in the event of a significant spill. In the event of a reportable spill, Manitoba Conservation and Water Stewardship will be notified through the emergency response line and appropriate measures will be taken according to Manitoba Conservation and Water Stewardship requirements.

A 100 m setback to watercourses will be maintained for fuelling activities. Vehicles will avoid entering the riparian zones. Re-establishment of vegetation will occur as soon as possible on areas of disturbed soil.

The proponent will conduct long term monitoring of Brokenhead River to verify impacts on water quality.

5.4 Groundwater

Groundwater is primarily protected by the natural hydrogeology in the area. Mitigation of potential groundwater impacts from petroleum products can be mitigated as described in Section 5.3. The availability of groundwater usage for this proposal and potential future users will be assessed through the Water Rights Act Licensing process. Groundwater monitoring will be performed as required to address potential issues associated with water quality and water level changes.

The recommended water quality sampling program consists of quarterly sampling of groundwater for the first year of operation. Following this initial year of sampling, the recommended frequency is a minimum of annually. The laboratory analyses should include conductivity, hardness, alkalinity, total dissolved solids, major cations and anions (calcium, sodium, magnesium, hydrogen carbonate, sulfate, chloride), dissolved metals (including arsenic), and total iron and manganese. The samples should be collected at a designated location on the raw water side of the water treatment system using sample bottles and methods in accordance with the laboratory instructions. [Note: This sampling is separate from any routine sampling program required as part of the operation from the water treatment plant].

The recommended groundwater level monitoring program would include the use of existing wells on the current WTP property. The monitoring well will be equipped with continuous groundwater level monitoring devices such as digital pressure transducers capable of recording groundwater levels on at least a daily basis. The information would be downloaded on a regular basis (typically quarterly) and be input into a suitable database capable of generating charts of water level trends over time. It is assumed at this stage that the Province will continue to maintain the groundwater monitoring stations, and will make the information available on an annual basis.

The availability of groundwater usage for potential future users will be assessed through the Water Rights Act Licensing process.

5.5 Vegetation and Wildlife

Displacing whole portions of topsoil with any known rare or endangered plant species can be implemented if necessary such that this material and plants can be placed back in its original location with minimal disturbance. Re-establishment of vegetation will occur as soon as possible on disturbed areas. Impacts to wildlife habitat can be limited by minimizing the area of construction, soil disturbance and vegetation disturbance. Other impacts resulting from dust or smoke will be minimized as previously indicated. Noise disturbance will be limited by use of muffling vehicles and equipment, limiting idling and limiting the construction area.

Any potential loss and disturbance to vegetation and wildlife during operation may be mitigated by restricting vehicular traffic to designated and previously disturbed areas, and by limiting monitoring and maintenance activities to previously disturbed areas.

5.6 Fisheries

Fisheries impacts will be minimized by implementing practices to reduce soil and contaminate runoff as previously mentioned in Sections 5.3 and 5.5. As shown in *Table 3.4*, 0.146 mg/L total ammonia is present in the raw water. Through the membrane treatment process the concentration of total ammonia increases to 0.60 mg/L. With a pH of 8.3 in the concentrate water, the recommended acceptable level of total ammonia in the discharge is below 1.091 mg/L at 19.7°C. The level of total ammonia in the concentrate discharge will be below the acceptable level and is not anticipated to change significantly.

Water quality monitoring on the Brokenhead River will provide data for the assessment of any water quality impacts affecting fish species. The proponent will work with the provincial officials should any concerns arise.

5.7 Noise and Vibration

Limiting any noise-creating activities, including regular maintenance and monitoring activities to normal working hours, and limiting unnecessary long-term idling can mitigate any potential increased noise and vibration effects.

5.8 Water Conservation

Water conservation measures include metering and pricing of water. Water conservation information in water bill mailings can be implemented. Leak detection will consist of reconciling on a quarterly basis the volume of water pumped and charged to ratepayers. Since these services are metered, abnormalities can be identified and rectified.

5.9 Socio-Economic Implications

There are no known negative environmental socio-economic impacts that require mitigation. Since the proposed development would provide a reliable healthy drinking water supply, it would be expected to enhance quality of life and economic viability for the Town. The proposed project may provide some economic benefits to the area for local businesses and employment opportunities during construction phase.

6.0 References

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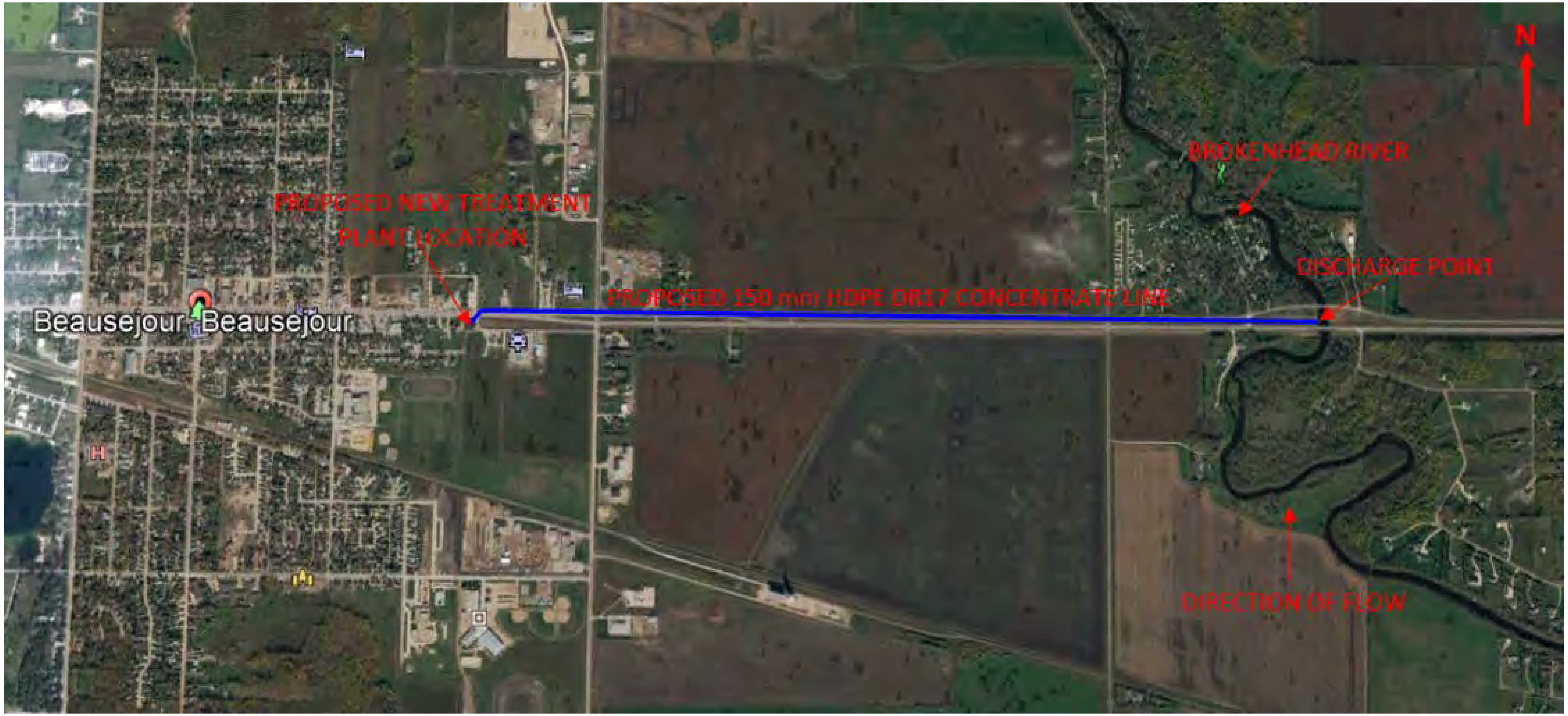
Appendix A

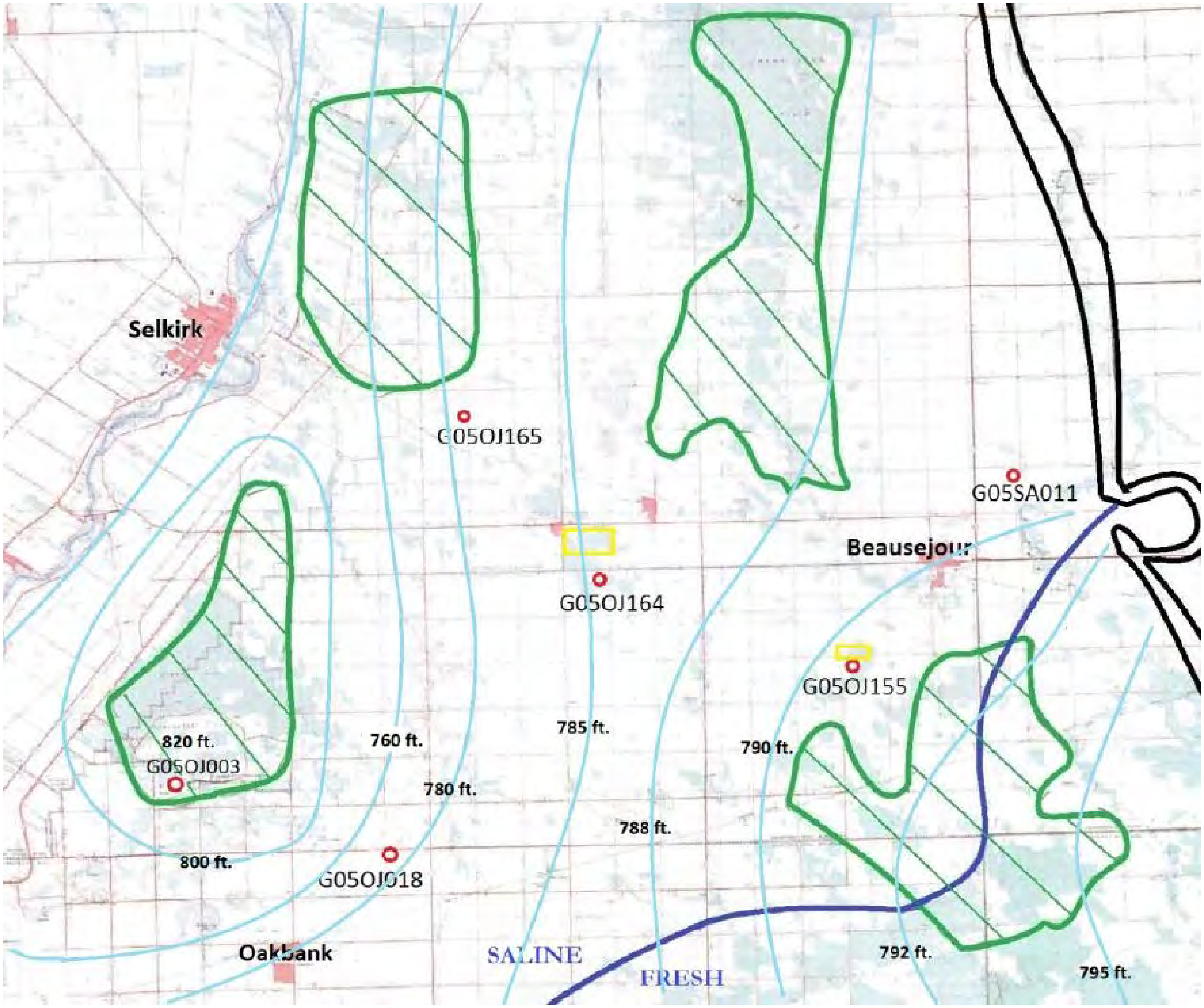
Proposed Concentrate Water Pipeline



PROPOSED CONCENTRATE PIPELINE ROUTE (GOOGLE EARTH, 2018)

Appendix B

Hydrogeology of the Town of Beausejour Area



HYDROGEOLOGY OF BEAUSEJOUR REGION (FRIESEN DRILLERS LTD., 2016)

The green areas depict recharge zones; the dark blue line is the boundary of fresh and saline groundwater; the yellow zones show major quarry operations and the black lines are bedrock contacts (MSD, 2016; Render, 1986; from Friesen Drillers, 2016).

Appendix C

Water Rights Licence

MG-14854 (English)

Licence to Use Water for Municipal-Distribution System Purposes

Manitoba
Sustainable Development
200 Saulteaux Cresc.
Winnipeg, Manitoba
R3J 3W3

Project: Town of Beausejour

Issued in accordance with the provisions of **The Water Rights Act** and regulations made thereunder.

Licence No.: **2005-023**
(Previous Lic. No.: 96-08)
U.T.M.: Zone 14 678660 E
5548070 N

Know all men by these presents that in consideration of and subject to the provisos, conditions and restrictions hereinafter contained, the Minister of Water Stewardship for the Province of Manitoba does by these presents give full right and liberty, leave and licence to **Town of Beausejour** in the Province of Manitoba (hereinafter called "the LICENSEE") to divert water from a **fractured limestone** aquifer by means of three (3) water wells, pumps, pipeline(s) and other appurtenances (hereinafter called "the WORKS"), located on the following described lands:

Main Supply Well - 871 Aston Avenue in the Town of Beausejour, in Lot 3 on Plan 22940 WLTO, Back-up Supply Wells - 914 Park Avenue in the Town of Beausejour, in Lot 4 on Plan 15968 WLTO, all in the Northeast Quarter of Section 36, in Township 12 and Range 7, East of the Principal Meridian in Manitoba

and more particularly shown on a plan filed in the office of the Executive Director, Infrastructure and Operations Division, a copy of which plan is hereto attached and marked Exhibit "A" for **municipal-distribution system** purposes on the following described lands:

Parts of Sections 35 and 36, in Township 12, and parts of Sections 1 and 2, in Township 13, all in Range 7, East of the Principal Meridian in Manitoba.

This licence is issued upon the express condition that it shall be subject to the provisions of The Water Rights Act and Regulations and all amendments thereto and, without limiting the generality of the aforesaid, to the following terms and conditions, namely:

1. The water shall be used solely for **municipal-distribution system** purposes.
2. The WORKS shall be operated in accordance with the terms herein contained.
3. a) The maximum rate at which water may be diverted pursuant hereto shall not exceed **0.0228 cubic metres per second (0.8 cubic feet per second)**.

   b) The total quantity of water diverted in any one year shall not exceed **450 cubic decametres (364.82 acre feet)**.
4. Water shall not be diverted during any period when the water level in the aquifer as measured at the well is more than **23.35 metres (76.6 feet)** beneath the surface of the ground.
5. The LICENSEE does hereby remise, release and forever discharge Her Majesty the Queen in Right of the Province of Manitoba, of and from all manner of action, causes of action, claims and demands whatsoever which against Her Majesty the LICENSEE ever had, now has or may hereafter have, resulting from the use of water for **municipal-distribution system** purposes.
6. In the event that the rights of others are infringed upon and/or damage to the property of others is sustained as a result of the operation or maintenance of the WORKS and the rights herein granted, the LICENSEE shall be solely responsible and shall save harmless and fully indemnify Her Majesty the Queen in Right of the Province of Manitoba, from and against any liability to which Her Majesty may become liable by virtue of the issue of this Licence and anything done pursuant hereto.
7. This Licence is not assignable or transferable by the LICENSEE and when no longer required by the LICENSEE this Licence shall be returned to the Executive Director, Infrastructure and Operations Division, for cancellation on behalf of the Minister.
8. Upon the execution of this Licence the LICENSEE hereby grants the Minister or the Minister's agents the right of ingress and egress to and from the lands on which the WORKS are located for the purpose of inspection of the WORKS and the LICENSEE shall at all times comply with such directions and/or orders that may be given by the Minister or the Minister's agents in writing from time to time with regard to the operation and maintenance of the WORKS.
9. If for any reason whatsoever the Minister deems it advisable to cancel this Licence, he may do so by letter addressed to the LICENSEE at **Box 1028, Beausejour, MB, R0E 0C0, Canada** and thereafter this Licence shall be determined to be at an end.
10. Notwithstanding anything preceding in this Licence, the LICENSEE must have legal control, by ownership or by rental, lease, or other agreement, of the lands on which the WORKS shall be placed and the water shall be used.
11. The term of this Licence shall be **twenty (20) years** and this Licence shall become effective only on the date of execution hereof by a person so authorized in the Department of Water Stewardship. The LICENSEE may apply for renewal of this Licence not more than 365 days and not less than 90 days prior to the expiry date.

Page 1 of 2

12. This Licence expires automatically upon the loss of the legal control of any of the lands on which the WORKS are located or on which water is used, unless the Licence is transferred or amended by the Minister upon application for Licence transfer or amendment.

13. The LICENSEE shall keep records of daily and annual water use and shall provide a copy of such records to the Executive Director, Infrastructure and Operations Division, not later than February 1st of the following year.

14. A flow meter must be installed, positioned to accurately measure instantaneous pumping rate and accumulative withdrawals from the water source.

15. The LICENSEE does hereby agree to correct, to the satisfaction of the Minister, any water supply problems to other currently existing wells, dugouts, or other forms of supply, which are partly or wholly attributable, in the opinion of the Minister, to the diversion of water as authorized by this Licence.

16. The LICENSEE shall hold and maintain all other regulatory approvals that may be required and shall comply with all other regulatory requirements for the construction, operation, or maintenance of the WORKS or to divert or use water as provided by this Licence.

In witness whereof I the undersigned hereby agree to accept the aforesaid Licence on the terms and conditions set forth therein

and hereby set my hand and seal this ______________ day of ________________ 20___ .

SIGNED, SEALED AND DELIVERED

In the presence of:

x ____________________________ } x ____________________________ (Seal)
Witness | Licensee

____________________________ } ____________________________
Witness (Print name) | Licensee (Print name)

FOR OFFICE USE ONLY

Issued at the City of Winnipeg, in the Province of Manitoba, this ___ day of ________________ A.D. 20 ___ .

____
The Honourable the Minister of Sustainable Development (or her/his designate)

Licence No.2005-023 Page 2 of 2

Appendix D

Raw & Treated Water Quality Analysis

Friesen Drillers Ltd
ATTN: PAULYNN ESTRELLA
307 PTH 12 N
Steinbach MB R5G 1T8

Date Received: 07-FEB-20
Report Date: 02-MAR-20
Version: INTERNAL

Client Phone: 204-326-2485

Certificate of Analysis

Lab Work Order #: L2414588
Project P.O. #: TOWN OF BEAUSEJOUR
Job Reference: 72 H PUMP TEST
C of C Numbers:
Legal Site Desc:

DRAFT

Kianna Brown
Account Manager

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

ADDRESS: 1329 Niakwa Road East, Unit 12, Winnipeg, MB R2J 3T4 Canada | Phone: +1 204 255 9720 | Fax: +1 204 255 9721
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

72 H PUMP TEST

L2414588 CONTD....
PAGE 2 of 9
Version: INTERNAL

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2414588-1 START							
Sampled By: GH on 05-FEB-20 @ 15:20							
Matrix: WATER							
ROU4W total							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	387		1.2	mg/L		11-FEB-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		11-FEB-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		11-FEB-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	318		1.0	mg/L		07-FEB-20	R4992976
Chloride in Water by IC							
Chloride (Cl)	20.0		0.50	mg/L		07-FEB-20	R4992492
Conductivity							
Conductivity	638		1.0	umhos/cm		07-FEB-20	R4992976
Fluoride in Water by IC							
Fluoride (F)	0.221		0.020	mg/L		07-FEB-20	R4992492
Hardness Calculated							
Hardness (as CaCO3)	353	HTC	0.20	mg/L		26-FEB-20	
Nitrate in Water by IC							
Nitrate (as N)	<0.020		0.020	mg/L		07-FEB-20	R4992492
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.070		0.070	mg/L		10-FEB-20	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		07-FEB-20	R4992492
Sulfate in Water by IC							
Sulfate (SO4)	29.7		0.30	mg/L		07-FEB-20	R4992492
TDS calculated							
TDS (Calculated)	372		5.0	mg/L		26-FEB-20	
Total Metals in Water by CRC ICPMS							
Calcium (Ca)-Total	63.2		0.050	mg/L	20-FEB-20	25-FEB-20	R5006908
Iron (Fe)-Total	1.06		0.010	mg/L	20-FEB-20	25-FEB-20	R5006908
Magnesium (Mg)-Total	47.4		0.0050	mg/L	20-FEB-20	25-FEB-20	R5006908
Manganese (Mn)-Total	0.0161		0.00010	mg/L	20-FEB-20	25-FEB-20	R5006908
Potassium (K)-Total	3.56		0.050	mg/L	20-FEB-20	25-FEB-20	R5006908
Sodium (Na)-Total	17.2		0.050	mg/L	20-FEB-20	25-FEB-20	R5006908
Turbidity							
Turbidity	13.1		0.10	NTU		07-FEB-20	R4992930
pH							
pH	7.81		0.10	pH units		07-FEB-20	R4992976
L2414588-2 24 HOUR							
Sampled By: GH on 05-FEB-20 @ 01:00							
Matrix: WATER							
ROU4W total							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	430		1.2	mg/L		11-FEB-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		11-FEB-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		11-FEB-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	352		1.0	mg/L		07-FEB-20	R4992976
Chloride in Water by IC							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

72 H PUMP TEST

L2414588 CONTD....
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Version: INTERNAL

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2414588-2 24 HOUR							
Sampled By: GH on 05-FEB-20 @ 01:00							
Matrix: WATER							
Chloride in Water by IC							
Chloride (Cl)	27.3		0.50	mg/L		07-FEB-20	R4992492
Conductivity							
Conductivity	720		1.0	umhos/cm		07-FEB-20	R4992976
Fluoride in Water by IC							
Fluoride (F)	0.266		0.020	mg/L		07-FEB-20	R4992492
Hardness Calculated							
Hardness (as CaCO3)	371	HTC	0.20	mg/L		20-FEB-20	
Nitrate in Water by IC							
Nitrate (as N)	<0.020		0.020	mg/L		07-FEB-20	R4992492
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.070		0.070	mg/L		10-FEB-20	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		07-FEB-20	R4992492
Sulfate in Water by IC							
Sulfate (SO4)	36.7		0.30	mg/L		07-FEB-20	R4992492
TDS calculated							
TDS (Calculated)	420		5.0	mg/L		20-FEB-20	
Total Metals in Water by CRC ICPMS							
Calcium (Ca)-Total	64.1		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Iron (Fe)-Total	0.940		0.010	mg/L	19-FEB-20	19-FEB-20	R4998628
Magnesium (Mg)-Total	51.2		0.0050	mg/L	19-FEB-20	19-FEB-20	R4998628
Manganese (Mn)-Total	0.0155		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Potassium (K)-Total	3.80		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Sodium (Na)-Total	25.4		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Turbidity							
Turbidity	15.6		0.10	NTU		07-FEB-20	R4992930
pH							
pH	7.67		0.10	pH units		07-FEB-20	R4992976
L2414588-3 48 HOUR							
Sampled By: GH on 06-FEB-20 @ 01:00							
Matrix: WATER							
ROU4W total							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	435		1.2	mg/L		11-FEB-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		11-FEB-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		11-FEB-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	357		1.0	mg/L		07-FEB-20	R4992976
Chloride in Water by IC							
Chloride (Cl)	31.2		0.50	mg/L		07-FEB-20	R4992492
Conductivity							
Conductivity	742		1.0	umhos/cm		07-FEB-20	R4992976
Fluoride in Water by IC							
Fluoride (F)	0.280		0.020	mg/L		07-FEB-20	R4992492
Hardness Calculated							
Hardness (as CaCO3)	370	HTC	0.20	mg/L		20-FEB-20	
Nitrate in Water by IC							
Nitrate (as N)	<0.020		0.020	mg/L		07-FEB-20	R4992492
Nitrate+Nitrite							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

72 H PUMP TEST

L2414588 CONTD....
PAGE 4 of 9
Version: INTERNAL

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2414588-3 48 HOUR							
Sampled By: GH on 06-FEB-20 @ 01:00							
Matrix: WATER							
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.070		0.070	mg/L		10-FEB-20	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		07-FEB-20	R4992492
Sulfate in Water by IC							
Sulfate (SO4)	38.7		0.30	mg/L		07-FEB-20	R4992492
TDS calculated							
TDS (Calculated)	431		5.0	mg/L		20-FEB-20	
Total Metals in Water by CRC ICPMS							
Calcium (Ca)-Total	64.4		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Iron (Fe)-Total	1.05		0.010	mg/L	19-FEB-20	19-FEB-20	R4998628
Magnesium (Mg)-Total	50.7		0.0050	mg/L	19-FEB-20	19-FEB-20	R4998628
Manganese (Mn)-Total	0.0157		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Potassium (K)-Total	3.89		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Sodium (Na)-Total	28.6		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Turbidity							
Turbidity	16.0		0.10	NTU		07-FEB-20	R4992930
pH							
pH	7.65		0.10	pH units		07-FEB-20	R4992976
L2414588-4 72 HOUR							
Sampled By: GH on 07-FEB-20 @ 10:00							
Matrix: WATER							
Miscellaneous Parameters							
Silica, Reactive (as SiO2)	16.4		1.0	mg/L		11-FEB-20	R4994188
Total Coliform and E.coli							
Total Coliforms	0		0	MPN/100mL		07-FEB-20	R4991976
Escherichia Coli	0		0	MPN/100mL		07-FEB-20	R4991976
MB Conservation test 72D							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	432		1.2	mg/L		11-FEB-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		11-FEB-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		11-FEB-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	354		1.0	mg/L		07-FEB-20	R4992976
Ammonia by colour							
Ammonia, Total (as N)	0.146		0.010	mg/L		07-FEB-20	R4991888
Chloride in Water by IC							
Chloride (Cl)	32.2		0.50	mg/L		07-FEB-20	R4992492
Colour, True							
Colour, True	<5.0		5.0	CU		07-FEB-20	R4992468
Conductivity							
Conductivity	750		1.0	umhos/cm		07-FEB-20	R4992976
Fluoride in Water by IC							
Fluoride (F)	0.280		0.020	mg/L		07-FEB-20	R4992492
Hardness Calculated							
Hardness (as CaCO3)	376	HTC	0.20	mg/L		20-FEB-20	
Ion Balance Calculation							
Cation - Anion Balance	0.8			%		20-FEB-20	
Anion Sum	8.81			me/L		20-FEB-20	
Cation Sum	8.95			me/L		20-FEB-20	
Langelier Index 4C							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

72 H PUMP TEST

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2414588-4 72 HOUR							
Sampled By: GH on 07-FEB-20 @ 10:00							
Matrix: WATER							
Langelier Index 4C							
Langelier Index (4 C)	0.24					20-FEB-20	
Langelier Index 60C							
Langelier Index (60 C)	1.0					20-FEB-20	
Nitrate in Water by IC							
Nitrate (as N)	<0.020		0.020	mg/L		07-FEB-20	R4992492
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.070		0.070	mg/L		10-FEB-20	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		07-FEB-20	R4992492
Sulfate in Water by IC							
Sulfate (SO4)	39.0		0.30	mg/L		07-FEB-20	R4992492
Total Carbon by Calculation							
Total Carbon	73.7		1.0	mg/L		18-FEB-20	
Total Dissolved Solids (TDS)							
Total Dissolved Solids	421		20	mg/L		13-FEB-20	R4997871
Total Inorganic Carbon by Combustion							
Total Inorganic Carbon	71.7		0.50	mg/L		15-FEB-20	R4997520
Total Kjeldahl Nitrogen							
Total Kjeldahl Nitrogen	0.28		0.20	mg/L	11-FEB-20	12-FEB-20	R4995328
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	<0.0030		0.0030	mg/L	19-FEB-20	19-FEB-20	R4998628
Antimony (Sb)-Total	<0.00010		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Arsenic (As)-Total	0.00459		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Barium (Ba)-Total	0.107		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	19-FEB-20	19-FEB-20	R4998628
Boron (B)-Total	0.109		0.010	mg/L	19-FEB-20	19-FEB-20	R4998628
Cadmium (Cd)-Total	<0.0000050		0.0000050	mg/L	19-FEB-20	19-FEB-20	R4998628
Calcium (Ca)-Total	64.1		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Cesium (Cs)-Total	<0.000010		0.000010	mg/L	19-FEB-20	19-FEB-20	R4998628
Chromium (Cr)-Total	<0.00010		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Cobalt (Co)-Total	0.00020		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Copper (Cu)-Total	<0.00050		0.00050	mg/L	19-FEB-20	19-FEB-20	R4998628
Iron (Fe)-Total	1.19		0.010	mg/L	19-FEB-20	19-FEB-20	R4998628
Lead (Pb)-Total	<0.000050		0.000050	mg/L	19-FEB-20	19-FEB-20	R4998628
Lithium (Li)-Total	0.0282		0.0010	mg/L	19-FEB-20	19-FEB-20	R4998628
Magnesium (Mg)-Total	52.5		0.0050	mg/L	19-FEB-20	19-FEB-20	R4998628
Manganese (Mn)-Total	0.0158		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Molybdenum (Mo)-Total	0.00218		0.000050	mg/L	19-FEB-20	19-FEB-20	R4998628
Nickel (Ni)-Total	0.00071		0.00050	mg/L	19-FEB-20	19-FEB-20	R4998628
Potassium (K)-Total	4.02		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Phosphorus (P)-Total	<0.030		0.030	mg/L	19-FEB-20	19-FEB-20	R4998628
Rubidium (Rb)-Total	0.00152		0.00020	mg/L	19-FEB-20	19-FEB-20	R4998628
Selenium (Se)-Total	<0.000050		0.000050	mg/L	19-FEB-20	19-FEB-20	R4998628
Silicon (Si)-Total	8.35		0.10	mg/L	19-FEB-20	19-FEB-20	R4998628
Silver (Ag)-Total	<0.000010		0.000010	mg/L	19-FEB-20	19-FEB-20	R4998628
Sodium (Na)-Total	30.3		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Strontium (Sr)-Total	0.287		0.00020	mg/L	19-FEB-20	19-FEB-20	R4998628
Sulfur (S)-Total	14.5		0.50	mg/L	19-FEB-20	19-FEB-20	R4998628
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	19-FEB-20	19-FEB-20	R4998628
Thallium (Tl)-Total	<0.000010		0.000010	mg/L	19-FEB-20	19-FEB-20	R4998628
Thorium (Th)-Total	<0.00010		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

72 H PUMP TEST

L2414588 CONTD....
PAGE 6 of 9
Version: INTERNAL

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2414588-4 72 HOUR							
Sampled By: GH on 07-FEB-20 @ 10:00							
Matrix: WATER							
Total Metals in Water by CRC ICPMS							
Tin (Sn)-Total	0.00012		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Titanium (Ti)-Total	<0.00030		0.00030	mg/L	19-FEB-20	19-FEB-20	R4998628
Tungsten (W)-Total	<0.00010		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Uranium (U)-Total	0.000548		0.000010	mg/L	19-FEB-20	19-FEB-20	R4998628
Vanadium (V)-Total	<0.00050		0.00050	mg/L	19-FEB-20	19-FEB-20	R4998628
Zinc (Zn)-Total	0.0069		0.0030	mg/L	19-FEB-20	19-FEB-20	R4998628
Zirconium (Zr)-Total	<0.00020		0.00020	mg/L	19-FEB-20	19-FEB-20	R4998628
Total Organic Carbon by Combustion							
Total Organic Carbon	1.96		0.50	mg/L		10-FEB-20	R4993340
Turbidity							
Turbidity	3.86		0.10	NTU		07-FEB-20	R4992930
UV Transmittance (Calculated)							
Transmittance, UV (254 nm)	91.2		1.0	%T/cm		07-FEB-20	R4992947
pH							
pH	7.61		0.10	pH units		07-FEB-20	R4992976

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Appendix E

Membrane Treatment System Projection

Integrated Membranes Solutions Design Software, 2018

Created on: 5/13/2020 04:41:07

Nitto HYDRANAUTICS Nitto Group Company

Concentrate Recirculation

Project name	Beausejour		Page : 1/5
Calculated by	RGG	Permeate flow/train	218.00 gpm
HP Pump flow	271.47 gpm	Raw water flow/train	256.47 gpm
Feed pressure	79.2 psi	Permeate recovery	80.30 %
Feed temperature	9.0 °C(48.2°F)	Total system recovery	85.00 %
Concentrate recirculation	15.00 gpm	Element age	0.0 years
Feed water pH	7.61	Flux decline %, per year	5.0
Chem dose, mg/l, -	None	Fouling factor	1.00
Specific energy	0.89 kwh/kgal	SP increase, per year	7.0 %
Pass NDP	61.0 psi	Inter-stage pipe loss	0.000 psi
Average flux rate	10.8 gfd		
		Feed type	Brackish Well Non-Fouling

Pass - Stage	Perm. Flow gpm	Flow / Vessel Feed gpm	Flow / Vessel Conc gpm	Flux gfd	DP psi	Flux Max gfd	Beta	Stagewise Pressure Perm. psi	Stagewise Pressure Boost psi	Stagewise Pressure Conc psi	Perm. TDS mg/l	Element Type	Element Quantity	PV# x Elem #
1-1	160.7	33.9	13.8	12.1	7.7	13.4	1.19	0	0	71.5	54.3	ESNA1-LF-LD	48	8 x 6M
1-2	57.4	27.7	13.3	8.6	5.9	10.2	1.13	0	0	65.6	166.1	ESNA1-LF-LD	24	4 x 6M

Ion (mg/l)	Raw Water	Feed Water	Permeate Water	Concentrate 1	Concentrate 2
Hardness, as CaCO3	375.41	484.52	28.506	1161.4	2348.9
Ca	64.10	82.73	4.867	198.3	401.1
Mg	52.50	67.76	3.986	162.4	328.5
Na	30.30	36.70	9.995	80.3	145.9
K	4.02	4.69	1.897	9.6	16.1
NH4	0.19	0.21	0.102	0.4	0.6
Ba	0.107	0.137	0.011	0.3	0.7
Sr	0.287	0.368	0.030	0.9	1.7
H	0.00	0.00	0.000	0.0	0.0
CO3	0.86	3.19	0.009	9.4	43.1
HCO3	432.00	551.17	50.312	1291.9	2558.4
SO4	39.00	50.80	1.436	123.2	252.6
Cl	32.20	40.10	7.005	91.7	175.4
F	0.28	0.32	0.137	0.7	1.1
NO3	0.00	0.00	0.000	0.0	0.0
PO4	0.00	0.00	0.000	0.0	0.0
OH	0.00	0.00	0.000	0.0	0.0
SiO2	16.40	20.32	3.931	46.1	87.3
B	0.00	0.00	0.000	0.0	0.0
CO2	20.40	20.40	20.40	20.40	20.40
NH3	0.00	0.00	0.00	0.00	0.00
TDS	**672.24**	**858.50**	**83.72**	**2015.02**	**4012.48**
pH	**7.61**	**7.71**	**6.71**	**8.06**	**8.33**

Saturations	**Raw Water**	**Feed Water**	**Concentrate**	**Limits**
CaSO4 / ksp * 100, %	1	2	11	400
SrSO4 / ksp * 100, %	0	0	3	1200
BaSO4 / ksp * 100, %	187	252	1549	10000
SiO2 saturation, %	17	21	75	140
CaF2 / ksp * 100, %	1	1	35	50000
Ca3(PO4)2 saturation index	0.0	0.0	0.0	2.4
CCPP, mg/l	32.78	69.49	887.81	850
Langelier saturation index	0.08	0.38	2.29	2.8
Ionic strength	0.01	0.02	0.08	
Osmotic pressure, psi	5.2	6.6	30.4	

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Nitto HYDRANAUTICS Nitto Group Company

Concentrate Recirculation

Project name	Beausejour		Page : 2/5
Calculated by	RGG	Permeate flow/train	218.00 gpm
HP Pump flow	271.47 gpm	Raw water flow/train	256.47 gpm
Feed pressure	79.2 psi	Permeate recovery	80.30 %
Feed temperature	9.0 °C(48.2°F)	Total system recovery	85.00 %
Concentrate recirculation	15.00 gpm	Element age	0.0 years
Feed water pH	7.61	Flux decline %, per year	5.0
Chem dose, mg/l, -	None	Fouling factor	1.00
Specific energy	0.89 kwh/kgal	SP increase, per year	7.0 %
Pass NDP	61.0 psi	Inter-stage pipe loss	0.000 psi
Average flux rate	10.8 gfd	Feed type	Brackish Well Non-Fouling

Pass - Stage	Perm. Flow gpm	Flow / Vessel Feed gpm	Flow / Vessel Conc gpm	Flux gfd	DP psi	Flux Max gfd	Beta	Stagewise Pressure Perm. psi	Stagewise Pressure Boost psi	Stagewise Pressure Conc psi	Perm. TDS mg/l	Element Type	Element Quantity	PV# x Elem #
1-1	160.7	33.9	13.8	12.1	7.7	13.4	1.19	0	0	71.5	54.3	ESNA1-LF-LD	48	8 x 6M
1-2	57.4	27.7	13.3	8.6	5.9	10.2	1.13	0	0	65.6	166.1	ESNA1-LF-LD	24	4 x 6M

Pass - Stage	Element no.	Feed Pressure psi	Pressure Drop psi	Conc Osmo. psi	NDP psi	Permeate Water Flow gpm	Permeate Water Flux gfd	Beta	Permeate (Stagewise cumulative) TDS	Ca	Mg	Na	Cl
1-1	1	79.2	1.96	7.3	72.5	3.7	13.4	1.11	34.4	1.939	1.588	4.366	2.928
1-1	2	77.2	1.65	8.3	68.9	3.5	12.7	1.12	37.4	2.113	1.73	4.728	3.18
1-1	3	75.6	1.37	9.4	66.5	3.4	12.3	1.13	40.6	2.301	1.885	5.112	3.451
1-1	4	74.2	1.12	10.9	64	3.3	11.8	1.15	44.4	2.52	2.064	5.55	3.762
1-1	5	73.1	0.89	12.8	61.4	3.1	11.3	1.17	48.8	2.783	2.279	6.065	4.131
1-1	6	72.2	0.68	15.5	58.4	3	10.8	1.19	54.3	3.107	2.544	6.688	4.583
1-2	1	71.5	1.45	17.1	55.3	2.8	10.2	1.1	105.3	6.116	5.009	12.59	8.816
1-2	2	70.1	1.23	19	52.3	2.7	9.6	1.11	114.3	6.649	5.446	13.588	9.548
1-2	3	68.8	1.04	21.3	49.1	2.5	9	1.11	124.5	7.263	5.948	14.721	10.385
1-2	4	67.8	0.87	23.9	45.7	2.3	8.3	1.12	136.3	7.975	6.532	16.016	11.349
1-2	5	66.9	0.72	27	42.1	2.1	7.7	1.13	150	8.807	7.213	17.508	12.467
1-2	6	66.2	0.59	30.6	38.1	1.9	6.9	1.13	166.2	9.79	8.018	19.238	13.775

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Nitto HYDRANAUTICS Nitto Group Company

Concentrate Recirculation

Project name	Beausejour		Page : 3/5
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Concentrate recirculation	15.00 gpm	Element age	0.0 years
Feed water pH	7.61	Flux decline %, per year	5.0
Chem dose, mg/l, -	None	Fouling factor	1.00
Specific energy	0.89 kwh/kgal	SP increase, per year	7.0 %
Pass NDP	61.0 psi	Inter-stage pipe loss	0.000 psi
Average flux rate	10.8 gfd		
		Feed type	Brackish Well Non-Fouling

THE FOLLOWING PARAMETERS EXCEED RECOMMENDED DESIGN LIMITS

Concentrate CCPP (887.8) is higher than limit (850).

The above saturations limits only apply when using effective scale inhibitor or dispersant. Without scale inhibitor or dispersant, the saturation and precipitation limit of the contaminant should not exceed its solubility in solution.

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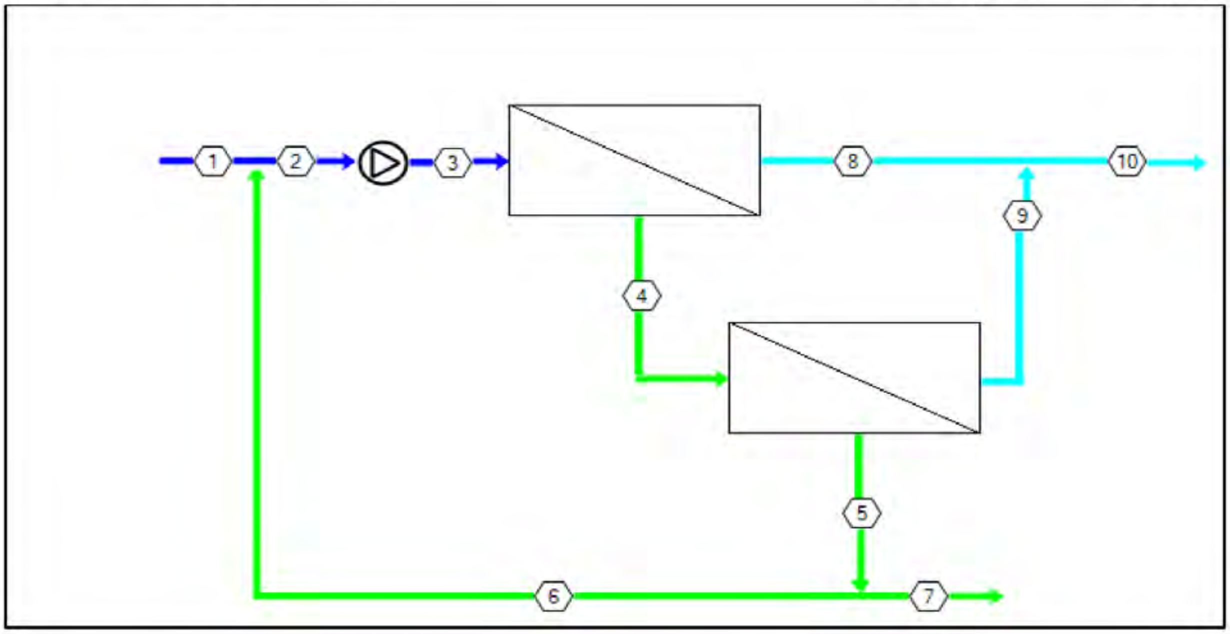
Concentrate Recirculation

Project name Beausejour Page : 4/5

Temperature : 9.0 °C Element age, P1 : 0.0 years



Stream No.	Flow (gpm)	Pressure (psi)	TDS (mg/l)	pH	Econd (µs/cm)
1	256	0	672	7.61	947
2	271	0	859	7.71	1246
3	271	79.2	859	7.71	1246
4	111	71.5	2015	8.06	2634
5	53.5	65.6	4012	8.33	4919
6	15.0	0	4012	8.33	4919
7	38.5	0	4012	8.33	4919
8	161	0	54.3	6.52	73.2
9	57.4	0	166	7.00	223
10	218	0	83.7	6.71	113

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Nitto HYDRANAUTICS Nitto Group Company

Concentrate Recirculation

Project name	Beausejour		Page : 5/5
Calculated by	RGG	Permeate flow/train	218.00 gpm
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Feed temperature	9.0 °C(48.2°F)	Total system recovery	85.00 %
Concentrate recirculation	15.00 gpm	Element age	0.0 years
Feed water pH	7.61	Flux decline %, per year	5.0
Chem dose, mg/l, -	None	Fouling factor	1.00
Specific energy	0.89 kwh/kgal	SP increase, per year	7.0 %
Pass NDP	61.0 psi	Inter-stage pipe loss	0.000 psi
Average flux rate	10.8 gfd		
		Feed type	Brackish Well Non-Fouling

Pass - Stage	Perm. Flow gpm	Flow / Vessel Feed gpm	Conc gpm	Flux gfd	DP psi	Flux Max gfd	Beta	Stagewise Pressure Perm. psi	Boost psi	Conc psi	Perm. TDS mg/l	Element Type	Element Quantity	PV# x Elem #
1-1	160.7	33.9	13.8	12.1	7.7	13.4	1.19	0	0	71.5	54.3	ESNA1-LF-LD	48	8 x 6M
1-2	57.4	27.7	13.3	8.6	5.9	10.2	1.13	0	0	65.6	166.1	ESNA1-LF-LD	24	4 x 6M

CALCULATION OF INVESTMENT AND WATER COST

Plant capacity as permeate	0.00 gpm
Specific investment	0.00 USD/gpm
Investment	000.00 USD
Plant life	0.0 years
Membrane life	0.0 years
Interest rate	0.0 %
Membrane cost	0.00 USD/element
Plant factor	0.0 %
Number of elements	72.0
Power cost	0.000 USD/kwhr
Inhibitor cost	0.00
Power consumption	0.89 kwhr/kgal
Inhibitor dosing	0.0
Maintenance(as % of investment)	0.0 %
Acid cost	0.00
Acid dosing	0.00

CALCULATION RESULTS

Capital cost	0.00 USD/kgal
Power cost	0.00 USD/kgal
Chemicals cost	0.00 USD/kgal
Membrane replacement costs	0.00 USD/kgal
Maintenance	0.00 USD/kgal
Total water cost	0.00 USD/kgal

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Appendix F

Water Treatment Plant Property Title

District: SELKIRK
Instrument Number: 4577201

M.A.V.A.S.
Land Titles Transactions

Page 51 of 88
Date Run: Feb 24, 2015

New CT#: Winnipeg - 2766789 Status: Active

Instrument Type	TRANSFER OF LAND	Sale Date	Feb 11, 2015
Vendor	ROBERT ANTHONY BILKOSKI	Consideration	$74,900
Consolidated?	No	Sworn Value	$74,900

\THE TOWN OF BEAUSEJOUR\

IS REGISTERED OWNER SUBJECT TO SUCH ENTRIES RECORDED HEREON
IN THE FOLLOWING DESCRIBED LAND:

LOT 1 PLAN 17169 WLTO
IN NE 1/4 36-12-7 EPM

Address:
THE TOWN OF BEAUSEJOUR
639 PARK AVENUE
BEAUSEJOUR, MB
R0E 0C0

Box 1028

From CT: Winnipeg - 2311446 ALL

Roll entries for this instrument: 401 - TOWN OF BEAUSEJOUR Roll: 79195 R

Appendix G

Town of Beausejour Hydrogeological Study – Friesen Drillers

Supplemental Municipal Groundwater Supply
Town of Beausejour

April 2020

Friesen
DRILLERS

Report to:

The Town of Beausejour

and

Manitoba Water Services Board

Supplemental Municipal Groundwater Supply
Town of Beausejour

April 29, 2020

Prepared by: Justin E. Neufeld, B.Sc.(G.Sc.), GIT Date: April 29, 2020

Reviewed by: Paulynn Estrella-Legal, B.Sc.(Mn.E.), P.Eng. Date: April 29, 2020

Authorized by: Jeff J. Bell, B.Sc.(G.E.), P.Eng. Date:

PROVINCE OF MANITOBA
J. J. BELL
Member
22821
REGISTERED PROFESSIONAL ENGINEER

APEGM
Certificate of Authorization
Friesen Drillers Limited
No. 4016 Date: Apr. 29/2020

Approved by: Jason D. Friesen Date: April 29, 2020

307 PTH 12 N Steinbach, MB. R5G 1T8 Phone 204-326-2485 Fax 204-326-2483 Toll Free-1-888-794-9355

Acknowledgements

Friesen Drillers acknowledges with appreciation the following individuals for their assistance and contributions during the completion of this project:

- The Town of Beausejour
  - Mayor and Council
  - Ms. Vesuvia (Vee) Scromeda, CAO
  - Ms. Katie Sanders and the Public Works Staff

- Manitoba Water Services Board
  - Mr. Nathan Wittemier, P.Eng.

- The RM of Brokenhead
  - Reeve and Council and Staff

Study Team

The study team consisted of the following individuals:

- Friesen Drillers Limited
  - Mr. Jeff Bell, B.Sc.(G.E.), P.Eng. – Hydrogeological Engineer
  - Ms. Paulynn Estrella-Legal, B.Sc.(Mn.E.), P.Eng. – Hydrogeological Engineer
  - Mr. Justin Neufeld, GIT – Groundwater Geologist
  - Mr. Peter Friesen – Lead Driller
  - Mr. Paul Sharples – Field Supervisor
  - Mr. Jason Friesen – Operations Manager

Notes

This study will utilize imperial measures, with the exception of water quality data and some velocity information, which will use metric measures. Use of the investigation results will follow the limitations and disclaimer in the report. Some of the data collected during this study was obtained from Manitoba Sustainable Development. Friesen Drillers has made no attempts to verify the information. It is assumed to be correct. The reports collected for background research on this aquifer have been obtained from public sources.

Friesen DRILLERS

Executive Summary

Friesen Drillers was retained by the Manitoba Water Services Board (MWSB) to undertake a hydrogeological investigation for a new supplementary municipal groundwater supply for the Town of Beausejour. The Town has experienced a steady rate of growth which is projected to continue into the future. The site of the new proposed groundwater supply is located at Section 26-12-07EPM, in the RM of Brokenhead, immediately southwest from the Beausejour townsite. This test area was suggested based on previous study results by Friesen Drillers.

The Town of Beausejour water supply is currently sourced from a wellfield completed into the carbonate bedrock aquifer. This water supply was first developed in the 1950s, with expansions in 1962 and 1995. Due to the local hydrogeological conditions, groundwater resource development is essentially limited to the fractured carbonate bedrock aquifer. The capacity of the carbonate aquifer is controlled by a naturally occurring fracture network in the bedrock. Well yields from the carbonate aquifer can vary widely, depending on the fractures intersected while drilling. The capacity of the carbonate aquifer within the Town of Beausejour is shown through previous work to be challenging and relatively limited. Consequently, it was recommended to explore areas southwest of the town where the aquifer formation has a greater overall thickness and the hydrogeological conditions are generally improved from those within town.

Two, 12 inch diameter, steel cased production wells (East and West) were completed into the Red River Formation Carbonate Aquifer. A 72-hour pumping test was conducted on the West production well, which included monitoring of the water level recovery after the pumps were shut off. A total drawdown of 3.6 feet was observed at the pumping well after 72 hours pumping at a rate of 510 U.S.G.P.M. (~32 L/s). A network of monitoring wells, located at various distances from the wellfield, was instrumented with transducers during the pumping test. Overall, the response of the carbonate aquifer to pumping revealed extremely high transmissive conditions which translated to very positive results for the project. The aquifer transmissivity (250,000 U.S.G.P.D./ft.) was noted to be a full order of magnitude greater than that of the existing town wellfield (25,000 U.S.G.P.D./ft.).

The groundwater quality shifted slightly during the pumping tests, although it was generally considered to be good quality calcium/magnesium/bicarbonate type groundwater. The total dissolved solids measured from the pumping well ranged from 372 to 431 mg/L during the 72 hour test. Water quality from the production wells was similar to the preliminary results obtained from test wells. Overall, the geochemistry is within the parameters required for the water treatment plant, as designed by Stantec Consulting. The production wells were also noted to produce sand free discharge, even at the high discharge rates up to 955 U.S.G.P.M. This reflects another significant improvement over the existing wellfield.

The aquifer test did not result in any negative interference effects for nearby residential water supplies. The total amount of additional drawdown in the closest well after one year of municipal pumping was calculated to be 5.6 ft. During operation, the pumping wells are expected to generate small amounts of drawdown (less than two feet) within about mile surrounding the site. Groundwater conditions in the area appear to be sufficient to support the demands of both the existing domestic and the proposed new municipal groundwater supplies.

Regionally, the proposed extraction of up to 641 cubic decameters per year (520 acre feet/year) is not expected to result in water level fluctuations beyond the natural amounts caused by seasonal and climatic effects. The overall amount of recharge to the regional carbonate aquifer system far exceeds the current rate of use on the aquifer. The proposed annual withdrawal from the new wellfield is not expected to cause negative impacts to the aquifer system.

It is recommended that the application process proceed for a new municipal groundwater supply at 26-12-07EPM. This will include an application for a Class 2 Environment Act Licence. Additional monitoring and reporting are recommended to monitor the aquifers in the area. Additional recommendations are contained in the report.

Supplemental Municipal Groundwater Supply

Town of Beausejour

April 29, 2020

Friesen
DRILLERS

307 PTH 12 N Steinbach, MB R5G1T8

Phone 204-326-2485 Fax 204-326-2483 Toll Free-1-888-794-9355

water…the lifeblood of the land

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

The Town of Beausejour is situated 46 km North East of Winnipeg on Highway 44. The town serves as a local hub for commercial and industrial business within a region dominated by rural, agricultural land uses. In addition to agriculture activity, numerous limestone and aggregate quarries operate in the area. The quarries are generally located where bedrock is shallow and sand and gravel deposits are abundant. The location of the Town of Beausejour is shown in Figure 1.

The use of groundwater in Beausejour has gradually increased over the years. A study conducted by J.R. Cousin Consultants (2015), found that upgrades to the present municipal water supply infrastructure, including the water treatment plant and groundwater well field, were needed to meet the future water supply demands of the community. As part of the upgrade strategy, additional supply wells were recommended.

The history of municipal groundwater development by the Town of Beausejour began in the 1950s. A detailed history of this development is provided in Section 3 of this report.

As part of the recent water supply expansion program, Friesen Drillers was retained by Manitoba Water Services Board to undertake hydrogeological drilling, testing, and analyses. Two locations southwest of the town, along Pescitelli Road, were selected for testing. The results of this test work are detailed in this report.

2 SCOPE OF SERVICES

The scope of work for this project is detailed below:

- Complete a physical well inventory within a 1 mile radius of the Pescitelli Road site. A listing of residents within the area was provided by the Town of Beausejour/ RM of Brokenhead.

- Complete a Preliminary Design including production well design, construction methodology, and testing methodology.

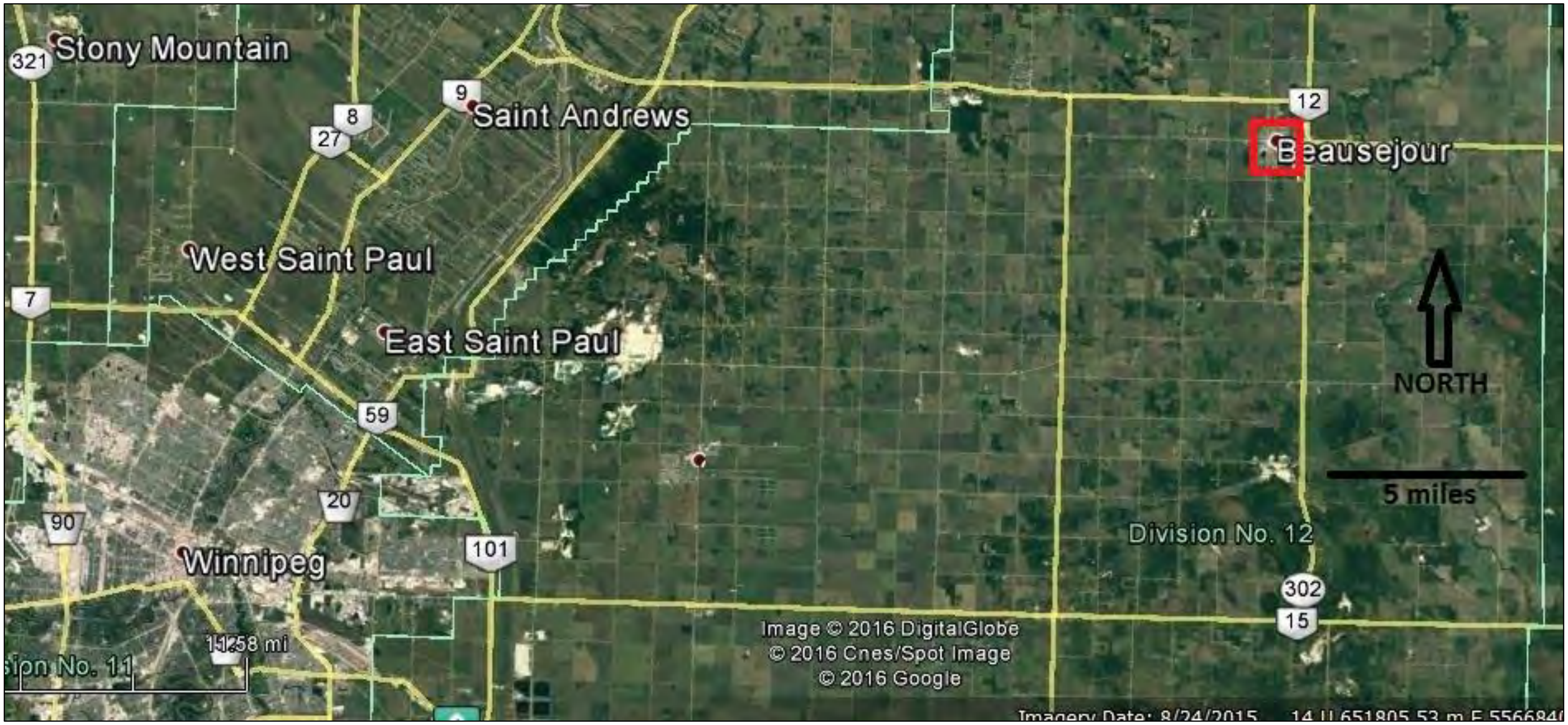
- Conduct a 72 Hour Pumping Test on the new production well.

- Design and implement an aquifer monitoring plan for the pump tests.

- Collect groundwater samples to be sent to an accredited laboratory for analysis of routine geochemistry, stable environmental isotopes of oxygen and hydrogen, and numerous additional parameters requested by Stantec to aid in the design of the new WTP.

- Complete a hydrogeological analysis and generate a final report for licence applications. The report will include but not be limited to the following aspects:
  - A review of the groundwater development history within the region.
  - Description of local and regional geological/hydrogeological conditions.
  - Review of historical hydrograph and meteorological data.
  - Assessment of existing groundwater users and groundwater development.
  - Assessment of the recharge dynamics for the regional groundwater systems.
  - Pumping test analyses.
  - Projected aquifer drawdown calculations and estimated long term impacts to aquifer and nearby groundwater users.
  - Detailed well inventory with a minimum radius of 1.0 mile from the production wells.

Figure 1 - Location of Beausejour 46 km northeast of Winnipeg, Manitoba



(Source - Google Earth, 2020)

3 GROUNDWATER DEVELOPMENT HISTORY

3.1 HISTORICAL WELLFIELD DEVELOPMENTS (1957-1995)

Development of groundwater from the Carbonate Aquifer has been ongoing in the Beausejour area, with well records dating back to the 1950s. The first municipal supply well was installed in 1957. The municipal supply system has since been expanded twice, with new supply wells constructed in 1962 and in 1995.

The existing supply wells were established as part of two hydrogeological investigations conducted by Reid, Crowther & Partners Limited with International Water Supply (1950s), and the Manitoba Water Services Board (MWSB) (Pedersen, 1987). A copy of the 1987 Pedersen report is provided in Appendix A. As the provincial water well database (GWDRILL) was only created in 1964, records of the 1950s test work are sparse. A summary of this early work was provided by MWSB which is also attached in Appendix A (Pedersen, 1973).

Based on the preliminary groundwater appraisal, the first two municipal supply wells were completed into fractured zones of the carbonate aquifer (Pedersen, 1973). Values for aquifer transmissivity at the wellfield were noted to be 35,000-46,600 USGPD/ft. The total yield of the well field was noted to be 500 U.S.G.P.M. with both wells (Well #1 and #2) pumping simultaneously (Pedersen, 1973). The report also noted a significant amount of sand was present in the overburden and upper fractured bedrock zones. It was noted that additional well development efforts would be required for the wells to produce sand free water at higher pumping rates.

Subsequent hydrogeological testing in Beausejour also indicated challenging conditions for groundwater development (Pedersen, 1987). Four sites, located approximately at each corner of the townsite, were tested as part of this work. The 1986 test locations are shown in Figure 2. In his report, Pedersen (1987) identified four potential sources of groundwater available for the town: drift sand, rock rubble at bedrock surface, carbonate bedrock, sandstone. A main conclusion from this report was that it was unlikely that better well sites than the existing site could be developed within the town. It was further stated that the existing wells should be able to supply the Town's future requirements, and that testing should be conducted to see if sand free production could be achieved at higher pump rates (Pedersen, 1987).

In 1995, a third municipal supply well (Well #3) was constructed at the site of Well #1 and Well #2 within the townsite. The specific capacity was noted to be 22.3 USGPM/ft. (pumping at 370 USGPM), although very fine white sand was noted in the discharge after well development (GWDRILL, 2018).

Figure 2 – Historical Test Sites

Previous testing locations. (Data source - Pedersen, 1987)

3.2 Current Upgrade Plans

The use of groundwater in Beausejour has gradually increased over the years. A study conducted by J.R. Cousin Consultants (2015), found that upgrades to the present municipal water supply infrastructure, including the water treatment plant and groundwater well field, were needed to meet the future demands of the community. As part of the upgrade strategy, additional supply wells were recommended.

Friesen Drillers was retained by JRCC to complete a desktop hydrogeological review (2016) of the Beausejour area and to make recommendations for potential groundwater development options. The review highlighted the historical concerns with groundwater development in the town and recommended that new supply well locations be sited away from the town.

In 2018, Friesen Drillers was retained by MWSB to undertake test drilling for additional production wells. At the direction of Stantec and MWSB, test wells were drilled near the existing water treatment plant (WTP) within the town. It is our understanding that these locations were preferred to minimize costs of connecting new supply wells to existing infrastructure. Four new test wells were constructed as part of the 2018 test drilling program. The test wells were drilled on two properties, two wells at the site of the future WTP and two wells at the site of the existing WTP. The testing locations are shown in Figure 3.

Figure 3 – 2018 Test Drilling Locations

The results of the 2018 test work indicated relatively poor conditions for development of additional municipal groundwater wells. The poor conditions resulted from a general lack of yield and bedrock fractures that were infilled with sediment. A report detailing the results of this work is attached in Appendix A. It was recommended that additional test work be undertaken at a location outside from the main townsite.

Friesen Drillers was retained in 2019 by MWSB to test two well sites at a secondary location along Pescitelli Road, southwest of Beausejour, within the RM of Brokenhead. The initial test results warranted the construction and testing of larger diameter municipal production wells. The details of this test work are the subject of this report.

4 WATER SUPPLY OPTIONS CONSIDERED

As far as the authors are aware, a comprehensive water supply sourcing study has not been completed for the Town of Beausejour. A notable lack of large scale surface water supplies is apparent for the immediate Beausejour area. It is noted that surface waters are typically more difficult and expensive to treat and are generally considered less favourable than groundwater sources. The main water supply options available in the area are from aquifer sources, and groundwater appears to be the only viable option for the Town in terms of cost, reliability, and long term security.

Friesen Drillers was retained in 2016 to undertake an assessment of groundwater resource potential in the Beausejour region. A copy of the 2016 report is included in

Appendix A. The assessment included a review of the hydrogeological appraisal completed for the Brokenhead Planning District by Rutulis (1979). The objective of the assessment was to review groundwater conditions within the Beausejour area and identify options for the best available groundwater quality and quantity.

As was noted by Rutulis (1979), Pedersen (1987), and Bell (2016), multiple aquifer types are present in the Beausejour area. These include unconsolidated sand and gravel aquifers in the overburden, the carbonate bedrock aquifer (and rubble zone), the deeper, sandstone bedrock aquifer, and the basement Precambrian bedrock.

Precambrian granites comprise the deepest geological units in the region. Well yields from the granite are generally very low and the water quality in the Beausejour region granite is expected to be saline (Betcher, 1986). Consequently, the Precambrian bedrock at Beausejour is generally unsuitable to develop a municipal water supply.

The Winnipeg Formation sandstone aquifer, which lies directly above the Precambrian, was tested by Pedersen (1986) and found to have a low capacity and poor overall water quality within the townsite. The electrical conductivity was noted to be 22,400 mmhos (Pedersen, 1987). These conditions make the sandstone aquifer unsuitable for development as a municipal water supply.

It is known from regional geological studies that the carbonate aquifer extends through the Beausejour region. The carbonate aquifer lies above the Winnipeg Formation sandstone aquifer, separated by a layer of shale. The carbonate aquifer formation becomes thinner towards the east and thicker towards the west of the town. The carbonate aquifer is covered by a layer of glacial till and clay overburden which provides some amount of aquifer protection from surface activities. The carbonate aquifer is locally fractured and well capacities can be high where fracturing is extensive. Groundwater quality in the carbonate aquifer is generally fresh and suitable for domestic use with limited treatment. The carbonate aquifer represents the only suitable bedrock aquifer available for municipal water supply development in the Beausejour area.

Overburden aquifers can be challenging for the development of municipal groundwater supplies, as they typically have an irregular and limited spatial distribution and are often highly susceptible to impacts from climatic fluctuations and surface activities. Large scale surface deposits are limited in the Beausejour area. The Sandilands glaciofluvial complex is located several km east of town. However, it is our understanding that the economic feasibility of developing this option precluded it from further consideration at this time. The Sandilands complex might represent a more suitable option for future developments, depending on the requirements and conditions present at that time.

Various groundwater protection and surface water treatment acts were developed in Canada after the Walkerton and North Battleford tragedies occurred in Canada in the early 2000's. In Manitoba, the Safe Drinking Water Act was developed and put into force in 2001. This Act makes a strong technical distinction between groundwater and surface water. Surface water sources now require significantly more complex and expensive treatment to remove such things as giardia, crypto sporidium, and various bacteria's and viruses that can be present in surface water.

5 RATIONALE FOR THE PESCITELLI ROAD WELL LOCATIONS

The groundwater availability review revealed the carbonate aquifer as the only feasible source of groundwater in the Beausejour area. However, the fractured nature of the carbonate aquifer results in substantial variability in well yields. Test work is typically required to assess aquifer conditions and locate suitable supply well locations.

As the 2018 test results indicated unfavorable conditions for additional municipal wells within the townsite, Friesen Drillers was retained by MWSB to review the regional conditions and to select secondary test locations. The desktop review was to, 1) identify any existing high-yielding wells, 2) delineate regions where the aquifer may have increased transmissive conditions, 3) review regional geochemistry data from the provincial hydrograph network, and 4) to provide a range of groundwater quality parameters for the proposed drilling targets.

Hydraulic data from drillers logs were obtained from the GWDRILL (2018) database and the apparent distribution of high yielding wells in the Beausejour area was assessed. Well yields were based on the specific capacity values calculated from pump test data, where available. The specific capacity review included a total of 547 well logs identified within a five by six mile (30 miles squared) area, approximately centered on the Town of Beausejour. In all, only 13 well logs (~2%) indicated appropriate testing conditions with a specific capacity value potential viable for municipal water supply application (~10 U.S.G.P.M./ft or greater).

The high capacity well locations were plotted and an approximate northeast-southwest trend through the Beausejour area was observed. As the thickness of the carbonate aquifer was known from regional geological data to decrease and pinch out entirely in the northeast direction, areas southwest of the town were selected for further study. The increased aquifer thickness in the westerly direction improved the potential to intersect water bearing fractures while drilling. The southwest area was also noted to be located approximately cross gradient from the main townsite, which limits the potential for negative impacts from existing domestic wells and septic systems.

The area that was recommended for further test drilling is shown in Figure 4. The target area was suggested based on the results of the well capacity review and the geological and hydrogeological conditions identified in earlier investigations. To minimize the potential piping costs, it was recommended that test work began at locations proximal to the town and progressed outward.

As the project was undertaken in conjunction with MWSB, the proposed test locations were located within a municipal Right of Way. The Manitoba Water Services Board Act provides authority to construct water wells within municipal Right of Ways. This is common practice for municipal water supplies in Manitoba. It was noted that test drilling could be done within the Right of Way at the proposed locations. It was also noted that some of the target area was within the boundaries of the Rural Municipality of Brokenhead

Figure 4 - Proposed Test Area - Pescitelli Road

Notes: Proposed areas for test drilling (within the road allowance); Yellow plotted points indicate existing specific capacity (USGPM/ft.). (Source - Friesen Drillers, 2019)

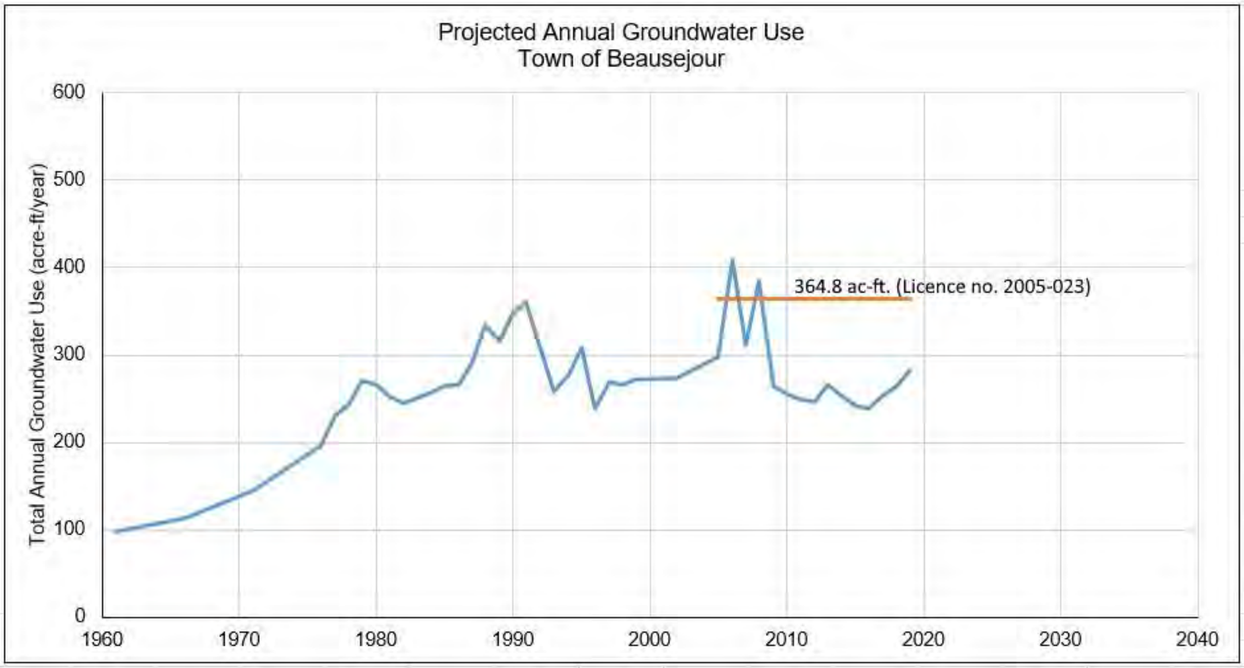
Prior to any field work in the secondary testing area, a preliminary public consultation campaign was undertaken by the Town and the RM of Brokenhead in October, 2019. Residents in the area immediately surrounding the test sites were contacted by the Town to discuss the project and answer questions related to the development.

6 Population and Water Use Trends

The annual groundwater pumping records from the Beausejour supply wells, beginning in 1961, are provided as Figure 5. It is evident from the plot that groundwater pumping gradually increased from 100 acre feet/year in the 1960s to over 400 acre feet/year in 2006. Annual groundwater use declined since 2009 and remained steady in subsequent years at around 250 acre feet/year. The current Water Rights Licence includes an annual allocation limit of 364.8 acre-ft/year.

The projected population for the service year 2039 was 4,640 people. This resulted in a projected raw water demand of 46 L/s (730 U.S.G.P.M.) (Stantec, 2018). Details of the water demand projections are provided in a subsequent section.

Figure 5 - Historical Groundwater Use - Town of Beausejour.



(Data source – Town of Beausejour, 2020)

7 Review of Local First Nations

The Brokenhead Ojibway Nation (Brokenhead 4 Indian Reserve), located about 32 km (20 miles) north of the Town of Beausejour, is the closest First Nation to the project site.

8 Regulatory Requirements for Municipal Groundwater Supplies

8.1 Water Rights Act and Existing Licences

The Province of Manitoba has the responsibility to distribute water under the Water Rights Act. This act requires that anyone using water exceeding 25,000 L/day for commercial, industrial, agricultural, and municipal use must obtain a license under the act. This is also required for industrial and geothermal heating/cooling applications. Water rights licensing is based on a first in time, first in right procedure. For groundwater projects, an exploration permit is required prior to starting the project. In order to provide approval for the exploration permit, Manitoba Conservation and Climate (MCC) – Drainage and Water Rights Licensing Branch reviews the available aquifer allocation (if available), to determine if the project is potentially suitable.

Upon completion of the testing of the project, MCC-WRLB reviews the proponent's proposal to determine if third party impacts may result. If these impacts are present, mitigation factors may be required. These include such things as groundwater interference plans, well repairs, replacements, and pump inspections. These programs are usually undertaken by the proponent of the project. Reports must be prepared for the project by a qualified hydrogeological engineer or hydrogeologist. The qualified person must be registered with Engineers Geoscientists Manitoba and have a proven expertise in the fields of hydrogeology and water supply development.

If the application is deemed acceptable and third party impacts are managed or addressed, MCC-WRLB will issue a licence for the diversion of groundwater. The proponent then has a conditional right to the water supply for a specific duration.

The Town of Beausejour currently holds a licence for their existing water supply system. The details of the current licence are contained in Appendix B.

8.1.1 Licence No. 2005-023 – Town of Beausejour

Licence no. 2005-023 allows for the pumping of 450 dam^3/year (364.82 acre-feet/year) from the fractured limestone aquifer. The well field includes three wells located at the WTP on Park Road. The water is used to supply the municipal-distribution system.

- The maximum instantaneous flow rate of diversion shall not exceed 0.8 ft^3/s (0.0228 m^3/s) or about 360 U.S.G.P.M.
- The license is for municipal use.
- There a number of additional conditions and clauses on the license. The current water rights license is valid for 20 years.

8.1.2 New Water Rights Licence

Friesen Drillers submitted an application for a Groundwater Exploration Permit (GEP) on September 10, 2018. MCC – WRLB issued a GEP on September 14, 2018. A number of conditions were included on the permit which corresponded well with the scope of work for the project. The authorization permit allowed for the testing of the wells under the supervision of a consulting hydrogeologist or hydrogeological engineer licensed with Engineers, Geoscientists Manitoba (EGM). A copy of the GEP application and authorization is attached as Appendix C.

In September, 2019, Friesen Drillers applied to have the GEP extended for another 12 month period and revised to include the new test area along Pescitelli Road. A letter authorizing the extension and revisions is also included in Appendix C.

The new water rights licence is planned to request a total annual groundwater allocation of 520 acre-ft./year (641 dam^3/year). This number is based upon the water demand calculations provided by Stantec (2018).

8.2 ENVIRONMENT ACT LICENCE

In the event that a groundwater supply project exceeds 200 dam^3/year, a Class 2 Environment Act License is required under Manitoba's Environment Act.

When a new water supply which exceeds the requirement is developed, or a qualifying existing water supply is modified, an Environment Act Proposal must be prepared. The proposal must identify potential environmental impacts from the water supply diversion, such as third party impacts and well interreference effects. Mitigation measures are then proposed and evaluated. The proposal is usually advertised for public comment and review. Environmental groups and organizations typically review the proposals to ensure that environmental effects are taken into consideration. In the event that significant public opposition is encountered, the Minister of Conservation and Climate may order a Clean Environment Commission to hold public hearings for the project. Although these public hearings are rare, they have been held for water supply projects in Manitoba.

Copies of Environment Act Proposals are also submitted to various organizations within governments for comments and review. Often, water supply proposals involving groundwater use are reviewed by the Provincial Groundwater Management Section of MCC. If the environmental impacts are deemed to be minor, or the mitigation proposals are acceptable, the director will issue an Environment Act License for the development.

The requirement for Environment Act assessments for water supplies was put into force in the mid 1990's. As a result of this requirement, several water supply systems that did not originally obtain an Environment Act License would be requested to undertake this aspect upon a request for additional groundwater use allocation.

The Town of Beausejour currently holds an Environment Act License (No. 2085) for the existing municipal water supply. A copy of this licence is attached in Appendix B. Pumping from Beausejour's new municipal wellfield will exceed the 200 dam^3 threshold requirements for a Class 2 development. Therefore, the existing Environment Act License will need to be amended. It is our understanding that an application to amend the licence will include new supply wells along with the water treatment plant and associated infrastructure (pipelines, etc.). This application will be filed by MWSB on behalf of the Town of Beausejour. This report addressed only those Environmental Licensing aspects which relate to the diversion of groundwater.

9 WATER SUPPLY REQUIREMENTS

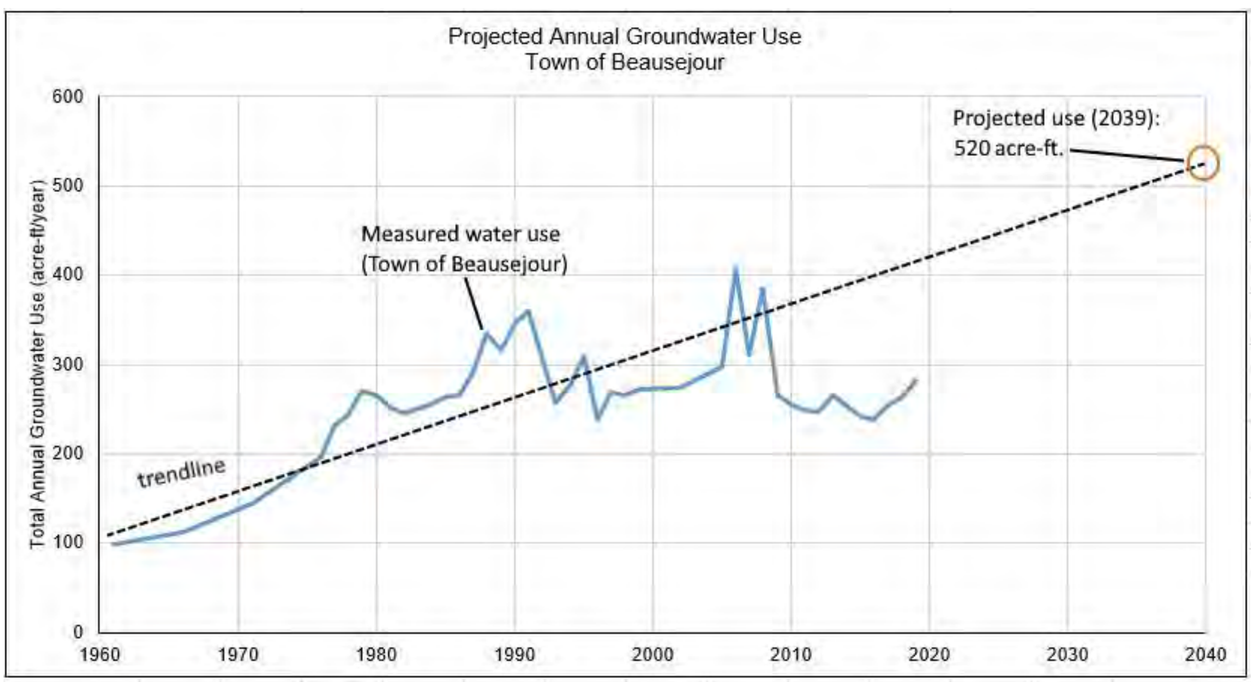
Based on the Stantec (2018) water treatment plant design, the average day, maximum day, and maximum hour water demand projections for Year 20 (2039) are listed below:

- Average day: Treated 17 L/s (222 U.S.G.P.M.); Raw 20 L/s (317 U.S.G.P.M.)
- Maximum day: Treated 33.5 L/s (539 U.S.G.P.M.); Raw 40 L/s (317 U.S.G.P.M.)
- Maximum hour: Treated 42 L/s (665 U.S.G.P.M.)

It is our understanding that the calculations were based on a 20 hour day for withdrawal rates (Stantec, 2018). Due to treatment processing requirements, the raw water demands are greater than the treated water demands (MWSB, 2020). The max hour demand would be supplied from the reservoir and never from the wells (MWSB, 2020). This results in a maximum instantaneous raw water flow rate of 42 L/s (665 U.S.G.P.M.) (Stantec, 2018).

The projected average daily (20 hour) raw water demand of 317 U.S.G.P.M. equates to an annual groundwater allocation of 426 acre-feet (or 526 dam^3/year). A 20 percent multiplier was applied to this value to accommodate annual fluctuations and to avoid future exceedances of the allocation limit. As a result, the requested allocation for the new groundwater supply will be 520 acre-ft./year (641 dam^3/year). The projected total annual groundwater allocation is shown in Figure 6.

Figure 6 – Projected Groundwater Use (2039) - Town of Beausejour.



(Data sources – Town of Beausejour, 2020; Stantec, 2018)

To meet the projected raw water demands, additional groundwater supply wells were requested (Stantec, 2018). The existing municipal well field consists of three supply wells. The oldest well (Well #1) is no longer used for production and, for the purposes of this investigation, is considered to be decommissioned/abandoned. It is our understanding that supply well #2 operates at approximately 200 USGPM (13 L/s), and supply well #3 operates at 300 U.S.G.P.M. (19 L/s) (Town of Beausejour, 2019).

Based on consultations with Stantec and MWSB, the preferred wellfield configuration would involve each new supply well (East and West) mechanized to produce 42 L/s (665 U.S.G.P.M.) in a duty/standby operating schedule.

10 Site Setting

The test area is one mile west of Provincial Road (PR) 302 and one mile south of PR 215, at the intersection of Rd 41 East and Rd 71 N. The test area is shown as Figure 7. The Town of Beausejour lies within the Brokenhead River Watershed, within the larger Red River Drainage Basin. Regionally, surface drainage is directed towards the Red River which flows north into Lake Winnipeg and ultimately discharges into Hudson's Bay. Local drainage is also provided by the Brokenhead River which flows northward into Lake Winnipeg. Surface drainage from the well sites on Pescitelli road is north westerly along the major ditches.

The regional climate is Continental. The average temperature in southern Manitoba is about 3.3 degrees Celsius (Environment Canada, 2020). According to Environment Canada, precipitation is around 500 to 525 mm/year, although it has been increasing over the last 40 years (Environment Canada, 2020).

The following land uses surround the well field area along Pescitelli Road:

- North: Agricultural land followed by residential properties of west Beausejour.
- East: Agricultural lands/rural residential properties; Brokenhead River lies about 3 miles to the east.
- South: Agricultural lands and rural residential properties.
- West: Rural residential properties and agricultural lands.

Figure 7 – Proposed Groundwater Supply – General Site Location

11 GEOLOGICAL SETTING

11.1 BEDROCK GEOLOGY

The Town of Beausejour is located on the eastern fringes of the Western Canadian Sedimentary Basin in southeastern Manitoba. The extent of the WCSB is shown in Figure 10 and a geological cross section of southern Manitoba is depicted in Figure 11. The regional geology has also been described in detail by Matile and Keller, 2012

The regional bedrock is composed of Ordovician sedimentary rocks overlying Precambrian granites. The Precambrian lies below about 240 ft. below grade (Pedersen, 1987). The Winnipeg Formation shale and sandstone lie directly upon the Precambrian and form the basal unit of the sedimentary succession. In Beausejour, the upper surface of the Winnipeg Formation lies at a depth of approximately 140 ft. below grade (Pedersen, 1987). The sandstone is overlain by carbonate rocks of the Red River Formation. The top of the Red River Formation carbonate bedrock at Beausejour lies at depths between about 70-100 ft. below grade (GWDRILL, 2018).

The bedrock formations dip gently to the west, where they become thicker and more deeply buried. West from the Town of Beausejour, the total thickness of the carbonate bedrock increases. Conversely, east from the town, the carbonate rock gradually becomes thinner and eventually pinches out completely. The Red River Formation is weathered to variable degrees, with some zones exhibiting only minor fracturing and others extensive fracturing and solution cavity development (Render, 1970).

