Environment Act Proposal
RM of St. Clements - East Selkirk Water System Upgrade

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The Manitoba Water Services Board
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Table of Contents

Executive Summary

The Rural Municipality (RM) of St. Clements 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 expansion of the East Selkirk Water Treatment Plant (ESWTP). The expansion and upgrade involves the following:

1. An increase in the current ESWTP treatment capacity of 12 L/s to 26 L/s to meet the 20-year demand of the growing population of East Selkirk as well as the Community of Lockport.
2. Increased footprint of the current ESWTP building to accommodate equipment and process upgrades.
3. Installation of a membrane treatment process to soften and improve water quality.
4. Installation of 150mm Ø pipeline and outfall to discharge membrane concentrate to Cooks Creek. The pipeline will also be connected to an existing lift station that is part of the East Selkirk low pressure sewer system to allow the option to discharge the concentrate to the municipal lagoon at times when the creek experiences low flow or freezing conditions.
5. Assessment and upgrades to current groundwater wells and pumps. To meet future demands past 2023 additional groundwater wells will be required that will involve further investigation and a Class 2 EAP.
6. Addition of 137 m^3 of reservoir storage capacity.
7. Installation of a 12 km water pipeline extending from the ESWTP to the Community of Lockport as part of a regional system.

The community of East Selkirk with a population of 675 (ESWTP Annual Report for 2019), is supplied potable water from the ESWTP. The proposed upgrade to the WTP will improve the water quality by softening the water supply while the increased capacity will allow more customers to be serviced with treated water.

The proposed treatment process consists of an integrated membrane system including a combination of reverse osmosis and nanofiltration elements. The system will also include a bypass cartridge filter to provide blend water. Concentrate water will be discharged through a 2 km pipeline into Cooks Creek with potential future disposal to the Red River. With the proposed expansion the operating capacity of the ESWTP will increase to 26 L/s of treated water 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
MAC	Maximum Acceptable Concentration
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 Rural Municipality (RM) of St. Clements 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 East Selkirk Water Treatment Plant (ESWTP). This document provides the compiled information required by Manitoba Conservation and Climate's Environment Act Proposal Report Guidelines and Supplementary Guidelines for Municipal Water Supply Systems. This Environment Act Proposal includes concentrate disposal and the installation of a 12 km potable water pipeline.

1.1 Background Information

The Village of East Selkirk is located approximately 41 km northeast of Winnipeg in the Rural Municipality of St. Clements. The current population is approximately 675 as per the ESWTP Annual Water Treatment Report for 2019. The Community of Lockport located on the east side of the Red River is also located in the RM of St. Clements approximately 10 km west of East Selkirk and has a population of 288. The total population of Lockport is 746. (Canada G. o., Statistics Canada, 2016)

The RM proposes to expand their current East Selkirk water treatment system to serve the growing East Selkirk population as well as potentially supplying potable water to 2,000 additional service connections in Lockport. This upgrade will improve water quality (softened) and increase treatment capacity.

The Village of East Selkirk receives raw water from a fractured carbonate aquifer, which supplies water to the public water system from a WTP that was originally constructed in 2011. Raw water is currently pumped from one of two wells with a capacity of 12.5 L/s (WSP, 2021). The current maximum day demand (MDD) for East Selkirk is 9.4 L/s (WSP, 2021).

The ESWTP supplies treated water for domestic and fire fighting purposes to the community. It is located on Kittson Road and consists of a single story pre-engineered building on top of a 547 m^3 reinforced concrete reservoir.

Raw water is supplied to the WTP from two groundwater wells located approximately 30 m to the east of the WTP building. Each well has a pumping capacity of 12.5 L/s. The water quality from the wells meets the Guidelines for Canadian Drinking Water Quality (GCDWQ) maximum acceptable concentration (MAC) as well as the aesthetic objective (AO) for all parameters with the exception of hardness and total dissolved solids (TDS). For this reason, provisions were made during the construction of the original WTP to allow for a future building expansion with the intention of upgrading the treatment process with membrane filtration to soften the water.

The current treatment process consists of raw water passing through a UV system for primary disinfection followed by chlorination utilizing 12% sodium hypochlorite prior to storage and distribution.

1.1.1 Previous Studies

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

***RM of St. Clements East Selkirk WTP Expansion Preliminary Design,* WSP, 2021.**

In 2021, WSP was retained by MWSB to provide engineering services for the Preliminary Design and Detailed Design of the RM of St. Clements East Selkirk Water Treatment Plant Expansion.

East Selkirk Water Supply Production Wells – proposed expansion investigation, Friesen Drillers 2021

In 2021, Friesen Drillers were retained by MWSB to provide engineering services for the proposed expansion of the water supply production wells for the RM of St. Clements East Selkirk Water Treatment Plant.

1.1.2 Population

Based on the 2020 RM of St. Clements Utility Report, the Village of East Selkirk has a population of 675. An additional development of 675 connections is expected in the near future. The projected population in East Selkirk will increase over the next few years at an annual population growth rate factor of 1% per year. A 20-year population of approximately 1680 people is projected for East Selkirk (WSP, 2021) as shown in *Figure 1.1* below.

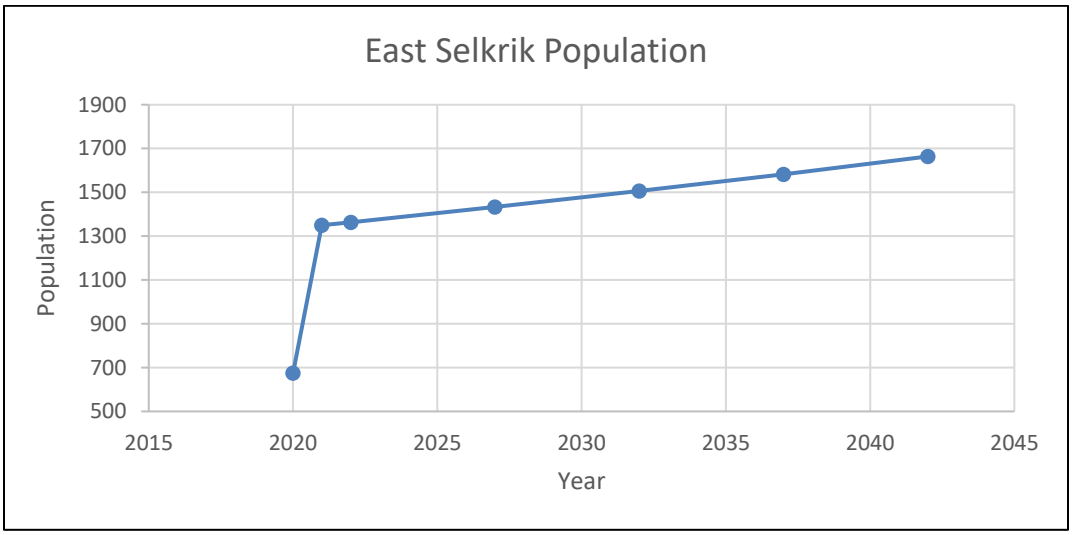

FIGURE 1.1 – VILLAGE OF EAST SELKIRK POPULATION PROJECTION

The RM of St. Clements is proposing to create a regional system that will deliver treated water from the ESWTP to Lockport to serve a future population of approximately 2,000 people. The regional system expansion will consist of the installation of approximately 12 km of a 200 mm pipeline to supply water from the ESWTP to Lockport, an 840 m^3 reservoir and a distribution system. The estimated combined population projection for East Selkirk and Lockport is 1350 as shown in *Figure 1.2* below (WSP, 2021).

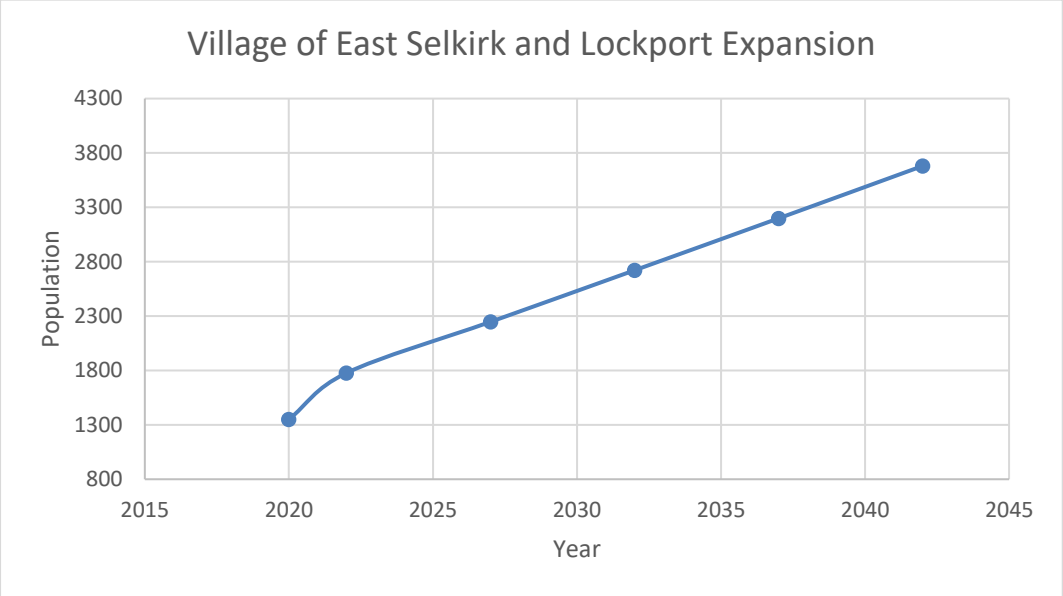

FIGURE 1.2 – VILLAGE OF EAST SELKIRK AND LOCKPORT POPULATION PROJECTION

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 250 L/capita/day water usage and a peak day factor of 2.0 were utilized for East Selkirk and Lockport (WSP, 2021). The current average day demand for the East Selkirk system is 4.73 L/s and the peak day demand is 9.4 L/s (WSP, 2021). The 20-year projected combined average day demand for East Selkirk and Lockport is 12.8 L/s with a peak day demand of 25.6 L/s (WSP, 2021).

The upgrade to the WTP will include an expansion of the current reservoir which satisfies the required water storage, chlorine contact disinfection time, and emergency fire storage for Class 2 Fire Protection (30 L/s) with a total storage capacity of 774m^3 (an increase of 137 m^3). The projected treated water demands are summarized in *Table 1.1* below.