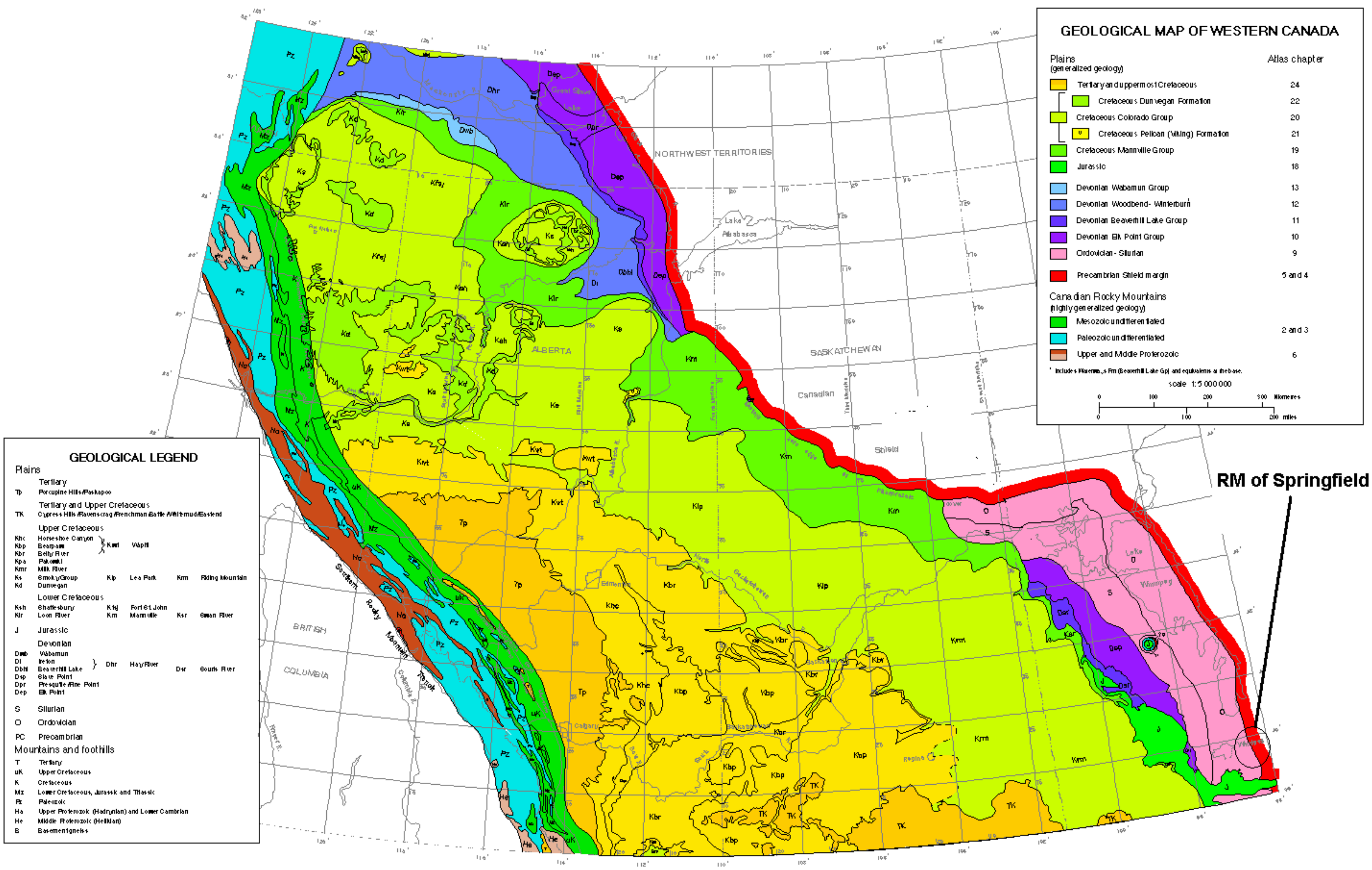
11.2 SURFICIAL GEOLOGY

The surficial geology of the study area is composed predominantly of Quaternary clay and till material with local deposits of sand and gravel. The regional sediments have been fairly well studied and mapped (Matile and Keller, 2004). Figure 10 illustrates the distribution of surficial deposits around Beausejour.

The quaternary geology of southern Manitoba includes a complex history of glacial activity (Teller, 1976). Several episodes of glacial advance and retreat and the development of proglacial lakes resulted in the distribution of surficial sediments observed today. In the east, extensive glacial till (diamicton) with scattered sand and gravel form a regional upland area identified as the Sandilands Glaciofluvial Complex. The upland area slopes towards the west and transitions into a low relief landscape composed predominantly of lacustrine clay with underlying glacial till.

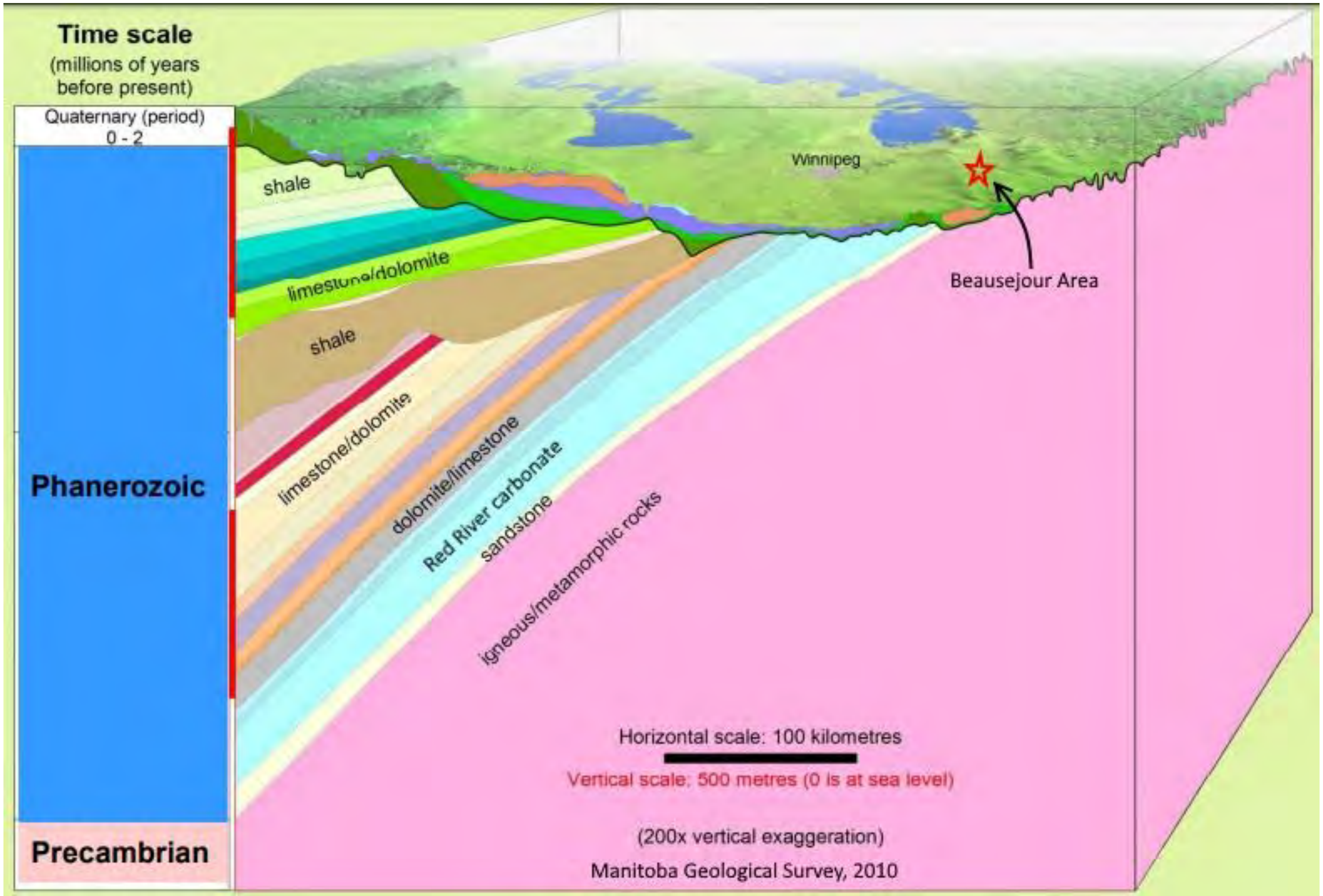
From Figure 10, Beausejour lies in an area mapped as calcareous silt diamicton (carbonate-rich silty till) with proximal glaciofluvial sediments (unconsolidated sand and gravel deposits). The area is surrounded by offshore glaciolacustrine deposits (clay) which underlie the surface throughout most of the Red River Valley.

Figure 8 - WCSB showing the Beausejour Location.



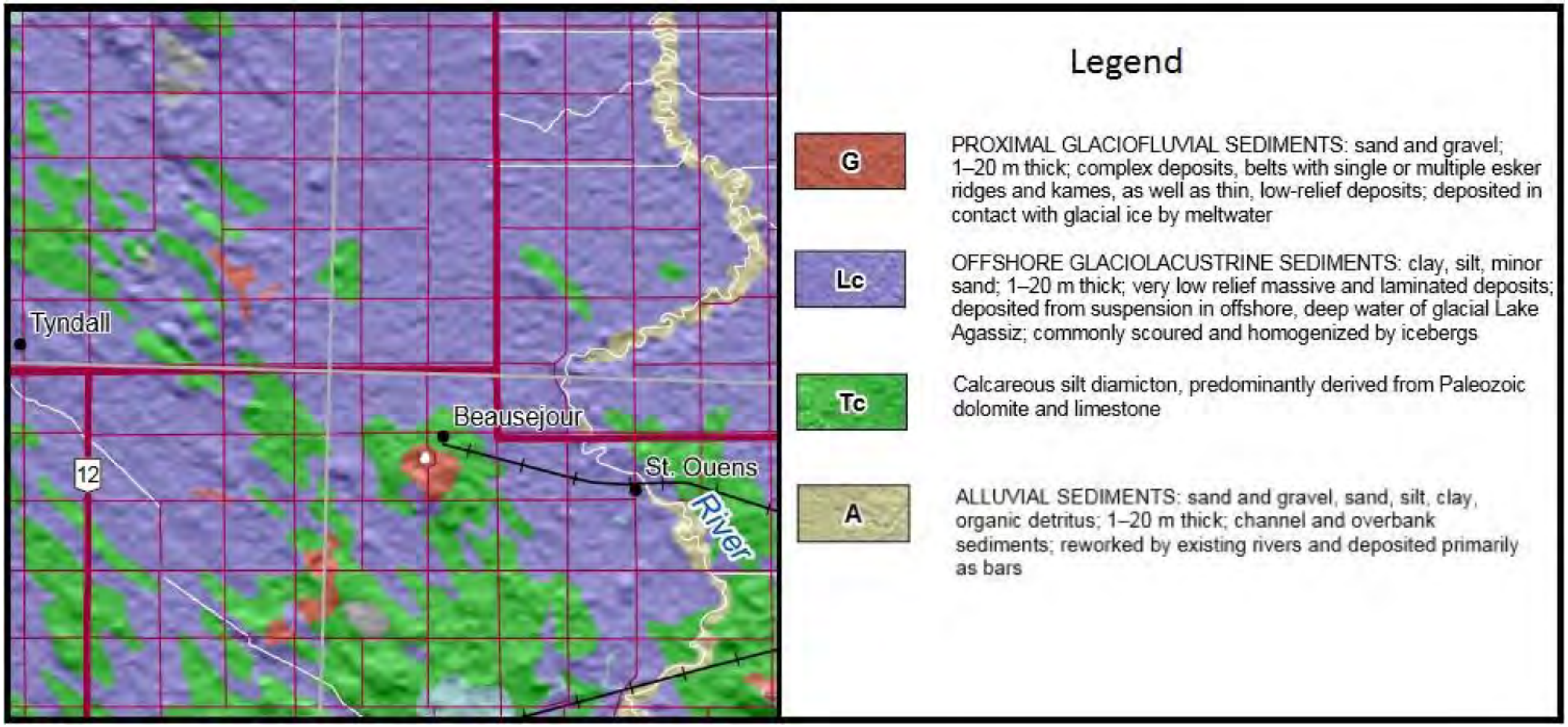
(Source - Alberta Geological Survey, 2009)

Figure 9 – Geological Cross Section – Southern Manitoba



(Modified source – *Bamburak, 2010*)

Figure 10 – Surficial Geology of the Beausejour region.



(Source - Manitoba Mineral Resources – Surficial Geology, 2013)

12 HYDROGEOLOGY OF BEAUSEJOUR

12.1 REGIONAL BEDROCK AQUIFERS

Three major sources of groundwater are potentially available for development in the Beausejour area. These include the Winnipeg Formation Sandstone Aquifer, the Red River Formation Carbonate Aquifer and surficial sand and gravel deposits. Previous work has examined the potential of each of these aquifers in the Beausejour area and concluded that the Red River Formation Carbonate Aquifer provides the most favorable source for development (Betcher et al., 1995; Render, 1987). The Carbonate Aquifer forms the most geologically extensive and widely developed groundwater source in Manitoba, extending through the southeast and Interlake regions of the Province (Betcher, et al., 1995). The Carbonate Aquifer is the main groundwater source available in the Beausejour region and all three existing municipal groundwater wells and two new production wells are completed into the Carbonate Aquifer. Consequently, this investigation focuses primarily on the Carbonate Aquifer.

The carbonate rock of the Red River Formation generally has very poor primary porosity, typically less than one percent (Render, 1970). Consequently, groundwater flow through this unit occurs predominantly in fractures and joint sets that developed after the rock was formed. Horizontal and vertical groundwater movement through the bedrock is controlled by the size, extent, and interconnectivity of these fracture systems. Due to this geologic condition, aquifer transmissivity and storativity can vary significantly over short distances and result in substantial variations in well yield depending on the fractures intersected while drilling the well. (Render, 1970).

The Sandstone Aquifer underlies the carbonate aquifer. The sandstone is generally well sorted and composed of very fine to fine grained, well rounded silica sand (Betcher, et al., 1995). Unlike the carbonate aquifer which mainly transmits groundwater through fractures, the sandstone aquifer transmits groundwater through interstitial pore space and well yields are generally more consistent and predictable.

12.2 GROUNDWATER RECHARGE/DISCHARGE

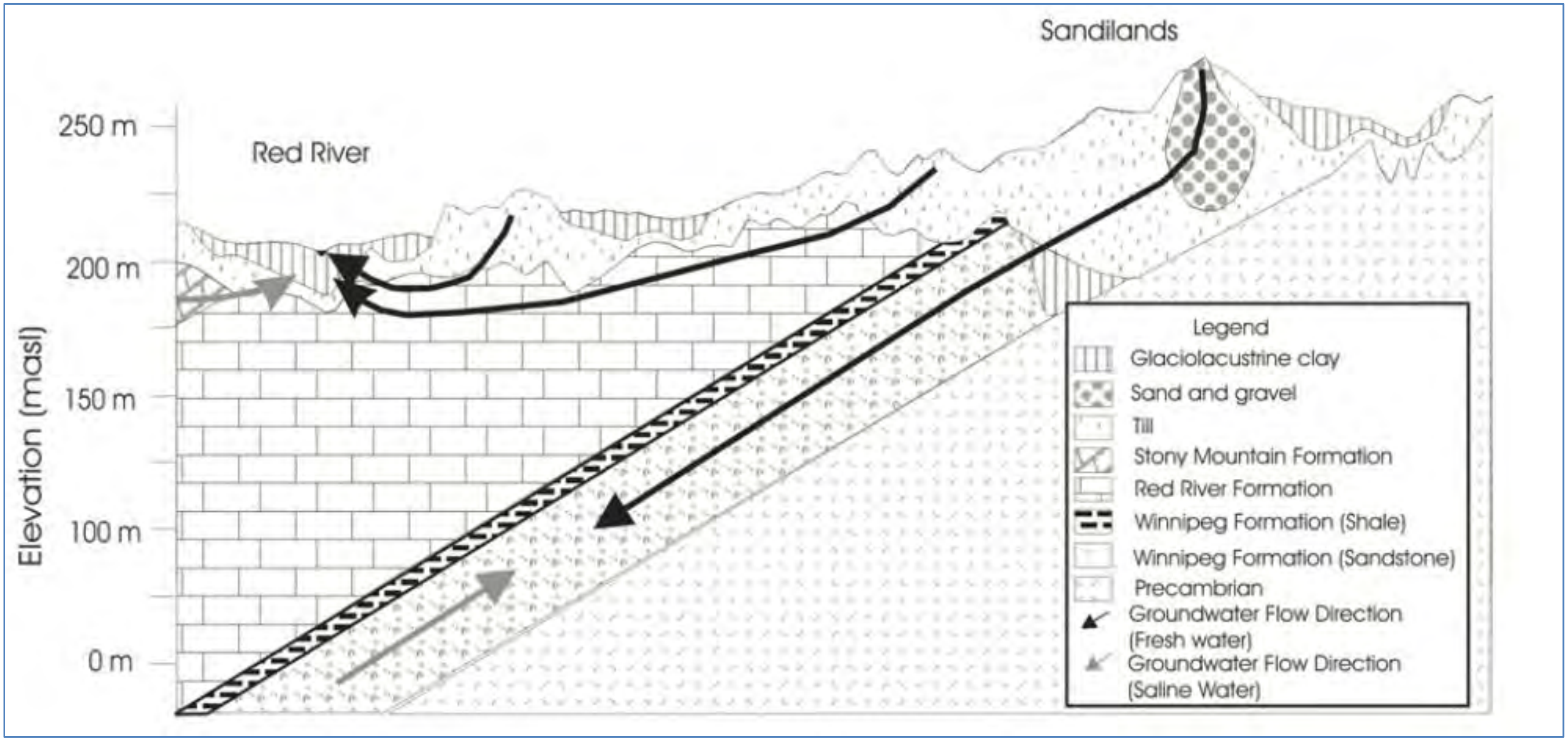
Recharge to the carbonate and sandstone aquifers occurs predominantly through the Sandilands sand and gravel moraine complex that lies to the east. The general recharge dynamic is shown as Figure 11 (Betcher and Ferguson, 2003). Within the Sandilands complex, coarse grained sand and gravel, interlayered with silt and clay, rest directly upon the eastern edge of the bedrock sub crop. Infiltrated snowmelt, run off, and rainfall within these highland moraines impose an elevated hydraulic head on the regional groundwater systems. The exact amount of groundwater recharge to the formations has not been determined by research.

Regionally, the main recharge areas for the carbonate aquifer are located in the east with discharge areas located towards the west-northwest, which generates the regional hydrogeological conditions illustrated in Figure 12. The regional flow direction is locally variable, including in the Beausejour area, where the hydraulic gradient may be easterly based on local factors. Among these factors are several smaller recharge areas mapped in the Beausejour area and the long term pumping of the municipal wellfield.

Figure 13 illustrates the local conditions around Beausejour, including four recharge zones identified by Render (1987). Quarry operations, particularly in the Garson and Tyndall area, are another important aspect of local groundwater flow. In generally, quarry operations often increase the potential for groundwater recharge and can impart some hydraulic influence on local groundwater dynamics (Render, 1987).

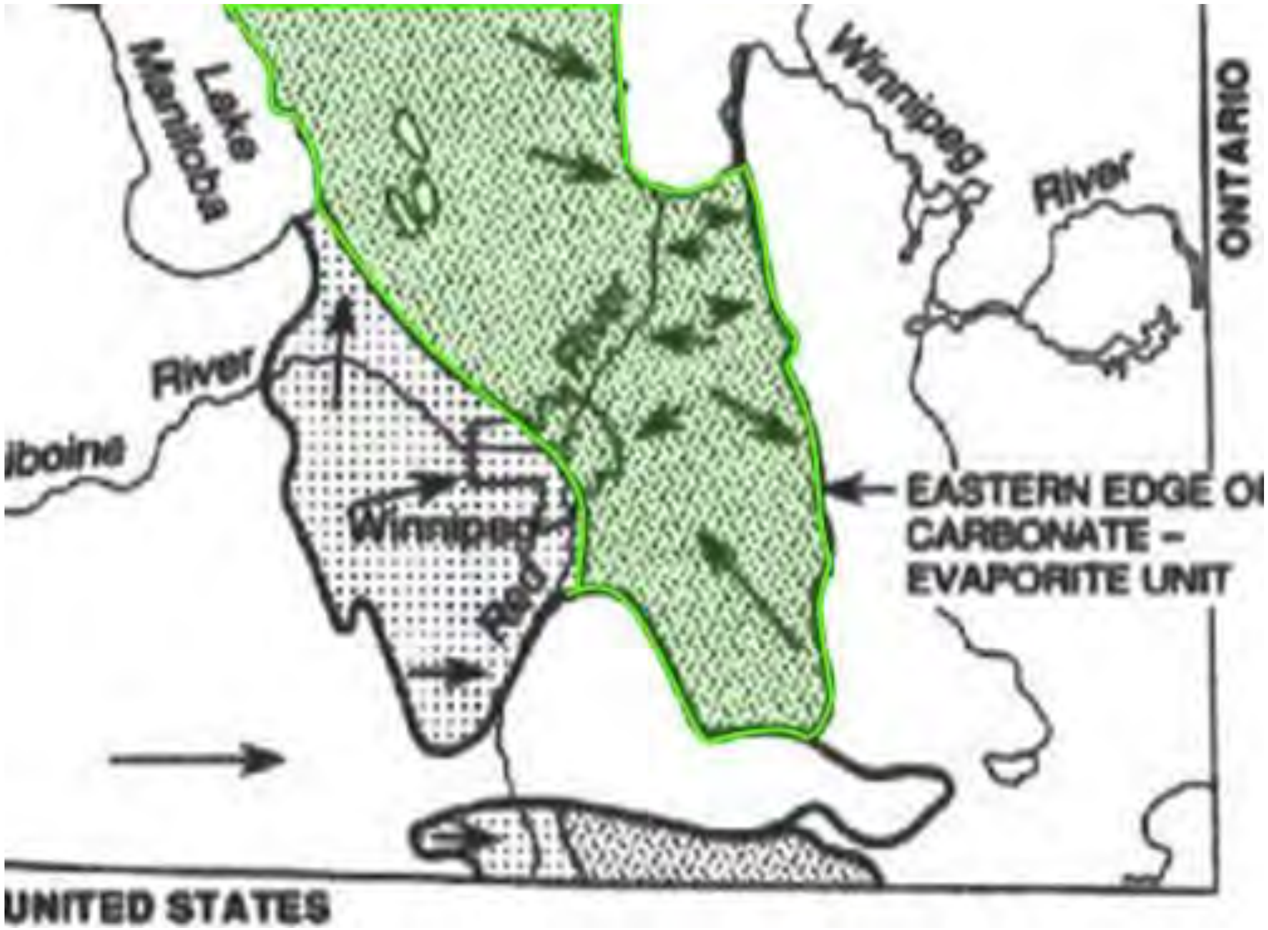
Groundwater discharge in the region occurs through a variety of means. The carbonate aquifer is known to discharge into the Red River Floodway and into numerous creeks, surface drains, and natural streams. There is also evidence to suggest that some groundwater is discharged into the Red River near the City of Winnipeg. In addition, a significant amount of groundwater likely discharges into Lake Winnipeg (Betcher et al., 1995). Further, extensive domestic, agricultural and municipal groundwater well consumption occurs on the aquifer. Groundwater discharge in the Winnipeg Formation occurs predominantly through domestic, farm and municipal well pumping, and basal discharge into Lake Winnipeg.

Figure 11 – Schematic Groundwater Recharge Dynamics – Southeastern Manitoba.



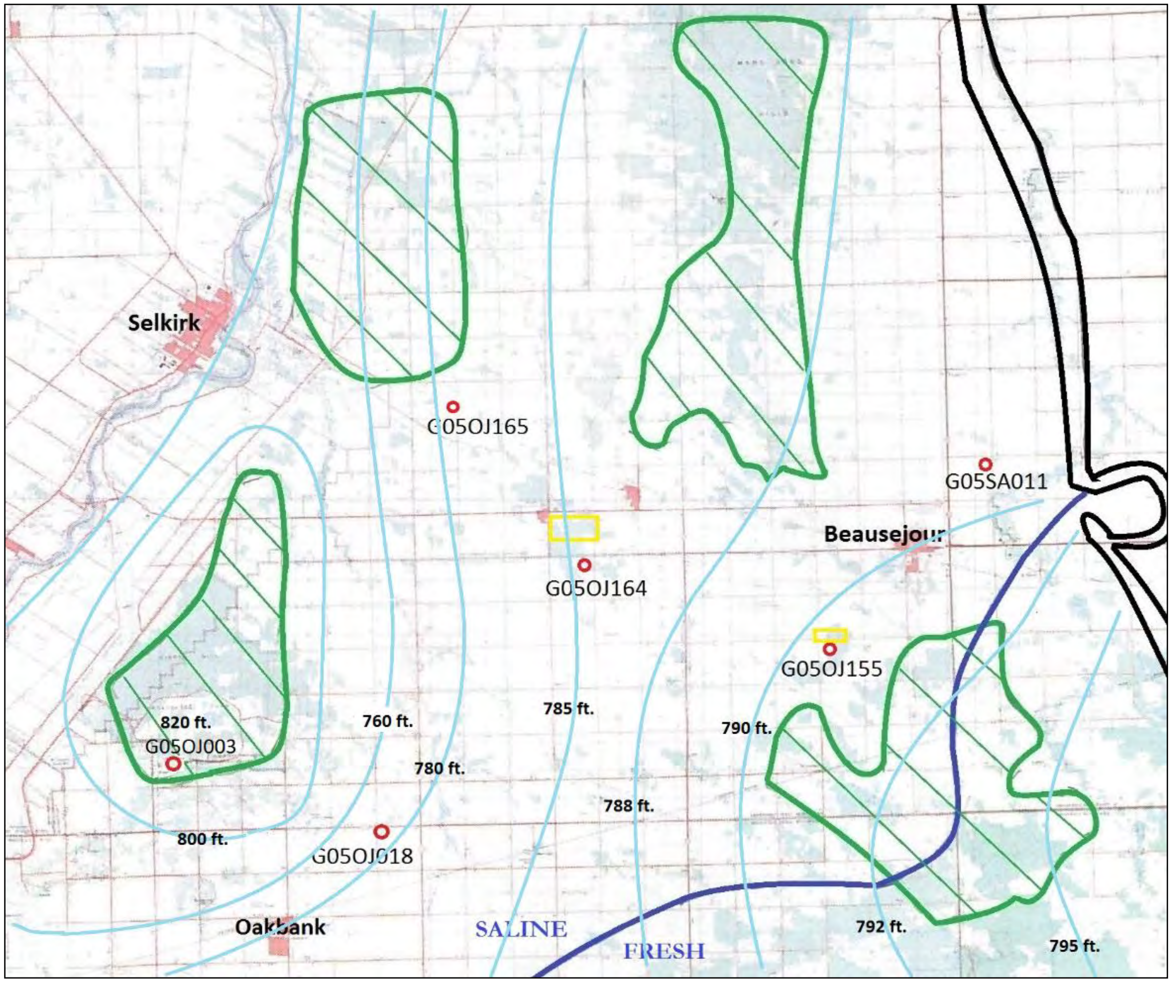
(Source: Betcher and Ferguson, 2003)

Figure 12 – Carbonate Aquifer, Regional Flow and Freshwater Distribution



Notes – Arrows indicate flow directions; Freshwater area shaded in green. (Source – Betcher et al., 1995.)

Figure 13 - Hydrogeology of the Beausejour Region



Legend: green outlines recharge zones; dark blue line is Winnipeg Fm. fresh/saline boundary; light blue are potentiometric elevations; yellow outlines major quarry operations; black lines are bedrock contacts of the Winnipeg Fm.

(Source - MCC, 2014; Render, 1986)

12.3 Potentiometric Surface and Groundwater Flow

It is apparent from a review of the regional potentiometric surface, plotted as light blue lines in Figure 13, that flow directions in the Carbonate Aquifer are locally variable, although a regional east to west–northwest flow direction is apparent.

The regional hydraulic gradient in the carbonate aquifer in the Beausejour area was determined to be about 8.49×10^{-4}. The flow direction in the sandstone was inferred to be similar, with a similar gradient.

The carbonate bedrock generally has variable permeability, with transmissivity values in the range of 5,000 to 150,000 U.S.G.P.D./ft. (Betcher et al., 1995). Due to the fractured rock nature of the aquifer, the permeability varies substantially with distance. In the Winnipeg Formation Sandstone, Phipps et al. (2008) determined the hydraulic conductivity to be about 2.38×10^{-5} m/s. Assuming an average formation thickness of 100 feet, the transmissivity was estimated to be about 5,000 U.S.G.P.D./ft. on average.

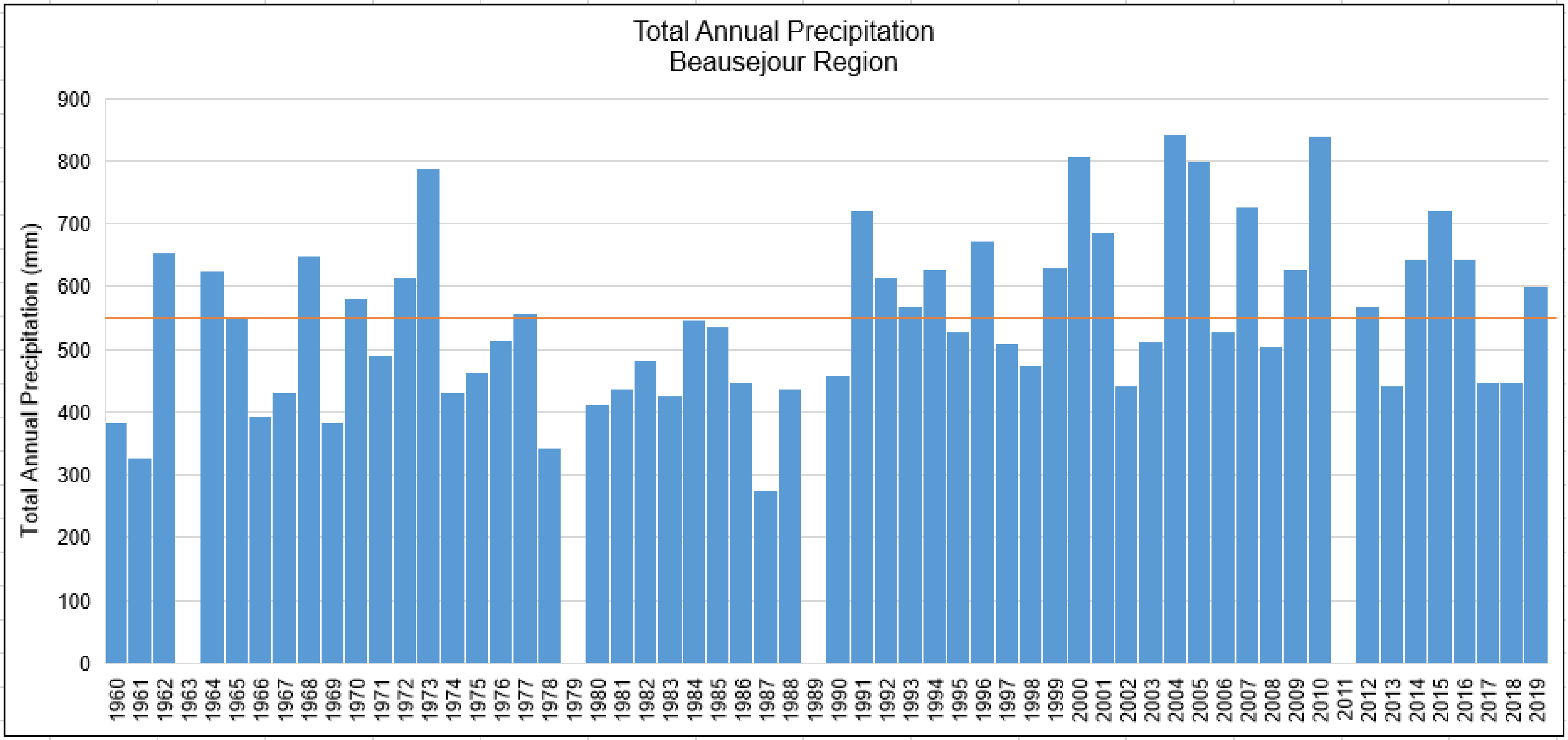
12.4 Local Hydrograph Review

A review of the hydrograph records for the Beausejour area was completed to better understand the regional hydrogeological conditions. In reviewing the hydrographs, it is important to consider the various components of the hydrological cycle, including the total annual precipitation (rain and snow melt) and leakance through the overburden. This data was also be compared with the annual metered consumption from the aquifer. These records allow for a comparison of the hydrographs within the state of nature that exists on the aquifer

12.4.1 Total Annual Precipitation

The total annual precipitation in the Beausejour region since 1960 is plotted in Figure 14. Average annual precipitation for the region over the observation period is 551 mm, although this has been increasing since about the early 1990s, with an average of 620 mm/year over the most recent 25-year period (Environment Canada, 2020). It is clear from the plot that precipitation is cyclical, with highs and lows occurring roughly on a decade scale. Precipitation in 2017 and 2018 was well below the average, while 2019 was slightly above the average.

Figure 14 - Total Annual Precipitation



Note: Average since 1960 (orange line) – 550 mm/year. (Data source - Environment Canada, 2020)

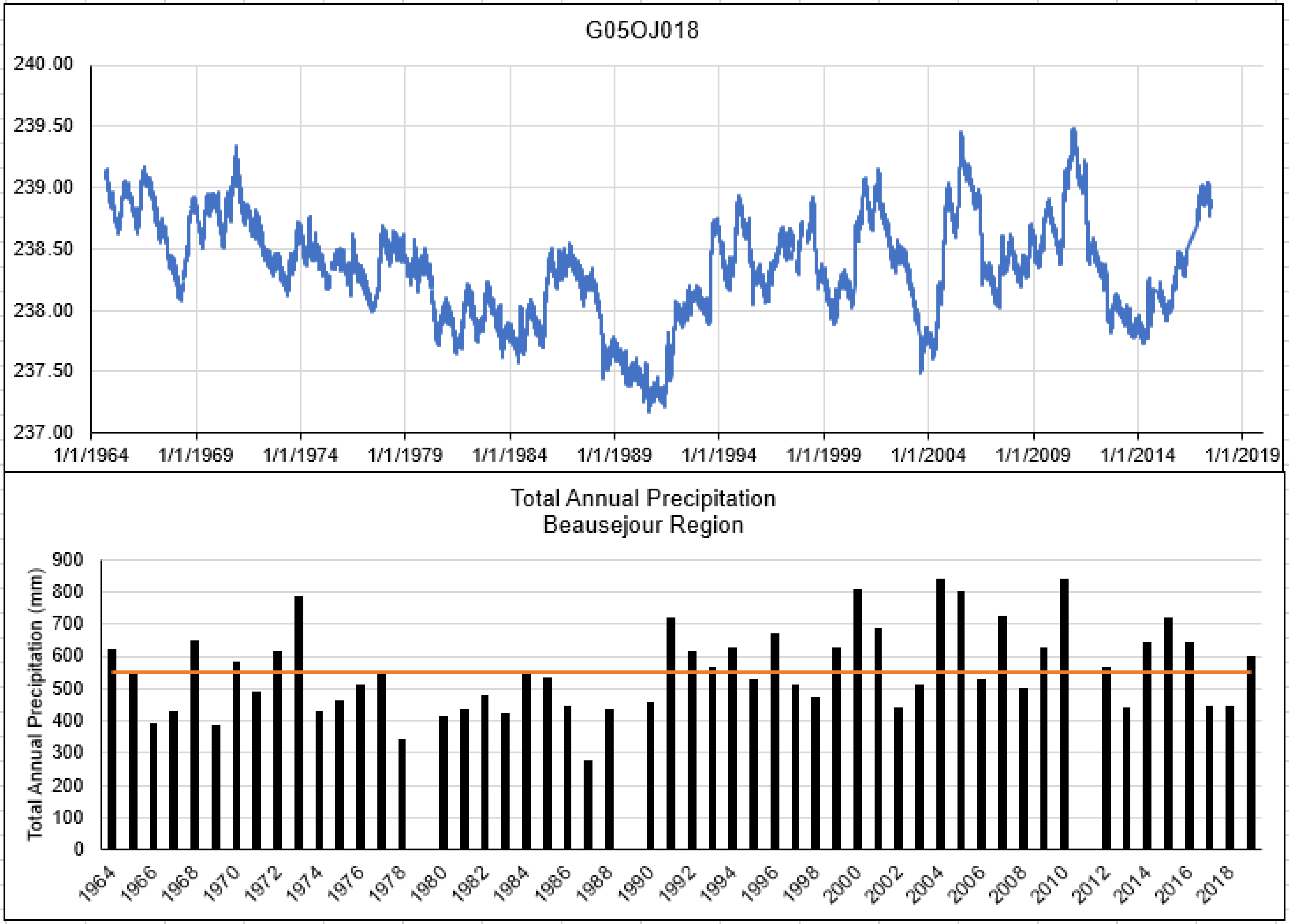
12.4.2 Provincial Hydrograph Stations

Figure 15 shows a comparison of total annual precipitation with groundwater levels recorded in provincial station G05OJ018, located several km west of the Town of Beausejour. This is the closest station to Beausejour that has a long term hydrograph record available. From the hydrograph, groundwater levels are shown to fluctuate seasonally on the order of 0.5-1.0 m (1.6-3.3 ft.). In addition to seasonal fluctuations, large scale trends and correlations are also apparent in the data. For example, during the period of 1965-1992, groundwater levels in G05OJ018 gradually declined by a total of 2 m (~6 ft.), from 239.3 to 237.3 m ASL. Similarly, total annual precipitation was frequently below to well below average during the same period. The total range for groundwater levels over the period of observation was 2.3 m (7.5 ft.).

A marked change is observed, beginning in the early 1990s, when both groundwater levels and total annual precipitation began to increase. The positive trend continued to the extent that, by 2005, groundwater levels had exceeded those recorded in the mid-1960s and total annual precipitation amounts reached record levels. It is clear from these trends that a strong correlation exists between total annual precipitation and the groundwater levels of the carbonate aquifer. This correlation suggests that precipitation has a direct affect upon groundwater levels within the carbonate aquifer in the Beausejour area.

It should be noted that no evidence of significant influence from consumptive groundwater use was observed on the hydrograph records from the Beausejour area. In addition, no long term regional progressive drawdown was apparent from the hydrographs.

Figure 15 - Annual precipitation and groundwater levels in G05OJ018



(Data source - Hydata, 2019; Environment Canada, 2020)

12.5 Interconnection of Regional Aquifers

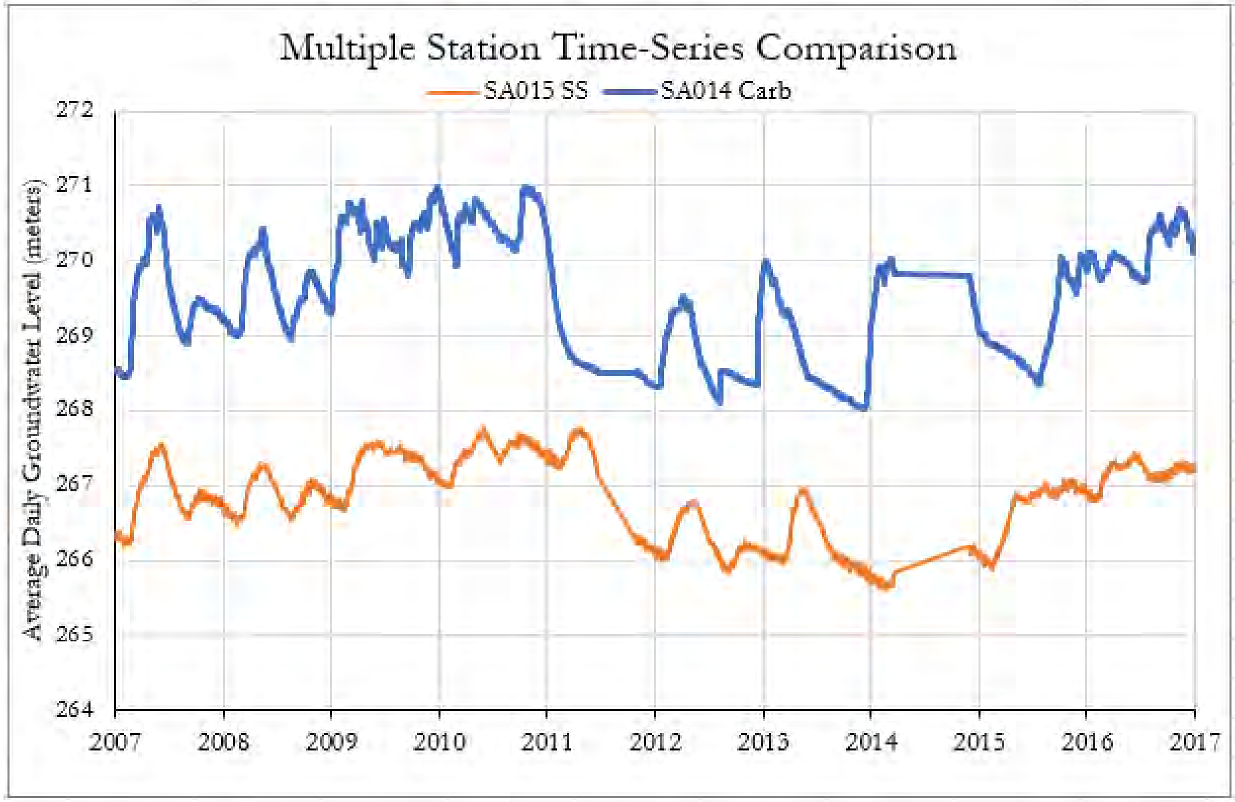
Inter-formational flow between the overlying carbonate aquifer system and the underlying Winnipeg Formation sandstone has been of considerable interest in Southeast Manitoba (Betcher,1986). The shale sequence which separates the sandstone and carbonate units is generally thought to be a highly effective aquitard between the two aquifer units. Betcher (1986) highlighted the geochemical differences between the two aquifers as evidence for the efficacy of the aquitard. In the Beausejour area, the shale is thought to compose a total thickness of around 90 ft. (Pedersen, 1987). It should be noted that this value is from a single borehole and has not been tested or confirmed. However, the large unit thickness of the shale likely provides a strong barrier to separate the saline/brackish groundwater in the sandstone from the freshwater in the overlying Carbonate Aquifer.

It is expected that some amount of fluid movement occurs through the Winnipeg Formation shale. However, due to the similar hydraulic heads between the two aquifers and the large thickness of shale, the fluid transfer between the two formations would be expected to be small (Betcher et al., 1995). The extent of fluid movement through the shale has not been well studied for the Beausejour area.

In 2007, six new sandstone monitoring wells were installed within the RM of Springfield, as part of a larger groundwater investigation for the southeast. This program has allowed for water levels in the Sandstone to be compared with those in the overlying carbonate aquifer system. To review the difference in static water levels between the carbonate aquifer and the underlying sandstone aquifer, hydrograph records from stations in both aquifers were plotted together. Figure 16 shows a composite plot of two paired sandstone/carbonate hydrographs in the eastern region of the RM of Springfield. It is anticipated that these conditions approximately reflect conditions in the Beausejour area.

The hydrograph records from both aquifers show nearly identical seasonal and yearly fluctuations in groundwater levels. In the eastern portions of the region, the static water level in the carbonate aquifer is up to 12 feet higher than the static water level in the Sandstone. With increasing distance westerly from the Sandilands recharge zone, the head difference between the two aquifers was noted to gradually decrease. The hydraulic head in the Sandstone aquifer at Beausejour was noted to be about 10 feet lower than that of the carbonate aquifer (Pedersen, 1987). This downward hydraulic gradient reduces the risk for saline water intrusion into the overlying carbonate aquifer. This gradient expected to be a significant factor for the sustained presence of freshwater in the carbonate around Beausejour.

Figure 16 – Sandstone-Carbonate Hydrograph Comparison



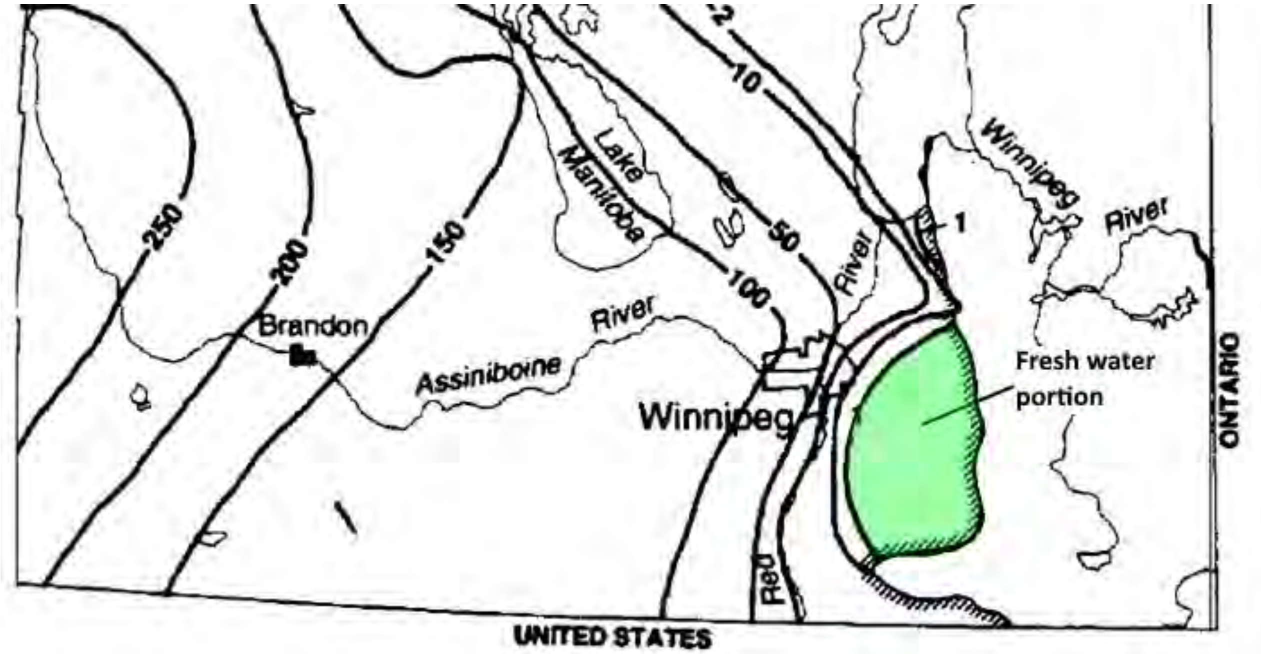
(Data source - Hydata, 2019)

12.6 Regional Groundwater Geochemistry – Carbonate Aquifer

The geochemistry of the two bedrock aquifers in southeastern Manitoba is complex. It has been proposed that prior to the start of the Pleistocene glaciations, both aquifers contained saline or brackish groundwater (Betcher et al., 1995). With the emplacement of the permeable glacial moraine features, freshwater began to recharge the bedrock aquifers on an annual basis. These recharge dynamics resulted in a wedge-like portion of freshwater in both the Carbonate and Sandstone aquifers as the older, saline water was displaced. The freshwater portion of the Carbonate aquifer is shown in Figure 12, the freshwater distribution within the Sandstone aquifers is shown in Figure 17.

To assess the groundwater geochemistry around Beausejour, groundwater samples from MCC hydrograph stations and Town wells were reviewed (Hydata, 2019). The major ion concentrations were plotted on a trilinear diagram for comparison purposes. The results are shown as Figure 18.

Figure 17 – Winnipeg Formation chemistry



Note – Green shaded area contains TDS values less than 1 g/L (1,000 mg/L)

(Source – Betcher et al., 1995)

Groundwater quality in the carbonate aquifer typically reflects the proximity to recharge areas. As groundwater flows away from the recharge areas, the amount of TDS tends to increase. The increased TDS in the carbonate aquifer primarily results from increased ionic concentrations of sodium, potassium and sulfate and chloride (Betcher et al., 1995). The changing ionic composition is representative of a transition from subglacial/modern meteoric recharge to subglacial recharge mixed with older, basin brines (Ferguson et al., 2007). Water quality is the poorest in the far western areas along the Red River Floodway, where total dissolved solids can exceed 1,200 mg/L. Overall, post glacial water is actively moving through the system from east to west (Render, 1970).

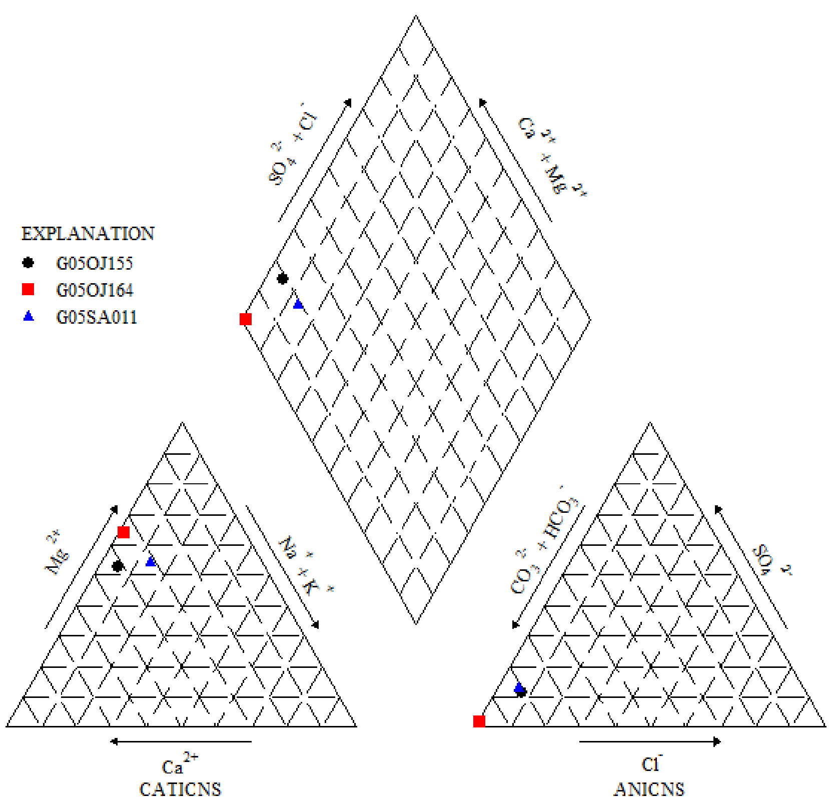
Another important consideration in groundwater quality is the presence of nitrate. Common sources of nitrate in groundwater include leaching or runoff from agricultural and fertilizer use, from sewage and manure, or as a product of excess ammonia or nitrification (Freeze and Cherry, 1979). The recommended maximum limit for nitrate in drinking water from the Canadian Drinking Water Quality Guidelines is 10 mg/L (Health Canada, 2018). High concentrations of nitrate in groundwater are a cause for concern, as it indicates that the groundwater has been impacted by surface water activities, with negative results. Layers of low permeability material, such as clay or till, which overlie the aquifer provide protection from surface impacts by limiting the downward migration of surface water.

From the available data, nitrate concentrations around Beausejour are below the MAC and were below detection limits in provincial stations G05OJ155 and G05SA011. Nitrate was detected at concentration of 2.6 mg/L in station G05OJ164, located west of Beausejour. The cause of the elevated nitrate in this area was not defined, although it is suspected that the bedrock in this area is relatively shallow with a thinner protective layer.

In places of southeast Manitoba, concentrations of barium have been reported to exceed the Maximum Acceptable Concentration (MAC) of 1.0 mg/L (Health Canada, 2018). This has been somewhat of an issue especially in areas where both aquifers have been extensively interconnected. The reason for the increased barium is not well understood, however, it is suggested to be a result of groundwater mixing between the carbonate and sandstone aquifers in those areas. Betcher et al. (2003) suggested that barium concentrations in groundwater are controlled by barite solubility which increases when sulfate concentrations are very low (<15 mg/L).

From a review of the provincial monitoring stations near Beausejour (G05OJ164, G05OJ165, and G05SA011), barium concentrations appear to be at background levels, with concentrations below 0.06 mg/L (MSD - C. Romano, 2014). The saline conditions in the sandstone around Beausejour mean that fewer wells will have been completed in this aquifer and the potential for inter aquifer mixing will be limited.

Figure 18 - Routine Geochemistry of Provincial Wells Near Beausejour



(Data source – MSD – C. Romano, 2014)

An analysis of the stable environmental isotopes ^{18}oxygen and deuterium is commonly used for hydrogeological investigations. Ratios of the main oxygen ($^{18}O/^{16}O$) and hydrogen ($^{2}H/^{1}H$) isotopes that compose the water molecule are compared relative to standard mean oceanic water (SMOW) (Freeze and Cherry, 1979).

The isotopic composition of water dictates the freezing and vapour points, which leads to variable concentrations as a result of freezing, condensation, melting, and evaporation (Freeze and Cherry, 1979). As water is evaporated from the ocean, there is a decline in the ^{18}O concentration by a specific amount. As the vapor condenses, the precipitation has a higher ^{18}O concentration. This process continues as the vapor moves inland and undergoes many cycles of condensation and evaporation. This fact makes deuterium and ^{18}O very useful for hydrogeological investigations, as the origin and mixing of different waters can be determined. The isotope concentrations are presented in delta (δ) units as parts per thousand or ‰, compared to the SMOW.

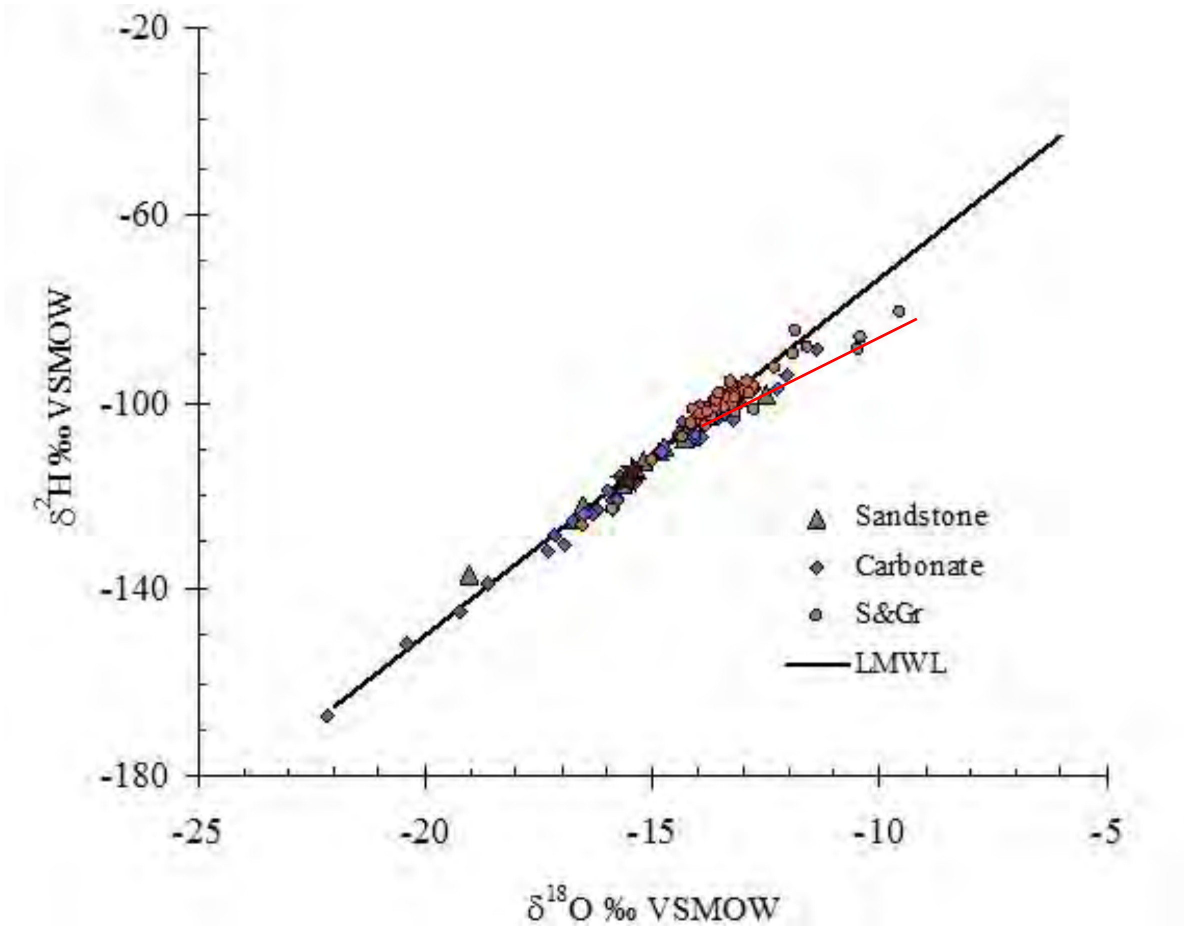
It should be noted that the term, meteoric water, refers to water which is derived from precipitation and includes water found at the surface and in the shallow subsurface, including rivers and lakes.

Phipps et al. (2008), conducted sampling of approximately 50 MCC observation and monitoring wells in 2008, as part of the southeast groundwater study. These results were plotted against a local meteoric water line, which was determined to be $\delta^{2}H = 7.6 \cdot \delta^{18}O + 2.2$, which is the virtually the same as the local meteoric water line (LMWL) for the Gimli area (IAEA, 2012). This plot is shown as Figure 19. The various aquifers in the southeast are distinguished in the plot.

The values indicate a range in isotopic concentration, however, nearly all groundwater samples plot along the LMWL, which suggests the water has undergone little modification since falling as precipitation. There is an indication of a slight slope change resulting from snow melt infiltration at the upper ranges of the plot, where sample points follow an evaporitic trend line (Fritz & Clark, 1997). The evaporitic isotopic values are predominantly from samples collected from sand and gravel aquifers, mostly obtained from the recharge moraine area. It should be noted that highly depleted samples are shown to the left on the local meteoric water line, which indicate recharge under very different climatic conditions. This is likely hold over water from the Pleistocene glaciation.

Within Manitoba, glaciogenic groundwater (~10,000 years old) typically shows ^{18}O concentrations of -19 to -23 δ (‰ V-SMOW), while modern groundwater typically shows concentrations between -14 to -16 δ (‰ V-SMOW) (Freeze and Cherry, 1979). Groundwater that contains a mixture of glaciogenic and modern groundwater typically plots between -17 to -19 δ (‰ V-SMOW).

Figure 19 - [18]Oxygen and Deuterium Concentrations in southeast Manitoba



Note - Results plotted with the Gimli Meteoric Line; red line approximates the evaporitic water line. (Source – Phipps et al., 2008)

In general, the isotope results indicate that the most recent groundwater is generally found in sand and gravel aquifers and in the eastern portions of the regional bedrock aquifers. Groundwater in both the carbonate and sandstone aquifers exhibits a full range of isotopic composition, from recent to ancient meteoric, with older waters typically located towards the west. These results are further evidence of the westerly flow regime through the region.

13 Physical Analysis of Groundwater Resources

13.1 Well Inventory and Public Consultations

An inventory of all wells within 1.0 miles of the proposed new well field was a conditions of the Groundwater Exploration Permit (GEP). Details regarding the methodology of the inventory were not provided in the permit. The well inventory was planned in two parts. The first part included site visits to inspect wells and collect background information on the water supplies from residents that allowed/arranged for the inspection. The second part included a desktop inventory conducted using the GWDRILL (2018) database.

In addition to the well inventory, public consultations, including a public open house, were conducted by the Town, its consultant (Stantec), and MWSB. Provisions for Friesen Drillers to attend these public events were also included as required.

13.1.1 Site Specific Well Inventory

The two production wells are located in Section 26-12-07 EPM, in the Rural Municipality of Brokenhead. A listing of all residents within a 1 mile radius of the Pescitelli Road sites was provided by the Town of Beausejour. In total, the listing included 54 residents.

Telephone numbers were provided for 25 of the 54 residents. Each resident with a provided phone number was contacted by telephone. The remaining 29 residents without telephone numbers were contacted by a mailed letter. A copy of the letter is attached in Appendix D. The letter requested an interview and site visit and provided contact information for them to schedule an appointment. Some residents elected to conduct the interview by telephone and declined the site visit. In total, 17 individual site reports were produced. It was noted that most of the residents immediately surrounding the wellfield site were included in the inventory. The details of the individual site visits are also provided in Appendix D.

The site specific well inventory was conducted through the use of a short questionnaire/interview with each participating resident about their water well details. The questionnaire included queries about well depth, drilling date, drilling company and water quality. The location of each domestic well was marked with a handheld GPS unit, a picture of the well was taken, notes on well condition and status, and also any questions, comments or concerns from well owners were documented.

With permission, water samples were collected and basic field parameters of salinity, total dissolved solids, electric conductivity, and pH were measured.

Of the supply wells inventoried, about fifty percent of the wells in the area have submersible pumps. Wells older than 30 years composed about 75 percent of the total inventory. About fifty percent of the wells were located in pits.

Based on the responses from homeowners, the main concerns with existing groundwater quality were related to hardness and iron content. Measurement of field parameters showed a range of water quality in the area. TDS values ranged from 420-3,170 mg/L with an average of 1,030 mg/L. The salinity values ranged from 400-1600 mg/L, with an average of 780 mg/L.

A few of the homeowners who participated do not have information about the wells on the property. Hence, a cross check between the provincial database and the field inventory could not be completed.

13.1.2 Desktop Well Inventory (2.0 mile Radius)

A table showing the desktop inventory results is attached in Appendix D. The GWDRILL (2018) database included records for 126 water wells in the 2.0 mile study area. Included in the inventory radius was provincial monitoring station G05OJ155, along with the three existing Town of Beausejour supply wells. It was evident that some of the wells contained in the GWDRILL database had been subsequently sealed and replaced with newer PVC cased wells.

The well locations were scattered fairly consistently throughout the area. The distance of existing wells to the new municipal well sites ranged from 560 to 3,195 m radial distance (1,840 - 10,480 ft.). However, from a review of satellite and images and data from the physical well inventory, it is expected that the closest existing well to the new municipal wells is about 250 ft. away from the east well, near the intersection of Pescitelli Rd and Rd. 41 East.

Approximately 35 percent of the reported water wells were completed as sand and gravel screened wells, with the remainder completed into the Carbonate Aquifer. None of the well logs showed completion into the Winnipeg Formation Sandstone Aquifer.

The construction data of the wells ranged from pre-1964 to 2017. The average construction date in the database was 1988. About half of the wells in the area were constructed with 4 or 5 inch diameter steel casing, with the balance being constructed with PVC well casing. This is consistent with the well ages, as the use of PVC well casing was implemented around 1990.

Static water levels ranged from at grade (0 ft.) to 40 feet below grade, with an average depth of 15 ft. below grade.

Generally speaking, the hook up style appeared to be modern, using pitless unit type connections, and brass fittings. Despite the high static water levels, few wells appear to be pumped using single line straight suction systems. Most wells appear to be equipped with submersible pump systems.

In addition to the GWDRILL database review, the Provincial Water Licensing Portal Mapping Tool was accessed to obtain a list of existing water rights licenses in the area. Through a review of the files, the only active licence for groundwater use in the area is for the existing Town of Beausejour municipal water supply. The closest third party groundwater licence was for Industrial uses in the RM of Brokenhead at section 27-12-07E. The application, submitted in 1999, has since been withdrawn and is not active.

The next closest active licensed groundwater user was noted to be a Municipal Groundwater supply (Licence No. 2005-083) located near the community of Tyndall at section NW 02 013 06 E. This supply is located approximately 6.5 miles away from the new supply wells along Pescitelli Road and is developed from the carbonate aquifer.

13.2 Field Investigations and Testing

13.2.1 Test Drilling, Monitoring Well Installations, and Production Well Site Selection

Friesen Drillers mobilized in September, 2019. Prior to any fieldwork, the status of all relevant permits, including the Groundwater Exploration Permit (GEP), were confirmed. Two test wells were constructed at the locations shown in Figure 20. The test well locations were suggested by Friesen Drillers and approved by the Town of Beausejour, the RM of Brokenhead, and MWSB. The wells were drilled within the right of way along the south side of Pescitelli Road (Rd 71 N), between Roads 40 and 41 East. Copies of the driller's logs are provided in Appendix E.

The geological conditions, noted to be similar between the east and west test sites, comprised clay, till and sand layers overyling carbonate bedrock. The thickness of each layer varied between the two sites. At the west site, clay and till extended from surface to 43 feet below grade, followed by sand and gravel to 59 ft., and interlayered carbonate rubble and till to 87 ft. below grade. Competent carbonate bedrock was intersected at a depth of 87 ft. below grade. Shale was intersected below the carbonate at 146 ft. below grade. At the east site, clay and till extended from surface to 10 feet below grade, followed by sand to 56 ft., and carbonate rubble to 68 ft. below grade. Competent carbonate bedrock was intersected at a depth of 68 ft. below grade.

The test well construction included 5 inch Φ diameter PVC casing set through the overburden and into the top of the bedrock with a 3 tier stepdown socket. The well casing was grouted in place with bentonite grout. The carbonate bedrock was drilled open hole until sufficient water bearing fractures were intersected or the underlying shale was reached. The depths of significant fractures are noted on the driller's logs. Details of the well construction are provided in Table 1.

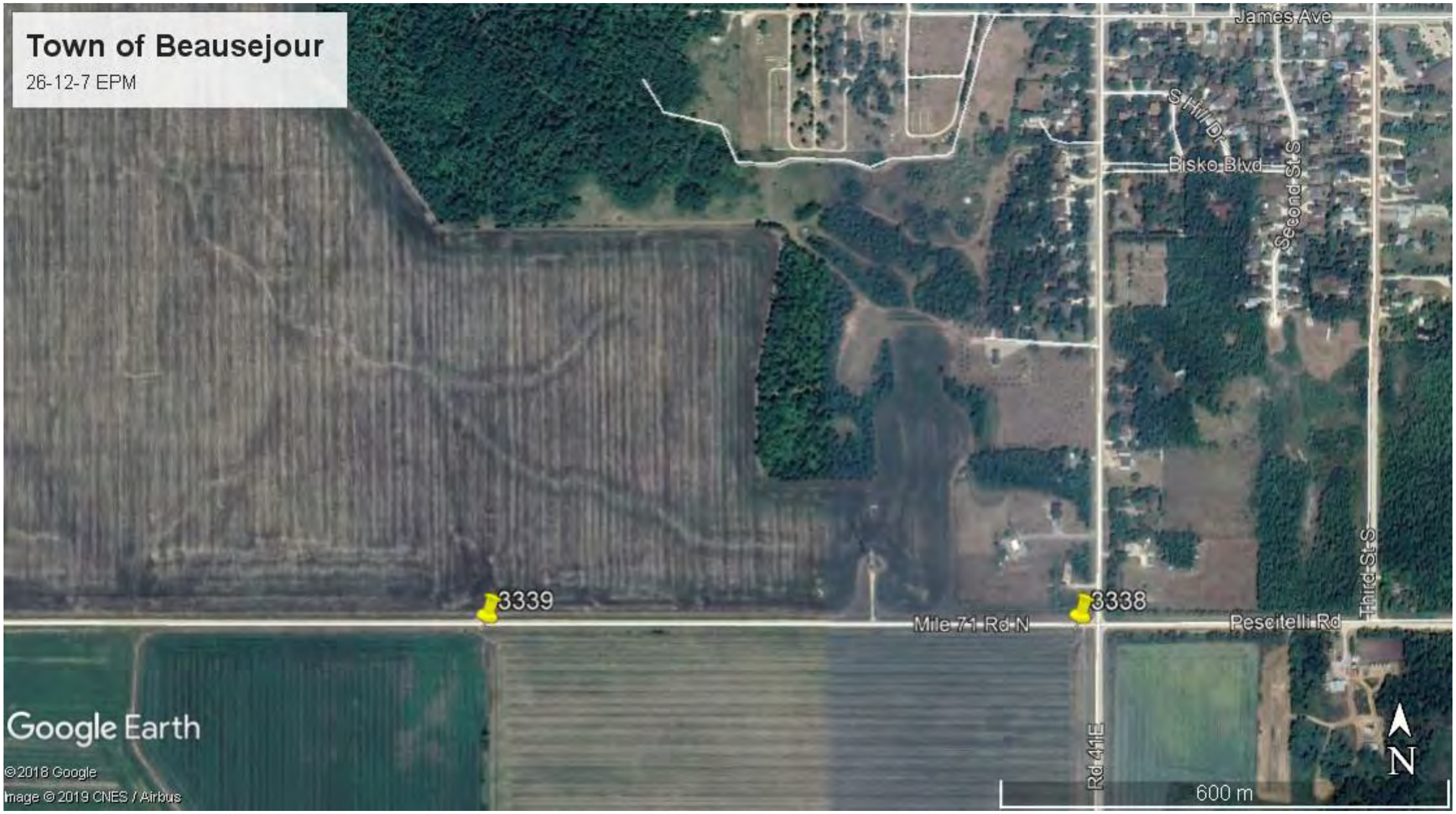
Table 1 – Test Well Construction Details

Table 1 Test Well Construction Details Town of Beausejour					
Well ID	**UTM X**	**UTM Y**	**Casing Depth**	**Casing Diameter**	**Total Well Depth**
Tag #3338	677439.1 m	5546794.6 m	70 feet	5 inch PVC	119 feet
Tag #3339	676645.9 m	5546769.5 m	89 feet	5 inch PVC	147 feet

In total, two new test wells were completed into the carbonate aquifer. A copy of the summary report for the test work is attached in Appendix A.

Basic groundwater chemistry parameters were tested for the carbonate aquifer at each test well location. The results of the chemistry analyses were provided to the MWSB and to Stantec for review.

Figure 20 – Test Well Locations



(Source – Google Earth, 2019)

13.2.2 Production Well Construction and Design

The two test wells were over drilled and converted into large diameter production wells (East Well & West Well) in January, 2020. The production wells were completed into the Carbonate Aquifer System. The production well designs were based on 5 inch test wells drilled at each site. To meet the planned flow requirements of the system, the wells were planned to have a full 12 inch diameter completion.

A 16 inch diameter surface casing was set, and a small diameter test borehole was drilled into the bedrock. Well casing was seated in the East well (3338) at 70 feet below grade and in the West Well (3339) at 89 feet below grade. The annulus space between the 16 inch and the 12 inch casing was then grouted in place with cement, and the 16 inch casing was extracted.

Once the casing was seated the bedrock was drilled open hole using an 11 inch diameter bit, to a depth of 119 and 145 ft. feet below grade in the East and West Wells, respectively. After some developing effort with compressed air, sand free water was produced. The fractures in the boreholes appeared to have very little infilling and were generally clean. The yield was noted to be significant during well development.

Following the well construction, each production well site was marked, tagged and located using a portable GPS unit. It should be noted that all GPS readings are subject to the normal error (+/- 10 feet both horizontally and vertically).

A temporary well cap was installed on each well, as per provincial regulations. Complete geologic and borehole construction logs for the production and monitoring wells are attached as Appendix E.

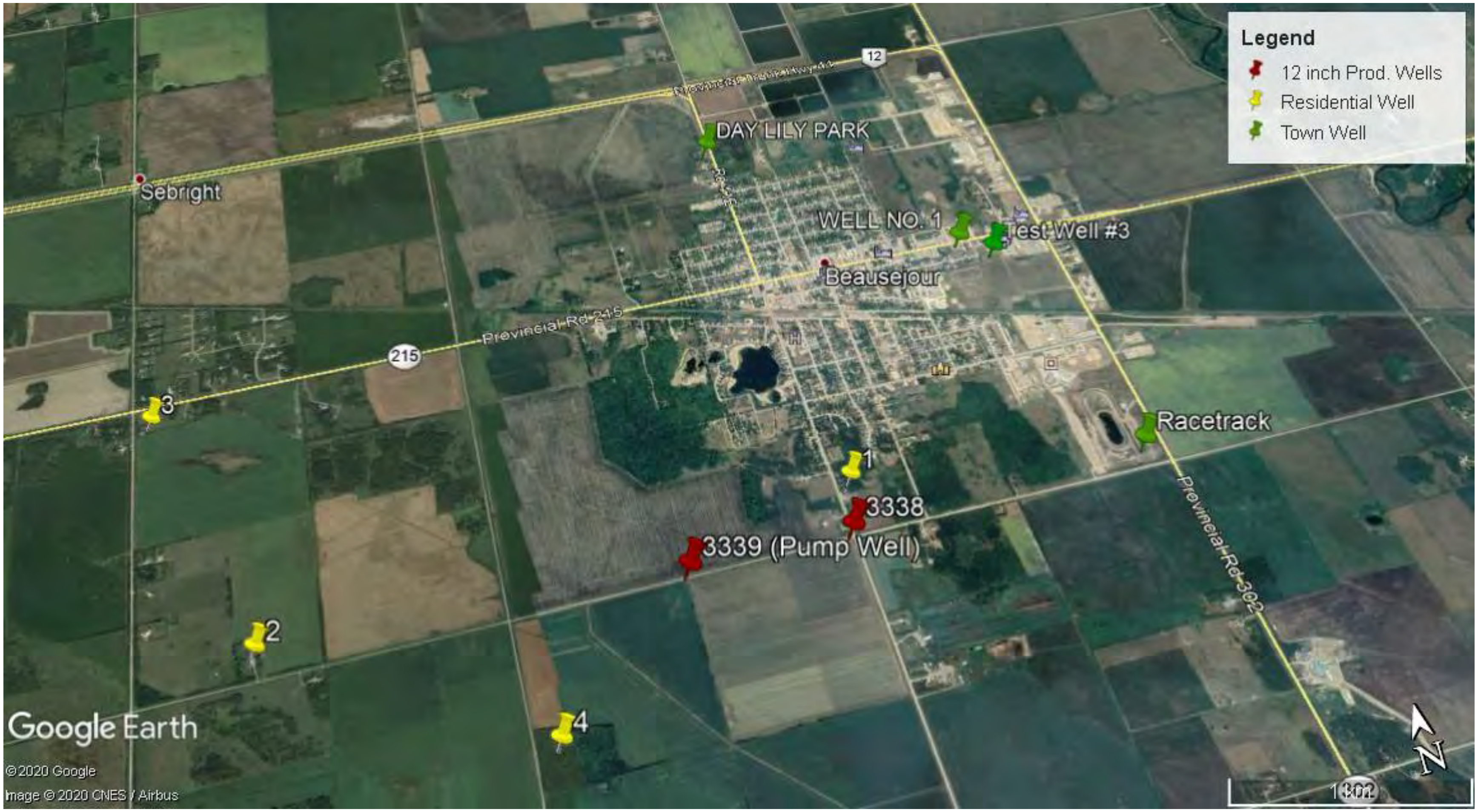
13.2.3 Aquifer Monitoring, Climatic Monitoring and Geodetic Surveying

To assess the aquifer response to pumping, a network of observation wells was implemented. Based on the well inventory results, a total of four private domestic wells and five Town wells were equipped with pressure transducers during the pumping test. The network allowed for monitoring in all directions from the central pumping well. Figure 21 contains a map of the monitoring network.

Solinst M30/F100 automatic, pressure transducers were installed in selected observation wells. Transducers used were the non-vented type, which require barometric pressure correction. A barometric pressure logger was deployed for use in data correction. The transducers were set to record data on fifteen-minute intervals and were installed about one week before the 72 hour pumping test. The transducers were removed about one week after the test. The corrected transducer plots and water levels measured in each observation well are attached as Appendix F.

In February of 2020, the Town of Beausejour dispatched a land surveyor to establish the coordinates of the monitoring network wells. The ground level and top of casing elevation of each monitoring well was surveyed to a common geodetic benchmark.

Figure 21 – Monitoring Network for 72-hour Pump Test



(Google Earth, 2020)

Table 2 – Monitoring Wells Radial Distance to Pump Well

Table 2 Monitoring Wells Radial Distance to Pump Well Proposed Water Supply – Town of Beausejour, Manitoba			
Well ID	**Radial Distance from West Pump (Meters)**	**Radial Distance from West Pump (Feet)**	**Well Elevation (m)**
Pump Well West	0	0	246.9
Pump Well East	792	2597	247.6
Domestic 1	913	2995	252.7
Domestic 4	975	3200	246.9
Domestic 2	1961	6437	247.3
Racetrack	2335	7664	245.1
Town Well 1	2530	8301	244.9
Test Well 3	2570	8432	244.5
Day Lily	2798	9183	241.2
Domestic 3	2832	9292	246.3

13.2.4 Pumping/Recovery Test, Geochemical, and Environmental Isotope Sampling

To assess the aquifer parameters and to determine how the proposed well field responds to pumping, a 72 hour (4,320 minute) pumping test was planned for the site. The testing duration was stated in the scope of work and approved by MCC – Groundwater Licensing Section. The pumping test duration was chosen to firmly establish the drawdown around the well.

The geologic conditions observed during the test well drilling indicated permeable overburden conditions at the Pescitelli Rd. well sites. In addition, surface water features are located approximately 0.5 miles north of the test sites. As a result, a 72 hour testing duration was planned to assess the potential for groundwater-surface water interaction under pumping conditions. The test duration also allowed the identification of potential aquifer boundary conditions or transmissive changes in the area. Recovery was to be monitored to at least 90% of the static water level, as mandated in the GEP. The main pump test results are attached in Appendix G.

A 40 HP Grundfos Electric submersible motor and pump (SP-650-2) was installed in the West Production Well at a depth of 80 feet below grade. Power was supplied by an on-site portable generator. During the installation and set-up, the pump and motor were tested for less than one hour to determine the well yield. This allowed the discharge valve to be set. This was undertaken a few days before the actual 72 hour test began. The pumping test commenced on February 4, 2020, and was completed on February 7, 2020.

Friesen Drillers staff attended the pump test site and collected water samples and field measurements of water quality parameters throughout the test. The target pumping rate for the 72 hour test was 430 U.S.G.P.M. (28 L/s). The actual average pumping rate was 510 U.S.G.P.M. (32.2 L/s).

Preparation for the pumping test required the input of staff from both the Town and the RM of Brokenhead for considerations of discharge drainage, regulatory approvals, ditch maintenance, etc. The ditches were cleared of snow prior to commencing the 72 hour test. The drainage route is shown on Figure 22. The pumping test set up at the site is shown on the following page as Figure 23.

The flow rate was maintained by using a 5 inch by 6 inch orifice meter. The flow meter was checked regularly throughout the test. Water levels were monitored using a Powers M-scope well sounder in the pumping well.

Figure 22 – Drainage Routing During 72-Hour Pump Test

(Source – Google Earth, 2020)

Figure 23 – West Production Well and Discharge Set Up

Pumping well setup (West Well), Pescitelli Road - facing west. (Friesen Drillers, 2020)

During the pumping test on the West Production well, field measurements of basic water quality parameters were collected. The field instruments were calibrated prior to the test. Field measurements were taken to show the water quality results prior to the release of CO_2 from the samples, which can affect the results over short periods of time. A summary of the water quality testing results is shown in Table 3. In addition, groundwater samples were collected from the pumping discharge once every 12 hours in laboratory supplied analytical sample bottles. The samples were submitted to ALS Laboratories for routine water quality parameters and metals scan analysis. The results will be discussed in the data analysis section. In addition to the routine geochemical analysis, two samples were collected for the analysis of environmental isotopes ^{18}oxygen and deuterium.

Table 3 – Field Water Quality Parameters – 72-Hour Pump Test

Table 3 Field Water Quality Measurements – 72-Hour Pumping Test Proposed Water Supply – Town of Beausejour, Manitoba			
Pumping Time	**Electrical Conductivity**	**Salinity**	**pH**
0 hours	827 umhos/cm	400 mg/L	8.37
12 hours	843 umhos/cm	400 mg/L	8.14
24 hours	856 umhos/cm	400 mg/L	8.07
36 hours	857 umhos/cm	400 mg/L	8.02
48 hours	884 umhos/cm	400 mg/L	8.06
60 hours	878 umhos/cm	400 mg/L	8.12
72 hours	884 umhos/cm	400 mg/L	8.10

(Friesen Drillers Pumping Test Data, 2020)

Table 4 – Pump Test Details – 72-Hour Pump Test – West Well (3339)

Table 4 Pumping Test Details – 72-Hour Pump Test – West Well (3339) Proposed Water Supply - Town of Beausejour, Manitoba				
Well	**Pumping Time**	**Static Water Level**	**Pumping Water Level**	**Average Pumping Rate**
West Well (3339)	4,320 minutes	13.74 feet	17.35 feet	510 U.S.G.P.M.

(Friesen Drillers Pumping Test Data, 2020)

Table 5 – Pump Test Details – Short Term Capacity Test – East Well (3338)

Table 5 Pumping Test Details – Short Term Pump Test – East Well (3338) Proposed Water Supply - Town of Beausejour, Manitoba				
Well	**Pumping Time**	**Static Water Level**	**Pumping Water Level**	**Pumping Rate**
East Well (3338)	60 minutes	14.0 feet	27.1 feet	955 U.S.G.P.M.

(Friesen Drillers Pumping Test Data, 2020)

14 DATA ANALYSIS

14.1 AQUIFER TESTING ANALYSIS

The Theis (1935) method is the most common approach for analyzing the results from aquifer pumping tests in confined aquifers. Critical assumptions integral to the method are detailed as follows:

- Darcy's law is valid
- The aquifer is horizontal and constant thickness
- The aquifer is infinite in areal extent
- The aquifer is bounded by impermeable strata above and below
- Uniform hydraulic conductivity
- Isotropic hydraulic conductivity
- Head always remains above the top of the pumped aquifer
- There are no water level changes not from pumping.
- Infinitesimal diameter of well
- Fully penetrating the aquifer formation
- Perfectly efficient well
- Single pumping well
- Constant pumping rate
- Constant storage properties through time
- The head is known everywhere prior to pumping.

Through a review of the assumptions, it can be seen that some of the assumptions for the analysis of the pumping tests conducted at the Pescitelli Road site are not fully satisfied for the Theis (1935) approach. For example, the aquifer is not infinite in areal extent, and conditions are far from isotropic.

The Theis (1935) approach is highly idealized to the assessment of the aquifer and represents the state of the art for the determination of aquifer parameters. The method has been found to be reasonably workable for aquifer engineering evaluation, all over the world, for more than 80 years. In this case, conditions of the Theis (1935) approach are not being severely violated and the methodology provides for good comparisons to the other regional work conducted in the area.

The pumping data was entered into Waterloo Hydrogeologic's AquiferTest Professional v2016.1, for analysis of aquifer parameters. The data was analyzed using the Cooper-Jacob (1946), and Theis (1935) methods, although similar results were expected, as the Cooper-Jacob method is a straight-line approximation of the Theis method. A derivative analysis was also used to assess the validity of the results (Bourdet et al., 1989). Hydraulic parameters inferred from the data are shown in Table 6.

Table 6 - Aquifer Parameter Assessment – 72-hour pumping test.

Table 6 Aquifer Parameters – 72 hour Pumping Test Proposed Water Supply – Town of Beausejour, Manitoba		
	West Production Well (3339)	
Drawdown	3.6 ft. @ 510 U.S.G.P.M.– 4,320 minutes (72 hours)	
Static Water Level	13.7 ft. below top of casing	
Specific Capacity	141.3 U.S.G.P.M./ft.	
	East Production Well (3338)	
Drawdown	13.1 ft. @ 955 U.S.G.P.M. – 60 minutes	
Static Water Level	14.0 ft. below top of casing	
Specific Capacity	72.9 U.S.G.P.M./ft.	
Method	**Transmissivity**	**Storativity**
Theis Method[1]	250,000 U.S.G./day/ft.	2.0×10^{-5}
Cooper - Jacob Method[2] (time)	250,000 U.S.G./day/ft.	2.0×10^{-5}
Cooper - Jacob Method[2] (distance)	250,000 U.S.G./day/ft.	2.0×10^{-5}
Theis Recovery Method[3]	230,000 U.S.G./day/ft.	N.A.
Notes	[1] Theis (1935) method using Waterloo Hydrogeologic Limited – Aquifer Test Professional v2016.1 [2] Cooper - Jacob (1946) method using Waterloo Hydrogeologic Limited – Aquifer Test Professional v2016.1 [3] Theis Recovery (1935) method using Waterloo Hydrogeologic Limited – Aquifer Test Professional v2016.1	

(Friesen Drillers Pumping Test Data, 2020)

In general, the aquifer was inferred from the data to have an approximate transmissivity of about 250,000 U.S.G./day/ft., based on the results of the 72 hour, single pumping well test, and the data from the responding observation wells. Not all of the observation wells recorded a response to pumping during the test. Drawdown from pumping was readily detectable in the closest wells, although no response was observed from the wells located within the Town (Well 1, TH-3, Day Lily Park). The storage coefficient was inferred from the data to be 2.0×10^{-5}.