TABLE 1.1 – PROJECTED TREATED WATER DEMAND FOR THE VILLAGE OF EAST SELKIRK AND LOCKPORT EXPANSION

Projected Treated Water Demand for the Village of East Selkirk and Lockport expansion Water System		
	Quantity	**Units**
2020 Population	1,350	Capita
2042 Population (@1 % Growth/yr)	3,680	Capita
Consumption/Capita/Day	250.0	L/c/day
2042 Average Day Consumption	920,000	L/day
2042 Average Day Demand (20- hour operating day)	12.8	L/s
Peak Day factor	2.0	-
2042 Peak Day Consumption	1,840,000	L/day
2042 Peak Day Demand (20-hour operating day)	25.6	L/s

1.1.4 Raw Water Source

Two wells 30 m east of the current WTP located at River lot 073, Parish of St. Clements as per *Figure 1.3* provide the raw water supply for the ESWTP from a fractured limestone, lower Carbonate Aquifer. The wells are suspected to be GUDI and Friesen Drillers (2021) recommends conducting further testing to confirm surface water intrusion.

FIGURE 1.3 – LOCATION OF EXISTING WELL FIELDS.

Raw water data was collected and sampled in June 2018 and the data is shown in the *Table 1.2* below.

TABLE 1.2 RAW WATER QUALITY IMPACT STUDY

Parameter	AO	MAC	Units	RAW
Colour, True	15		CU	<5.0
Hardness (as CaCO3)	500		mg/L	**558**
Langelier Index (4*C)			-	0.66
pH	7-10		pH Units	7.79
TDS	500		mg/L	**604**
Turbidity		NTU	NTU	<0.10
Alkalinity (Total) $CaCO_3$			mg/L	495
Chloride (Cl)	250		mg/L	27.6
Fluoride (F)		1.5	mg/L	0.237
Nitrate (as N)		10	mg/L	7.54
Nitrite (as N)		1	mg/L	<0.0020
Sulphate (SO4)	500		mg/L	51.8
D.O.C			mg/L	2.42
T.O.C			mg/L	2.23
Aluminium (Al)	0.1		mg/L	0.0032
Arsenic (As)		0.01	mg/L	0.00013
Barium (Ba)		2	mg/L	0.0583
Cadmium (Cd)		0.005	mg/L	0.0000071
Chromium (Cr)		0.05	mg/L	<0.0001
Copper (Cu)	1		mg/L	0.00156
Iron (Fe)	0.3		mg/L	<0.010
Lead (Pb)		0.005	mg/L	0.000145
Manganese (Mn)	0.02	0.12	mg/L	0.00047
Nickel (Ni)			mg/L	0.00119
Selenium (se)		0.05	mg/L	0.00280
Sodium (Na)	200		mg/L	18.6
Strontium (Sr)		7	mg/L	0.472
Uranium (U)		0.02	mg/L	0.0125
Zinc (Zn)	5		mg/L	0.0059

There were no parameters in the raw water that were of any concern based on the Aesthetic Objective with the exception of hardness and total dissolved solids (TDS). No parameters exceed the Maximum Allowable Concentration.

1.1.5 Water Rights Act

The RM of St. Clements utilizes Water Rights License No. 2014-147. The Licence allows the maximum instantaneous rate of withdrawal to be 13 L/s and a maximum annual usage of 199 dam^3/year from the aquifer. The Water Rights License is included in *Appendix C.*

As per the preliminary design study from WSP (2021) the estimated 20-year treated water demand is 12.8 L/s average day and 25.6 L/s peak day (WSP, 2021).

TABLE 1.3 – PROJECTED TREATED WATER DEMAND FOR THE EAST SELKIRK WTP

	Treated Demand	Raw Demand	Units
Average Consumption	12.8	15.65	L/s
Instantaneous Withdrawal	25.6	31.3	L/s
Annual Allocation	336.4	946	dam^3/year

With the implementation of a new membrane filtration system, an additional raw water draw will be required due to the waste generated from the membrane reject and cleaning streams. The amount of waste generated depends on a number of factors (design criteria), and is approximately 23% of the water entering the membrane skids.

Table 1.4 demonstrates the volumetric impacts on the WTP based on the population and demand established in *Table 1.1*. For the purposes of calculations, it is assumed that 80% of the water enters the membrane system (thereby contributing to waste) and 20% bypasses the membranes for blending.

TABLE 1.4 – IMPACT OF WASTE GENERATION PERCENTAGES ON RAW DEMAND

Year	2020	2022	2027	2032	2037	2042
Population	1,350	1,777	2,247	2,721	3,199	3,680
ADD (m^3)	338	444	562	680	800	920
Raw Demand W/ 23% Membrane waste (m^3)	414	544	688	833	980	1127
MDD (m^3)	676	888	1124	1360	1600	1840
Raw Demand W/ 23 % Membrane waste (m^3)	828	1088	1377	1666	1960	2254
Raw Demand w 23% Membrane waste (L/s)	11.5	15.1	19.1	23.1	27.2	31.3

As observed from *Table 1.4*, it is estimated that the MDD in 2042 on the raw water wells could be as high as 2,254 m^3, corresponding to 31.3 L/s for a 20 hour operating day. Given the licenced draw rate of 13 L/s (per well), the RM will exceed the draw rate in 2022 based

on the current projections. The expectation is that the draw rate will be exceeded when future connections come on-line around 2023.

Friesen Drillers will assess the well capacity and apply for an amendment to the WRL on behalf of the RM of St. Clements. Further investigation will be required to establish an additional well site in order to meet the future annual allocation of 946 dam^3/year (WSP, 2021) and at that time, a Class 2 EAP and a public open house will be conducted.

1.1.6 Water Quality

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 1.5* on the following page.

No raw water quality parameters currently exceed the GCDWQ MAC health requirements. Treated water quality parameters at the existing treatment plant do not exceed any GCDWQ AO or MAC with the exception of hardness and TDS. The proposed treatment system upgrade will reduce these parameter concentrations and provide a softened water source able to meet all current regulations under the DWSA and the GCDWQ.

TABLE 1.5 WATER QUALITY RESULTS FOR EAST SELKIRK WTP 2012 - 2018)

Parameter	AO	MAC	Units	RAW MIN	RAW MAX	Treated MIN	Treated MAX
Hardness (as CaCO3) [a]	500		mg/L	506	577	525	576
Langelier Index (4*C)			-	0.59	0.75	0.56	0.74
pH	7-10		pH Units	7.79	7.91	7.77	7.92
TDS	500		mg/L	573	604	579	618
Turbidity [b]			NTU	0.42	0.46	0.10	0.21
Alkalinity (Total) $CaCO_3$			mg/L	473	495	474	498
Chloride (Cl)	250		mg/L	23.2	27.6	29.5	32.0
Fluoride (F)		1.5	mg/L	0.237	0.257	0.239	0.254
Nitrate (as N)		10	mg/L	6.870	7.540	6.740	9.970
Nitrite (as N)		1	mg/L	0.0051	0.0051	0.0165	0.0172
Sulphate (SO4)	500		mg/L	52	55	54	56
D.O.C [c]			mg/L	1.6	3	1.0	3.3
T.O.C [d]			mg/L	2.2	3.6	1.9	3.3
Aluminium (Al)	0.1		mg/L	0.0032	0.0032	0.0139	0.0139
Arsenic (As)		0.01	mg/L	0.00013	0.00013	0.00019	0.00025
Barium (Ba)		2	mg/L	0.0583	0.6990	0.0571	0.0599

Cadmium (Cd)		0.005	mg/L	7.2E-06	7.2E-06	0.0000195	0.0000195
Chromium (Cr)		0.05	mg/L	0.00000	0.00000	0.00000	0.00000
Copper (Cu)	1		mg/L	0.00156	0.00687	0.01180	0.54300
Iron (Fe)	0.3		mg/L	0.022	0.022	0.000	0.000
Lead (Pb)		0.005	mg/L	0.000145	0.000313	0.000096	0.001170
Manganese (Mn)	0.02	0.12	mg/L	0.0005	0.0013	0.0003	0.0019
Nickel (Ni)			mg/L	0.0012	0.0028	0.0085	1.0800
Selenium (se)		0.05	mg/L	0.002800	0.003000	0.002600	0.003240
Sodium (Na)	200		mg/L	14.7	19.7	20.9	24.8
Strontium (Sr)		7	mg/L	0.404	0.472	0.418	0.455
Uranium (U)		0.02	mg/L	0.01120	0.01450	0.01110	0.01220
Zinc (Zn)	5		mg/L	0.0059	0.0070	0.0062	0.1620

[a] Hardness levels greater than 200 are considered poor but tolerable. Hardness levels greater than 500 are generally considered unacceptable
[b] 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.
[c] D.O.C – Dissolved Organic Carbon
[d] T.O.C – Total Organic Carbon

1.1.7 Compliance Plan

There is no active compliance plan for the East Selkirk Water Treatment Plant.

2.0 Description of Proposed Development

2.1 Project Description

The proposed development includes:

- Expansion to add 194 m^2 area to the current WTP building and expanding the current reservoir by 137 m^3.
- Construction of a two new membrane skids including a dual–train membrane treatment process with side–stream cartridge filters to provide a combined treated capacity of 26 L/s.
- Construction of 2.0 km 150mm diameter concentrate water discharge pipeline from the WTP to Cooks Creek with a connection to an existing lift station to allow option to discharge to municipal lagoon.
- The assessment and upgrade of current wells to supply increased capacity for proposed 20-year East Selkirk population.
- Installation of a 12 km water pipeline to service Community of Lockport as part of a regional system.

Figure 2.1 below shows the location of the ESWTP site and the proposed discharge route. Future plans as East Selkirk grows is to extend the discharge route to the Red River in order to eliminate any reliance on the sewer system for concentrate disposal.

FIGURE 2.1 –PROPOSED DISCHARGE LOCATION TO COOKS CREEK AND FUTURE DISCHARGE LOCATION TO RED RIVER

2.1.1 Water Source

Water will be supplied from the carbonate groundwater aquifer which has supplied ESWTP since 2012.

2.1.1.1 Well Installations

In 2011, the two main supply wells were constructed using 8 inch diameter steel casing set to a depth of approximately 100 feet below grade. Both wells were drilled to a depth of 220 feet below grade (Friesen Drillers, 2011). The drawdown at a radial distance of 8,000 feet was determined to be approximately 1.5 feet after pumping one year of continuously at a rate of 100 U.S. G/day/ft, with an assumed storage coefficient of 1.0×10^{-4}.

In 2012 when the well field was tested initially, the transmissivity was 52,800 U.S.G.P.D./ft and the storativity was 1.36×10^{-4}.

Using these aquifer parameters and the proposed flow rate of 30 L/s (475 U.S.G.P.M.), drawdowns in the area were calculated using the Theis (1935) equation. This flow rate would equate to an annual allocation of about 767 acre feet/year (946 dam^3/year).