The results from the pumping test indicate highly transmissive conditions for the Carbonate Aquifer at the new well sites. The transmissivity value of 230,000 USGPD/ft. is significantly higher than the 35,000 - 45,000 USGPD/ft noted within the townsite by Pedersen (1987). The increased transmissivity reflects improved hydrogeological conditions over those within the town. The high transmissivity value is consistent with the upper range of values noted from regional results for the Carbonate Aquifer (Rutulis, 1973; Render, 1970; Betcher et al., 1995).

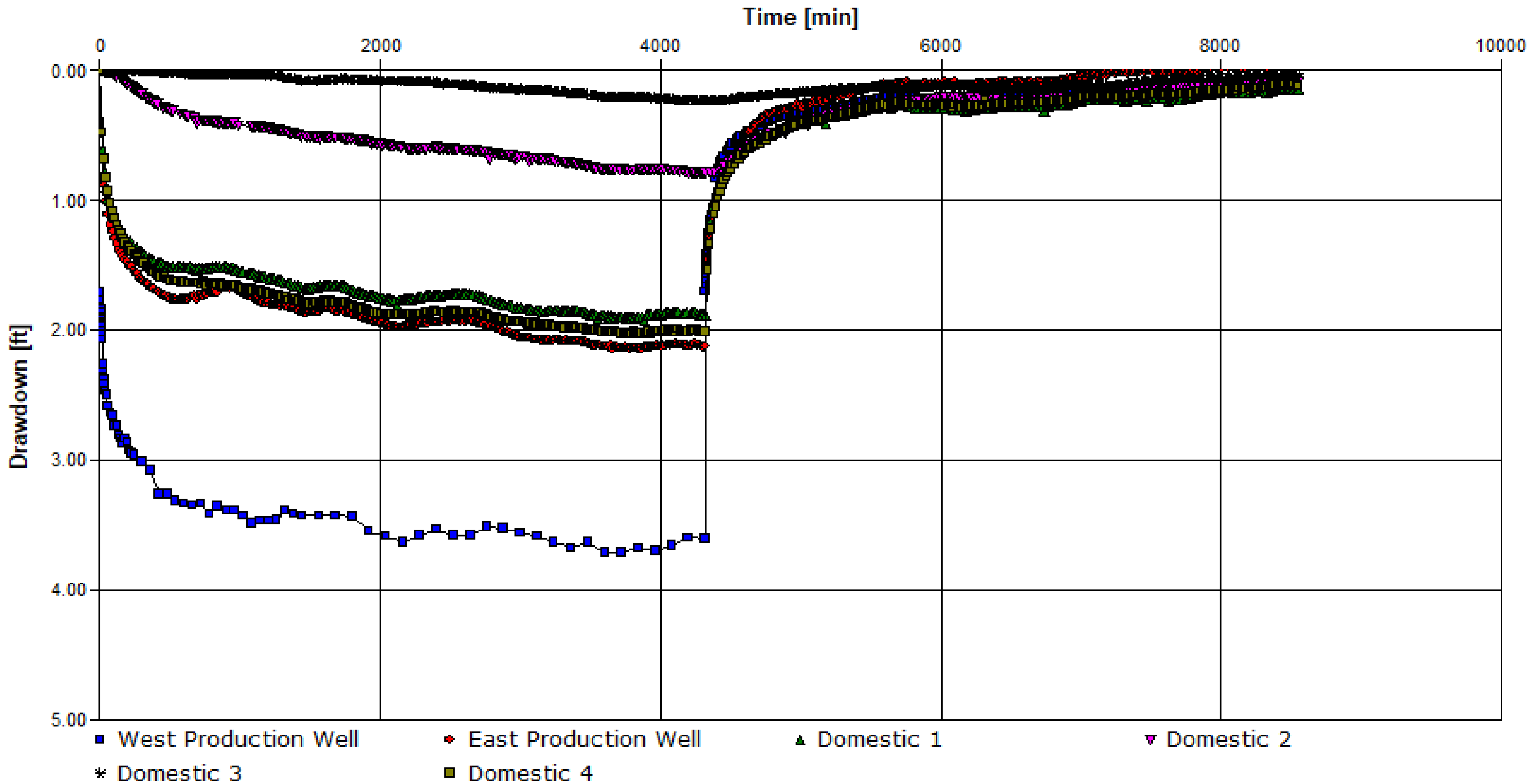
The drawdown versus time for the pumping test is shown as Figure 24. The extent of the drawdown cone generated in the Carbonate Aquifer after 72 hours of pumping is shown as Figure 25. It is apparent from the plot that the geometry of the drawdown cone developed with shallow sides and a wide areal extent. The cone appeared to extend slightly farther in the westerly direction. This is likely a result of improved aquifer conditions to the west, with increased aquifer thickness and higher bulk transmissivity. Drawdown cones that develop in higher transmissive aquifer conditions are generally shallow and extend a greater distance from the pump well. Consequently, impacts from the pumping at the Beausejour wellfield may be observed in a larger number of wells, although the amount of additional drawdown will be minor for existing wells in the area.

During the analysis, the $t_{critical}$ was assumed to be less than approximately 30 minutes for casing storage; therefore, the data previous to 30 minutes was not considered in the analysis.

The Cooper-Jacob (1946) method was used primarily, since emphasis is not placed on early time measurements. The pumping well configuration was nearly fully penetrating, as the production wells were completed with open hole sections through the carbonate formation. Test holes drilled in the area and background data/reports available for the Beausejour region suggest that the aquifer is relatively anisotropic, which may reflect a breach in the conditions of the Theis method. Following standard practise, the aquifer was assumed to be Theissian. Although this may or may not be totally correct in this instance, this methodology follows the standard practise for aquifer analysis of this nature. It was further assumed that skin effects for the supply well would be minimal after the developing and jetting procedures.

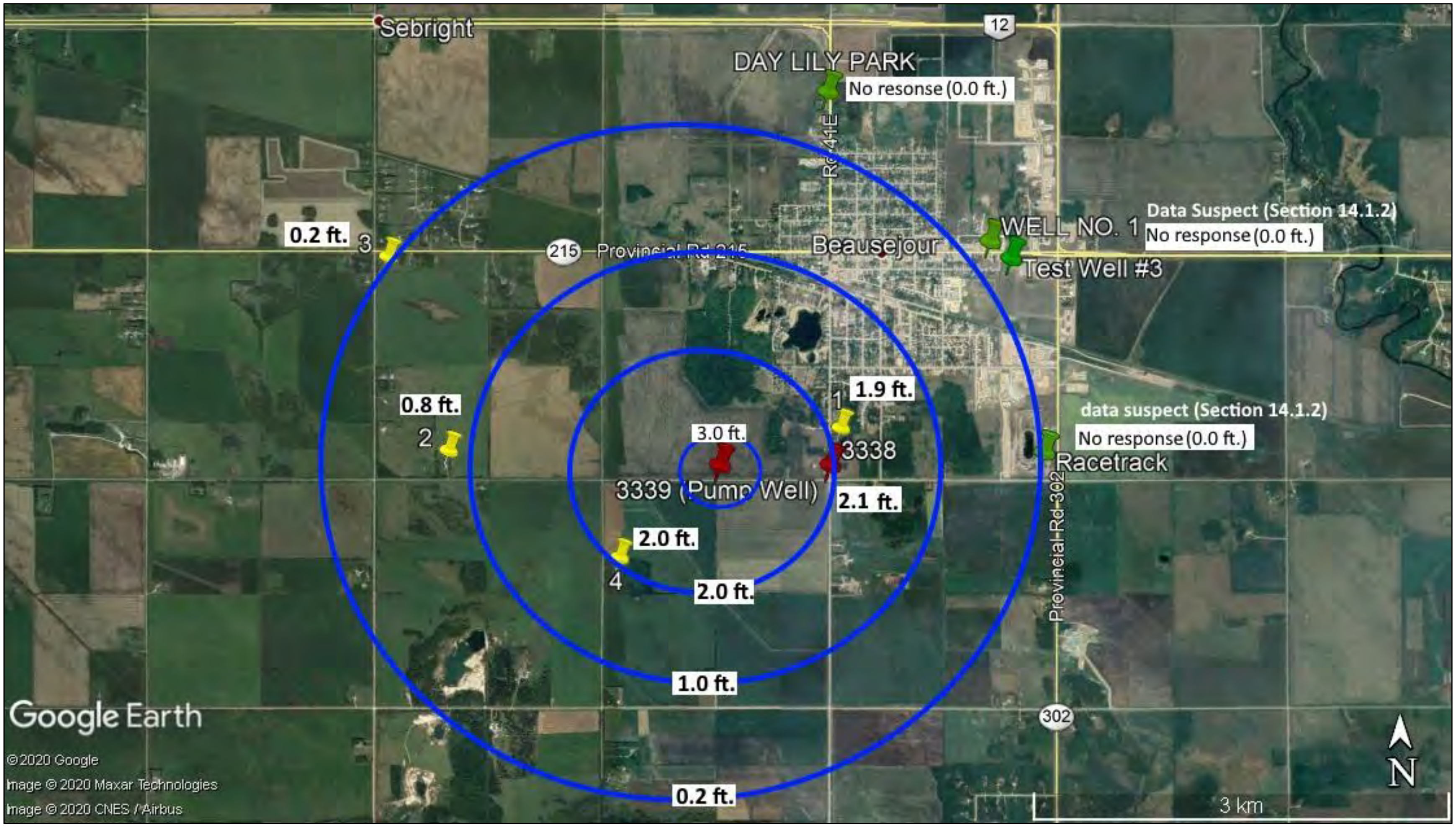
The Theis (1935), Cooper–Jacob (1946) time versus drawdown and distance versus drawdown, and Theis Recovery (1935) method plots are shown as Figures 26-29.

Figure 24 - Drawdown versus Time – 72 Hour Pumping Test



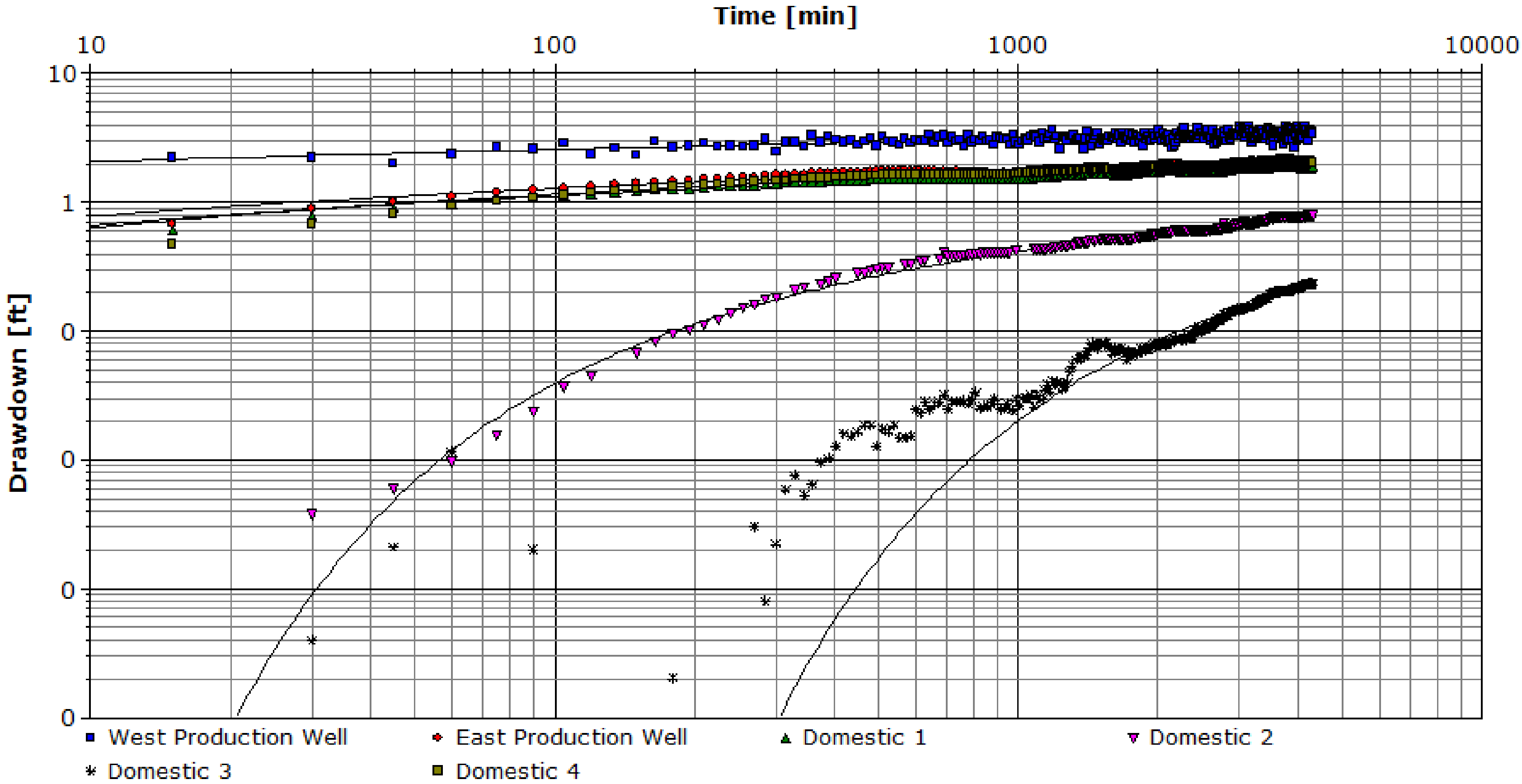
Average pumping rate - 510 U.S.G.P.M.

Figure 25 - Area of Drawdown in the Carbonate Aquifer – 72 Hour Pump Test



Blue lines indicate drawdown after 72 hours of pumping based on the drawdown measurements from the monitoring well network. (data source – Friesen Drillers, 2020)

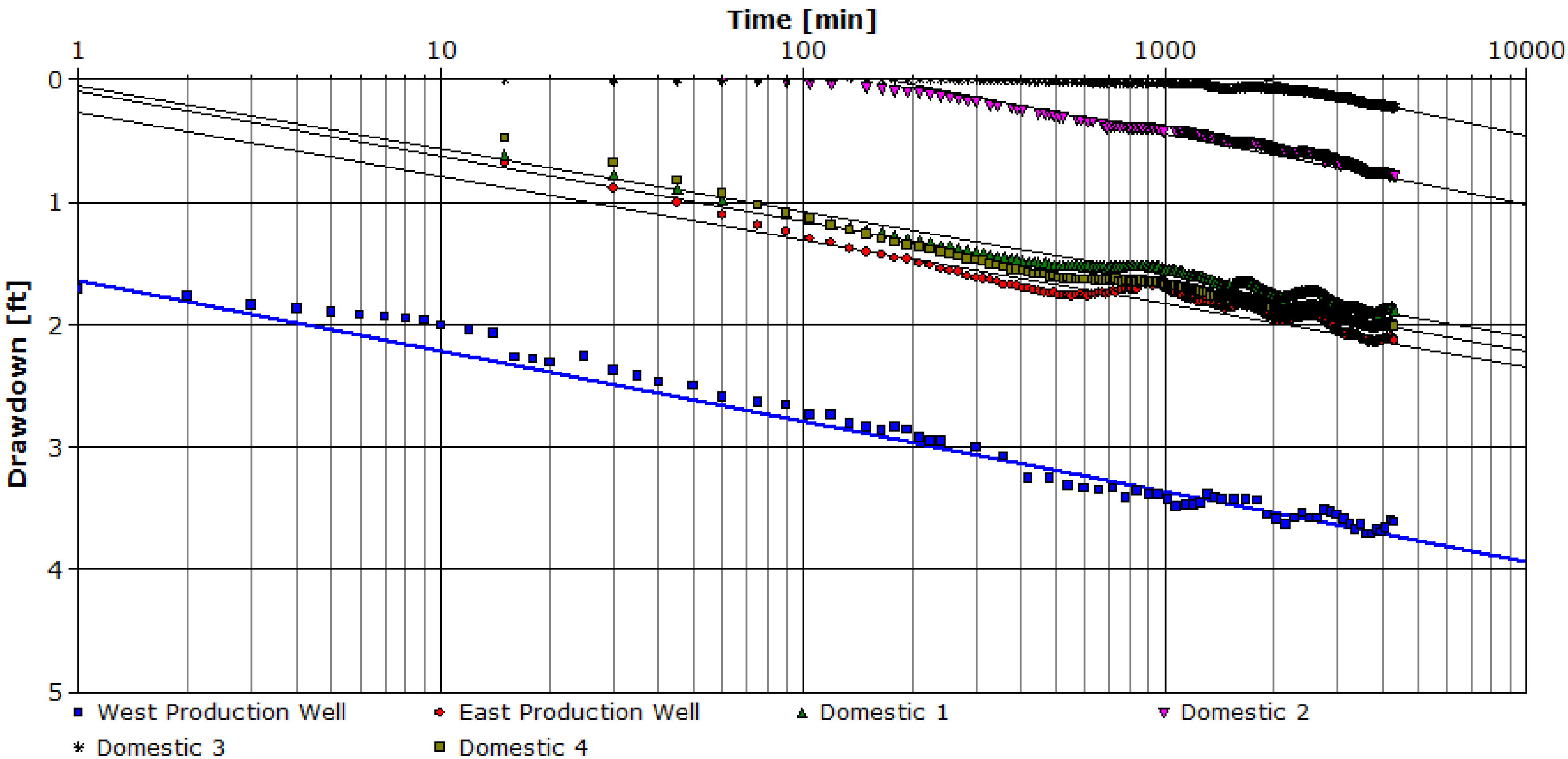
Figure 26 - Theis (1935) Plot for 72 Hour Pump Test



The constant pumping rate is 510 U.S.G.P.M. The derivative was used in the analysis, although was not plotted for clarity due to the number of observation wells used.

(Data source – Friesen Drillers, 2020)

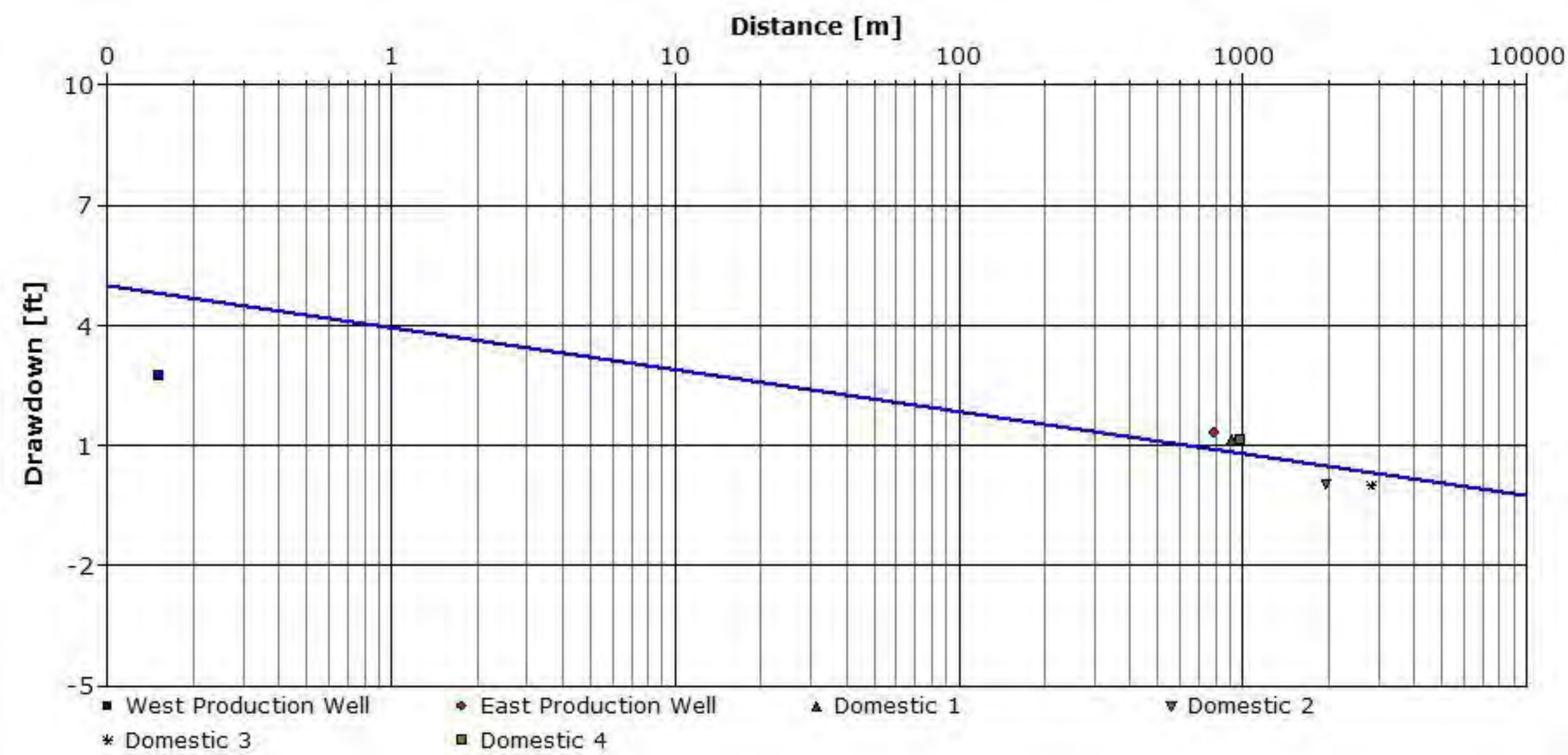
Figure 27 - Cooper – Jacob (1946) Time versus Drawdown – 72 Hour Pumping Test



Constant pumping rate - 510 U.S.G.P.M.

(Data source – Friesen Drillers, 2020)

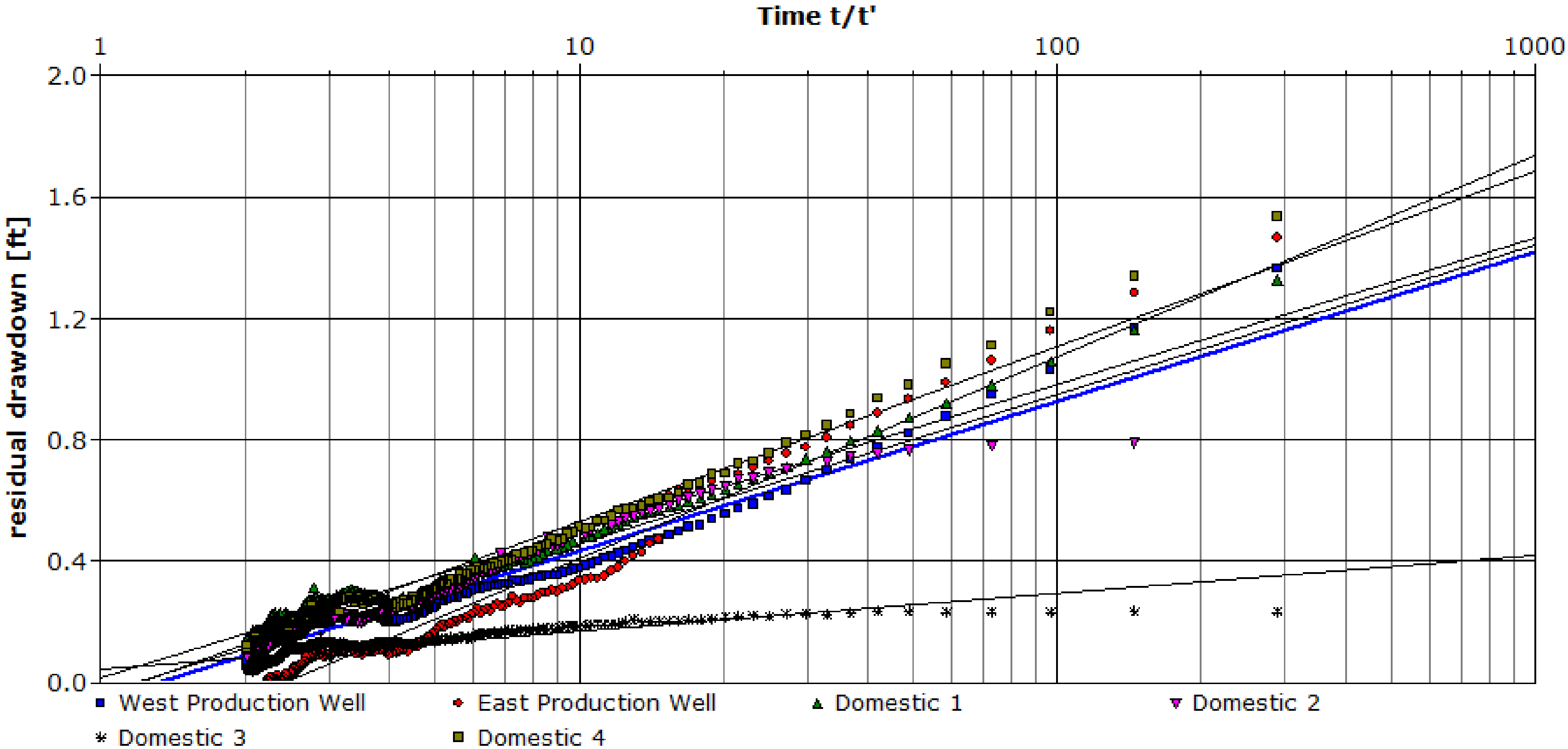
Figure 28 - Cooper – Jacob (1946) Distance versus Drawdown – 72 Hour Pumping Test



Constant pumping rate - 510 U.S.G.P.M.

(Data source – Friesen Drillers, 2020)

Figure 29 - Theis (1946) Recovery Plot – 72 Hour Pump Test



Constant pumping rate - 510 U.S.G.P.M.

Note: *t* is elapsed time since start of pumping; *t′* is elapsed time since pumping stopped

(Data source – Friesen Drillers, 2020)

14.1.1 Background Groundwater Level Fluctuations

It was evident from the monitoring data that small scale (2-3 inches) oscillations in the groundwater level occurred throughout the pumping test. These fluctuations are most easily observed in Figures 24 and 27. As the drawdown data was corrected for fluctuations in atmospheric barometric pressure, the cause of these small scale water level fluctuations was not exactly clear.

A composite plot of longer term transducer records from Domestic 3, Domestic 4, and Day Lily Park is shown as Figure 30. These three wells reflect groundwater conditions during the 72 hour pump test at locations within the drawdown cone (Domestic 4), at the outer boundary of the drawdown cone (Domestic 3), and firmly outside the drawdown cone (Day Lily Park). The monitoring data include a period of nearly two weeks after the completion of the 72 hour pump test.

It is apparent from Figure 30 that water level fluctuations on the scale of 2-3 inches are observed in all three monitoring wells, although they were most pronounced in Domestic 3. The fluctuations occurred before, during, and after the 72 hour test and did not appear to be impacted by the pumping test. The cyclical nature of the fluctuations suggests large scale municipal or industrial pumping as a likely cause. Due to the extremely high transmissive conditions observed for the area, it is common for influences from pumping to travel great distances. Potential sources of pumping would be the Town of Beausejour municipal wellfield and pumping from industrial or quarry operations in the Tyndall-Garson area.

While the exact source of these minor groundwater level fluctuations has not been confirmed at this stage, the small scale nature of the impacts is expected to have no significant influence on the Pescitelli wellfield.

14.1.2 Individual Transducer Responses

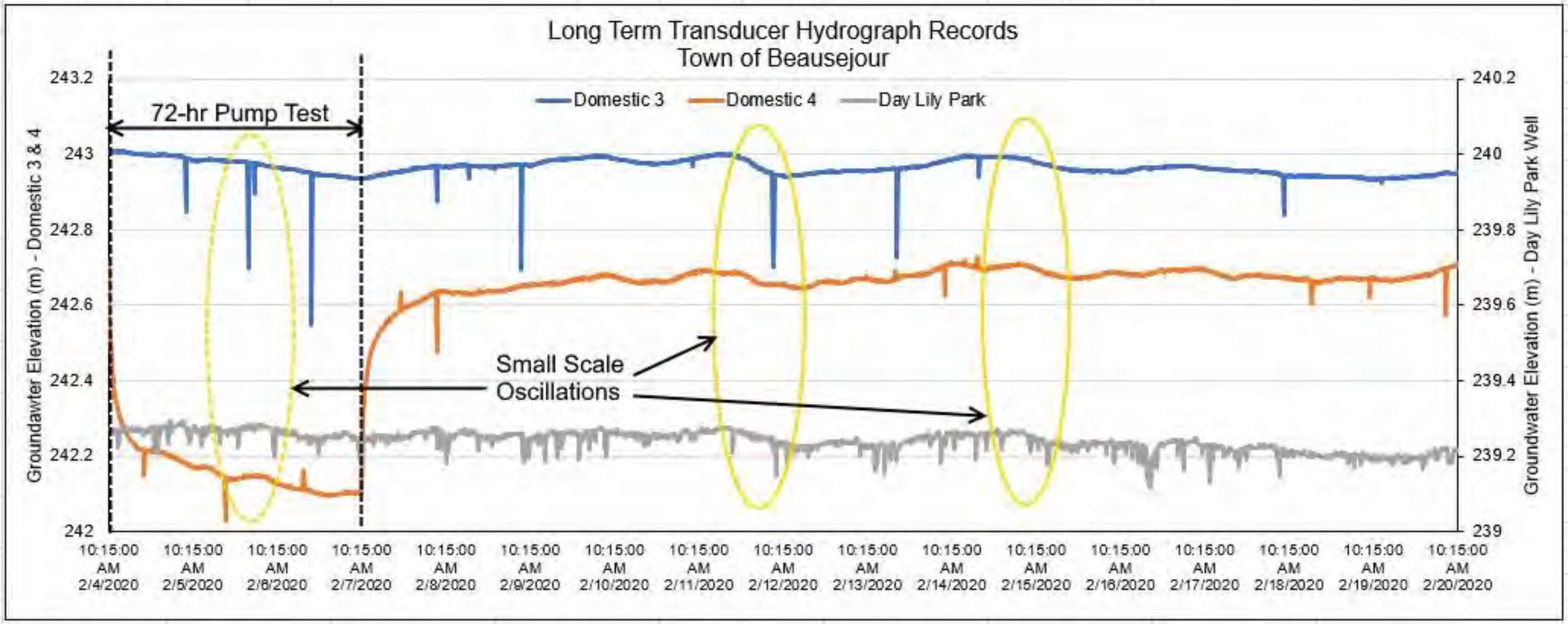
The transducers installed in Town Well #1, Test Well #3, and the Racetrack well require some additional notes.

Due to a technical malfunction, the transducer data from Town Well #1 could not be downloaded. These types of errors, while rare, do occur from time to time. The risk of technical errors is part of the reason multiple monitoring stations are used in the overall monitoring network. Sufficient data was available from available stations to support the data analysis overall.

The transducer from Test well #3 recorded short term water level fluctuations on the order of 0.01 ft., with a total change of only 0.1 ft. over the entire period of observation. This amount of fluctuation is less than the 2-3 inches observed in the other monitoring wells, such as Day Lily Park. In addition, drawdown impacts from the nearby existing municipal wellfield were not observed in Test Well #3. Due to the proximity of Test Well #3 to the existing Town wells (~400 ft.), a drawdown response on the order of a few feet would be expected during normal operation of the wellfield. The lack of response in Test Well #3 is interpreted to indicate a poor hydraulic connection between the well and carbonate aquifer, with the water inside the well insulated from local aquifer impacts. The location of Test Well #3 is relatively far from the Pescitelli pump wells and the expected drawdown during the 72 hour pump test would be small (fractions of an inch) to begin with. Consequently, the monitoring data from Test Well #3 was not included in the final hydraulic analysis of the 72 hour pumping test. The transducer record for Test Well #3 is attached in Appendix F.

The transducer data from the Racetrack well had evidence of changes to the transducer setting within the well. This could result from tampering, movements related to the pump, or from changes in the transducer line (knots, etc.). A transducer sensor is sensitive to changes in the depth of the device within the well. It is apparent from the record that the transducer changed depths a number of times throughout the monitoring period. It was also noted by Friesen Drillers' staff that the transducer was at surface when the unit was retrieved. Consequently, some form of tampering, potentially inadvertent, is a likely cause for the changes. While the Racetrack well transducer provided useful background data, including drawdown data from the capacity test of the East Production well, the transducer data during the 72 hour period was considered to be suspect and was not used in the aquifer analysis.

Figure 30 – Small Scale Groundwater Level Fluctuations



Notes: Water level response from monitoring wells at varying distance to pump well.

A secondary scale was used for the Day Lily Park data to allow for plotting on same chart.

14.2 GEOCHEMICAL SAMPLING AND RESULTS

Prior to conducting any pumping in the area, some of the observation wells used during this investigation were sampled for routine geochemical analysis. All samples were analyzed by ALS Laboratories in Winnipeg. The results are contained in Appendix H.

During the 72 hour pumping test on the West Production Well, a total of four groundwater sample sets were collected for analysis. In addition, one set of samples was collected during the capacity test on the East Production Well. The groundwater samples were collected in laboratory supplied sample bottles. Upon collection, the sample was kept cool for delivery to the analytical laboratory. All Production Well samples were analyzed by ALS Laboratories in Winnipeg (L2414588 and L2411609). The stable environmental isotopic analysis was conducted by EIL Laboratory at the University of Waterloo, Ontario. A copy of these laboratory analytical results is attached in Appendix H.

The major results are shown as Table 7. Figure 31 depicts a Tri-Linear plot comparing samples collected from various times of the pumping test.

Overall, the samples plot as a calcium/magnesium/bicarbonate type groundwater. A minor shift in water quality was apparent throughout the course of the pumping test. The shift was characterized by a relative increase in sodium and chloride concentrations with increased pumping duration. The sample points plotted progressively closer to the plot of the East Well sample. It is expected that with prolonged well field operation, both the East and West Production wells will produce water with similar geochemistry. The results from the 72 hour sample are taken to best reflect the expected operating conditions for the well field. It is apparent that some variability in geochemistry will result until conditions around the wellfield stabilize.

The total iron content was around 1.0 mg/L. The water was hard, with a total hardness of around 370 mg/L. According to Health Canada, groundwater hardness is not of direct public health concern, however, concentrations above 180 mg/L are considered to be very hard. System design should take the groundwater quality, specifically the hardness into consideration, as it could cause incrustation problems over time.

Nitrates were not detected in any of the pumping or observation wells. While nitrates levels are not a significant concern at present, ongoing monitoring of the water quality in the area is recommended to identify trends of increasing nitrate levels and take pre-emptive measures, such as public education and awareness, and recommending the sealing of abandoned water wells.

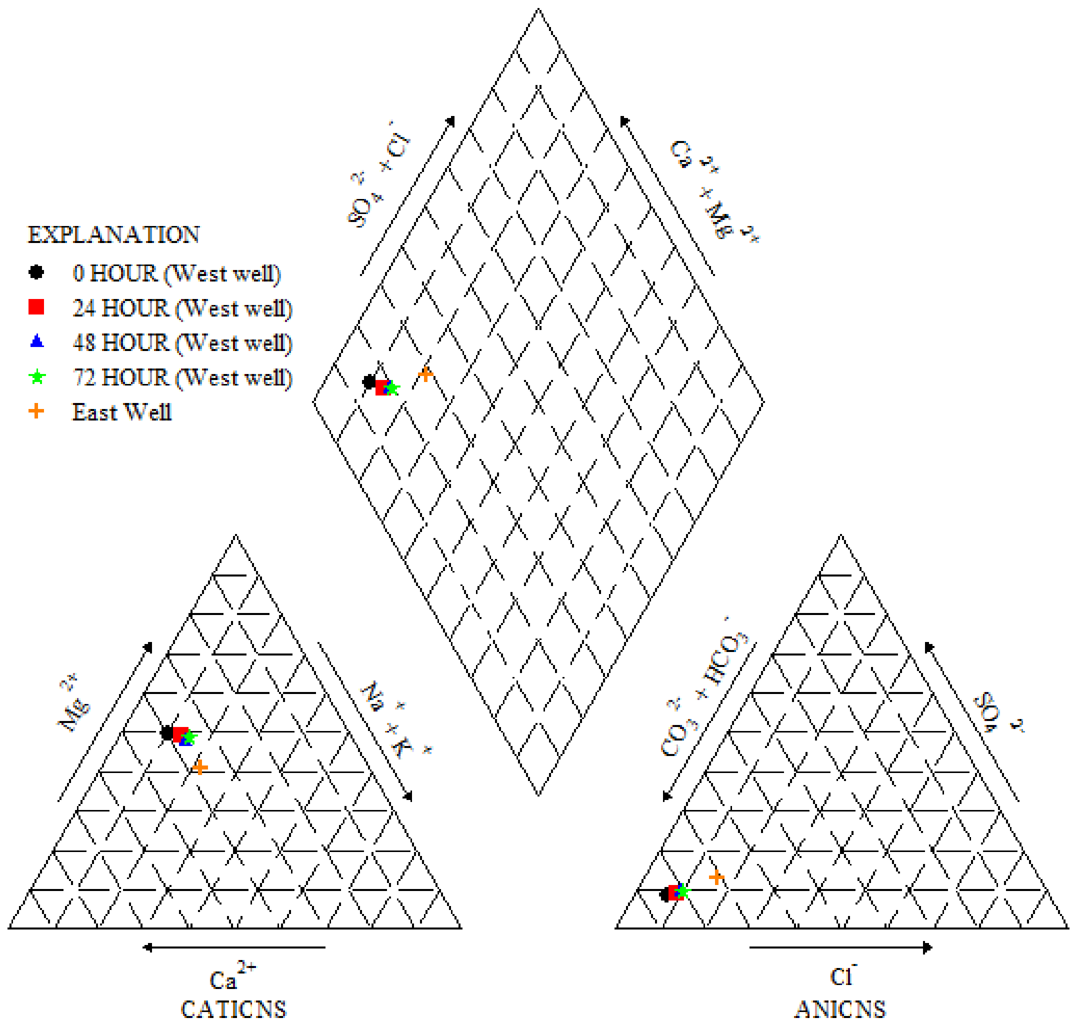
It should be noted that ammonia concentrations in the West and East supply wells were 0.15 mg/L and 0.23 mg/L, respectively (ALS - L2414588 and L2411609, 2020). While Health Canada does set a limit on this parameter, it is an important consideration for the water treatment process.

Table 7 – Groundwater Geochemistry Results – 72-Hour Pump Test

Table 7 Groundwater Analysis Results – 72-Hour Pump Test Proposed Water Supply – Town of Beausejour, Manitoba					
Time	**TDS**	**Calcium**	**Chloride**	**Nitrate**	**Hardness**
0 hours	372 mg/L	63.2 mg/L	20.0 mg/L	<0.020 mg/L	353 mg/L
24 hours	420 mg/L	64.1 mg/L	27.3 mg/L	<0.020 mg/L	371 mg/L
48 hours	431 mg/L	64.4 mg/L	31.2 mg/L	<0.020 mg/L	370 mg/L
72 hours	421 mg/L	64.1 mg/L	32.2 mg/L	<0.020 mg/L	376 mg/L

(Source: ALS L2414588)

Figure 31 – Tri-Linear Plot of samples East and West Production Wells



(Source - ALS L2414588 and L2411609, 2020)

Isotopic results presented with the Gimli LMWL are shown as Figure 32. The groundwater samples collected during the 72 hour pump test are consistent with the regional results for the SMOW in the area. The deuterium level was approximately -103 ‰, and the ^{18}O level of about -14.0 ‰. This result indicates a fairly recent meteoric groundwater source that has undergone negligible isotopic modification since it fell as precipitation. The samples collected during the pumping test appear to be lacking any noticeable evaporitic component.

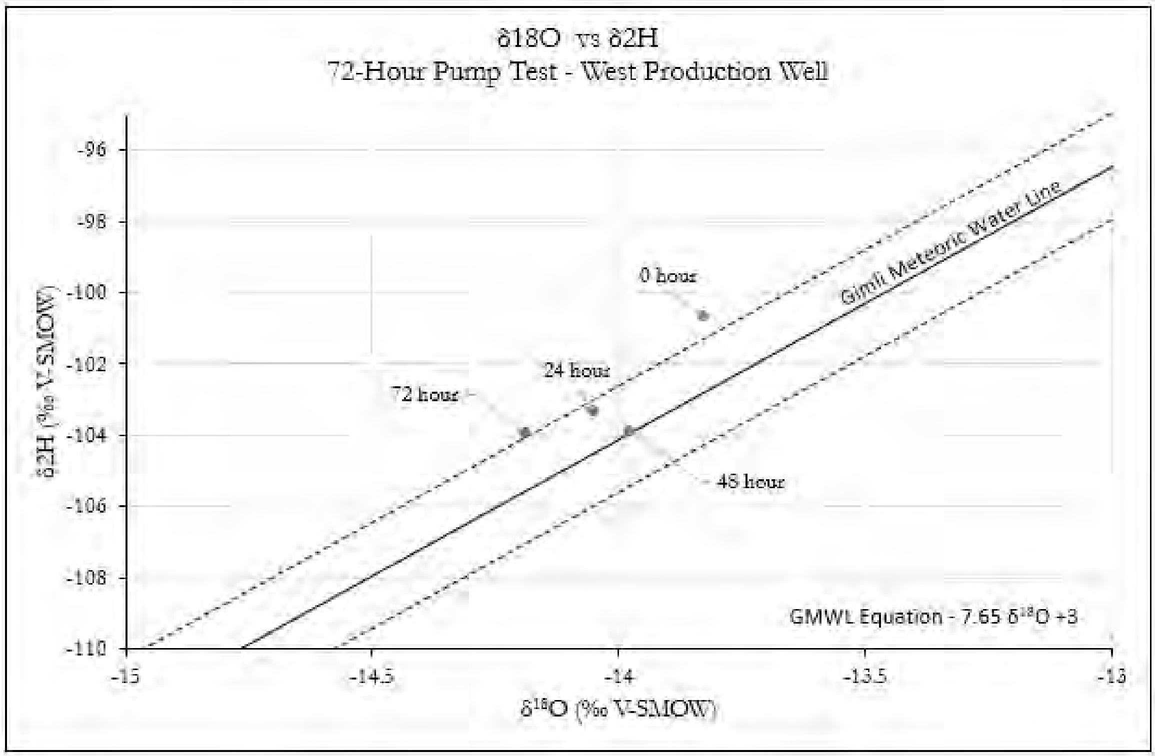
Similar to the routine geochemistry parameters, a slight shift in the isotopic composition was noted between the early and late time water samples. With increased pumping time, groundwater samples became more depleted with respect to ^{18}oxygen. This shift is indicative of an increased contribution of slightly older groundwater, potentially from deeper zones of the aquifer or from the down-dip area west of the pump wells. This interpretation is consistent with the slight increases of chloride and sodium concentrations observed in the routine geochemistry. It is anticipated that the isotopic composition will stabilize over time with regular pumping.

Table 8 – Isotope Analysis Results – 72-Hour Pump Test

Table 8 Isotope Analysis Results – 72-Hour Pump Test Proposed Water Supply – Town of Beausejour, Manitoba		
Sample ID	**^{18}Oxygen (‰ V- SMOW)**	**Deuterium (‰ V- SMOW)**
0 hours	-13.83	-100.69
24 hours	-14.05	-103.35
48 hours	-13.98	-103.91
72 hours	-14.19	-103.94

(Source: ALS L2414588, 2020)

Figure 32 – Isotope Plot – New Production Wells



(Source: ALS L2414588; IAEA, 2012)

14.3 Well Interference

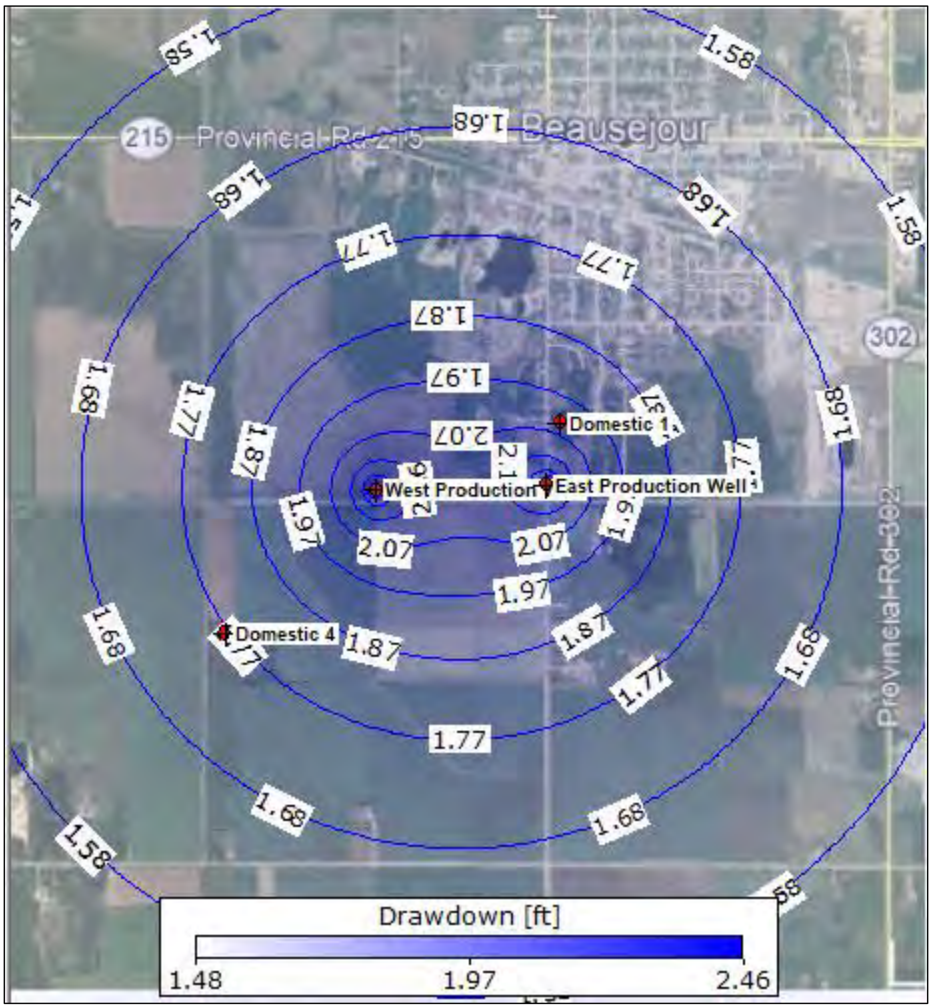
The Town of Beausejour is requesting an annual allocation of 520 acre-ft./year (641 dam^3/year), for the new well field. This allocation equates to a constant pumping rate of 322 U.S.G.P.M. for one full year (365 days). During peak day demand, the well field is expected to operate at 665 U.S.G.P.M. (42 L/s) for 20 consecutive hours.

To assess potential offsite impacts of this pumping, the Theis (1935) equation was used to calculate water level for both the long term and short term pumping scenarios. The drawdowns were calculated using the aquifer parameters determined from the 72 hour pumping test. The results assumed homogenous aquifer conditions and no other pumping wells in operation. The estimated long term and short term drawdown, with increasing distance from the production wells is presented in Tables 9 and 10 respectively. The simulated drawdown around the wellfield under both pumping scenarios is illustrated in Figures 33 and 34. It should be noted that these calculations assume wells that are perfectly efficient with no losses.

Table 9 – Long Term Calculated Drawdown – 520 acre-ft./year

Table 9 Calculated Long Term Drawdown – 365 Days Pumping Rate – 322 U.S.G.P.M. (161 U.S.G.P.M. per well) Annual Allocation – 520 Acre-ft./year (641 dam^3)						
Radius	**250 ft.**	**500 ft.**	**1,000 ft.**	**2,500 ft.**	**5,280 ft. (1 mile)**	**10,560 ft (2 miles)**
Drawdown	2.1 ft.	1.9 ft.	2.3 ft.	1.7 ft.	1.4 ft.	1.0 ft.
Calculation follow assumptions of the Theis (1935) equation.						

Figure 33 – Long Term Drawdown - 365 days - 520 acre-ft./year



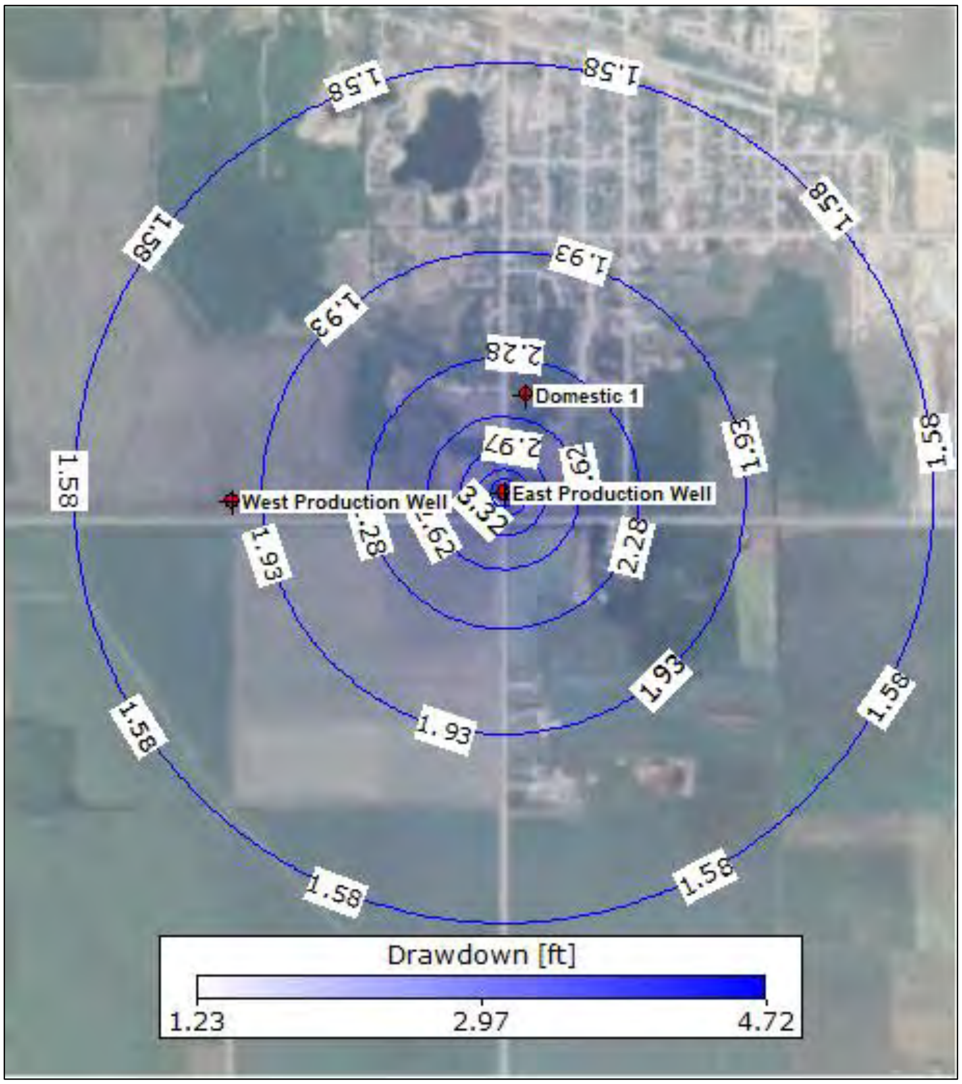
Notes - Drawdown cone after 365 days pumping at a combined rate of 322 U.S.G.P.M. (annual allocation of 520 acre-ft./year (641 dam^3/year));

Based on the Theis (1936) equation. AquiferTest Professional, V2016.1

Table 10 – Short Term Calculated Drawdown – Peak Demand - 42 L/s

Table 9 Peak Demand Drawdown - Single Pump Well - 1 Day (20 hrs) Pumping Rate – 42 L/s (665 U.S.G.P.M.)						
Radius	**250 ft.**	**500 ft.**	**1,000 ft.**	**2,500 ft.**	**5,280 ft. (1 mile)**	**10,560 ft (2 miles)**
Drawdown	3.8 ft.	3.1 ft.	2.6 ft.	2.0 ft.	1.5 ft.	1.1 ft.
Calculation follow assumptions of the Theis (1935) equation.						

Figure 34 – Short Term Drawdown – Peak Demand – 42 L/s (20 hours)



Notes - Drawdown cone after 20 hours pumping at 665 U.S.G.P.M. (single pump well)

Based on the Theis (1936) equation. AquiferTest Professional, V2016.1

The drawdown after one year of pumping, at a radial distance of 5,280 ft. (1 mile) from the pumping wells, was calculated to be 1.3 ft. The closest well identified in the inventory was 250 ft. away from East Production Well. Based on this analysis, the total amount of additional drawdown in the closest well after one year of municipal pumping is expected to be 2.1 ft.

The drawdown after 20 hours of pumping at the peak day rate (665 USGPM), at a radial distance of 5,280 ft. (1 mile), was calculated to be 1.8 ft. The calculated drawdown in the closest well (250 ft away) after 20 hours pumping at 665 USGPM was 3.8 ft.

The amount of addition drawdown calculated for the wellfield is within the historical range of natural groundwater level fluctuations observed in regional hydrograph stations. After one year of municipal pumping, the cumulative additional drawdown impact observed in the closest domestic wells is calculated to be 5.6 ft., or about six feet. The natural groundwater level fluctuations observed in regional hydrographs were up to approximately 7.5 feet. Thus, it is expected that existing wells in the area are already capable of handing this amount of water level change.

As per the conditions of the Groundwater Exploration Permit, the Town of Beausejour, as the proponent of the water supply project, is responsible to correct any existing water supplies that are negatively impacted as a result of a new municipal groundwater supply. It should be noted that this responsibility is limited to issues related to the operation of the new groundwater supply, such as increased drawdown or water quality changes caused by the new wellfield. It should be noted that the proponent is not legally responsible for pre-existing plumbing issues or for problems that are not a result of the new production wells. The proponent is responsible to resolve interference issues to the satisfaction of the Minister.

No well interference complaints were received during the course of the testing project. A significant finding from the site assessments was that groundwater levels in the area are generally high (within 20 ft. of grade). Thus, it is expected that any well interference issues would be related to the well hookup configurations and component conditions and not related to a lack of groundwater. Long term monitoring and a well interference program will be required to address these concerns.

14.4 Groundwater Under Direct Influence of Surface Water

The Groundwater Under Direct Influence of surface water (GUDI) classification refers to conditions where microbial pathogens can travel from surface water, through the aquifer and into a water well. Groundwater determined to be GUDI inherits an increased potenital for poor water quality. Several parameters must be considered when assesing whether groundwater is GUDI. These parameters include the concentrations of nitrate, carbonate and chloride in the well water, the presence or absence of bacteria, the stable isotope geochemistry, and the local geology.

14.4.1 Groundwater Geochemistry Parameters

The concentrations of nitrate and carbonate in groundwater samples from the new production wells were both below detection limits for all samples. These parameters were also noted to be absent in the historical chemistry data for the existing municipal water supply and for provincial monitoring stations G05OJ155, and G05SA011. Provincial station, G05OJ164, was the only sample with detectable nitrate, with a value of 2.6 mg/L (MCC, 2014). It is noted that this station is located close to the quarry operations at Garson and Tyndall where the bedrock is exposed closer to the surface. Overall, the nitrate and carbonate parameters are below detection limits fo the new production wellfield.

Chloride is a common constituent in groundwater. An assessment of chloride levels in the new production wells relative to background regional values was undertaken. Local provincial monitoring stations (G05OJ164, G05OJ155, and G05SA011) indicated a range in chloride concentrations from 2 to 22 mg/L (MCC, 2014). In addition, chloride concentrations from the existing Town of Beausejour supply wells were noted to range from 33 to 52 mg/L (Town of Beasejour, 2016). The chloride concentrations from the new supply wells along Pescitelli Rd ranged from 20.0 mg/L to 32.2 mg/L (Table 7). Based on the currently available data, chloride concentrations from the new production wells appear to be similar to the levels from the existing supply wells.

Groundwater in the underlying sandstone aquifer may have some influence on chloride concentrations in the carbonate aquifer around Beausejour as the sandstone is saline and chloride levels are expected to be significantly elevated over the carbonate aquifer. Although the hydraulic relationship between the two aquifers in not well understood for the Beausejour area, it is conceivable that some upward leakage could occur from the saline sandstone aquifer into the carbonate aquifer. This interaction could also be influenced by the drawdown generated from the existing municipal pumping in the carbonate aquifer. Continued monitoring is required to establish potential trends of the chloride concentrations in the local carbonate groundwater.

Bacteriological analysis is a regulatory requirement for municipal water supplies. Water samples are collected biweekly and the results are made available through annual reporting. Reports by the Town of Beausejour Water Works Department have no record of positive results for the presence of coliform in their water supply. There is no indication at this time that the Town of Beausejour groundwater supply is being negatively affected by bacteriological impacts.

Stable environmental isotopes ^{18}oxygen and deuterium are useful to assess the source and relative age of groundwater. Due to the effects of evaporation, surface waters that are enriched in ^{18}oxygen would plot below the meteoric line as shown in Figure 19. The samples from new produciton wells plot at or above the meteoric line, in the range of modern groundwater (Fig. 31). There does not appear to be any evidence of an evaporitic component to the groundwater at the supply wells. The implication is that the groundwater is modern meteoric.

14.4.2 Physical Hydrogeological Considerations

The geology at each test site comprised clay, till and sand layers overyling the carbonate aquifer. The thickness of these confining layers ranged from 68 at the East Well to 87 feet at the West Well. The East Well was noted to contain a greater abundance of permeable sand and gravel materials in the overburder.

The site geology indicates confining conditions for the carbonate aquifer. The overburden materials act as a confining layer which limit the rates of downward migration by surface waters. The confined aquifer interpretation is further supported by the aquifer response observed during the 72 hour pumping test and the suitability of the results generated from confined aquifer analysis methods.

It is noted, however, that the confining layers include sandy materials, especially at the east well site. The permeable sand and gravel intervals will limit the overall effectivness of the overburden as a protective boundary. It should also be noted that quarry operations west of the sites, further reduce the local overburden cover and increase the potential for surface water impacts to reach the local groundwater aquifer.

The presence of quarries and gravel pits in the area present another concern for GUDI conditions. The expansion of the drawdown cone around the wellfield after long term pumping will likely extend under existing surface water features and gravel pits; most notably, the surface water feature located directly north of the wells in west Beausejour, and southwest of the wells along Rd 70 North between Rd 40 and 39 E. The locations of these features requries that monitoring be in place to observe for potential surface water-groundwater interactions under long term pumping conditions. The isotopic analysis will be of particular interest in this regard and will provide important data to monitor for potenital changes to groundwater quality over time. The isotope results from the 72 hour pump test indicated a slight shift towards older, meteoric groundwater. Overall, the amount of drawdown generated around the new wellfield will be relatively small, and consequently, the hydraulic gradients generated towards the wells will also be relatvely small.

As a final consideration, the large number of private water wells documented within and around the Town of Beausejour is of concern for groundwater quality and must be considered in a GUDI assessment. A review of GWDRILL (2018) revealed more than 124 wells within a two mile radius of the new well field site. It is further assumed that the GWDRILL database typically under represents the actual number of wells in a region, as the database effectively covers water wells completed from 1964 to present. Consequently, wells drilled before 1964 generally do no have a well log record.

In the well log review, most of the wells were completed in the carbonate aquifer. It is unknown at this time how many of these wells are still in use or if they have been properly abandoned. The overall density of private wells within the area is cause for concern with regards to groundwater quality, as each additional well increases the potential for surface impacts to enter the aquifer. Compounding the concern, the JRCC report (2016) indicated 60 residential lots use private septic tanks connected to a low pressure sewer system and several lots are serviced by holding tanks. Aging septic fields and tanks are of concern as they can become a potential source of chloride and bacteriological pathogens for the local aquifer. Although the carbonate aquifer appears to be localy confined, these considerations are important for local groundwater quality.

14.4.3 Summary of GUDI Conditions

In general, the negative bacteria results, isotopic geochemistry, absence of nitrates and carbonates and the confined hydrogeological setting suggest the new supply wells are non-GUDI at this time. However, the concerns detailed in this section highlight the importance for ongoing monitoring, as conditions could change over time both naturally and with additional development/pumping pressures.

It is important to note that this assessment is based on currently available information and that the aquifer conditions are dynamic. Continued monitoring is very important.

15 DISCUSSIONS

15.1 LONG TERM HYDROGRAPH RESPONSE

The Town of Beausejour is located near to major recharge areas for the carbonate aquifer in the southeast of Manitoba. Through a review of regional hydrograph data (Fig. 15), the following comments can be made:

- The high transmissive conditions in the carbonate aquifer result in drawdown cones that are shallow with a large areal extent.
- The carbonate aquifer is highly responsive to seasonal and climatic variations. Water levels in the carbonate aquifer appear to decline rapidly during prolonged dry periods. The aquifer appears to be similar to an open reservoir and pipe analogy; when the water level in the reservoir falls, the potential in the pipe declines very rapidly. This means that during prolonged dry periods, static water levels in the area will respond rapidly, and decline accordingly.
- Operation of the new well field is expected to generate additional drawdown within the carbonate aquifer that is within the range of seasonal and climatic fluctuations observed from regional hydrographs (~7.5 ft.). Existing monitoring wells in the area should be established and preserved and monitored regularly to check these assumptions.

- Hydrograph information for the sandstone aquifer is sparse in the Beausejour region. A comparison of the hydrographs of G05SA015 and G05SA014, the carbonate and sandstone aquifers appear to respond in a very similar manner. A downward hydraulic gradient from the carbonate aquifer to the sandstone aquifer is expected in the Beausejour area. Based on the available information, the new wellfield is not expected to cause significant changes to the existing interactions between the carbonate and sandstone aquifers.

15.2 AQUIFER SUSTAINABILITY

As discussed, the Sandilands area is a recharge area for the bedrock aquifer system. This recharge area covers approximately 400 square miles (Betcher et al., 1995). An assessment of long term average groundwater sustainability for this area is provided as follows.

The Upper Pine Creek Basin of the Assiniboine Delta Aquifer is the only area in Manitoba, known to the author, where aquifer recharge has been determined (Render, 1986). Render determined the average local precipitation during the period of evaluation was 482.8 mm (17.0 in) and calculated average annual groundwater discharge from the basin over 17 years was 34.3 mm (1.4 in). This value was considered the sustainable yield of the aquifer in that basin. Due to the importance of the yield for agricultural activities on the Assiniboine Delta Aquifer, this work was reviewed by a committee chaired by R.N. Farvolden from the University of Waterloo.

While the Sandilands area is not a perfect replica of the Upper Pine Creek Basin, there are quite a few similarities. The author considered that if the Upper Pine Creek recharge value was adjusted for the current climatic precipitation average in the Sandilands area it would produce a reasonable estimate of the Sandilands sustainability. The current climatic average for precipitation provided by Environment Canada (2020) from 1981 to 2010 shows an average annual value of precipitation of 575 mm (22.64 in) for the Sandilands area. This value was used to adjust the Upper Pine Creek recharge rate to an approximate rate for the Sandilands area.

If this value is used for the long term average annual recharge, then the 400 square miles of the Sandilands would produce 1,666,814,197 cubic feet (47,198,921 cubic meters) of water per annum. This amount of water is considerably above the amount of water flowing westward through the carbonate and sandstone bedrock aquifers. From the view point of those aquifers, means that if there is a decline in water level in the carbonate aquifer due to additional withdrawals, the recharge area can likely supply the requested allocation.

15.3 ESTIMATED WESTWARD GROUNDWATER FLOW IN THE BEDROCK AQUIFERS

The flow of groundwater moving out of the Sandilands area can be estimated using a groundwater gradient of, 1.24 x 10^{-3}, and an average transmissivity of 50,000 U.S.G.P.D./ft. for the carbonate aquifer and 5,000 U.S.G.P.D./ft. for the Winnipeg Sandstone Aquifer. The flow front, estimated from satellite images, is about 40 miles wide. Using these numbers, a total westward flow of about 711,848,649 cubic feet (20,172,798 cubic meters) per annum can be calculated. These figures are less than half the recharge estimate. Therefore, if some additional stress is put on the flow system, there appears to be ample groundwater recharge to make up the difference.

The Birds Hill Glacio-Fluvial Complex is a major sand and gravel feature composed of sand and gravel material that has, in places, been deposited directly on top of the carbonate bedrock. In some parts of the complex the sand and gravel are separated from the bedrock by a layer of glacial till. The surface area of the complex was estimated to be approximately 8 square miles. Render (1986) suggested that recharge to the carbonate aquifer was on the order of 0.71 ft^3/s, or approximately 320 U.S.G.P.M. Under current climate conditions, this equates to about 350 U.S.G.P.M. (0.79 ft^3/s) or nearly 700,000 m^3 per year. It should be noted that this volume calculation includes recharge to the entire complex. Groundwater in the Birds Hill areas is shown to flow radially outward from the complex. Render (1986) suggests that nearly half of the total recharge volume flows west/southwest towards the floodway. As a result, only a portion of the recharge would be expected to flow south/southeast and contribute to the available groundwater resources in the region. Recharge from the Sandilands complex, contributes the vast majority of groundwater flow to regional aquifers in the Beausejour region.

15.4 ESTIMATED GROUNDWATER USAGE

Estimates of the total average annual groundwater usage in the area are challenging due to a general lack of data. However, this value must be within the order of the groundwater flow to the west from the Sandilands. It is recognized that there is some discharge to river, creeks and swamps in the region. The population density is variable in the area. To a large extent, the regional aquifers are well utilized by municipal, agriculture, industry and private residences. Groundwater allotted to licensed users in the region (including The RM of Springfield) totals approximately 10,200,000 m^3/year (MCC-WRLB, 2019). The estimated total groundwater consumption by private domestic users, assuming 0.37 dam^3/year per well, is estimated to be 2,405,000 m^3/year. This results in an estimated total groundwater usage of approximately 17,000,000 m^3/year.

It is important to note that licensed users generally consume less than the licensed amount. In addition, the value for domestic use was conservatively estimated by assuming each of the 6,500 wells in the GWDRILL database (2018) supplies groundwater for a family of four at the average rate of 250 L/day/person, which may over estimate actual conditions as many wells in the database are no longer in use.

While the numbers by the nature of their derivation have to be approximations, they do indicate that substantially more groundwater is in the system on an annual basis than is being used. A further indication of the fact that recharge exceeds usage is the continuance of many flowing wells in the area. The fact that flowing wells continue to exist suggests the system is at or close to equilibrium. In reviewing the local static water levels, it can be assumed that most private well systems in the area have taken current conditions as static for the area.

16 Integrated Water Supply and Watershed Planning Study

A water supply investigation and development of this size requires careful planning and assessment. Although it is assumed that groundwater supplies are the best option, an integrated water supply and watershed planning study is an important tool in the evaluation process.

An integrated planning study for water supply would identify future and prospective water supply sources, and the relative availability. This would document and address items such as river supplies, allocations, and other water supply alternatives. This is important for future water supply licensing and environment act licensing.

Integrated water supply and watershed planning studies are often required in obtaining environment act licensing for new proposed water supplies in the province.

17 Well Hook Up and Mechanical Considerations

The following recommendations should be followed with respect to the mechanical connection to the wells:

- Both wells should be equipped with a center hung, full spool type pitless unit for ease of future servicing. The contract engineer should review the material for the pitless unit construction with the Town prior to specifying the product, although stainless steel is generally recommended. The pitless units should be installed so that no diameter restrictions are placed within the well at the pitless unit/casing connection. The pitless units should be installed concentric with the well casing with a proper hold down assemblies.
- The recommended maximum pumping rate for each well is 665 U.S.G.P.M. (42 L/s).
- A pump intake should not be installed below the well casing. If mechanized for the maximum recommended flow rate of 665 U.S.G.P.M., the submersible pumps should be installed at a depth of 68 feet below grade in each well.

- The well field design and layout should allow for truck access to the wells in the future. The sites should be landscaped to direct drainage away from the well heads. The wells should be protected from vehicular impact and be secured against vandalism.
- The entire system design should take into account the local water quality. Water quality could get slightly worse with prolonged pumping.
- Provisions should be made to properly vent the wells during winter periods. A hydrogeologist should assist in this design.
- Proper records, including daily and weekly measurements of water levels in the wells should be recorded by the operators.

It is important to note that Friesen Drillers Limited did not undertake any design or review of the mechanical engineering design of the piping/delivery system. It should be noted that all piping, selection of submersible pumps, and connections to the wells were beyond the scope of this hydrogeological assessment.

18 RECOMMENDATIONS

The following recommendations are provided based on our investigation for the proposed new municipal water supply for the Town of Beausejour:

- Under normal seasonal and climatic conditions, the proposed new municipal wellfield can provide the requested allocation of 520 acre feet/year (641 dam^3/year).
- The Town should proceed with the Water Rights License application and an Environmental Act Licence amendment.
- The hydraulic conditions on the site indicate highly transmissive conditions in the carbonate aquifer. The inferred transmissivity at the site is about 250,000 U.S.G.P.D/ft. This is at the higher end of the range for regional transmissivity and much higher than the transmissivity observed at the previous wellfield location.
- The specific capacity of the West and East production wells is 141 U.S.G.P.M./ft. (at 510 U.S.G.P.M.) and 73 U.S.G.P.M./ft. (at 955 U.S.G.P.M.), respectively. The specific capacity values may change over time which can impact overall well yields. It is recommended to redevelop the wells regularly to maintain overall well efficiency.
- The recommended maximum pumping rate for each well is 665 U.S.G.P.M. (42 L/s). Groundwater levels should be monitored closely and reviewed after the first year of operation.
- The expected drawdown cone will extend beyond the wellfield. However, the amount of additional drawdown during regular operation is expected to be less than the

natural groundwater level fluctuations in regional hydrograph stations (~7.5 ft.). This suggests that existing supply wells are capable to accommodate the small amounts of increased drawdown from the new municipal pumping. The highly transmissive aquifer conditions reduce the potential for negative impacts to third party wells.

- Domestic supply wells that are connected with single line suction pumps are the most vulnerable to changing groundwater levels, whether naturally occurring or induced by pumping. These types of hookups should be monitored closely and should be converted to submersible pumps where possible.
- Groundwater quality was noted to be similar to that of the old wellfield, although several parameters appear to be somewhat higher. Overall, the groundwater quality is suitable for use in municipal applications. The groundwater geochemistry was provided to Stantec for use in their water treatment plant design process.
- Based on the information available at this time, the two new production wells appear to pump recent meteoric groundwater. The evidence support a non-GUDI designation with monitoring. However, it is important to note the conditions detailed in Section 14.4 of this report. Aquifer systems are dynamic and groundwater conditions change over time. In addition, the long standing practice of agricultural land use has been shown to impact groundwater quality in the carbonate aquifer in other parts of the province. The GUDI designation should be reviewed as more hydrogeological data becomes available for the wellfield.
- A Groundwater Monitoring Program should be implemented. The program should be designed and supervised by a hydrogeologist/ hydrogeological engineer registered to practice in Manitoba. Dedicated monitoring wells should be established and instrumented with pressure transducers; this may require that new 5 inch dedicated monitoring well(s) be constructed at strategic locations.
- The transducer and regional hydrograph monitoring data should be reviewed after one year of well field operation. In addition, groundwater samples should be collected from the monitoring wells and analyzed for routine geochemical parameters and stable environmental isotopes of ^{18}oxygen and deuterium. The results of the groundwater monitoring program results should be publicly reported.
- The Town of Beausejour should develop an Aquifer/Well Head Protection Program for all municipal wells and develop a contingency plan for the event that the aquifer becomes impacted or unusable in some manner.
- The existing municipal supply wells should be maintained to provide water supply redundancy and to allow for potentially increased capacity in the future.

- The Town should develop a Well Interference Plan to resolve future well interference complaints. The plan should detail the complaint investigation procedure and establish criteria for decisions on complaint resolution. The plan should be designed and implemented under the supervision of a qualified hydrogeologist/ hydrogeological engineer. It should be noted that an effective Well Interference Plan typically relies on data produced from a Groundwater Monitoring Program.

- In the event of significantly lower regional static water levels in the carbonate aquifer (i.e. chart record low levels), water levels in the production wells should be monitored daily. It is recommended that each production well be equipped with automatic data recording pressure transducers to assist the Town in monitoring and recording pumping water levels.
- The new production wells will require regular maintenance. The pump and motor assembly should be removed and inspected at least once every 4 years.

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20 LIMITATIONS AND DISCLAIMERS

20.1 LIMITATIONS

The scope of this report is limited to the matters expressly covered and is intended solely for the client to whom it is addressed. Friesen Drillers Limited makes no warranties, expressed or implied, including without limitation, as to the marketability of the site, or fitness to a particular use. The assessment was conducted using standard engineering and scientific judgment, principles, and practices, within a practical scope and budget. It is based partially on the observations of the assessor during the site visit in conjunction with archival information obtained from a number of sources, which is assumed to be correct. Except as provided, Friesen Drillers Limited has made no independent investigations to verify the accuracy or completeness of the information obtained from secondary sources or personal interviews. Generally, the findings, conclusions, and recommendations are based on a limited amount of data (e.g. number of boreholes drilled or water quality samples submitted for laboratory analysis) interpolated between sampling points and the actual conditions on the site may vary from that described above. Any findings regarding the site conditions different from those described above upon which this report was based will consequently change Friesen Drillers Limited's conclusions and recommendations.

20.2 DISCLAIMER

This Friesen Drillers Limited report has been prepared in response to the specific requests for services from the client to whom it is addressed. The content of this document is not intended to be relied upon by any person, firm, or corporation, other than the client of Friesen Drillers Limited, to who it is addressed. Friesen Drillers Limited denies any liability whatsoever to other parties who may obtain access to this document by them, without express prior written authority of Friesen Drillers Limited and the client who has commissioned this document.

Friesen DRILLERS

Appendix A

Background Hydrogeological Reports
Town of Beausejour Groundwater Supply

Preliminary Groundwater Appraisal – 1973, Pedersen (MWSB)

Groundwater Investigation at Beausejour- 1986, Pedersen (MWSB)

Desktop Hydrogeological Assessment of the Carbonate Aquifer as a Municipal Water Supply for the Town of Beausejour – Friesen Drillers Ltd., 2016

Summary of 2018 Hydrogeological Test Work – Friesen Drillers Ltd., 2019

Well Inventory, Geochemistry Review and Recommendations for Further Hydrogeological Testing Town of Beausejour Groundwater Supply – Friesen Drillers Ltd., 2019

Summary of Hydrogeological Test Work - Town of Beausejour Groundwater Supply Secondary Test Site – 26-12-7 EPM - Pescitelli Road, Rural Municipality of Brokenhead – Friesen Drillers Ltd., 2019

L. Gray, P. Eng.
Sr. Groundwater Geologist

October 12, 1973

A. Pedersen
Groundwater Geologist

File: 20.1.7 Town of Beausejour
M.W.S.B. Beausejour

Preliminary Groundwater Appraisal;
Town of Beausejour.

A groundwater appraisal for the Town of Beausejour was requested by the M.W.S.B. Information used for this appraisal was from the following:

- drill reports from W.R.B. groundwater data files,
- logs and test data for the two town wells from the consulting engineer (Reid, Crowther & Partners Ltd.)
- data from International Water Supply Re: Service Work Done on the Well Pumps.

The information available is sketchy and in some cases contradictory. However, it is sufficient to outline the geological and aquifer conditions in the vicinity of the town and reveals some information on the present town wells. The information available for each well is summarized on the attached sheets.

Aquifer

The aquifer developed by the two town wells is subcropping bedrock carbonate rock of the Red River formation (dolomite and dolomitic limestone). The eastern limit of this formation (and aquifer) occurs approximately one mile east of the town. The aquifer is overlain by glacial drift and underlain by shale of the Winnipeg formation. Well No. 2 develops a highly fractured zone at the bedrock surface. No log is available for Well No. 1 but it is also completed in the bedrock. Drill reports in the area indicate substantial amounts of sand and gravel in the drift and it is likely that there is hydraulic connection between the bedrock aquifer and the drift sand and gravel.

Figure 1, drawn from reported drill logs, shows the general geological and aquifer conditions in the vicinity of the town, the section extends from approximately 3.5 miles N.E. of the town (in sec. 9-13-8E) through the town to approximately 4 miles S.W. of the town (in sec. 21-12-7E).

The coefficient of transmissibilities calculated for the carbonate aquifer are as follows:

- from distance-drawdown data T = 46,600 USGPD/ft.
- at Well No. 2 from specific capacity data T = 45,000 USGPD/ft.
- at Well No. 1 from specific capacity data T = 35,000 USGPD/ft.

Thus, the transmissibility is in the range 35,000 to 46,600. Distance-drawdown data gives a much better indication of T, therefore the transmissibility is probably close to the higher end of the range.

A comparison of static water levels in the town wells from 1962 to 1972 shows no noticeable lowering of the piezometric surface.

Well Capacities

Well No. 2 - this well was pumped at rates up to 400 USGPM when tested in 1962. Well efficiency started to drop with pumping rates greater than 300 USGPM. This yield should be considered the maximum for this well.

- the well is presently equipped with a pump designed to deliver 125 USGPM at 166 ft. T.D.H.

- the well was only developed to be sand free at 200 USGPM. If a higher yield is developed, the well may require more development.

Well No. 1 - the maximum reported pumping rate for this well is 246 USGPM.

- the available information indicates a higher potential yield.

- it is not known if the well is developed for yield higher than presently pumped.

- the well is presently equipped with a pump designed to deliver 125 USGPM at 166 ft T.D.H.

Water Quality

Attached is an analysis from a sample taken from well No. 2 in 1962. This water is fresh.

There is some indication that brackish water occurs in deeper zones under the town. It is not known whether this occurs in deeper portions of the carbonate aquifer or in the underlying Winnipeg formation.

Conclusions

1. The capacity of the present well system if one well is used as the supply well and the other as a standby, is approximately 300 USGPM (not with present pumps).

2. The capacity of the well system, if both wells are used, is approximately 500 USGPM (not with present pumps)

3. The aquifer has the capacity to yield greater amounts of water. More wells could be installed if necessary.

4. If the pumping rates of the present wells are significantly increased the wells may require more developing. It would also be advisable to do some testing of the wells in this case.

5. The only reason to do test drilling in this area would be to determine where the brackish water occurs and if there is a potential intrusion hazard.

AP

Enclosure(s)

A. Pedersen

BEAUSEJOUR - WELL NO. 1

Installed by:	D. J. Coyle; Winnipeg
Date:	1957
Depth:	113.4 ft (from base plate)
Diameter:	16 inch I.D.
Log:	no log available. Well is completed in bedrock.
Located:	approximately 214 ft. north of Well No. 2.

AVAILABLE TEST DATA

From Reid, Crowther & Partners (Jan. 1962)

- static water level - 18 feet below datum

- for a pumpin g rate of 120 USGPM at Well No. 1 the pumping level was 28 feet. This gives a drawdown of 10 feet and a specific capacity of 12 USGPM/ft.

Water Levels of Well No. 1 with Well No. 2 pumping (No. 1 off).

ENTERED
G. W. D.

Well No. 2 Pumping Rate (USGPM)	Water Level in Well No. 1	Drawdown
140	23.5	5.5
200	26.5	8.5
260	28	10
300	30	12
350	34	16
400	39	21

From International Water Supply (1972)

- static water level - 18.05 ft. (air gauge reads 16 ft.)

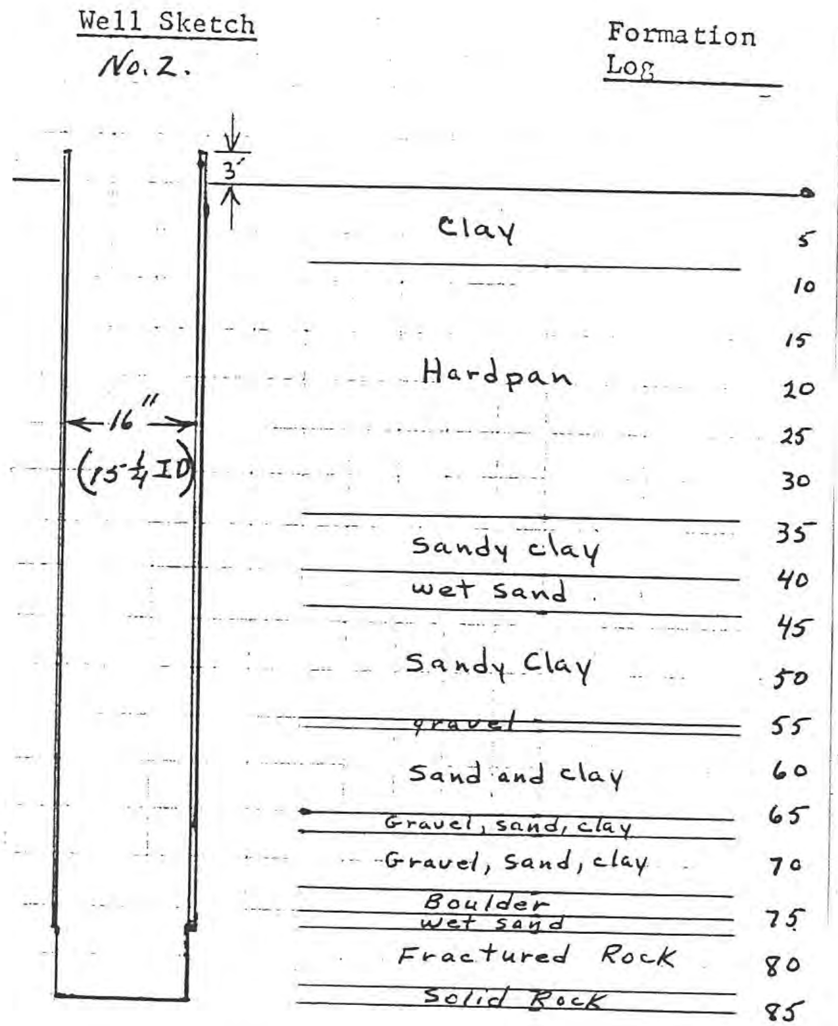
Pumping Rate IGPM (USGPM)	Pumping Level (air gauge)	Drawdown	Specific Capacity USGPM/ft.
0 0	16	0	
120 (144)	28	12	12
160 (192)	35	19	10.1
205 (246)	40	24	10.3

Transmissibility:
- from specific capacity T = 30,000-40,000 USGPD/ft.
- from distance-drawdown T = 46,600 USGPD/ft.

Present Pump:
- designed to deliver 125 USGPM at 166 ft. T.D.H.

BEAUSEJOUR - WELL NO. 2

Installed by: Pruden Drilling; Selkirk
Date: 1961
Depth Drilled: 85 ft. (below ground)
Diameter: $15\frac{1}{4}$ inches (I.D.)
Log:



ENTERED
G. W. D.

AVAILABLE TEST DATA

From Reid, Crowther & Partners (Jan. 1962)

- static water level - 10 feet below datum

- with Well No. 1 pumping at 120 USGPM the water level in Well No. 2 was 14 feet (4 feet from drawdown)

Test on Well No. 2

Pumping Rate USGPM	Pumping Level	Drawdown	Specific Capacity
200	23	13	15.4
260	28.3	18.3	14.2
280	30.1	20.1	13.9
300	30.7	20.7	14.5
350	37.5	27.5	12.7
400	49	39	10.3

Note: sand pumped at rates over 200 USGPM

From International Water Supply (1972)

- well depth = 84.7 ft. (from base plate)
- static water level = 14.29 ft.

Pumping Rate IGPM (USGPM)	Pumping Level	Drawdown	Specific Capacity
0	15	0	
118 (141)	16.5	1.5	94 (USGPM/ft)
150 (180)	18	3	60 (USGPM/ft)

does not agree with other tests
Faulty air gauge?

Transmissibility:
- from specific capacity T = 45,000 USGPD/ft.
- from distance-drawdown T = 46,600 USGPD/ft.

Present Pump:
- designed to deliver 125 USGPM @ 166 ft. I.D.H.
- recommended replacing pump bowl in 1975.

Adk ~~[illegible]~~

4403 - 8

THE NATIONAL TESTING LABORATORIES LIMITED

Consulting Engineers

Office WINNIPEG

Date JANUARY 29, 1962

CHEMICAL ANALYSIS OF WATER

LAB. NO. M-1405

REPORTED TO: G. S. LANGMAN, P. ENG., HADDIN, DAVIS & BROWN CO. LTD.

Identification of Sample:

WELL #2, BEAUSEJOUR, MANITOBA.