The drawdowns produced from the Theis (1935) equation would typically produce a circular drawdown effect around the well field. With the local experience, and the details contained in Render (1986), it is evident that the Red River is acting as a constant head boundary in many cases through the area. Very near to the site is the Lister Rapids, which is present at the St. Andrews Lock and Dam site. At these rapids, the Red River is running directly on the surface of the carbonate aquifer, and there is a significant connection with groundwater. These conditions are thought to occur in several areas along the Red Diver towards the City of Selkirk. Assuming the conditions of Theis (1935), the predicted drawdowns are shown in the *Figure 2.2 below*:

Predicted Drawdown – 30 L/s (946 dam³/year)
RM of St. Clements – East Selkirk Groundwater Supply
* Calculations based on Theis (1935); Transmissivity of 52,800 U.S.G.P.D./ft.; Storativity of 1.36 x 10-4

Radius	500 feet	1,500 feet	½ mile	1 mile	1 ½ mile	2 miles	3 miles
Drawdown	12.4 ft.	10.2 ft.	9.0 ft.	7.6 ft.	6.7 ft.	6.1 ft.	5.3 ft.

Table 1 – Calculated drawdown pumping at a rate of 475 U.S.G.P.M. for 365 days, following Theis (1935) equation.

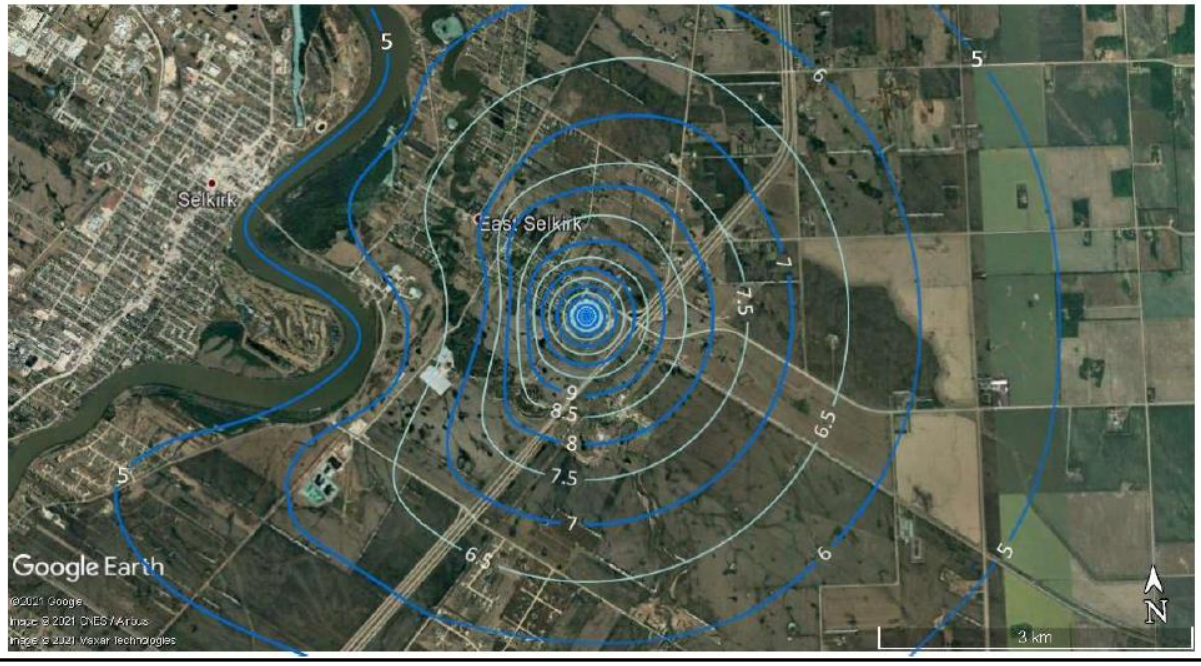

FIGURE 2.2 – PREDICTED DRAWDOWN AT 30 L/S (946 DAM³/YEAR) – EAST SELKIRK WATER SUPPLY

Overall, it is expected that the proposed expanded water supply would develop a drawdown cone similar to what was previously seen on the west side of the river. It can easily be seen that this predicted drawdown cone would have a fairly large aerial extent and would likely result in water level changes of several feet within several miles of the well field.

Since this area is well populated, with a long history of extensive groundwater development. Friesen Drillers 2021, has recommended the following activities be undertaken:

- A public consultation/public awareness plan is not currently required but will be in the future when new well field is investigated.
- A Hydrogeological Engineer/Hydrogeologist should investigate and supervise a testing program in the area to determine how the proposed well field will respond to pumping at the increased rates.
- EAP for a Class 2 Development with the increased annual draw of greater than 200 dam^3/year

2.1.1.2 Raw Water Quality

On December 1, 2020, water samples were collected and submitted for laboratory analysis to characterize the raw water quality of the aquifer (WSP, 2021). 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 1.1*. 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 complete raw water analysis can be found in *Appendix D*.

2.1.1.3 Water Treatment Plant

The East Selkirk WTP is currently classified as a Class 1 Water Treatment Facility and will be upgraded to a Class 2 with the addition of membrane treatment. The proposed membrane filtration process with primary disinfection 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 and TDS. The upgraded treatment system will supply the projected 20-year population demand of the Community 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.

Membrane concentrate accounts for 18.4% of the total raw water flow through the WTP. Using a 23% concentrate rate and a 20% by-pass through a pressure filter results in an instantaneous raw water demand of 31.3 L/s.

The membrane system will be designed to reduce hardness ions to range between 80 – 120 mg/L $CaC0_3$. 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 to be blended with treated membrane permeate. Alone, membrane permeate is generally chemically unstable and benefits from the addition of 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. The proposed membrane system was modeled for a 77% recovery with 23% of the flow through the membrane unit being concentrated (Delco, 2020).

It is proposed that membrane concentrate be discharged to the Cooks Creek with the option of sending to the municipal lagoon through a 2 Km long, 150 mm diameter pipeline.

2.1.1.5 Operation and Maintenance

East Selkirk 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 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.

2.1.1.6 Lockport Regional Water Supply Pipeline

The expansion of the ESWTP will allow a regional water supply system to be established in the RM of St. Clements to service the Community of Lockport located on the east side of the Red River. A 200 mm diameter HDPE pipeline will run from the ESWTP to the future site of the Lockport reservoir. The proposed pipeline will be installed along PTH 59, PR 509 and an easement with Central Manitoba Railway (CEMR) and will cross PTH 44 and the Red River Floodway. The proposed pipeline route is found in *Appendix A*.

2.2 Certificate of Title

The WTP will be constructed on land owned by the RM of St. Clements. Certificate of Title is attached in *Appendix F*.

The concentrate water pipeline and water supply pipeline will be installed along municipal and provincial right-of-ways (ROWs). Approval from the Manitoba Infrastructure will be required. Easements will be requested if necessary to facilitate the installation of the pipelines.

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 ROWs or an easement. 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, concentrate discharge line and water supply pipeline to Lockport is anticipated to occur as a single phase project. The project is scheduled to commence in 2021 depending on the availability of funding and the receipt of all approvals.

2.7 Project Funding

This project will be cost shared between the Manitoba Restart Funding Program, MWSB and the RM of St. Clements. Regulatory Approvals for 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 Climate
Office of Drinking Water
Manitoba Infrastructure

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

2.8 Public Consultation

No public consultation will be conducted as part of this project as it involves the expansion of existing infrastructure. However, a public consultation will be held when further investigation is conducted for additional well capacity and a Class 2 EAP is required.

2.9 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 site 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 (sodium hypochlorite) and new plant (antiscalant, 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.

2.10 Duty to Consult

The proposed project does not involve any federally owned or Reserve lands.

3.0 Physical Environment

3.1 Physiographic Setting and Climate

East Selkirk and Lockport are located in southeastern Manitoba, about 41 km northeast of Winnipeg. The topography of the area has some slight elevation changes varying between 248 and 237 m geodetic elevation. The East Selkirk area is located on the east side of the Red River, opposite the City of Selkirk. The community is mainly rural residential, with the largest major industrial site being the Manitoba Hydro generating facility. The site is bordered to the east by PTH 59.

Based on Environment Canada climate data for Stony Mountain (Climate ID 5022791), the mean annual temperature in the area is approximately 4.2 degrees Celsius based on data from 1981 to 2020. The daily average was sub zero for months November to March. Although the station closest to East Selkirk has no recorded data since 2008, precipitation records over the past decade for Stony Mountain (Climate ID 5022791) approximately 30 km west and south (260.66 degrees) of East Selkirk respectively, are presented in *Figure 3.1* below. Mean annual precipitation was found to be 590 mm/year during this period (Environment Canada, 2018).

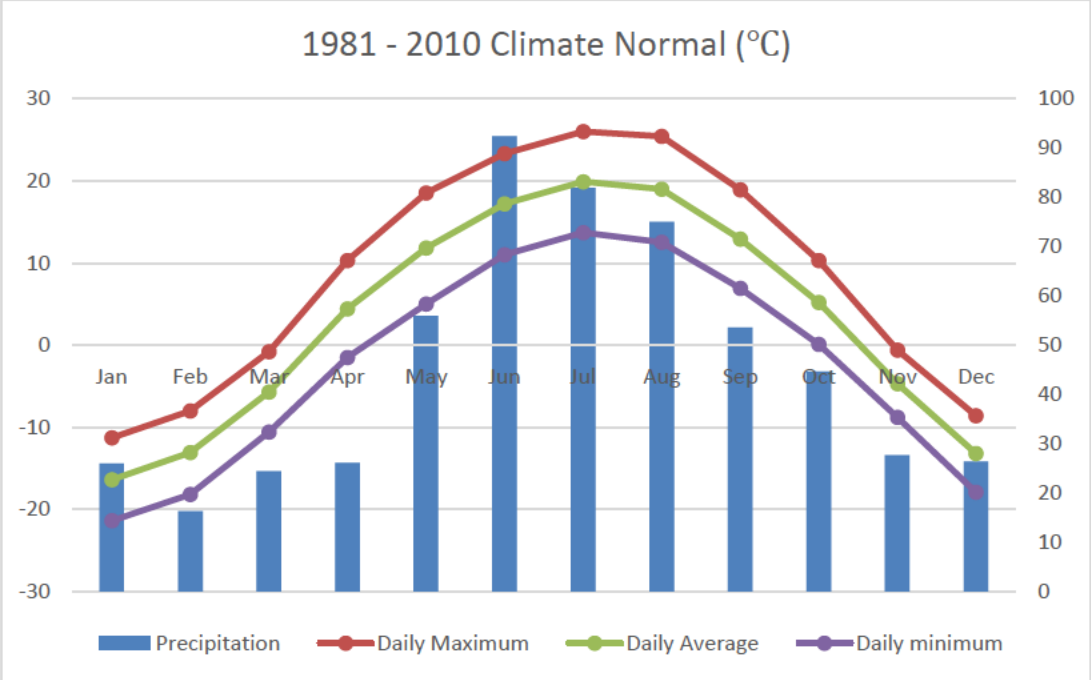

FIGURE 3.1 – 1981 TO 2010 CLIMATE NORMAL

3.2 Hydrogeology

The subsurface geology consists of silty grey clay, approximately 15 feet thick, overlying a 25 feet thick unit of calcareous grey clay till with some layers of sand and gravel. Underlying the clay till

unit is a highly fractured carbonate rock rubble zone. The thickness of the rubble zone varies up from 10 to 20 feet across the area. The rubble zone gradually changes into the more competent, fractured carbonate rock of the Red River Formation. The Red River formation typically consists of alternating layers of limestone and dolostone with basal shale layers. The Red River Formation is in turn underlain by the Winnipeg Formation clastic (sandstone and shale) unit, and Precambrian basal bedrock (Render, 1970). With the exception of the carbonate rock surface, which is typically quite irregular due to erosion, fracturing, and karst features, the geology within the study area is fairly uniform and consistent (Friesen Drillers, March 2012).