SAMPLE TAKEN JANUARY 10TH, RECEIVED FOR TEST JANUARY 15TH, 1962.

Taken By HADDIN, DAVIS & BROWN CO. LTD.

	Constituent	PPM as	A	B	C	D
Cations	Calcium .... C^{++}	$CaCO_3$	160			
	Magnesium .... Mg^{++}	"	115			
	Sodium .... Na^+	"	217			
	Hydrogen .... H^+	"	-			
	Total Cations	"	492			
Anions	Bicarbonate .... HCO_3^-	"	324			
	Carbonate .... CO_3^{--}	"	0		ENTERED G. W. D.	
	Hydroxide .... OH^-	"	0			
	Phosphate .... PO_4^{---}	"	-			
	Chloride .... Cl^-	"	97			
	Sulphate .... SO_4^{--}	"	70			
	Nitrate .... NO_3	"	1.0			
	Total Anions	"	492			
Total Hardness		"	274			
Non-Carbonate Hardness		"	0			
Alkalinity (M.O.)		"	324			
Alkalinity (P)		"	0			
Sodium Alkalinity		"	50			
Total Dissolved Solids BY EVAP.			556			
Iron (Filtered)		Fe	.22			
Iron, Total		Fe	.60			
Manganese		Mn	0			
Free Carbon Dioxide		CO_2	-			
Dissolved Oxygen		O_2	-			
Silica		SiO_2	13			
Turbidity			-			
Color			-			
pH			7.9			
pHs			-			
Odor			0			
Fluoride		F	LESS THAN .1			
Nitrate Nitrogen		N.	.65			
Nitrite Nitrogen			-			
Free Amm. Nitrogen			-			
Albuminoid Nitrogen			-			

(over)

Manitoba

Agriculture

The Manitoba Water
Services Board

P.O. Box 1059
2022 Currie Boulevard
Brandon, Manitoba, CANADA
R7A 6A3

(204) 727-1917

February 9, 1987

Mr. Henry P. Colmer
Secretary-Treasurer
Town of Beausejour
Box 1028
639 Park
Beausejour, Manitoba
ROE OCO

Dear Mr. Colmer:

Re: Groundwater Investigation at Beausejour

In response to your Council's request for groundwater investigations to increase the water supply to the Town of Beausejour, Board staff conducted the work in 1986. The investigation was expanded to include several test holes around the Town rather than one, after discussions with Mr. Glen Steinke.

I am pleased to forward to you eight (8) copies of the report for the consideration of your Council. I would like to take this opportunity to apologize for the delay in completing this report, which was strictly due to staff/time limitations.

If you wish to discuss the technical aspects of the report, we would be happy to meet with your Council at a mutually convenient date. If you have any questions, please do not hesitate to call me (728-0053).

Yours truly

R. Menon

R. Menon, P. Eng.
Chief Engineer

RM/vs

Encl.

copy to
each Council member
and
Glenn Steinke

Manitoba

Memorandum

Date: February 3, 1987

To: W. E. Griffin
General Manager
M.W.S.B.

From: A. Pedersen, P. Eng.
Sr. Groundwater Eng.
M.W.S.B.

Subject: GROUNDWATER INVESTIGATION AT BEAUSEJOUR

Telephone

The request from the Town of Beausejour indicated that they were interested in "an extra source of water" and "of better quality than is available from the Town's existing two wells". The letter suggested drilling a 6-inch test well in the northwest part of the Town. In discussions with Town personnel it was decided that rather than just drilling one test well, several test holes would be drilled around the Town to get a more complete picture of the geology and groundwater in the area of the Town.

Four sites were test drilled roughly near the corners of the Town, including the site first suggested by the Town. The locations are shown on the attached Town plan. Detailed locations, logs, and test data are given on the attached drillers' reports. The test results are summarized in Table 1 and lab analysis are given in Table 2.

Aquifers

These are four aquifer types in the area of the Town. These are:

1. Drift sand
2. Rock rubble at or near the bedrock surface
3. Carbonate rock
4. Sandstone

1. Drift Sand: drift sand occurs at all of the test sites and appears to be part of a complex outwash deposit. The yield potential varies from low to very high. TH-3A has sand from 23 to 58 feet and showed high yield potential and was the only site where a high capacity well is possible. Water quality is good except for high iron @ 2.0 mg/L.

2. Rock Rubble: rock rubble occurs at or near the carbonate rock surface. Yield potential appears to be generally low and water quality would be the same as from the carbonate rock.

3. Carbonate Rock: carbonate rock of the Red River formation underlies the whole town. Test holes TH-1, 2 and 3 penetrated this formation and only TH-1 yielded any amount of water. The coefficient of trans. at this site is only one-tenth that at the existing Town wells. Water quality is relatively good except for high iron at 1.8 mg/L.

4. Sandstone: the sandstone occurs at the base of the Winnipeg formation which underlies the Red River formation. TH-1 was drilled through to the Precambrian rock to check this formation. The Winnipeg formation consists of shale from 138 to 231 feet and sand from 231 to 235 feet, the Precambrian rock surface.

Testing showed that the Winnipeg sand aquifer has very low yield potential and quite saline water, e.g. electrical conductivity @ 22,400 mmhos. The testing also showed that the piezometric head in Winnipeg sand is about 10 feet lower than in the carbonate rock so there is little danger of salt water intrusion from the zone.

Conclusions

The investigation has shown that it is unlikely that better well sites than the existing Town wells can be developed in this area when considering both quality and quantity. The existing wells should be able to supply the Town's future requirements.

Recommendations

The only problems with the existing Town wells are the age and that they produce sand when pumped at higher rates. It is recommended that the existing wells be tested, checked to see if any repair work is required and to try and develop them to be sand free at higher pumping rates. The estimated cost for this work is $10,000 - $20,000.

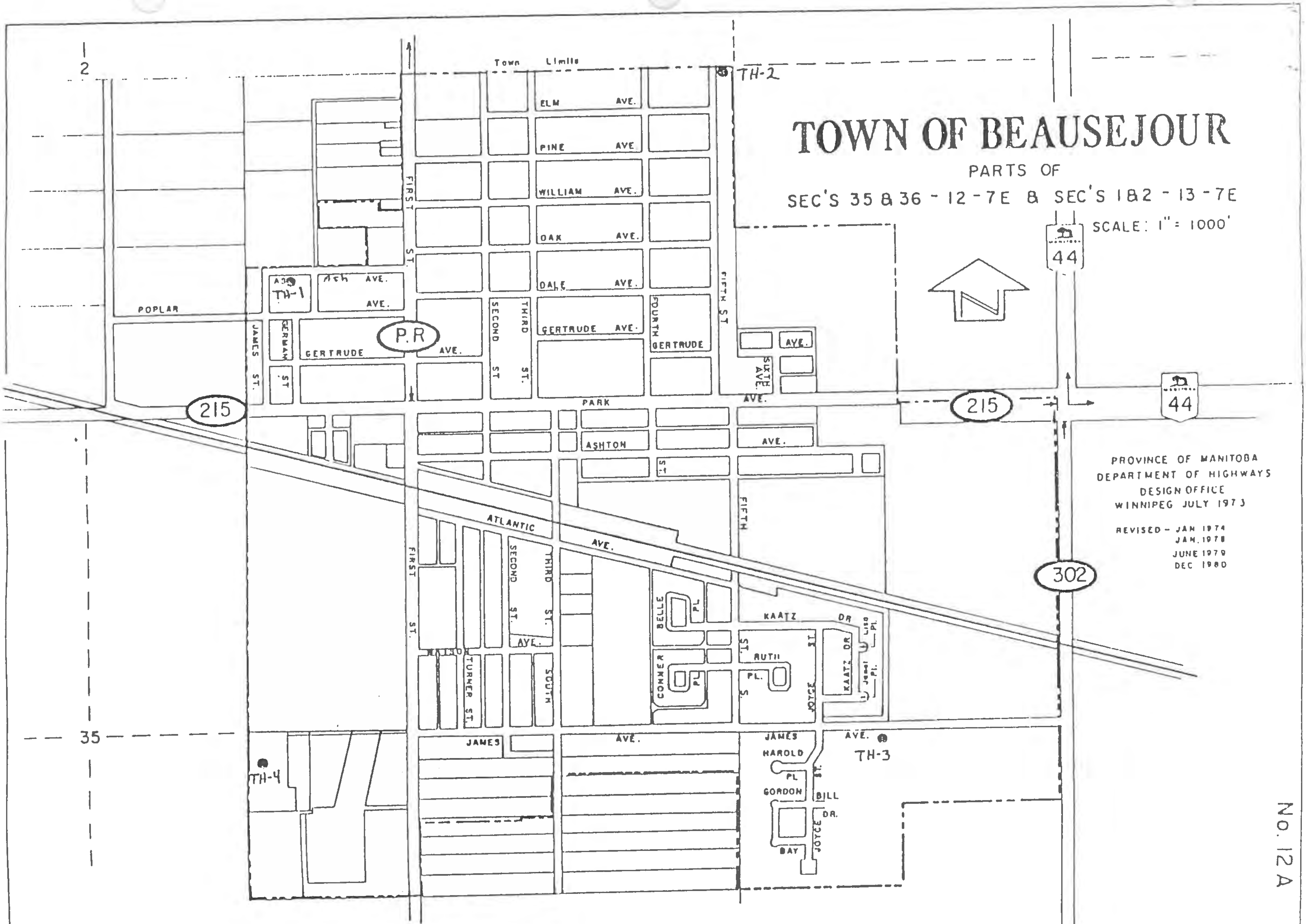
A. Pedersen/sk

A. Pedersen, P. Eng.

AP:sk

Attachments

c.c.: R. Menon
M. Kluke



Location of 1986 Test Holes: Beausejour.

PROVINCE OF MANITOBA

THE MANITOBA WATER SERVICES BOARD

PROJECT No. | ENGINEER | SCHEME | DATE | SHEET OF

Test Hole	Aquifer	Zone Tested (ft)	Static Water Level (ft)	Test Pump Rate IGPM	Coef. of Trans. IGPD/ft	EC mmhos	Hard g.p.g	Iron mg/l	Mn mg/l	Other
TH-1A	Sand	40-50	3	40	7000	690	28	2.6	low	Water Smells; Note down gradient
T.H.-1	Rubble & Rock	68-77		22						Results same as for 70-120
"	Carbonate RK	70-77		33						
"	" "	70-120	9.6	33	4600	525	20	1.8		
"	Wpg. Sand	229-235	19.5	6	95	22,400				
TH-2A	Sand	10-20	4	23	13,000	490	20	0.7		
"	Sand	50-60	4	11	415	495	19	1.8		
TH-2	Carb. Rock	59-128		2-3	low					
T.H-3A	Sand	33-43		7 1/2		510		0.8		
"	Sand	48-58	8.5	17	52,000	510	18	2.0		
TH-3	Carb. Rock	73-126		0	very low					
T.H-4	Sand	44-54	24	10	2200	340	16	1.0		
Town wells										
No. 1	Carb. Rock	? to 113		up to 205	46,000		19	0.9		
No. 2	Carb. Rock	77-85	10	up to 333						Pumps sand over 165 IGPM or 200 USGPM

Table 1: Summary of Test Data ; Beausejour

WATER ANALYSIS

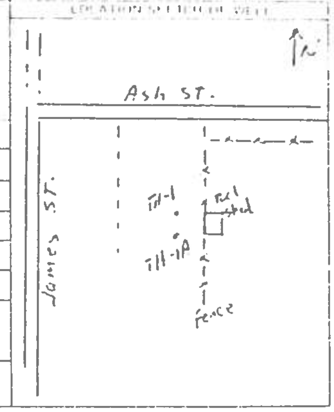
SAMPLE	LOCATION	AQUIFER	ZONE SAMPLED FT	TO FT	PUMP RATE IGPM	E.C. micromhos/cm 25° LAB	FIELD	PH	CATIONS Mgs./L. Ca	Mg	Na	K	Fe Lab	Fe Field	Mn	TOTAL CATIONS	ANIONS Mgs./L. HCO_3	CO_3	OH	SO_4	Cl	F	PO_4	NO_3	TOTAL ANIONS	TOTAL DISSOLVED SOLIDS Mgs./L.	TOTAL HARDNESS Mgs./L.	ALKALINITY $CaCO_3$ Mgs./L.	REMARKS
	TH-1A	Sand.	40	50	40	903	690	7.3	91	50	29		2.0	2.6	.07		427	0	0	95	50	.19		<.01			432	350	Water smells
	TH-1	Carbonate Rock	69	120	33	747	525	7.5	67	48	32		1.6	1.8	.05		429	0	0	60	36	0.3		<.01			366	352	
	TH-1	Winnipeg Sandstone	229	235	6	22,400		7.6	335	63	4320		0.7		.07		121	0	0	2520	7000	1.4		.02			1100	99	
	TH-2A	Sand	10	20	23	624	490	7.5	72	30	16		0.33	0.7	.07		351	0	0	25	30	.26		.13			304	288	
	TH-2A	Sand	50	60	11	669	495	7.5	61	36	29		1.6	1.8	.07		348	0	0	50	32	.22		.03			302	285	
	T.H.-3A	Sand	33	43	7½	666	510	8.0	110	45	18		2.4	0.8	.09		371	0	0	65	27	.15		.04			459	304	
	TH-3A	Sand	48	58	17	672	510	7.9		67	17			1.5 -2.0				0	0	70	24			.07			est. 310		
	T.H.-4	Sand	44	54	10	482	340	7.9		40	6			est. 1.0				0	0	25	6			2.6					
	Town Supply	Carbonate Rock				756		7.6	67	39	30		.87		.032		372	0	0	58	39	.24		<.01		430	326	305	Jan 1982 Sample

Table 2: Lab. Analyses : Beausejour

DRILLER'S REPORT

WELL LOCATION: QTR SE SEC 24 TWP 13 RGE 7 E [X] W [ ]
R. LOT ___ PARISH 40 ft. south of corner of fence
REMARKS 35 ft west of fence

LOCATION SKETCH OF WELL



WELL OWNER: NAME MWSB Beausejour
ADDRESS ___
PHONE ___

WELL IDENTIFICATION (NO. NAME) TH-1

WELL USE: PRODUCTION [ ] TEST WELL [X] RECHARGE [ ] OBSERVATION WELL [ ]

WATER USE: DOMESTIC [ ] LIVESTOCK [ ] MUNICIPAL [ ] INDUSTRIAL [ ] IRRIGATION [ ] AIR CONDITIONING [ ] OTHER [ ] (Specify) ___

DATE WELL COMPLETED: DAY 10 MONTH Sept 19 86

WELL LOG

Page 1 of 3

DEPTH BELOW GROUND IN FEET FROM	TO	DESCRIPTION	WATER RECORD (KIND OF WATER)
0	8½	Clay; brown	
8½	11½	Light grey sandy till?	
11½	12	Clay; grey	
12	19	Fine sand to silt; silica; brown	
19	22	Sand; grey	
22	40	Sand; fine to medium; white	
42	53	Sand; med. to coarse; silica	
53	57	Rough; till, light gray; stoney, sandy, silty	
57	60½	Till?; gravelly, sandy.	
60½	61	Dolomite; light grey, very hard	
61	63	Carbonate rock; brown, softer	
63	69	Rock rubble, stoney till or gravel; not sure	
69	120	Carbonate rock; light brown; some grey @ 110'	
*		when hole @ 80 feet, hole reamed and 5-inch steel casing set to 70 feet	
120	138	Layered carbonate rock and shaley carbonate rock — grey, light to dark.	
*		when hole @ 138 ft and casing at 70 all mud pumped from hole and pumped with air; pumped nothing. Continue drilling with mud.	

(continued on Page 2)

WELL CONSTRUCTION

Test No. 6

DEPTH BELOW GROUND LEVEL IN FEET FROM	TO	CASING	OPEN HOLE	PERFORATIONS	GRAVEL PACK	CASING GROUT	PITLESS UNIT	INSIDE DIAMETER INCHES	OUTSIDE DIAMETER INCHES	SCREEN SLOT SIZE NO. OR INCH	TYPE	MATERIAL	MAKE
0	40	X						5				steel	
40	50			X				5		18	ww	SS	
					X						none		
								-develop	w		isc-block for 2 hrs.		
								—					

TOP OF CASING OR PITLESS UNIT ___ FEET ABOVE [ ] BELOW [ ] GROUND LEVEL

REMARKS Note: test No. 5 done @ TH-1A ~ 15 ft south of TH-1

PL @ 3 min	12.1 below gd	Field Anal
10	12.55	EC - 690 mmhos
35	12.95	Hard - 27 gpg
40	13.0	Iron - 2.6 mg/l
		Mn - not detectable
		N - 3 or less

water smells Lab. anal.

Recovery → T = 7000 IGPD; good curve

PUMPING TEST

DATE OF TEST DAY ___ MONTH ___ 19 ___

PUMPING [X] FLOWING [ ] RATE 40 IGPM w suction

WATER LEVEL BEFORE PUMPING ~3 FT ABOVE [ ] BELOW [X] GRD. LEVEL

PUMPING LEVEL AT END OF TEST 13 FT ABOVE [ ] BELOW [X] GRD. LEVEL

DURATION OF TEST ___ HOURS 40 MINUTES S.C = 4

WATER TEMPERATURE ___ °F

RECOMMENDED PUMPING RATE ___ IGPM

CONTRACTOR

LICENCE NO ___

NAME Cosens Drilling Ltd

ADDRESS Virden

DRILL OPERATOR Tom Cosens

A. Pedersen

DRILLER'S REPORT

WELL LOCATION — QTR SE SEC 21 TWP 13 RGE 7 E [X] W [ ]
R LOT ______ PARISH ______
REMARKS ______

LOCATION SKETCH OF WELL: See Page 1

WELL OWNER — NAME: MWSB Beausejour
ADDRESS ______ PHONE ______

WELL IDENTIFICATION (NO. NAME): TH-1

WELL USE: PRODUCTION [ ] TEST WELL [X] RECHARGE [ ] OBSERVATION WELL [ ]

WATER USE: DOMESTIC [ ] LIVESTOCK [ ] MUNICIPAL [ ] INDUSTRIAL [ ] IRRIGATION [ ] AIR-CONDITIONING [ ] OTHER [ ] (Specify) ______

DATE WELL COMPLETED: DAY 10 MONTH Sept. 19 86

WELL LOG

Page 2 of 3

DEPTH BELOW GROUND IN FEET FROM	TO	DESCRIPTION	WATER RECORD (KIND OF WATER)
		Continued from Page 1	
138	151	Shale ; brown to grey	
151	~210	Shale ; blue, green, grey	
~210	231	Shale ; brown; thin sandstone layers + silty	
231	235	Sand ; med to coarse ; brownish grey	
235	235½	Granite rubble	
235½	236	Rock	
*Test No. 1		All mud blown out of hole ; pumping approx 50 IGPM with air from open hole ; much silt at start	
		@ 10 min EC - 900 mmhos	
		40 " EC - 1900	
		70 " EC - 2900	
		100 " EC - 1350	
		WL after pumping stopped for 10 min - 13 ft bl. gd.	
		- most of water must be coming from top of rock	
		Note Test No. 3	

WELL CONSTRUCTION

Test No. 2

DEPTH BELOW GROUND LEVEL IN FEET FROM	TO	CASING	OPEN HOLE	PERFORATIONS	GRAVEL PACK	CASING GROUT	PITLESS UNIT	INSIDE DIAMETER INCHES	OUTSIDE DIAMETER INCHES	SCREEN SLOT SIZE NO. OR INCH	TYPE	MATERIAL	MAKE
0	70	X						5				steel	
0	226	X						2				steel	
226	235			X				2		18	ww		
~200	236				X			2	5		local coarse sand.		

Pumped 6 IGPM for 50 min. ; fairly clean
- air line @ 120 ft.
- W.L between 2-inch + 5-inch @ 13 ft. at start and @ 12 ft after 40 min. Recovering

TOP OF CASING OR PITLESS UNIT ______ FEET ABOVE [ ] BELOW [ ] GROUND LEVEL

REMARKS: Recovery → T = 95 IGPM/ft ; good curve.
* Overnite W.L from Winnipeg Sand ; 19.45 ft b.l. gd
W.L in 5-inch casing 9.6 " " "
∴ there is a 10 ft down gradient between the upper part of the carb. rock and the Wpg Sand.
Lab. analysis → EC - 22,400 mmhos

PUMPING TEST

DATE OF TEST DAY ___ MONTH ___ 19 ___
PUMPING [ ] FLOWING [ ] RATE ______ IGPM
WATER LEVEL BEFORE PUMPING ______ FT ABOVE [ ] BELOW [ ] GRD LEVEL
PUMPING LEVEL AT END OF TEST ______ FT ABOVE [ ] BELOW [ ] GRD LEVEL
DURATION OF TEST ___ HOURS ___ MINUTES
WATER TEMPERATURE ______ °F
RECOMMENDED PUMPING RATE ______ IGPM

CONTRACTOR

LICENCE NO ______
NAME: Cosens Drilling Ltd
ADDRESS: Virden
DRILL OPERATOR: Tom Cosens
G. Pedersen

DRILLER'S REPORT

WELL LOCATION — QTR: SE SEC: 2 TWP: 13 RGE: 7 E: [X] W: [ ]
R. LOT: ____ PARISH: ____
REMARKS: ____

LOCATION SKETCH OF WELL: See Page 1

WELL OWNER — NAME: MWSB Beausejour
ADDRESS: ____ PHONE: ____

WELL IDENTIFICATION (NO. NAME): TH-1

WELL USE: PRODUCTION [ ] TEST WELL [X] RECHARGE [ ] OBSERVATION WELL [ ]

WATER USE: DOMESTIC [ ] LIVESTOCK [ ] MUNICIPAL [ ] INDUSTRIAL [ ] IRRIGATION [ ] AIR CONDITIONING [ ] OTHER [ ] (Specify) ____

DATE WELL COMPLETED: DAY 10 MONTH Sept. 19 86

WELL LOG

Page 3 of 3

DEPTH BELOW GROUND IN FEET FROM	TO	DESCRIPTION	WATER RECORD (KIND OF WATER)
		Continued from Page 2	
Test No. 3			
		- pulled 2-inch pipe; backfilled hole to 120 feet	
		with gravelly sand.	
		- pumped out with air; almost no backfill sand pumped out.	
		Pump with suction Quality	
		PR - 33 IGPM @ 5 min	EC-600
		PL - @ 3 min 17.8' from MP=1' 10 "	EC 550 H-205
		20 18.6	Fe - 2.1 murky
		35 18.8 25 "	EC-525
		45 18.8 35 "	EC-525
		45 "	Fe - 1.8 mg/l
		Recovery → T = 4600 IGPD/ft; good curve	
		Spec. Cap = 4	
		Lab. analysis	
Test No. 4			
		- backfill hole to 77 ft. with gravelly sand	
		- pump with air for 15 min; only minor amount of sand pumped	
		Pump with suction @ 33 IGPM + PL of 18.6 ft.	
		- thus no change from Test No. 3 and little or	
		no water in 77 to 120 ft area	

WELL CONSTRUCTION

DEPTH BELOW GROUND LEVEL IN FEET FROM	TO	CASING	OPEN HOLE	PERFORATIONS	GRAVEL PACK	CASING GROUT	PITLESS UNIT	INSIDE DIAMETER INCHES	OUTSIDE DIAMETER INCHES	SCREEN SLOT SIZE NO OR INCH	TYPE	MATERIAL	MAKE
Test No. 5													

- pulled 5-inch casing back 2.2 ft.
- 5-inch casing now @ ~68 ft.
- pumped out with air.
- pump with suction
  PR - 22 IGPM
  PL @ 4 min 25.7 MP 3.2'
  7 min 25.9
  Spec. Cap = 1.65

TOP OF CASING OR PITLESS UNIT ____ FEET ABOVE [ ] BELOW [ ] GROUND LEVEL

REMARKS: - thus capacity was lost by lifting casing, probably because of loose zone.
- water probably all at top of rock.

Test No. 6 See Page 1

PUMPING TEST

DATE OF TEST: DAY ____ MONTH ____ 19 ____
PUMPING [ ] FLOWING [ ] RATE ____ IGPM
WATER LEVEL BEFORE PUMPING ____ FT ABOVE [ ] BELOW [ ] GRD LEVEL
PUMPING LEVEL AT END OF TEST ____ FT ABOVE [ ] BELOW [ ] GRD LEVEL
DURATION OF TEST ____ HOURS ____ MINUTES
WATER TEMPERATURE ____ °F
RECOMMENDED PUMPING RATE ____ IGPM

CONTRACTOR

LICENCE NO ____
NAME: Cosens Drilling Ltd
ADDRESS: Virden
DRILL OPERATOR: Tom Cosens

A. Pedersen

DRILLER'S REPORT

WELL LOCATION
SE corner
QTR NW | SEC 1 | TWP 13 | RGE 7 | E [X] | W [ ]
R LOT — 31 ft. east of south gate post (6" pipe)
REMARKS 30 ft. South " " "

LOCATION SKETCH OF WELL
House
Gate
Manhole
N
TH-2
Fifth St.
Elm

WELL OWNER
NAME MWSB Beausejour
ADDRESS
PHONE

WELL IDENTIFICATION (NO. NAME) TH-2

WELL USE: PRODUCTION [ ] TEST WELL [X] RECHARGE [ ] OBSERVATION WELL [ ]

WATER USE: DOMESTIC [ ] LIVESTOCK [ ] MUNICIPAL [ ] INDUSTRIAL [ ] IRRIGATION [ ] AIR CONDITIONING [ ] OTHER [ ] (Specify)

DATE WELL COMPLETED DAY 11 MONTH Sept 1986

WELL LOG

DEPTH BELOW GROUND IN FEET FROM	TO	DESCRIPTION	WATER RECORD (KIND OF WATER)
0	1	Soil	
1	3	Sand	
3	5	clay	
5	12	Sand; medium	
12	15	Sand + gravel	
15	-	Thin layer of clay	
15	20	Sand; fine	
20	46	Sand; very fine to silt; white	
46	51	Till; stoney, silty; light grey	
51	53	Gravelly sand	
53	58	Sand; medium	
57	59½	Carbonate rock	
59½	61	Loose; rubble or fractured	
61	62	Carbonate rock	
62	63	Loose; carb. rock rubble with granitic fragments	
63	67	Carbonate rock	
	*	stop @ 65' + set 5-inch casing to 59.3 ft	
		- now drilling with air; no water pumped	
67	67½	Loose; rubble? no water	
67½	70	Carbonate rock	
	*	@ 68 ft. switch back to mud drilling; problem w rubble	

(continued on page 2)

WELL CONSTRUCTION

Test No. 3

DEPTH BELOW GROUND LEVEL IN FEET FROM	TO	CASING	OPEN HOLE	PERFORATIONS	GRAVEL PACK	CASING GROUT	PITLESS UNIT	INSIDE DIAMETER INCHES	OUTSIDE DIAMETER INCHES	SCREEN SLOT SIZE NO. OR INCH	TYPE	MATERIAL	MAKE
0	10	X						2				Steel	
10	20			X				2		18			

TOP OF CASING OR PITLESS UNIT ____ FEET ABOVE [ ] BELOW [ ] GROUND LEVEL

REMARKS Pulled up in redrilled hole after Test No. 2 done
Recovery curve → good curve of T=26,400 IGPD/ft; however this is water table T estimated @ 13,000 IGPD/ft
EC - 490 mmhos
Hard - 20 gpg
Iron - 0.7 mg/l lab anal.

PUMPING TEST

DATE OF TEST DAY ___ MONTH ___ 19 ___
PUMPING [X] FLOWING [ ] RATE 23 IGPM w suction
WATER LEVEL BEFORE PUMPING ~4 FT ABOVE [ ] BELOW [X] GRD. LEVEL
PUMPING LEVEL AT END OF TEST ___ FT ABOVE [ ] BELOW [ ] GRD. LEVEL
DURATION OF TEST ___ HOURS 40 MINUTES
WATER TEMPERATURE ___ °F
RECOMMENDED PUMPING RATE ___ IGPM

CONTRACTOR

LICENCE NO.
NAME Cosens Drilling Ltd
ADDRESS Virden
DRILL OPERATOR Tom Cosens

A. Pedersen

DRILLER'S REPORT

WELL LOCATION	QTR NW SEC 11 TWP 13 RGE 7 E [X] W [ ]	LOCATION SKETCH OF WELL
	R LOT ___ PARISH ___	See Page 1
	REMARKS	
WELL OWNER	NAME MWSB Beausejour	
	ADDRESS	
	PHONE	
WELL IDENTIFICATION (NO. NAME)	TH-2	
WELL USE	PRODUCTION [ ] TEST WELL [X] RECHARGE [ ] OBSERVATION WELL [ ]	
WATER USE	DOMESTIC [ ] LIVESTOCK [ ] MUNICIPAL [ ] INDUSTRIAL [ ] IRRIGATION [ ] AIR-CONDITIONING [ ] OTHER [ ] (Specify)	
DATE WELL COMPLETED	DAY 11 MONTH Sept. 19 86	

WELL LOG

DEPTH BELOW GROUND IN FEET FROM	TO	DESCRIPTION Page 2 of 2	WATER RECORD (KIND OF WATER)
70	70½	Red shale	
70½	73½	Carbonate rock; brown to grey	
73½	74	Loose; fractured rock	
74	97	Carbonate Rock; more greyish	
		- thin loose zone @ 86'	
97		Shaley carb. rock.	
97	128	Carbonate rock	
		- thin shale layers @ 105 + 111'	
		115-116 layered shale + carb. rock	
		- thin shale layers @ 123 + 126'	
128	131	Shale; yellow brown	
		Little cirulation loss while drilling	
Test No. 1			
		- pull rods back to 60 ft and pump with air	
		- pumped a couple IGPM for 1 hour; pumping very dirty	
		- recovery very slow starting @ 24 ft.	
		Moved 15 ft west and redrilled to 60 ft	

WELL CONSTRUCTION

Test No. 2

DEPTH BELOW GROUND LEVEL IN FEET FROM	TO	CASING	OPEN HOLE	PERFORATIONS	GRAVEL PACK	CASING GROUT	PITLESS UNIT	INSIDE DIAMETER INCHES	OUTSIDE DIAMETER INCHES	SCREEN SLOT SIZE NO. OR INCH	TYPE	MATERIAL	MAKE
0	50	X						2				steel	
50	60			X				2		18	ww		
40	60				X			2	5		gravelly	sand	

TOP OF CASING OR PITLESS UNIT ___ FEET ABOVE [ ] BELOW [ ] GROUND LEVEL

REMARKS Pumped w air for 10 min to clean it up; then w suction
Recovery → T = 415 IGPD/ft; good curve

Field Anal
EC - 495 mmhos
Hard. - 19 g.p.g
Iron - 1.8 mg/l
Lab. Anal.

PUMPING TEST

DATE OF TEST DAY ___ MONTH ___ 19 ___

PUMPING [X] FLOWING [ ] RATE 11 IGPM w suction

WATER LEVEL BEFORE PUMPING ~4 FT ABOVE [ ] BELOW [X] GRD. LEVEL

PUMPING LEVEL AT END OF TEST 24.3 FT ABOVE [ ] BELOW [X] GRD. LEVEL

DURATION OF TEST ___ HOURS 35 MINUTES SC = 0.5

WATER TEMPERATURE ___ °F

RECOMMENDED PUMPING RATE ___ IGPM

CONTRACTOR

LICENCE NO ___

NAME Cosens Drilling Ltd

ADDRESS Virden

DRILL OPERATOR Tom Cosens

A. Pedersen

DRILLER'S REPORT

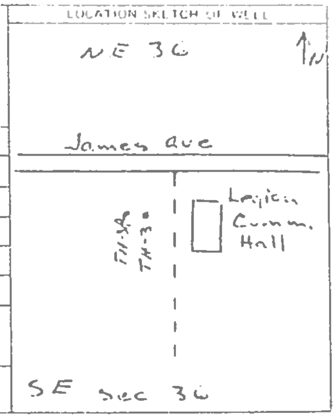
WELL LOCATION

QTR SE SEC 36 TWP 12 RGE 7 E [X] W [ ]

R 101 ______ PARISH ______

REMARKS ______

LOCATION SKETCH OF WELL



WELL OWNER

NAME MWSB Beausejour

ADDRESS ______ PHONE ______

WELL IDENTIFICATION (NO. NAME) TH-3

WELL USE: PRODUCTION [ ] TEST WELL [X] RECHARGE [ ] OBSERVATION WELL [ ]

WATER USE: DOMESTIC [ ] LIVESTOCK [ ] MUNICIPAL [ ] INDUSTRIAL [ ] IRRIGATION [ ] AIR CONDITIONING [ ] OTHER [ ] (Specify) ______

DATE WELL COMPLETED DAY 15 MONTH Sept. 1976

WELL LOG

DEPTH BELOW GROUND IN FEET FROM	TO	DESCRIPTION	WATER RECORD (KIND OF WATER)
0	6	Clay; yellow brown	
6	18½	Till; yellow	
18½	22	Till; light grey	
23	32	Sand; medium	
32	37	Sand; medium to course	
37	—	Clay layer	
37	41	Sand; course	
41	51	Sand; gravelly	
55	60	Till or rubble rock; carbonate rock with fair	
		amount of granitic fragments	
60	73	Till; stoney, light grey	
73	124	Carbonate rock; brown + grey	
124	126	Shale + carbonate rock	
126	131	Shale; grey	
		- when test hole @ 76 ft. hole was reamed and	
		5-inch casing set to 73 ft. Tried pumping	
		with air but no water	
		- drilled rest of hole with water	
		- tried pumping with air again when hole completed	
		- again no water pumped	

WELL CONSTRUCTION

DEPTH BELOW GROUND LEVEL IN FEET FROM	TO	CASING	OPEN HOLE	PERFORATIONS	GRAVEL PACK	CASING GROUT	PITLESS UNIT	INSIDE DIAMETER INCHES	OUTSIDE DIAMETER INCHES	SCREEN SLOT SIZE NO OR INCH	TYPE	MATERIAL	MAKE

TOP OF CASING OR PITLESS UNIT ______ FEET ABOVE [ ] BELOW [ ] GROUND LEVEL

REMARKS - backfilled hole to 73 ft with gravelly sand
- pulled casing + backfilled hole to 22 ft.
- tremied in 2 bags neat cement because this could be a swimming pool site
· Pulled ahead 63 ft west + drilled TH-3A to test sand + gravel

PUMPING TEST

DATE OF TEST DAY ___ MONTH ___ 19 ___

PUMPING [ ] FLOWING [ ] RATE ______ I.G.P.M.

WATER LEVEL BEFORE PUMPING ______ FT ABOVE [ ] BELOW [ ] GRD LEVEL

PUMPING LEVEL AT END OF TEST ______ FT ABOVE [ ] BELOW [ ] GRD LEVEL

DURATION OF TEST ______ HOURS ______ MINUTES

WATER TEMPERATURE ______ °F

RECOMMENDED PUMPING RATE ______ I.G.P.M.

CONTRACTOR

LICENCE NO ______

NAME Cosens Drilling Ltd

ADDRESS Virden

DRILL OPERATOR Tom Cosens

A. Pedersen

DRILLER'S REPORT

WELL LOCATION
QTR SE SEC 36 TWP 12 RGE 7 E [X] W [ ]
R. LOT ___ PARISH ___
REMARKS 63 ft west of TH-3

LOCATION SKETCH OF WELL: See log for TH-3

WELL OWNER
NAME MWSB Beausejour
ADDRESS ___
PHONE ___

WELL IDENTIFICATION (NO. NAME) TH-3A

WELL USE: PRODUCTION [ ] TEST WELL [X] RECHARGE [ ] OBSERVATION WELL [ ]

WATER USE: DOMESTIC [ ] LIVESTOCK [ ] MUNICIPAL [ ] INDUSTRIAL [ ] IRRIGATION [ ] AIR-CONDITIONING [ ] OTHER [ ] (Specify) ___

DATE WELL COMPLETED DAY 15 MONTH Sept. 19 86

WELL LOG

DEPTH BELOW GROUND IN FEET FROM	TO	DESCRIPTION	WATER RECORD (KIND OF WATER)
0	2	Black clay soil	
2	7	Clay; brown	
7	23½	Till; brown	
		– Trace of sand @ 9½	
23½	30	Gravelly sand	
30	35	Sand	
35	45	Sand; coarse to gravelly	
45	48	Rough; gravel	
48	58	Fine sand with some coarse	
58	60	Till; grey	
		Test No. 2	
		– set 2-inch 18 slot screen 33-43 ft	
		Pumped 7½ IGPM for 15 min	
		Recovery to 8.6' bel. gd in 1 min + stabilized	
		EC – 510 mmhos	
		Iron – 0.8	

WELL CONSTRUCTION

Test No. 1

DEPTH BELOW GROUND LEVEL IN FEET FROM	TO	CASING	OPEN HOLE	PERFORATIONS	GRAVEL PACK	CASING GROUT	PITLESS UNIT	INSIDE DIAMETER INCHES	OUTSIDE DIAMETER INCHES	SCREEN SLOT SIZE NO OR INCH	TYPE		MATERIAL		MAKE
0	48	X						2					Steel		
48	58			X				2		18	WW				

TOP OF CASING OR PITLESS UNIT ___ FEET ABOVE [ ] BELOW [ ] GROUND LEVEL

REMARKS Recovery → T = 52,000 IGPD/ft ; fair curve
T is high
EC – 510 mmhos
Hard – 18 gpg
Iron – 1.5 to 2.0 mg/l Sample milky.

PUMPING TEST

DATE OF TEST DAY ___ MONTH ___ 19 ___

PUMPING [X] FLOWING [ ] RATE 17 IGPM

WATER LEVEL BEFORE PUMPING 8.5 FT ABOVE [ ] BELOW [X] GRD LEVEL

PUMPING LEVEL AT END OF TEST ___ FT ABOVE [ ] BELOW [ ] GRD LEVEL

DURATION OF TEST ___ HOURS 30 MINUTES

WATER TEMPERATURE ___ °F

RECOMMENDED PUMPING RATE ___ IGPM

CONTRACTOR

LICENCE NO ___

NAME Cosens Drilling Ltd

ADDRESS Virden

DRILL OPERATOR Tom Cosens

A. Pedersen

DRILLER'S REPORT

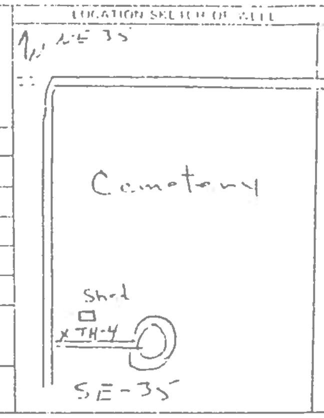
WELL LOCATION

QTR SE SEC 35 TWP 12 RGE 7 E [X] W [ ]

R. LOT ______ PARISH ______

REMARKS ______

LOCATION SKETCH OF WELL



WELL OWNER

NAME HWS B Beausejour

ADDRESS ______ PHONE ______

WELL IDENTIFICATION (NO., NAME) ______

WELL USE: PRODUCTION [ ] TEST WELL [X] RECHARGE [ ] OBSERVATION WELL [ ]

WATER USE: DOMESTIC [ ] LIVESTOCK [ ] MUNICIPAL [ ] INDUSTRIAL [ ] IRRIGATION [ ] AIR-CONDITIONING [ ] OTHER [ ] (Specify) ______

DATE WELL COMPLETED DAY 15 MONTH Sept. 19 86

WELL LOG

DEPTH BELOW GROUND IN FEET FROM	TO	DESCRIPTION	WATER RECORD (KIND OF WATER)
0	30	Sand; fine to med.; brown } Taking circulation	
30	54	Fine sand	
54	56	Rough; stoney	
56	59	Till; light grey; silty	
59	60	Rubble; sl. & gravel	
		- couldn't drill further; boulder fell in hole	

WELL CONSTRUCTION

DEPTH BELOW GROUND LEVEL IN FEET FROM	TO	CASING	OPEN HOLE	PERFORATIONS	GRAVEL PACK	CASING GROUT	PITLESS UNIT	INSIDE DIAMETER INCHES	OUTSIDE DIAMETER INCHES	SCREEN SLOT SIZE NO. OR INCH	TYPE	MATERIAL	MAKE
0	44	X						2				Steel	
45	54			X				2		12	ww		

TOP OF CASING OR PITLESS UNIT ______ FEET ABOVE [ ] BELOW [ ] GROUND LEVEL

REMARKS

Recovery → T = 2200 IGPD/ft

Field Anal.

EC - 340 mmhos

Hard - 16 [illegible]

Iron - est. 1.0 mg/L

PUMPING TEST

DATE OF TEST DAY ____ MONTH ______ 19 ____

PUMPING [X] FLOWING [ ] RATE 10 IGPM w air

WATER LEVEL BEFORE PUMPING ~34 FT ABOVE [ ] BELOW [X] GRD LEVEL

PUMPING LEVEL AT END OF TEST ______ FT ABOVE [ ] BELOW [ ] GRD LEVEL

DURATION OF TEST ____ HOURS ____ MINUTES

WATER TEMPERATURE ____ °F

RECOMMENDED PUMPING RATE ______ I.G.P.M.

WITH PUMP INTAKE AT ______ FEET BELOW GROUND LEVEL

CONTRACTOR

LICENCE NO. ______

NAME Cosens Drilling Ltd

ADDRESS Virden

DRILL OPERATOR Tom Cosens

A. Pedersen

Signature [illegible]

Friesen Drillers Ltd.

307 PTH 12 N Steinbach, MB. R5G 1T8 Phone 204-326-2485 Fax 204-326-2483 Toll Free-1-888-794-9355

August 4, 2016

Chris Trupish, CET
Director of Operations
Town of Beausejour
P.O. Box 429
Beausejour, MB R0M 1L0

Dear Sir,

Subject **Hydrogeological Assessment of the Carbonate Aquifer as a Municipal Water Supply for the Town of Beausejour**

Friesen Drillers is pleased to present this report detailing the results of our hydrogeological assessment for the Town of Beausejour groundwater supply wells. This investigation included an extensive review of hydrograph stations, precipitation amounts, groundwater geochemistry and water use data from the carbonate aquifer in the Beausejour area. Additionally, a pumping test of each Town supply well was conducted to determine local aquifer parameters which were used to estimate the potential impacts of additional supply wells in the area.

Project Background

Development of the carbonate aquifer in the Beausejour area has been ongoing, with groundwater well use records dating back to the 1950s. The first Town of Beausejour groundwater well was installed in 1957, followed by two additional wells drilled in 1962 and 1995. In addition to the municipal supply wells, the GWDRILL (2014) data base has records about 65 private wells within a one mile radius of the water treatment plant (WTP). Annual groundwater pumping records for the town supply wells, beginning in 1961, were obtained from the Town of Beausejour and are provided below as Figure 1. From the plot of annual use, it is evident that groundwater pumping has gradually increased since the 1960s from 100 acre feet/year to over 400 acre feet/year in 2006. Annual groundwater use is shown to have reduced since 2009 and remain steady in subsequent years at around 250 acre feet/year. The current Water Rights License (2005-023) issued to the Town of Beausejour authorizes them to divert 362.82 acre feet/year. A copy of the License is attached.

A recent study conducted by J.R. Cousin Consultants (2016), found that the present state of the municipal water supply infrastructure, including the water treatment plant and groundwater well field is inadequate to meet the future water supply demands of the community. As part of the strategy to upgrade the groundwater supply, an additional groundwater well is required. The current well field consists of three supply wells, the oldest of which (well #1) is no longer used for production and, for the purposes of this investigation, is considered to be decommissioned/abandoned. The initial combined capacity of the well field was 47 L/s, however, the capacity of production wells #2 and #3 is 37.5 L/s or about 590 US gallons per minute (U.S.G.P.M.).

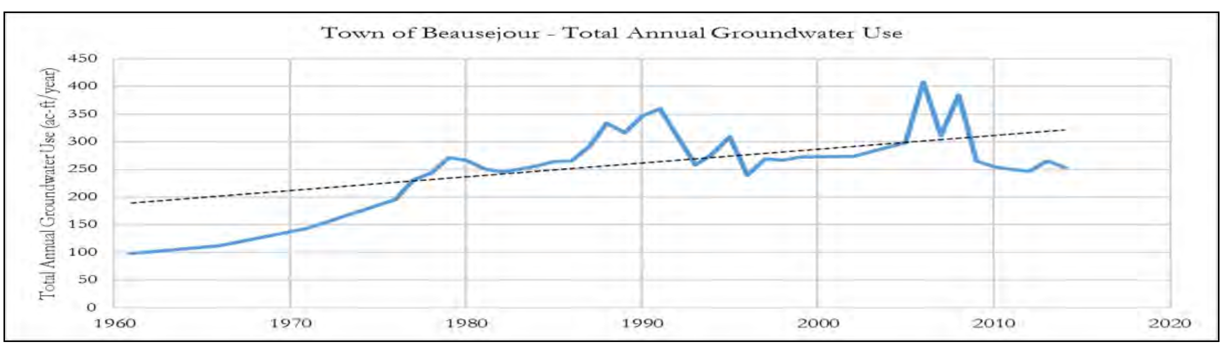


Figure 1. Historical Groundwater use by the Town of Beausejour. (source - Town of Beausejour records, 2015)

Site Setting

Physical Setting

The Town of Beausejour, located approximately 25 miles northeast of Winnipeg in southeastern Manitoba, lies in a rural region of the Province surrounded by land used predominantly for agricultural purposes. In addition to agriculture, numerous limestone and

Physical Setting (Cont'd)

aggregate quarries operate in local areas of shallow buried bedrock and sand and gravel deposits. The topography of the region is generally of low relief; however, a prominent topographic rise occurs several miles east of the Town, formed as a result of past glacial activity, which generates local relief up to a few hundred feet. The location of the Town of Beausejour is shown below in Figure 2.

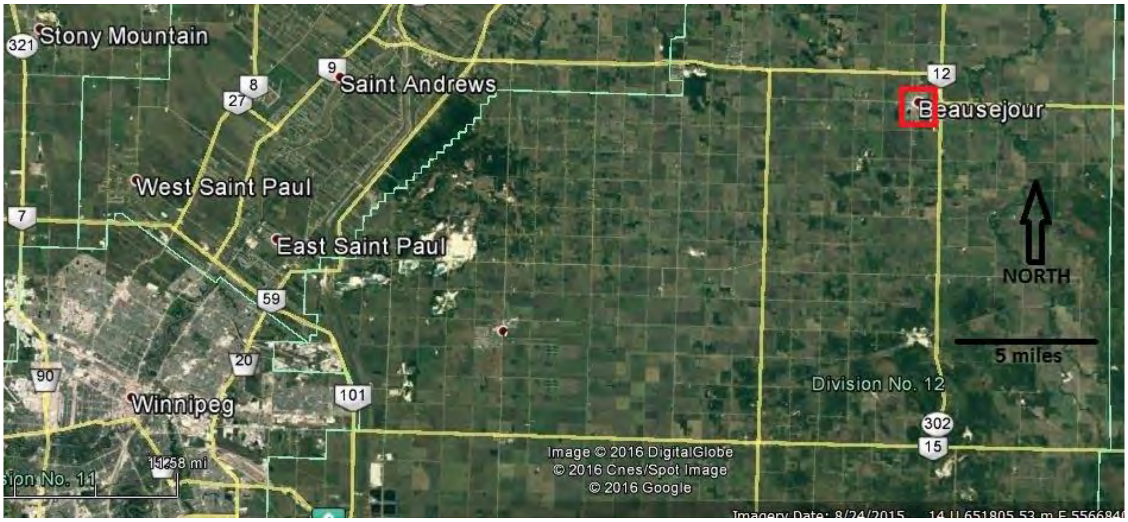


Figure 2. Location of Beausejour ~25 miles northeast of Winnipeg, Manitoba (red square). (source - Google Earth, 2016)

Geological/Hydrogeological Setting

The Town of Beausejour is located on the eastern fringes of the Western Canadian Sedimentary Basin in southeastern Manitoba. Bedrock in the Beausejour area comprises a succession of Ordovician sedimentary rocks consisting of basal Winnipeg Formation shale and sandstone with overlying Red River Formation dolomitic limestone, deposited upon basement Precambrian granites. The bedrock geology of southern Manitoba is depicted below in Figure 3. Regionally, the bedrock formations dip gently to the west, where they become thicker and more deeply buried. The surficial geology of the area, illustrated on the following page in Figure 4, consists of a complex distribution of glaciolacustrine deposits, generally as interlayered clay and till with local deposits of sand and gravel. Boulders have also been encountered in numerous boreholes in the Beausejour area.

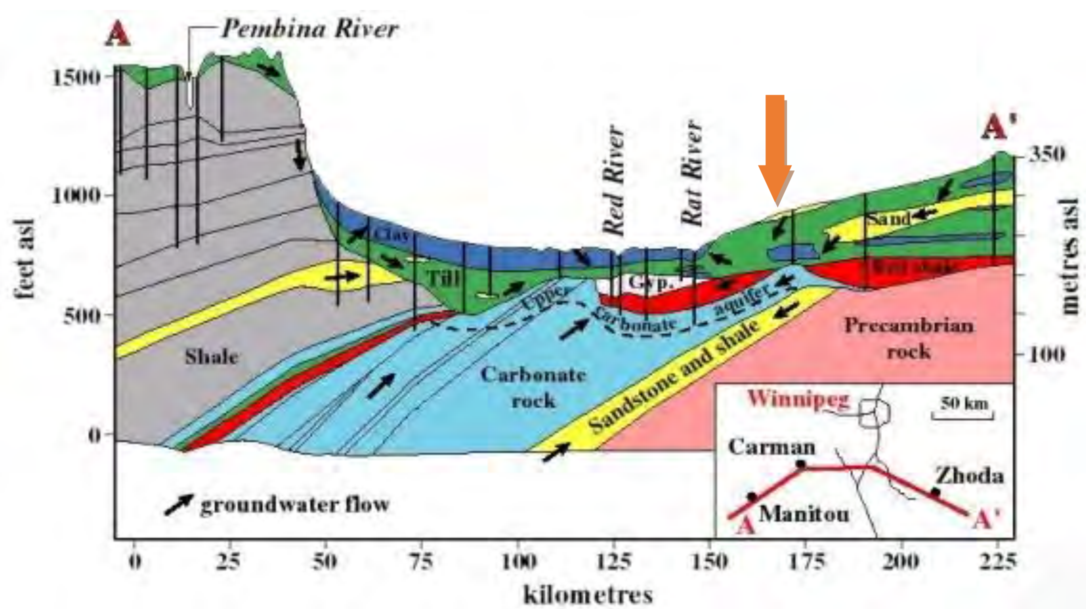


Figure 3. Geology of southern Manitoba; orange arrow indicates approximate location of Beausejour (source - GSC, 2007)

Geological/Hydrogeological Setting (Cont'd)

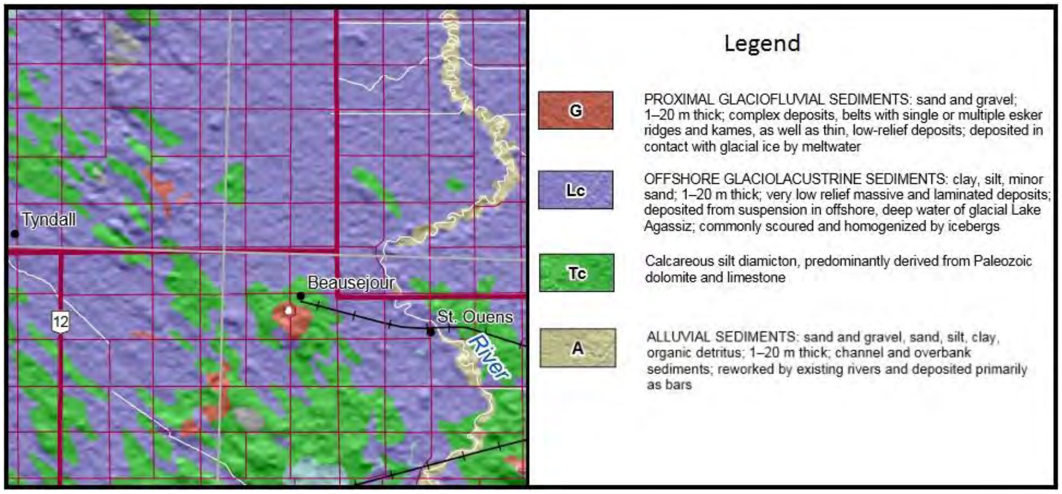


Figure 4. Surficial Geology of the Beausejour region. (source - MGS, 2016)

The geology of the region allows for multiple potential sources of groundwater for development, including the Winnipeg Formation sandstone, the Red River Formation limestone and the surficial sand and gravel deposits. Previous work has examined the potential of each of these aquifers in the Beausejour area and determined that the Red River Formation provides the most favorable source for development (Betcher et. al, 1995; Render, 1987). As a result, the City of Beausejour has installed all three of their municipal groundwater wells into the carbonate aquifer and this investigation will focus on the effects of further development within the carbonate aquifer.

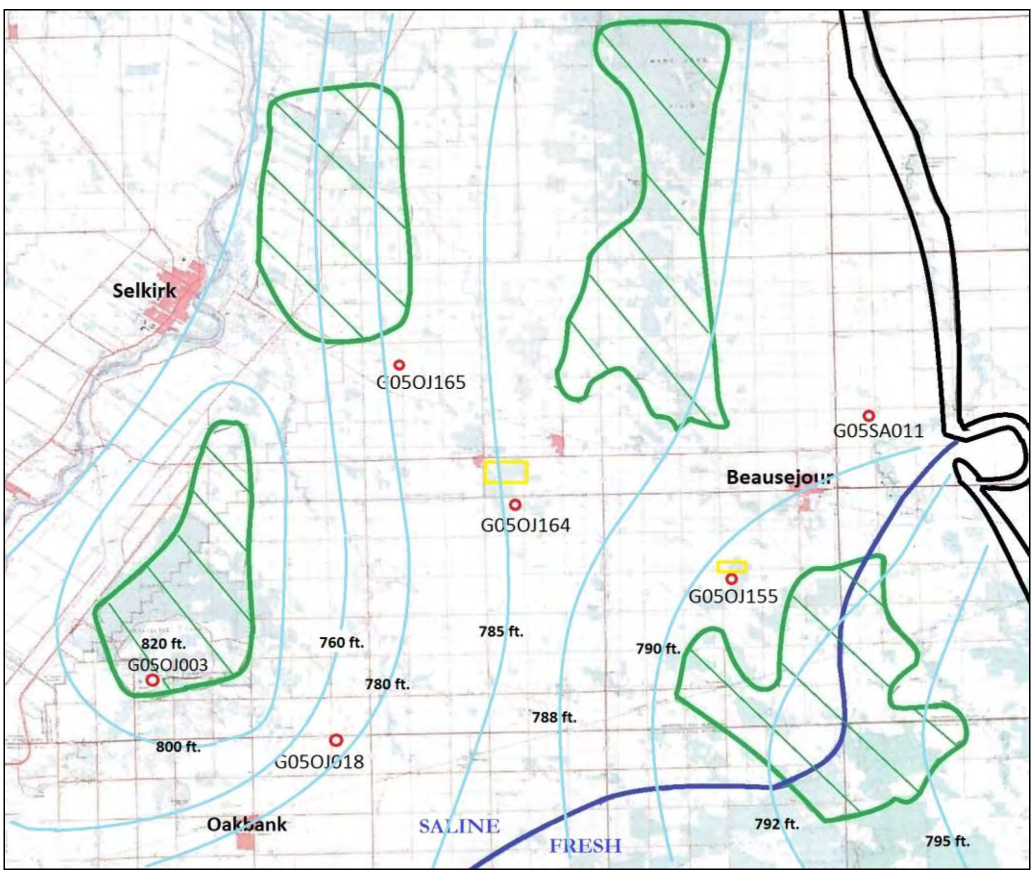


Figure 5. Regional hydrogeology of the Beausejour region: green outlines recharge zones; dark blue line is Winnipeg Fm. fresh/saline boundary; light blue are potentiometric elevations; yellow outlines major quarry operations; black lines are bedrock contacts of the Winnipeg Fm. (source - MSD, 2016; Render, 1986)

Geological/Hydrogeological Setting (Cont'd)

Groundwater flow in the carbonate bedrock of the Red River Formation generally occurs in the fracture and joint sets in the rock. The size, extent, and interconnectivity of the fracture system govern horizontal and vertical groundwater movement through the bedrock. Due to this geologic condition, aquifer transmissivity and storativity can vary significantly over a relatively short distance, resulting in substantial variations in well yield (Render, 1970). The Red River Formation is therefore considered to be a significant resource throughout the central portion of Manitoba, being developed for municipal, commercial, and private water supply systems (Betcher et. al, 1995).

Figure 5, shown on the previous page, illustrates the proximity of Beausejour to four major recharge zones identified by Render (1987). Additionally, quarry operations, particularly in the Garson and Tyndall area west of the Town of Beausejour, increase the potential for groundwater recharge and influence local groundwater dynamics. It is apparent from a review of the regional potentiometric surface in the study area, shown as light blue lines in Figure 5, that groundwater flow direction in the carbonate aquifer is variable as a result of the numerous local recharge zones, however, regional groundwater flow is generally from east to west – north west.

Groundwater in the Winnipeg Formation sandstone is being recharged on the eastern sub crop through a series of permeable sand and gravel moraines (Betcher et. al, 2008). These features, which are known locally as the Sandilands Glaciofluvial area, allow steady recharge of freshwater to the formation. The sand and gravel allow for a high head of recharge to be imposed on the aquifer which results in an east to west groundwater flow direction. Overall, there is very little discharge from the aquifer. Betcher, Phipps, and Wang note that discharge is likely occurring by slow upward migration through the shale aquitard and slow seepage into Lake Winnipeg (Betcher et. al, 2008). It is felt that a significant amount of discharge actually occurs through pumping wells and losses into the overlying carbonate aquifer system through inter-borehole discharge. The sandstone aquifer contains freshwater in the southeastern portion of the province, however, in the Beausejour area it is known to be brackish/saline and is generally not suitable for domestic use.

Local Hydrograph Review

As part of the current investigation, the review of the hydrograph records for the Beausejour area is particularly important. In reviewing the hydrograph records, it is important to consider the various components of the hydrological cycle, including the total annual precipitation (rain and snow melt) and leakance through the overburden. This data must also be compared with the annual metered consumption from the aquifer. These records allow for a comparison of the hydrographs within the state of nature that exists on the aquifer

Total Annual Precipitation

Figure 6, shown below, illustrates the total annual precipitation in the Beausejour region since 1960. Average annual precipitation for the region over the observation period is 551 mm, although amounts have been elevated and increasing since about the early 1990s, with an average of 620 mm/year over the most recent 25-year period. It is clear from Figure 6 that annual precipitation is cyclical, with highs and lows occurring roughly on a decade scale. Precipitation in recent years has been slightly above the average, between 650 and 750 mm/year.

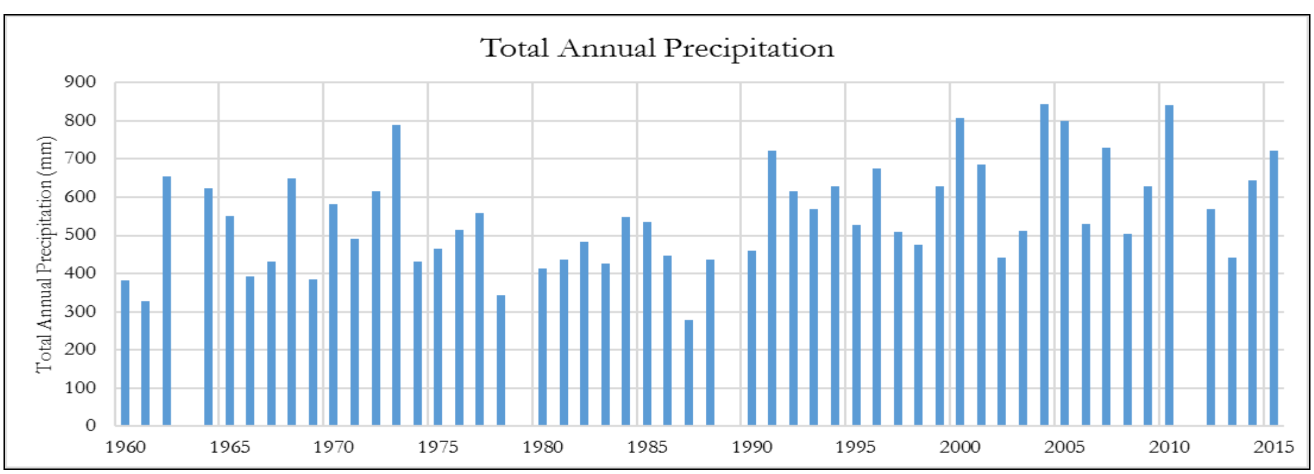


Figure 6. Total Annual Precipitation of the Beausejour region. (source - Environment Canada, 2016)

Provincial Hydrograph Stations

Figure 7, shown below, compares total annual precipitation with the potentiometric surface elevations recorded in Provincial station G05OJ018, located several km west of the Town of Beausejour. Beyond seasonal fluctuations in groundwater elevation, large scale trends and correlations are also apparent in the data. For example, during the period of 1965-1992, groundwater levels in G05OJ018 gradually declined by a total of 2 m (~6 ft.), from 239.3 to 237.3 m ASL. Similarly, total annual precipitation was frequently below to well below average during the same period.

A marked change is observed, beginning in the early 1990s, when both the potentiometric surface and total annual precipitation began to increase. The positive trend continued to the extent that, by 2005, groundwater levels had exceeded those recorded in the mid-1960s and total annual precipitation amounts reached record levels. It is clear from these large scale trends that a strong correlation exists between total annual precipitation and the potentiometric surface of the aquifer. This correlation suggests that precipitation has a direct affect upon groundwater levels within the carbonate aquifer in the Beausejour area.

It should be noted that there is no evidence of significant influence from consumptive groundwater withdrawal recorded by hydrograph station G05OJ018.

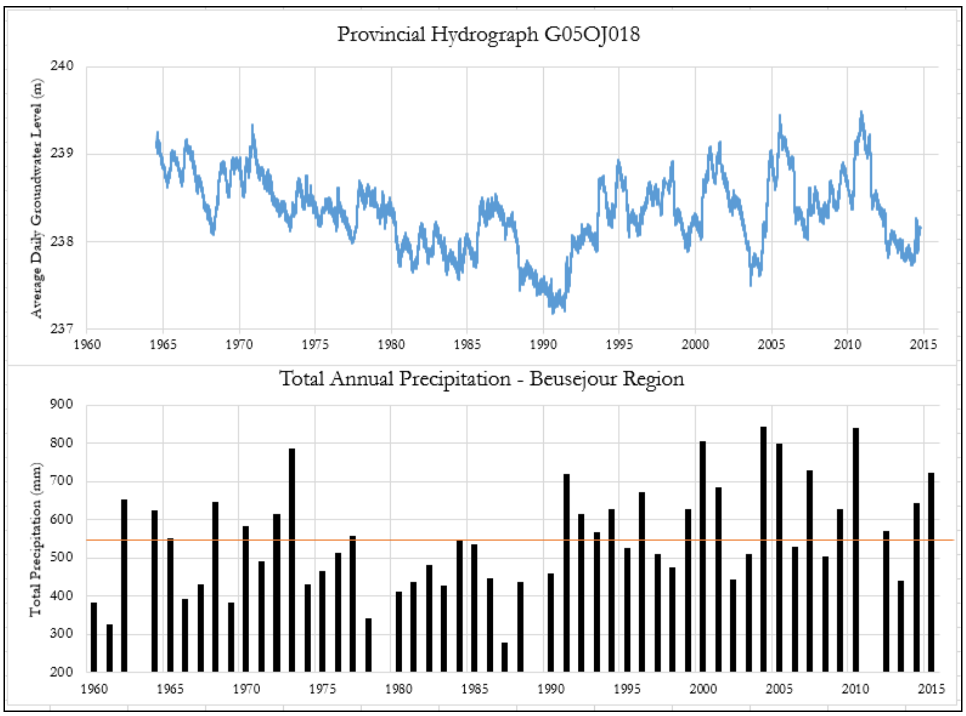


Figure 7. Comparison of annual precipitation and the potentiometric surface in G05OJ018. (source - MSD, 2016)

Groundwater Geochemistry and Isotope Review

As part of the groundwater investigation, results from groundwater quality sampling in the Beausejour area were reviewed to identify any changes in water quality since the time the municipal wells were installed. Laboratory results from samples collected from Town wells in 2015 are attached (L1613055). Figure 8, shown on subsequent pages, contains a plot of routine chemistry that compares samples collected from the Beausejour groundwater supply wells in 1982, 1992 and 2015. The general routine chemistry results are consistent between the years, with overall good quality, bicarbonate/calcium/magnesium-type groundwater. A comparison of significant sampling results is presented in Table 1, on the following page.

While the general water type has remained consistent under pumping, some trends are discernible within the geochemistry results. The chloride concentrations measured in well #2 have increased since at least 1992. It is unclear from the data which supply well the 1982 sample was taken from (either well #1 or #2) however, it is apparent that well #2 is pumping groundwater with gradually increasing chloride concentration. It should be noted that the chloride concentration measured in well #3 is only slightly above the regional background levels of between 2 and 25 mg/L. The potential trend of increasing chloride concentrations in the supply wells could be an indication of adverse quality impacts, as will be discussed below, however, additional monitoring is required to confirm if this is the case.

Groundwater Geochemistry and Isotope Review (Cont'd)

Another important consideration in groundwater quality is the presence of nitrate. Common sources of nitrate in groundwater include leaching or runoff from agricultural and fertilizer use, from sewage and manure, or as a product of excess ammonia or nitrification (Freeze and Cherry, 1979). The recommended maximum limit for nitrate in drinking water from the Canadian Drinking Water Quality Guidelines is 10 mg/L (Health Canada, 2014). High concentrations of nitrate in groundwater are a cause for concern, as it indicates that the groundwater has been impacted by surface water activities, with negative results. Layers of low permeability material, such as clay or till, which overlie the aquifer provide protection from surface impacts by limiting the downward migration of surface water.

Values for total hardness of the water are consistent between the samples and the total iron content appears to be stable since the 1992 sampling. According to Health Canada, groundwater hardness is not of direct public health concern, however, groundwater with concentrations above 180 mg/L is considered to be very hard. System design should take the groundwater quality, specifically the hardness into consideration, as it could cause incrustation problems in the future.

Overall, the available geochemistry data suggests that only minor changes to groundwater quality have occurred as a result of the continuous operation of the town well field.

Table 1
Municipal Well Sampling – Comparison of Chemistry Highlights
Town of Beausejour, Manitoba

Parameter	**G05SA011**	**2015**		**1982**	**1992**	**1962**
	2005	Well #2	Well #3		Well #2	Well #2
Sodium (mg/L)	32.1	42.4	23	30	45.9	
Chloride (mg/L)	22.4	51.8	33.1	39	47	217
Nitrate/nitrite	n.d.	n.d.	n.d.	n.d.	n.d.	0.97
Carbonate (mg/L)	n.d.	n.d.	n.d.	n.d.	n.d.	0.65
Total Dissolved Solids (mg/L)	524	473	440	430	500	n.d.
Iron (mg/L)	1.08	0.51	0.55	0.87	1.29	556
Hardness (mg/L)	456	355	371	326	370	0.6
n.d. = not detectable; (-) = not available						

Table 1. Geochemistry highlights from town well samples compared with provincial station G05SA011. (source - ALS Laboratories)

Environmental isotopes of deuterium (^2H), ^{18}oxygen (^{18}O), and tritium (^3H) were used to determine the apparent age and origin of the groundwater within the carbonate aquifer. The ratios of the main isotopes that compose the water molecule ($^{18}O/^{16}O$) and $^2H/^1H$ are important for hydrogeological investigations (Freeze and Cherry, 1979). The units are presented in delta (δ) units as parts per thousand or ‰ (Freeze and Cherry, 1979) relative to standard mean oceanic water (SMOW). The two isotopes of water have different freezing and vapour points, which lead to different concentrations as a result of freezing, condensation, melting, and evaporation (Freeze and Cherry, 1979). As water is evaporated from the ocean, there is a decline in the ^{18}O concentration by a specific amount. As the vapor condenses, the precipitation has a higher ^{18}O concentration. This process continues as the vapour moves inland and undergoes many cycles of condensation and evaporation. This fact makes deuterium and ^{18}oxygen very useful for hydrogeological investigations, as the origin and mixing of different waters can be determined. In order to determine the changes from local precipitation, deuterium and ^{18}oxygen results are plotted to determine the local meteoric water line (LMWL), which would be expected to be the typical concentrations in recent precipitation events in the area.

Within Manitoba, glaciogenic groundwater (~10,000 years old) typically shows ^{18}O concentrations of -19 to -23 δ (‰ V-SMOW), while modern groundwater typically shows concentrations between -14 to -16 δ (‰ V-SMOW) (Freeze and Cherry, 1979). Groundwater that contains a mixture of glaciogenic and modern groundwater typically plots between -17 to -19 δ (‰ V-SMOW). The ^{18}oxygen and deuterium results from Beausejour supply wells are shown on the following page as Figure 9.

Groundwater Geochemistry and Isotope Review (Cont'd)

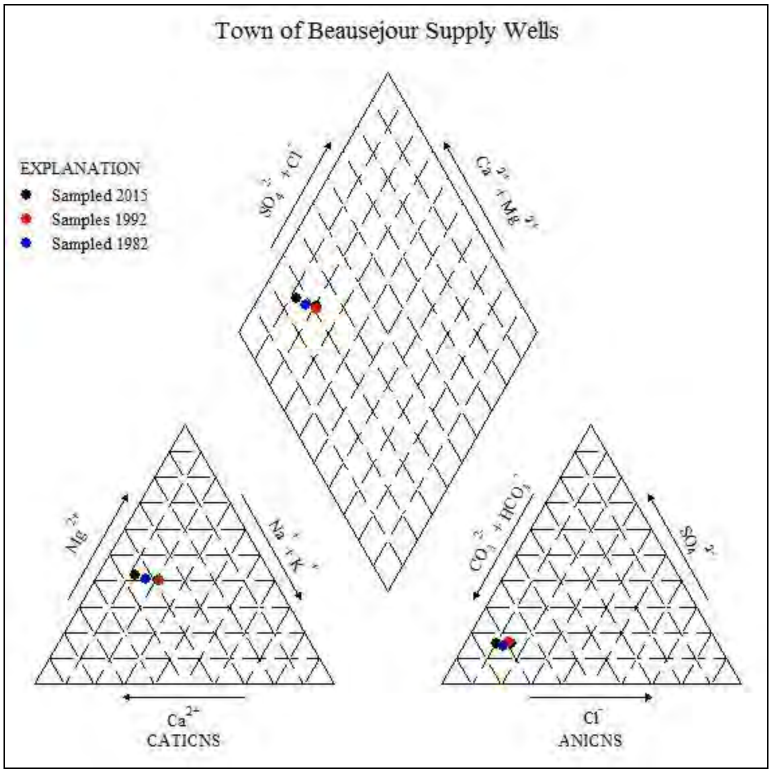


Figure 8. Plot of routine chemistry results from Town wells collected in 1982, 1992 & 2015. (source - ALS Laboratories)

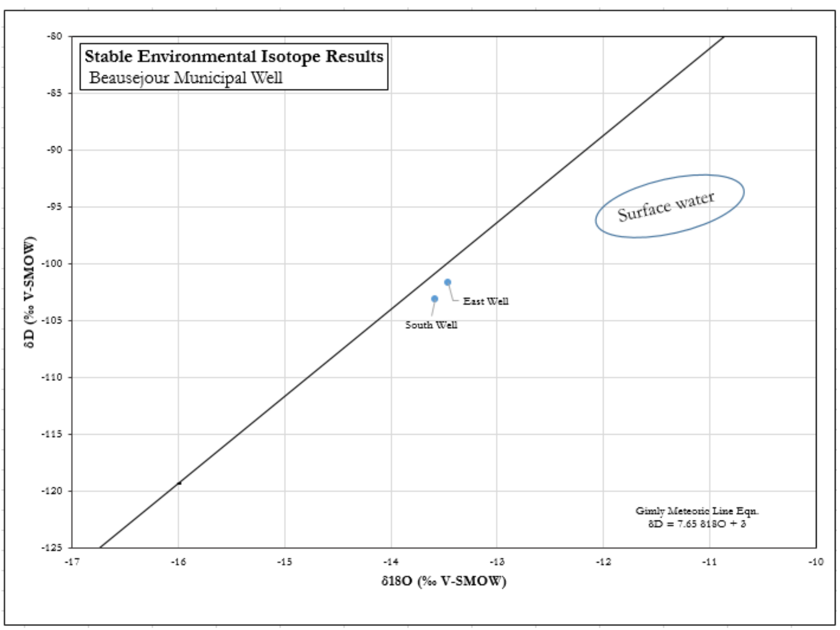


Figure 9. Results of ^{18}O and deuterium from Town wells plotted with the Gimli Meteoric Line. (source - ALS Laboratories)

Tritium, another important occurrence in the hydrological cycle, is known to occur naturally in groundwater in quantities thought to be less than 2 to 4 TU (Tritium Units). Increases in tritium concentration were noted as a result of the extensive testing of nuclear weapons by the Union of Soviet Socialist Republics and the United States in the 1950's and into the early 1960's. Levels of tritium in the atmosphere and in groundwater have been monitored extensively in Canada since the cessation of nuclear testing. Since tritium has a half life of 12.3 years, groundwater that was recharged from surface before 1953 is expected to have a tritium level less than 2 to 4 TU (Freeze and Cherry, 1979).

Groundwater Geochemistry and Isotope Review (Cont'd)

Following Fritz and Clark (1997), for continental regions, the following interpretations can be made regarding tritium concentrations:

- < 0.8 T.U. Sub-modern groundwater – recharged to the aquifer prior to 1953
- 0.8 to ~ 4 T.U. Mixture of sub-modern and recent recharge
- 5 to 15 T.U. Modern recharge (5 to 10 years)
- 15 to 30 T.U. Considerable recharge from the 1960's (peak bomb water)

Tritium analysis from the Beausejour supply wells yielded values of 6.0 and 9.3 T.U., indicating groundwater from modern recharge.

The isotope results indicate that groundwater from the municipal supply wells is slightly enriched in ^{18}oxygen and represents modern meteoric groundwater. The plotting of the points below the meteoric line indicates a potential evaporitic component to the groundwater, possibly contributed by snow melt; however, the shift below the line is slight and may be due to local changes in the LMWL. Local recharge is expected to be in the -14 to -15 ‰ range. The interpretation of these samples as modern groundwater is further supported by the concentration of tritium in the samples. While modern groundwater may be advantageous for some aspects of water quality (e.g. lower TDS), it also raises concerns that the groundwater may be under direct influence of surface water (GUDI), a condition with inherent vulnerabilities that would require additional considerations for monitoring and water treatment.

Assesment of Groundwater Under Direct Influence of Surface Water

The Groundwater Under Direct Influence of surface water (GUDI) classification refers to conditions where microbial pathogens can travel from surface water, through the aquifer and into a water well. Groundwater determined to be GUDI inherits an increased potenital for poor water quality. Several parameters must be considered when assesing whether groundwater is GUDI. These parameters include the concentrations of nitrate, carbonate and chloride in the well water, the presence or absence of bacteria, the stable isotope geochemistry, and the local geology.

Referring back to Table 1, nitrate and carbonate concentrations are both below detection limits, with the single exception of minor nitrate detected in the 1962 sample. Results from the 1962 analysis are somewhat anomalous from the more recent analysis for all parameters, which can likely be attributed, in part, to older sampling and analytical methods. Results from multiple samples collected over the last three decades show non-detected nitrate concentrations in the wells.

To determine if the concentration of chloride, a common constituent in groundwater, is elevated in the supply wells, sample results should be compared against regional trends in chloride concentrations. A review of data from Provincial monitoring wells in the region reveals a range in chloride concentrations from 2 to 25 mg/L. The chloride concentrations of 33.1 and 51.8 mg/L, measured from the municipal wells, are somewhat elevated above background levels. Groundwater in the underlying sandstone aquifer may have some influence on the chloride concentrations in the carbonate aquifer. The drawdown generated from pumping in the carbonate aquifer effectively increases the hydraulic gradient between the carbonate and the sandstone aquifers, thereby increasing the potential for upward leakage from the lower, saline groundwater into the carbonate aquifer. Continued monitoring is required to establish any trends of the chloride concentrations in the local carbonate groundwater.

Bacteriological analysis is a regulatory requirement for municipal water supplies. Water samples are collected biweekly and the results are made available through annual reporting. Reports by the Town of Beausejour Water Works Department have no record of positive results for the presence of colliform in their water supply. There is no indication at this time that the Town of Beausejour groundwater supply is being negatively affected by bacteriological impacts.

Stable environmental isotopes ^{18}oxygen and deuterium are useful to determine the source and relative age of groundwater. Due to the effects of evaporation, surface water from the Beausejour area, enriched in ^{18}oxygen, would plot below the meteoric line as shown on the previous page in Figure 9. The samples from Town supply wells plot slightly below the meteoric line, however, they plot in the range of modern groundwater. Although there is an evaporitic component to the groundwater at the supply wells, a distinction can be made between modern groundwater and the more depleted surface water. The implication is that the groundwater is modern meteoric.

The local geology, determined from well logs, includes a continuous layer of till and clay, 25-35 ft. thick, that directly underlies the surface to produce confining conditions within the aquifer at this location. The confining layer acts as an hydraulic barrier to the

Assesment of Groundwater Under Direct Influence of Surface Water (Cont'd)

downward migration of surface waters and helps to insulate the aquifer from surficial impacts. It is noted, however, that the confining layers are moderately sandy, which may limit their effectivness as a protective boundary. Quarry operations in the region further reduce the local overburden cover and also increase the potential for surface water impacts to reach the local groundwater aquifer.

Finally, the large number of private water wells documented within the Town of Beausejour is of concern for groundwater quality and must be considered in the GUDI assessment. A review of GWDRILL (2014) revealed more than 69 production wells within a one mile radius and an additional 46 wells within a two mile radius of the water treatment plant. It is further assumed that the GWDRILL database under represents the number of wells in a region, often by as much as 50%. The database effectively covers water wells completed from 1964 to present. Consequently, wells drilled before 1964 generally do no have a well log record. In reviewing the well logs, it is apparent that the majority of these wells are completed into the limestone aquifer. It is unknown at this time how many of these wells are still in use or if they have been properly abandoned. The density of private wells within the town is cause for concern with regards to groundwater quality, as each well increases the potential to introduce poor quality water and other surface impacts into the aquifer. Compounding the issue, the J.R. Cousin Consultants report (2016) indicates that 60 residential lots use private septic tanks connected to a low pressure sewer system and several lots are serviced by holding tanks. Aging septic tanks are of concern to local groundwater quality as they become a potential source of elevated chlorides and bacteriological pathogens to the local aquifer. Although the aquifer in the area is reasonably confined, the combination of a large number of septic tanks with the high density of private groundwater wells is an important concern to groundwater quality.

In general, the negative bacteria results, isotopic geochemistry, absence of nitrates and carbonates and the moderately confined conditions suggest that the Town of Beausejour supply wells are likely non-GUDI. However, the abundance of private septic tanks and wells along with the slightly elevated chloride concentrations, sandy confining material and tritium results represent a potential risk to groundwater quality. These aspects should be given special consideration when deciding on the location of the new well. It should be noted that this assessment is based on currently available information and that the aquifer conditions are dynamic. Continued monitoring is very important.

Aquifer Pumping/Recovery Test

As part of the water supply investigation, a pumping test of the two municipal supply wells was conducted to assess the parameters of the carbonate aquifer in the Beausejour area and to determine any well field pumping impacts. The pumping test proceeded by pumping each municipal well individually for as long as possible (10-15 hours), and allowing for maximum recovery time in between pumping tests (4-8 hours). The wells were tested separately to isolate the drawdown effects of each pumping well and to avoid interference between the two wells which, in turn, simplified the data analysis.

The pumping test was conducted while maintaining the necessary production for the municipal groundwater supply system; as a result, pumping start up and shutdown times were dictated automatically by the control system. Groundwater drawdown within the aquifer during the pumping test was recorded in two monitoring wells, each equipped with a Solinst Levelogger pressure transducer: 1) Town well #1, located on the water treatment plant property; and 2) Day Lily Park well, located northwest of the well field, within the town limits. The locations of the pumping and monitoring wells and a summary of well details are shown on the following page as Figure 10 and in Table 2, shown below. It should be noted that the Day Lily Park well proved useful only for obtaining background groundwater fluctuations and did not respond to pumping from town supply wells.

Table 2
Town Well Locations and Details
Town of Beausejour – NE36-12-7 EPM

Well	Location	UTM x	UTM y	Casing Depth	Total Depth	Diameter
Town Well #1	NE36-12-7E	678552 m	5548439 m	N.A.	113 feet	16 inch
Town Well #2	NE36-12-7E	678553 m	5548372 m	75 feet	85 feet	16 inch
Town Well #3	NE36-12-7E	678500 m	5548432 m	77 feet	120 feet	10 inch
Day Lily Park	NE2-13-7E	677339 m	5549479 m	49 feet	85 feet	5 inch

Table 2. Well locations and construction details - Town of Beausejour

The plot of transducer data from observation well #1, shown on the following page as Figure 11, illustrates the typical groundwater level fluctuations resulting from the operation of the current municipal well field. From the plot, it is evident that regular pumping operations result in a fairly uniform pattern of local groundwater drawdown and recovery, as groundwater levels in the aquifer cycle between approximately 243.5 and 237 m geodetic elevation, a range of roughly 6.5 m (21 ft.). A copy of the drawdown data is attached.

Aquifer Pumping/Recovery Test (Cont'd)

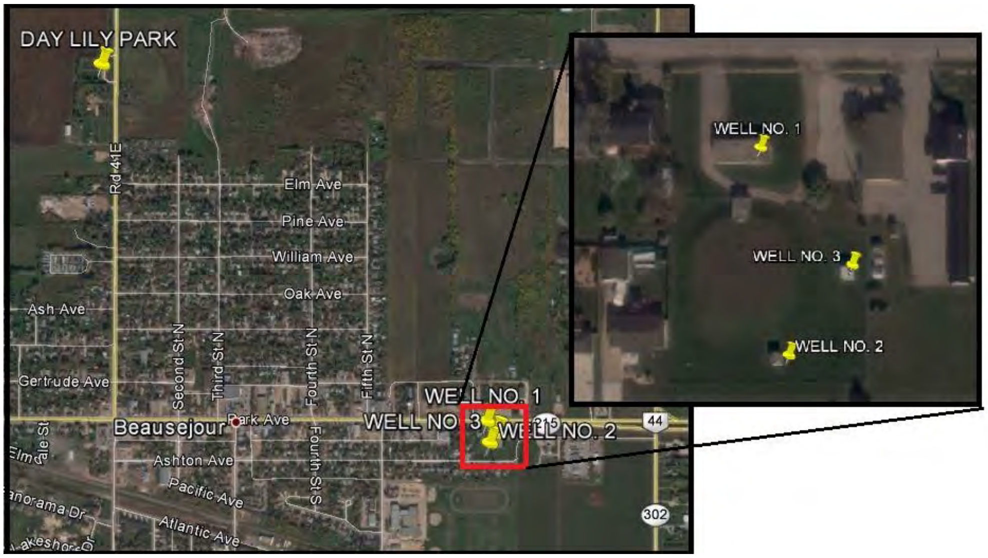


Figure 10. WTP yard (red outline) and Day Lily Park monitoring well; Inset shows supply wells. (source - Google Earth, 2016)

Two distinct cycles are evident within the transducer record which can be correlated with the two municipal production wells. The larger amplitude cycle that fluctuates over the previously described range is attributed to pumping from Town well #3, which pumps at a rate of 300 U.S.G.P.M. The smaller amplitude cycle, which fluctuates roughly 3.5 m (11.5 ft.) between about 243.5 m and 240 m geodetic elevation, results from the pumping of Town well #2 at a rate of about 200 U.S.G.P.M. It is important to note that the record shows the groundwater levels recover to pre pumping conditions after each pumping event.