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).

Groundwater flow within the City of Selkirk is directed towards the two major aquifer users in the area. These include the City of Selkirk well field, and Gerdau Ameristeel. Groundwater flow is towards the large drawdown cone that exists. Along the eastern and western outskirts of the city, static water levels can be 15 to 20 feet below grade or higher. Within the central part of the city, near the City Hall, static water levels are in the 70 to 80 feet below grade level. Groundwater flow direction in East Selkirk appears to southwesterly, towards the pumping drawdown cone that surrounds the City of Selkirk production wells, which are the largest major pumping wells nearest to the East Selkirk area. The average gradient, based on mid summer 2010 groundwater levels appears to be approximately 2.53 x 10-2, or approximately 2.5%, which is extremely strong towards the centre of the City of Selkirk. Groundwater is recharged to the carbonate aquifer to the east of Selkirk, from the Birds Hill Glaciao-Fluvial complex, and the Garson/Tyndall upland areas (refer *Appendix B*).

In general, the aquifer was determined to have an estimated transmissivity of about 53,000 U.S.G/day/ft., based on the results of the 12 hour single well test. This estimation appears to be fairly typical from the Transmissivity mapping that was undertaken by Render, in 1986. Render's mapping showed levels of about 50,000 U.S.G./day/ft., although there did not appear to be an abundance of data points within the East Selkirk area, as the primary focus of his investigations was the City of Selkirk. 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 used in the analysis. The Cooper-Jacob (1946) method was used, since emphasis is not placed on early time measurements. The pumping well configuration was not fully penetrating. The aquifer is not

continuous, or isotropic, and displays a strong spatial variability. There is also evidence of vertical leakance from the upper aquifer. The complete report is included in *Appendix H*.

3.3 Hydrology

Cooks Creek is a major tributary that runs through the Village of East Selkirk, discharging into Red River.

The Cooks Creek basin has a gross drainage area of approximately 750 km^2. All tributaries and drains flow east or west into the centrally located Cooks Creek which flows in a north-westerly direction, from west of Ross, to where it joins the Red River north of Selkirk (*refer Figure 3.2*).

Flows on the Cooks Creek are monitored by the Water Survey of Canada at Station 05OJ020 rather than 05OJ006 due to more recent data, with data up to 2018. Flow data is not recorded when ice covers the creek. For Cooks Creek, mean monthly flows varied from 0.00 m^3/s to 1.91 m^3/s over the 1990 – 2018 period (0 – 1910 L/s). Mean discharge data for the Cooks Creek can be found summarized below in *Table 3.1* (Canada G. o., Daily Discharge data for Cooks Creek Diversion (05OJ020), 2018).

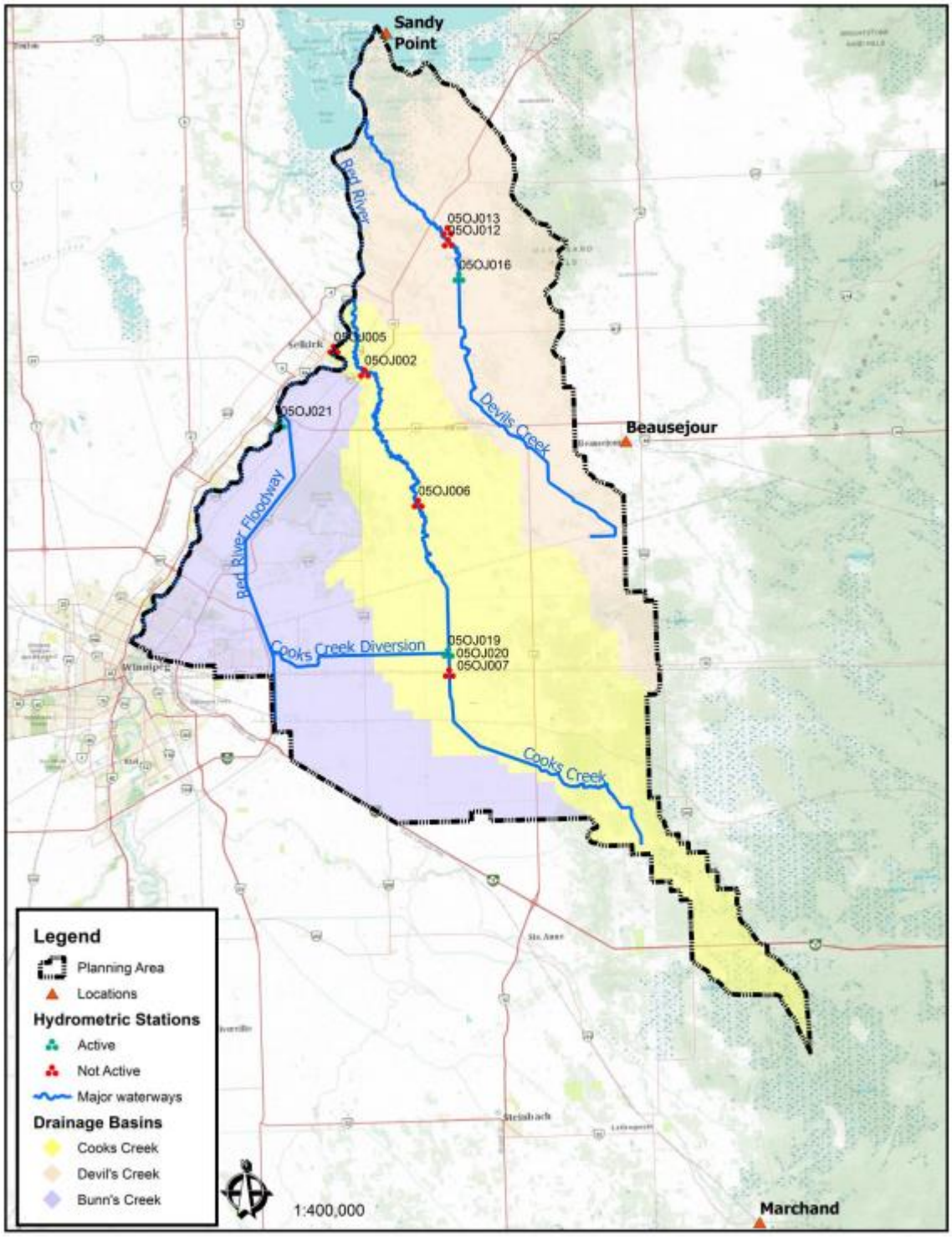

FIGURE 3.2: COOKS-DEVIL'S CREEK PLANNING AREA WITH STATION NUMBERS.

TABLE 3.1. – COOKS CREEK – 2008-2018 MEAN MONTHLY DISCHARGE

Year	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
2018	-	-	0.00	0.005	0.002	0.023	0.068	0.00	0.00	0.00	-	-
2017	-	-	1.69	3.97	0.260	0.003	0.006	0.00	0.00	0.00	-	-
2016	-	-	2.27	1.65	0.369	2.14	1.25	0.215	0.425	0.149	-	-
2015	-	-	-	0.035	1.25	0.154	1.77	3.15	1.31	0.003	-	-
2014	-	-	0.007	0.862	0.835	1.15	0.843	0.00	0.00	0.00	-	-
2013	-	-	0.00	1.00	0.784	0.517	0.00	0.00	0.00	0.00	-	-
2012	-	-	-	0.008	0.007	0.00	0.00	0.00	0.00	0.032	-	-
2011	-	-	0.594	7.56	2.09	0.940	0.007	0.00	0.00	0.00	-	-
2010	-	-	0.772	0.444	2.17	5.01	1.14	0.458	2.73	1.41	-	-
2009	-	-	-	5.46	1.71	-	-	-	-	-	-	-
2008	-	-	0.00	0.203	0.084	-	-	-	-	-	-	-
Mean*	-	-	0.465	1.91	0.964	0.877	0.661	0.483	0.366	0.197	-	-
Max	-	-	3.02	7.56	6.22	5.01	4.61	3.81	2.73	1.42	-	-
Min	-	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-

* Mean, Max and Min values are derived from data from 1990 to 2018.

FIGURE 3.3 BELOW SHOWS DAILY DISCHARGE CHARACTERISTICS FOR THE COOKS CREEK (STATION 05OJ020).