Aquifer Parameter Analysis

To estimate the local aquifer parameters, a single cycle of drawdown and recovery from each pumping test was isolated and entered into Waterloo Hydrogeologic's AquiferTest Professional v2016.1. The data was analyzed using the Cooper-Jacob (1946) and Theis (1935) methods, although similar results should be expected, as the Cooper -Jacob (1946) method is a semi-log plot approximation of the Theis (1935) method. In order to determine the acceptability of the results, a derivative analysis was used (Bourdet, et. al., 1989). The hydraulic parameters determined by each of the pumping tests are shown on the following page as Table 3.

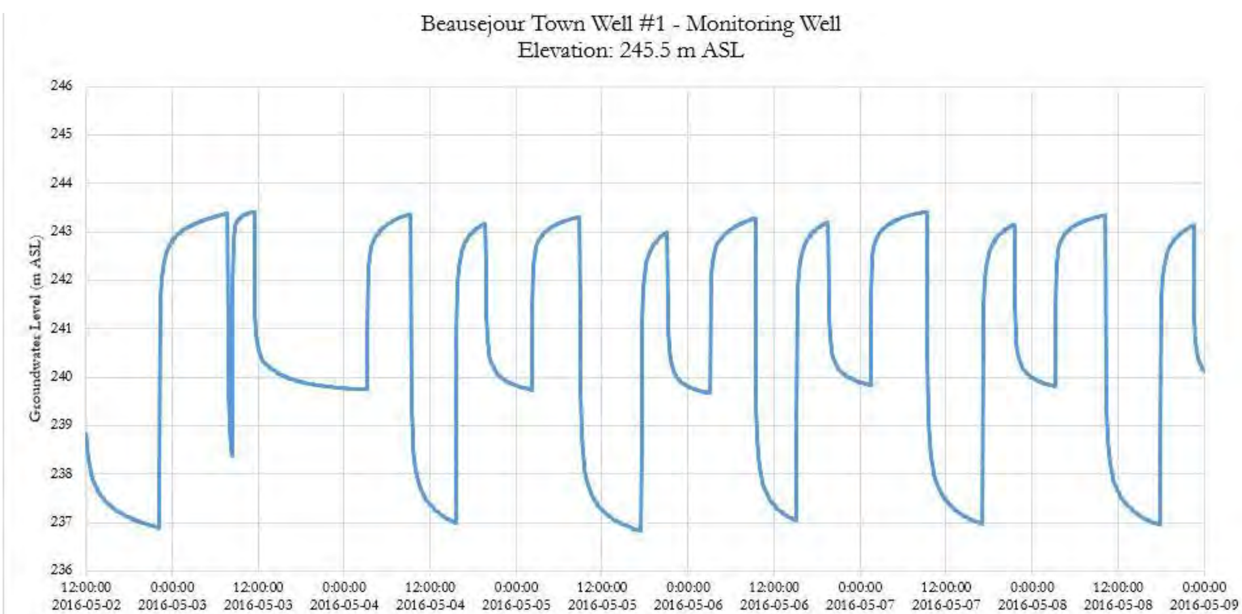


Figure 11. Local potentiometric fluctuations resulting from regular operations of the municipal supply well field.

Aquifer Parameter Analysis (Cont'd)

In reviewing the pumping test results, the Cooper-Jacob (1946) method was used primarily, since emphasis is not placed on early time measurements. By this method, transmissivity values are estimated from the data to be 16,000 to 25,000 U.S.G./day/ft., with a hydraulic conductivity (k) of approximately 92.57 feet/day or 3.3 x 10^{-4} m/s. These results are consistent with the range of values expected for karstic limestone/dolomite formations (Freeze and Cherry, 1979). Gray and Padersen (1973) estimated transmissivity in the local limestone, from specific capacity and distance drawdown methods, to range from 35,000 to 46,600 U.S.G./day/ft. Although these values are somewhat higher than the estimates obtained herein, they are reasonably close; the different values likely reflect the variable conditions of in the aquifer over time, such as the potentiometric elevation. A transmissivity value of 25,000 U.S.G./day/ft. will be used for calculations in subsequent sections of this report. Figures 12-15, shown of the following pages, contain drawdown vs. time and Cooper-Jacob (1946) plots of the pumping test data for each town well #2 and #3.

Table 3 Confined Aquifer Parameters – Observation Well #1 Town of Beausejour Water Supply – NE36-12-7E		
	Well #2 Pump Test	
Static Water Level	9.9 feet	
Pumping Water Level	22.0 feet	
Drawdown	12.1 ft. @ 200 U.S.GPM – 15 hours 45 minutes	
Method	**Transmissivity**	**Storativity (estimated)**
Theis Method[1]	24,310 U.S.G./day/ft.	5.0 x 10^{-4}
Cooper - Jacob Method[2]	24,230 U.S.G./day/ft.	5.0 x 10^{-4}
Notes [1] Theis (1935) method using Waterloo Hydrogeologic Limited – AquiferTest Pro v2016.1 [2] Cooper-Jacob (1946) method using Waterloo Hydrogeologic Limited – AquiferTest Pro v2016.1		
	Well #3 Pump Test	
Static Water Level	10.0 feet	
Pumping Water Level	31.25 feet	
Drawdown	21.25 ft. @ 300 U.S.GPM – 11 hours 5 minutes	
Method	**Transmissivity**	**Storativity (estimated)**
Theis Method[1]	15,780 U.S.G./day/ft.	5.0 x 10^{-4}
Cooper - Jacob Method[2]	15,700 U.S.G./day/ft.	5.0 x 10^{-4}
Notes [1] Theis (1935) method using Waterloo Hydrogeologic Limited – AquiferTest Pro v2016.1 [2] Cooper-Jacob (1946) method using Waterloo Hydrogeologic Limited – AquiferTest Pro v2016.1		

Table 3. Aquifer Parameters – Pumping Well #2 and #3 – NE36-12-7E

The attempts at evaluating a storativity value produced unrealistic numbers for a fractured limestone aquifer. It is considered that the transmissivity value of 25,000 U.S.G./day/ft. obtained from observation well#1 data is realistic for the site. Values for storativity in fractured limestone aquifers are typically in the order of 10^{-4} to 10^{-5} (Freeze and Cherry, 1979). For further consideration of the effects of long term pumping at the site, a representative storativity value of 5.0 x 10^{-4} will be applied.

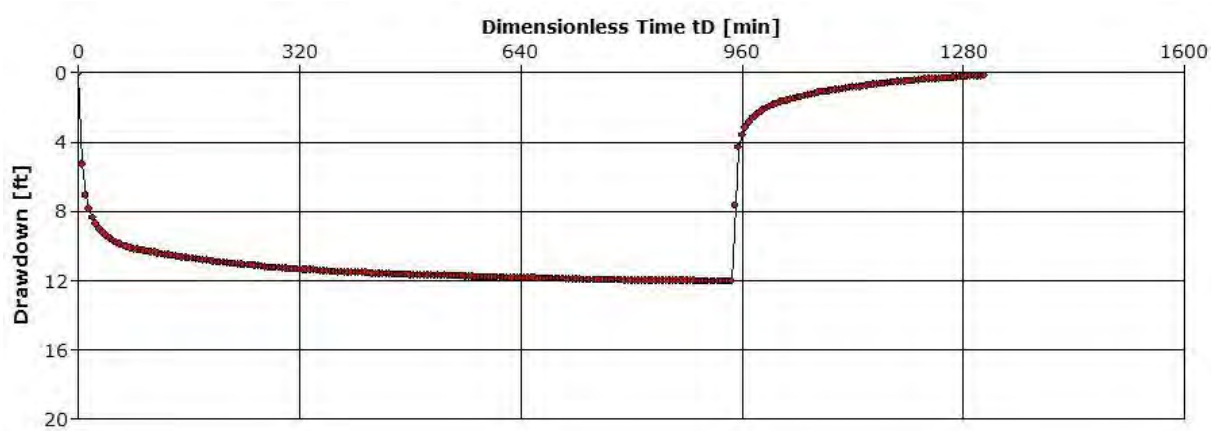


Figure 12. Drawdown vs. Time plot of the pumping test data from pumping well #2.

Aquifer Parameter Analysis (Cont'd)

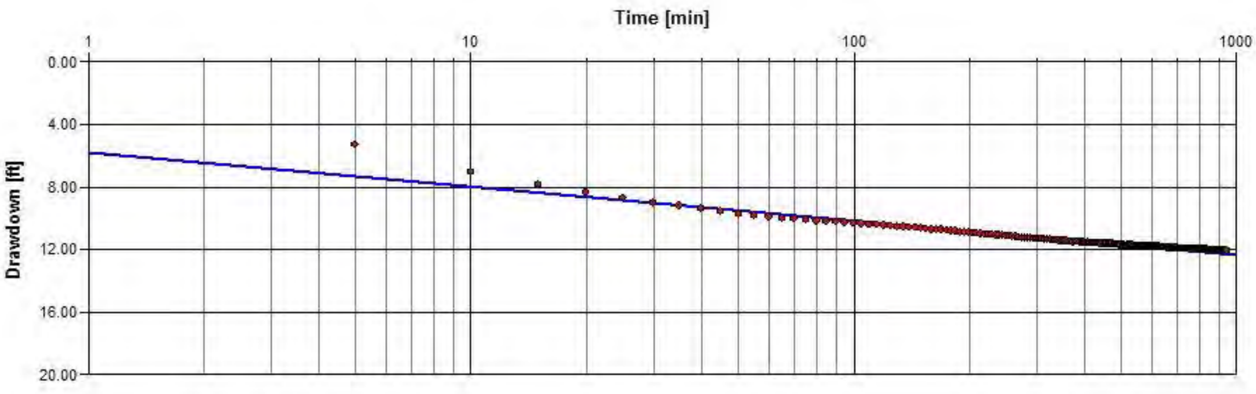


Figure 13. Cooper-Jacob (1946) plot of the pumping test data from pumping well #2.

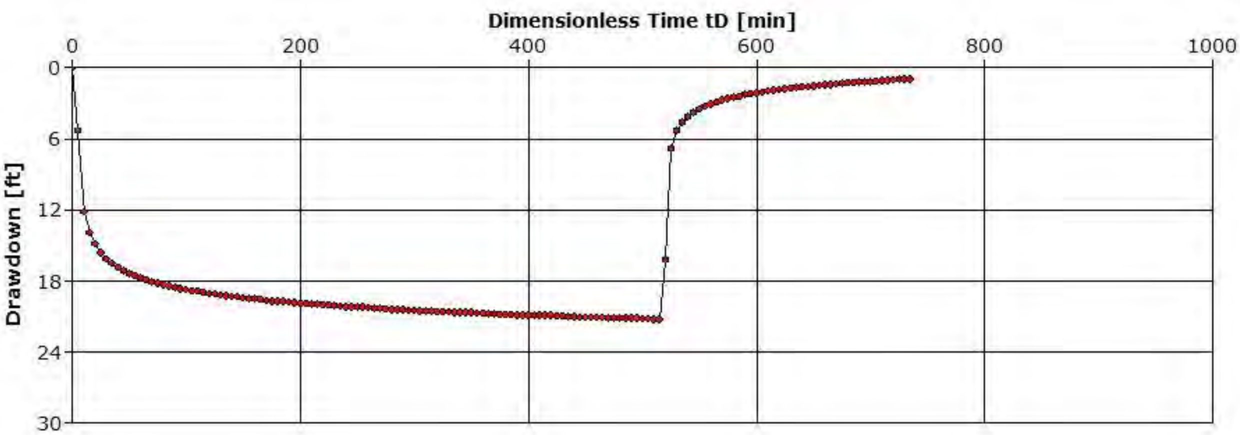


Figure 14. Drawdown vs. Time plot of the pumping test data from pumping well #3.

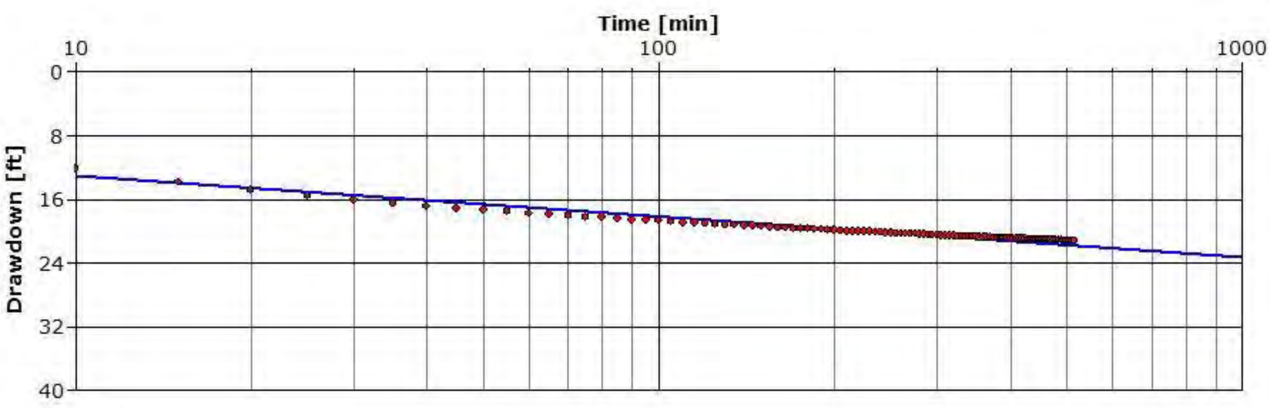


Figure 15. Cooper-Jacob (1946) plot of the pumping test data from pumping well #3.

Prediction of Additional Drawdown Impacts

The current Town of Beausejour license allows for the pumping of the existing wells at a maximum rate of 22.8 L/s, with total annual withdrawal limited to 364.82 acre feet/year. From the water use records, Beausejour is currently using 80-100% of the total allotment. According to the JRCC Report (2016), the groundwater well field should be capable of providing the maximum pumping demand of the water supply system with any one pump out of service. The average daily demand in the year 2034 is estimated to be 22.5 L/s (356.6 U.S.G.P.M), with a maximum daily demand of 33.8 L/s (535.7 U.S.G.P.M) (JRCC, 2016) which equates to roughly 575 acre

Prediction of Additional Drawdown Impacts (Cont'd)

feet/year; an increase of 171 acre feet/year. The current minimum supply capacity of the well field with one well out of service is 15.1 L/s. Consequently, an additional well with a capacity of 18.7 L/s (296.4 U.S.G.P.M) is required to meet the maximum pumping demands of 33.8 L/s.

In order to conservatively determine the additional drawdown effects of operating the well field at the proposed rate of 356.6 U.S.G.P.M, the drawdown was calculated at a distance using the Theis equation, after one year of operation for the site. This allows for about 513,600 U.S.G.P.D to be produced from the well field, an increase of 188,100 U.S.G.P.D over current production capacity. These drawdown calculations follow all the assumptions of the Theis method.

For the purposes of the calculations, the following aquifer parameters were assumed:

• Transmissivity ~ 25,000 U.S.G.P.D./ft. with a storage coefficient of 5.00 x 10^{-4}.

• Pumping duration – 365 days/year.

Under a conservative regional transmissivity of 25,000 U.S.G.P.D./ft., the additional drawdown at a radial distance of one mile from the production well field was calculated to be approximately 4.3 feet after pumping one year continuously at a rate of 105 U.S.G.P.M. (Walton, 1979/1983). This analysis is considered to be very conservative; it assumes that no recharge occurs and that the wells are pumped continuously the entire year. As shown by hydrograph records, recharge occurs rapidly during the spring and rainfall events. It should also be noted that municipal wells do not operate continuously, but rather operate on cycles based on water supply demands. Therefore, the actual amount of water supply pumped should be less than the amount assumed in the analysis. Additionally, transducer records from Beausejour well #1 show the groundwater levels to rebound to static level after pumping stops, with no apparent long term residual drawdown of the potentiometric surface. As noted from the regional hydrograph network, water supplies in the area have to be capable of managing over 6 feet of water level changes from natural fluctuations. The results are shown below as Table 4.

To the author's knowledge, a sustainable yield for the aquifer in this area has not been determined. The most significant user in the immediate area is the Town of Beausejour production wells. It should be noted that the future drawdown is estimated without taking into account natural gradients and the effects of other unknown pumping wells that may be present.

Table 4
Predicted Drawdown – Town of Beausejour
Municipal Supply – NE36-12-7 EPM

Pump Well	50 feet	100 feet	250 feet	500 feet	1000 feet	2500 feet	4500 feet	5280 feet
14.6 feet	10.0 feet	9.1 feet	8.0 feet	7.2 feet	6.3 feet	5.3 feet	4.6 feet	4.3 feet

Table 4. Predicted drawdown after one year, pumping an additional 171 acre feet/year following the Theis (1935) equation

Location of Additional Groundwater Wells

The aquifer conditions derived from the current hydrogeological investigation apply generally to the limestone aquifer in the Beausejour area. From the geological review, the limestone bedrock appears to be contiguous in the immediate vicinity of the Town. However, the limestone aquifer transmits groundwater primarily through fracture systems and, as a result, the yield of individual groundwater wells will vary by location based, in part, on local fracture density and interconnectivity. Consequently, test hole drilling to determine local bedrock aquifer conditions should be carried out at the proposed site prior to installation of a new production well.

The number of nearby private wells and septic tanks is an important consideration when deciding on a location for the new municipal supply well. The well should be installed in an area with thickest overburden to provide the aquifer with maximum protection from surface impacts. To reduce the risk of surface impacts from private wells and septic tanks, the new supply well should be located up gradient from these higher risk areas.

Finally, the area is well populated and, to some extent, the aquifer appears utilized by private residences. Although the overall influence on the aquifer is estimated to be minimal, a new supply well with the required capacity of ~300 U.S.G.P.M. is expected to result in localized drawdown similar to well #3 (also 300 U.S.G.P.M.), with more than 21 feet of drawdown at the pumping well under operating conditions. As a result, the new well should be located a far from private wells as is feasible to minimize the effects of localized drawdown under pumping conditions.

Discussion

The current hydrogeological investigation has provided interesting results regarding the carbonate aquifer as a water supply source for the Town of Beausejour. The geological review indicates that the carbonate bedrock contiguously underlies the town of Beausejour and that the carbonate aquifer is moderately confined in the area. The confining layer thickness is shown, however, to be highly variable throughout the region and may be locally compromised by the numerous private wells in the area of the town.

Operation of the town well field is shown to result in a cyclical pattern of local drawdown and recovery. From the transducer records, no residual drawdown is apparent after pumping events. Aquifer transmissivity and hydraulic conductivity is estimated from pumping-test data to be approximately 25,000 U.S Gallons/day/ft. and 92.57 feet/day or 3.3 x 10^{-4} m/s, respectively. With these parameters, an expanded municipal well field withdrawing 709 dam^3/year is conservatively estimated to result in an additional four to five feet of drawdown at one mile radial distance. This additional drawdown is not anticipated to negatively impact any nearby groundwater wells as it is within the range of groundwater fluctuation observed in the regional monitoring stations. Although additional drawdown is expected during well field operation, long term pumping of the expanded well field is not likely to cause sustained drawdown within the carbonate aquifer in the Beausejour area.

It should be noted that an expanded water supply will require the submission of a Water Rights License Application. As the required demand exceeds 200 dam^3/year, an Environment Act License Proposal will also be required. The Environment Act License (EAL) requirement was introduced in 1996. Consequently, groundwater supply systems that originated before this date may not currently hold an EAL; this will need to be obtained when an update to the existing Water Rights License is undertaken.

Water quality samples from the supply wells yielded results similar to samples collected from previous decades, which suggests that the water quality has remained relatively stable under the gradual increase in groundwater use. A possible exception is the apparent slight elevation in chloride concentrations which may be a result of influences from deeper, saline groundwater. Isotope analysis reveals that modern meteoric groundwater is being extracted from the municipal supply wells. The groundwater geochemistry and local geology suggest that the modern groundwater is likely non-GUDI. It is important to note that the conditions identified in this investigation are based upon the known available data at the time and, due to the dynamic nature of surface activities and groundwater aquifer systems, may change in the future. Consequently, continuous monitoring of groundwater quality should be a high priority.

Recommendations

The following recommendations come as a result of the hydrogeological investigation:

- Continued monitoring of the carbonate aquifer water levels and groundwater quality should be a high priority.
- Pumping test analysis indicates that the carbonate aquifer in the Beausejour area is capable to sustain an additional groundwater production well that would increase total annual groundwater withdrawal to 575 acre feet/year (513,600 U.S. Gallons per day).
- The new production well should be located in an area that has maximum protection from confining materials, low private well density and is up gradient from the majority of the private water wells and septic tanks.
- Test drilling at the new well site will be necessary to confirm the aquifer conditions at a specific location.
- The estimated future water demand will require a new Water Rights License and an updated Environment Act License for an expanded annual groundwater allotment.
- The Town should undertake a detailed inventory of private wells and septic tanks within the town, to ascertain the age, condition and current use statistics.
- Based on the results of the inventory, a well abandonment and septic tank replacement program should be implemented.
    - The Town should promote the proper abandonment of private wells by licensed well drilling contractors.
- Groundwater sensitive areas, such as areas with minimal protective overburden should be identified; any on-site sewage and waste disposal systems should be designed to prevent seepage and infiltration into the aquifer.
- Land use activities in the groundwater sensitive areas should be reviewed with respect to groundwater protection. Possible uses such as un-lined landfills, lagoons, dumps, and sewage ejectors may cause impact to the groundwater resources in the area.

Should you require anything further or have any additional questions, please call me at (204) 326-2485.

Sincerely,

Friesen Drillers Limited

J.E.(Justin) Neufeld, B.Sc.(G.Sc.), GIT
Hydrogeological Technician

Reviewed by:

Friesen Drillers Limited

J.J.(Jeff) Bell, B.Sc.(G.E.), P.Eng.
Hydrogeological Engineer

Attachments Town of Beausejour Water Rights License (2005-023)
Analytical Results – ALS Laboratories # L1656085
Pumping Test Data
MSD, 2015 – Data Sources

References

Betcher, R.N., Grove, G., and Pupp, C. (1995): *Groundwater in Manitoba*. NHRI Contribution No. CS-93017

Render, F.W. (1970): *Geohydrology of the Metropolitan Winnipeg Area as Related to Groundwater Supply and Construction*

Render, F.W. (1987): *Aquifer Capacity Investigations 1980- 1986*

Environment Canada, Environment and Natural Resources (2016): *Past Weather and Climate.*

International Atomic Energy Association (2012): *Meteoric Water Line – Manitoba.*

JRCC Engineering Consultants (2016): *Town of Beausejour: Water and Wastewater System Assessment Study.*

Manitoba Sustainable Development, Hydata Database (2016)

Limitations

The scope of this report is limited to the matters expressly covered and is intended solely for the client to whom it is addressed. Friesen Drillers Limited makes no warranties, expressed or implied, including without limitation, as to the marketability of the site, or fitness to a particular use. The assessment was conducted using standard engineering and scientific judgment, principles, and practices, within a practical scope and budget. It is based partially on the observations of the assessor during the site visit in conjunction with archival information obtained from a number of sources, which is assumed to be correct. Except as provided, Friesen Drillers Limited has made no independent investigations to verify the accuracy or completeness of the information obtained from secondary sources or personal interviews. Generally, the findings, conclusions, and recommendations are based on a limited amount of data (e.g. number of boreholes drilled or water quality samples submitted for laboratory analysis) interpolated between sampling points and the actual conditions on the site may vary from that described above. Any findings regarding the site conditions different from those described above upon which this report was based will consequently change Friesen Drillers Limited's conclusions and recommendations.

Disclaimer

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February 27, 2019

Mr. Nathan Wittmeier, P.Eng.
Senior Project Engineer
Manitoba Water Services Board
2010 Currie Blvd, Brandon, MB R7A 6Y9

Dear Mr. Wittmeier,

Subject **Summary of Hydrogeological Test Work Conducted for the Town of Beausejour Groundwater Supply**

Friesen Drillers is pleased to provide this letter to detail results of the hydrogeological test work undertaken for the Town of Beausejour municipal groundwater supply. The work built upon previous investigations conducted in the area and included test well drilling and well capacity testing at new well locations within the town.

Project Background

Development of groundwater from the Carbonate Aquifer has been ongoing in the Beausejour area, with well records dating back to the 1950s. The first municipal well was installed in 1957, followed by two additional wells drilled in 1962 and 1995. The wells were established as part of two hydrogeological investigations of the area conducted by Reid, Crowther & Partners Ltd. and International Water Supply (1950s), and the Manitoba Water Resources Branch (1980s). Records of the earlier test work are sparse, as the provincial water well database (GWDRILL) was only created in 1964. However, it was noted that several test wells were drilled as part of the project. The 1986 investigation drilled four wells at locations shown below in Figure 1. A copy of the 1987 report is attached.

Figure 1 – Test well locations of previous studies (Pederson, 1987; Google Earth, 2019)

The previous work indicated challenging conditions for groundwater development from the carbonate bedrock within the Town of Beausejour. Aquifer yields across the town were noted to be highly variable and generally inadequate for large scale use. Of the wells drilled in 1987, only test well #1 yielded any amount of water. It was further noted that the transmissivity at that location was one tenth of the existing production well site. Many of the fractures were also noted to be filled with sand and finer grained sediments.

Project Background (cont'd)

It was concluded that other areas within the town were not likely to produce better results than the existing site. It should be noted that sand pumping remains a persistent issue for the existing municipal well field.

The use of groundwater in Beausejour has gradually increased over the years. A recent study conducted by J.R. Cousin Consultants (JRCC), found that upgrades to the present municipal water supply infrastructure, including the water treatment plant and groundwater well field, were needed to meet the future water supply demands of the community. As part of the upgrade strategy, additional supply wells were recommended.

Friesen Drillers was retained by JRCC in 2016 to undertake a desktop hydrogeological review of the Beausejour area and to make recommendations for potential groundwater development options. The review highlighted concerns with the construction of additional wells within the townsite and recommended that locations away from the town be considered. The recommendations were based in part on low well yields and the potential for negative quality impacts from the high density of private wells.

In 2018, Friesen Drillers was retained by Manitoba Water Services Board (MWSB) to undertake test drilling to identify potential locations for additional production wells. At the direction of Stantec and MWSB, the test wells were drilled within town near the water treatment plant (WTP). It is our understanding that these locations were preferred to minimize costs associated with connecting new wells to existing infrastructure.

Test Drilling Results

Four test wells were constructed as part of the drilling program. The locations of the test wells are shown below in Figure 2. The test well locations were selected at the direction of staff from MWSB and Stantec. The test wells were drilled on two properties, two wells at the site of the future WTP and two wells at the site of the existing WTP. Table 1, shown on the following page, details the wells construction. Copies of the driller's logs are also attached.

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Figure 2 – Test well locations at two sites in the Town of Beausejour. (source – Google Earth, 2019)

Test Drilling Results (cont'd)

In the well construction process, a borehole was drilled through the overburden until competent bedrock was encountered. Then, PVC casing was set into the bedrock with a 3 tier stepdown socket and the casing was grouted in place. Following casing installation, the bedrock was drilled open hole until final depth. Due to the relatively thin sequence of carbonate rock present in the Beausejour area, the wells were drilled until the underlying shale was intersected, which indicated the bottom of the carbonate formation. The well was then developed with compressed air to remove cuttings and sediment from the fractures.

It should be noted that the casing and completion depths of the test wells were similar to those of the existing municipal production wells.

The geological conditions observed during the test work were similar between the test wells. From surface down, the stratigraphy comprised 3 to 8 feet of soil and clay, followed by 58 to 70 feet of till that included seams of sand and gravel. A rubble zone, with a total thickness of 3 to 7 feet, lay directly above the carbonate bedrock. Competent carbonate rock was intersected at depths between 70 and 75 feet below grade. The carbonate was underlain by shale at depths between 123 and 130 feet below grade.

Table 1 **Well Construction Details – Town of Beausejour**					
Well ID	**UTM X**	**UTM Y**	**Casing Depth**	**Casing Diameter**	**Total Depth**
Test Well #1	678671.68 m	5548340.38 m	75 feet	5 inch PVC	130 feet
Test Well #2	678520.65 m	5548443.28 m	73 feet	5 inch PVC	132 feet
Test Well #3	678698.19 m	5548319.00 m	77 feet	5 inch PVC	125 feet
Test Well #4	678524.50 m	5548371.07 m	77 feet	5 inch PVC	127 feet

Table 1 - Well Construction Details – Town of Beausejour.

After the wells were constructed and developed, a short term capacity test was conducted to assess well yield. The capacity test results are shown below in Table 2. The values for specific capacity were below 1.0 U.S.G.P.M./ft. for all wells, with the exception of test well #1. It is suspected that deeper lower static water levels measured in wells 2 and 4 reflect some interference from the existing production wells. Overall, the yields observed, although suitable for domestic purposes, were largely inadequate to establish a municipal supply well.

Table 2 **Well Construction Details – Town of Beausejour**				
Well ID	**Static Water Level**	**Pumping Water Level**	**Pumping Rate**	**Specific Capacity**
Test Well #1	10.9 feet	22.8 feet	100 U.S.G.P.M.	8.40 U.S.G.P.M./ft.
Test Well #2	26.0 feet	51.1 feet	12 U.S.G.P.M.	0.48 U.S.G.P.M./ft.
Test Well #3	11.3 feet	42.8 feet	18 U.S.G.P.M.	0.57 U.S.G.P.M./ft.
Test Well #4	25.6 feet	45.5 feet	15 U.S.G.P.M.	0.75 U.S.G.P.M./ft.

Table 2 – Capacity test results – Town of Beausejour.

It should be noted that the well with the highest yield, Test Well #1, also produced significant amounts of sand which clogged the pump after a short pumping duration. The well was developed with compressed air for several hours. However, the amount of sand did not appear to reduce. After consultations with MWSB and Stantec, it was decided to abandon the well and attempt the additional test wells.

Discussion and Recommendations

Existing Supply Wells

The existing municipal well field includes three large diameter production wells completed into the carbonate aquifer. The well locations were established through extensive test drilling across the townsite. The yields of the existing wells have been adequate to meet the historical demands of the town; however, the wells have also produced a notable amount of sand and sediment. In addition, wells 1 and 2 are nearly 60 years old and it is anticipated that the steel casing is in poor condition.

It is recommended that a condition assessment of existing supply wells 1 and 2 be conducted to assess the integrity of the well casing and bedrock fractures. This assessment should include a survey with a downhole camera and a pumping test to confirm the well capacities. This work should be conducted by a licensed well driller and supervised by a professional engineer or hydrogeologist. Based on these results, recommendations about the feasibility of reconstructing the wells and the total maximum yield of the well field could be made.

Existing Supply Wells (Cont'd)

This should include well interreference calculations between the production wells. It should also be noted than an agreement is in place to complete the assessment of production well #3.

The well condition assessments should be conducted by a licenced well driller and the results should be reviewed by a licensed hydrogeological engineer or hydrogeologist. Overall, the work could be completed within about two weeks.

Regulatory Considerations and Public Consultations

The revisions to the groundwater supply for the Town of Beausejour will require licensing under the Environment Act. The Environment Act process is a public process undertaken at the end of a project. In our experience, the challenges associated with a successfully application are easy to underestimate. The circumstances for each groundwater supply project are unique and it is recommended to approach each project from the ground up to avoid late stage opposition which could jeopardize the project. To mitigate the risks, it is strongly recommended that a stakeholder engagement process is initiated prior to any exploratory field work.

It should be noted that the existing Groundwater Exploration Permit will need to be amended if testing at additional sites is required.

Additional Testing and Development

The results from the recent test work reflect conditions which are generally unfavorable for municipal use purposes. Based on these results and the results of previous investigations, further test work within the townsite is not recommended. Instead, it is recommended that future test drilling be targeted to regions outside of the town, towards the west-southwest, where a thicker sequence of limestone and improved aquifer protection are available.

It should be noted that locating a well field outside municipal boundaries is common in Manitoba. For example, the Town of Selkirk historically developed groundwater from a well field located within town limits (Bell et al., 2017). Over time, the water demands exceeded the sustainable yield of the underlying carbonate aquifer. A new well site, located approximately 5 miles northwest of the town, was identified in the late 1970s as having excellent conditions to develop a new municipal groundwater supply. The Town eventually constructed new wells in 2015 and the municipal water supply system has been greatly improved as a result. In that case, the existing municipal wells have also been retained for backup supply and increased capacity. The example highlights the challenges that can be associated with developing a municipal water supply, even when a community is located above a known aquifer, such as the case with Beausejour.

It is recommended that a hydrogeological assessment of aquifer conditions surrounding Beausejour be undertaken. This work should include test drilling, well capacity tests, groundwater sampling and hydrogeological analysis. The goal of this work should be to identify locations in the carbonate aquifer that are suitable for future development and provide an approximate range of groundwater quality that can be expected from new supply wells in those locations. This work should be supervised by a hydrogeological engineer or hydrogeologist registered to practice in Manitoba. In addition, this work should be conducted in accordance with a public consultation process.

The scope of work should include provisions to construct, pump test and sample five to ten test wells across an area of several square miles. The target area should be selected based on the available information for the area, including water levels, geochemistry, well construction and any other pertinent hydrogeological data. The test wells could be drilled within road allowances to minimize the challenges associated with land access. Based on the results of the hydrogeological test work, recommendations for larger diameter municipal wells can be made.

To complete a project of this magnitude, including test work, public consultations, licensing, and construction, can take 8-9 months. A breakdown of the approximate timeline is shown on the following page as Table 3.

Additional Testing and Development (Cont'd)

Table 3 **Approximate Project Schedule**	
Task	**Timeline**
Background review and target area selection	2 weeks
Round 1 - Stakeholder meetings	4 weeks
Field work (test drilling, water sampling, capacity tests.)	8 weeks
Round 2 - Stakeholder meetings	8 weeks
Final reporting, licence application	12 weeks
Approximate Total	**34 weeks**

Table 3 – Approximate timeline to test, construct and license a new municipal groundwater supply.

Should you require anything further or have any questions, please call us at 204-326-2485.

Sincerely,

Friesen Drillers Limited

Justin Neufeld, GIT
Groundwater Geologist

Reviewed by,

Friesen Drillers Limited

Jeff Bell, P.Eng.
Hydrogeological Engineer

Attachments Groundwater Investigations at Beausejour 1987 – Unpublished Report
Driller's logs – Friesen Drillers

References

Bell, J.J., Estrella-Legal, P.J., Neufeld, J.E., and Render, F.W. 2017. Development of a Water Supply in the Carbonate Aquifer for the City of Selkirk, Manitoba; 12th Joint International Association of Hydrogeologists – Canadian National Chapter – 70th Canadian Geotechnical Society Conference Proceedings – Ottawa, Ontario.

Pederson, A. 1987. Groundwater Investigation at Beausejour. Manitoba Water Services Board. Unpublished report.

Limitations

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July 9, 2019

Mr. Nathan Wittmeier, P.Eng.
Senior Project Engineer
Manitoba Water Services Board
2010 Currie Blvd, Brandon, MB R7A 6Y9

Dear Mr. Wittmeier,

Subject **Well Inventory, Geochemistry Review and Recommendations for Further Hydrogeological Testing Town of Beausejour Groundwater Supply**

Friesen Drillers is pleased to provide this letter to detail results of the hydrogeological review undertaken for the Town of Beausejour municipal groundwater supply. The work included a well inventory and geochemistry review of the Beausejour. Recommendations for further hydrogeological testing are also provided.

Project Background and Scope of Work

The use of groundwater in Beausejour has gradually increased over the years. A recent study conducted by J.R. Cousin Consultants (JRCC), found that upgrades to the present municipal water supply infrastructure, including the water treatment plant and groundwater well field, were needed to meet the future water supply demands of the community. As part of the upgrade strategy, additional supply wells were recommended.

Development of groundwater from the Carbonate Aquifer has been ongoing in the Beausejour area, with well records dating back to the 1950s. The first municipal well was installed in 1957, followed by two additional wells drilled in 1962 and 1995. The wells were established as part of two hydrogeological investigations of the area conducted by Reid, Crowther & Partners Ltd. and International Water Supply (1950s), and the Manitoba Water Resources Branch (1980s). Records of the earlier test work are sparse, as the provincial water well database (GWDRILL) was only created in 1964. However, it was noted that several test wells were drilled as part of the project.

Previous work in the area indicated challenging conditions for groundwater development from the carbonate bedrock within the Town of Beausejour. Aquifer yields across the town were highly variable and generally inadequate for large scale development. Only one (test well #1) of the four wells drilled in 1987 yielded any amount of water. It was further noted that the transmissivity at that location was one tenth of the existing production well site. Many of the fractures were also noted to be filled with sand and finer grained sediments.

In 2018, Friesen Drillers was retained by Manitoba Water Services Board (MWSB) to undertake test drilling in an effort to identify additional production well locations. At the direction of Stantec and MWSB, the test wells were drilled within town near the water treatment plant (WTP). It is our understanding that these locations were preferred to minimize costs associated with connecting new wells to existing infrastructure. Four new test wells were constructed as part of the test drilling program. The test wells were drilled on two properties, two wells at the site of the future WTP and two wells at the site of the existing WTP. The results of the test work indicated relatively poor conditions for development of a municipal groundwater supply. These conditions related to a general lack of yield and sediment infilled fractures.

In 2019, Friesen Drillers was retained by MWSB to undertake additional review and test drilling with the following scope work:

- Conduct a desktop review of the existing hydrogeological information available for the Beausejour area.
    - Identify existing high-yielding wells that may be present.
    - Delineate regions where the aquifer may have increased transmissive conditions.
- Review regional geochemistry data from the provincial hydrograph network
    - Provide a range of groundwater quality parameters for the proposed drilling targets.

Project Background and Scope of Work (Cont'd)

- Provide a summary report to MWSB, Stantec and the Town of Beausejour.
- Conduct test drilling at 2 or 3 approved test locations, complete with a short-term capacity test on each test well.
- Collect a water sample from each test well for laboratory analysis of routine geochemistry parameters.

Well Inventory of High Capacity Wells in the Beausejour Area

The hydraulic data from drillers logs obtained from the GWDRILL (2016) database were reviewed to assess the apparent distribution of high yielding wells in the Beausejour area. Well yields were derived from the specific capacity values calculated from the available pump test data. Specific capacity is defined as the amount of water produced (U.S.G.P.M.) per foot of drawdown generated in the well. While specific capacity data are useful to identify potential areas of increased aquifer transmissivity, it should be noted that specific capacity values are sensitive to the rate at which the well was tested. For example, an artificially high specific capacity value may result where testing rates were low and no drawdown was created or where nothing was done at all and the yields were simply estimated. For this reason, only wells that were tested at rates greater than 20 U.S.G.P.M. were included in this assessment. It should also be noted that, although specific capacity is a good preliminary indicator of aquifer conditions, additional site specific test work will be required to confirm the results.

The study area for the specific capacity review is shown below in Figure 1. As shown in previous hydrogeological investigations of the Beausejour region, while the major carbonate aquifer formation extends a great distance in the westerly direction, it terminates within a mile or two east from the town site (Betcher et al., 1995; Bell, 2016). The study area shown in Figure 1 was extended farther to the west and south to include a larger area of the available carbonate aquifer formation.

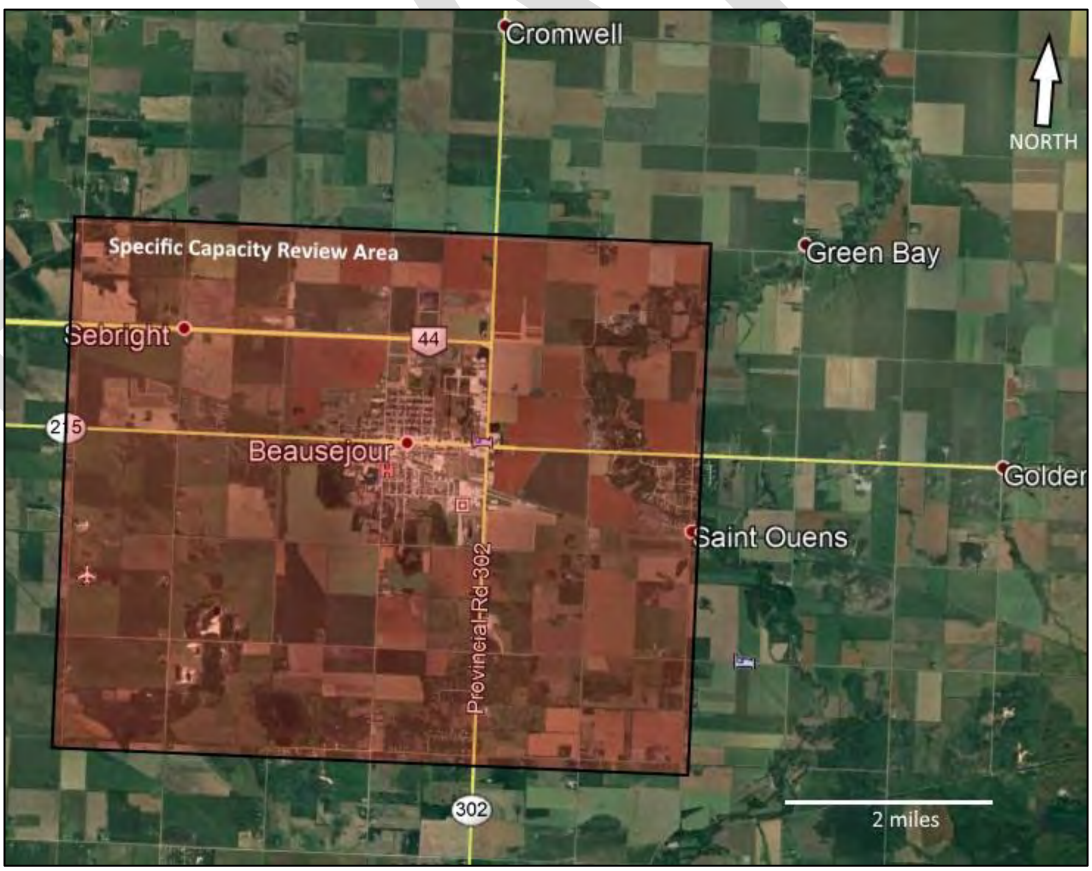

Figure 1 – Area reviewed for specific capacity data. (Google Earth, 2019)

Well Inventory of High Capacity Wells in the Beausejour Area (Cont'd)

A total of 547 well logs were identified within the study area (GWDRILL, 2016). From that total, 213 logs did not contain sufficient information to calculate a specific capacity value, and 322 well logs indicated a test rate less than 20 U.S.G.P.M. More than 80 percent (269/334) of the well logs with complete data had a specific capacity value less than 2.0 U.S.G.P.M./ft. In all, only 13 well logs indicated appropriate testing conditions and had a specific capacity value that would be potential viable for municipal water supply development (~10 U.S.G.P.M./ft or greater). Details of these well logs are shown in Table 1. A map of the well locations is shown as Figure 2.

Table 1
Specific Capacity Review – Highest Capacity Wells
Town of Beausejour

Well Owner	UTM X	UTM Y	Specific Capacity (USGPM/ft.)	Pumping Rate (USGPM)	SWL (ft)	PWL (ft.)
A Selch	679838.38	5549384	50	49.9	8	9
Town of Beausejour	678659.8	5548070.2	27	81	10	13
Gary Boriskewich	679203	5543578	20	40	7	9
Town of Beausejour	678500	5548432	18.1	307	10	27
Paul Zillman	677042	5547210	15.7	110	8	15
Schlup Family Farms	676903.68	5552145.1	12.5	99.9	2	10
Steven Thompson	673191.3	5546557	11.3	45	5	9
Town Of Beausejour	678553	5548372	10.3	399.8	10	49
R.B. Homes	678779.55	5543980	10	20	9	11
Ken Merke	671174	5541774	10	20	13	15
David Wotzke	671387	5544560	8.3	50	6	12
D Wilson	681084.61	5549036.3	8.3	50	6	12
Notes: SWL – Static Water Level; PWL – Pumping Water Level						

Table 1 - Specific capacity review – Town of Beausejour (Data source – GWDRILL, 2016)

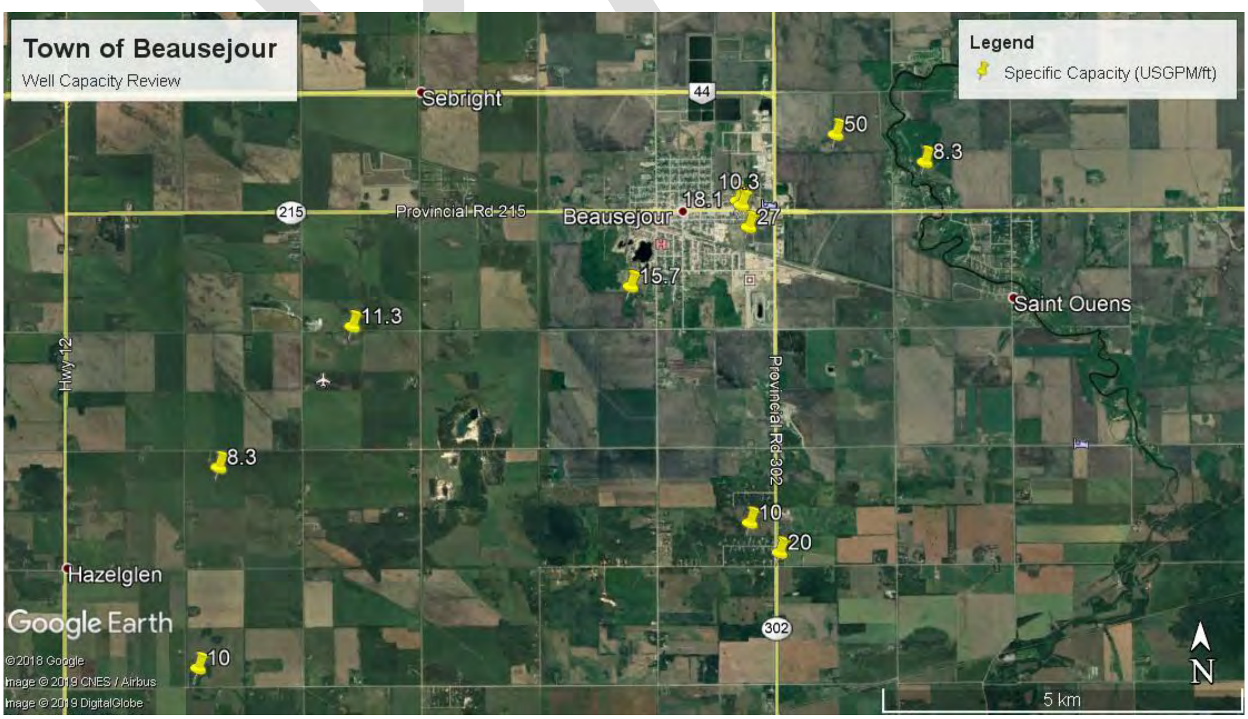

Figure 2 – Locations of wells with potentially suitable aquifer conditions. (Data source – GWDRILL, 2016)

Preferred Testing Locations

It is apparent from Figure 2 that the highest capacity wells plot along an approximate northeast-southwest trend through the Beausejour area. As the thickness of the carbonate aquifer is know to decrease and pinch out entirely in the northwest direction, areas southwest of the town are recommended. The increased aquifer thickness in the westerly direction improves the potential for water bearing fractures to be intersected when drilling. The southwest area is also located approximately cross gradient from the main townsite, which limits the potential for negative impacts from existing domestic wells and septic systems.

The area recommended for further test drilling is shown below in Figure 3. The target area is suggested based on the results of the well capacity review and the geological and hydrogeological conditions identified in earlier investigations. To minimize the potential piping costs, test work could begin at locations proximal to the town and progress outward. It is expected that drilling could be done within the road allowances, although some of the area may lie within the boundaries of the Rural Municipality of Brokenhead.

Figure 3 – Proposed area for test drilling within the road allowance; Yellow plotted points indicate specific capacity (USGPM/ft.). (Google Earth, 2019; GWDRILL, 2016)

Regional Geochemistry Review

MSD maintains three observation wells in the Beausejour area, the locations are shown on the following page as Figure 4. Groundwater geochemistry data from these wells were obtained and compared with data from the existing Beausejour Town wells to establish an approximate range of quality for groundwater supplies developed within the area.

Details of the groundwater geochemistry data are shown on the following page in Table 2. A plot of the major ion concentrations is shown on the following page as Figure 5.

Regional Geochemistry Review (Cont'd)

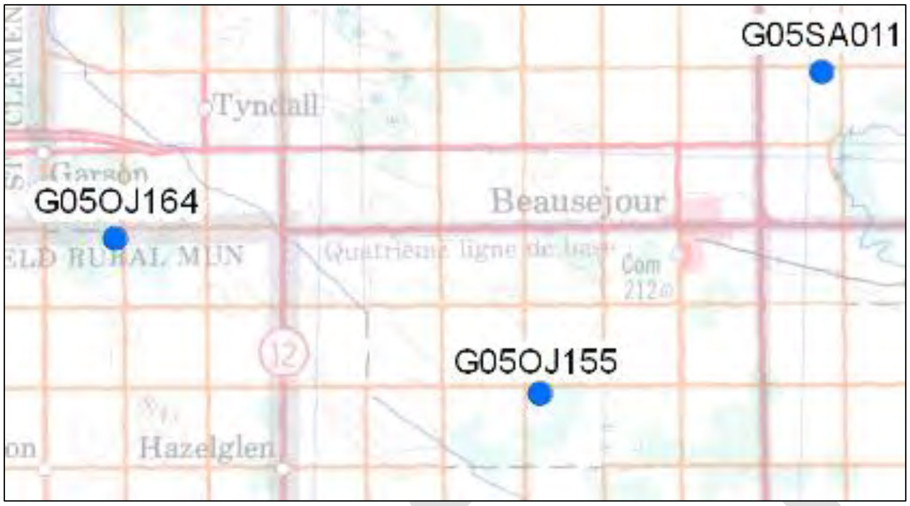

Figure 4 – Provincial monitoring stations surrounding the Town of Beausejour. (Source – MSD - C. Romano, 2014)

Table 2
Regional Geochemistry

Station ID	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	Cl (mg/L)	SO_4 (mg/L)	TDS (mg/L)	Nitrate (mg/L)	Hardness (mg/L)
G05OJ155	50.1	38	5.9	20.25	40	286	0.01	282
G05OJ164	63	69.9	2.5	1.63	5.77	444	2.57	446
G05SA011	68.2	69.3	32.1	22.4	63.5	524	0.01	456
South Well	70.1	43.8	42.4	51.8	68.5	473	<0.02	355
East Well	77.4	43.3	23	33.1	65.4	440	<0.02	371
Range	**50-78**	**38-70**	**2-43**	**2-52**	**6-69**	**286-524**	**<0.01-2.6**	**282-456**

Table 2 – Geochemistry of groundwater in the Beausejour region. (data source – MSD – C. Romano, 2014; Town of Beausejour, 2016)

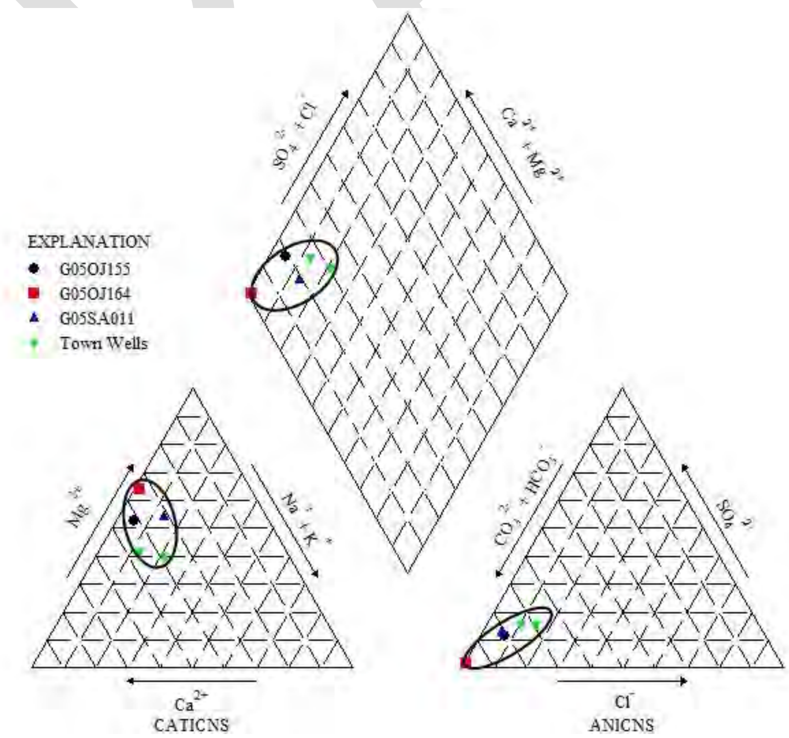

Figure 5 – Plot of major ion geochemistry from the Beausejour area. (Data source – MSD, C.Romano, 2014; Town of Beausejour)

Regional Geochemistry Review (Cont'd)

A large number of private water wells (>130 wells) are documented within the Town of Beausejour which are of concern for local groundwater quality. In reviewing the well logs, it is apparent that a majority of these wells were completed into the limestone aquifer. It is unknown at this time how many of these wells are still in use or if they have been properly sealed and abandoned. The density of private wells within the town is cause for concern as each well increases the potential to introduce poor quality water and other surface impacts into the aquifer. Compounding the issue, the J.R. Cousin Consultants report (2016) indicated that 60 residential lots use private septic tanks connected to a low pressure sewer system and several lots are serviced by holding tanks. Aging septic tanks are of concern to local groundwater quality as they become a potential source of elevated chlorides and bacteriological pathogens to the local aquifer. Although the aquifer in the area is reasonably confined, the combination of a large number of septic tanks with the high density of private groundwater wells is an important concern to groundwater quality.

Overall, groundwater quality in the proposed test area is expected to be similar to the water quality produced by the current municipal production wells. The groundwater is generally fresh, with TDS values below about 500 mg/L, and hard to very hard. The location of the proposed test area, southwest of the town, is across gradient from the main townsite and provides some mitigation for potential negative impacts to groundwater quality created by the high density of domestic water and wastewater systems.

Discussion and Recommendations

Based on the results of the well inventory and regional geochemistry review detailed in this letter, the follow recommendations are provided as next steps for the Town of Beausejour's municipal groundwater supply:

- Two test wells should be constructed and tested within the proposed target area delineated in Figure 3. The suggested wells locations are along the south side of mile Road 71 North, west of Road 41 East, as shown in Figure 3. It is expected that the test wells could be drilled within the road allowances to simplify site access.

- The Town should select appropriate locations and make arrangements for site access. It is noted that portions of the target area are expected to lie within the RM of Brokenhead.

- To minimize pipe costs, the first well could be located closer to the town, with successive wells located progressively farther away.

- For each test well, a short term capacity test will be conducted and a water sample will be collected for analysis of routine geochemistry parameters.

- Based on the results of the hydrogeological test work, recommendations for next steps will be provided.

- It should be noted that a public consultations process might become necessary in the event that positive results are obtained outside of the Town of Beausejour boundaries. Conducting test work in advance of public consultations also poses some risks to future aspects of the project. For example, public perception of the project as a foregone conclusion can cause issues later on.

Should you require anything further or have any questions, please call us at 204-326-2485.

Sincerely,

Friesen Drillers Limited

Justin Neufeld, GIT
Groundwater Geologist

Reviewed by,

Friesen Drillers Limited

Jeff Bell, P.Eng.
Hydrogeological Engineer

References

Bell, J. 2016. Hydrogeological Assessment of the Carbonate Aquifer as a Municipal Water Supply for the Town of Beausejour, Unpublished Report.

Betcher, R.N., Grove, G., and Pupp, C, 1995. Groundwater in Manitoba. NHRI Contribution No. CS-93017.

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Manitoba Sustainable Development, Hydata, 2014. Provided by Chris Romano (MSD).

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Friesen DRILLERS

October 21, 2019

Mr. Nathan Wittmeier, P.Eng.
Senior Project Engineer
Manitoba Water Services Board
2010 Currie Blvd, Brandon, MB R7A 6Y9

Dear Mr. Wittmeier,

Subject **Summary of Hydrogeological Test Work - Town of Beausejour Groundwater Supply**
Secondary Test Site – 26-12-7 EPM - Pescitelli Road, Rural Municipality of Brokenhead

Friesen Drillers is pleased to provide this letter to detail results of the hydrogeological test work undertaken for the Town of Beausejour municipal groundwater supply. The test work was conducted at a secondary site, southwest from the town of Beausejour along Pescitelli Road between Roads 40 and 41 East.

The work was based upon previous investigations conducted in the area and involved drilling and capacity testing two new test wells.

Project Background

Development of groundwater from the Carbonate Aquifer has been ongoing in the Beausejour area, with well records dating back to the 1950s. The first municipal well was installed in 1957, followed by two additional wells drilled in 1962 and 1995. The wells were established as part of two hydrogeological investigations of the area conducted by Reid, Crowther & Partners Ltd. and International Water Supply (1950s), and the Manitoba Water Resources Branch (1980s). Records of the earlier test work are sparse, as the provincial water well database (GWDRILL) was only created in 1964. However, it was noted that several test wells were drilled as part of the project.

The previous work indicated challenging conditions for groundwater development from the carbonate bedrock within the Town of Beausejour. Aquifer yields across the town were noted to be highly variable and generally inadequate for large scale use. It was concluded that other areas within the town were not likely to produce better results than the existing site. It should be noted that sand pumping remains a persistent issue for the existing municipal well field.

Friesen Drillers was retained by JRCC in 2016 to undertake a desktop hydrogeological review of the Beausejour area and to make recommendations for potential groundwater development options. The review highlighted concerns with low well yields and sand pumping as well as the potential for negative water quality impacts from the high density of private wells within town. In addition, the geological assessments suggested improved aquifer conditions would likely be present in the westerly-southwesterly direction. Based on these considerations, it was recommended that locations away from the town be considered for testing.

In 2018, Friesen Drillers was retained by Manitoba Water Services Board (MWSB) to undertake test drilling for additional municipal wells. At the direction of Stantec and MWSB, the test wells were drilled near the water treatment plant (WTP) sites. It is our understanding that these locations were preferred to minimize costs associated with connecting to existing infrastructure. The target flow rates for the new wells is around 28 L/s (430 U.S.G.P.M.) per well. A summary of the test results was provided in a letter dated Feb. 27, 2019 (Friesen Drillers). In general, the results were unfavorable for the development of additional municipal production wells. It was recommended that additional test work be undertaken at a secondary location southwest of the town.

Friesen Drillers was retained in 2019 by MWSB to drill and test two sites in a secondary location. An area along Pescitelli Road, southwest of Beausejour within the RM of Brokenhead was selected for testing. The locations of the two test well sites are shown on the following page in Figure 1. The results of this testing are detailed in the following paragraphs.

Prior to completing any field work in the secondary testing area, a preliminary public consultation campaign was undertaken by the Town and the RM. Residents in the area immediately surrounding the test sites were contacted by the Town to discuss the project and answer questions.

Test Drilling Results

Two test wells were constructed at the locations shown below in Figure 1. The test well locations were suggested by Friesen Drillers and approved by the Town of Beausejour, the RM of Brokenhead, and MWSB. The wells were drilled within the right of way along the south side of Pescitelli Road, between Roads 40 and 41 East.

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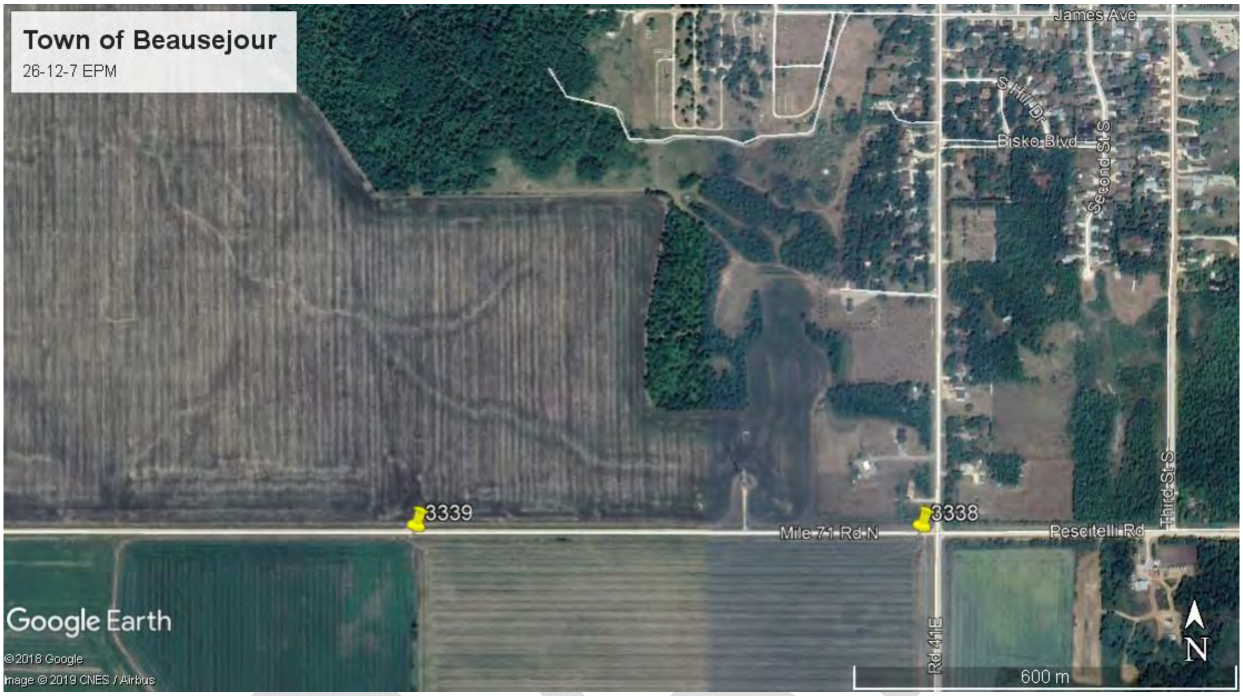

Figure 1 – Test well locations along Pescitelli Rd., southwest of the Town of Beausejour. (source – Google Earth, 2019)

The geological conditions observed during the test work were similar between the test wells. From surface down, the stratigraphy comprised 5 to 6 feet of clay, followed by 65 to 68 feet of till that included significant layers of sand and gravel. A rubble zone, with a total thickness of 11 to 14 feet, lay directly above the carbonate bedrock. Competent carbonate rock was intersected at depths between 82 and 87 feet below grade. Shale was intersected below the carbonate rock at a depth of 146 feet below grade. Copies of the driller's logs are attached.

The well construction included PVC casing set through the overburden and into the top of the bedrock with a 3 tier stepdown socket. The well casing was then grouted in place with bentonite grout. The carbonate bedrock was then drilled open hole until sufficient water bearing fractures were intersected or the shale was reached. The depths of significant fractures are noted on the drillers logs. Table 1, shown below, details the wells construction.

Table 1
Well Construction Details – Town of Beausejour

Well ID	UTM X	UTM Y	Casing Depth	Casing Diameter	Total Depth
Tag #3338	677439.1 m	5546794.6 m	70 feet	5 inch PVC	119 feet
Tag #3339	676645.9 m	5546769.5 m	89 feet	5 inch PVC	147 feet

Table 1 - Well Construction Details – Secondary Site - Town of Beausejour.

After the wells were constructed and developed, a short term capacity test was conducted to assess well yield. The capacity test results are shown in Table 2. The specific capacity of each well was around 50 U.S.G.P.M./ft. Due to time restrictions, testing of the second test well (Tag #3339) at a higher rate was not completed at the time of writing. Overall, the well yields observed warrant further testing for municipal water supply purposes.

It should be noted that minor amounts of fine grained sand were noted in the discharge during the capacity tests. Overall, the amount of sediment was significantly less than the amounts observed from existing town wells. In addition, the sediment will likely be reduced after some additional well development effort.

Test Drilling Results (Cont'd)

Table 2 Well Capacity Test Results – Town of Beausejour				
Well ID	**Static Water Level**	**Pumping Water Level**	**Pumping Rate**	**Specific Capacity**
Tag #3338	15.65 feet	17.33 feet	80 U.S.G.P.M.	47.6 U.S.G.P.M./ft.
Tag #3339	10.4 feet	10.8 feet	25 U.S.G.P.M.	62.5 U.S.G.P.M./ft.

Table 2 – Capacity test results – Town of Beausejour.

It should be noted that the specific capacity of the test wells may decline slightly with pumping at higher rates. It is imperative that the large diameter wells are installed and tested sufficiently to confirm the required well yields.

Groundwater Geochemistry

Groundwater samples were collected from each test well. Highlights of the basic water quality are shown below in Table 3. The water quality of samples collected from the Town wells #2 & #3 are shown in Table 3 for comparison purposes.

Table 3 Basic Water Quality Results – Town of Beausejour				
Well ID	**Electrical Conductivity**	**Total Dissolved Solids**	**Salinity**	**pH**
Tag #3338	1,033 uS/cm	730 mg/L	500 mg/L	7.8
Tag #3339	860 uS/cm	607 mg/L	400 mg/L	8.1
Existing Town Wells	731-804 uS/cm	440-473 mg/L	n/a	7.6

Table 3 – Basic water quality results – Town of Beausejour (Source – Friesen Drillers, 2019; ALS - L1613055, 2015)

The results indicate a range for water quality between the two test wells, with well #3338 containing higher concentrations for each parameter. Overall, it is expected that the groundwater quality at the new well field location will be similar to that produced at the existing municipal well field, although the TDS values appear to be somewhat higher at the new wellfield location. It should be noted that the water quality could change with pumping. Comprehensive testing of groundwater quality is required in the next stages of the project development.

The water quality should be reviewed by the WTP design team. Additional water quality analysis should be undertaken in the next phases of the project.

Discussion and Recommendations

Water supply projects can be challenging with respect to stakeholder concerns. Individuals and groups often express a range of concerns around the idea that existing water supply services in the vicinity of a new change may be negatively impacted. These concerns can derail an otherwise sound environmental licensing process. A well-planned stakeholder engagement process addresses these challenges.

The revisions to the groundwater supply for the Town of Beausejour will require licensing under both the Environment Act and the Water Rights Act. The Environment Act process is typically a public process undertaken at the end of a project. In our experience, the challenges associated with a successfully licensing application are easy to underestimate.

To mitigate the risks, it is strongly recommended that the stakeholder engagement process that was initiated by the Town be continued and expanded to include all groundwater users within the area. It is strongly recommended that this consultation process be conducted prior to any further work in the field.

As the results from the recent test work indicate favorable hydrogeological conditions for the development of additional municipal use production wells, further test work along Pescitelli Road is recommended. The recommended scope of work for the next phase of testing is provided below. The work involves expanded public consultations and the construction and testing of larger diameter test wells at the target flow rate of 430 U.S.G.P.M. (~28 L/s) per well:

Discussion and Recommendations (Cont'd)

- An extensive public consultation program should be completed prior to conducting any further work in the field. Based on our experience with these types of projects, a thorough public consultation phase is critical to a successful outcome.

- All relevant licences and permits should be reviewed to ensure that they are current and comply with regulations.

- Two well locations should be surveyed near to the two existing test well sites (Tag #3338 & 3339) along Pescitelli Road. The sites should be sited with GPS to ensure that the wells will be located within the right of way. As it is expected that these could become the final production well locations, it will be important to ensure proper site access, security, and land title.

- Two, 10 inch or 12 inch diameter, steel cased test wells should be constructed at the selected locations. The wells should be installed by a licensed well driller. Although a flow rate of 430 U.S.G.P.M. is likely achievable with 10 inch well casing, the additional cost to install 12 inch casing is expected to be only marginally higher. The larger casing diameter would provide additional pump and motor options and would be better able to accommodate higher flow rates.

- The large diameter wells should be completed into the carbonate aquifer and should be designed based on the results of the test wells (Tag #3338 & 3339). Well casing should be extended through the overburden and into the top of the carbonate bedrock. The open hole section of the well should be drilled until the shale underlying the carbonate aquifer is intersected. Under no circumstances should the underlying shale layer be penetrated, as this would result in saline water intrusion from the deeper sandstone aquifer. The final well design should be approved by a qualified hydrogeologist/hydrogeological engineer.

- A 24 hour pumping test should be conducted on one of the larger diameter production wells. The pumping test should be conducted at a rate of at least 430 U.S.G.P.M. (28 L/s). After 24 hours of pumping, the pump should be shut off and the water level recovery monitored until at least 90% recovery is reached, as is required by regulation. The pumping test should be supervised by a qualified hydrogeologist/hydrogeological engineer.

- An aquifer monitoring plan should be developed by a qualified hydrogeologist. The plan should monitor aquifer conditions during the pumping test to adequately characterize the time drawdown and distance drawdown response of the regional aquifer system. This should include multiple monitoring wells at distance from the pump well.

- Groundwater samples should be collected during the first hour of testing and during the last hour of the pumping test. The groundwater samples should be sent to an accredited laboratory to be analyzed for routine geochemical parameters, isotopes of oxygen-18 and deuterium, and any additional parameters which may be required to design the WTP. In addition, field water quality parameters (TDS, electrical conductivity, and pH) should be measured periodically during the test.

- Upon completion of the pumping tests, the drawdown/recovery data should be analyzed and checked using analytical software. The conclusions and recommendations from the test should be presented in a report that is signed by a licensed Professional Hydrogeological Engineer. The report should satisfy all requirements to obtain both a Water Use License and an Environment Act License amendment.

  The report should include the following contents:

  - Review of local and regional geological/hydrogeological conditions.
  - Review of historical hydrograph and meteorological data.
  - Assessment of existing groundwater users and groundwater development.
  - Assessment of the recharge dynamics for the regional groundwater systems.
  - Assessment of GUDI potential.
  - Pumping test analysis.
  - Projected aquifer drawdown results.
  - Estimated long term impacts to aquifer and nearby groundwater users.
  - Detailed well inventory with a minimum radius of 1 mile from the production wells.

Should you require anything further or have any questions, please call us at 204-326-2485.

Sincerely,

Friesen Drillers Limited

Justin Neufeld, GIT
Groundwater Geologist

Reviewed by,

Friesen Drillers Limited

Jeff Bell, P.Eng.
Hydrogeological Engineer

Attachments Driller's logs – Friesen Drillers

References

Bell, J.J., Estrella-Legal, P.J., Neufeld, J.E., and Render, F.W. 2017. Development of a Water Supply in the Carbonate Aquifer for the City of Selkirk, Manitoba; 12th Joint International Association of Hydrogeologists – Canadian National Chapter – 70th Canadian Geotechnical Society Conference Proceedings – Ottawa, Ontario.

Pederson, A. 1987. Groundwater Investigation at Beausejour. Manitoba Water Services Board. Unpublished report.

Limitations

The scope of this report is limited to the matters expressly covered and is intended solely for the client to whom it is addressed. Friesen Drillers Limited makes no warranties, expressed or implied, including without limitation, as to the marketability of the site, or fitness to a particular use. The assessment was conducted using standard engineering and scientific judgment, principles, and practices, within a practical scope and budget. It is based partially on the observations of the assessor during the site visit in conjunction with archival information obtained from a number of sources, which is assumed to be correct. Except as provided, Friesen Drillers Limited has made no independent investigations to verify the accuracy or completeness of the information obtained from secondary sources or personal interviews. Generally, the findings, conclusions, and recommendations are based on a limited amount of data (e.g. number of boreholes drilled or water quality samples submitted for laboratory analysis) interpolated between sampling points and the actual conditions on the site may vary from that described above. Any findings regarding the site conditions different from those described above upon which this report was based will consequently change Friesen Drillers Limited's conclusions and recommendations.

Disclaimer

This Friesen Drillers Limited report has been prepared in response to the specific requests for services from the client to whom it is addressed. The content of this document is not intended to be relied upon by any person, firm, or corporation, other than the client of Friesen Drillers Limited, to who it is addressed. Friesen Drillers Limited denies any liability whatsoever to other parties who may obtain access to this document by them, without express prior written authority of Friesen Drillers Limited and the client who has commissioned this document.

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DRILLERS

Appendix B

Water Rights and Environment Act Licenses
Town of Beausejour

Water Rights Licence 2005-023 & Exhibit A

Environment Act Licence 2085 (-1995) – Town of Beausejour

MG-14854 (English)

Licence to Use Water for Municipal-Distribution System Purposes

Manitoba Water Stewardship
Infrastructure and Operations Division
200 Saulteaux Cresc.
Winnipeg, Manitoba
R3J 3W3

Project: Town of Beausejour

Issued in accordance with the provisions of **The Water Rights Act** and regulations made thereunder.

Licence No.: **2005-023**
(Original Lic. No.: 96-08)
U.T.M.: Zone 14 678660 E
5548070 N

Know all men by these presents that in consideration of and subject to the provisos, conditions and restrictions hereinafter contained, the Minister of Water Stewardship for the Province of Manitoba does by these presents give full right and liberty, leave and licence to **Town of Beausejour** in the Province of Manitoba (hereinafter called "the LICENSEE") to divert water from a **fractured limestone** aquifer by means of three (3) water wells, pumps, pipeline(s) and other appurtenances (hereinafter called "the WORKS"), located on the following described lands:

Main Supply Well - 871 Aston Avenue in the Town of Beausejour, in Lot 3 on Plan 22940 WLTO, Back-up Supply Wells - 914 Park Avenue in the Town of Beausejour, in Lot 4 on Plan 15968 WLTO, all in the Northeast Quarter of Section 36, in Township 12 and Range 7, East of the Principal Meridian in Manitoba

and more particularly shown on a plan filed in the office of the Executive Director, Infrastructure and Operations Division, a copy of which plan is hereto attached and marked Exhibit "A" for **municipal-distribution system** purposes on the following described lands:

Parts of Sections 35 and 36, in Township 12, and parts of Sections 1 and 2, in Township 13, all in Range 7, East of the Principal Meridian in Manitoba.

This licence is issued upon the express condition that it shall be subject to the provisions of The Water Rights Act and Regulations and all amendments thereto and, without limiting the generality of the aforesaid, to the following terms and conditions, namely:

1. The water shall be used solely for **municipal-distribution system** purposes.

2. The WORKS shall be operated in accordance with the terms herein contained.

3. a) The maximum rate at which water may be diverted pursuant hereto shall not exceed **0.0228 cubic metres per second (0.8 cubic feet per second)** .

   b) The total quantity of water diverted in any one year shall not exceed **450 cubic decametres (364.82 acre feet)** .

4. Water shall not be diverted during any period when the water level in the aquifer as measured at the well is more than **23.35 metres (76.6 feet)** beneath the surface of the ground.

5. The LICENSEE does hereby remise, release and forever discharge Her Majesty the Queen in Right of the Province of Manitoba, of and from all manner of action, causes of action, claims and demands whatsoever which against Her Majesty the LICENSEE ever had, now has or may hereafter have, resulting from the use of water for **municipal-distribution system** purposes.

6. In the event that the rights of others are infringed upon and/or damage to the property of others is sustained as a result of the operation or maintenance of the WORKS and the rights herein granted, the LICENSEE shall be solely responsible and shall save harmless and fully indemnify Her Majesty the Queen in Right of the Province of Manitoba, from and against any liability to which Her Majesty may become liable by virtue of the issue of this Licence and anything done pursuant hereto.

7. This Licence is not assignable or transferable by the LICENSEE and when no longer required by the LICENSEE this Licence shall be returned to the Executive Director, Infrastructure and Operations Division, for cancellation on behalf of the Minister.

8. Upon the execution of this Licence the LICENSEE hereby grants the Minister or the Minister's agents the right of ingress and egress to and from the lands on which the WORKS are located for the purpose of inspection of the WORKS and the LICENSEE shall at all times comply with such directions and/or orders that may be given by the Minister or the Minister's agents in writing from time to time with regard to the operation and maintenance of the WORKS.

9. If for any reason whatsoever the Minister deems it advisable to cancel this Licence, he may do so by letter addressed to the LICENSEE at **Box 1028, Beausejour, MB, R0E 0C0, Canada** and thereafter this Licence shall be determined to be at an end.

10. Notwithstanding anything preceding in this Licence, the LICENSEE must have legal control, by ownership or by rental, lease, or other agreement, of the lands on which the WORKS shall be placed and the water shall be used.

11. The term of this Licence shall be **twenty (20) years** and this Licence shall become effective only on the date of execution hereof by a person so authorized in the Department of Water Stewardship. The LICENSEE may apply for renewal of this Licence not more than 365 days and not less than 90 days prior to the expiry date.

12. This Licence expires automatically upon the loss of the legal control of any of the lands on which the WORKS are located or on which water is used, unless the Licence is transferred or amended by the Minister upon application for Licence transfer or amendment.

13. The LICENSEE shall keep records of daily and annual water use and shall provide a copy of such records to the Executive Director, Infrastructure and Operations Division, not later than February 1st of the following year.

14. A flow meter must be installed, positioned to accurately measure instantaneous pumping rate and accumulative withdrawals from the water source.

15. The LICENSEE does hereby agree to correct, to the satisfaction of the Minister, any water supply problems to other currently existing wells, dugouts, or other forms of supply, which are partly or wholly attributable, in the opinion of the Minister, to the diversion of water as authorized by this Licence.

16. The LICENSEE shall hold and maintain all other regulatory approvals that may be required and shall comply with all other regulatory requirements for the construction, operation, or maintenance of the WORKS or to divert or use water as provided by this Licence.

In witness whereof I the undersigned hereby agree to accept the aforesaid Licence on the terms and conditions set forth therein and hereby set my hand and seal this 28th day of April A.D. 2005.

SIGNED, SEALED AND DELIVERED
in the presence of

Witness

Licensee Mayor
Town of Beausejour (Seal)

Canada, PROVINCE OF MANITOBA To Wit:

I, James Fenske of the Town

of Beausejour in the Province of Manitoba, MAKE OATH AND SAY:

1. That I was personally present and did see Harvey J. Giesbrecht, the within named party, execute the within Instrument.

2. That I know the said Harvey J. Giesbrecht and am satisfied that he/she is of the full age of eighteen years.

3. That the said Instrument was executed at the Town of Beausejour aforesaid and that I am subscribing witness thereto.

SWORN BEFORE me at the Town of Beausejour

in the Province of Manitoba this 28th day of April A.D. 2005.

Valerie Ranseth

A COMMISSIONER FOR OATHS
in and for the Province of Manitoba

Witness James Fenske

My Commission expires February 12, 2006

Issued at the City of Winnipeg, in the Province of Manitoba, this 6 day of May A.D. 2005.

The Honourable the Minister of Water Stewardship

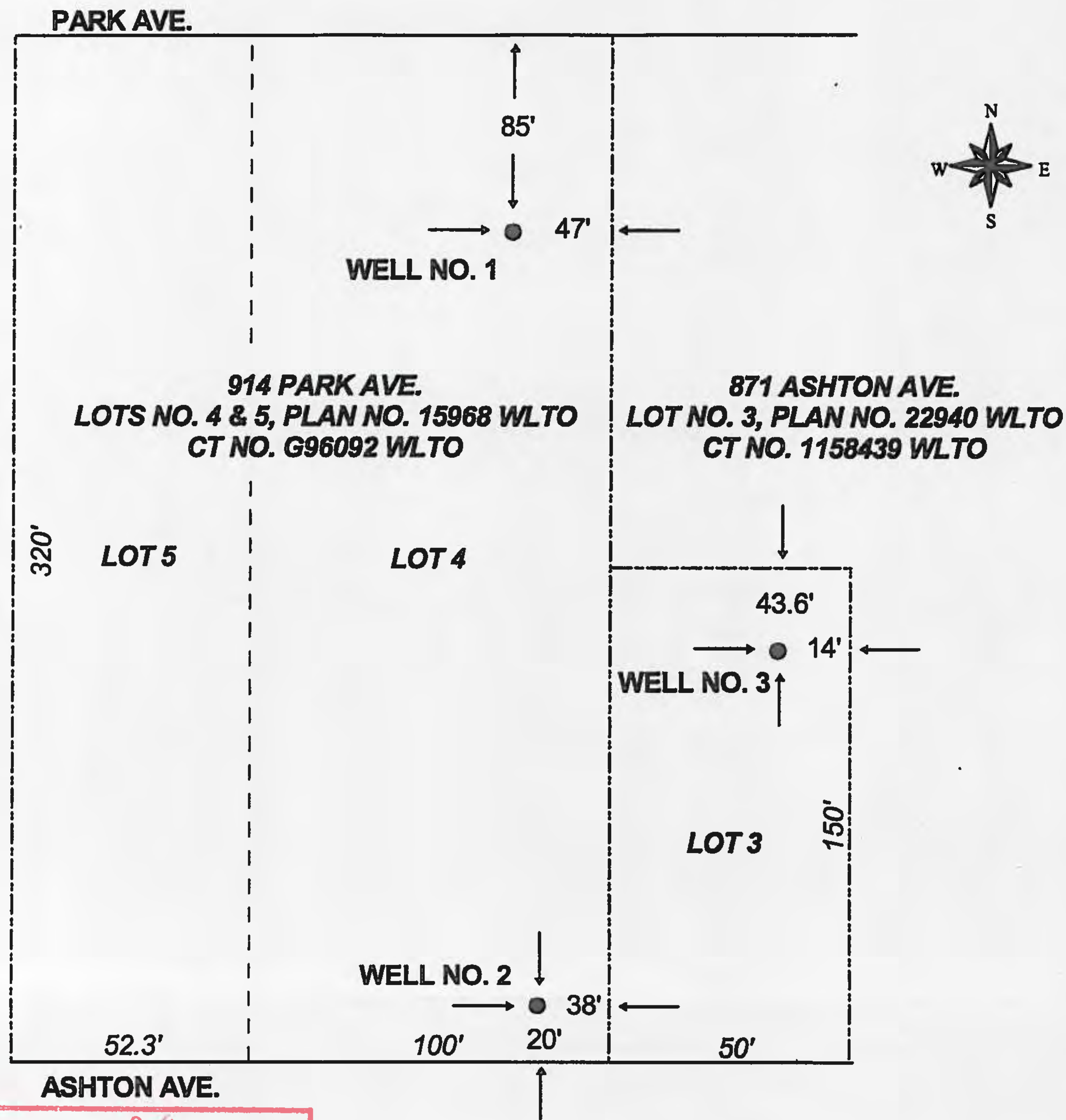

EXHIBIT "A"
THIS PLAN IS AN INTEGRAL PART OF
LICENSE NO 2005-023
ISSUED UNDER THE WATER RIGHTS ACT

LOCATION PLAN OF MUNICIPAL WELLS

FOR

TOWN OF BEAUSEJOUR

IN NE 1/4 SEC 36 - 12 - 7E

K.E.A. MARCH 18, 2005

Town of Beausejour
639 Park Avenue
Box 1028
Beausejour, Manitoba
R0E 0C0

facsimile transmittal

To:	Kristina Anderson	Fax:	(204) 945-7419
From:	Glenn Steinke, B.Sc. Honors	Date:	02/23/05
		Pages:	3

☐ Urgent ☐ For Review ☐ Please Comment ☐ Please Reply ☐ Please Recycle

Re: Environment Act Licence No. 2085 issued to the Town of Beausejour

Environment Act Licence

Manitoba Environment

Licence No. 2085

Issue Date August 1, 1995

In accordance with the Manitoba Environment Act (C.C.S.M. c. E125)

THIS LICENCE IS ISSUED TO:

THE TOWN OF BEAUSEJOUR; "the Licencee"

for the construction and operation of the Development being a municipal water supply well and associated piping located at 914 Park Avenue in the Town of Beausejour, subject to the following specifications, limits, terms and conditions:

SPECIFICATIONS, LIMITS, TERMS AND CONDITIONS

1. The Licencee shall construct the Development in accordance with The Environment Act Proposal dated May 19, 1995.

2. The Licencee shall, prior to the commencement of construction activities, submit plans of all components of the Development for the approval of the Director.

3. The Licencee shall notify the Director of Manitoba Environment's Eastern-Interlake Region not less than two weeks prior to beginning construction of the Development.

4. The Licencee shall ensure that the rate of water withdrawal from the well does not exceed 18.2 litres per second (240 Imperial gallons per minute). Total instantaneous and total annual withdrawals from the combined new and existing water supply system shall be in accordance with limitations specified in a Water Rights Licence issued to the Licencee by Manitoba Natural Resources - Water Resources Branch.

5. The Licencee shall maintain records of daily withdrawals and weekly drawdown levels in each well in the water supply system. These records shall be made available to Manitoba Environment and Manitoba Natural Resources on request.

6. The Licencee shall ensure that approved backflow prevention devices are installed in new connections to the town water supply system where necessary to prevent cross-connections between the Development and existing private water supply systems.

7. The Licencee shall ensure that private water supply wells which may be abandoned as a result of the Development are sealed by a licensed well driller in accordance with the requirements and recommendations of the Groundwater Management Section of the Manitoba Water Resources Branch.

8. The Licencee shall ensure that the operation of the municipal water supply is in accordance with Manitoba Regulations under The Public Health Act and all operating requirements as recommended by Manitoba Environment.

9. The Licencee shall ensure that all used oil products and other regulated hazardous wastes generated by the machinery used in the construction and operation of the Development are collected and disposed of in accordance with all applicable Manitoba Environment and legislation requirements.

10. The Licencee shall ensure that fuel storage areas established for the construction and operation of the Development shall comply with the requirements of ***Manitoba Regulation 97/88R*** respecting ***Storage and Handling of Gasoline and Associated Products.***

REVOCATION

If, in the opinion of the Director, the Licencee has exceeded or is exceeding the limits, or has not complied or is not complying with the specifications, terms or conditions set out herein, the Director may revoke this Licence either temporarily or permanently.

L. Strachan

Larry Strachan, P. Eng.
Director
Environment Act

File No: 4029.00

Friesen
DRILLERS

Appendix C

Groundwater Exploration Permit Application and Authorization

Sustainable Development
Drainage and Water Rights Licensing Branch
Box 16, 200 Saulteaux Crescent
Winnipeg, Manitoba, Canada R3J 3W3
T 204-945-3983 **F** 204-948-2357 **E :** wateruse@gov.mb.ca
www.manitoba.ca

September 14, 2018

File: Town of Beausejour -1

Don Dowle
Chief Administrative Officer
639 Park Avenue, P.O. Box 1028,
Town of Beausejour, MB R0E 0C0

Dear Mr. Dowle:

Attached is a **Groundwater Exploration Permit,** issued in response to your application received on September 10, 2018, for a licence to construct well(s) and divert groundwater in NE 36-12-7 EPM, Rural Municipality of Brokenhead, Manitoba.

The Groundwater Exploration Permit authorizes the Town of Beausejour to carry out exploration test well drilling, construct well(s), and conduct aquifer pump testing. The purpose of the pump testing is to determine if sufficient water is available from the well(s) and from the aquifer to support the project and to determine water level impacts on existing local wells and/or registered projects with earlier precedence dates than the proposed project. Please note that during testing, pumping must cease if any local water supplies are negatively impacted as a result of testing. The Town of Beausejour would further be responsible to correct any water supply problems or provide temporary water supply to anyone whose water supplies are negatively impacted as a result of testing. Please familiarize yourself with the terms and conditions of the Groundwater Exploration Permit.

A licensing decision on this project will be held pending submission of the required information. Please note that diversion of water without a Water Rights Licence or written authorization would constitute a violation of *The Water Rights Act* and may be subject to enforcement.

Please contact Ronaldo Miranda, directly at 204-945-6475 should you have any questions regarding the requirements outlined in this letter and the attached permit or the water rights licensing aspects of this project.

Yours truly,

Kylene Wiseman

Kylene Wiseman, P.Geo.
A/Head of Groundwater Licensing
Drainage & Water Rights Licensing Branch

Cc: Sue Sutherland, CAO, RM of Brokenhead
Justin Neufeld, GIT, Friesen Drillers Ltd.
Ronaldo Miranda, SD

Manitoba
Sustainable Development
Drainage & Water Rights Licensing Branch

FORM F

200 Saulteaux Crescent
Winnipeg, Manitoba
R3J 3W3

Groundwater Exploration Permit

Pursuant to The Water Rights Act

Town of Beausejour

is hereby permitted to construct a water well or wells on the following described lands, **NE 36-12-7 EPM, Rural Municipality of Brokenhead, MB** for **Municipal Purposes**, subject, however, to the following conditions:

1. The permittee must have legal access to the site where the exploration work and project wells are to be located.

2. This Authorization is not transferable or assignable to any other party.

3. Prior to undertaking any work or construction of any works authorized by this permit the permittee is required to retain the services of a hydrogeologist registered with Engineers Geoscientists Manitoba, who would be required to:
   - Plan and supervise the drilling of boreholes, test wells, production wells, observation wells and well pump testing as authorized by this permit.
   - Conduct a constant rate pumping test on proposed production well(s) in accordance with Form H (http://www.gov.mb.ca/conservation/waterstewardship/licensing/wlb/pdf/form_h_july_2013.pdf).
   - Conduct a recovery test for a period equal to pump test or 90% recovery.
   - Carry out an inventory of private and commercial wells within a 1-mile radius surrounding the project well site. The inventory may need to be expanded based on the assessment of the expected area of water level drawdown impact resulting from future pumping.
   - Prepare and submit to the Drainage and Water Rights Licensing Branch a technical report on drilling of boreholes and wells, pump testing of wells, well inventory and water quality sampling. The report would contain, but not limited to, such things as: well driller's reports for test wells, production wells, and observation wells; a plan showing the location of these wells on the property and/or GPS locations of the wells; an analysis of aquifer pumping tests; calculations of transmissivity; and a description of the amount of water level that would be expected to occur at existing local wells that are located within a 1 mile radius of the project well site. <u>Two copies of the report shall be submitted, one hardcopy and one digital copy.</u>

4. During any pumping tests that may be conducted, pumping must cease immediately if any local water supplies are negatively impacted as a result of the tests. The permittee is also responsible to correct any water supply problems or provide temporary water supply to anyone whose water supplies are negatively impacted as a result of the tests.

5. This permit expires within twelve (12) months of the date of issuance.

Issued at the City of Winnipeg in the Province of Manitoba, this 26th day of September, A.D. 2018

for The Honourable Minister of Sustainable Development

Manitoba
Sustainable Development
Water Use Licensing Section
Box 16, 200 Saulteaux Crescent, Winnipeg MB R3J 3W3
T: 204-945-3983 *F: 204-948-2357* *E: wateruse@gov.mb.ca*
www.manitoba.ca

September 20, 2019

File: Beausejour, Town of -1

Don Dowle
Chief Administrative Officer
639 Park Avenue, P.O. Box 1028,
Town of Beausejour, MB R0E 0C0

Dear Mr. Dowle:

This letter is in response to an email from Friesen Drillers Ltd., on behalf of the Town of Beausejour, requesting an extension to the **Groundwater Exploration Permit** issued on September 26, 2018, for one (1) year; as well as the addition of land.

This letter shall amend the **"Groundwater Exploration Permit"** issued to The Town of Beausejour as follows:

Remove –
NE 36-12-7 EPM

Replace with –
NE ½ 26-12-7 EPM

Remove –
5. This permit expires within twelve (12) months of the date of issuance.

Replace with –
5. This permit shall expire on September 26, 2020.

Please attach this letter to your original **"Groundwater Exploration Permit"**. All other terms and conditions shall remain the same.

The issuance of this extension does not imply that the Department will extend or renew the permit in subsequent years.

Please contact Ronaldo Miranda at 204-945-6475 should you have any questions regarding this letter or the water rights licensing aspects of this project.

Yours truly,

Kylene Wiseman

Kylene Wiseman, P. Geo.
A/Head of Groundwater Licensing
Drainage and Water Rights Licensing Branch

Cc: Ronaldo Miranda, (SD)
Justin Neufeld, GIT, Friesen Drillers Ltd.

September 10, 2018

Ms. Kylene Wiseman, P.Geo.
Water Use Licensing Section
Manitoba Sustainable Development
200 Salteaux Crescent
Winnipeg, MB R3J 3V2

Dear Kylene,

Subject **Hydrogeological Test Drilling - Proposed Expansion of the Municipal Groundwater Supply**
Water Rights Licence 2005-023 - Town of Beausejour, Rural Municipality of Brokenhead, Manitoba

Friesen Drillers Ltd. has been retained by the Manitoba Water Services Board to undertake test well drilling and aquifer testing for a proposed expansion of the municipal groundwater supply currently serving the Town of Beausejour. The site is located in the Rural Municipality of Brokenhead in Southeastern Manitoba. The location of the site is shown below as Figure 1.

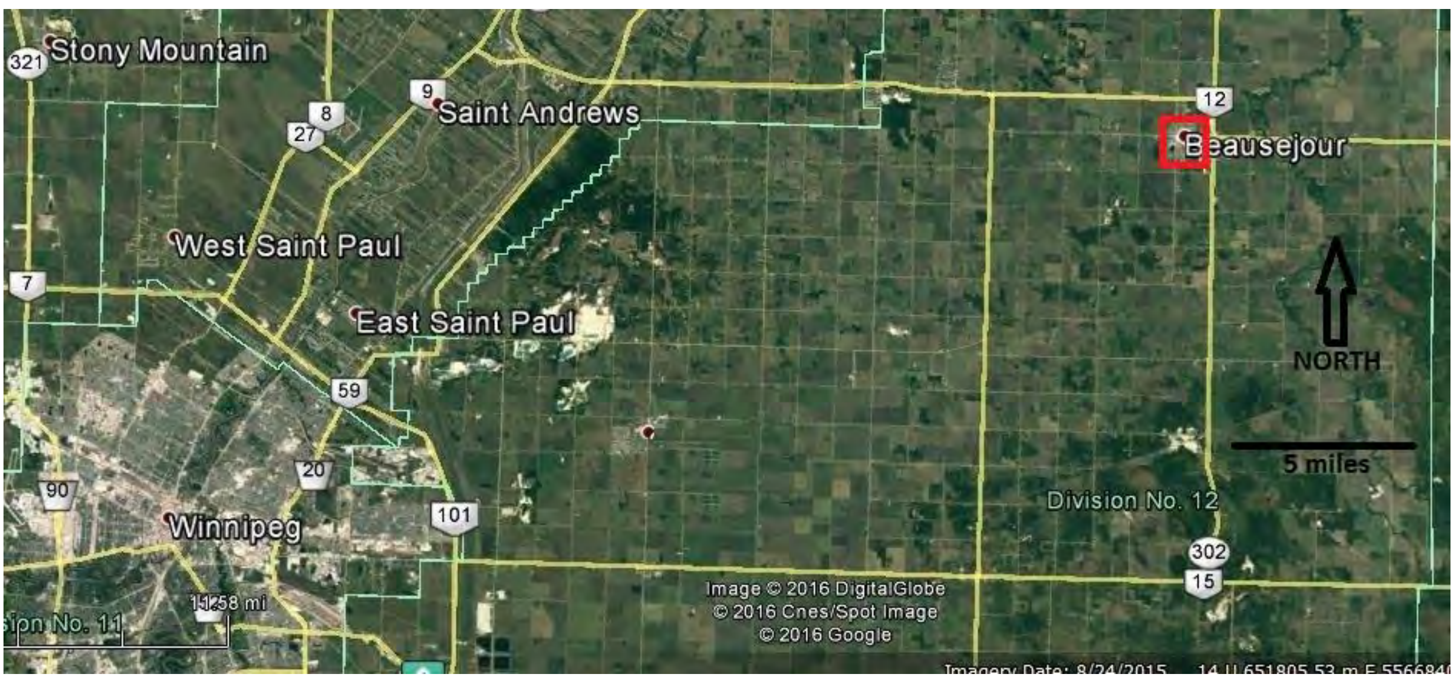

Figure 1 — Location of the project site northeast of the City of Winnipeg in the RM of Broken Head. (Source – Google Earth, 2018)

The Town of Beausejour currently operates a municipal groundwater supply from three production wells located on the grounds of the water treatment plant. The location of the existing system is shown on the following page as Figure 2. The groundwater supply operates under Water Rights Licence number 2005-023. The terms of the licence are valid until the year 2025. In addition, the system has an Environment Act Licence No. 2085, which was issued to the Town in 1995. The testing undertaken during this project is intended to increase the capacity of the existing system.

Friesen Drillers proposes to conduct test drilling to assess the aquifer capacity at a new well site within the Town boundaries. The proposed location for the test well is south of Park Avenue along the west side of Ashton Street. The target area is also shown on Figure 2.

The project will include the construction and testing of a single test well. The test well will be constructed with 5 inch diameter PVC casing through the overburden and completed open hole into the carbonate aquifer. The casing will be set in a 3-tier, step down socket and grouted in place.

Upon completion of the well construction, a pumping test will be conducted on the test well. The initial testing will be conducted at rates up to 100 U.S. Gallons Per Minute. Nearby wells will be instrumented with pressure transducers and the water level in the pumping well will be measured manually with a depth sounder.

Groundwater samples will be collected during the pumping test and sent to an accredited laboratory for analysis of routine parameters and stable environmental isotopes. The results of the test drilling and hydrogeological analysis will be provided in a final report.

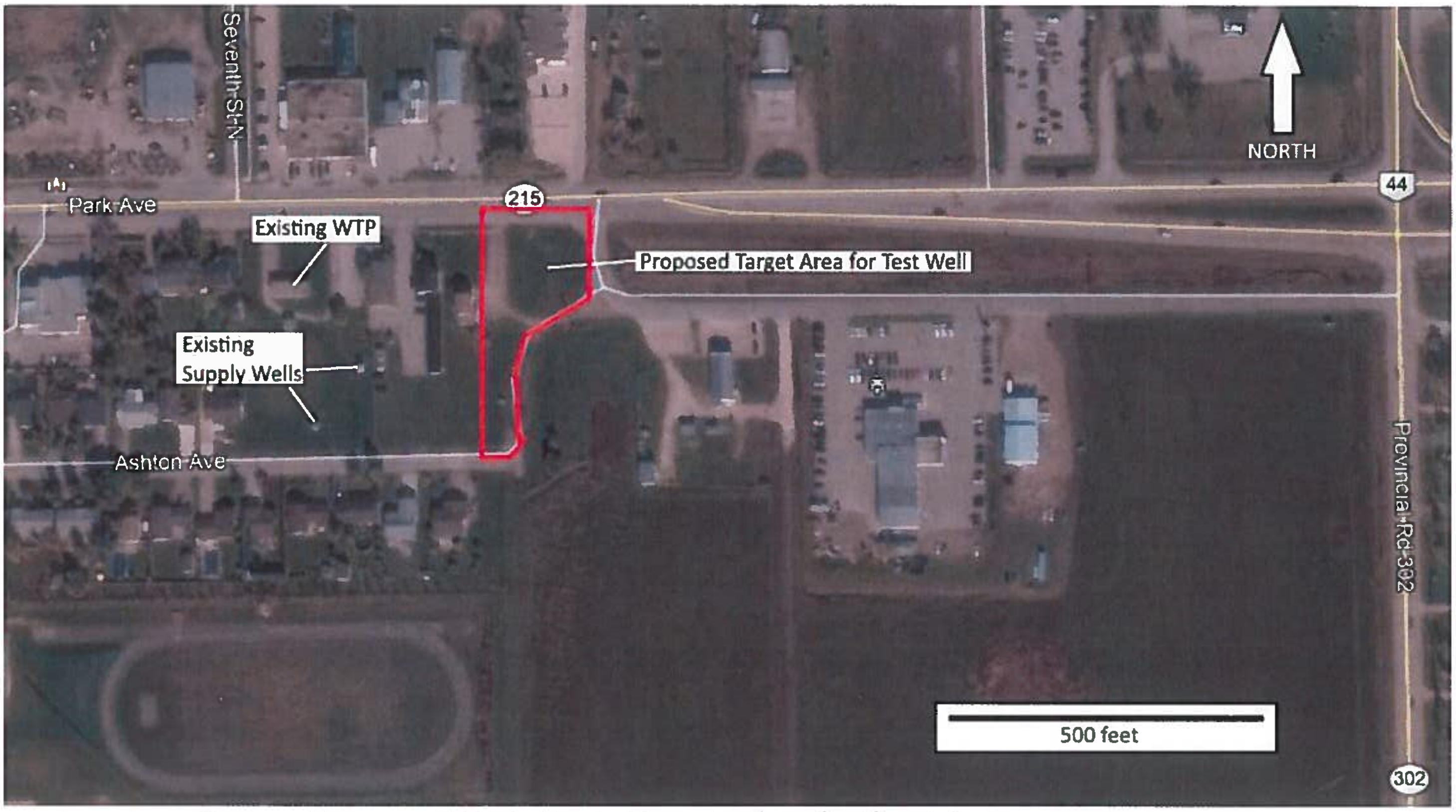

Figure 2 – Target area within the Town of Beausejour is outlined in red. (source – Google Earth, 2018

If a test hole is unsuccessful, it will be sealed and abandoned according to provincial regulations.

A copy of the Application for License to Construct a Well and Divert Groundwater is attached.

Should you require anything further or have additional questions, please call us at 204-326-2485.

Sincerely,

Friesen Drillers Limited

Justin Neufeld, GIT
Groundwater Geologist

Reviewed by:

Friesen Drillers Limited

Jeff Bell, P.Eng.
Hydrogeological Engineer

Attachments　Application for License to Construct a Well and Divert Groundwater – Town of Beausejour.

Friesen DRILLERS

September 13, 2019

Ms. Kylene Wiseman, P.Geo.
Water Use Licensing Section
Manitoba Sustainable Development
200 Salteaux Crescent
Winnipeg, MB R3J 3V2

Dear Kylene,

Subject **Project Update and Permit Extension/Expansion Request – N½ 26-12-07 WPM**
Hydrogeological Test Drilling - Proposed Expansion of the Municipal Groundwater Supply
Water Rights Licence 2005-023 - Town of Beausejour, Rural Municipality of Brokenhead, Manitoba

Friesen Drillers Ltd. is pleased to provide this letter to update the progress of the project and to request that the existing GEP be extended for another 12 month period to allow for additional test work to be completed. It is also requested that the testing area be expanded to include additional testing locations southwest of the main townsite.

Friesen Drillers was retained by the Manitoba Water Services Board in 2018 to undertake hydrogeological test work for a proposed expansion of the municipal groundwater supply serving the Town of Beausejour. The groundwater supply operates under Water Rights Licence number 2005-023. The system also has an Environment Act Licence No. 2085, which was issued to the Town in 1995.

On behalf of the Town of Beausejour, Friesen Drillers applied for a Groundwater Exploration Permit on September 10, 2018 and received a signed permit on September 14, 2018. A copy of the GEP is attached.

Friesen Drillers constructed and tested a total of four test wells at the new and existing water treatment plant sites. The test well locations are shown below in Figure 1.

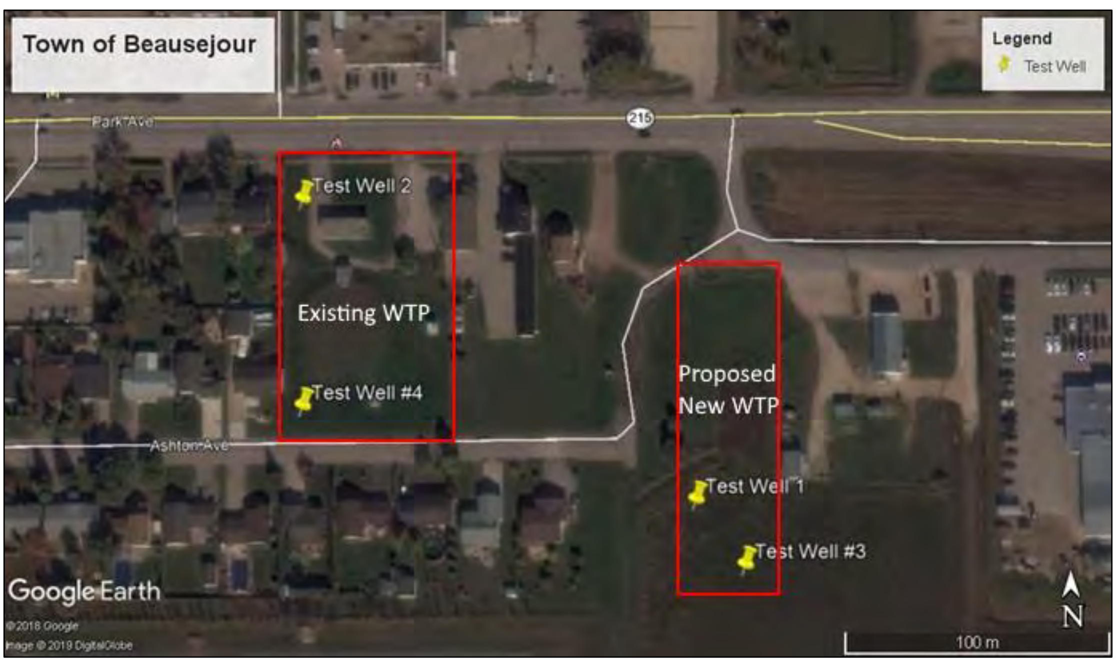

Figure 1 – Four test well locations at two sites in the Town of Beausejour. (source – Google Earth, 2019)

The results of the test work to date have been challenging. The new test wells have either produced large volumes of sand or have resulted in poor well yields. As a result, further test work at locations within town is not recommended.

After discussions with our clients, we have been retained to conduct further testing at N½ 26-12-07 WPM, southwest of Beausejour. The area selected for test work is along the south side of Pescitelli Road (71 N), between Rd. 40 E and Rd. 41 E. The testing would be done at two locations within the provincial road allowance (right-of-way). The proposed testing area is shown below as Figure 2.

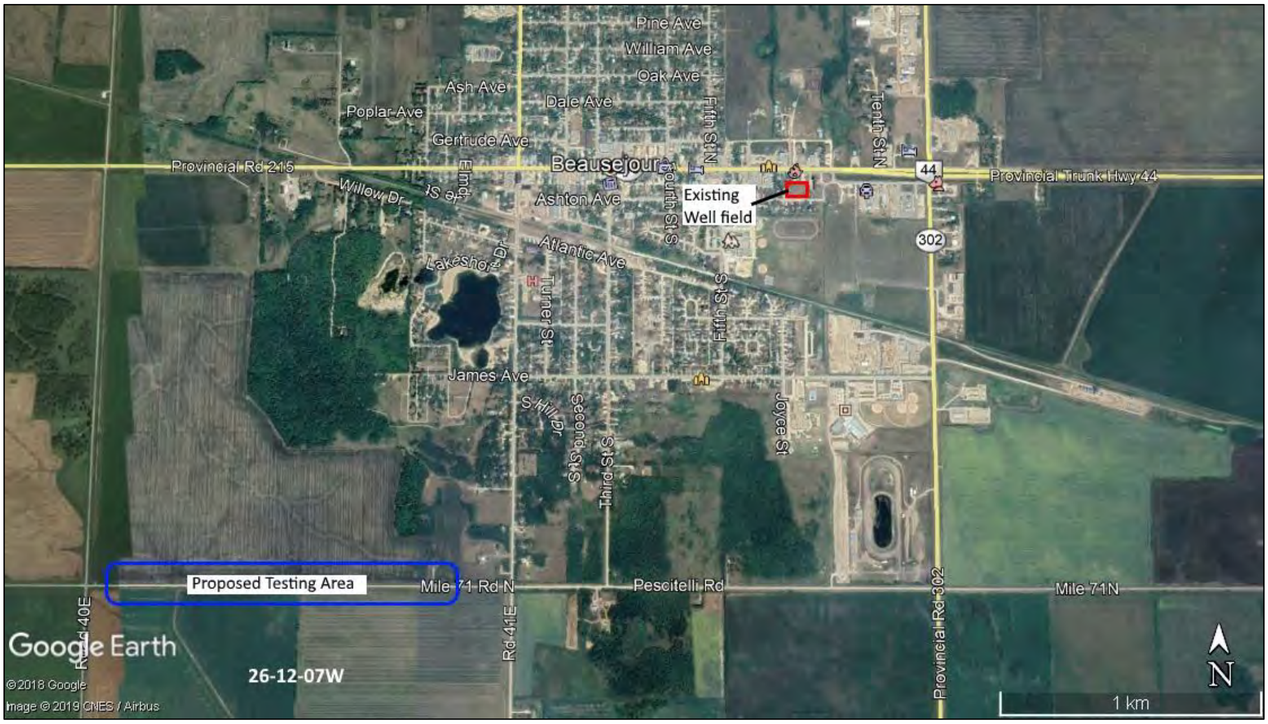

Figure 2 – Proposed testing location along Pescitelli Road (71 N). (Source – Google Earth, 2019)

The additional test work is planned to include the installation and testing of two test wells. The wells will be constructed with 5 inch diameter PVC casing through the overburden with open hole completion into the carbonate aquifer. The casing will be set in a 3-tier, step down socket and grouted in place. After well construction, a short term pumping test will be completed for each test well. The initial testing will be conducted at rates up to 100 U.S. Gallons Per Minute.

Groundwater samples will be collected during the pumping test and sent to an accredited laboratory for analysis of routine parameters and stable environmental isotopes. The results of the test drilling and hydrogeological analysis will be provided in a final report.

If a test hole is unsuccessful, it will be sealed and abandoned according to provincial regulations.

Should you require anything further or have additional questions, please call us at 204-326-2485.

Sincerely,

Friesen Drillers Limited

Justin Neufeld

Justin Neufeld, GIT
Groundwater Geologist

Attachments Groundwater Exploration Permit – Town of Beausejour – September 14, 2018

Friesen
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Appendix D

Well Inventory Results

Desktop Well Inventory Table – 2 Mile Radius

Physical Well Inventory - Letter to Residents; Site Visit Reports

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Content removed due to the sensitive and confidential nature of the information contained this Appendix.

As per requirements for the licence application process, a copy of this Appendix was provided to Manitoba Conservation and Climate - Drainage and Water Rights Licensing Branch

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Appendix E

Borehole Logs – Production and Test Wells
Friesen Drillers Limited

Well Construction Report

Manitoba

Sheet 1 of 1 — For PDF submission: Report must be printed on legal size paper (8.5 x 14 inches) and be signed in ink. — Form No. WELLCON-V01-PDF

Owner Name: Town of Beausejour (First / Last)
Mailing Address
Town/City
Postal Code Phone
Email

Well Location: (see note 3; attach sketch if necessary)
Civic Address (if different than mailing address)
Quarter ___ Section ___ Township ___ Range ___ ☐E ☐W
Parish ___ Type & Lot No. ___

Well Name: (if applicable) West Production Well
Well Identification Tag Number 3339
Location of Tag ☒ Attached to casing stick-up
☐ Other (specify)

GPS: (see note 4), Accuracy +/- 9 ☒ feet ☐ metres
Latitude (decimal degrees) 50.04697
Longitude (decimal degrees) 96.53265

Rockwood Sensitive Area: ☐ Yes - Permit No. ___ ☒ No

Test Hole (see note 5) - Sealed ☐ Yes ☐ No **or**
Well Use: ☐ test well - Sealed ☐ Yes ☐ No
☒ production/source ☐ recharge/return
☐ monitoring ☐ dewatering ☐ geotechnical
☐ other (specify)

Method of Construction:
☐ auger ☐ bored ☐ backhoe/dug
☐ rotary (mud) ☐ rotary (air)
☒ dual rotary ☐ driven ☐ jetted
☐ other (specify)

Water Use: (Check all that apply)
☐ domestic ☒ public/semi-public ☐ irrigation
☐ commercial/industrial ☐ livestock/poultry
☐ earth energy (heating/cooling)
☐ other (specify)

Lithologic Description: (see notes 6 and 7) - Measure From/To depths from ground surface. Attach another sheet if needed.

From (ft)	To (ft)	Colour	Material Description (use recommended names on guide)	Observations
0	5	Grey	Clay	
5	15	Brown	Till	
15	43	Grey	Till	
43	59	Grey	Sand & Gravel	
59	62	Grey	Limestone Rubble	
62	73	Grey	Till	
73	87	Grey	Limestone Rubble	
87	145	Grey	Limestone	
145	-	-	-	Bottom of Hole
0				

Well Construction: (see note 8) - Measure From/To depths from ground surface. Attach another sheet if needed.

From (ft)	To (ft)	Borehole	Casing	Liner	Open Hole	Well Screen	Surface Seal	Annular Fill	Filter Pack	ID (inches)	OD (inches)	Type of Material (ex: casing and screen material, screen type and slot size, use of shale traps, packers, screen blanks or tail pipes, and type and size of surface seal/annular fill/filter pack material)	Method of Placement (ex: poured, tremie)
0	89		X							12	12¾	Welded Black Steel	
89	145				X					11⅞			

Well Completion: Day 31 Month March Year 2020
Top of casing 24 inches ☒ags ☐ bgs; Well vented: ☒ Yes ☐ No
Well disinfected: ☒ Yes ☐ No; Well cover installed: ☒ Yes ☐ No
Pitless adapter/unit installed at ___ feet bgs; ☒Not installed

Source of Drilling Water: ☒ Groundwater ☐ Surface water
Water contains a minimum of 10 mg/L free chlorine: ☒ Yes ☐ No
Name/Location of water source Friesen Drillers Ltd.

Drilling Additives Used: ☒ Yes (list type & quantity) 6 Bags Wyo-Ben Extra High Yield Bentonite ☐ No

Well Yield Test (see note 9),
Date of Test: Day 04 Month February Year 2020
☐ Same as date of well completion
Static Water Level Before Test 13.7 feet ☒ bgs ☐ ags
Method of Test: ☒pumping ☐air lift ☐bailing ☐recovery
☐ other (specify)
Water level at end of test 17.4 feet ☒ bgs ☐ ags
Length of test 72 hours ___ minutes
Estimated rate of discharge 510 ☐IGPM ☒ USGPM

Well Development: ☒ air lifting ☐ surging ☐ pumping ☐ jetting
☐ bailing ☐ hydrofracturing ☐ other (specify)
Water Quality Characteristics: ☒ fresh ☐ salty ☐ clear ☐ cloudy
☐ sediment ☐ odour (specify)

Flowing Artesian Well ☒ No ☐ Yes - If yes, estimated rate of artesian flow ___ ☐IGPM ☐USGPM Annular space cemented: ☐ Yes ☐ No
Flow control device installed: ☐ Yes ☐ No
Does water leak from around the outside of the casing: ☐ Yes ☒ No

Recommended Pumping Rate: 510 ☐IGPM ☒ USGPM with pump intake at 68 feet bgs;
Will your company be installing a pump?: ☐ Yes ☒ No

Remarks (see note 10) Report by Friesen Drillers - March 31, 2020.

Well Drilling Contractor: Company Name Friesen Drillers Ltd Licence No. 607-19
Well Driller: Print Name Peter Friesen / Stanley Flear Signature

Declaration: I certify that to the best of my knowledge the information provided herein is accurate and true and complies with The Groundwater and Water Well Act.

Well Construction Report

Manitoba

Sheet 1 of 1 **For PDF submission: Report must be printed on legal size paper (8.5 x 14 inches) and be signed in ink.** Form No. WELLCON-V01-PDF

Owner Name: Town of Beausejour
First Last
Mailing Address
Town/City
Postal Code Phone
Email

Well Location: (see note 3; attach sketch if necessary)
Civic Address
(if different than mailing address)
Quarter ___ Section ___ Township ___ Range ___ ☐E ☐W
Parish ___ Type & Lot No. ___

Well Name: (if applicable) East Production Well
Well Identification Tag Number 3338
Location of Tag ☒ Attached to casing stick-up
☐ Other (specify)

GPS: (see note 4), Accuracy +/- 9 ☒ feet ☐ metres
Latitude (decimal degrees) 50.04696
Longitude (decimal degrees) 96.52157

Rockwood Sensitive Area: ☐ Yes - Permit No. ___ ☒ No

Test Hole (see note 5) - Sealed ☐ Yes ☐ No **or**
Well Use: ☐ test well - Sealed ☐ Yes ☐ No
☒ production/source ☐ recharge/return
☐ monitoring ☐ dewatering ☐ geotechnical
☐ other (specify)

Method of Construction:
☐ auger ☐ bored ☐ backhoe/dug
☐ rotary (mud) ☐ rotary (air)
☒ dual rotary ☐ driven ☐ jetted
☐ other (specify)

Water Use: (Check all that apply)
☐ domestic ☒ public/semi-public ☐ irrigation
☐ commercial/industrial ☐ livestock/poultry
☐ earth energy (heating/cooling)
☐ other (specify)

Lithologic Description (see notes 6 and 7) - Measure From/To depths from ground surface. Attach another sheet if needed.

From (ft)	To (ft)	Colour	Material Description (use recommended names on guide)	Observations
0	6	Grey	Clay	
6	10	Brown	Till	
10	56		Sand	
56	68		Limestone Rubble	
68	119		Limestone	
119	-	-	-	Bottom of Hole
0				
0				
0				
0				

Well Construction: (see note 8) - Measure From/To depths from ground surface. Attach another sheet if needed.

From (ft)	To (ft)	Borehole	Casing	Liner	Open Hole	Well Screen	Surface Seal	Annular Fill	Filter Pack	ID (inches)	OD (inches)	Type of Material (ex: casing and screen material, screen type and slot size, use of shale traps, packers, screen blanks or tail pipes, and type and size of surface seal/annular fill/filter pack material)	Method of Placement (ex: poured, tremie)
0	70		X							12	12 3/4	Welded Black Steel	
70	119				X					11 3/4			

Well Completion: Day 31 Month March Year 2020
Top of casing 24 inches ☒ags ☐ bgs; Well vented: ☒ Yes ☐ No
Well disinfected: ☒ Yes ☐ No; Well cover installed: ☒ Yes ☐ No
Pitless adapter/unit installed at ___ feet bgs; ☐Not installed

Source of Drilling Water: ☒ Groundwater ☐ Surface water
Water contains a minimum of 10 mg/L free chlorine: ☒ Yes ☐ No
Name/Location of water source Friesen Drillers Ltd.

Drilling Additives Used: ☒ Yes (list type & quantity) Bags Wyo-Ben Extra High Yield Bentonite ☐ No

Well Yield Test (see note 9),
Date of Test: Day 29 Month January Year 2020
☐ Same as date of well completion
Static Water Level Before Test 14.0 feet ☒ bgs ☐ ags
Method of Test: ☒pumping ☐air lift ☐bailing ☐recovery
☐ other (specify)
Water level at end of test 27.1 feet ☒ bgs ☐ ags
Length of test ___ hours 60 minutes
Estimated rate of discharge 955 ☐IGPM ☒ USGPM

Well Development: ☒ air lifting ☐ surging ☐ pumping ☐ jetting
☐ bailing ☐ hydrofracturing ☐ other (specify)
Water Quality Characteristics: ☒ fresh ☐ salty ☐ clear ☐ cloudy
☐ sediment ☐ odour (specify)

Flowing Artesian Well ☒ No ☐ Yes - If yes, estimated rate of artesian flow ___ ☐IGPM ☐ USGPM Annular space cemented: ☐ Yes ☐ No
Flow control device installed: ☐ Yes ☐ No
Does water leak from around the outside of the casing: ☐ Yes ☒ No

Recommended Pumping Rate: 510 ☐IGPM ☒ USGPM with pump intake at 68 feet bgs;
Will your company be installing a pump?: ☐ Yes ☒ No

Remarks (see note 10) Report by Friesen Drillers - March 31, 2020.

Well Drilling Contractor: Company Name Friesen Drillers Ltd Licence No. 607-19
Well Driller: Print Name Jay St. Godard / Stanley Flear Signature

Declaration: I certify that to the best of my knowledge the information provided herein is accurate and true and complies with The Groundwater and Water Well Act.

Well Construction Report

Manitoba

Sheet 1 of 1 — For PDF submission: Report must be printed on legal size paper (8.5 x 14 inches) and be signed in ink. — Form No. WELLCON-V01-PDF

Owner Name: Town of Beausejour (First / Last)
Mailing Address
Town/City
Postal Code — Phone
Email

Well Location: (see note 3; attach sketch if necessary)
Civic Address (if different than mailing address)
Quarter ___ Section ___ Township ___ Range ___ ☐E ☐W
Parish ___ Type & Lot No. ___

Well Name: (if applicable) West Test Well
Well Identification Tag Number 3339
Location of Tag ☒ Attached to casing stick-up
☐ Other (specify)

GPS: (see note 4), Accuracy +/- 9 ☒ feet ☐ metres
Latitude (decimal degrees) 50.04697
Longitude (decimal degrees) 96.53265
Rockwood Sensitive Area: ☐ Yes - Permit No. ___ ☒ No

Test Hole (see note 5) - Sealed ☐ Yes ☐ No **or**
Well Use: ☒ test well - Sealed ☐ Yes ☐ No
☐ production/source ☐ recharge/return
☐ monitoring ☐ dewatering ☐ geotechnical
☐ other (specify)

Method of Construction:
☐ auger ☐ bored ☐ backhoe/dug
☒ rotary (mud) ☐ rotary (air)
☐ dual rotary ☐ driven ☐ jetted
☐ other (specify)

Water Use: (Check all that apply)
☐ domestic ☒ public/semi-public ☐ irrigation
☐ commercial/industrial ☐ livestock/poultry
☐ earth energy (heating/cooling)
☐ other (specify)

Lithologic Description: (see notes 6 and 7) Measure From/To depths from ground surface. Attach another sheet if needed.

From (ft)	To (ft)	Colour	Material Description (use recommended names on guide)	Observations
0	5	Grey	Clay	
5	15	Brown	Till	
15	43	Grey	Till	
43	53		Sand	
53	59		Gravel	
59	62		Limestone	
62	73	Grey	Till	
73	87		Limestone Rubble	
87	146		Limestone	
146	147	Blue	Shale	

Well Construction: (see note 8) - Measure From/To depths from ground surface. Attach another sheet if needed.

From (ft)	To (ft)	Borehole	Casing	Liner	Open Hole	Well Screen	Surface Seal	Annular Fill	Filter Pack	ID (inches)	OD (inches)	Type of Material (ex: casing and screen material, screen type and slot size, use of shale traps, packers, screen blanks or tail pipes, and type and size of surface seal/annular fill/filter pack material)	Method of Placement (ex: poured, tremie)
0	89	X									7 7/8		
0	89		X							5	5½	Insert Glued PVC	
89	147				X						4¾		
0	89						X					Envirogrout	Poured

Well Completion: Day 16 Month October Year 2019
Top of casing 24 inches ☒ags ☐ bgs; Well vented: ☒ Yes ☐ No
Well disinfected: ☒ Yes ☐ No; Well cover installed: ☒ Yes ☐ No
Pitless adapter/unit installed at ___ feet bgs; ☒Not installed

Source of Drilling Water: ☒ Groundwater ☐ Surface water
Water contains a minimum of 10 mg/L free chlorine: ☒ Yes ☐ No
Name/Location of water source Friesen Drillers Ltd.

Drilling Additives Used: ☒ Yes (list type & quantity) 6 Bags Wyo-Ben Extra High Yield Bentonite ☐ No

Well Yield Test (see note 9),
Date of Test: Day ___ Month ___ Year 20___
☒ Same as date of well completion
Static Water Level Before Test 10.4 feet ☒ bgs ☐ ags
Method of Test: ☒pumping ☐air lift ☐bailing ☐recovery
☐ other (specify)
Water level at end of test 10.5 feet ☒ bgs ☐ ags
Length of test 1 hours ___ minutes
Estimated rate of discharge 25 ☒IGPM ☐ USGPM

Well Development: ☒ air lifting ☐ surging ☐ pumping ☐ jetting
☐ bailing ☐ hydrofracturing ☐ other (specify)
Water Quality Characteristics: ☒ fresh ☐ salty ☐ clear ☐ cloudy
☐ sediment ☐ odour (specify)

Flowing Artesian Well ☒ No ☐ Yes - If yes, estimated rate of artesian flow ___ ☐IGPM ☐USGPM Annular space cemented: ☐ Yes ☐ No
Flow control device installed: ☐ Yes ☐ No
Does water leak from around the outside of the casing: ☐ Yes ☒ No

Recommended Pumping Rate: ___ ☒IGPM ☐ USGPM with pump intake at ___ feet bgs;
Will your company be installing a pump?: ☐ Yes ☒ No

Remarks (see note 10) Grains Hardness: 23 Well must be vented.

Well Drilling Contractor: Company Name Friesen Drillers Ltd Licence No. 607-19
Well Driller: Print Name Mason Friesen / Tyler Chambers Signature

Declaration: I certify that to the best of my knowledge the information provided herein is accurate and true and complies with The Groundwater and Water Well Act.

Well Construction Report

Manitoba

Sheet 1 of 1 — For PDF submission: Report must be printed on legal size paper (8.5 x 14 inches) and be signed in ink. — Form No. WELLCON-V01-PDF

Owner Name: Town of Beausejour (First / Last)
Mailing Address
Town/City
Postal Code — Phone
Email

Well Location: (see note 3; attach sketch if necessary)
Civic Address (if different than mailing address)
Quarter ___ Section ___ Township ___ Range ___ ☐E ☐W
Parish ___ Type & Lot No. ___

Well Name: (if applicable) East Test Well
Well Identification Tag Number 3338
Location of Tag ☒ Attached to casing stick-up
☐ Other (specify)

GPS: (see note 4), Accuracy +/- 9 ☒ feet ☐ metres
Latitude (decimal degrees) 50.04696
Longitude (decimal degrees) 96.52157

Rockwood Sensitive Area: ☐ Yes - Permit No. ___ ☒ No

Test Hole (see note 5) - Sealed ☐ Yes ☐ No **or**
Well Use: ☐ test well - Sealed ☐ Yes ☐ No
☒ production/source ☐ recharge/return
☐ monitoring ☐ dewatering ☐ geotechnical
☐ other (specify)

Method of Construction:
☐ auger ☐ bored ☐ backhoe/dug
☒ rotary (mud) ☐ rotary (air)
☐ dual rotary ☐ driven ☐ jetted
☐ other (specify)

Water Use: (Check all that apply)
☒ domestic ☐ public/semi-public ☐ irrigation
☐ commercial/industrial ☐ livestock/poultry
☐ earth energy (heating/cooling)
☐ other (specify)

Lithologic Description: (see notes 6 and 7) Measure From/To depths from ground surface. Attach another sheet if needed.

From (ft)	To (ft)	Colour	Material Description (use recommended names on guide)	Observations
0	6	Grey	Clay	
6	10	Brown	Till	
10	56		Sand	
56	68		Limestone Rubble With Till	
68	71		Limestone	
71	82		Limestone Rubble	
82	119		Limestone	
119				
0				
0				

Well Construction: (see note 8) - Measure From/To depths from ground surface. Attach another sheet if needed.

From (ft)	To (ft)	Borehole	Casing	Liner	Open Hole	Well Screen	Surface Seal	Annular Fill	Filter Pack	ID (inches)	OD (inches)	Type of Material (ex: casing and screen material, screen type and slot size, use of shale traps, packers, screen blanks or tail pipes, and type and size of surface seal/annular fill/filter pack material)	Method of Placement (ex: poured, tremie)
0	70	X									7 7/8		
0	70		X							5	5½	Insert Glued PVC	
70	119				X						4¾		
0	70						X					Envirogrout	Poured

Well Completion: Day 15 Month October Year 20 19
Top of casing 36 inches ☒ ags ☐ bgs; Well vented: ☒ Yes ☐ No
Well disinfected: ☒ Yes ☐ No; Well cover installed: ☒ Yes ☐ No
Pitless adapter/unit installed at ___ feet bgs; ☒ Not installed

Source of Drilling Water: ☒ Groundwater ☐ Surface water
Water contains a minimum of 10 mg/L free chlorine: ☒ Yes ☐ No
Name/Location of water source Friesen Drillers Ltd.

Drilling Additives Used: ☒ Yes (list type & quantity) 6 Bags Wyo-Ben Extra High Yield Bentonite ☐ No

Well Yield Test (see note 9),
Date of Test: Day ___ Month ___ Year 20 ___
☒ Same as date of well completion
Static Water Level Before Test 16 feet ☒ bgs ☐ ags
Method of Test: ☒ pumping ☐ air lift ☐ bailing ☐ recovery
☐ other (specify)
Water level at end of test 16.63 feet ☒ bgs ☐ ags
Length of test 1 hours ___ minutes
Estimated rate of discharge 25 ☒ IGPM ☐ USGPM

Well Development: ☒ air lifting ☐ surging ☐ pumping ☐ jetting
☐ bailing ☐ hydrofracturing ☐ other (specify)
Water Quality Characteristics: ☒ fresh ☐ salty ☐ clear ☐ cloudy
☐ sediment ☐ odour (specify)

Flowing Artesian Well ☒ No ☐ Yes - If yes, estimated rate of artesian flow ___ ☐ IGPM ☐ USGPM Annular space cemented: ☐ Yes ☐ No
Flow control device installed: ☐ Yes ☐ No
Does water leak from around the outside of the casing: ☐ Yes ☒ No

Recommended Pumping Rate: ___ ☒ IGPM ☐ USGPM with pump intake at ___ feet bgs;
Will your company be installing a pump?: ☐ Yes ☒ No

Remarks (see note 10) Grains Hardness: 24 Well must be vented.

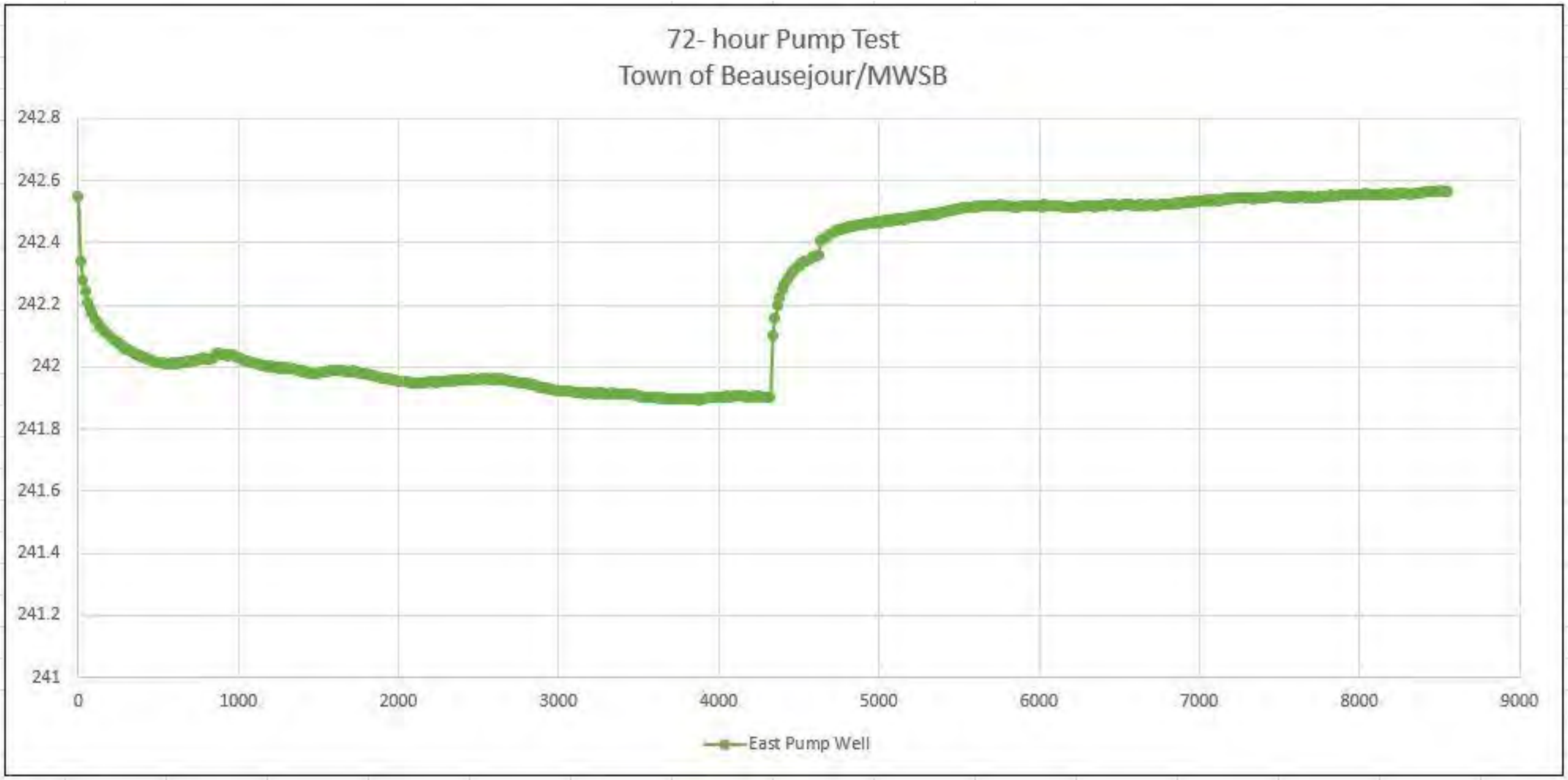
Well Drilling Contractor: Company Name Friesen Drillers Ltd Licence No. 607-19
Well Driller: Print Name Mason Friesen /Tyler Chambers Signature

Declaration: I certify that to the best of my knowledge the information provided herein is accurate and true and complies with The Groundwater and Water Well Act.

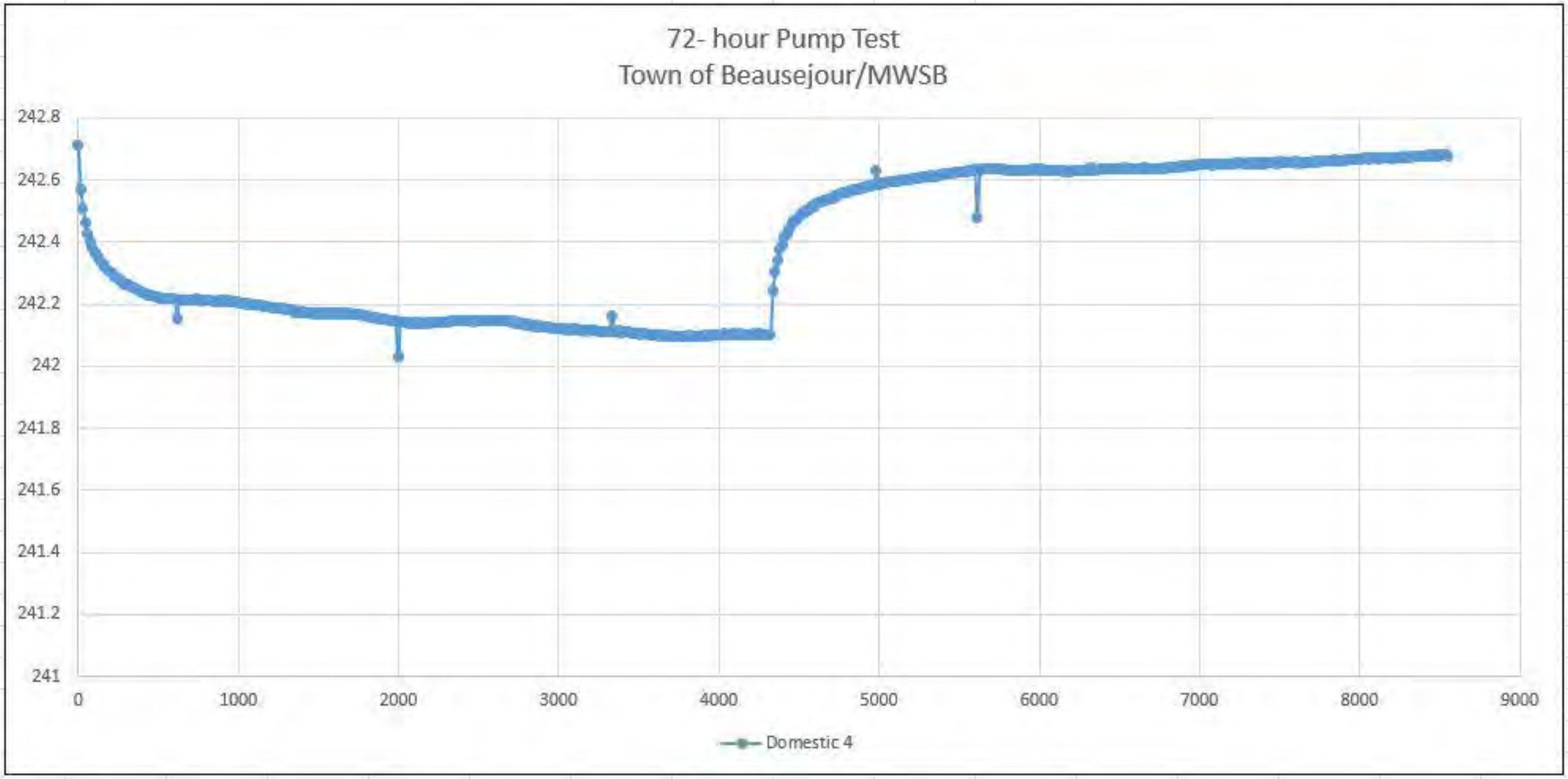
Friesen
DRILLERS

Appendix F

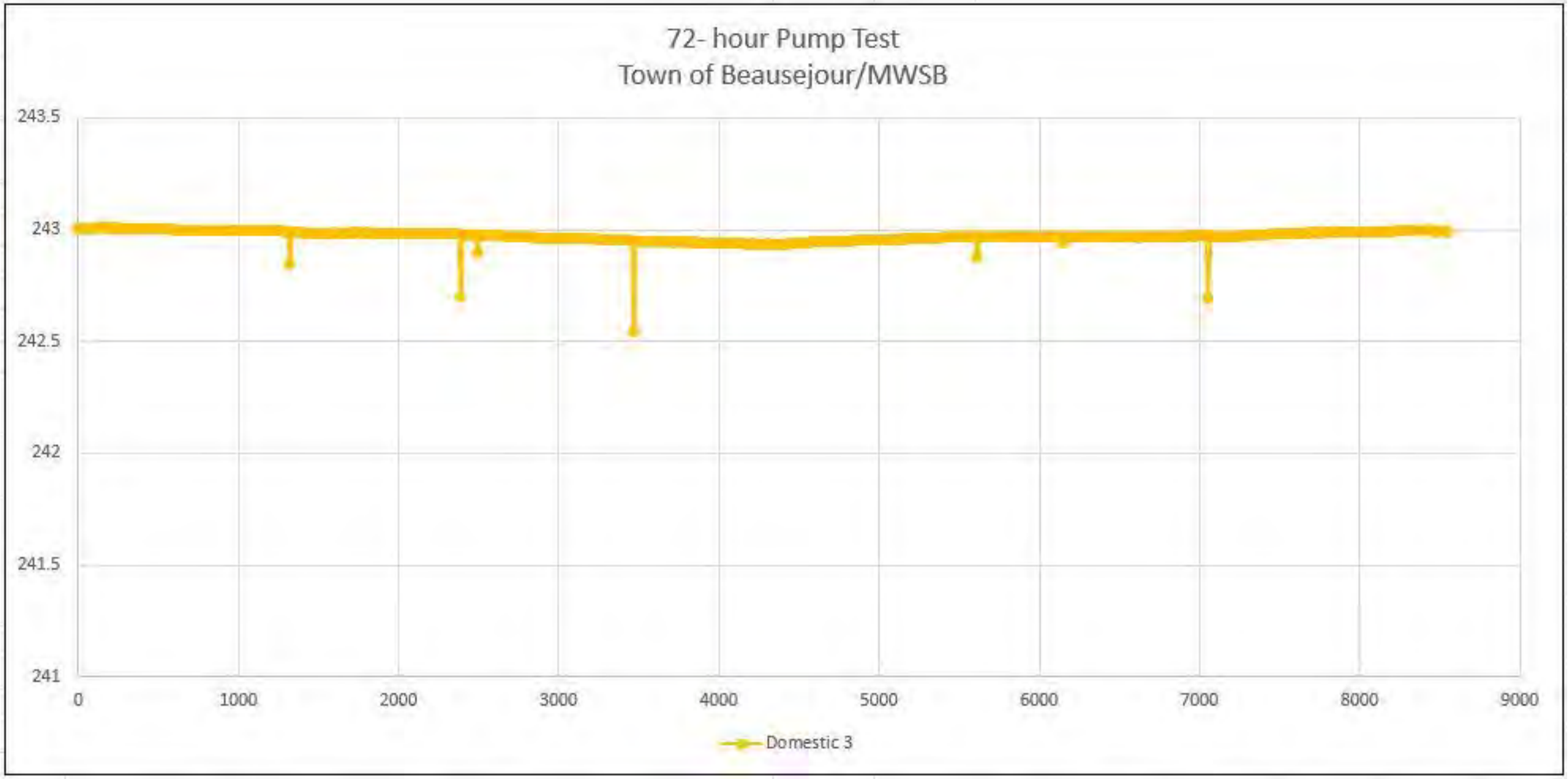
Transducer Hydrograph Plots

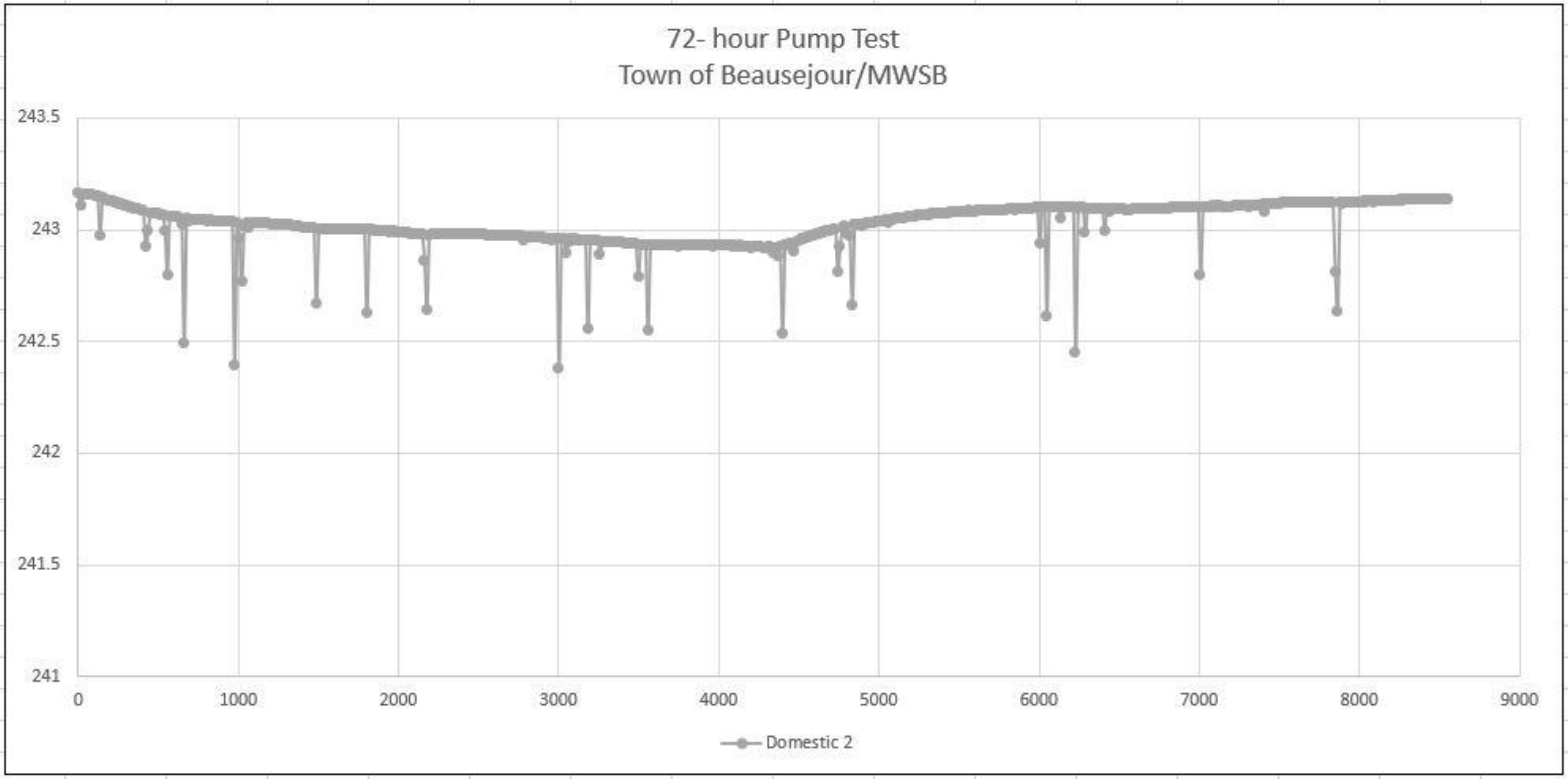


72- hour Pump Test
Town of Beausejour/MWSB
242.8
242.6
242.4
242.2
242
241.8
241.6
241.4
241.2
241
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
East Pump Well

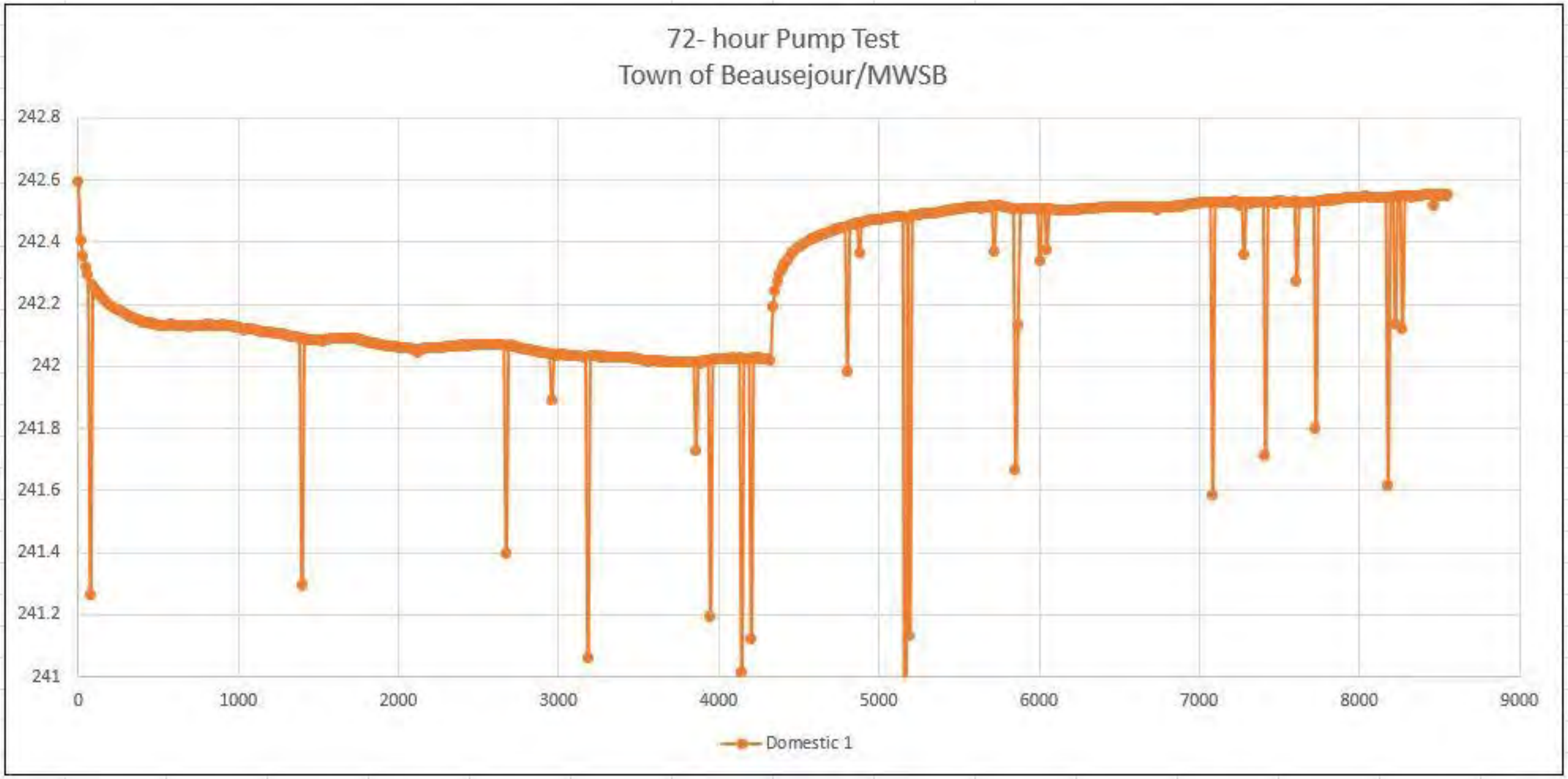


72- hour Pump Test
Town of Beausejour/MWSB
242.8
242.6
242.4
242.2
242
241.8
241.6
241.4
241.2
241
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
Domestic 4

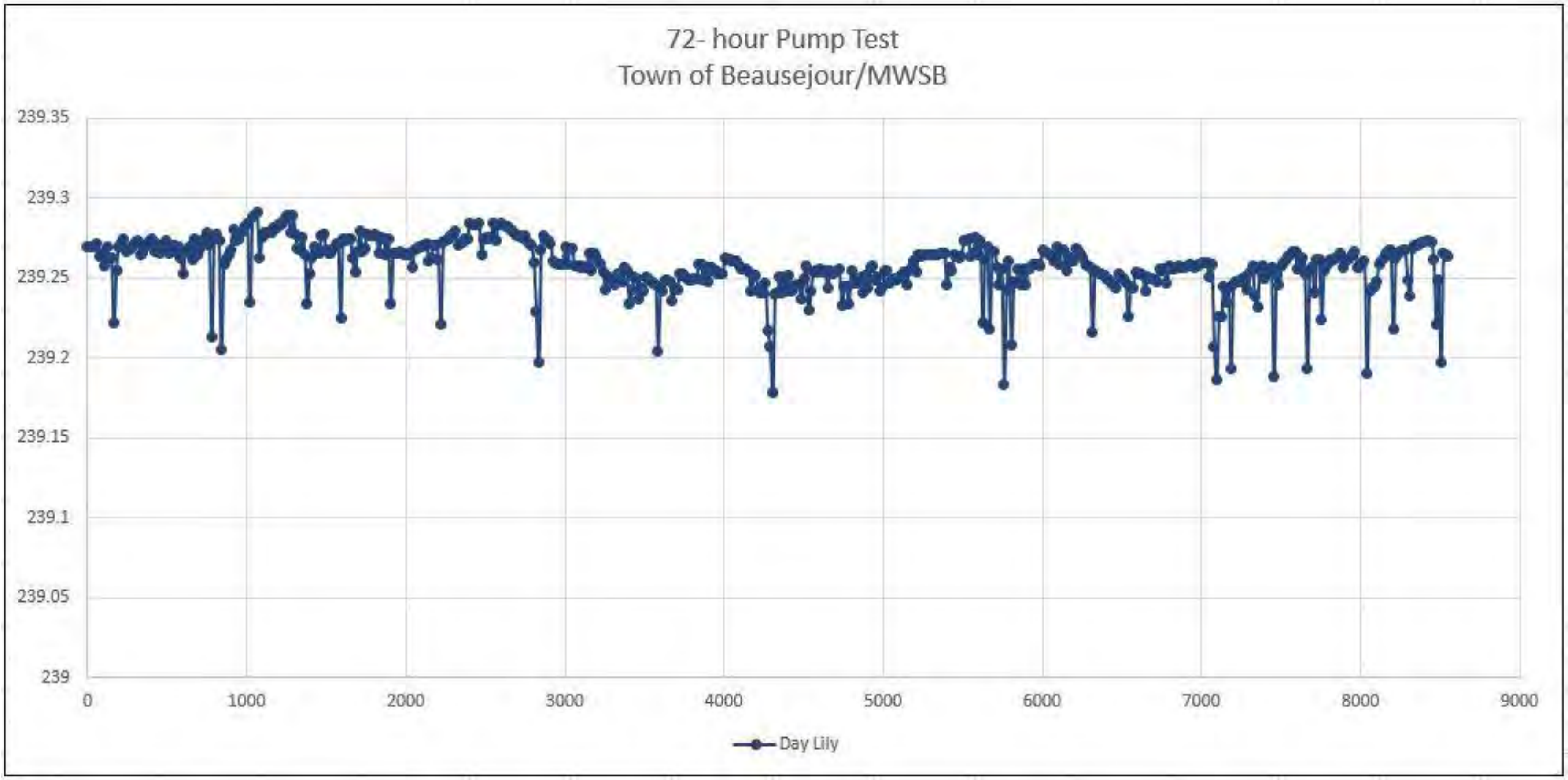

72- hour Pump Test
Town of Beausejour/MWSB
243.5
243
242.5
242
241.5
241
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
Domestic 3



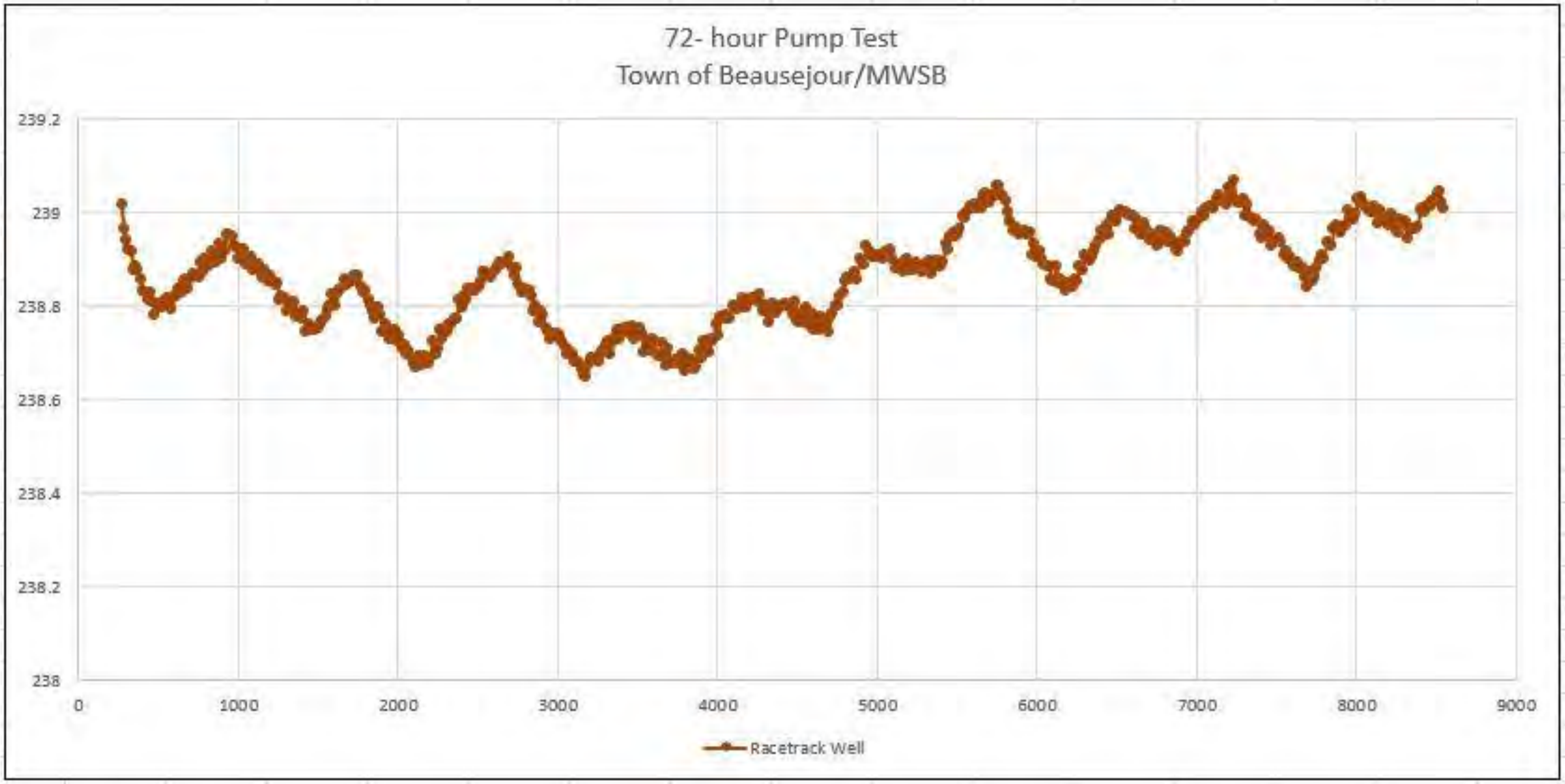
72- hour Pump Test
Town of Beausejour/MWSB
243.5
243
242.5
242
241.5
241
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
Domestic 2



72- hour Pump Test
Town of Beausejour/MWSB
242.8
242.6
242.4
242.2
242
241.8
241.6
241.4
241.2
241
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
Domestic 1



72- hour Pump Test
Town of Beausejour/MWSB
239.35
239.3
239.25
239.2
239.15
239.1
239.05
239
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
Day Lily


72- hour Pump Test
Town of Beausejour/MWSB
239.2
239
238.8
238.6
238.4
238.2
238
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
Racetrack Well

Friesen DRILLERS

Appendix G

Pumping Test Data

72 Hour Pumping Test (West Well)
Short Term Capacity Test (East Well)

	Pumping Test - Water Level Data Page 1 of 8
	Project: Town of Beausejour
	Number: Feb2020
	Client: MWSB

Location: Pescitelli Road	Pumping Test: Pumping Test 1	Pumping Well: West Production Well
Test Conducted by: FDL	Test Date: 2/4/2020	Discharge: variable, average rate 510 [U.S. gal/mi
Observation Well: West Production Well	Static Water Level [ft]: 0.00	Radial Distance to PW [m]: -

	Time [min]	Water Level [ft]	Drawdown [ft]
1	0	0.00	0.00
2	1	1.71	1.71
3	2	1.77	1.77
4	3	1.84	1.84
5	4	1.87	1.87
6	5	1.90	1.90
7	6	1.92	1.92
8	7	1.94	1.94
9	8	1.95	1.95
10	9	1.97	1.97
11	10	2.01	2.01
12	12	2.04	2.04
13	14	2.07	2.07
14	16	2.27	2.27
15	18	2.28	2.28
16	20	2.31	2.31
17	25	2.26	2.26
18	30	2.38	2.38
19	35	2.42	2.42
20	40	2.47	2.47
21	50	2.50	2.50
22	60	2.59	2.59
23	75	2.64	2.64
24	90	2.66	2.66
25	105	2.74	2.74
26	120	2.74	2.74
27	135	2.81	2.81
28	150	2.84	2.84
29	165	2.87	2.87
30	180	2.84	2.84
31	195	2.86	2.86
32	210	2.93	2.93
33	225	2.95	2.95
34	240	2.96	2.96
35	300	3.01	3.01
36	360	3.08	3.08
37	420	3.26	3.26
38	480	3.26	3.26
39	540	3.32	3.32
40	600	3.34	3.34
41	660	3.35	3.35
42	720	3.34	3.34
43	780	3.42	3.42
44	840	3.36	3.36
45	900	3.39	3.39
46	960	3.39	3.39
47	1020	3.43	3.43
48	1080	3.49	3.49

Pumping Test - Water Level Data	Page 2 of 8
Project: Town of Beausejour	
Number: Feb2020	
Client: MWSB	

	Time [min]	Water Level [ft]	Drawdown [ft]
49	1140	3.47	3.47
50	1200	3.47	3.47
51	1260	3.46	3.46
52	1320	3.39	3.39
53	1380	3.42	3.42
54	1440	3.43	3.43
55	1560	3.43	3.43
56	1680	3.43	3.43
57	1800	3.44	3.44
58	1920	3.55	3.55
59	2040	3.59	3.59
60	2160	3.64	3.64
61	2280	3.58	3.58
62	2400	3.54	3.54
63	2520	3.58	3.58
64	2640	3.58	3.58
65	2760	3.52	3.52
66	2880	3.53	3.53
67	3000	3.56	3.56
68	3120	3.59	3.59
69	3240	3.63	3.63
70	3360	3.68	3.68
71	3480	3.63	3.63
72	3600	3.71	3.71
73	3720	3.71	3.71
74	3840	3.68	3.68
75	3960	3.70	3.70
76	4080	3.66	3.66
77	4200	3.60	3.60
78	4320	3.61	3.61
79	4321	1.7007	1.7007
80	4322	1.6507	1.6507
81	4323	1.6007	1.6007
82	4324	1.5607	1.5607
83	4325	1.5307	1.5307
84	4326	1.5107	1.5107
85	4327	1.4907	1.4907
86	4328	1.4607	1.4607
87	4329	1.4507	1.4507
88	4330	1.4407	1.4407
89	4331	1.4207	1.4207
90	4332	1.4007	1.4007
91	4333	1.3807	1.3807
92	4334	1.3607	1.3607
93	4335	1.3607	1.3607
94	4336	1.3407	1.3407
95	4337	1.3307	1.3307
96	4338	1.3107	1.3107
97	4339	1.3107	1.3107
98	4340	1.3007	1.3007
99	4342	1.2707	1.2707
100	4344	1.2607	1.2607
101	4346	1.2407	1.2407

Pumping Test - Water Level Data

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
102	4348	1.2207	1.2207
103	4350	1.2107	1.2107
104	4355	1.1607	1.1607
105	4360	1.1407	1.1407
106	4365	1.1107	1.1107
107	4370	1.0807	1.0807
108	4375	1.0607	1.0607
109	4380	1.0307	1.0307
110	4390	0.8307	0.8307
111	4400	0.7907	0.7907
112	4410	0.7607	0.7607
113	4420	0.7307	0.7307
114	4430	0.7107	0.7107
115	4440	0.6907	0.6907
116	4455	0.6607	0.6607
117	4470	0.6207	0.6207
118	4485	0.6107	0.6107
119	4500	0.5907	0.5907
120	4515	0.5607	0.5607
121	4530	0.5507	0.5507
122	4545	0.5307	0.5307
123	4560	0.5207	0.5207
124	4575	0.5107	0.5107
125	4590	0.5007	0.5007
126	4605	0.4907	0.4907
127	4620	0.4707	0.4707
128	4635	0.4707	0.4707
129	4650	0.4655	0.4655
130	4665	0.4567	0.4567
131	4680	0.4455	0.4455
132	4695	0.4355	0.4355
133	4710	0.4263	0.4263
134	4725	0.4125	0.4125
135	4740	0.4103	0.4103
136	4755	0.3977	0.3977
137	4770	0.3897	0.3897
138	4785	0.3838	0.3838
139	4800	0.3752	0.3752
140	4815	0.3724	0.3724
141	4830	0.3648	0.3648
142	4845	0.3615	0.3615
143	4860	0.3534	0.3534
144	4875	0.3515	0.3515
145	4890	0.3527	0.3527
146	4905	0.3506	0.3506
147	4920	0.3452	0.3452
148	4935	0.3456	0.3456
149	4950	0.3382	0.3382
150	4965	0.3366	0.3366
151	4980	0.3329	0.3329
152	4995	0.3345	0.3345
153	5010	0.3343	0.3343
154	5025	0.3252	0.3252

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
155	5040	0.3251	0.3251
156	5055	0.3251	0.3251
157	5070	0.3211	0.3211
158	5085	0.3178	0.3178
159	5100	0.3174	0.3174
160	5115	0.3139	0.3139
161	5130	0.3129	0.3129
162	5145	0.3095	0.3095
163	5160	0.3115	0.3115
164	5175	0.3098	0.3098
165	5190	0.3012	0.3012
166	5205	0.2948	0.2948
167	5220	0.2895	0.2895
168	5235	0.2955	0.2955
169	5250	0.2895	0.2895
170	5265	0.2812	0.2812
171	5280	0.2828	0.2828
172	5295	0.279	0.279
173	5310	0.2793	0.2793
174	5325	0.2732	0.2732
175	5340	0.2694	0.2694
176	5355	0.2703	0.2703
177	5370	0.2655	0.2655
178	5385	0.256	0.256
179	5400	0.2501	0.2501
180	5415	0.2458	0.2458
181	5430	0.2423	0.2423
182	5445	0.2387	0.2387
183	5460	0.2366	0.2366
184	5475	0.2309	0.2309
185	5490	0.2285	0.2285
186	5505	0.2289	0.2289
187	5520	0.2247	0.2247
188	5535	0.2222	0.2222
189	5550	0.2167	0.2167
190	5565	0.2152	0.2152
191	5580	0.2119	0.2119
192	5595	0.2093	0.2093
193	5610	0.208	0.208
194	5625	0.2071	0.2071
195	5640	0.208	0.208
196	5655	0.205	0.205
197	5670	0.2037	0.2037
198	5685	0.2001	0.2001
199	5700	0.203	0.203
200	5715	0.1977	0.1977
201	5730	0.2034	0.2034
202	5745	0.2043	0.2043
203	5760	0.1975	0.1975
204	5775	0.1992	0.1992
205	5790	0.2035	0.2035
206	5805	0.2084	0.2084
207	5820	0.21	0.21

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
208	5835	0.2129	0.2129
209	5850	0.2223	0.2223
210	5865	0.2189	0.2189
211	5880	0.2164	0.2164
212	5895	0.2185	0.2185
213	5910	0.2223	0.2223
214	5925	0.2169	0.2169
215	5940	0.2143	0.2143
216	5955	0.2171	0.2171
217	5970	0.2194	0.2194
218	5985	0.2134	0.2134
219	6000	0.2147	0.2147
220	6015	0.2146	0.2146
221	6030	0.2126	0.2126
222	6045	0.2158	0.2158
223	6060	0.2128	0.2128
224	6075	0.212	0.212
225	6090	0.2157	0.2157
226	6105	0.2162	0.2162
227	6120	0.2187	0.2187
228	6135	0.2231	0.2231
229	6150	0.2254	0.2254
230	6165	0.2218	0.2218
231	6180	0.2234	0.2234
232	6195	0.2179	0.2179
233	6210	0.2203	0.2203
234	6225	0.2212	0.2212
235	6240	0.222	0.222
236	6255	0.2148	0.2148
237	6270	0.2208	0.2208
238	6285	0.2135	0.2135
239	6300	0.2196	0.2196
240	6315	0.2133	0.2133
241	6330	0.2131	0.2131
242	6345	0.2139	0.2139
243	6360	0.2108	0.2108
244	6375	0.2078	0.2078
245	6390	0.2089	0.2089
246	6405	0.2078	0.2078
247	6420	0.2081	0.2081
248	6435	0.2041	0.2041
249	6450	0.204	0.204
250	6465	0.1997	0.1997
251	6480	0.1987	0.1987
252	6495	0.2037	0.2037
253	6510	0.1999	0.1999
254	6525	0.2003	0.2003
255	6540	0.1976	0.1976
256	6555	0.1954	0.1954
257	6570	0.2017	0.2017
258	6585	0.196	0.196
259	6600	0.2029	0.2029
260	6615	0.2011	0.2011

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
261	6630	0.2011	0.2011
262	6645	0.1993	0.1993
263	6660	0.2011	0.2011
264	6675	0.1999	0.1999
265	6690	0.1973	0.1973
266	6705	0.1979	0.1979
267	6720	0.1941	0.1941
268	6735	0.199	0.199
269	6750	0.1963	0.1963
270	6765	0.1956	0.1956
271	6780	0.194	0.194
272	6795	0.1868	0.1868
273	6810	0.1908	0.1908
274	6825	0.1865	0.1865
275	6840	0.188	0.188
276	6855	0.1857	0.1857
277	6870	0.1812	0.1812
278	6885	0.1828	0.1828
279	6900	0.1786	0.1786
280	6915	0.1762	0.1762
281	6930	0.1737	0.1737
282	6945	0.1692	0.1692
283	6960	0.1659	0.1659
284	6975	0.1605	0.1605
285	6990	0.1629	0.1629
286	7005	0.1597	0.1597
287	7020	0.1571	0.1571
288	7035	0.1509	0.1509
289	7050	0.155	0.155
290	7065	0.1523	0.1523
291	7080	0.1529	0.1529
292	7095	0.1569	0.1569
293	7110	0.1536	0.1536
294	7125	0.1504	0.1504
295	7140	0.1488	0.1488
296	7155	0.1508	0.1508
297	7170	0.1519	0.1519
298	7185	0.1507	0.1507
299	7200	0.1478	0.1478
300	7215	0.1427	0.1427
301	7230	0.1396	0.1396
302	7245	0.146	0.146
303	7260	0.144	0.144
304	7275	0.1474	0.1474
305	7290	0.1455	0.1455
306	7305	0.1505	0.1505
307	7320	0.1491	0.1491
308	7335	0.1488	0.1488
309	7350	0.1509	0.1509
310	7365	0.15	0.15
311	7380	0.1459	0.1459
312	7395	0.1461	0.1461
313	7410	0.1494	0.1494