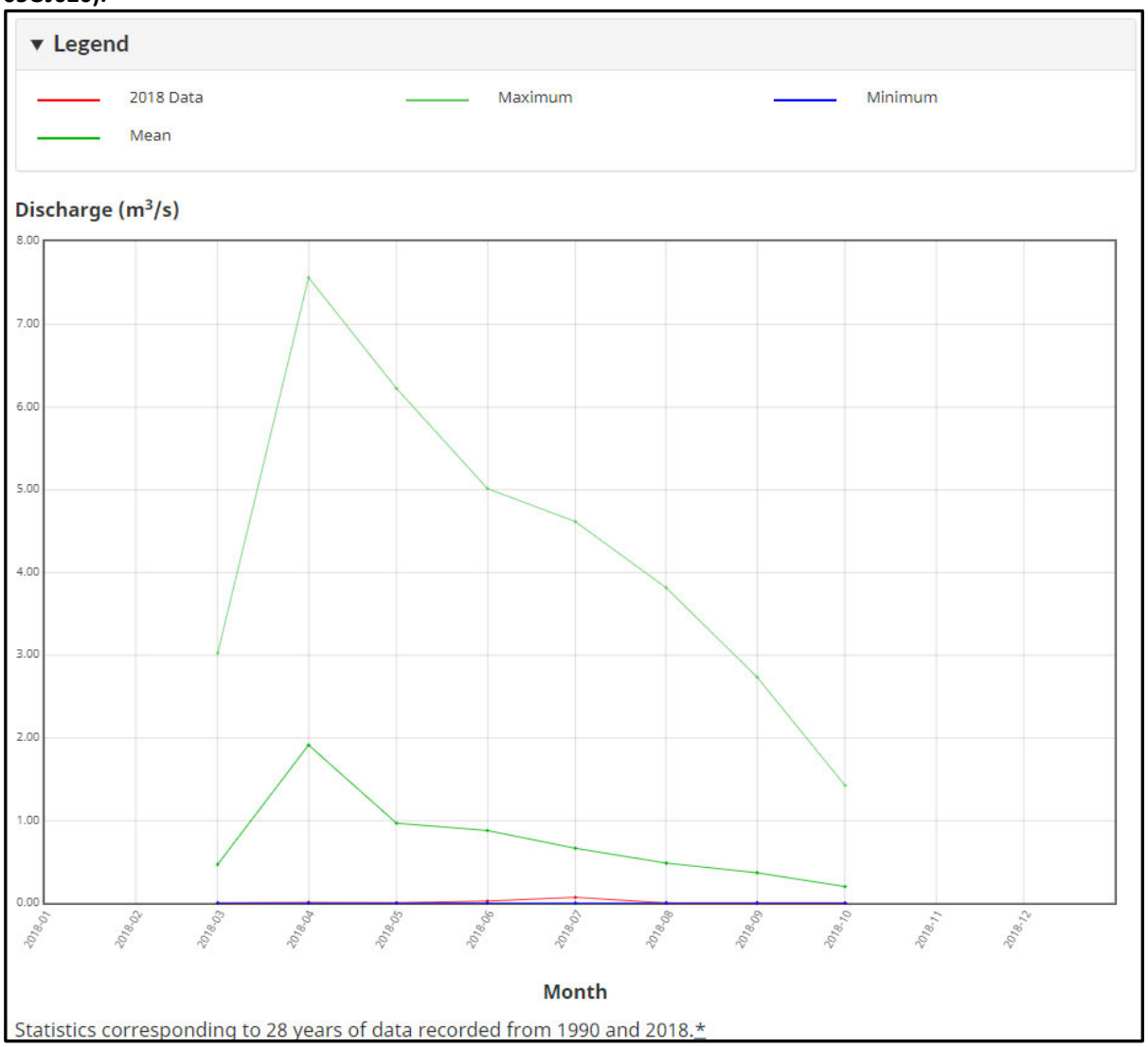

FIGURE 3.3 WATER SURVEY OF CANADA STATISTICS CORRESPONDING TO 28 YEARS OF DATA RECORDED FROM 1990 TO 2018

The projected discharge concentrate flow rate from the membrane unit is 5.6 L/s. Cooks Creek experiences seasonal mean monthly flows that range between 465 L/s in March and 877 L/s in June (Canada G. o., Daily Discharge data for Cooks Creek Diversion (05OJ020), 2018).The proposed 5.6 L/s concentrate represents 1.1 % of the flow of the Creek based on the previous 20 year mean annual data. During the months of November to February flows are not recorded as 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 pipe installed at the bottom of the creek to allow for discharge into the receiving waters (the outfall

structure design can be found in *Appendix G*). While some ice cover will surround the discharge point, open water may persist into the winter depending on flow.

The concentrate flow from the WTP will undergo significant mixing upon entering Cooks Creek. 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 Cooks Creek during average flow, discharge must be acceptable during the periods of lowest flow. Water from the Cooks Creek was sampled, and chemistry from the creek was used to determine the concentrate blend effects on the receiving body of water as shown in *Table 3.2* below. Based on the limited data for Cooks Creek, the minimum mean monthly flow during 1990-2018 was calculated to be 197 L/s (0.197 m^3/s). During the months of November to February, no flow was recorded (Canada G. o., Daily Discharge data for Cooks Creek Diversion (05OJ020), 2018).

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 East Selkirk 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	3.18 mg/L
	Water >5°C or Early Life Stages Present	4 Days	<1 in 3 years	7Q10	7.96 mg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	12.14 mg/L
	Water ≤5°C or Early Life Stages Absent	30 Days	<1 in 3 years	30Q10	5.17 mg/L
	Water ≤5°C or Early Life Stages Absent	4 Days	<1 in 3 years	7Q10	12.14 mg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	12.14 mg/L
	Early Life Stages Present	30 Days	<1 in 3 years	30Q10	3.18 mg/L
	Early Life Stages Present	4 Days	<1 in 3 years	7Q10	7.96 mg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	8.11 mg/L
	Early Life Stages Absent	30 Days	<1 in 3 years	30Q10	5.17 mg/L
	Early Life Stages Absent	4 Days	<1 in 3 years	7Q10	8.11 mg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	8.11 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	< 0.42 µg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	< 4.24 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	< 138.73 µg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	< 1066.5 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	< µg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	< 17.23 µg/L
Lead	All Periods	4 Days	<1 in 3 years	7Q10	< 5.73 µg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	< 146.99 µg/L
Nickel	All Periods	4 Days	<1 in 3 years	7Q10	< 99.38 µg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	< 894.76 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	< 225.98 µg/L
	All Periods	1 Hour	<1 in 3 years	1Q10	< 224.15 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	Units	Regulation Limit	Concentrate Discharge
Phosphorus, Total	(mg/L)	1.0	<0.030
Ammonia	(mg/L)	Site Specific	0.04
Nitrogen, Total	(mg/L)	15	<0.020
Fecal Coliform	CFU / 100 ml	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)	Cooks Creek (mg/L)	Combined Flow	Discharge Regulation Limit
Hardness CaCO3 (mg/L)	558	2790	183	212.24	
Ammonia (mg/L)	0.015	0.004	0.384	0.380	0.78
Arsenic (mg/L)	0.00013	0.00065	0.00246	0.002	0.15
Barium (mg/L)	0.0583	0.3	0.0342	0.037	
Cadmium (mg/L)	<0.0000050	0.0000355	0.0000205	0.0000206	0.00064
Calcium (mg/L)	82.7	370.55	33.7	37.479	
Chloride (mg/L)	27.6	213.34	18.9	21.081	
Chromium, Total (mg/L)	<0.0001	0.0005	0.00069	0.001	0.23067
Conductivity (µS/cm)	979	4537	410	456.29	1000

Copper	0.00156	0.0078	0.00069	0.003	0.02928
CO3 (mg/L)	<0.60	41.92	0.6	1.064	
Fluoride (mg/L)	0.237	1.14	0.139	0.150	
Iron (mg/L)	0.01	0.05	0.462	0.457	
Lead (mg/L)	0.000145	<0.000050	0.00121	0.001	0.01094
Magnesium (mg/L)	85.2	431.87	23.9	28.477	
Manganese (mg/L)	0.00047	0	0.0502	0.050	
Nickel (mg/L)	0.00119	0.00595	0.00309	0.003	
NO3 (mg/L)	7.54	37.7	0.107	0.529	10
Potassium (mg/L)	4.25	21.98	8.81	8.958	
pH	7.79	8.45	7.81	7.817	
Sodium (mg/L)	18.6	118.37	13.7	14.874	
Strontium (mg/L)	0.472	2.09	0.118	0.140	
SO4 (mg/L)	51.8	343.07	48.5	51.805	
SiO2 (mg/L)	14.15	72.03	4.72	5.475	
TDS (mg/L)	604	4368.76	242	288.295	700
Zinc (mg/L)	0.0059	0.0295	0.0088	0.009	0.3793

As observed from *Table 3.4*, none of the aforementioned parameters are in exceedance with the water guidelines.

POTENTIAL DISCHARGE TO RED RIVER

Flows on the Red River are monitored by the Water Survey of Canada at Station 05OJ005, with data up to 2019. Flow data is not recorded when ice covers the river. The Red River has a gross drainage area of 1580 km^2. For the Red River, mean monthly flows varied from 87.8 m^3/s to 1,010 m^3/s over the 2008-2019 period (87800 – 1,010,000 L/s). Mean discharge data for the Red River can be found summarized below in *Table 3.5* (Canada G. o., Daily Discharge for Red River Nat Selkirk (05OJ005), 2018)). At the increased flow rate of the Red River it is expected that the concentrate discharge will not exceed the water guidelines. Further testing will be done in the future should a change in the discharge route occur.

TABLE 3.5 – RED RIVER – 2008-2019 MEAN MONTHLY DISCHARGE

Year	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
2019	49.6	44.6	75	1150	1050	-	-	-	-	-	-	-
2018	46.2	36.9	61.4	511	488	291	201	92.4	75.9	110	85.1	64.7
2017	181	168	599	1,510	573	286	205	86.5	105	179	93.3	68.6
2016	91.6	74.0	598	590	504	631	495	340	352	285	291	239
2015	112	101	238	408	682	646	412	277	225	147	159	127

2014	73.5	56.2	55.8	750	1,030	921	1,120	534	492	288	157	141
2013	57.1	56.7	70.2	238	1,580	914	614	256	144	150	110	63.2
2012	97.7	72.9	246	272	269	273	302	133	91.8	112	81.3	79.8
2011	199	191	217	1,920	2,250	1,340	1,280	860	385	211	157	133
2010	90.6	82.8	606	1,430	637	963	538	379	593	629	662	306
2009	79.4	81.9	339	2,370	1,780	635	560	176	145	143	233	147
2008	-	-	-	-	260	396	182	150	159	316	376	123
Mean	98.0	87.8	282	1,010	925	663	537	299	252	234	219	136
Max	199	191	606	2,370	2,250	1,340	1,280	860	593	629	662	306
Min	46.2	36.9	55.8	238	260	273	182	86.5	75.9	110	81.3	63.2

**Note: all units are in m^3/s.*

Daily discharge characteristics for the Red River (Station 05OJ005) are demonstrated in *Figure 3.4* below.