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
314	7425	0.1441	0.1441
315	7440	0.1499	0.1499
316	7455	0.1455	0.1455
317	7470	0.1456	0.1456
318	7485	0.1421	0.1421
319	7500	0.139	0.139
320	7515	0.1355	0.1355
321	7530	0.1439	0.1439
322	7545	0.1404	0.1404
323	7560	0.1373	0.1373
324	7575	0.14	0.14
325	7590	0.139	0.139
326	7605	0.1405	0.1405
327	7620	0.1395	0.1395
328	7635	0.1428	0.1428
329	7650	0.1448	0.1448
330	7665	0.1454	0.1454
331	7680	0.142	0.142
332	7695	0.141	0.141
333	7710	0.1424	0.1424
334	7725	0.1391	0.1391
335	7740	0.1309	0.1309
336	7755	0.1322	0.1322
337	7770	0.1315	0.1315
338	7785	0.1243	0.1243
339	7800	0.1226	0.1226
340	7815	0.1238	0.1238
341	7830	0.1242	0.1242
342	7845	0.1185	0.1185
343	7860	0.1162	0.1162
344	7875	0.1148	0.1148
345	7890	0.1123	0.1123
346	7905	0.105	0.105
347	7920	0.1093	0.1093
348	7935	0.1045	0.1045
349	7950	0.1099	0.1099
350	7965	0.1051	0.1051
351	7980	0.1021	0.1021
352	7995	0.1013	0.1013
353	8010	0.0955	0.0955
354	8025	0.0947	0.0947
355	8040	0.0931	0.0931
356	8055	0.0923	0.0923
357	8070	0.0996	0.0996
358	8085	0.0956	0.0956
359	8100	0.1023	0.1023
360	8115	0.0985	0.0985
361	8130	0.0995	0.0995
362	8145	0.0947	0.0947
363	8160	0.0949	0.0949
364	8175	0.0964	0.0964
365	8190	0.0934	0.0934
366	8205	0.0918	0.0918

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
367	8220	0.0854	0.0854
368	8235	0.0893	0.0893
369	8250	0.0866	0.0866
370	8265	0.0833	0.0833
371	8280	0.0829	0.0829
372	8295	0.0818	0.0818
373	8310	0.0794	0.0794
374	8325	0.0828	0.0828
375	8340	0.0807	0.0807
376	8355	0.0805	0.0805
377	8370	0.0763	0.0763
378	8385	0.074	0.074
379	8400	0.0698	0.0698
380	8415	0.0702	0.0702
381	8430	0.0658	0.0658
382	8445	0.0663	0.0663
383	8460	0.0651	0.0651
384	8475	0.0634	0.0634
385	8490	0.0621	0.0621
386	8505	0.066	0.066
387	8520	0.0696	0.0696
388	8535	0.0646	0.0646
389	8550	0.0691	0.0691

Pumping Test - Water Level Data	
Project:	Town of Beausejour
Number:	Feb2020
Client:	MWSB

Location: Pescitelli Road	Pumping Test: Pumping Test 1	Pumping Well: West Production Well
Test Conducted by: FDL	Test Date: 2/4/2020	Discharge: variable, average rate 510 [U.S. gal/mi
Observation Well: East Production Well	Static Water Level [ft]: 0.00	Radial Distance to PW [m]: 794.39

	Time [min]	Water Level [ft]	Drawdown [ft]
1	0	0.00	0.00
2	15	0.6801	0.6801
3	30	0.886	0.886
4	45	1.0056	1.0056
5	60	1.1109	1.1109
6	75	1.1897	1.1897
7	90	1.2423	1.2423
8	105	1.2963	1.2963
9	120	1.3314	1.3314
10	135	1.3852	1.3852
11	150	1.4052	1.4052
12	165	1.4309	1.4309
13	180	1.4591	1.4591
14	195	1.4711	1.4711
15	210	1.505	1.505
16	225	1.5143	1.5143
17	240	1.544	1.544
18	255	1.5598	1.5598
19	270	1.5668	1.5668
20	285	1.6003	1.6003
21	300	1.6198	1.6198
22	315	1.6237	1.6237
23	330	1.6375	1.6375
24	345	1.6465	1.6465
25	360	1.6755	1.6755
26	375	1.6769	1.6769
27	390	1.6863	1.6863
28	405	1.7022	1.7022
29	420	1.7022	1.7022
30	435	1.7237	1.7237
31	450	1.7275	1.7275
32	465	1.7368	1.7368
33	480	1.752	1.752
34	495	1.7459	1.7459
35	510	1.7593	1.7593
36	525	1.7616	1.7616
37	540	1.7635	1.7635
38	555	1.7679	1.7679
39	570	1.7624	1.7624
40	585	1.7574	1.7574
41	600	1.7629	1.7629
42	615	1.7656	1.7656
43	630	1.7572	1.7572
44	645	1.7541	1.7541
45	660	1.7456	1.7456
46	675	1.7366	1.7366
47	690	1.7571	1.7571
48	705	1.7366	1.7366

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
49	720	1.7284	1.7284
50	735	1.739	1.739
51	750	1.7203	1.7203
52	765	1.7201	1.7201
53	780	1.7081	1.7081
54	795	1.7125	1.7125
55	810	1.7139	1.7139
56	825	1.7178	1.7178
57	840	1.7096	1.7096
58	855	1.6774	1.6774
59	870	1.6581	1.6581
60	885	1.6708	1.6708
61	900	1.6651	1.6651
62	915	1.6681	1.6681
63	930	1.6799	1.6799
64	945	1.664	1.664
65	960	1.6703	1.6703
66	975	1.6841	1.6841
67	990	1.6996	1.6996
68	1005	1.7069	1.7069
69	1020	1.7192	1.7192
70	1035	1.73	1.73
71	1050	1.7372	1.7372
72	1065	1.7448	1.7448
73	1080	1.7457	1.7457
74	1095	1.756	1.756
75	1110	1.7624	1.7624
76	1125	1.7734	1.7734
77	1140	1.781	1.781
78	1155	1.7894	1.7894
79	1170	1.7891	1.7891
80	1185	1.7966	1.7966
81	1200	1.7886	1.7886
82	1215	1.8079	1.8079
83	1230	1.8119	1.8119
84	1245	1.8053	1.8053
85	1260	1.8132	1.8132
86	1275	1.8089	1.8089
87	1290	1.8139	1.8139
88	1305	1.8088	1.8088
89	1320	1.8187	1.8187
90	1335	1.8229	1.8229
91	1350	1.8266	1.8266
92	1365	1.8344	1.8344
93	1380	1.8387	1.8387
94	1395	1.8491	1.8491
95	1410	1.8451	1.8451
96	1425	1.8538	1.8538
97	1440	1.8632	1.8632
98	1455	1.8673	1.8673
99	1470	1.8709	1.8709
100	1485	1.8641	1.8641
101	1500	1.8638	1.8638

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
102	1515	1.8566	1.8566
103	1530	1.8583	1.8583
104	1545	1.8604	1.8604
105	1560	1.862	1.862
106	1575	1.8444	1.8444
107	1590	1.8396	1.8396
108	1605	1.8341	1.8341
109	1620	1.8391	1.8391
110	1635	1.8337	1.8337
111	1650	1.8414	1.8414
112	1665	1.8476	1.8476
113	1680	1.855	1.855
114	1695	1.8596	1.8596
115	1710	1.8415	1.8415
116	1725	1.8473	1.8473
117	1740	1.8601	1.8601
118	1755	1.8672	1.8672
119	1770	1.8697	1.8697
120	1785	1.8658	1.8658
121	1800	1.8778	1.8778
122	1815	1.8845	1.8845
123	1830	1.8835	1.8835
124	1845	1.8935	1.8935
125	1860	1.8991	1.8991
126	1875	1.9044	1.9044
127	1890	1.9145	1.9145
128	1905	1.9169	1.9169
129	1920	1.9256	1.9256
130	1935	1.9235	1.9235
131	1950	1.9394	1.9394
132	1965	1.9414	1.9414
133	1980	1.9419	1.9419
134	1995	1.9478	1.9478
135	2010	1.947	1.947
136	2025	1.9601	1.9601
137	2040	1.9601	1.9601
138	2055	1.9609	1.9609
139	2070	1.9727	1.9727
140	2085	1.9667	1.9667
141	2100	1.9691	1.9691
142	2115	1.972	1.972
143	2130	1.9774	1.9774
144	2145	1.9771	1.9771
145	2160	1.9707	1.9707
146	2175	1.9683	1.9683
147	2190	1.9605	1.9605
148	2205	1.9551	1.9551
149	2220	1.9593	1.9593
150	2235	1.9645	1.9645
151	2250	1.9612	1.9612
152	2265	1.9585	1.9585
153	2280	1.9524	1.9524
154	2295	1.9463	1.9463

Pumping Test - Water Level Data

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
155	2310	1.9523	1.9523
156	2325	1.9419	1.9419
157	2340	1.9503	1.9503
158	2355	1.9381	1.9381
159	2370	1.9432	1.9432
160	2385	1.9431	1.9431
161	2400	1.9412	1.9412
162	2415	1.9398	1.9398
163	2430	1.9322	1.9322
164	2445	1.9323	1.9323
165	2460	1.9217	1.9217
166	2475	1.9336	1.9336
167	2490	1.9333	1.9333
168	2505	1.9291	1.9291
169	2520	1.928	1.928
170	2535	1.9274	1.9274
171	2550	1.9254	1.9254
172	2565	1.9349	1.9349
173	2580	1.93	1.93
174	2595	1.9275	1.9275
175	2610	1.9308	1.9308
176	2625	1.9247	1.9247
177	2640	1.9273	1.9273
178	2655	1.9399	1.9399
179	2670	1.9374	1.9374
180	2685	1.9477	1.9477
181	2700	1.9464	1.9464
182	2715	1.9512	1.9512
183	2730	1.9537	1.9537
184	2745	1.9635	1.9635
185	2760	1.9745	1.9745
186	2775	1.9658	1.9658
187	2790	1.9713	1.9713
188	2805	1.9784	1.9784
189	2820	1.9797	1.9797
190	2835	1.9945	1.9945
191	2850	1.9957	1.9957
192	2865	2.0066	2.0066
193	2880	2.0141	2.0141
194	2895	2.0202	2.0202
195	2910	2.0158	2.0158
196	2925	2.0199	2.0199
197	2940	2.0339	2.0339
198	2955	2.0412	2.0412
199	2970	2.0438	2.0438
200	2985	2.0531	2.0531
201	3000	2.0587	2.0587
202	3015	2.0619	2.0619
203	3030	2.0569	2.0569
204	3045	2.0588	2.0588
205	3060	2.0624	2.0624
206	3075	2.0588	2.0588
207	3090	2.0705	2.0705

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
208	3105	2.0738	2.0738
209	3120	2.0698	2.0698
210	3135	2.0778	2.0778
211	3150	2.0718	2.0718
212	3165	2.0884	2.0884
213	3180	2.0784	2.0784
214	3195	2.0751	2.0751
215	3210	2.0747	2.0747
216	3225	2.0884	2.0884
217	3240	2.0797	2.0797
218	3255	2.073	2.073
219	3270	2.0721	2.0721
220	3285	2.0902	2.0902
221	3300	2.0855	2.0855
222	3315	2.0846	2.0846
223	3330	2.0737	2.0737
224	3345	2.0834	2.0834
225	3360	2.0882	2.0882
226	3375	2.0836	2.0836
227	3390	2.0874	2.0874
228	3405	2.0805	2.0805
229	3420	2.086	2.086
230	3435	2.0929	2.0929
231	3450	2.0933	2.0933
232	3465	2.0939	2.0939
233	3480	2.1018	2.1018
234	3495	2.1116	2.1116
235	3510	2.1183	2.1183
236	3525	2.1206	2.1206
237	3540	2.1202	2.1202
238	3555	2.1153	2.1153
239	3570	2.118	2.118
240	3585	2.1245	2.1245
241	3600	2.1257	2.1257
242	3615	2.1252	2.1252
243	3630	2.1352	2.1352
244	3645	2.1198	2.1198
245	3660	2.1436	2.1436
246	3675	2.1368	2.1368
247	3690	2.1351	2.1351
248	3705	2.1409	2.1409
249	3720	2.1412	2.1412
250	3735	2.1418	2.1418
251	3750	2.1328	2.1328
252	3765	2.1385	2.1385
253	3780	2.1427	2.1427
254	3795	2.1411	2.1411
255	3810	2.1417	2.1417
256	3825	2.1373	2.1373
257	3840	2.1429	2.1429
258	3855	2.1431	2.1431
259	3870	2.1489	2.1489
260	3885	2.1355	2.1355

Pumping Test - Water Level Data	Page 6 of 11
Project: Town of Beausejour	
Number: Feb2020	
Client: MWSB	

	Time [min]	Water Level [ft]	Drawdown [ft]
261	3900	2.132	2.132
262	3915	2.1318	2.1318
263	3930	2.1285	2.1285
264	3945	2.1228	2.1228
265	3960	2.123	2.123
266	3975	2.1203	2.1203
267	3990	2.1235	2.1235
268	4005	2.1282	2.1282
269	4020	2.117	2.117
270	4035	2.1234	2.1234
271	4050	2.1128	2.1128
272	4065	2.1188	2.1188
273	4080	2.1151	2.1151
274	4095	2.1093	2.1093
275	4110	2.1036	2.1036
276	4125	2.1128	2.1128
277	4140	2.1118	2.1118
278	4155	2.1096	2.1096
279	4170	2.1193	2.1193
280	4185	2.1148	2.1148
281	4200	2.1231	2.1231
282	4215	2.1171	2.1171
283	4230	2.1109	2.1109
284	4245	2.1039	2.1039
285	4260	2.1169	2.1169
286	4275	2.1146	2.1146
287	4290	2.1223	2.1223
288	4305	2.1291	2.1291
289	4320	2.1263	2.1263
290	4335	1.4635	1.4635
291	4350	1.284	1.284
292	4365	1.1597	1.1597
293	4380	1.061	1.061
294	4395	0.9884	0.9884
295	4410	0.9333	0.9333
296	4425	0.8879	0.8879
297	4440	0.846	0.846
298	4455	0.8079	0.8079
299	4470	0.7766	0.7766
300	4485	0.7525	0.7525
301	4500	0.7266	0.7266
302	4515	0.7061	0.7061
303	4530	0.6853	0.6853
304	4545	0.6892	0.6892
305	4560	0.6661	0.6661
306	4575	0.651	0.651
307	4590	0.6374	0.6374
308	4605	0.6326	0.6326
309	4620	0.6162	0.6162
310	4635	0.4707	0.4707
311	4650	0.4546	0.4546
312	4665	0.4271	0.4271
313	4680	0.4172	0.4172

	Time [min]	Water Level [ft]	Drawdown [ft]
314	4695	0.3978	0.3978
315	4710	0.379	0.379
316	4725	0.3676	0.3676
317	4740	0.3506	0.3506
318	4755	0.3415	0.3415
319	4770	0.3422	0.3422
320	4785	0.3397	0.3397
321	4800	0.3342	0.3342
322	4815	0.3204	0.3204
323	4830	0.3114	0.3114
324	4845	0.3091	0.3091
325	4860	0.2973	0.2973
326	4875	0.3052	0.3052
327	4890	0.2942	0.2942
328	4905	0.2952	0.2952
329	4920	0.2865	0.2865
330	4935	0.2758	0.2758
331	4950	0.2771	0.2771
332	4965	0.2776	0.2776
333	4980	0.2613	0.2613
334	4995	0.267	0.267
335	5010	0.2837	0.2837
336	5025	0.2614	0.2614
337	5040	0.2507	0.2507
338	5055	0.252	0.252
339	5070	0.26	0.26
340	5085	0.2488	0.2488
341	5100	0.2332	0.2332
342	5115	0.2435	0.2435
343	5130	0.2329	0.2329
344	5145	0.2268	0.2268
345	5160	0.2434	0.2434
346	5175	0.229	0.229
347	5190	0.2226	0.2226
348	5205	0.2085	0.2085
349	5220	0.2118	0.2118
350	5235	0.2075	0.2075
351	5250	0.2053	0.2053
352	5265	0.1975	0.1975
353	5280	0.2017	0.2017
354	5295	0.1934	0.1934
355	5310	0.1966	0.1966
356	5325	0.1848	0.1848
357	5340	0.1785	0.1785
358	5355	0.191	0.191
359	5370	0.1803	0.1803
360	5385	0.1734	0.1734
361	5400	0.1627	0.1627
362	5415	0.1599	0.1599
363	5430	0.1517	0.1517
364	5445	0.1517	0.1517
365	5460	0.1416	0.1416
366	5475	0.1402	0.1402

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
367	5490	0.1352	0.1352
368	5505	0.1324	0.1324
369	5520	0.1178	0.1178
370	5535	0.1238	0.1238
371	5550	0.1199	0.1199
372	5565	0.122	0.122
373	5580	0.1137	0.1137
374	5595	0.1016	0.1016
375	5610	0.1142	0.1142
376	5625	0.1048	0.1048
377	5640	0.1029	0.1029
378	5655	0.106	0.106
379	5670	0.1042	0.1042
380	5685	0.0959	0.0959
381	5700	0.1008	0.1008
382	5715	0.0981	0.0981
383	5730	0.0968	0.0968
384	5745	0.1011	0.1011
385	5760	0.0902	0.0902
386	5775	0.101	0.101
387	5790	0.105	0.105
388	5805	0.1046	0.1046
389	5820	0.1061	0.1061
390	5835	0.1082	0.1082
391	5850	0.1137	0.1137
392	5865	0.1192	0.1192
393	5880	0.1008	0.1008
394	5895	0.0997	0.0997
395	5910	0.105	0.105
396	5925	0.1059	0.1059
397	5940	0.0995	0.0995
398	5955	0.1007	0.1007
399	5970	0.1058	0.1058
400	5985	0.1002	0.1002
401	6000	0.1022	0.1022
402	6015	0.1092	0.1092
403	6030	0.0899	0.0899
404	6045	0.1012	0.1012
405	6060	0.096	0.096
406	6075	0.0974	0.0974
407	6090	0.0959	0.0959
408	6105	0.0911	0.0911
409	6120	0.1049	0.1049
410	6135	0.1035	0.1035
411	6150	0.1078	0.1078
412	6165	0.112	0.112
413	6180	0.1132	0.1132
414	6195	0.1141	0.1141
415	6210	0.1163	0.1163
416	6225	0.1083	0.1083
417	6240	0.1137	0.1137
418	6255	0.0969	0.0969
419	6270	0.0998	0.0998

	Pumping Test - Water Level Data	
	Project: Town of Beausejour	
	Number: Feb2020	
	Client: MWSB	

	Time [min]	Water Level [ft]	Drawdown [ft]
420	6285	0.1008	0.1008
421	6300	0.0991	0.0991
422	6315	0.102	0.102
423	6330	0.0954	0.0954
424	6345	0.1088	0.1088
425	6360	0.0982	0.0982
426	6375	0.0981	0.0981
427	6390	0.095	0.095
428	6405	0.0963	0.0963
429	6420	0.0893	0.0893
430	6435	0.0855	0.0855
431	6450	0.0897	0.0897
432	6465	0.0866	0.0866
433	6480	0.0936	0.0936
434	6495	0.0947	0.0947
435	6510	0.093	0.093
436	6525	0.0839	0.0839
437	6540	0.0854	0.0854
438	6555	0.0801	0.0801
439	6570	0.0827	0.0827
440	6585	0.0918	0.0918
441	6600	0.1007	0.1007
442	6615	0.0906	0.0906
443	6630	0.0886	0.0886
444	6645	0.09	0.09
445	6660	0.0974	0.0974
446	6675	0.0954	0.0954
447	6690	0.0882	0.0882
448	6705	0.0848	0.0848
449	6720	0.0932	0.0932
450	6735	0.102	0.102
451	6750	0.0858	0.0858
452	6765	0.0875	0.0875
453	6780	0.0775	0.0775
454	6795	0.0815	0.0815
455	6810	0.0764	0.0764
456	6825	0.0757	0.0757
457	6840	0.0766	0.0766
458	6855	0.0707	0.0707
459	6870	0.0832	0.0832
460	6885	0.0681	0.0681
461	6900	0.0611	0.0611
462	6915	0.0669	0.0669
463	6930	0.0561	0.0561
464	6945	0.0581	0.0581
465	6960	0.0587	0.0587
466	6975	0.0474	0.0474
467	6990	0.046	0.046
468	7005	0.0566	0.0566
469	7020	0.0434	0.0434
470	7035	0.0537	0.0537
471	7050	0.0372	0.0372
472	7065	0.043	0.043

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
473	7080	0.0401	0.0401
474	7095	0.0298	0.0298
475	7110	0.0473	0.0473
476	7125	0.0426	0.0426
477	7140	0.0338	0.0338
478	7155	0.0339	0.0339
479	7170	0.0224	0.0224
480	7185	0.0319	0.0319
481	7200	0.0186	0.0186
482	7215	0.0163	0.0163
483	7230	0.0148	0.0148
484	7245	0.0205	0.0205
485	7260	0.0149	0.0149
486	7275	0.0152	0.0152
487	7290	0.0158	0.0158
488	7305	0.017	0.017
489	7320	0.0111	0.0111
490	7335	0.0251	0.0251
491	7350	0.0072	0.0072
492	7365	0.0111	0.0111
493	7380	0.0145	0.0145
494	7395	0.008	0.008
495	7410	0.0088	0.0088
496	7425	0.008	0.008
497	7440	0.0019	0.0019
498	7455	0.0054	0.0054
499	7470	0.0011	0.0011
500	7485	-0.001	-0.001
501	7500	-0.0017	-0.0017
502	7515	-0.0048	-0.0048
503	7530	0.023	0.023
504	7545	-0.0041	-0.0041
505	7560	0.0091	0.0091
506	7575	0.0089	0.0089
507	7590	0.0007	0.0007
508	7605	0.0119	0.0119
509	7620	-0.0022	-0.0022
510	7635	0.0041	0.0041
511	7650	-0.0014	-0.0014
512	7665	0.0126	0.0126
513	7680	0.0117	0.0117
514	7695	0.0061	0.0061
515	7710	0.0122	0.0122
516	7725	0.0153	0.0153
517	7740	0.0057	0.0057
518	7755	0.0147	0.0147
519	7770	0.006	0.006
520	7785	-0.0076	-0.0076
521	7800	0.0022	0.0022
522	7815	-0.0181	-0.0181
523	7830	0.0051	0.0051
524	7845	-0.0093	-0.0093
525	7860	-0.0021	-0.0021

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
526	7875	-0.0101	-0.0101
527	7890	-0.0138	-0.0138
528	7905	-0.0204	-0.0204
529	7920	-0.0215	-0.0215
530	7935	-0.02	-0.02
531	7950	-0.0247	-0.0247
532	7965	-0.0216	-0.0216
533	7980	-0.0176	-0.0176
534	7995	-0.0172	-0.0172
535	8010	-0.0161	-0.0161
536	8025	-0.0238	-0.0238
537	8040	-0.0267	-0.0267
538	8055	-0.0213	-0.0213
539	8070	-0.0235	-0.0235
540	8085	-0.0208	-0.0208
541	8100	-0.0165	-0.0165
542	8115	-0.0186	-0.0186
543	8130	-0.0186	-0.0186
544	8145	-0.0213	-0.0213
545	8160	-0.0336	-0.0336
546	8175	-0.0208	-0.0208
547	8190	-0.0238	-0.0238
548	8205	-0.0181	-0.0181
549	8220	-0.0284	-0.0284
550	8235	-0.0263	-0.0263
551	8250	-0.0333	-0.0333
552	8265	-0.0373	-0.0373
553	8280	-0.0321	-0.0321
554	8295	-0.0392	-0.0392
555	8310	-0.0251	-0.0251
556	8325	-0.0175	-0.0175
557	8340	-0.0329	-0.0329
558	8355	-0.0352	-0.0352
559	8370	-0.0425	-0.0425
560	8385	-0.0429	-0.0429
561	8400	-0.0451	-0.0451
562	8415	-0.0437	-0.0437
563	8430	-0.0581	-0.0581
564	8445	-0.0544	-0.0544
565	8460	-0.0517	-0.0517
566	8475	-0.053	-0.053
567	8490	-0.0521	-0.0521
568	8505	-0.064	-0.064
569	8520	-0.0525	-0.0525
570	8535	-0.0591	-0.0591
571	8550	-0.0558	-0.0558

Pumping Test - Water Level Data

Project:	Town of Beausejour
Number:	Feb2020
Client:	MWSB

Location: Pescitelli Road	Pumping Test: Pumping Test 1	Pumping Well: West Production Well
Test Conducted by: FDL	Test Date: 2/4/2020	Discharge: variable, average rate 510 [U.S. gal/mi
Observation Well: Domestic 1	Static Water Level [ft]: 0.00	Radial Distance to PW [m]: 914.6

	Time [min]	Water Level [ft]	Drawdown [ft]
1	0	0.00	0.00
2	15	0.6164	0.6164
3	30	0.785	0.785
4	45	0.8997	0.8997
5	60	0.9841	0.9841
6	90	1.0955	1.0955
7	105	1.139	1.139
8	120	1.1759	1.1759
9	135	1.2081	1.2081
10	150	1.2331	1.2331
11	165	1.2556	1.2556
12	180	1.2835	1.2835
13	195	1.2982	1.2982
14	210	1.3167	1.3167
15	225	1.3345	1.3345
16	240	1.3538	1.3538
17	255	1.3622	1.3622
18	270	1.3808	1.3808
19	285	1.3943	1.3943
20	300	1.4063	1.4063
21	315	1.4205	1.4205
22	330	1.434	1.434
23	345	1.4467	1.4467
24	360	1.4521	1.4521
25	375	1.4599	1.4599
26	390	1.4722	1.4722
27	405	1.4825	1.4825
28	420	1.4863	1.4863
29	435	1.4879	1.4879
30	450	1.4942	1.4942
31	465	1.501	1.501
32	480	1.5096	1.5096
33	495	1.5166	1.5166
34	510	1.5181	1.5181
35	525	1.5155	1.5155
36	540	1.5162	1.5162
37	555	1.516	1.516
38	570	1.51	1.51
39	585	1.5136	1.5136
40	600	1.5191	1.5191
41	615	1.5181	1.5181
42	630	1.519	1.519
43	645	1.5152	1.5152
44	660	1.5214	1.5214
45	675	1.5178	1.5178
46	690	1.5361	1.5361
47	705	1.522	1.522
48	720	1.5209	1.5209

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
49	735	1.5282	1.5282
50	750	1.5202	1.5202
51	765	1.5222	1.5222
52	780	1.5181	1.5181
53	795	1.5145	1.5145
54	810	1.5184	1.5184
55	825	1.5134	1.5134
56	840	1.5176	1.5176
57	855	1.5158	1.5158
58	870	1.5165	1.5165
59	885	1.516	1.516
60	900	1.5149	1.5149
61	915	1.5176	1.5176
62	930	1.5222	1.5222
63	945	1.5189	1.5189
64	960	1.5269	1.5269
65	975	1.5358	1.5358
66	990	1.5431	1.5431
67	1005	1.548	1.548
68	1020	1.55	1.55
69	1050	1.5577	1.5577
70	1065	1.5576	1.5576
71	1080	1.5609	1.5609
72	1095	1.5649	1.5649
73	1110	1.5691	1.5691
74	1125	1.5755	1.5755
75	1140	1.5908	1.5908
76	1155	1.5877	1.5877
77	1170	1.5887	1.5887
78	1185	1.5944	1.5944
79	1200	1.5948	1.5948
80	1215	1.6007	1.6007
81	1230	1.6008	1.6008
82	1245	1.6047	1.6047
83	1260	1.6098	1.6098
84	1275	1.6116	1.6116
85	1290	1.6178	1.6178
86	1305	1.6239	1.6239
87	1320	1.6353	1.6353
88	1335	1.6363	1.6363
89	1350	1.6387	1.6387
90	1365	1.6465	1.6465
91	1380	1.6556	1.6556
92	1410	1.6596	1.6596
93	1425	1.6674	1.6674
94	1440	1.6723	1.6723
95	1455	1.674	1.674
96	1470	1.6757	1.6757
97	1485	1.6792	1.6792
98	1500	1.6761	1.6761
99	1515	1.6722	1.6722
100	1545	1.6682	1.6682
101	1560	1.6667	1.6667

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
102	1575	1.6572	1.6572
103	1590	1.6566	1.6566
104	1605	1.6526	1.6526
105	1620	1.6538	1.6538
106	1635	1.6562	1.6562
107	1650	1.6552	1.6552
108	1665	1.6606	1.6606
109	1680	1.658	1.658
110	1695	1.6566	1.6566
111	1710	1.655	1.655
112	1725	1.6555	1.6555
113	1740	1.6591	1.6591
114	1755	1.6685	1.6685
115	1770	1.6775	1.6775
116	1785	1.689	1.689
117	1800	1.6895	1.6895
118	1815	1.6997	1.6997
119	1830	1.7064	1.7064
120	1845	1.7113	1.7113
121	1860	1.7149	1.7149
122	1875	1.7235	1.7235
123	1890	1.7263	1.7263
124	1905	1.7276	1.7276
125	1920	1.733	1.733
126	1935	1.7348	1.7348
127	1950	1.7389	1.7389
128	1965	1.7447	1.7447
129	1980	1.7454	1.7454
130	1995	1.7501	1.7501
131	2010	1.7557	1.7557
132	2025	1.7587	1.7587
133	2040	1.7627	1.7627
134	2055	1.7609	1.7609
135	2070	1.7635	1.7635
136	2085	1.7733	1.7733
137	2100	1.7685	1.7685
138	2115	1.8078	1.8078
139	2130	1.7712	1.7712
140	2145	1.7712	1.7712
141	2160	1.7642	1.7642
142	2175	1.7643	1.7643
143	2190	1.7626	1.7626
144	2205	1.7601	1.7601
145	2220	1.7587	1.7587
146	2235	1.7548	1.7548
147	2250	1.7523	1.7523
148	2265	1.7507	1.7507
149	2280	1.7492	1.7492
150	2295	1.7451	1.7451
151	2310	1.7423	1.7423
152	2325	1.7372	1.7372
153	2340	1.7384	1.7384
154	2355	1.7346	1.7346

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
155	2370	1.7327	1.7327
156	2385	1.7288	1.7288
157	2400	1.7265	1.7265
158	2415	1.7336	1.7336
159	2430	1.7325	1.7325
160	2445	1.7293	1.7293
161	2460	1.7268	1.7268
162	2475	1.7264	1.7264
163	2490	1.7279	1.7279
164	2505	1.7218	1.7218
165	2520	1.7203	1.7203
166	2535	1.7201	1.7201
167	2550	1.7248	1.7248
168	2565	1.7232	1.7232
169	2580	1.7235	1.7235
170	2595	1.7218	1.7218
171	2610	1.7198	1.7198
172	2625	1.7224	1.7224
173	2640	1.7254	1.7254
174	2655	1.7289	1.7289
175	2685	1.7334	1.7334
176	2700	1.7311	1.7311
177	2715	1.7432	1.7432
178	2730	1.7484	1.7484
179	2745	1.7514	1.7514
180	2760	1.7591	1.7591
181	2775	1.7688	1.7688
182	2790	1.7698	1.7698
183	2805	1.7791	1.7791
184	2820	1.7803	1.7803
185	2835	1.7909	1.7909
186	2850	1.791	1.791
187	2865	1.7974	1.7974
188	2880	1.8005	1.8005
189	2895	1.8087	1.8087
190	2910	1.8117	1.8117
191	2925	1.8134	1.8134
192	2940	1.8171	1.8171
193	2970	1.8259	1.8259
194	2985	1.8327	1.8327
195	3000	1.8265	1.8265
196	3015	1.8309	1.8309
197	3030	1.8326	1.8326
198	3045	1.8346	1.8346
199	3060	1.8379	1.8379
200	3075	1.8408	1.8408
201	3090	1.8455	1.8455
202	3105	1.8457	1.8457
203	3120	1.8491	1.8491
204	3135	1.8492	1.8492
205	3150	1.8514	1.8514
206	3165	1.8578	1.8578
207	3195	1.8458	1.8458

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
208	3210	1.8481	1.8481
209	3225	1.8484	1.8484
210	3240	1.8478	1.8478
211	3255	1.8502	1.8502
212	3270	1.85	1.85
213	3285	1.8493	1.8493
214	3300	1.852	1.852
215	3315	1.8507	1.8507
216	3330	1.8511	1.8511
217	3345	1.8546	1.8546
218	3360	1.8554	1.8554
219	3375	1.8534	1.8534
220	3390	1.8522	1.8522
221	3405	1.85	1.85
222	3420	1.859	1.859
223	3435	1.859	1.859
224	3450	1.8655	1.8655
225	3465	1.8686	1.8686
226	3480	1.8732	1.8732
227	3495	1.8777	1.8777
228	3510	1.8795	1.8795
229	3525	1.8832	1.8832
230	3540	1.8876	1.8876
231	3555	1.9086	1.9086
232	3570	1.8869	1.8869
233	3585	1.8887	1.8887
234	3600	1.8917	1.8917
235	3615	1.891	1.891
236	3630	1.9032	1.9032
237	3645	1.897	1.897
238	3660	1.9061	1.9061
239	3675	1.8998	1.8998
240	3690	1.8999	1.8999
241	3705	1.9013	1.9013
242	3720	1.9001	1.9001
243	3735	1.9019	1.9019
244	3750	1.9034	1.9034
245	3765	1.9031	1.9031
246	3780	1.9086	1.9086
247	3795	1.9049	1.9049
248	3810	1.9005	1.9005
249	3825	1.9039	1.9039
250	3840	1.9015	1.9015
251	3870	1.902	1.902
252	3885	1.9209	1.9209
253	3900	1.8864	1.8864
254	3915	1.886	1.886
255	3930	1.8837	1.8837
256	3960	1.8821	1.8821
257	3975	1.8758	1.8758
258	3990	1.8748	1.8748
259	4005	1.8819	1.8819
260	4020	1.8715	1.8715

		Pumping Test - Water Level Data	Page 6 of 11
		Project: Town of Beausejour	
		Number: Feb2020	
		Client: MWSB	

	Time [min]	Water Level [ft]	Drawdown [ft]
261	4035	1.8682	1.8682
262	4050	1.8674	1.8674
263	4065	1.8729	1.8729
264	4080	1.8629	1.8629
265	4095	1.8666	1.8666
266	4110	1.868	1.868
267	4125	1.8641	1.8641
268	4155	1.8731	1.8731
269	4170	1.8717	1.8717
270	4185	1.8684	1.8684
271	4215	1.866	1.866
272	4230	1.8668	1.8668
273	4245	1.8619	1.8619
274	4260	1.8734	1.8734
275	4275	1.8772	1.8772
276	4290	1.8826	1.8826
277	4305	1.8821	1.8821
278	4320	1.8905	1.8905
279	4335	1.328	1.328
280	4350	1.1616	1.1616
281	4365	1.0564	1.0564
282	4380	0.9791	0.9791
283	4395	0.9175	0.9175
284	4410	0.8727	0.8727
285	4425	0.8302	0.8302
286	4440	0.7987	0.7987
287	4455	0.7586	0.7586
288	4470	0.7359	0.7359
289	4485	0.7108	0.7108
290	4500	0.6859	0.6859
291	4515	0.6694	0.6694
292	4530	0.6537	0.6537
293	4545	0.6358	0.6358
294	4560	0.6204	0.6204
295	4575	0.6069	0.6069
296	4590	0.5964	0.5964
297	4605	0.5843	0.5843
298	4620	0.5778	0.5778
299	4635	0.5682	0.5682
300	4650	0.5617	0.5617
301	4665	0.5553	0.5553
302	4680	0.5455	0.5455
303	4695	0.5305	0.5305
304	4710	0.5221	0.5221
305	4725	0.5112	0.5112
306	4740	0.5046	0.5046
307	4755	0.4915	0.4915
308	4770	0.4827	0.4827
309	4785	0.4803	0.4803
310	4815	0.464	0.464
311	4830	0.4528	0.4528
312	4845	0.4495	0.4495
313	4860	0.4408	0.4408

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
314	4890	0.4339	0.4339
315	4905	0.4226	0.4226
316	4920	0.413	0.413
317	4935	0.411	0.411
318	4950	0.3993	0.3993
319	4965	0.3966	0.3966
320	4980	0.408	0.408
321	4995	0.4089	0.4089
322	5010	0.4025	0.4025
323	5025	0.3883	0.3883
324	5040	0.3862	0.3862
325	5055	0.3838	0.3838
326	5070	0.3832	0.3832
327	5085	0.3747	0.3747
328	5100	0.373	0.373
329	5115	0.3737	0.3737
330	5130	0.3693	0.3693
331	5145	0.3681	0.3681
332	5175	0.4101	0.4101
333	5205	0.3499	0.3499
334	5220	0.3511	0.3511
335	5235	0.3503	0.3503
336	5250	0.346	0.346
337	5265	0.3432	0.3432
338	5280	0.3423	0.3423
339	5295	0.3413	0.3413
340	5310	0.3397	0.3397
341	5325	0.3363	0.3363
342	5340	0.3338	0.3338
343	5355	0.3301	0.3301
344	5370	0.3218	0.3218
345	5385	0.3206	0.3206
346	5400	0.3131	0.3131
347	5415	0.308	0.308
348	5430	0.3058	0.3058
349	5445	0.2996	0.2996
350	5460	0.2961	0.2961
351	5475	0.2937	0.2937
352	5490	0.2913	0.2913
353	5505	0.2866	0.2866
354	5520	0.2787	0.2787
355	5535	0.2793	0.2793
356	5550	0.2752	0.2752
357	5565	0.2732	0.2732
358	5580	0.2659	0.2659
359	5595	0.2676	0.2676
360	5610	0.2643	0.2643
361	5625	0.2664	0.2664
362	5640	0.2816	0.2816
363	5655	0.2748	0.2748
364	5670	0.2635	0.2635
365	5685	0.2621	0.2621
366	5700	0.2598	0.2598

				Pumping Test - Water Level Data	Page 8 of 11
				Project: Town of Beausejour	
				Number: Feb2020	
				Client: MWSB	

	Time [min]	Water Level [ft]	Drawdown [ft]
367	5730	0.2571	0.2571
368	5745	0.2576	0.2576
369	5760	0.2587	0.2587
370	5775	0.2762	0.2762
371	5790	0.2715	0.2715
372	5805	0.2744	0.2744
373	5820	0.2806	0.2806
374	5835	0.2825	0.2825
375	5880	0.2873	0.2873
376	5895	0.2871	0.2871
377	5910	0.2892	0.2892
378	5925	0.2889	0.2889
379	5940	0.2876	0.2876
380	5955	0.2885	0.2885
381	5970	0.285	0.285
382	5985	0.287	0.287
383	6015	0.2944	0.2944
384	6030	0.2876	0.2876
385	6060	0.2912	0.2912
386	6075	0.2928	0.2928
387	6090	0.2966	0.2966
388	6105	0.2992	0.2992
389	6120	0.2969	0.2969
390	6135	0.2969	0.2969
391	6150	0.3048	0.3048
392	6165	0.3066	0.3066
393	6180	0.3071	0.3071
394	6195	0.299	0.299
395	6210	0.3002	0.3002
396	6225	0.3005	0.3005
397	6240	0.2962	0.2962
398	6255	0.2918	0.2918
399	6270	0.2921	0.2921
400	6285	0.2905	0.2905
401	6300	0.2924	0.2924
402	6315	0.2873	0.2873
403	6330	0.2835	0.2835
404	6345	0.2819	0.2819
405	6360	0.2855	0.2855
406	6375	0.2756	0.2756
407	6390	0.2771	0.2771
408	6405	0.2763	0.2763
409	6420	0.2742	0.2742
410	6435	0.2733	0.2733
411	6450	0.2729	0.2729
412	6465	0.2696	0.2696
413	6480	0.2747	0.2747
414	6495	0.2736	0.2736
415	6510	0.2653	0.2653
416	6525	0.2669	0.2669
417	6540	0.2658	0.2658
418	6555	0.2701	0.2701
419	6570	0.275	0.275

Pumping Test - Water Level Data	Page 9 of 11
Project: Town of Beausejour	
Number: Feb2020	
Client: MWSB	

	Time [min]	Water Level [ft]	Drawdown [ft]
420	6585	0.2739	0.2739
421	6600	0.2725	0.2725
422	6615	0.2723	0.2723
423	6630	0.275	0.275
424	6645	0.2727	0.2727
425	6660	0.2781	0.2781
426	6675	0.2764	0.2764
427	6690	0.2778	0.2778
428	6705	0.2764	0.2764
429	6720	0.2751	0.2751
430	6735	0.3108	0.3108
431	6750	0.2769	0.2769
432	6765	0.2718	0.2718
433	6780	0.2669	0.2669
434	6795	0.2644	0.2644
435	6810	0.2666	0.2666
436	6825	0.2668	0.2668
437	6840	0.2657	0.2657
438	6855	0.2601	0.2601
439	6870	0.2592	0.2592
440	6885	0.2619	0.2619
441	6900	0.2557	0.2557
442	6915	0.249	0.249
443	6930	0.2431	0.2431
444	6945	0.2415	0.2415
445	6960	0.2362	0.2362
446	6975	0.2355	0.2355
447	6990	0.2298	0.2298
448	7005	0.2266	0.2266
449	7020	0.2239	0.2239
450	7035	0.2262	0.2262
451	7050	0.2156	0.2156
452	7065	0.2196	0.2196
453	7095	0.2185	0.2185
454	7110	0.2172	0.2172
455	7125	0.2201	0.2201
456	7140	0.2208	0.2208
457	7155	0.215	0.215
458	7170	0.2156	0.2156
459	7185	0.2182	0.2182
460	7200	0.2163	0.2163
461	7215	0.2082	0.2082
462	7230	0.2082	0.2082
463	7260	0.2174	0.2174
464	7290	0.2201	0.2201
465	7305	0.2273	0.2273
466	7320	0.2306	0.2306
467	7335	0.2217	0.2217
468	7350	0.2212	0.2212
469	7365	0.218	0.218
470	7380	0.2193	0.2193
471	7395	0.2144	0.2144
472	7425	0.2148	0.2148

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
473	7440	0.2189	0.2189
474	7455	0.2161	0.2161
475	7470	0.2294	0.2294
476	7485	0.21	0.21
477	7500	0.2095	0.2095
478	7515	0.2076	0.2076
479	7530	0.214	0.214
480	7545	0.2118	0.2118
481	7560	0.2136	0.2136
482	7575	0.2139	0.2139
483	7590	0.2101	0.2101
484	7620	0.2298	0.2298
485	7635	0.2139	0.2139
486	7650	0.2196	0.2196
487	7665	0.2212	0.2212
488	7680	0.2217	0.2217
489	7695	0.2239	0.2239
490	7710	0.2171	0.2171
491	7740	0.2054	0.2054
492	7755	0.2033	0.2033
493	7770	0.2018	0.2018
494	7785	0.1979	0.1979
495	7800	0.1919	0.1919
496	7815	0.1876	0.1876
497	7830	0.1959	0.1959
498	7845	0.1892	0.1892
499	7860	0.1895	0.1895
500	7875	0.183	0.183
501	7890	0.1786	0.1786
502	7905	0.1742	0.1742
503	7920	0.1751	0.1751
504	7935	0.172	0.172
505	7950	0.1675	0.1675
506	7965	0.1662	0.1662
507	7980	0.1656	0.1656
508	7995	0.1644	0.1644
509	8010	0.1621	0.1621
510	8025	0.1593	0.1593
511	8040	0.1594	0.1594
512	8055	0.1633	0.1633
513	8070	0.1646	0.1646
514	8085	0.1691	0.1691
515	8100	0.1671	0.1671
516	8115	0.1656	0.1656
517	8130	0.1673	0.1673
518	8145	0.1688	0.1688
519	8160	0.1663	0.1663
520	8190	0.1709	0.1709
521	8205	0.1683	0.1683
522	8235	0.1587	0.1587
523	8250	0.1569	0.1569
524	8280	0.1578	0.1578
525	8295	0.154	0.154

Pumping Test - Water Level Data	Page 11 of 11
Project: Town of Beausejour	
Number: Feb2020	
Client: MWSB	

	Time [min]	Water Level [ft]	Drawdown [ft]
526	8310	0.1556	0.1556
527	8325	0.1682	0.1682
528	8340	0.1605	0.1605
529	8355	0.1514	0.1514
530	8370	0.1483	0.1483
531	8385	0.1484	0.1484
532	8400	0.143	0.143
533	8415	0.1418	0.1418
534	8430	0.1399	0.1399
535	8445	0.1383	0.1383
536	8475	0.1369	0.1369
537	8490	0.1343	0.1343
538	8505	0.1485	0.1485
539	8520	0.1414	0.1414
540	8535	0.147	0.147
541	8550	0.1412	0.1412

	Pumping Test - Water Level Data
	Project: Town of Beausejour
	Number: Feb2020
	Client: MWSB

Location: Pescitelli Road	Pumping Test: Pumping Test 1	Pumping Well: West Production Well
Test Conducted by: FDL	Test Date: 2/4/2020	Discharge: variable, average rate 510 [U.S. gal/mi
Observation Well: Domestic 2	Static Water Level [ft]: 0.00	Radial Distance to PW [m]: 1959.19

	Time [min]	Water Level [ft]	Drawdown [ft]
1	0	0.00	0.00
2	30	0.0038	0.0038
3	45	0.006	0.006
4	60	0.0097	0.0097
5	75	0.0155	0.0155
6	90	0.0237	0.0237
7	105	0.0366	0.0366
8	120	0.0452	0.0452
9	150	0.0668	0.0668
10	165	0.0819	0.0819
11	180	0.0962	0.0962
12	195	0.1027	0.1027
13	210	0.1109	0.1109
14	225	0.123	0.123
15	240	0.1385	0.1385
16	255	0.1507	0.1507
17	270	0.1608	0.1608
18	285	0.1751	0.1751
19	300	0.1817	0.1817
20	330	0.209	0.209
21	345	0.2179	0.2179
22	375	0.2326	0.2326
23	390	0.2432	0.2432
24	405	0.2541	0.2541
25	450	0.28	0.28
26	465	0.2821	0.2821
27	480	0.2944	0.2944
28	495	0.3003	0.3003
29	510	0.3087	0.3087
30	525	0.3101	0.3101
31	570	0.3302	0.3302
32	585	0.3313	0.3313
33	615	0.3486	0.3486
34	630	0.3511	0.3511
35	675	0.3679	0.3679
36	690	0.4016	0.4016
37	705	0.3825	0.3825
38	720	0.3806	0.3806
39	735	0.3802	0.3802
40	750	0.3877	0.3877
41	765	0.3876	0.3876
42	780	0.3887	0.3887
43	795	0.3937	0.3937
44	810	0.3977	0.3977
45	825	0.3933	0.3933
46	840	0.4004	0.4004
47	855	0.4001	0.4001
48	870	0.4007	0.4007

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
49	885	0.4008	0.4008
50	900	0.4056	0.4056
51	915	0.4031	0.4031
52	930	0.4063	0.4063
53	945	0.4071	0.4071
54	960	0.4044	0.4044
55	990	0.4212	0.4212
56	1080	0.4311	0.4311
57	1095	0.4282	0.4282
58	1110	0.4287	0.4287
59	1125	0.4267	0.4267
60	1140	0.4354	0.4354
61	1155	0.4407	0.4407
62	1170	0.4376	0.4376
63	1185	0.4401	0.4401
64	1200	0.4436	0.4436
65	1215	0.4467	0.4467
66	1230	0.4466	0.4466
67	1245	0.4514	0.4514
68	1260	0.4597	0.4597
69	1275	0.4571	0.4571
70	1290	0.4635	0.4635
71	1305	0.4642	0.4642
72	1320	0.4646	0.4646
73	1335	0.4739	0.4739
74	1350	0.4812	0.4812
75	1365	0.4827	0.4827
76	1380	0.4838	0.4838
77	1395	0.4904	0.4904
78	1410	0.489	0.489
79	1425	0.5004	0.5004
80	1440	0.5048	0.5048
81	1455	0.4993	0.4993
82	1470	0.5092	0.5092
83	1500	0.5127	0.5127
84	1515	0.5132	0.5132
85	1530	0.5162	0.5162
86	1545	0.5151	0.5151
87	1560	0.5135	0.5135
88	1575	0.5199	0.5199
89	1590	0.5137	0.5137
90	1605	0.516	0.516
91	1620	0.5138	0.5138
92	1635	0.5165	0.5165
93	1650	0.5155	0.5155
94	1665	0.5184	0.5184
95	1680	0.5178	0.5178
96	1710	0.5171	0.5171
97	1725	0.5192	0.5192
98	1740	0.5207	0.5207
99	1755	0.5194	0.5194
100	1770	0.5223	0.5223
101	1785	0.5276	0.5276

Pumping Test - Water Level Data	Page 3 of 10
Project: Town of Beausejour	
Number: Feb2020	
Client: MWSB	

	Time [min]	Water Level [ft]	Drawdown [ft]
102	1815	0.5263	0.5263
103	1830	0.5312	0.5312
104	1845	0.5435	0.5435
105	1860	0.5377	0.5377
106	1875	0.5385	0.5385
107	1890	0.5433	0.5433
108	1905	0.5429	0.5429
109	1920	0.5472	0.5472
110	1935	0.5639	0.5639
111	1950	0.5523	0.5523
112	1965	0.5543	0.5543
113	1980	0.559	0.559
114	1995	0.5659	0.5659
115	2010	0.5742	0.5742
116	2025	0.571	0.571
117	2040	0.5712	0.5712
118	2055	0.5732	0.5732
119	2070	0.5818	0.5818
120	2085	0.582	0.582
121	2100	0.5821	0.5821
122	2115	0.5855	0.5855
123	2130	0.5833	0.5833
124	2145	0.5948	0.5948
125	2190	0.6083	0.6083
126	2205	0.5997	0.5997
127	2220	0.5995	0.5995
128	2235	0.6024	0.6024
129	2250	0.598	0.598
130	2265	0.5998	0.5998
131	2280	0.5991	0.5991
132	2295	0.596	0.596
133	2310	0.60	0.60
134	2325	0.5993	0.5993
135	2355	0.5954	0.5954
136	2370	0.5939	0.5939
137	2385	0.5945	0.5945
138	2400	0.5919	0.5919
139	2415	0.601	0.601
140	2430	0.5989	0.5989
141	2445	0.5976	0.5976
142	2460	0.5959	0.5959
143	2475	0.5992	0.5992
144	2490	0.599	0.599
145	2505	0.6027	0.6027
146	2520	0.6026	0.6026
147	2535	0.6038	0.6038
148	2550	0.6095	0.6095
149	2580	0.608	0.608
150	2595	0.6076	0.6076
151	2610	0.6106	0.6106
152	2625	0.6153	0.6153
153	2640	0.612	0.612
154	2655	0.6145	0.6145

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
155	2670	0.6161	0.6161
156	2685	0.6174	0.6174
157	2700	0.6204	0.6204
158	2715	0.6222	0.6222
159	2730	0.6203	0.6203
160	2745	0.6246	0.6246
161	2760	0.6269	0.6269
162	2775	0.6764	0.6764
163	2790	0.6368	0.6368
164	2805	0.6382	0.6382
165	2820	0.6399	0.6399
166	2835	0.6431	0.6431
167	2850	0.6464	0.6464
168	2865	0.6448	0.6448
169	2880	0.646	0.646
170	2895	0.6478	0.6478
171	2910	0.6512	0.6512
172	2925	0.6522	0.6522
173	2940	0.6575	0.6575
174	2955	0.69	0.69
175	2970	0.6721	0.6721
176	2985	0.6633	0.6633
177	3015	0.6653	0.6653
178	3030	0.6642	0.6642
179	3060	0.7011	0.7011
180	3075	0.6716	0.6716
181	3090	0.6774	0.6774
182	3105	0.6737	0.6737
183	3120	0.6768	0.6768
184	3135	0.6769	0.6769
185	3150	0.6766	0.6766
186	3165	0.6798	0.6798
187	3195	0.6832	0.6832
188	3210	0.6868	0.6868
189	3225	0.6913	0.6913
190	3240	0.6928	0.6928
191	3270	0.7013	0.7013
192	3285	0.6976	0.6976
193	3300	0.7012	0.7012
194	3315	0.7024	0.7024
195	3330	0.7076	0.7076
196	3345	0.7115	0.7115
197	3360	0.7134	0.7134
198	3375	0.713	0.713
199	3390	0.7201	0.7201
200	3405	0.721	0.721
201	3420	0.7229	0.7229
202	3435	0.7257	0.7257
203	3450	0.7259	0.7259
204	3465	0.7368	0.7368
205	3480	0.7415	0.7415
206	3510	0.7503	0.7503
207	3525	0.7464	0.7464

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
208	3540	0.7534	0.7534
209	3570	0.7583	0.7583
210	3585	0.7594	0.7594
211	3600	0.7599	0.7599
212	3615	0.7604	0.7604
213	3630	0.7597	0.7597
214	3645	0.7589	0.7589
215	3660	0.7629	0.7629
216	3675	0.7633	0.7633
217	3705	0.7663	0.7663
218	3735	0.761	0.761
219	3750	0.7689	0.7689
220	3765	0.7654	0.7654
221	3795	0.7656	0.7656
222	3810	0.7653	0.7653
223	3840	0.7651	0.7651
224	3855	0.7622	0.7622
225	3870	0.7626	0.7626
226	3885	0.7652	0.7652
227	3900	0.7639	0.7639
228	3915	0.7628	0.7628
229	3930	0.7625	0.7625
230	3945	0.7662	0.7662
231	3975	0.7624	0.7624
232	3990	0.7645	0.7645
233	4005	0.765	0.765
234	4020	0.7637	0.7637
235	4050	0.766	0.766
236	4065	0.7657	0.7657
237	4080	0.7679	0.7679
238	4095	0.7658	0.7658
239	4125	0.7671	0.7671
240	4140	0.7731	0.7731
241	4155	0.7697	0.7697
242	4170	0.78	0.78
243	4200	0.7912	0.7912
244	4215	0.7808	0.7808
245	4230	0.7841	0.7841
246	4245	0.7842	0.7842
247	4260	0.7852	0.7852
248	4275	0.7927	0.7927
249	4290	0.7905	0.7905
250	4305	0.7848	0.7848
251	4320	0.7867	0.7867
252	4350	0.7904	0.7904
253	4380	0.7807	0.7807
254	4410	0.7647	0.7647
255	4425	0.754	0.754
256	4440	0.7411	0.7411
257	4455	0.7281	0.7281
258	4485	0.703	0.703
259	4500	0.6908	0.6908
260	4515	0.6736	0.6736

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
261	4530	0.6708	0.6708
262	4545	0.6481	0.6481
263	4560	0.6332	0.6332
264	4575	0.6223	0.6223
265	4590	0.6105	0.6105
266	4605	0.5969	0.5969
267	4620	0.5834	0.5834
268	4635	0.5729	0.5729
269	4650	0.5671	0.5671
270	4665	0.5546	0.5546
271	4680	0.5471	0.5471
272	4695	0.5394	0.5394
273	4710	0.5293	0.5293
274	4725	0.5172	0.5172
275	4770	0.5001	0.5001
276	4785	0.4865	0.4865
277	4845	0.461	0.461
278	4860	0.4517	0.4517
279	4875	0.4512	0.4512
280	4890	0.4786	0.4786
281	4905	0.4438	0.4438
282	4920	0.4333	0.4333
283	4935	0.43	0.43
284	4950	0.4218	0.4218
285	4965	0.4207	0.4207
286	4980	0.4143	0.4143
287	4995	0.4114	0.4114
288	5010	0.4073	0.4073
289	5025	0.3996	0.3996
290	5040	0.3915	0.3915
291	5055	0.4245	0.4245
292	5070	0.3816	0.3816
293	5085	0.3762	0.3762
294	5100	0.369	0.369
295	5115	0.3671	0.3671
296	5130	0.3622	0.3622
297	5145	0.359	0.359
298	5160	0.3532	0.3532
299	5175	0.3465	0.3465
300	5190	0.3379	0.3379
301	5205	0.3307	0.3307
302	5220	0.3262	0.3262
303	5235	0.3253	0.3253
304	5250	0.3159	0.3159
305	5265	0.3106	0.3106
306	5280	0.3119	0.3119
307	5295	0.3066	0.3066
308	5310	0.3061	0.3061
309	5325	0.3026	0.3026
310	5340	0.2948	0.2948
311	5355	0.2936	0.2936
312	5370	0.2956	0.2956
313	5385	0.2932	0.2932

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
314	5400	0.2864	0.2864
315	5415	0.2825	0.2825
316	5430	0.2817	0.2817
317	5445	0.2752	0.2752
318	5460	0.2729	0.2729
319	5475	0.2708	0.2708
320	5490	0.2666	0.2666
321	5505	0.2644	0.2644
322	5520	0.2631	0.2631
323	5535	0.2628	0.2628
324	5550	0.2574	0.2574
325	5565	0.2514	0.2514
326	5580	0.2592	0.2592
327	5595	0.2576	0.2576
328	5610	0.255	0.255
329	5625	0.2539	0.2539
330	5640	0.2545	0.2545
331	5655	0.2519	0.2519
332	5685	0.2445	0.2445
333	5700	0.2436	0.2436
334	5715	0.2434	0.2434
335	5730	0.2387	0.2387
336	5745	0.2348	0.2348
337	5760	0.2384	0.2384
338	5775	0.2343	0.2343
339	5790	0.237	0.237
340	5805	0.2328	0.2328
341	5820	0.2313	0.2313
342	5835	0.2319	0.2319
343	5895	0.2246	0.2246
344	5910	0.227	0.227
345	5925	0.2184	0.2184
346	5940	0.2154	0.2154
347	5955	0.2146	0.2146
348	5985	0.2071	0.2071
349	6015	0.2054	0.2054
350	6030	0.2017	0.2017
351	6060	0.1983	0.1983
352	6075	0.203	0.203
353	6090	0.1996	0.1996
354	6120	0.2014	0.2014
355	6150	0.2008	0.2008
356	6165	0.2007	0.2007
357	6180	0.2056	0.2056
358	6195	0.2026	0.2026
359	6210	0.2038	0.2038
360	6240	0.2224	0.2224
361	6270	0.2099	0.2099
362	6300	0.2105	0.2105
363	6315	0.2132	0.2132
364	6330	0.2119	0.2119
365	6345	0.2145	0.2145
366	6360	0.2134	0.2134

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
367	6375	0.2161	0.2161
368	6390	0.2135	0.2135
369	6435	0.2583	0.2583
370	6450	0.2291	0.2291
371	6465	0.2276	0.2276
372	6480	0.2285	0.2285
373	6495	0.2298	0.2298
374	6510	0.2278	0.2278
375	6525	0.2318	0.2318
376	6540	0.2342	0.2342
377	6555	0.2363	0.2363
378	6570	0.236	0.236
379	6585	0.232	0.232
380	6600	0.2312	0.2312
381	6615	0.2269	0.2269
382	6630	0.2297	0.2297
383	6645	0.2288	0.2288
384	6660	0.2253	0.2253
385	6675	0.2237	0.2237
386	6690	0.2216	0.2216
387	6705	0.2234	0.2234
388	6720	0.2202	0.2202
389	6735	0.2201	0.2201
390	6750	0.2159	0.2159
391	6765	0.2196	0.2196
392	6795	0.2103	0.2103
393	6810	0.2108	0.2108
394	6825	0.2092	0.2092
395	6855	0.2048	0.2048
396	6870	0.2051	0.2051
397	6900	0.1987	0.1987
398	6915	0.1979	0.1979
399	6930	0.1968	0.1968
400	6945	0.196	0.196
401	6960	0.1928	0.1928
402	6975	0.1929	0.1929
403	6990	0.1901	0.1901
404	7020	0.1874	0.1874
405	7035	0.1919	0.1919
406	7050	0.1873	0.1873
407	7065	0.1871	0.1871
408	7080	0.1866	0.1866
409	7095	0.189	0.189
410	7110	0.1853	0.1853
411	7125	0.1845	0.1845
412	7140	0.1887	0.1887
413	7155	0.1884	0.1884
414	7185	0.1909	0.1909
415	7200	0.188	0.188
416	7215	0.1863	0.1863
417	7230	0.1818	0.1818
418	7245	0.1834	0.1834
419	7260	0.1844	0.1844

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
420	7275	0.18	0.18
421	7290	0.1775	0.1775
422	7305	0.19	0.19
423	7320	0.1749	0.1749
424	7335	0.1694	0.1694
425	7350	0.1688	0.1688
426	7365	0.1668	0.1668
427	7380	0.164	0.164
428	7395	0.1571	0.1571
429	7425	0.1554	0.1554
430	7440	0.1508	0.1508
431	7455	0.1522	0.1522
432	7470	0.1456	0.1456
433	7485	0.1441	0.1441
434	7500	0.1432	0.1432
435	7515	0.1371	0.1371
436	7530	0.1334	0.1334
437	7545	0.1318	0.1318
438	7560	0.1368	0.1368
439	7575	0.1321	0.1321
440	7590	0.1302	0.1302
441	7605	0.1326	0.1326
442	7620	0.1312	0.1312
443	7635	0.1306	0.1306
444	7650	0.1244	0.1244
445	7665	0.1237	0.1237
446	7695	0.1251	0.1251
447	7725	0.1255	0.1255
448	7740	0.1234	0.1234
449	7755	0.1193	0.1193
450	7770	0.1268	0.1268
451	7785	0.1197	0.1197
452	7800	0.1175	0.1175
453	7830	0.1199	0.1199
454	7890	0.1497	0.1497
455	7905	0.1252	0.1252
456	7920	0.122	0.122
457	7935	0.1236	0.1236
458	7950	0.1222	0.1222
459	7965	0.1225	0.1225
460	7980	0.1184	0.1184
461	7995	0.1198	0.1198
462	8010	0.1213	0.1213
463	8025	0.1167	0.1167
464	8040	0.1179	0.1179
465	8055	0.1153	0.1153
466	8070	0.1134	0.1134
467	8085	0.1182	0.1182
468	8100	0.1116	0.1116
469	8115	0.1106	0.1106
470	8130	0.1093	0.1093
471	8145	0.1113	0.1113
472	8160	0.1074	0.1074

Pumping Test - Water Level Data		
Project:	Town of Beausejour	
Number:	Feb2020	
Client:	MWSB	

	Time [min]	Water Level [ft]	Drawdown [ft]
473	8175	0.1031	0.1031
474	8190	0.1009	0.1009
475	8205	0.1021	0.1021
476	8220	0.1025	0.1025
477	8235	0.0996	0.0996
478	8250	0.0933	0.0933
479	8265	0.0948	0.0948
480	8280	0.0934	0.0934
481	8295	0.0875	0.0875
482	8310	0.0887	0.0887
483	8325	0.0874	0.0874
484	8340	0.0825	0.0825
485	8355	0.0848	0.0848
486	8370	0.0821	0.0821
487	8385	0.0872	0.0872
488	8415	0.0823	0.0823
489	8430	0.0798	0.0798
490	8445	0.0755	0.0755
491	8460	0.0787	0.0787
492	8475	0.0822	0.0822
493	8490	0.084	0.084
494	8505	0.0793	0.0793
495	8520	0.0805	0.0805
496	8535	0.0816	0.0816
497	8550	0.0828	0.0828

Pumping Test - Water Level Data

Project:	Town of Beausejour
Number:	Feb2020
Client:	MWSB

Location: Pescitelli Road	Pumping Test: Pumping Test 1	Pumping Well: West Production Well
Test Conducted by: FDL	Test Date: 2/4/2020	Discharge: variable, average rate 510 [U.S. gal/mi
Observation Well: Domestic 3	Static Water Level [ft]: 0.00	Radial Distance to PW [m]: 2829.09

	Time [min]	Water Level [ft]	Drawdown [ft]
1	0	0.00	0.00
2	15	-0.0021	-0.0021
3	30	0.0004	0.0004
4	45	0.0021	0.0021
5	60	0.0116	0.0116
6	75	-0.0014	-0.0014
7	90	0.002	0.002
8	105	-0.0044	-0.0044
9	120	-0.0031	-0.0031
10	135	-0.0102	-0.0102
11	150	-0.0055	-0.0055
12	165	-0.0002	-0.0002
13	180	0.0002	0.0002
14	195	-0.0071	-0.0071
15	210	-0.0039	-0.0039
16	225	-0.0025	-0.0025
17	240	-0.0021	-0.0021
18	255	-0.0035	-0.0035
19	270	0.003	0.003
20	285	0.0008	0.0008
21	300	0.0022	0.0022
22	315	0.0058	0.0058
23	330	0.0076	0.0076
24	345	0.0053	0.0053
25	360	0.0064	0.0064
26	375	0.0096	0.0096
27	390	0.0103	0.0103
28	405	0.0128	0.0128
29	420	0.016	0.016
30	435	0.0152	0.0152
31	450	0.0164	0.0164
32	465	0.0186	0.0186
33	480	0.0186	0.0186
34	495	0.0127	0.0127
35	510	0.0174	0.0174
36	525	0.0164	0.0164
37	540	0.0186	0.0186
38	555	0.0148	0.0148
39	570	0.0149	0.0149
40	585	0.0153	0.0153
41	600	0.0245	0.0245
42	615	0.0229	0.0229
43	630	0.0282	0.0282
44	645	0.0245	0.0245
45	660	0.0267	0.0267
46	675	0.0283	0.0283
47	690	0.0319	0.0319
48	705	0.0248	0.0248

		Pumping Test - Water Level Data	
		Project: Town of Beausejour	
		Number: Feb2020	
		Client: MWSB	

	Time [min]	Water Level [ft]	Drawdown [ft]
49	720	0.0287	0.0287
50	735	0.0285	0.0285
51	750	0.0282	0.0282
52	765	0.0288	0.0288
53	780	0.0269	0.0269
54	795	0.0295	0.0295
55	810	0.0332	0.0332
56	825	0.0249	0.0249
57	840	0.0264	0.0264
58	855	0.0254	0.0254
59	870	0.0266	0.0266
60	885	0.0295	0.0295
61	900	0.0274	0.0274
62	915	0.0243	0.0243
63	930	0.0246	0.0246
64	945	0.0274	0.0274
65	960	0.0247	0.0247
66	975	0.0242	0.0242
67	990	0.0291	0.0291
68	1005	0.0261	0.0261
69	1020	0.0303	0.0303
70	1035	0.0298	0.0298
71	1050	0.0297	0.0297
72	1065	0.0317	0.0317
73	1080	0.0258	0.0258
74	1095	0.0317	0.0317
75	1110	0.0301	0.0301
76	1125	0.0296	0.0296
77	1140	0.0351	0.0351
78	1155	0.038	0.038
79	1170	0.0339	0.0339
80	1185	0.0404	0.0404
81	1200	0.0383	0.0383
82	1215	0.0396	0.0396
83	1230	0.0389	0.0389
84	1245	0.0351	0.0351
85	1260	0.0374	0.0374
86	1275	0.0402	0.0402
87	1290	0.0483	0.0483
88	1305	0.0532	0.0532
89	1335	0.0597	0.0597
90	1350	0.0616	0.0616
91	1365	0.0625	0.0625
92	1380	0.0624	0.0624
93	1395	0.0658	0.0658
94	1410	0.0688	0.0688
95	1425	0.0748	0.0748
96	1440	0.0817	0.0817
97	1455	0.0768	0.0768
98	1470	0.0773	0.0773
99	1485	0.0734	0.0734
100	1500	0.0789	0.0789
101	1515	0.0791	0.0791

Project: Town of Beausejour

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Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
102	1530	0.0803	0.0803
103	1545	0.0813	0.0813
104	1560	0.0757	0.0757
105	1575	0.0741	0.0741
106	1590	0.0661	0.0661
107	1605	0.0722	0.0722
108	1620	0.074	0.074
109	1635	0.0699	0.0699
110	1650	0.0705	0.0705
111	1665	0.0721	0.0721
112	1680	0.069	0.069
113	1695	0.0674	0.0674
114	1710	0.0602	0.0602
115	1725	0.0698	0.0698
116	1740	0.0647	0.0647
117	1755	0.0642	0.0642
118	1770	0.069	0.069
119	1785	0.0689	0.0689
120	1800	0.0659	0.0659
121	1815	0.0699	0.0699
122	1830	0.0717	0.0717
123	1845	0.0687	0.0687
124	1860	0.0714	0.0714
125	1875	0.0715	0.0715
126	1890	0.0743	0.0743
127	1905	0.0714	0.0714
128	1920	0.0748	0.0748
129	1935	0.0726	0.0726
130	1950	0.0788	0.0788
131	1965	0.0807	0.0807
132	1980	0.0751	0.0751
133	1995	0.0758	0.0758
134	2010	0.0812	0.0812
135	2025	0.0806	0.0806
136	2040	0.0797	0.0797
137	2055	0.0785	0.0785
138	2070	0.0773	0.0773
139	2085	0.0801	0.0801
140	2100	0.0788	0.0788
141	2115	0.0818	0.0818
142	2130	0.079	0.079
143	2145	0.0845	0.0845
144	2160	0.0818	0.0818
145	2175	0.084	0.084
146	2190	0.0868	0.0868
147	2205	0.085	0.085
148	2220	0.0864	0.0864
149	2235	0.0868	0.0868
150	2250	0.0863	0.0863
151	2265	0.0832	0.0832
152	2280	0.0883	0.0883
153	2295	0.0871	0.0871
154	2310	0.0846	0.0846

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Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
155	2325	0.0883	0.0883
156	2340	0.0872	0.0872
157	2355	0.0873	0.0873
158	2370	0.086	0.086
159	2400	0.0978	0.0978
160	2415	0.0988	0.0988
161	2430	0.0979	0.0979
162	2445	0.1083	0.1083
163	2460	0.0994	0.0994
164	2475	0.0985	0.0985
165	2505	0.1034	0.1034
166	2520	0.1036	0.1036
167	2535	0.1051	0.1051
168	2550	0.1037	0.1037
169	2565	0.1068	0.1068
170	2580	0.1123	0.1123
171	2595	0.1123	0.1123
172	2610	0.1087	0.1087
173	2625	0.1112	0.1112
174	2640	0.1113	0.1113
175	2655	0.1155	0.1155
176	2670	0.1189	0.1189
177	2685	0.1247	0.1247
178	2700	0.1199	0.1199
179	2715	0.1202	0.1202
180	2730	0.1237	0.1237
181	2745	0.1254	0.1254
182	2760	0.1275	0.1275
183	2775	0.1341	0.1341
184	2790	0.1306	0.1306
185	2805	0.1331	0.1331
186	2820	0.1321	0.1321
187	2835	0.1318	0.1318
188	2850	0.1395	0.1395
189	2865	0.1374	0.1374
190	2880	0.1405	0.1405
191	2895	0.1411	0.1411
192	2910	0.1428	0.1428
193	2925	0.1416	0.1416
194	2940	0.1434	0.1434
195	2955	0.1442	0.1442
196	2970	0.1482	0.1482
197	2985	0.1464	0.1464
198	3000	0.142	0.142
199	3015	0.1454	0.1454
200	3030	0.1451	0.1451
201	3045	0.1458	0.1458
202	3060	0.1477	0.1477
203	3075	0.1528	0.1528
204	3090	0.15	0.15
205	3105	0.1494	0.1494
206	3120	0.1534	0.1534
207	3135	0.1534	0.1534

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	Time [min]	Water Level [ft]	Drawdown [ft]
208	3150	0.1536	0.1536
209	3165	0.1516	0.1516
210	3180	0.1514	0.1514
211	3195	0.1572	0.1572
212	3210	0.157	0.157
213	3225	0.1587	0.1587
214	3240	0.1621	0.1621
215	3255	0.1676	0.1676
216	3270	0.1631	0.1631
217	3285	0.1652	0.1652
218	3300	0.1686	0.1686
219	3315	0.1659	0.1659
220	3330	0.1734	0.1734
221	3345	0.1762	0.1762
222	3360	0.1737	0.1737
223	3375	0.1787	0.1787
224	3390	0.1777	0.1777
225	3405	0.1769	0.1769
226	3420	0.1811	0.1811
227	3435	0.1801	0.1801
228	3450	0.1792	0.1792
229	3480	0.1905	0.1905
230	3495	0.1905	0.1905
231	3510	0.1936	0.1936
232	3525	0.1924	0.1924
233	3540	0.1954	0.1954
234	3555	0.2006	0.2006
235	3570	0.1969	0.1969
236	3585	0.1962	0.1962
237	3600	0.1988	0.1988
238	3615	0.199	0.199
239	3630	0.2039	0.2039
240	3645	0.2008	0.2008
241	3660	0.2012	0.2012
242	3675	0.2032	0.2032
243	3690	0.2052	0.2052
244	3705	0.204	0.204
245	3720	0.2061	0.2061
246	3735	0.2022	0.2022
247	3750	0.2032	0.2032
248	3765	0.2057	0.2057
249	3780	0.2062	0.2062
250	3795	0.2047	0.2047
251	3810	0.2035	0.2035
252	3825	0.2061	0.2061
253	3840	0.2062	0.2062
254	3855	0.2018	0.2018
255	3870	0.2072	0.2072
256	3885	0.2087	0.2087
257	3900	0.2107	0.2107
258	3915	0.2103	0.2103
259	3930	0.2121	0.2121
260	3945	0.2113	0.2113

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Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
261	3960	0.2127	0.2127
262	3975	0.2152	0.2152
263	3990	0.2154	0.2154
264	4005	0.2107	0.2107
265	4020	0.2145	0.2145
266	4035	0.2144	0.2144
267	4050	0.2179	0.2179
268	4065	0.219	0.219
269	4080	0.2169	0.2169
270	4095	0.2227	0.2227
271	4110	0.2248	0.2248
272	4125	0.2222	0.2222
273	4140	0.2256	0.2256
274	4155	0.224	0.224
275	4170	0.2308	0.2308
276	4185	0.2303	0.2303
277	4200	0.2264	0.2264
278	4215	0.2258	0.2258
279	4230	0.2345	0.2345
280	4245	0.2331	0.2331
281	4260	0.233	0.233
282	4275	0.2343	0.2343
283	4290	0.234	0.234
284	4305	0.2281	0.2281
285	4320	0.2291	0.2291
286	4335	0.2317	0.2317
287	4350	0.2345	0.2345
288	4365	0.232	0.232
289	4380	0.2322	0.2322
290	4395	0.2303	0.2303
291	4410	0.2326	0.2326
292	4425	0.2327	0.2327
293	4440	0.2288	0.2288
294	4455	0.2223	0.2223
295	4470	0.2237	0.2237
296	4485	0.2234	0.2234
297	4500	0.2168	0.2168
298	4515	0.219	0.219
299	4530	0.2185	0.2185
300	4545	0.212	0.212
301	4560	0.2076	0.2076
302	4575	0.2046	0.2046
303	4590	0.2046	0.2046
304	4605	0.2014	0.2014
305	4620	0.2025	0.2025
306	4635	0.2021	0.2021
307	4650	0.1994	0.1994
308	4665	0.1973	0.1973
309	4680	0.2056	0.2056
310	4695	0.1981	0.1981
311	4710	0.192	0.192
312	4725	0.19	0.19
313	4740	0.1904	0.1904

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	Time [min]	Water Level [ft]	Drawdown [ft]
314	4755	0.1893	0.1893
315	4770	0.1889	0.1889
316	4785	0.1885	0.1885
317	4800	0.1856	0.1856
318	4815	0.1828	0.1828
319	4830	0.1848	0.1848
320	4845	0.182	0.182
321	4860	0.1782	0.1782
322	4875	0.1783	0.1783
323	4890	0.1748	0.1748
324	4905	0.1782	0.1782
325	4920	0.1723	0.1723
326	4935	0.1765	0.1765
327	4950	0.1741	0.1741
328	4965	0.1742	0.1742
329	4980	0.171	0.171
330	4995	0.1691	0.1691
331	5010	0.1694	0.1694
332	5025	0.1723	0.1723
333	5040	0.1685	0.1685
334	5055	0.1647	0.1647
335	5070	0.1605	0.1605
336	5085	0.1642	0.1642
337	5100	0.1619	0.1619
338	5115	0.1607	0.1607
339	5130	0.1601	0.1601
340	5145	0.1561	0.1561
341	5160	0.1635	0.1635
342	5175	0.1544	0.1544
343	5190	0.1483	0.1483
344	5205	0.1426	0.1426
345	5220	0.1438	0.1438
346	5235	0.1491	0.1491
347	5250	0.1455	0.1455
348	5265	0.1422	0.1422
349	5280	0.1426	0.1426
350	5295	0.1406	0.1406
351	5310	0.1458	0.1458
352	5325	0.1418	0.1418
353	5340	0.139	0.139
354	5355	0.1426	0.1426
355	5370	0.1394	0.1394
356	5385	0.1372	0.1372
357	5400	0.1327	0.1327
358	5415	0.1345	0.1345
359	5430	0.134	0.134
360	5445	0.1347	0.1347
361	5460	0.1327	0.1327
362	5475	0.1334	0.1334
363	5490	0.1305	0.1305
364	5505	0.1326	0.1326
365	5520	0.1277	0.1277
366	5535	0.131	0.131

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	Time [min]	Water Level [ft]	Drawdown [ft]
367	5550	0.1242	0.1242
368	5565	0.1257	0.1257
369	5580	0.1272	0.1272
370	5595	0.1234	0.1234
371	5625	0.1276	0.1276
372	5640	0.1275	0.1275
373	5655	0.1281	0.1281
374	5670	0.1311	0.1311
375	5685	0.1328	0.1328
376	5700	0.1331	0.1331
377	5715	0.1322	0.1322
378	5730	0.1332	0.1332
379	5745	0.1299	0.1299
380	5760	0.1311	0.1311
381	5775	0.1285	0.1285
382	5790	0.1325	0.1325
383	5805	0.1314	0.1314
384	5820	0.1332	0.1332
385	5835	0.1305	0.1305
386	5850	0.1323	0.1323
387	5865	0.13	0.13
388	5880	0.124	0.124
389	5895	0.1255	0.1255
390	5910	0.128	0.128
391	5925	0.1226	0.1226
392	5940	0.1193	0.1193
393	5955	0.1171	0.1171
394	5970	0.1224	0.1224
395	5985	0.1217	0.1217
396	6000	0.1189	0.1189
397	6015	0.1164	0.1164
398	6030	0.1179	0.1179
399	6045	0.1131	0.1131
400	6060	0.1146	0.1146
401	6075	0.1176	0.1176
402	6090	0.1193	0.1193
403	6105	0.1203	0.1203
404	6120	0.1201	0.1201
405	6135	0.118	0.118
406	6165	0.1187	0.1187
407	6180	0.1201	0.1201
408	6195	0.1207	0.1207
409	6210	0.1191	0.1191
410	6225	0.1195	0.1195
411	6240	0.1233	0.1233
412	6255	0.124	0.124
413	6270	0.1269	0.1269
414	6285	0.1265	0.1265
415	6300	0.1261	0.1261
416	6315	0.127	0.127
417	6330	0.1317	0.1317
418	6345	0.127	0.127
419	6360	0.1281	0.1281

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	Time [min]	Water Level [ft]	Drawdown [ft]
420	6375	0.1245	0.1245
421	6390	0.1204	0.1204
422	6405	0.1274	0.1274
423	6420	0.1289	0.1289
424	6435	0.1308	0.1308
425	6450	0.1278	0.1278
426	6465	0.1287	0.1287
427	6480	0.1289	0.1289
428	6495	0.132	0.132
429	6510	0.1276	0.1276
430	6525	0.1334	0.1334
431	6540	0.1287	0.1287
432	6555	0.1283	0.1283
433	6570	0.1337	0.1337
434	6585	0.1292	0.1292
435	6600	0.131	0.131
436	6615	0.1493	0.1493
437	6630	0.1309	0.1309
438	6645	0.1298	0.1298
439	6660	0.1269	0.1269
440	6675	0.1304	0.1304
441	6690	0.1287	0.1287
442	6705	0.1274	0.1274
443	6720	0.1265	0.1265
444	6735	0.1274	0.1274
445	6750	0.1282	0.1282
446	6765	0.1242	0.1242
447	6780	0.12	0.12
448	6795	0.116	0.116
449	6810	0.1188	0.1188
450	6825	0.1194	0.1194
451	6840	0.117	0.117
452	6855	0.118	0.118
453	6870	0.1133	0.1133
454	6885	0.114	0.114
455	6900	0.1159	0.1159
456	6915	0.1146	0.1146
457	6930	0.11	0.11
458	6945	0.1112	0.1112
459	6960	0.1131	0.1131
460	6975	0.1159	0.1159
461	6990	0.1126	0.1126
462	7005	0.1093	0.1093
463	7020	0.1056	0.1056
464	7035	0.1112	0.1112
465	7065	0.1155	0.1155
466	7080	0.1106	0.1106
467	7095	0.1155	0.1155
468	7110	0.1156	0.1156
469	7125	0.1143	0.1143
470	7140	0.1165	0.1165
471	7155	0.1134	0.1134
472	7170	0.1152	0.1152

	Time [min]	Water Level [ft]	Drawdown [ft]
473	7185	0.1225	0.1225
474	7200	0.1186	0.1186
475	7215	0.1176	0.1176
476	7230	0.1219	0.1219
477	7245	0.1148	0.1148
478	7260	0.1178	0.1178
479	7275	0.1123	0.1123
480	7290	0.1091	0.1091
481	7305	0.1074	0.1074
482	7320	0.1042	0.1042
483	7335	0.1002	0.1002
484	7350	0.1012	0.1012
485	7365	0.0991	0.0991
486	7380	0.0964	0.0964
487	7395	0.0906	0.0906
488	7410	0.0921	0.0921
489	7425	0.0903	0.0903
490	7440	0.0891	0.0891
491	7455	0.0896	0.0896
492	7470	0.0834	0.0834
493	7485	0.0808	0.0808
494	7500	0.0762	0.0762
495	7515	0.0751	0.0751
496	7530	0.0745	0.0745
497	7545	0.0754	0.0754
498	7560	0.0753	0.0753
499	7575	0.0733	0.0733
500	7590	0.0733	0.0733
501	7605	0.0764	0.0764
502	7620	0.0713	0.0713
503	7635	0.0712	0.0712
504	7650	0.071	0.071
505	7665	0.0674	0.0674
506	7680	0.0671	0.0671
507	7695	0.0637	0.0637
508	7710	0.0662	0.0662
509	7725	0.0644	0.0644
510	7740	0.0692	0.0692
511	7755	0.065	0.065
512	7770	0.0684	0.0684
513	7785	0.0639	0.0639
514	7800	0.0654	0.0654
515	7815	0.0658	0.0658
516	7830	0.0646	0.0646
517	7845	0.066	0.066
518	7860	0.0598	0.0598
519	7875	0.0618	0.0618
520	7890	0.0609	0.0609
521	7905	0.0572	0.0572
522	7920	0.0611	0.0611
523	7935	0.0598	0.0598
524	7950	0.0572	0.0572
525	7965	0.0588	0.0588

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
526	7980	0.0536	0.0536
527	7995	0.0598	0.0598
528	8010	0.0546	0.0546
529	8025	0.0574	0.0574
530	8040	0.0563	0.0563
531	8055	0.0559	0.0559
532	8070	0.0554	0.0554
533	8085	0.0561	0.0561
534	8100	0.0514	0.0514
535	8115	0.0525	0.0525
536	8130	0.0501	0.0501
537	8145	0.05	0.05
538	8160	0.0477	0.0477
539	8175	0.0437	0.0437
540	8190	0.0476	0.0476
541	8205	0.0476	0.0476
542	8220	0.042	0.042
543	8235	0.0397	0.0397
544	8250	0.0417	0.0417
545	8265	0.0386	0.0386
546	8280	0.0414	0.0414
547	8295	0.0404	0.0404
548	8310	0.0386	0.0386
549	8325	0.0408	0.0408
550	8340	0.0381	0.0381
551	8355	0.0345	0.0345
552	8370	0.0407	0.0407
553	8385	0.0389	0.0389
554	8400	0.0389	0.0389
555	8415	0.0409	0.0409
556	8430	0.0382	0.0382
557	8445	0.037	0.037
558	8460	0.0368	0.0368
559	8475	0.0434	0.0434
560	8490	0.0441	0.0441
561	8505	0.043	0.043
562	8520	0.0422	0.0422
563	8535	0.0474	0.0474
564	8550	0.0454	0.0454