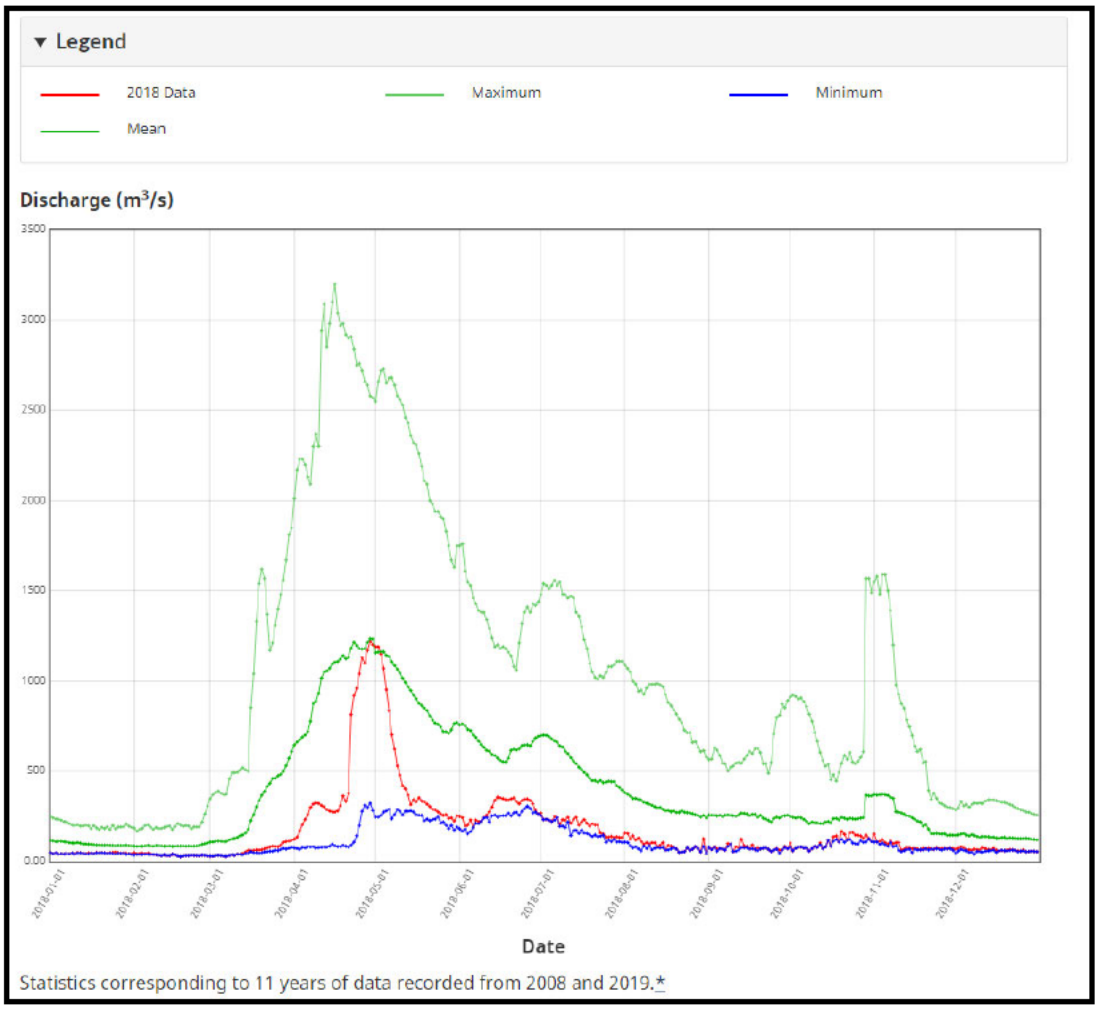

FIGURE 3.4 WATER SURVEY OF CANADA STATISTICS CORRESPONDING TO 11 YEARS OF DATA RECORDED FROM 2008 TO 2019 for RED RIVER.

3.4 Fish and Fish Habitat

Fish species found in the Cooks Creek have been provided from the Manitoba-Minnesota Transmission Project (Ltd., Manitoba-Minnesota Transmission Project: Fish and Fish Habitat Technical Data, 2015). 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.

- Fathead Minnow (*Pimephales promelas*)
- Finescale Dace (*Phoxinus neogaeus*)
- Iowa Darter (Etheostoma exile)
- Johnny Darter (*Etheostoma nigrum*)
- White Sucker (*Catostomus commersonii*)

3.5 Wildlife Habitat and Vegetation

The Village of East Selkirk and the community of Lockport are located in the Interlake Plain Ecoregion within the Boreal Plain Eco zone. The Boreal Plains Eco zone has a total area of 73,728,656 hectares consisting of 66,247,429 hectares of land and 7,301,227 hectares of fresh water. The Ecological Framework of Canada website contains information on the wildlife and vegetation within this region (Canada E. F.).

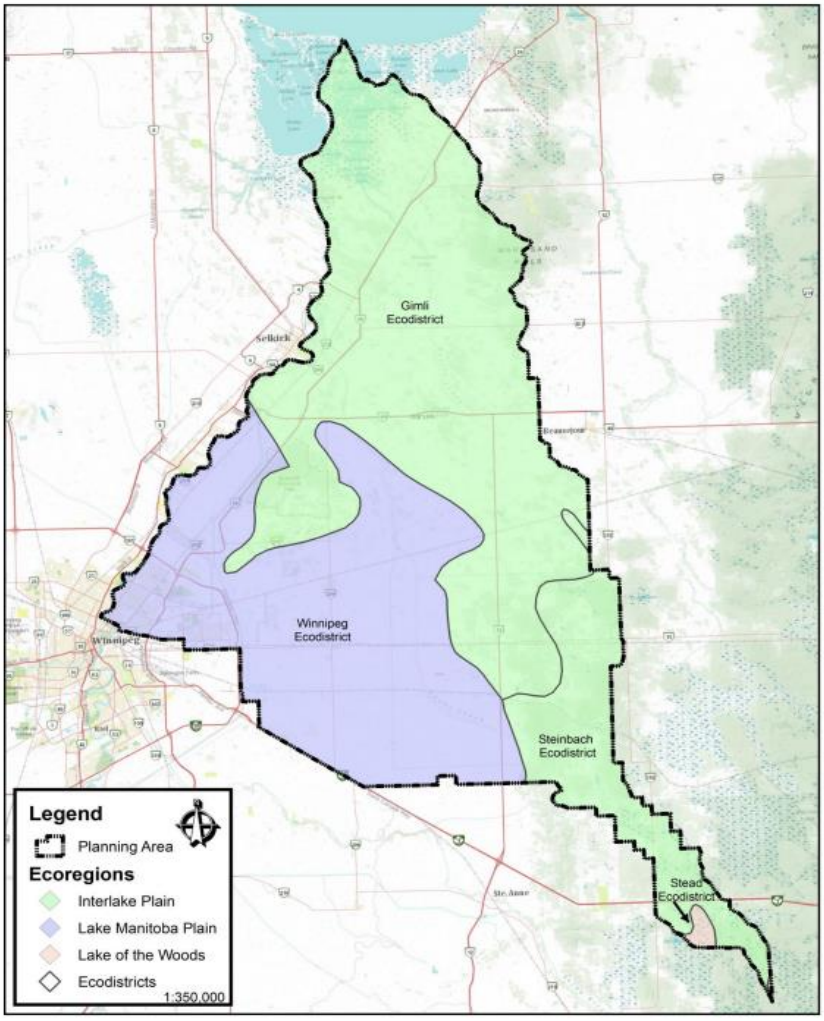

FIGURE 3.5: COOKS-DEVIL'S PLANNING AREA – ECOREGIONS AND ECODISTRICTS.

Characteristic Wildlife:

- Moose (*Alces alces*)
- Black Bear (*Ursus americanus*))
- Woodland Caribou (*Rangifer tarandus*)
- Mule Deer (*Odocoileus hemionus*)
- Elk (*Cervus canadensis manitobensis*)
- Beaver (*Castor Canadensis)*
- Gray Jay (*Perisoreus Canadensis)*
- Common Loon (Gavia immer)
- White-crowned Sparrow (*Zonotrichia leucophrys)*
- American Redstart (*Setophaga ruticilla)*
- Canada Warbler (*Cardellina Canadensis)*
- Ovenbird (*Seiurus aurocapilla)*

Characteristic Vegetation:

- Jack Pine (*Pinus banksiana*)
- White Spruce (*Picea glauca*)
- Black Spruce (*Picea mariana*)
- Balsam Fir (*Abies balsamea*)
- Tamarack (*Larix laricina*)

A one km boundary search criteria was selected for both the water treatment plant and the potential point of discharge to find the species at risk and potential concerns. *Table 3.6* shows the flora and fauna species at risk in this area. The data was requested from Wildlife and Fisheries Branch, Manitoba Conservation Data Centre.

TABLE 3.6 – SPECIES AT RISK WITHIN 1 KM BUFFER

Site	Common Name	Scientific Name	S Rank
Water treatment plant	Yellow-banded Bumble Bee	*Bombus terricola*	S3S5
Water treatment plant	Blue Cohosh	*Caulophyllum thalictroides*	S2
Water treatment plant	False Indigo	*Amorpha fruticosa*	S1S2
Water treatment plant	Leathery Grapefern	*Sceptridium multifidum*	S3
Discharge Location	Chestnut Lamprey	*Ichthyomyzon castaneus*	S3
Discharge Location	Chimney Swift	*Chaetura pelagica*	S2B
Discharge Location	Wabash Pigtoe	*Fusconaia flava*	S3
Discharge Location	Yellow-banded Bumble Bee	*Bombus terricola*	S3S5
Discharge Location	Mapleleaf Mussel	*Quadrula quadrula*	S1
Discharge Location	Blue Cohosh	*Caulophyllum thalictroides*	S2
Discharge Location	Red-rooted Flatsedge	*Cyperus erythrorhizos*	S1
Discharge Location	False Indigo	*Amorpha fruticosa*	S1S2
Discharge Location	Leathery Grapefern	*Sceptridium multifidum*	S3

3.6 Socioeconomic

The project area is located within the RM of St. Clements, the Village of East Selkirk and the Community of Lockport. East Selkirk has an area of approximately 5.35 km^2 and a population of approximately 675 (ESWTP Annual Water Treatment Report for 2019). Lockport has an area of approximately 2.48 km^2 and a population of approximately 458 on the west side of the Red River and 288 present on the east side of the Red River (Canada G. o., Statistics Canada, 2016). The RM of St. Clements had a population of 10,876 in the 2016 Census with a 3.5% 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 owned property 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 Cooks Creek, 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

An amendment to the existing WRL will be applied for in the short term to increase instantaneous withdrawal rates, further investigation for additional annual withdrawal will require a new WRL and Class 2 EAP.

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 and provincial 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 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 East Selkirk and Lockport due to the costs of developing the water system; however, the RM of St. Clements will have a sustainable potable water supply to meet future demands of the growing municipality. There will be some local economic benefit during construction. The proposed project will address the issue of hard water which increases fixture replacement for East Selkirk and provide a sustainable, treated water supply to the Community of Lockport. . 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 East Selkirk and Lockport. 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.

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 Climate will be notified through the emergency response line and appropriate measures will be taken according to Manitoba Conservation and Climate 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.

They will conduct monitoring as per the issued Environmental Act License.

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 will follow the requirements of the Environment Act License, if granted.

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*, 0.015 mg/L total ammonia is present in the raw water. Through the membrane treatment process the

concentration of total ammonia is 0.004 mg/L. With a pH of 8.45 in the concentrate water, the recommended acceptable level of total ammonia in the discharge is below 1.09 mg/L at 5°C. The level of total ammonia in the concentrate discharge will be below the acceptable level and is not anticipated to change significantly.