	Pumping Test - Water Level Data
	Project: Town of Beausejour
	Number: Feb2020
	Client: MWSB

Location: Pescitelli Road	Pumping Test: Pumping Test 1	Pumping Well: West Production Well
Test Conducted by: FDL	Test Date: 2/4/2020	Discharge: variable, average rate 510 [U.S. gal/mi
Observation Well: Domestic 4	Static Water Level [ft]: 0.00	Radial Distance to PW [m]: 974.65

	Time [min]	Water Level [ft]	Drawdown [ft]
1	0	0.00	0.00
2	15	0.473	0.473
3	30	0.6802	0.6802
4	45	0.8239	0.8239
5	60	0.9331	0.9331
6	75	1.0233	1.0233
7	90	1.0899	1.0899
8	105	1.1379	1.1379
9	120	1.1877	1.1877
10	135	1.2286	1.2286
11	150	1.2643	1.2643
12	165	1.296	1.296
13	180	1.325	1.325
14	195	1.3477	1.3477
15	210	1.3655	1.3655
16	225	1.3929	1.3929
17	240	1.4143	1.4143
18	255	1.4258	1.4258
19	270	1.446	1.446
20	285	1.4678	1.4678
21	300	1.475	1.475
22	315	1.4826	1.4826
23	330	1.5098	1.5098
24	345	1.5166	1.5166
25	360	1.5318	1.5318
26	375	1.5476	1.5476
27	390	1.5536	1.5536
28	405	1.5635	1.5635
29	420	1.576	1.576
30	435	1.5896	1.5896
31	450	1.5878	1.5878
32	465	1.5887	1.5887
33	480	1.6126	1.6126
34	495	1.6061	1.6061
35	510	1.621	1.621
36	525	1.6252	1.6252
37	540	1.6212	1.6212
38	555	1.6237	1.6237
39	570	1.6292	1.6292
40	585	1.6304	1.6304
41	600	1.631	1.631
42	630	1.6383	1.6383
43	645	1.6398	1.6398
44	660	1.6368	1.6368
45	675	1.6402	1.6402
46	690	1.6399	1.6399
47	705	1.6388	1.6388
48	720	1.6465	1.6465

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
49	735	1.6243	1.6243
50	750	1.6464	1.6464
51	765	1.6533	1.6533
52	780	1.6414	1.6414
53	795	1.6497	1.6497
54	810	1.6504	1.6504
55	825	1.6425	1.6425
56	840	1.6505	1.6505
57	855	1.6567	1.6567
58	870	1.6432	1.6432
59	885	1.6575	1.6575
60	900	1.6487	1.6487
61	915	1.6511	1.6511
62	930	1.6545	1.6545
63	945	1.6495	1.6495
64	960	1.6536	1.6536
65	975	1.6613	1.6613
66	990	1.6665	1.6665
67	1005	1.6746	1.6746
68	1020	1.6792	1.6792
69	1035	1.6742	1.6742
70	1050	1.6871	1.6871
71	1065	1.6777	1.6777
72	1080	1.687	1.687
73	1095	1.6964	1.6964
74	1110	1.6929	1.6929
75	1125	1.6986	1.6986
76	1140	1.6919	1.6919
77	1155	1.703	1.703
78	1170	1.7076	1.7076
79	1185	1.7123	1.7123
80	1200	1.7181	1.7181
81	1215	1.7211	1.7211
82	1230	1.725	1.725
83	1245	1.7281	1.7281
84	1260	1.7289	1.7289
85	1275	1.7324	1.7324
86	1290	1.7425	1.7425
87	1305	1.7456	1.7456
88	1320	1.7475	1.7475
89	1335	1.7499	1.7499
90	1350	1.7676	1.7676
91	1365	1.7634	1.7634
92	1380	1.768	1.768
93	1395	1.7634	1.7634
94	1410	1.7772	1.7772
95	1425	1.7764	1.7764
96	1440	1.7789	1.7789
97	1455	1.7822	1.7822
98	1470	1.7883	1.7883
99	1485	1.7793	1.7793
100	1500	1.7998	1.7998
101	1515	1.8005	1.8005

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
102	1530	1.7819	1.7819
103	1545	1.7834	1.7834
104	1560	1.7893	1.7893
105	1575	1.7832	1.7832
106	1590	1.7883	1.7883
107	1605	1.7727	1.7727
108	1620	1.7785	1.7785
109	1635	1.7876	1.7876
110	1650	1.7768	1.7768
111	1665	1.7887	1.7887
112	1680	1.7895	1.7895
113	1695	1.7815	1.7815
114	1710	1.7886	1.7886
115	1725	1.7957	1.7957
116	1740	1.7904	1.7904
117	1755	1.7913	1.7913
118	1770	1.7993	1.7993
119	1785	1.8072	1.8072
120	1800	1.8113	1.8113
121	1815	1.823	1.823
122	1830	1.8216	1.8216
123	1845	1.831	1.831
124	1860	1.8213	1.8213
125	1875	1.8429	1.8429
126	1890	1.8483	1.8483
127	1905	1.8425	1.8425
128	1920	1.8467	1.8467
129	1935	1.8589	1.8589
130	1950	1.8568	1.8568
131	1965	1.8672	1.8672
132	1980	1.8674	1.8674
133	2010	1.874	1.874
134	2025	1.8807	1.8807
135	2040	1.8719	1.8719
136	2055	1.8788	1.8788
137	2070	1.8851	1.8851
138	2085	1.8855	1.8855
139	2100	1.8755	1.8755
140	2115	1.8847	1.8847
141	2130	1.8842	1.8842
142	2145	1.8858	1.8858
143	2160	1.8858	1.8858
144	2175	1.8826	1.8826
145	2190	1.8861	1.8861
146	2205	1.8812	1.8812
147	2220	1.8804	1.8804
148	2235	1.8743	1.8743
149	2250	1.8732	1.8732
150	2265	1.8818	1.8818
151	2280	1.8813	1.8813
152	2295	1.8741	1.8741
153	2310	1.8736	1.8736
154	2325	1.8569	1.8569

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
155	2340	1.8617	1.8617
156	2355	1.8676	1.8676
157	2370	1.8575	1.8575
158	2385	1.8523	1.8523
159	2400	1.8572	1.8572
160	2415	1.8646	1.8646
161	2430	1.8625	1.8625
162	2445	1.8632	1.8632
163	2460	1.8684	1.8684
164	2475	1.862	1.862
165	2490	1.8608	1.8608
166	2505	1.8521	1.8521
167	2520	1.8555	1.8555
168	2535	1.8538	1.8538
169	2550	1.8606	1.8606
170	2565	1.8636	1.8636
171	2580	1.8569	1.8569
172	2595	1.8613	1.8613
173	2610	1.8587	1.8587
174	2625	1.8573	1.8573
175	2640	1.8583	1.8583
176	2655	1.866	1.866
177	2670	1.8656	1.8656
178	2685	1.8628	1.8628
179	2700	1.8787	1.8787
180	2715	1.866	1.866
181	2730	1.8876	1.8876
182	2745	1.8734	1.8734
183	2760	1.8846	1.8846
184	2775	1.8883	1.8883
185	2790	1.9014	1.9014
186	2805	1.8976	1.8976
187	2820	1.9112	1.9112
188	2835	1.9092	1.9092
189	2850	1.9185	1.9185
190	2865	1.9244	1.9244
191	2880	1.915	1.915
192	2895	1.9327	1.9327
193	2910	1.9281	1.9281
194	2925	1.9246	1.9246
195	2940	1.9297	1.9297
196	2955	1.935	1.935
197	2970	1.9405	1.9405
198	2985	1.9385	1.9385
199	3000	1.9412	1.9412
200	3015	1.9413	1.9413
201	3030	1.9394	1.9394
202	3045	1.9539	1.9539
203	3060	1.9558	1.9558
204	3075	1.9478	1.9478
205	3090	1.9559	1.9559
206	3105	1.9492	1.9492
207	3120	1.9617	1.9617

	Time [min]	Water Level [ft]	Drawdown [ft]
208	3135	1.9611	1.9611
209	3150	1.9669	1.9669
210	3165	1.971	1.971
211	3180	1.9668	1.9668
212	3195	1.9666	1.9666
213	3210	1.9646	1.9646
214	3225	1.9672	1.9672
215	3240	1.9743	1.9743
216	3255	1.9729	1.9729
217	3270	1.9709	1.9709
218	3285	1.9731	1.9731
219	3300	1.9784	1.9784
220	3315	1.9828	1.9828
221	3345	1.9738	1.9738
222	3360	1.9794	1.9794
223	3375	1.9662	1.9662
224	3390	1.9853	1.9853
225	3405	1.9782	1.9782
226	3420	1.9818	1.9818
227	3435	1.979	1.979
228	3450	1.9854	1.9854
229	3465	1.9989	1.9989
230	3480	1.9922	1.9922
231	3495	1.9981	1.9981
232	3510	2.0053	2.0053
233	3525	1.9924	1.9924
234	3540	2.0008	2.0008
235	3555	2.0037	2.0037
236	3570	2.0037	2.0037
237	3585	2.0098	2.0098
238	3600	2.0141	2.0141
239	3615	2.0136	2.0136
240	3630	2.0192	2.0192
241	3645	2.0082	2.0082
242	3660	2.0204	2.0204
243	3675	2.0171	2.0171
244	3690	2.0224	2.0224
245	3705	2.0198	2.0198
246	3720	2.0256	2.0256
247	3735	2.0246	2.0246
248	3750	2.0234	2.0234
249	3765	2.0232	2.0232
250	3780	2.0291	2.0291
251	3795	2.0283	2.0283
252	3810	2.016	2.016
253	3825	2.0229	2.0229
254	3840	2.019	2.019
255	3855	2.0256	2.0256
256	3870	2.0249	2.0249
257	3885	2.0225	2.0225
258	3900	2.0207	2.0207
259	3915	2.0159	2.0159
260	3930	2.0279	2.0279

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
261	3945	2.007	2.007
262	3960	2.0126	2.0126
263	3975	2.0079	2.0079
264	3990	2.0051	2.0051
265	4005	2.0034	2.0034
266	4020	2.0085	2.0085
267	4035	2.0011	2.0011
268	4050	2.0015	2.0015
269	4065	2.0091	2.0091
270	4080	2.0046	2.0046
271	4095	2.0009	2.0009
272	4110	2.0069	2.0069
273	4125	1.9917	1.9917
274	4140	2.003	2.003
275	4155	2.0047	2.0047
276	4170	2.0156	2.0156
277	4185	2.0052	2.0052
278	4200	2.0104	2.0104
279	4215	2.0009	2.0009
280	4230	2.0052	2.0052
281	4245	2.0021	2.0021
282	4260	2.00	2.00
283	4275	2.0129	2.0129
284	4290	2.0096	2.0096
285	4305	2.0139	2.0139
286	4320	2.0127	2.0127
287	4335	1.5335	1.5335
288	4350	1.3387	1.3387
289	4365	1.2187	1.2187
290	4380	1.1108	1.1108
291	4395	1.0491	1.0491
292	4410	0.9786	0.9786
293	4425	0.9348	0.9348
294	4440	0.8834	0.8834
295	4455	0.8467	0.8467
296	4470	0.8142	0.8142
297	4485	0.7897	0.7897
298	4500	0.7556	0.7556
299	4515	0.7268	0.7268
300	4530	0.7184	0.7184
301	4545	0.6875	0.6875
302	4560	0.6839	0.6839
303	4575	0.6565	0.6565
304	4590	0.6489	0.6489
305	4605	0.6246	0.6246
306	4620	0.6065	0.6065
307	4635	0.6032	0.6032
308	4650	0.5948	0.5948
309	4665	0.5816	0.5816
310	4680	0.5721	0.5721
311	4695	0.5695	0.5695
312	4710	0.5645	0.5645
313	4725	0.5443	0.5443

			Pumping Test - Water Level Data	Page 7 of 11
			Project: Town of Beausejour	
			Number: Feb2020	
			Client: MWSB	

	Time [min]	Water Level [ft]	Drawdown [ft]
314	4740	0.531	0.531
315	4755	0.5302	0.5302
316	4770	0.5074	0.5074
317	4785	0.505	0.505
318	4800	0.5105	0.5105
319	4815	0.4936	0.4936
320	4830	0.4882	0.4882
321	4845	0.4715	0.4715
322	4860	0.4673	0.4673
323	4875	0.4709	0.4709
324	4890	0.4529	0.4529
325	4905	0.4508	0.4508
326	4920	0.4458	0.4458
327	4935	0.4339	0.4339
328	4950	0.4308	0.4308
329	4965	0.4251	0.4251
330	4995	0.4212	0.4212
331	5010	0.4058	0.4058
332	5025	0.3979	0.3979
333	5040	0.4002	0.4002
334	5055	0.3958	0.3958
335	5070	0.387	0.387
336	5085	0.3893	0.3893
337	5100	0.3829	0.3829
338	5115	0.383	0.383
339	5130	0.3733	0.3733
340	5145	0.376	0.376
341	5160	0.3792	0.3792
342	5175	0.3702	0.3702
343	5190	0.37	0.37
344	5205	0.3594	0.3594
345	5220	0.3565	0.3565
346	5235	0.3598	0.3598
347	5250	0.355	0.355
348	5265	0.3394	0.3394
349	5280	0.3404	0.3404
350	5295	0.3384	0.3384
351	5310	0.3393	0.3393
352	5325	0.3256	0.3256
353	5340	0.3356	0.3356
354	5355	0.3305	0.3305
355	5370	0.3258	0.3258
356	5385	0.3183	0.3183
357	5400	0.3096	0.3096
358	5415	0.3069	0.3069
359	5430	0.3045	0.3045
360	5445	0.2986	0.2986
361	5460	0.2989	0.2989
362	5475	0.2907	0.2907
363	5490	0.2877	0.2877
364	5505	0.2838	0.2838
365	5520	0.2801	0.2801
366	5535	0.2828	0.2828

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
367	5550	0.2827	0.2827
368	5565	0.2698	0.2698
369	5580	0.2654	0.2654
370	5595	0.2615	0.2615
371	5625	0.2692	0.2692
372	5640	0.2554	0.2554
373	5655	0.2577	0.2577
374	5670	0.258	0.258
375	5685	0.2621	0.2621
376	5700	0.2471	0.2471
377	5715	0.2473	0.2473
378	5730	0.2586	0.2586
379	5745	0.253	0.253
380	5760	0.2514	0.2514
381	5775	0.2532	0.2532
382	5790	0.264	0.264
383	5805	0.2678	0.2678
384	5820	0.2685	0.2685
385	5835	0.2652	0.2652
386	5850	0.2682	0.2682
387	5865	0.2681	0.2681
388	5880	0.273	0.273
389	5895	0.2649	0.2649
390	5910	0.2739	0.2739
391	5925	0.2665	0.2665
392	5940	0.2661	0.2661
393	5955	0.2608	0.2608
394	5970	0.2673	0.2673
395	5985	0.2618	0.2618
396	6000	0.2677	0.2677
397	6015	0.2583	0.2583
398	6030	0.2701	0.2701
399	6045	0.2695	0.2695
400	6060	0.2662	0.2662
401	6075	0.2795	0.2795
402	6090	0.2797	0.2797
403	6105	0.2671	0.2671
404	6120	0.2637	0.2637
405	6135	0.2713	0.2713
406	6150	0.2801	0.2801
407	6165	0.2782	0.2782
408	6180	0.2815	0.2815
409	6195	0.2843	0.2843
410	6210	0.2729	0.2729
411	6225	0.2723	0.2723
412	6240	0.2717	0.2717
413	6255	0.2647	0.2647
414	6270	0.2695	0.2695
415	6285	0.2693	0.2693
416	6300	0.275	0.275
417	6315	0.2305	0.2305
418	6330	0.2657	0.2657
419	6345	0.2717	0.2717

		Pumping Test - Water Level Data Page 9 of 11
		Project: Town of Beausejour
		Number: Feb2020
		Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
420	6360	0.2637	0.2637
421	6375	0.2606	0.2606
422	6390	0.263	0.263
423	6405	0.2598	0.2598
424	6420	0.2607	0.2607
425	6435	0.2575	0.2575
426	6450	0.2608	0.2608
427	6465	0.2529	0.2529
428	6480	0.2557	0.2557
429	6495	0.2554	0.2554
430	6510	0.2554	0.2554
431	6525	0.2448	0.2448
432	6540	0.2591	0.2591
433	6555	0.2484	0.2484
434	6570	0.257	0.257
435	6585	0.2485	0.2485
436	6600	0.2524	0.2524
437	6615	0.2469	0.2469
438	6630	0.2496	0.2496
439	6645	0.2487	0.2487
440	6660	0.2454	0.2454
441	6675	0.2485	0.2485
442	6690	0.2521	0.2521
443	6705	0.249	0.249
444	6720	0.2469	0.2469
445	6735	0.2478	0.2478
446	6750	0.2532	0.2532
447	6765	0.2513	0.2513
448	6780	0.2523	0.2523
449	6795	0.238	0.238
450	6810	0.2366	0.2366
451	6825	0.2375	0.2375
452	6840	0.2371	0.2371
453	6855	0.23	0.23
454	6870	0.2388	0.2388
455	6885	0.2285	0.2285
456	6900	0.2302	0.2302
457	6915	0.2177	0.2177
458	6930	0.2284	0.2284
459	6945	0.2248	0.2248
460	6960	0.2133	0.2133
461	6975	0.2207	0.2207
462	6990	0.2107	0.2107
463	7005	0.2091	0.2091
464	7020	0.2073	0.2073
465	7035	0.2012	0.2012
466	7050	0.2052	0.2052
467	7065	0.198	0.198
468	7080	0.2132	0.2132
469	7095	0.2113	0.2113
470	7110	0.2027	0.2027
471	7125	0.2084	0.2084
472	7140	0.2001	0.2001

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
473	7155	0.2066	0.2066
474	7170	0.2071	0.2071
475	7185	0.2041	0.2041
476	7200	0.2021	0.2021
477	7215	0.2009	0.2009
478	7230	0.1882	0.1882
479	7245	0.184	0.184
480	7260	0.1939	0.1939
481	7275	0.2015	0.2015
482	7290	0.2012	0.2012
483	7305	0.1949	0.1949
484	7320	0.202	0.202
485	7335	0.1954	0.1954
486	7350	0.1983	0.1983
487	7365	0.193	0.193
488	7380	0.20	0.20
489	7395	0.1895	0.1895
490	7410	0.1996	0.1996
491	7425	0.1896	0.1896
492	7440	0.1851	0.1851
493	7455	0.1906	0.1906
494	7470	0.1964	0.1964
495	7485	0.1889	0.1889
496	7500	0.1796	0.1796
497	7515	0.1866	0.1866
498	7530	0.1845	0.1845
499	7545	0.1867	0.1867
500	7560	0.1912	0.1912
501	7575	0.1891	0.1891
502	7590	0.176	0.176
503	7605	0.1861	0.1861
504	7620	0.2003	0.2003
505	7635	0.183	0.183
506	7650	0.195	0.195
507	7665	0.193	0.193
508	7680	0.1893	0.1893
509	7695	0.1902	0.1902
510	7710	0.1878	0.1878
511	7725	0.1774	0.1774
512	7740	0.1852	0.1852
513	7755	0.1751	0.1751
514	7770	0.1765	0.1765
515	7785	0.1704	0.1704
516	7800	0.1779	0.1779
517	7815	0.1758	0.1758
518	7830	0.168	0.168
519	7845	0.1601	0.1601
520	7860	0.1693	0.1693
521	7875	0.1734	0.1734
522	7890	0.1638	0.1638
523	7905	0.1667	0.1667
524	7920	0.1511	0.1511
525	7935	0.159	0.159

Project: Town of Beausejour

Number: Feb2020

Client: MWSB

	Time [min]	Water Level [ft]	Drawdown [ft]
526	7950	0.1563	0.1563
527	7965	0.1495	0.1495
528	7980	0.1563	0.1563
529	7995	0.1564	0.1564
530	8010	0.1491	0.1491
531	8025	0.1453	0.1453
532	8040	0.1399	0.1399
533	8055	0.1493	0.1493
534	8070	0.1417	0.1417
535	8085	0.1356	0.1356
536	8100	0.1401	0.1401
537	8115	0.1553	0.1553
538	8130	0.1374	0.1374
539	8145	0.145	0.145
540	8160	0.1415	0.1415
541	8175	0.1389	0.1389
542	8190	0.1437	0.1437
543	8205	0.151	0.151
544	8220	0.1368	0.1368
545	8235	0.1397	0.1397
546	8250	0.1351	0.1351
547	8265	0.1295	0.1295
548	8280	0.1376	0.1376
549	8295	0.1303	0.1303
550	8310	0.1272	0.1272
551	8325	0.1299	0.1299
552	8340	0.1239	0.1239
553	8355	0.1242	0.1242
554	8370	0.1255	0.1255
555	8385	0.1164	0.1164
556	8400	0.1139	0.1139
557	8415	0.1201	0.1201
558	8430	0.1102	0.1102
559	8445	0.114	0.114
560	8460	0.1118	0.1118
561	8475	0.1183	0.1183
562	8490	0.1154	0.1154
563	8505	0.1074	0.1074
564	8520	0.1077	0.1077
565	8535	0.1112	0.1112
566	8550	0.1206	0.1206

Pumping Test - Discharge Data	Page 1 of 1
Project: Town of Beausejour	
Number: Feb2020	
Client: MWSB	

Location: Pescitelli Road	Pumping Test: Pumping Test 1	Pumping Well: West Production Well
Test Conducted by: FDL	Test Date: 2/4/2020	Discharge: variable, average rate 510 [U.S. gal/mi
Observation Well: West Production Well		Radial Distance to PW [m]: -

	Time [min]	Discharge [U.S. gal/min]
1	4320	510.00

Friesen
DRILLERS

Appendix H

Analytical Laboratory Data
(L2411609 and L2414588)

Friesen Drillers Ltd
ATTN: PAULYNN ESTRELLA
307 PTH 12 N
Steinbach MB R5G 1T8

Date Received: 07-FEB-20
Report Date: 03-MAR-20 12:09 (MT)
Version: FINAL

Client Phone: 204-326-2485

Certificate of Analysis

Lab Work Order #: L2414588
Project P.O. #: TOWN OF BEAUSEJOUR
Job Reference: 72 H PUMP TEST
C of C Numbers:
Legal Site Desc:

Hua Wo
Chemistry Laboratory Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2414588-1 START							
Sampled By: GH on 05-FEB-20 @ 15:20							
Matrix: WATER							
Miscellaneous Parameters							
Special Request	See Attached					02-MAR-20	R5013068
ROU4W total							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	387		1.2	mg/L		11-FEB-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		11-FEB-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		11-FEB-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	318		1.0	mg/L		07-FEB-20	R4992976
Chloride in Water by IC							
Chloride (Cl)	20.0		0.50	mg/L		07-FEB-20	R4992492
Conductivity							
Conductivity	638		1.0	umhos/cm		07-FEB-20	R4992976
Fluoride in Water by IC							
Fluoride (F)	0.221		0.020	mg/L		07-FEB-20	R4992492
Hardness Calculated							
Hardness (as CaCO3)	353	HTC	0.20	mg/L		26-FEB-20	
Nitrate in Water by IC							
Nitrate (as N)	<0.020		0.020	mg/L		07-FEB-20	R4992492
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.070		0.070	mg/L		10-FEB-20	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		07-FEB-20	R4992492
Sulfate in Water by IC							
Sulfate (SO4)	29.7		0.30	mg/L		07-FEB-20	R4992492
TDS calculated							
TDS (Calculated)	372		5.0	mg/L		26-FEB-20	
Total Metals in Water by CRC ICPMS							
Calcium (Ca)-Total	63.2		0.050	mg/L	20-FEB-20	25-FEB-20	R5006908
Iron (Fe)-Total	1.06		0.010	mg/L	20-FEB-20	25-FEB-20	R5006908
Magnesium (Mg)-Total	47.4		0.0050	mg/L	20-FEB-20	25-FEB-20	R5006908
Manganese (Mn)-Total	0.0161		0.00010	mg/L	20-FEB-20	25-FEB-20	R5006908
Potassium (K)-Total	3.56		0.050	mg/L	20-FEB-20	25-FEB-20	R5006908
Sodium (Na)-Total	17.2		0.050	mg/L	20-FEB-20	25-FEB-20	R5006908
Turbidity							
Turbidity	13.1		0.10	NTU		07-FEB-20	R4992930
pH							
pH	7.81		0.10	pH units		07-FEB-20	R4992976
L2414588-2 24 HOUR							
Sampled By: GH on 05-FEB-20 @ 01:00							
Matrix: WATER							
Miscellaneous Parameters							
Special Request	See Attached					02-MAR-20	R5013068
ROU4W total							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	430		1.2	mg/L		11-FEB-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		11-FEB-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		11-FEB-20	
Alkalinity, Total (as CaCO3)							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2414588-2 24 HOUR							
Sampled By: GH on 05-FEB-20 @ 01:00							
Matrix: WATER							
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	352		1.0	mg/L		07-FEB-20	R4992976
Chloride in Water by IC							
Chloride (Cl)	27.3		0.50	mg/L		07-FEB-20	R4992492
Conductivity							
Conductivity	720		1.0	umhos/cm		07-FEB-20	R4992976
Fluoride in Water by IC							
Fluoride (F)	0.266		0.020	mg/L		07-FEB-20	R4992492
Hardness Calculated							
Hardness (as CaCO3)	371	HTC	0.20	mg/L		20-FEB-20	
Nitrate in Water by IC							
Nitrate (as N)	<0.020		0.020	mg/L		07-FEB-20	R4992492
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.070		0.070	mg/L		10-FEB-20	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		07-FEB-20	R4992492
Sulfate in Water by IC							
Sulfate (SO4)	36.7		0.30	mg/L		07-FEB-20	R4992492
TDS calculated							
TDS (Calculated)	420		5.0	mg/L		20-FEB-20	
Total Metals in Water by CRC ICPMS							
Calcium (Ca)-Total	64.1		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Iron (Fe)-Total	0.940		0.010	mg/L	19-FEB-20	19-FEB-20	R4998628
Magnesium (Mg)-Total	51.2		0.0050	mg/L	19-FEB-20	19-FEB-20	R4998628
Manganese (Mn)-Total	0.0155		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Potassium (K)-Total	3.80		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Sodium (Na)-Total	25.4		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Turbidity							
Turbidity	15.6		0.10	NTU		07-FEB-20	R4992930
pH							
pH	7.67		0.10	pH units		07-FEB-20	R4992976
L2414588-3 48 HOUR							
Sampled By: GH on 06-FEB-20 @ 01:00							
Matrix: WATER							
Miscellaneous Parameters							
Special Request	See Attached					02-MAR-20	R5013068
ROU4W total							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	435		1.2	mg/L		11-FEB-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		11-FEB-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		11-FEB-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	357		1.0	mg/L		07-FEB-20	R4992976
Chloride in Water by IC							
Chloride (Cl)	31.2		0.50	mg/L		07-FEB-20	R4992492
Conductivity							
Conductivity	742		1.0	umhos/cm		07-FEB-20	R4992976
Fluoride in Water by IC							
Fluoride (F)	0.280		0.020	mg/L		07-FEB-20	R4992492
Hardness Calculated							
Hardness (as CaCO3)	370	HTC	0.20	mg/L		20-FEB-20	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2414588-3 48 HOUR							
Sampled By: GH on 06-FEB-20 @ 01:00							
Matrix: WATER							
Nitrate in Water by IC							
Nitrate (as N)	<0.020		0.020	mg/L		07-FEB-20	R4992492
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.070		0.070	mg/L		10-FEB-20	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		07-FEB-20	R4992492
Sulfate in Water by IC							
Sulfate (SO4)	38.7		0.30	mg/L		07-FEB-20	R4992492
TDS calculated							
TDS (Calculated)	431		5.0	mg/L		20-FEB-20	
Total Metals in Water by CRC ICPMS							
Calcium (Ca)-Total	64.4		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Iron (Fe)-Total	1.05		0.010	mg/L	19-FEB-20	19-FEB-20	R4998628
Magnesium (Mg)-Total	50.7		0.0050	mg/L	19-FEB-20	19-FEB-20	R4998628
Manganese (Mn)-Total	0.0157		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Potassium (K)-Total	3.89		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Sodium (Na)-Total	28.6		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Turbidity							
Turbidity	16.0		0.10	NTU		07-FEB-20	R4992930
pH							
pH	7.65		0.10	pH units		07-FEB-20	R4992976
L2414588-4 72 HOUR							
Sampled By: GH on 07-FEB-20 @ 10:00							
Matrix: WATER							
Miscellaneous Parameters							
Silica, Reactive (as SiO2)	16.4		1.0	mg/L		11-FEB-20	R4994188
Special Request	See Attached					02-MAR-20	R5013068
Total Coliform and E.coli							
Total Coliforms	0		0	MPN/100mL		07-FEB-20	R4991976
Escherichia Coli	0		0	MPN/100mL		07-FEB-20	R4991976
MB Conservation test 72D							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	432		1.2	mg/L		11-FEB-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		11-FEB-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		11-FEB-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	354		1.0	mg/L		07-FEB-20	R4992976
Ammonia by colour							
Ammonia, Total (as N)	0.146		0.010	mg/L		07-FEB-20	R4991888
Chloride in Water by IC							
Chloride (Cl)	32.2		0.50	mg/L		07-FEB-20	R4992492
Colour, True							
Colour, True	<5.0		5.0	CU		07-FEB-20	R4992468
Conductivity							
Conductivity	750		1.0	umhos/cm		07-FEB-20	R4992976
Fluoride in Water by IC							
Fluoride (F)	0.280		0.020	mg/L		07-FEB-20	R4992492
Hardness Calculated							
Hardness (as CaCO3)	376	HTC	0.20	mg/L		20-FEB-20	
Ion Balance Calculation							
Cation - Anion Balance	0.8			%		20-FEB-20	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2414588-4 72 HOUR							
Sampled By: GH on 07-FEB-20 @ 10:00							
Matrix: WATER							
Ion Balance Calculation							
Anion Sum	8.81			me/L		20-FEB-20	
Cation Sum	8.95			me/L		20-FEB-20	
Langelier Index 4C							
Langelier Index (4 C)	0.24					20-FEB-20	
Langelier Index 60C							
Langelier Index (60 C)	1.0					20-FEB-20	
Nitrate in Water by IC							
Nitrate (as N)	<0.020		0.020	mg/L		07-FEB-20	R4992492
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.070		0.070	mg/L		10-FEB-20	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		07-FEB-20	R4992492
Sulfate in Water by IC							
Sulfate (SO4)	39.0		0.30	mg/L		07-FEB-20	R4992492
Total Carbon by Calculation							
Total Carbon	73.7		1.0	mg/L		18-FEB-20	
Total Dissolved Solids (TDS)							
Total Dissolved Solids	421		20	mg/L		13-FEB-20	R4997871
Total Inorganic Carbon by Combustion							
Total Inorganic Carbon	71.7		0.50	mg/L		15-FEB-20	R4997520
Total Kjeldahl Nitrogen							
Total Kjeldahl Nitrogen	0.28		0.20	mg/L	11-FEB-20	12-FEB-20	R4995328
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	<0.0030		0.0030	mg/L	19-FEB-20	19-FEB-20	R4998628
Antimony (Sb)-Total	<0.00010		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Arsenic (As)-Total	0.00459		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Barium (Ba)-Total	0.107		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	19-FEB-20	19-FEB-20	R4998628
Boron (B)-Total	0.109		0.010	mg/L	19-FEB-20	19-FEB-20	R4998628
Cadmium (Cd)-Total	<0.0000050		0.0000050	mg/L	19-FEB-20	19-FEB-20	R4998628
Calcium (Ca)-Total	64.1		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Cesium (Cs)-Total	<0.000010		0.000010	mg/L	19-FEB-20	19-FEB-20	R4998628
Chromium (Cr)-Total	<0.00010		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Cobalt (Co)-Total	0.00020		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Copper (Cu)-Total	<0.00050		0.00050	mg/L	19-FEB-20	19-FEB-20	R4998628
Iron (Fe)-Total	1.19		0.010	mg/L	19-FEB-20	19-FEB-20	R4998628
Lead (Pb)-Total	<0.000050		0.000050	mg/L	19-FEB-20	19-FEB-20	R4998628
Lithium (Li)-Total	0.0282		0.0010	mg/L	19-FEB-20	19-FEB-20	R4998628
Magnesium (Mg)-Total	52.5		0.0050	mg/L	19-FEB-20	19-FEB-20	R4998628
Manganese (Mn)-Total	0.0158		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Molybdenum (Mo)-Total	0.00218		0.000050	mg/L	19-FEB-20	19-FEB-20	R4998628
Nickel (Ni)-Total	0.00071		0.00050	mg/L	19-FEB-20	19-FEB-20	R4998628
Potassium (K)-Total	4.02		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Phosphorus (P)-Total	<0.030		0.030	mg/L	19-FEB-20	19-FEB-20	R4998628
Rubidium (Rb)-Total	0.00152		0.00020	mg/L	19-FEB-20	19-FEB-20	R4998628
Selenium (Se)-Total	<0.000050		0.000050	mg/L	19-FEB-20	19-FEB-20	R4998628
Silicon (Si)-Total	8.35		0.10	mg/L	19-FEB-20	19-FEB-20	R4998628
Silver (Ag)-Total	<0.000010		0.000010	mg/L	19-FEB-20	19-FEB-20	R4998628
Sodium (Na)-Total	30.3		0.050	mg/L	19-FEB-20	19-FEB-20	R4998628
Strontium (Sr)-Total	0.287		0.00020	mg/L	19-FEB-20	19-FEB-20	R4998628
Sulfur (S)-Total	14.5		0.50	mg/L	19-FEB-20	19-FEB-20	R4998628

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2414588-4 72 HOUR							
Sampled By: GH on 07-FEB-20 @ 10:00							
Matrix: WATER							
Total Metals in Water by CRC ICPMS							
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	19-FEB-20	19-FEB-20	R4998628
Thallium (Tl)-Total	<0.000010		0.000010	mg/L	19-FEB-20	19-FEB-20	R4998628
Thorium (Th)-Total	<0.00010		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Tin (Sn)-Total	0.00012		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Titanium (Ti)-Total	<0.00030		0.00030	mg/L	19-FEB-20	19-FEB-20	R4998628
Tungsten (W)-Total	<0.00010		0.00010	mg/L	19-FEB-20	19-FEB-20	R4998628
Uranium (U)-Total	0.000548		0.000010	mg/L	19-FEB-20	19-FEB-20	R4998628
Vanadium (V)-Total	<0.00050		0.00050	mg/L	19-FEB-20	19-FEB-20	R4998628
Zinc (Zn)-Total	0.0069		0.0030	mg/L	19-FEB-20	19-FEB-20	R4998628
Zirconium (Zr)-Total	<0.00020		0.00020	mg/L	19-FEB-20	19-FEB-20	R4998628
Total Organic Carbon by Combustion							
Total Organic Carbon	1.96		0.50	mg/L		10-FEB-20	R4993340
Turbidity							
Turbidity	3.86		0.10	NTU		07-FEB-20	R4992930
UV Transmittance (Calculated)							
Transmittance, UV (254 nm)	91.2		1.0	%T/cm		07-FEB-20	R4992947
pH							
pH	7.61		0.10	pH units		07-FEB-20	R4992976

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
LPML	Lab-Preserved for Total Metals. Sample received with pH > 2 and preserved at the lab. Total Metals results may be biased low.

Sample Parameter Qualifier Key:

Qualifier	Description
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-CO3CO3-CALC-WP	Water	Alkalinity, Carbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by carbonate is calculated and reported as mg CO3 2-/L.

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-HCO3HCO3-CALC-WP	Water	Alkalinity, Bicarbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by bicarbonate is calculated and reported as mg HCO3-/L

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-OHOH-CALC-WP	Water	Alkalinity, Hydroxide	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by hydroxide is calculated and reported as mg OH-/L.

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-WP	Water	Alkalinity, Total (as CaCO3)	APHA 2320B

The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. Total alkalinity is determined by titration with a strong standard mineral acid to the successive HCO3- and H2CO3 endpoints indicated electrometrically.

ALS Test Code	Matrix	Test Description	Method Reference**
C-TC-CALC-WP	Water	Total Carbon by Calculation	CALCULATED

Total carbon represents the sum of total inorganic carbon and total organic carbon. For the purpose of calculation, results less than the detection limit (DL) are treated as zero.

ALS Test Code	Matrix	Test Description	Method Reference**
C-TIC-HTC-WP	Water	Total Inorganic Carbon by Combustion	APHA 5310 B-WP

Sample is injected into a heated reaction chamber where it is acidified converting all inorganic carbon to CO2, which is then transported in the carrier gas stream and measured via a non-dispersive infrared analyzer.

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOC-HTC-WP	Water	Total Organic Carbon by Combustion	APHA 5310 B-WP

Sample is acidified and purged to remove inorganic carbon, then injected into a heated reaction chamber where organic carbon is oxidized to CO2 which is then transported in the carrier gas stream and measured via a non-dispersive infrared analyzer.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-WP	Water	Chloride in Water by IC	EPA 300.1 (mod)

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

ALS Test Code	Matrix	Test Description	Method Reference**
COLOUR-TRUE-WP	Water	Colour, True	APHA 2120C

True Colour is measured spectrophotometrically by comparison to platinum-cobalt standards using the single wavelength method (450 - 465 nm) after filtration of sample through a 0.45 um filter. Colour measurements can be highly pH dependent, and apply to the pH of the sample as received (at time of testing), without pH adjustment. Concurrent measurement of sample pH is recommended.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-WP	Water	Conductivity	APHA 2510B

Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.

ALS Test Code	Matrix	Test Description	Method Reference**
ETL-LANGELIER-4-WP	Water	Langelier Index 4C	Calculated
ETL-LANGELIER-60-WP	Water	Langelier Index 60C	Calculated
ETL-SOLIDS-CALC-WP	Water	TDS calculated	CALCULATION
F-IC-N-WP	Water	Fluoride in Water by IC	EPA 300.1 (mod)

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

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-WP	Water	Hardness Calculated	APHA 2340B

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

IONBALANCE-CALC-WP | Water | Ion Balance Calculation | APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance (as % difference) cannot be calculated accurately for waters with very low electrical conductivity (EC), and is reported as "Low EC" where EC < 100 uS/cm (umhos/cm). Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-T-CCMS-WP | Water | Total Metals in Water by CRC ICPMS | EPA 200.2/6020B (mod.)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

N-TOTKJ-WP | Water | Total Kjeldahl Nitrogen | APHA 4500 NorgD (modified)

Aqueous samples are digested in a block digester with sulfuric acid and copper sulfate as a catalyst. Total Kjeldahl Nitrogen is then analyzed using a discrete analyzer with colorimetric detection.

NH3-COL-WP | Water | Ammonia by colour | APHA 4500 NH3 F

Ammonia in water samples forms indophenol when reacted with hypochlorite and phenol. The intensity is amplified by the addition of sodium nitroprusside and measured colourmetrically.

NO2+NO3-CALC-WP | Water | Nitrate+Nitrite | CALCULATION

NO2-IC-N-WP | Water | Nitrite in Water by IC | EPA 300.1 (mod)

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

NO3-IC-N-WP | Water | Nitrate in Water by IC | EPA 300.1 (mod)

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

PH-WP | Water | pH | APHA 4500H

The pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.

SIO2-COL-WP | Water | Reactive Silica by colour | APHA 4500 SIO2

This analysis is carried out using procedures adapted from APHA Method 4500-SiO2 "Silica". Molybdate Reactive Silica is determined by analysis of the sample using the heteropoly blue colourimetric method.

SO4-IC-N-WP | Water | Sulfate in Water by IC | EPA 300.1 (mod)

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

SPECIAL REQUEST-UW | Misc. | Special Request University of Waterloo | SEE SUBLET LAB RESULTS

TC,EC-QT51-WP | Water | Total Coliform and E.coli | APHA 9223B QT51

This analysis is carried out using procedures adapted from APHA Method 9223B "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture of hydrolyzable substrates and then sealed in a 51-well packet. The packet is incubated at 35.0 +/- 0.5 degrees C for 18 or 24 hours and then the number of wells exhibiting positive responses are counted. The final results are obtained by comparing the number of positive responses to a probability table.

TDS-WP | Water | Total Dissolved Solids (TDS) | APHA 2540 SOLIDS C,E

A well-mixed sample is filtered through a glass fiber filter paper. The filtrate is then evaportaed to dryness in a pre-weighed vial and dried at 180 – 2C. The increase in vial weight represents the total dissolved solids.

TURBIDITY-WP | Water | Turbidity | APHA 2130B (modified)

Turbidity in aqueous matrices is determined by the nephelometric method.

UV-%TRANS-WP | Water | UV Transmittance (Calculated) | APHA 5910B

Test method is adapted from APHA Method 5910B. A sample is filtered through a 0.45 um polyethersulfone (PES) filter and its UV Absorbance is measured in a quartz cell at 254 nm. UV Transmittance is calculated from the UV Absorbance result and reported as UV Transmittance per cm. The

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

analysis is carried out without pH adjustment.

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

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

Laboratory Definition Code	Laboratory Location
UW	UNIVERSITY OF WATERLOO
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: Friesen Drillers Ltd
307 PTH 12 N
Steinbach MB R5G 1T8
Contact: PAULYNN ESTRELLA

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R4992976								
WG3273330-14 LCS								
Alkalinity, Total (as CaCO3)			103.9		%		85-115	07-FEB-20
WG3273330-11 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	07-FEB-20
C-TIC-HTC-WP	**Water**							
Batch R4997520								
WG3276866-2 LCS								
Total Inorganic Carbon			98.8		%		80-120	15-FEB-20
WG3276866-1 MB								
Total Inorganic Carbon			<0.50		mg/L		0.5	15-FEB-20
C-TOC-HTC-WP	**Water**							
Batch R4993340								
WG3273555-2 LCS								
Total Organic Carbon			102.9		%		80-120	10-FEB-20
WG3273555-1 MB								
Total Organic Carbon			<0.50		mg/L		0.5	10-FEB-20
CL-IC-N-WP	**Water**							
Batch R4992492								
WG3271559-10 LCS								
Chloride (Cl)			98.6		%		90-110	07-FEB-20
WG3271559-9 MB								
Chloride (Cl)			<0.50		mg/L		0.5	07-FEB-20
COLOUR-TRUE-WP	**Water**							
Batch R4992468								
WG3271759-2 LCS								
Colour, True			98.3		%		85-115	07-FEB-20
WG3271759-1 MB								
Colour, True			<5.0		CU		5	07-FEB-20
EC-WP	**Water**							
Batch R4992976								
WG3273330-13 LCS								
Conductivity			98.2		%		90-110	07-FEB-20
WG3273330-11 MB								
Conductivity			<1.0		umhos/cm		1	07-FEB-20
F-IC-N-WP	**Water**							

Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
F-IC-N-WP	**Water**							
Batch R4992492								
WG3271559-10 LCS								
Fluoride (F)			99.0		%		90-110	07-FEB-20
WG3271559-9 MB								
Fluoride (F)			<0.020		mg/L		0.02	07-FEB-20
MET-T-CCMS-WP	**Water**							
Batch R4998628								
WG3276998-2 LCS								
Aluminum (Al)-Total			105.7		%		80-120	19-FEB-20
Antimony (Sb)-Total			110.2		%		80-120	19-FEB-20
Arsenic (As)-Total			104.7		%		80-120	19-FEB-20
Barium (Ba)-Total			103.9		%		80-120	19-FEB-20
Beryllium (Be)-Total			103.9		%		80-120	19-FEB-20
Bismuth (Bi)-Total			99.8		%		80-120	19-FEB-20
Boron (B)-Total			101.9		%		80-120	19-FEB-20
Cadmium (Cd)-Total			104.5		%		80-120	19-FEB-20
Calcium (Ca)-Total			101.7		%		80-120	19-FEB-20
Cesium (Cs)-Total			113.5		%		80-120	19-FEB-20
Chromium (Cr)-Total			105.5		%		80-120	19-FEB-20
Cobalt (Co)-Total			104.8		%		80-120	19-FEB-20
Copper (Cu)-Total			104.1		%		80-120	19-FEB-20
Iron (Fe)-Total			99.1		%		80-120	19-FEB-20
Lead (Pb)-Total			104.6		%		80-120	19-FEB-20
Lithium (Li)-Total			108.2		%		80-120	19-FEB-20
Magnesium (Mg)-Total			114.7		%		80-120	19-FEB-20
Manganese (Mn)-Total			105.8		%		80-120	19-FEB-20
Molybdenum (Mo)-Total			108.1		%		80-120	19-FEB-20
Nickel (Ni)-Total			104.5		%		80-120	19-FEB-20
Potassium (K)-Total			98.6		%		80-120	19-FEB-20
Phosphorus (P)-Total			105.2		%		80-120	19-FEB-20
Rubidium (Rb)-Total			103.2		%		80-120	19-FEB-20
Selenium (Se)-Total			104.5		%		80-120	19-FEB-20
Silicon (Si)-Total			104.8		%		80-120	19-FEB-20
Silver (Ag)-Total			107.3		%		80-120	19-FEB-20
Sodium (Na)-Total			103.5		%		80-120	19-FEB-20
Strontium (Sr)-Total			109.7		%		80-120	19-FEB-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WP	**Water**							
Batch R4998628								
WG3276998-2 LCS								
Sulfur (S)-Total			102.1		%		80-120	19-FEB-20
Tellurium (Te)-Total			104.3		%		80-120	19-FEB-20
Thallium (Tl)-Total			102.2		%		80-120	19-FEB-20
Thorium (Th)-Total			101.0		%		80-120	19-FEB-20
Tin (Sn)-Total			103.4		%		80-120	19-FEB-20
Titanium (Ti)-Total			101.4		%		80-120	19-FEB-20
Tungsten (W)-Total			102.4		%		80-120	19-FEB-20
Uranium (U)-Total			105.5		%		80-120	19-FEB-20
Vanadium (V)-Total			104.2		%		80-120	19-FEB-20
Zinc (Zn)-Total			104.4		%		80-120	19-FEB-20
Zirconium (Zr)-Total			105.6		%		80-120	19-FEB-20
WG3276998-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	19-FEB-20
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	19-FEB-20
Arsenic (As)-Total			<0.00010		mg/L		0.0001	19-FEB-20
Barium (Ba)-Total			<0.00010		mg/L		0.0001	19-FEB-20
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	19-FEB-20
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	19-FEB-20
Boron (B)-Total			<0.010		mg/L		0.01	19-FEB-20
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	19-FEB-20
Calcium (Ca)-Total			<0.050		mg/L		0.05	19-FEB-20
Cesium (Cs)-Total			<0.000010		mg/L		0.00001	19-FEB-20
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	19-FEB-20
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	19-FEB-20
Copper (Cu)-Total			<0.00050		mg/L		0.0005	19-FEB-20
Iron (Fe)-Total			<0.010		mg/L		0.01	19-FEB-20
Lead (Pb)-Total			<0.000050		mg/L		0.00005	19-FEB-20
Lithium (Li)-Total			<0.0010		mg/L		0.001	19-FEB-20
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	19-FEB-20
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	19-FEB-20
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	19-FEB-20
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	19-FEB-20
Potassium (K)-Total			<0.050		mg/L		0.05	19-FEB-20
Phosphorus (P)-Total			<0.030		mg/L		0.03	19-FEB-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WP	**Water**							
Batch R4998628								
WG3276998-1 MB								
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	19-FEB-20
Selenium (Se)-Total			<0.000050		mg/L		0.00005	19-FEB-20
Silicon (Si)-Total			<0.10		mg/L		0.1	19-FEB-20
Silver (Ag)-Total			<0.000010		mg/L		0.00001	19-FEB-20
Sodium (Na)-Total			<0.050		mg/L		0.05	19-FEB-20
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	19-FEB-20
Sulfur (S)-Total			<0.50		mg/L		0.5	19-FEB-20
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	19-FEB-20
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	19-FEB-20
Thorium (Th)-Total			<0.00010		mg/L		0.0001	19-FEB-20
Tin (Sn)-Total			<0.00010		mg/L		0.0001	19-FEB-20
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	19-FEB-20
Tungsten (W)-Total			<0.00010		mg/L		0.0001	19-FEB-20
Uranium (U)-Total			<0.000010		mg/L		0.00001	19-FEB-20
Vanadium (V)-Total			<0.00050		mg/L		0.0005	19-FEB-20
Zinc (Zn)-Total			<0.0030		mg/L		0.003	19-FEB-20
Zirconium (Zr)-Total			<0.00020		mg/L		0.0002	19-FEB-20
Batch R5006908								
WG3277816-2 LCS								
Calcium (Ca)-Total			101.8		%		80-120	25-FEB-20
Iron (Fe)-Total			100.3		%		80-120	25-FEB-20
Magnesium (Mg)-Total			115.4		%		80-120	25-FEB-20
Manganese (Mn)-Total			105.4		%		80-120	25-FEB-20
Potassium (K)-Total			110.1		%		80-120	25-FEB-20
Sodium (Na)-Total			106.0		%		80-120	25-FEB-20
WG3277816-1 MB								
Calcium (Ca)-Total			<0.050		mg/L		0.05	25-FEB-20
Iron (Fe)-Total			<0.010		mg/L		0.01	25-FEB-20
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	25-FEB-20
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	25-FEB-20
Potassium (K)-Total			<0.050		mg/L		0.05	25-FEB-20
Sodium (Na)-Total			<0.050		mg/L		0.05	25-FEB-20
N-TOTKJ-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
N-TOTKJ-WP	**Water**							
Batch R4995328								
WG3272782-14 LCS								
Total Kjeldahl Nitrogen			103.4		%		75-125	12-FEB-20
WG3272782-13 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	12-FEB-20
NH3-COL-WP	**Water**							
Batch R4991888								
WG3272045-10 LCS								
Ammonia, Total (as N)			99.5		%		85-115	07-FEB-20
WG3272045-9 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	07-FEB-20
NO2-IC-N-WP	**Water**							
Batch R4992492								
WG3271559-10 LCS								
Nitrite (as N)			100.3		%		90-110	07-FEB-20
WG3271559-9 MB								
Nitrite (as N)			<0.010		mg/L		0.01	07-FEB-20
NO3-IC-N-WP	**Water**							
Batch R4992492								
WG3271559-10 LCS								
Nitrate (as N)			100.4		%		90-110	07-FEB-20
WG3271559-9 MB								
Nitrate (as N)			<0.020		mg/L		0.02	07-FEB-20
PH-WP	**Water**							
Batch R4992976								
WG3273330-12 LCS								
pH			7.32		pH units		7.3-7.5	07-FEB-20
SIO2-COL-WP	**Water**							
Batch R4994188								
WG3273849-3 DUP		**L2414588-4**						
Silica, Reactive (as SiO2)		16.4	15.9		mg/L	3.3	20	11-FEB-20
WG3273849-2 LCS								
Silica, Reactive (as SiO2)			101.1		%		85-115	11-FEB-20
WG3273849-1 MB								
Silica, Reactive (as SiO2)			<1.0		mg/L		1	11-FEB-20
WG3273849-4 MS		**L2414588-4**						
Silica, Reactive (as SiO2)			N/A	MS-B	%		-	11-FEB-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-IC-N-WP	**Water**							
Batch R4992492								
WG3271559-10 LCS								
Sulfate (SO4)			100.4		%		90-110	07-FEB-20
WG3271559-9 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	07-FEB-20
TC,EC-QT51-WP	**Water**							
Batch R4991976								
WG3271868-3 DUP		**L2414588-4**						
Total Coliforms		0	0		MPN/100mL	0.0	65	07-FEB-20
Escherichia Coli		0	0		MPN/100mL	0.0	65	07-FEB-20
WG3271868-1 MB								
Total Coliforms			0		MPN/100mL		1	07-FEB-20
Escherichia Coli			0		MPN/100mL		1	07-FEB-20
WG3271868-2 MB								
Total Coliforms			0		MPN/100mL		1	07-FEB-20
Escherichia Coli			0		MPN/100mL		1	07-FEB-20
TDS-WP	**Water**							
Batch R4997871								
WG3274955-2 LCS								
Total Dissolved Solids			98.9		%		85-115	13-FEB-20
WG3274955-1 MB								
Total Dissolved Solids			<4.0		mg/L		4	13-FEB-20
TURBIDITY-WP	**Water**							
Batch R4992930								
WG3273290-2 LCS								
Turbidity			98.0		%		85-115	07-FEB-20
WG3273290-1 MB								
Turbidity			<0.10		NTU		0.1	07-FEB-20
UV-%TRANS-WP	**Water**							
Batch R4992947								
WG3273319-4 IRM		**BLANK**						
Transmittance, UV (254 nm)			100.0		%		99.5-100.5	07-FEB-20
WG3273319-2 LCS								
Transmittance, UV (254 nm)			96.2		%		85-115	07-FEB-20

Quality Control Report

Legend:

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

Sample Parameter Qualifier Definitions:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	05-FEB-20 15:20	07-FEB-20 12:00	0.25	45	hours	EHTR-FM
	2	05-FEB-20 01:00	07-FEB-20 12:00	0.25	59	hours	EHTR-FM
	3	06-FEB-20 01:00	07-FEB-20 12:00	0.25	35	hours	EHTR-FM
	4	07-FEB-20 10:00	07-FEB-20 12:00	0.25	1.9	hours	EHTR-FM

Legend & Qualifier Definitions:

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

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2414588 were received on 07-FEB-20 23:35.

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

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

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

Client: Dalmaijer
ALS Laboratories
Work Order: L2414588

ISO# 2020119
Location:
4 for 18O, 2H

#	Sample	Lab#	$\delta^{18}O$	Result	Repeat	$\delta^{2}H$	Result	Repeat	pH	EC	AZD
			H_2O	VSMOW	± 0.2‰	H_2O	VSMOW	± 0.8‰		uS/cm	
1	L2414588-1	438571	X	-13.76	-13.83	X	-100.69	-100.60	7.81	638	
2	L2414588-2	438572	X	-14.05		X	-103.35		7.67	720	
3	L2414588-3	438573	X	-13.98	-14.10	X	-103.91	-103.97	7.65	742	
4	L2414588-4	438574	X	-14.19		X	-103.94		7.61	750	

To Contact uwEILAB:
519 888 4732

Rick Heemskerk
uwEILAB Manager
rkhmskrk@uwaterloo.ca
519 888 4567 ext 35838

L2414588

COC #: OL-2858

ALS Environmental

L2414588-COFC

Report To		Report		Service Requested
Company:	Friesen Drillers Limited	Distribution:	☐Fax ☐Mail ☑Email	◉ Regular (Standard Turnaround Times - Business Days) - R
Contact:	Paulynn Estrella-Legal	☐ Criteria on Report (select from Guidelines below)		○ Priority (3 Days) - surcharge will apply - P
Address:	307 PTH 12 N Steinbach, MB Canada, R5G 1T8	Report Type:	☐Excel ☑Digital	○ Priority (2 Days) - surcharge will apply - P2
		Report Format:		○ Emergency (1-2 day) – surcharge will apply - E
		Report Email(s):	Paulynn@friesendrillers.com Justin@friesendrillers.com Jeff@friesendrillers.com	○ Same Day or Weekend Emergency - surcharge will apply - E2
				○ Specify date required - X
Phone:	204-326-2485 Fax: 204-326-2483			
Invoice To	☑Email ☐Mail	EDD Format:		
Company:	Friesen Drillers Limited	EDD Email(s):		
Contact:	Kim Friesen			
Address:	307 PTH 12 N Steinbach, MB Canada, R5G 1T8	Project Info		
		Job #:	72 H Pump Test	
		PO/AFE:	Town of Beausejour	
Email:	Accts@friesendrillers.com	LSD:		
Phone:	204-326-2485	Quote #:		
Lab Work Order # (lab use only)		ALS Contact: Judy	Sampler: GH	

Analysis Requests (Please indicate below Filtered, Preserved or both(F, P, F/P))

Sample #	Sample Identification (This will appear on the report)	Longitude	Latitude	Date	Time	Sample Type	Number of Containers	ROU4W-T-WP	Oxygen-18/Deuterium	TC,EC-QT51-WP	MUN-WTP-72D-WP	Reactive Silica
	Start			Feb-05-2020	03:20 PM	Water	2	R	R			
	24 hour			Feb-05-2020	01:00 AM	Water	2	R	R			
	48 Hour			Feb-06-2020	01:00 AM	Water	2	R	R			
	72 hour			Feb-07-2020	10:00 AM	Water	4		R	R	R	R

Special Instructions/Comments

The questions below must be answered for water samples (check Yes or No)

Are any sample taken from a regulated DW system? ☐Yes ☐No

If yes, please use an authorized drinking water COC

Is the water sampled intended to be potable for human consumption? ☐Yes ☐No

Guidelines

SAMPLE CONDITION (lab use only)

☐Frozen ☐Cold ☐Ambient ☐Cooling Initiated

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date:	Time:	Received by: CEL	Date: Feb 7	Time: 11:35	Temperature: 10.4 °C	Verified by:	Date:	Time:	Observations: ☐Yes If Yes add SIF

Friesen Drillers Ltd
ATTN: JEFF BELL
307 PTH 12 N
Steinbach MB R5G 1L9

Date Received: 30-JAN-20
Report Date: 12-FEB-20 11:09 (MT)
Version: FINAL

Client Phone: 204-326-2485

Certificate of Analysis

Lab Work Order #: L2411609
Project P.O. #: NOT SUBMITTED
Job Reference: BEAUSEJOUR
C of C Numbers:
Legal Site Desc:

Hua Wo
Chemistry Laboratory Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2411609-1 EAST WELL							
Sampled By: AF on 29-JAN-20 @ 14:30							
Matrix: WATER							
Miscellaneous Parameters							
Silica, Reactive (as SiO2)	15.9		1.0	mg/L		03-FEB-20	R4988472
Total Coliform and E.coli							
Total Coliforms	0		0	MPN/100mL		30-JAN-20	R4985170
Escherichia Coli	0		0	MPN/100mL		30-JAN-20	R4985170
MB Conservation test 72D							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	436		1.2	mg/L		31-JAN-20	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		31-JAN-20	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		31-JAN-20	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	357		1.0	mg/L		30-JAN-20	R4984870
Ammonia by colour							
Ammonia, Total (as N)	0.228		0.010	mg/L		04-FEB-20	R4990539
Chloride in Water by IC							
Chloride (Cl)	58.0		1.0	mg/L		30-JAN-20	R4986520
Colour, True							
Colour, True	<5.0		5.0	CU		30-JAN-20	R4985227
Conductivity							
Conductivity	844		1.0	umhos/cm		30-JAN-20	R4984870
Fluoride in Water by IC							
Fluoride (F)	0.225		0.040	mg/L		30-JAN-20	R4986520
Hardness Calculated							
Hardness (as CaCO3)	497	HTC	0.20	mg/L		10-FEB-20	
Ion Balance Calculation							
Cation - Anion Balance	11.7			%		10-FEB-20	
Anion Sum	10.1			me/L		10-FEB-20	
Cation Sum	12.7			me/L		10-FEB-20	
Langelier Index 4C							
Langelier Index (4 C)	0.30					10-FEB-20	
Langelier Index 60C							
Langelier Index (60 C)	1.1					10-FEB-20	
Nitrate in Water by IC							
Nitrate (as N)	<0.040	DLM	0.040	mg/L		30-JAN-20	R4986520
Nitrate+Nitrite							
Nitrate and Nitrite as N	<0.070		0.070	mg/L		03-FEB-20	
Nitrite in Water by IC							
Nitrite (as N)	<0.020	DLM	0.020	mg/L		30-JAN-20	R4986520
Sulfate in Water by IC							
Sulfate (SO4)	61.3		0.60	mg/L		30-JAN-20	R4986520
Total Carbon by Calculation							
Total Carbon	72.0		1.0	mg/L		05-FEB-20	
Total Dissolved Solids (TDS)							
Total Dissolved Solids	475		20	mg/L		31-JAN-20	R4990009
Total Inorganic Carbon by Combustion							
Total Inorganic Carbon	69.1		0.50	mg/L		30-JAN-20	R4985146
Total Kjeldahl Nitrogen							
Total Kjeldahl Nitrogen	0.39		0.20	mg/L	03-FEB-20	04-FEB-20	R4987778
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	0.872		0.0030	mg/L	05-FEB-20	06-FEB-20	R4991295
Antimony (Sb)-Total	<0.00010		0.00010	mg/L	05-FEB-20	06-FEB-20	R4991295

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2411609-1 EAST WELL							
Sampled By: AF on 29-JAN-20 @ 14:30							
Matrix: WATER							
Total Metals in Water by CRC ICPMS							
Arsenic (As)-Total	0.00509		0.00010	mg/L	05-FEB-20	06-FEB-20	R4991295
Barium (Ba)-Total	0.133		0.00010	mg/L	05-FEB-20	06-FEB-20	R4991295
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	05-FEB-20	06-FEB-20	R4991295
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	05-FEB-20	06-FEB-20	R4991295
Boron (B)-Total	0.191		0.010	mg/L	05-FEB-20	07-FEB-20	R4992330
Cadmium (Cd)-Total	0.0000121		0.0000050	mg/L	05-FEB-20	06-FEB-20	R4991295
Calcium (Ca)-Total	94.9		0.050	mg/L	05-FEB-20	06-FEB-20	R4991295
Cesium (Cs)-Total	0.000130		0.000010	mg/L	05-FEB-20	06-FEB-20	R4991295
Chromium (Cr)-Total	0.00179		0.00010	mg/L	05-FEB-20	06-FEB-20	R4991295
Cobalt (Co)-Total	0.00092		0.00010	mg/L	05-FEB-20	06-FEB-20	R4991295
Copper (Cu)-Total	0.00197		0.00050	mg/L	05-FEB-20	06-FEB-20	R4991295
Iron (Fe)-Total	2.38		0.010	mg/L	05-FEB-20	06-FEB-20	R4991295
Lead (Pb)-Total	0.00107		0.000050	mg/L	05-FEB-20	06-FEB-20	R4991295
Lithium (Li)-Total	0.0318		0.0010	mg/L	05-FEB-20	06-FEB-20	R4991295
Magnesium (Mg)-Total	63.3		0.0050	mg/L	05-FEB-20	06-FEB-20	R4991295
Manganese (Mn)-Total	0.0584		0.00010	mg/L	05-FEB-20	06-FEB-20	R4991295
Molybdenum (Mo)-Total	0.00244		0.000050	mg/L	05-FEB-20	06-FEB-20	R4991295
Nickel (Ni)-Total	0.00292		0.00050	mg/L	05-FEB-20	06-FEB-20	R4991295
Potassium (K)-Total	4.56		0.050	mg/L	05-FEB-20	06-FEB-20	R4991295
Phosphorus (P)-Total	0.161		0.030	mg/L	05-FEB-20	06-FEB-20	R4991295
Rubidium (Rb)-Total	0.00326		0.00020	mg/L	05-FEB-20	06-FEB-20	R4991295
Selenium (Se)-Total	<0.000050		0.000050	mg/L	05-FEB-20	06-FEB-20	R4991295
Silicon (Si)-Total	9.23		0.10	mg/L	05-FEB-20	06-FEB-20	R4991295
Silver (Ag)-Total	<0.000010		0.000010	mg/L	05-FEB-20	06-FEB-20	R4991295
Sodium (Na)-Total	61.3		0.050	mg/L	05-FEB-20	06-FEB-20	R4991295
Strontium (Sr)-Total	0.325		0.00020	mg/L	05-FEB-20	06-FEB-20	R4991295
Sulfur (S)-Total	20.1		0.50	mg/L	05-FEB-20	06-FEB-20	R4991295
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	05-FEB-20	06-FEB-20	R4991295
Thallium (Tl)-Total	0.000028		0.000010	mg/L	05-FEB-20	06-FEB-20	R4991295
Thorium (Th)-Total	0.00063		0.00010	mg/L	05-FEB-20	06-FEB-20	R4991295
Tin (Sn)-Total	0.00024		0.00010	mg/L	05-FEB-20	06-FEB-20	R4991295
Titanium (Ti)-Total	0.0539		0.00030	mg/L	05-FEB-20	06-FEB-20	R4991295
Tungsten (W)-Total	<0.00010		0.00010	mg/L	05-FEB-20	06-FEB-20	R4991295
Uranium (U)-Total	0.000604		0.000010	mg/L	05-FEB-20	06-FEB-20	R4991295
Vanadium (V)-Total	0.00198		0.00050	mg/L	05-FEB-20	06-FEB-20	R4991295
Zinc (Zn)-Total	0.0087		0.0030	mg/L	05-FEB-20	06-FEB-20	R4991295
Zirconium (Zr)-Total	0.00087		0.00020	mg/L	05-FEB-20	06-FEB-20	R4991295
Total Organic Carbon by Combustion							
Total Organic Carbon	2.84		0.50	mg/L		04-FEB-20	R4990108
Turbidity							
Turbidity	92.0		0.10	NTU		31-JAN-20	R4986559
UV Transmittance (Calculated)							
Transmittance, UV (254 nm)	91.0		1.0	%T/cm		30-JAN-20	R4984847
pH							
pH	7.52		0.10	pH units		30-JAN-20	R4984870

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Sample Parameter Qualifier Key:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-CO3CO3-CALC-WP	Water	Alkalinity, Carbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by carbonate is calculated and reported as mg CO3 2-/L.

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-HCO3HCO3-CALC-WP	Water	Alkalinity, Bicarbonate	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by bicarbonate is calculated and reported as mg HCO3-/L

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-OHOH-CALC-WP	Water	Alkalinity, Hydroxide	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by hydroxide is calculated and reported as mg OH-/L.

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-WP	Water	Alkalinity, Total (as CaCO3)	APHA 2320B

The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. Total alkalinity is determined by titration with a strong standard mineral acid to the successive HCO3- and H2CO3 endpoints indicated electrometrically.

ALS Test Code	Matrix	Test Description	Method Reference**
C-TC-CALC-WP	Water	Total Carbon by Calculation	CALCULATED

Total carbon represents the sum of total inorganic carbon and total organic carbon. For the purpose of calculation, results less than the detection limit (DL) are treated as zero.

ALS Test Code	Matrix	Test Description	Method Reference**
C-TIC-HTC-WP	Water	Total Inorganic Carbon by Combustion	APHA 5310 B-WP

Sample is injected into a heated reaction chamber where it is acidified converting all inorganic carbon to CO2, which is then transported in the carrier gas stream and measured via a non-dispersive infrared analyzer.

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOC-HTC-WP	Water	Total Organic Carbon by Combustion	APHA 5310 B-WP

Sample is acidified and purged to remove inorganic carbon, then injected into a heated reaction chamber where organic carbon is oxidized to CO2 which is then transported in the carrier gas stream and measured via a non-dispersive infrared analyzer.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-WP	Water	Chloride in Water by IC	EPA 300.1 (mod)

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

ALS Test Code	Matrix	Test Description	Method Reference**
COLOUR-TRUE-WP	Water	Colour, True	APHA 2120C

True Colour is measured spectrophotometrically by comparison to platinum-cobalt standards using the single wavelength method (450 - 465 nm) after filtration of sample through a 0.45 um filter. Colour measurements can be highly pH dependent, and apply to the pH of the sample as received (at time of testing), without pH adjustment. Concurrent measurement of sample pH is recommended.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-WP	Water	Conductivity	APHA 2510B

Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.

ALS Test Code	Matrix	Test Description	Method Reference**
ETL-LANGELIER-4-WP	Water	Langelier Index 4C	Calculated
ETL-LANGELIER-60-WP	Water	Langelier Index 60C	Calculated
F-IC-N-WP	Water	Fluoride in Water by IC	EPA 300.1 (mod)

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

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-WP	Water	Hardness Calculated	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-CALC-WP	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance (as % difference) cannot be calculated accurately for waters with very low electrical conductivity (EC), and is reported as "Low EC" where EC < 100 uS/cm (umhos/cm). Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-T-CCMS-WP	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020B (mod.)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

N-TOTKJ-WP	Water	Total Kjeldahl Nitrogen	APHA 4500 NorgD (modified)

Aqueous samples are digested in a block digester with sulfuric acid and copper sulfate as a catalyst. Total Kjeldahl Nitrogen is then analyzed using a discrete analyzer with colorimetric detection.

NH3-COL-WP	Water	Ammonia by colour	APHA 4500 NH3 F

Ammonia in water samples forms indophenol when reacted with hypochlorite and phenol. The intensity is amplified by the addition of sodium nitroprusside and measured colourmetrically.

NO2+NO3-CALC-WP	Water	Nitrate+Nitrite	CALCULATION
NO2-IC-N-WP	Water	Nitrite in Water by IC	EPA 300.1 (mod)

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

NO3-IC-N-WP	Water	Nitrate in Water by IC	EPA 300.1 (mod)

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

PH-WP	Water	pH	APHA 4500H

The pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.

SIO2-COL-WP	Water	Reactive Silica by colour	APHA 4500 SIO2

This analysis is carried out using procedures adapted from APHA Method 4500-SiO2 "Silica". Molybdate Reactive Silica is determined by analysis of the sample using the heteropoly blue colourimetric method.

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

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

TC,EC-QT51-WP	Water	Total Coliform and E.coli	APHA 9223B QT51

This analysis is carried out using procedures adapted from APHA Method 9223B "Enzyme Substrate Coliform Test". E. coli and Total Coliform are determined simultaneously. The sample is mixed with a mixture of hydrolyzable substrates and then sealed in a 51-well packet. The packet is incubated at 35.0 +/- 0.5 degrees C for 18 or 24 hours and then the number of wells exhibiting positive responses are counted. The final results are obtained by comparing the number of positive responses to a probability table.

TDS-WP	Water	Total Dissolved Solids (TDS)	APHA 2540 SOLIDS C,E

A well-mixed sample is filtered through a glass fiber filter paper. The filtrate is then evaportaed to dryness in a pre-weighed vial and dried at 180 – 2C. The increase in vial weight represents the total dissolved solids.

TURBIDITY-WP	Water	Turbidity	APHA 2130B (modified)

Turbidity in aqueous matrices is determined by the nephelometric method.

UV-%TRANS-WP	Water	UV Transmittance (Calculated)	APHA 5910B

Test method is adapted from APHA Method 5910B. A sample is filtered through a 0.45 um polyethersulfone (PES) filter and its UV Absorbance is measured in a quartz cell at 254 nm. UV Transmittance is calculated from the UV Absorbance result and reported as UV Transmittance per cm. The analysis is carried out without pH adjustment.

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

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

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L2411609 Report Date: 12-FEB-20

Client: Friesen Drillers Ltd
307 PTH 12 N
Steinbach MB R5G 1L9
Contact: JEFF BELL

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R4984870								
WG3267115-9 LCS								
Alkalinity, Total (as CaCO3)			102.2		%		85-115	30-JAN-20
WG3267115-6 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	30-JAN-20
C-TIC-HTC-WP	**Water**							
Batch R4985146								
WG3267284-2 LCS								
Total Inorganic Carbon			95.7		%		80-120	30-JAN-20
WG3267284-1 MB								
Total Inorganic Carbon			<0.50		mg/L		0.5	30-JAN-20
C-TOC-HTC-WP	**Water**							
Batch R4990108								
WG3270047-2 LCS								
Total Organic Carbon			104.6		%		80-120	04-FEB-20
WG3270047-1 MB								
Total Organic Carbon			<0.50		mg/L		0.5	04-FEB-20
CL-IC-N-WP	**Water**							
Batch R4986520								
WG3266735-14 LCS								
Chloride (Cl)			103.6		%		90-110	30-JAN-20
WG3266735-13 MB								
Chloride (Cl)			<0.50		mg/L		0.5	30-JAN-20
COLOUR-TRUE-WP	**Water**							
Batch R4985227								
WG3267306-5 LCS								
Colour, True			99.2		%		85-115	30-JAN-20
WG3267306-4 MB								
Colour, True			<5.0		CU		5	30-JAN-20
EC-WP	**Water**							
Batch R4984870								
WG3267115-8 LCS								
Conductivity			97.9		%		90-110	30-JAN-20
WG3267115-6 MB								
Conductivity			<1.0		umhos/cm		1	30-JAN-20
F-IC-N-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
F-IC-N-WP	**Water**							
Batch R4986520								
WG3266735-14 LCS								
Fluoride (F)			104.5		%		90-110	30-JAN-20
WG3266735-13 MB								
Fluoride (F)			<0.020		mg/L		0.02	30-JAN-20
MET-T-CCMS-WP	**Water**							
Batch R4991295								
WG3269550-2 LCS								
Aluminum (Al)-Total			103.2		%		80-120	06-FEB-20
Antimony (Sb)-Total			101.7		%		80-120	06-FEB-20
Arsenic (As)-Total			103.2		%		80-120	06-FEB-20
Barium (Ba)-Total			103.1		%		80-120	06-FEB-20
Beryllium (Be)-Total			99.2		%		80-120	06-FEB-20
Bismuth (Bi)-Total			101.7		%		80-120	06-FEB-20
Cadmium (Cd)-Total			103.4		%		80-120	06-FEB-20
Calcium (Ca)-Total			101.7		%		80-120	06-FEB-20
Cesium (Cs)-Total			107.9		%		80-120	06-FEB-20
Chromium (Cr)-Total			103.5		%		80-120	06-FEB-20
Cobalt (Co)-Total			103.2		%		80-120	06-FEB-20
Copper (Cu)-Total			103.2		%		80-120	06-FEB-20
Iron (Fe)-Total			98.2		%		80-120	06-FEB-20
Lead (Pb)-Total			101.5		%		80-120	06-FEB-20
Lithium (Li)-Total			98.8		%		80-120	06-FEB-20
Magnesium (Mg)-Total			111.0		%		80-120	06-FEB-20
Manganese (Mn)-Total			103.6		%		80-120	06-FEB-20
Molybdenum (Mo)-Total			100.8		%		80-120	06-FEB-20
Nickel (Ni)-Total			102.9		%		80-120	06-FEB-20
Potassium (K)-Total			103.9		%		80-120	06-FEB-20
Phosphorus (P)-Total			108.4		%		80-120	06-FEB-20
Rubidium (Rb)-Total			102.0		%		80-120	06-FEB-20
Selenium (Se)-Total			103.0		%		80-120	06-FEB-20
Silicon (Si)-Total			88.1		%		80-120	06-FEB-20
Silver (Ag)-Total			99.98		%		80-120	06-FEB-20
Sodium (Na)-Total			104.3		%		80-120	06-FEB-20
Strontium (Sr)-Total			106.0		%		80-120	06-FEB-20
Sulfur (S)-Total			91.5		%		80-120	06-FEB-20

ALS Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WP	**Water**							
Batch R4991295								
WG3269550-2 LCS								
Tellurium (Te)-Total			101.6		%		80-120	06-FEB-20
Thallium (Tl)-Total			100.6		%		80-120	06-FEB-20
Thorium (Th)-Total			105.1		%		80-120	06-FEB-20
Tin (Sn)-Total			98.7		%		80-120	06-FEB-20
Titanium (Ti)-Total			100.3		%		80-120	06-FEB-20
Tungsten (W)-Total			101.4		%		80-120	06-FEB-20
Uranium (U)-Total			110.1		%		80-120	06-FEB-20
Vanadium (V)-Total			104.2		%		80-120	06-FEB-20
Zinc (Zn)-Total			103.2		%		80-120	06-FEB-20
Zirconium (Zr)-Total			99.2		%		80-120	06-FEB-20
WG3269550-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	06-FEB-20
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	06-FEB-20
Arsenic (As)-Total			<0.00010		mg/L		0.0001	06-FEB-20
Barium (Ba)-Total			<0.00010		mg/L		0.0001	06-FEB-20
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	06-FEB-20
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	06-FEB-20
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	06-FEB-20
Calcium (Ca)-Total			<0.050		mg/L		0.05	06-FEB-20
Cesium (Cs)-Total			<0.000010		mg/L		0.00001	06-FEB-20
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	06-FEB-20
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	06-FEB-20
Copper (Cu)-Total			<0.00050		mg/L		0.0005	06-FEB-20
Iron (Fe)-Total			<0.010		mg/L		0.01	06-FEB-20
Lead (Pb)-Total			<0.000050		mg/L		0.00005	06-FEB-20
Lithium (Li)-Total			<0.0010		mg/L		0.001	06-FEB-20
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	06-FEB-20
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	06-FEB-20
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	06-FEB-20
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	06-FEB-20
Potassium (K)-Total			<0.050		mg/L		0.05	06-FEB-20
Phosphorus (P)-Total			<0.030		mg/L		0.03	06-FEB-20
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	06-FEB-20
Selenium (Se)-Total			<0.000050		mg/L		0.00005	06-FEB-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-WP	**Water**							
Batch R4991295								
WG3269550-1 MB								
Silicon (Si)-Total			<0.10		mg/L		0.1	06-FEB-20
Silver (Ag)-Total			<0.000010		mg/L		0.00001	06-FEB-20
Sodium (Na)-Total			<0.050		mg/L		0.05	06-FEB-20
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	06-FEB-20
Sulfur (S)-Total			<0.50		mg/L		0.5	06-FEB-20
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	06-FEB-20
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	06-FEB-20
Thorium (Th)-Total			<0.00010		mg/L		0.0001	06-FEB-20
Tin (Sn)-Total			<0.00010		mg/L		0.0001	06-FEB-20
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	06-FEB-20
Tungsten (W)-Total			<0.00010		mg/L		0.0001	06-FEB-20
Uranium (U)-Total			<0.000010		mg/L		0.00001	06-FEB-20
Vanadium (V)-Total			<0.00050		mg/L		0.0005	06-FEB-20
Zinc (Zn)-Total			<0.0030		mg/L		0.003	06-FEB-20
Zirconium (Zr)-Total			<0.00020		mg/L		0.0002	06-FEB-20
N-TOTKJ-WP	**Water**							
Batch R4987778								
WG3267456-18 LCS								
Total Kjeldahl Nitrogen			97.1		%		75-125	04-FEB-20
WG3267456-17 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	04-FEB-20
NH3-COL-WP	**Water**							
Batch R4990539								
WG3270459-3 DUP		**L2411609-1**						
Ammonia, Total (as N)		0.228	0.226		mg/L	1.0	20	04-FEB-20
WG3270459-2 LCS								
Ammonia, Total (as N)			99.1		%		85-115	04-FEB-20
WG3270459-1 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	04-FEB-20
WG3270459-4 MS		**L2411609-1**						
Ammonia, Total (as N)			84.7		%		75-125	04-FEB-20
NO2-IC-N-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-IC-N-WP	**Water**							
Batch R4986520								
WG3266735-14 LCS								
Nitrite (as N)			99.7		%		90-110	30-JAN-20
WG3266735-13 MB								
Nitrite (as N)			<0.010		mg/L		0.01	30-JAN-20
NO3-IC-N-WP	**Water**							
Batch R4986520								
WG3266735-14 LCS								
Nitrate (as N)			103.6		%		90-110	30-JAN-20
WG3266735-13 MB								
Nitrate (as N)			<0.020		mg/L		0.02	30-JAN-20
PH-WP	**Water**							
Batch R4984870								
WG3267115-7 LCS								
pH			7.40		pH units		7.3-7.5	30-JAN-20
SIO2-COL-WP	**Water**							
Batch R4988472								
WG3269480-3 DUP		**L2411609-1**						
Silica, Reactive (as SiO2)		15.9	15.7		mg/L	1.1	20	03-FEB-20
WG3269480-2 LCS								
Silica, Reactive (as SiO2)			100.2		%		85-115	03-FEB-20
WG3269480-1 MB								
Silica, Reactive (as SiO2)			<1.0		mg/L		1	03-FEB-20
WG3269480-4 MS		**L2411609-1**						
Silica, Reactive (as SiO2)			N/A	MS-B	%		-	03-FEB-20
SO4-IC-N-WP	**Water**							
Batch R4986520								
WG3266735-14 LCS								
Sulfate (SO4)			106.4		%		90-110	30-JAN-20
WG3266735-13 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	30-JAN-20
TC,EC-QT51-WP	**Water**							
Batch R4985170								
WG3266780-1 MB								
Total Coliforms			0		MPN/100mL		1	30-JAN-20
Escherichia Coli			0		MPN/100mL		1	30-JAN-20
WG3266780-2 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TC,EC-QT51-WP	**Water**							
Batch R4985170								
WG3266780-2 MB								
Total Coliforms			0		MPN/100mL		1	30-JAN-20
Escherichia Coli			0		MPN/100mL		1	30-JAN-20
TDS-WP	**Water**							
Batch R4990009								
WG3267253-7 DUP		**L2411609-1**						
Total Dissolved Solids		475	484		mg/L	2.0	20	31-JAN-20
WG3267253-6 LCS								
Total Dissolved Solids			96.8		%		85-115	31-JAN-20
WG3267253-5 MB								
Total Dissolved Solids			<4.0		mg/L		4	31-JAN-20
TURBIDITY-WP	**Water**							
Batch R4986559								
WG3268313-2 LCS								
Turbidity			97.0		%		85-115	31-JAN-20
WG3268313-1 MB								
Turbidity			<0.10		NTU		0.1	31-JAN-20
UV-%TRANS-WP	**Water**							
Batch R4984847								
WG3267125-16 IRM		**BLANK**						
Transmittance, UV (254 nm)			100.0		%		99.5-100.5	30-JAN-20
WG3267125-14 LCS								
Transmittance, UV (254 nm)			96.2		%		85-115	30-JAN-20

Quality Control Report

Legend:

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

Sample Parameter Qualifier Definitions:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	29-JAN-20 14:30	30-JAN-20 12:00	0.25	22	hours	EHTR-FM

Legend & Qualifier Definitions:

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

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2411609 were received on 30-JAN-20 13:20.

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

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

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

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2411609-COFC

COC Number: 17 - 781976

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Friesen Drillers Ltd
Contact:	Jeff Bell P.Eng
Phone:	204 326 2485
	Company address below will appear on the final report
Street:	307 PTH 12 N
City/Province:	Steinbach MB
Postal Code:	R5G 1T8

Report Format / Distribution	
Select Report Format:	☑ PDF ☐ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report	☑ YES ☐ NO
☐ Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	Jeff@friesendrillers.com
Email 2	Justin@friesendrillers.com
Email 3	

Select Service Level Below - Contact your AM to confirm all E&P TATs (surcharges may apply)

- Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply
- PRIORITY (Business Days): 4 day [P4-20%] ☐; 3 day [P3-25%] ☐; 2 day [P2-50%] ☐
- EMERGENCY: 1 Business day [E - 100%] ☐; Same Day, Weekend or Statutory holiday [E2 -200% (Laboratory opening fees may apply)] ☐
- Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm
- For tests that can not be performed according to the service level selected, you will be contacted.

Invoice To		
Same as Report To	☑ YES	☐ NO
Copy of Invoice with Report	☐ YES	☐ NO
Company:		
Contact:		

Invoice Distribution	
Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	accts@friesendrillers.com
Email 2	

Project Information	
ALS Account # / Quote #:	
Job #:	Beausejour
PO / AFE:	
LSD:	
ALS Lab Work Order # (lab use only):	

Oil and Gas Required Fields (client use)	
AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	
ALS Contact: Judy	Sampler: AF

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	MUN-WTP-72D-WP	Reactive Silica	TC-EC-QT51-WP	SAMPLES ON HOLD	SUSPECTED HAZARD (see Special Instructions)
	East Well	29-Jan-20	14:30	Water	5	/	/	/		

Drinking Water (DW) Samples[1] (client use)	
Are samples taken from a Regulated DW System?	☐ YES ☑ NO
Are samples for human consumption/ use?	☐ YES ☐ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐		SIF Observations	Yes ☐ No ☐
Ice Packs ☐	Ice Cubes ☐	Custody seal intact	Yes ☐ No ☐
Cooling Initiated ☐			

INITIAL COOLER TEMPERATURES °C	FINAL COOLER TEMPERATURES °C
10.9	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by: AK	Date: 30 Jan	Time: 1:20	Received by:	Date: JAN 3 0 2020	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION — WHITE - LABORATORY COPY — YELLOW - CLIENT COPY

JUNE 2018 FRONT

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