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 East Selkirk and Lockport. 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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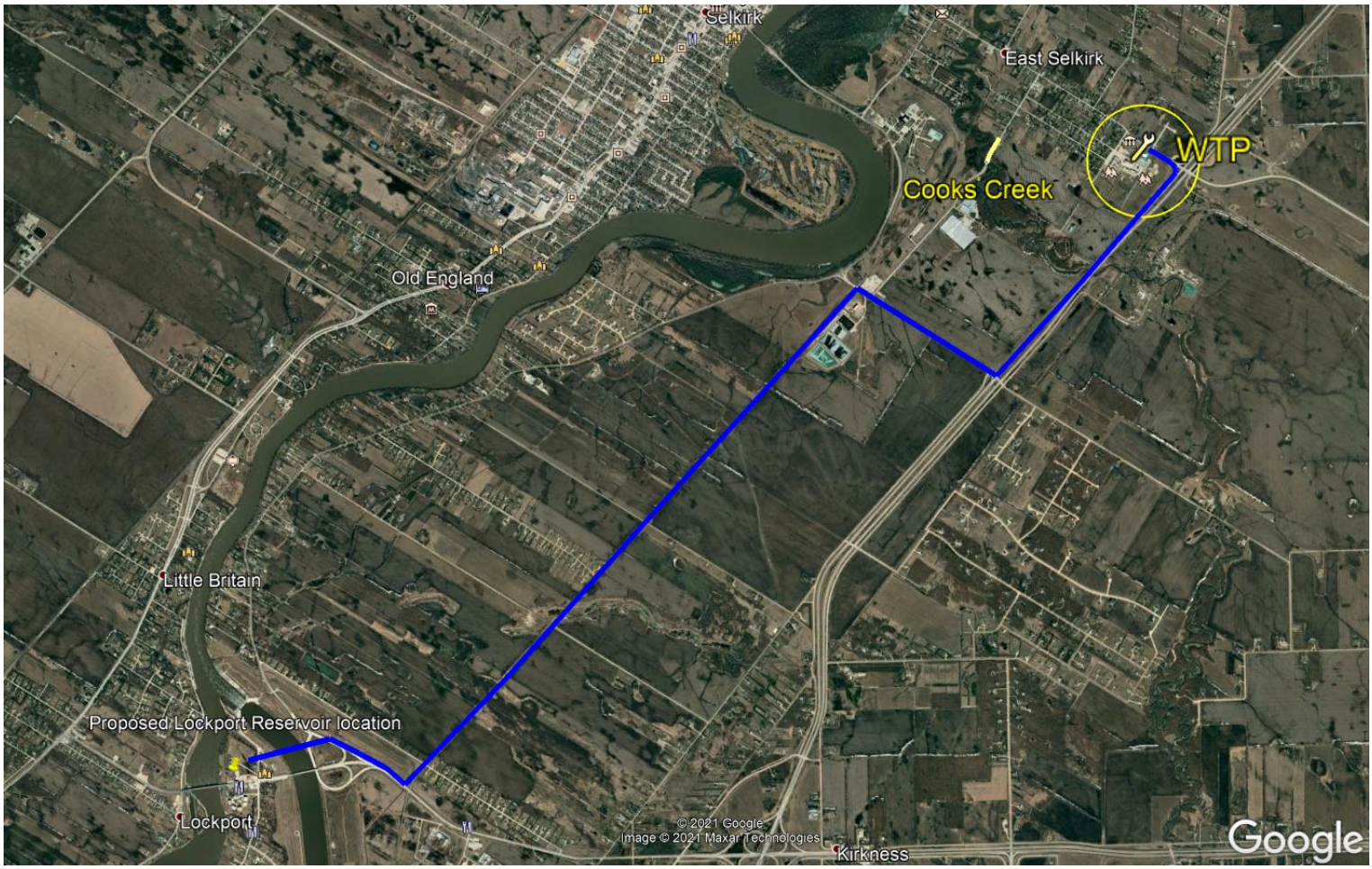
WSP. (2020). *RM of St. Clements East Selkirk Water Treatment Plant Expansion.* Selkirk: WSP.

Appendix A

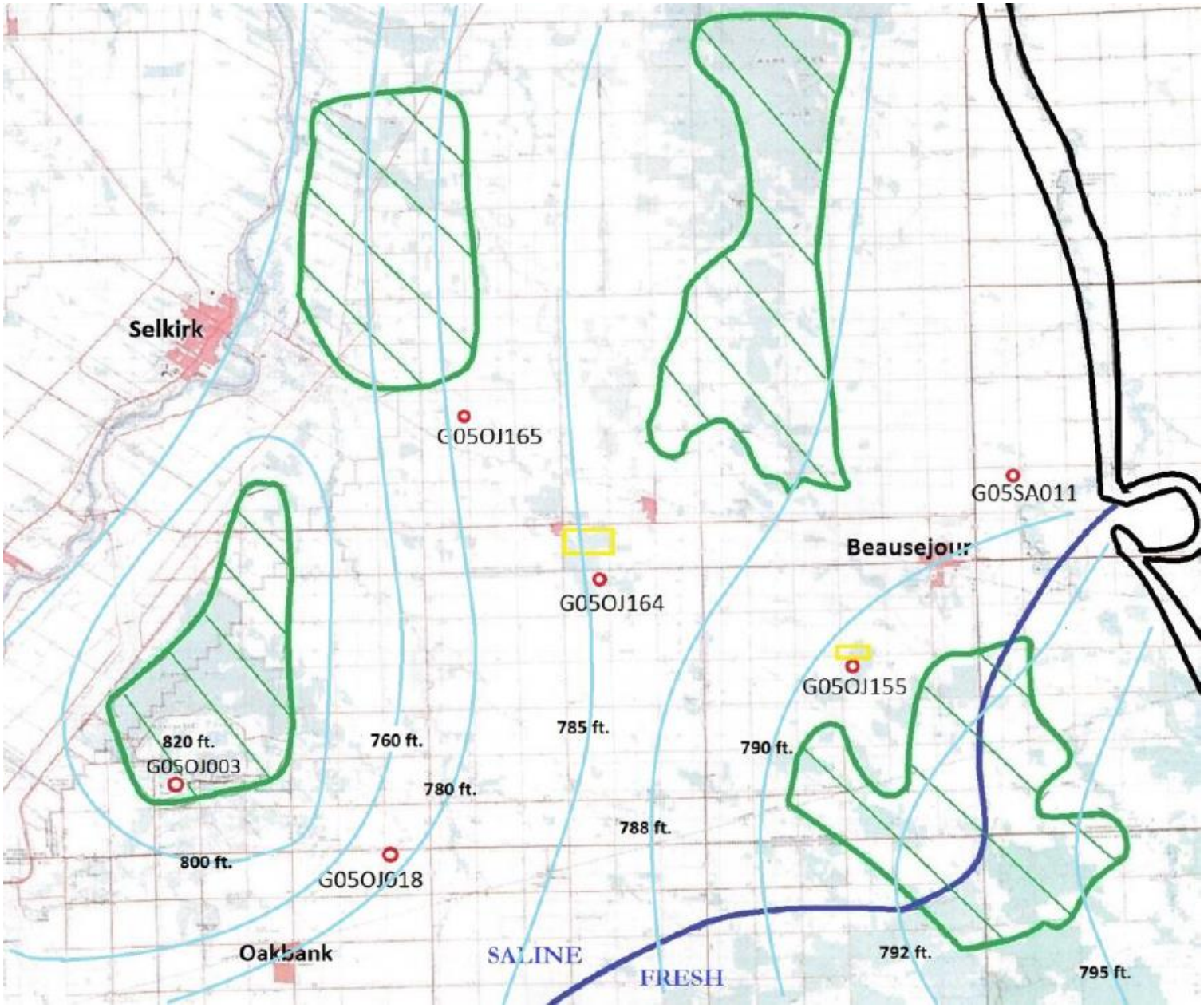
Proposed Lockport Pipeline Route



PROPOSED PIPELINE TO LOCKPORT RESERVOIR LOCATION

Appendix B

Hydrogeology of the East Selkirk Area



HYDROGEOLOGY OF SELKIRK-EAST SELKIRK - BEASEJOUR 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 Purposes

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

Project: Community of East Selkirk

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

Licence No.: **2017-147**
(Previous Lic. No.: 2012-160)
U.T.M.: Zone 14 655626 E
5555499 N

Subject to the terms and conditions contained in this Licence, the Minister of Sustainable Development authorizes:

The Rural Municipality of St. Clements in the Province of Manitoba (the "LICENSEE") to construct, operate, establish and maintain a project consisting of water well(s), pump(s), transmittal pipeline(s) and other works specific to the type of use (the "WORKS") and divert water from a **fractured limestone** aquifer located on the following land:

River Lot 073, Parish of St. Clements

as more particularly located and shown on the attached Exhibit "A" for **municipal** purposes on the following lands:

Community of East Selkirk

This licence is issued upon the express condition that it shall be subject to the provisions of The Water Rights Act and Regulation 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** 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 **0.013 cubic metres per second (0.5 cubic feet per second)** .

   b) The total quantity of water diverted in any one year shall not exceed **199 cubic decametres (161.33 acre feet)** .
4. Water shall not be diverted during any period when the water level in the aquifer as measured at:

   a) Well No. 1 is more than 30.48 metres (100.0 feet) beneath the surface of the ground.
   b) Well No. 2 is more than 27.13 metres (89.0 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** 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 Water Use Licensing Section 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. This Licence may be amended, suspended or cancelled by the Minister in accordance with The Water Rights Act by letter addressed to the LICENSEE at **Box 2, Group 35, R.R. 1, East Selkirk, MB, R0E 0M0, 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 **ten (10) years** and this Licence shall become effective only on the date of execution hereof by a person so authorized in the Department of Sustainable Development. 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 Water Use Licensing Section 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.

Page 1 of 2

15. The LICENSEE does hereby agree to correct, to the satisfaction of the Minister, any water supply problems to wells or other forms of supply, which were constructed and operating prior to the date of the original application for the project and 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 22 day of JANUARY 20 18.

SIGNED, SEALED AND DELIVERED in the presence of:

X _____ } Witness

X [redacted] (Seal)
Licensee

_____ } Witness (Print name)

[redacted]
Licensee (Print name)

FOR OFFICE USE ONLY

Issued at the City of Winnipeg, in the Province of Manitoba, this 29th day of January A.D. 20 18.

[redacted]
The Honourable the Minister of Sustainable Development (or her/his designate)

ence No.2017-147

Page 2 of 2

Appendix D

Raw & Treated Water Quality Analysis

RM of St. Clements
ATTN: KEVIN GRABOWSKI
1043 Kitson Road, Box 2, Group 35, RR1
East Selkirk MB R0E 0M0

Date Received: 24-MAR-21
Report Date: 31-MAR-21 13:30 (MT)
Version: FINAL

Client Phone: 204-482-3300

Certificate of Analysis

Lab Work Order #: L2570031
Project P.O. #: NOT SUBMITTED
Job Reference: EAST SELKIRK OUTFALL
C of C Numbers:
Legal Site Desc:

[redacted]
Hua Wo
Chemistry Laboratory Manager

ADDRESS: 1329 Niakwa Road East, Unit 12, Winnipeg, MB R2J 3T4 Canada | Phone: +1 204 255 9720 | Fax: +1 204 255 9721
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EAST SELKIRK OUTFALL

L2570031 CONTD....
PAGE 2 of 6
Version: FINAL

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2570031-1 BR306669							
Sampled By: CLIENT on 24-MAR-21 @ 10:00							
Matrix: WATER							
MB Conservation test 72D							
Alkalinity, Bicarbonate							
Bicarbonate (HCO3)	168		1.2	mg/L		26-MAR-21	
Alkalinity, Carbonate							
Carbonate (CO3)	<0.60		0.60	mg/L		26-MAR-21	
Alkalinity, Hydroxide							
Hydroxide (OH)	<0.34		0.34	mg/L		26-MAR-21	
Alkalinity, Total (as CaCO3)							
Alkalinity, Total (as CaCO3)	138		1.0	mg/L		25-MAR-21	R5414784
Ammonia by colour							
Ammonia, Total (as N)	0.384		0.010	mg/L		25-MAR-21	R5415473
Chloride in Water by IC							
Chloride (Cl)	18.9		0.50	mg/L		24-MAR-21	R5415256
Colour, True							
Colour, True	58.7		5.0	CU		25-MAR-21	R5415594
Conductivity							
Conductivity	410		1.0	umhos/cm		25-MAR-21	R5414784
Fluoride in Water by IC							
Fluoride (F)	0.139		0.020	mg/L		24-MAR-21	R5415256
Hardness Calculated							
Hardness (as CaCO3)	183	HTC	0.20	mg/L		29-MAR-21	
Ion Balance Calculation							
Cation - Anion Balance	1.2			%		29-MAR-21	
Anion Sum	4.39			me/L		29-MAR-21	
Cation Sum	4.50			me/L		29-MAR-21	
Langelier Index 4C							
Langelier Index (4 C)	-0.19					29-MAR-21	
Langelier Index 60C							
Langelier Index (60 C)	0.58					29-MAR-21	
Nitrate in Water by IC							
Nitrate (as N)	1.06		0.020	mg/L		24-MAR-21	R5415256
Nitrate+Nitrite							
Nitrate and Nitrite as N	1.17		0.070	mg/L		25-MAR-21	
Nitrite in Water by IC							
Nitrite (as N)	0.107		0.010	mg/L		24-MAR-21	R5415256
Sulfate in Water by IC							
Sulfate (SO4)	48.5		0.30	mg/L		24-MAR-21	R5415256
Total Carbon by Calculation							
Total Carbon	40.3		1.0	mg/L		30-MAR-21	
Total Dissolved Solids (TDS)							
Total Dissolved Solids	242		20	mg/L		26-MAR-21	R5417725
Total Inorganic Carbon by Combustion							
Total Inorganic Carbon	28.5		0.50	mg/L		24-MAR-21	R5416658
Total Kjeldahl Nitrogen							
Total Kjeldahl Nitrogen	1.54		0.20	mg/L	30-MAR-21	31-MAR-21	R5417797
Total Metals in Water by CRC ICPMS							
Aluminum (Al)-Total	0.397		0.0030	mg/L	26-MAR-21	26-MAR-21	R5416402
Antimony (Sb)-Total	0.00014		0.00010	mg/L	26-MAR-21	26-MAR-21	R5416402
Arsenic (As)-Total	0.00246		0.00010	mg/L	26-MAR-21	26-MAR-21	R5416402
Barium (Ba)-Total	0.0342		0.00010	mg/L	26-MAR-21	26-MAR-21	R5416402
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	26-MAR-21	26-MAR-21	R5416402
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	26-MAR-21	26-MAR-21	R5416402
Boron (B)-Total	0.047		0.010	mg/L	26-MAR-21	26-MAR-21	R5416402

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

EAST SELKIRK OUTFALL

L2570031 CONTD....
PAGE 3 of 6
Version: FINAL

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2570031-1 BR306669							
Sampled By: CLIENT on 24-MAR-21 @ 10:00							
Matrix: WATER							
Total Metals in Water by CRC ICPMS							
Cadmium (Cd)-Total	0.0000205		0.0000050	mg/L	26-MAR-21	26-MAR-21	R5416402
Calcium (Ca)-Total	33.7		0.050	mg/L	26-MAR-21	26-MAR-21	R5416402
Cesium (Cs)-Total	0.000044		0.000010	mg/L	26-MAR-21	26-MAR-21	R5416402
Chromium (Cr)-Total	0.00069		0.00010	mg/L	26-MAR-21	26-MAR-21	R5416402
Cobalt (Co)-Total	0.00052		0.00010	mg/L	26-MAR-21	26-MAR-21	R5416402
Copper (Cu)-Total	0.00281		0.00050	mg/L	26-MAR-21	26-MAR-21	R5416402
Iron (Fe)-Total	0.462		0.010	mg/L	26-MAR-21	26-MAR-21	R5416402
Lead (Pb)-Total	0.00121		0.000050	mg/L	26-MAR-21	26-MAR-21	R5416402
Lithium (Li)-Total	0.0231		0.0010	mg/L	26-MAR-21	26-MAR-21	R5416402
Magnesium (Mg)-Total	23.9		0.0050	mg/L	26-MAR-21	26-MAR-21	R5416402
Manganese (Mn)-Total	0.0502		0.00010	mg/L	26-MAR-21	26-MAR-21	R5416402
Molybdenum (Mo)-Total	0.00178		0.000050	mg/L	26-MAR-21	26-MAR-21	R5416402
Nickel (Ni)-Total	0.00309		0.00050	mg/L	26-MAR-21	26-MAR-21	R5416402
Potassium (K)-Total	8.81		0.050	mg/L	26-MAR-21	26-MAR-21	R5416402
Phosphorus (P)-Total	0.343		0.030	mg/L	26-MAR-21	26-MAR-21	R5416402
Rubidium (Rb)-Total	0.00225		0.00020	mg/L	26-MAR-21	26-MAR-21	R5416402
Selenium (Se)-Total	0.000296		0.000050	mg/L	26-MAR-21	26-MAR-21	R5416402
Silicon (Si)-Total	4.72		0.10	mg/L	26-MAR-21	26-MAR-21	R5416402
Silver (Ag)-Total	<0.000010		0.000010	mg/L	26-MAR-21	26-MAR-21	R5416402
Sodium (Na)-Total	13.7		0.050	mg/L	26-MAR-21	26-MAR-21	R5416402
Strontium (Sr)-Total	0.118		0.00020	mg/L	26-MAR-21	26-MAR-21	R5416402
Sulfur (S)-Total	16.8		0.50	mg/L	26-MAR-21	26-MAR-21	R5416402
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	26-MAR-21	26-MAR-21	R5416402
Thallium (Tl)-Total	<0.000010		0.000010	mg/L	26-MAR-21	26-MAR-21	R5416402
Thorium (Th)-Total	<0.00010		0.00010	mg/L	26-MAR-21	26-MAR-21	R5416402
Tin (Sn)-Total	<0.00010		0.00010	mg/L	26-MAR-21	26-MAR-21	R5416402
Titanium (Ti)-Total	0.0133		0.00030	mg/L	26-MAR-21	26-MAR-21	R5416402
Tungsten (W)-Total	<0.00010		0.00010	mg/L	26-MAR-21	26-MAR-21	R5416402
Uranium (U)-Total	0.00341		0.000010	mg/L	26-MAR-21	26-MAR-21	R5416402
Vanadium (V)-Total	0.00326		0.00050	mg/L	26-MAR-21	26-MAR-21	R5416402
Zinc (Zn)-Total	0.0088		0.0030	mg/L	26-MAR-21	26-MAR-21	R5416402
Zirconium (Zr)-Total	0.00067		0.00020	mg/L	26-MAR-21	26-MAR-21	R5416402
Total Organic Carbon by Combustion							
Total Organic Carbon	11.8		0.50	mg/L		27-MAR-21	R5416423
Turbidity							
Turbidity	10.7		0.10	NTU		25-MAR-21	R5415431
UV Transmittance (Calculated)							
Transmittance, UV (254 nm)	43.7		1.0	%T/cm		25-MAR-21	R5415607
pH							
pH	7.81		0.10	pH units		25-MAR-21	R5414784

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

PAGE 4 of 6
Version: FINAL

Reference Information

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.			
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			
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.			
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.			
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.			
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.			
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.			
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.			
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.			
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.			
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.			
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.			
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)			

EAST SELKIRK OUTFALL

L2570031 CONTD....
PAGE 5 of 6
Version: FINAL

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

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.

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.

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:

Laboratory Definition Code	Laboratory Location
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

EAST SELKIRK OUTFALL

L2570031 CONTD....
PAGE 6 of 6
Version: FINAL

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

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.

Appendix E

Membrane Treatment System Projection

SUEZ Water Technologies & Solutions

Winflows Version 4.02 **DataBase Version 4.00**

Input Data Summary

Project Information

Project Name	4216658 (St Clements) SuezWinflow Well 1 - 6-4_6e 80 pct v001 (2021-03-16)
Engineer	
Location	
Mail ID	
Phone No.	
Comments	

Flowsheet Configuaration

Flowsheet Type	Single Pass Flowsheet	Feed Dosing	No
AfterFeed Dosing	No	Product Dosing 1	No
Product Dosing 2	Yes	Feed Stripping	No
Product Stripping	No	Raw Feed Bypass	Yes

Feed Information

Temperature, °C	5	RO-1:	5
Feed pH	8.18	Silt Density Index:	1

Feed Stream Composition(mg/l): Source -

Calcium (Ca)	76.70	**Sulfate (SO4)**	68.90
Magnesium (Mg)	89.30	**Chloride (Cl)**	44.09
Sodium (Na)	24.70	**Fluoride (F)**	0.24
Potassium (K)	4.59	**Nitrate (NO3)**	19.62
Ammonia - N (NH4)	0.01	**Bromide (Br)**	0.04
Barium (Ba)	0.06	**Phosphate (PO4)**	0.00
Strontium (Sr)	0.43	**Boron (B)**	0.09
Iron (Fe)	0.01	**Silica (SiO2)**	14.80
Manganese (Mn)	0.00	**Hydrogen Sulfide (H2S)**	0.00
		Bicarbonate (HCO3)	564.59
		Carbon Dioxide (CO2)	7.54
		Carbonate (CO3)	3.49

Flow Rate Specifications

Product Flow:		206.00 gpm		
Recovery %	RO1	80		
Feed ByPass	27.99999900 68972	gpm	RO1 to RO1 Recycle	10.00000017 gpm 25261

First Pass Array Data

					Pre-stage Pressure Change, psi		Permeate Pressure	Annual Change %	
Stage	Housing	Element	Element Type	Element Age (yr)	Boost	Drop	psi	A-Value	B-Value
1	6	6	AK8040F 400	0	0.00	0.00	0.00	3	5
2	4	6	AK8040F 400	0	0.00	0.00	0.00	3	5

Dosing Specification

Product Dosing 2 to 8 pH using Sodium Hydroxide

Page 1 of 9

SUEZ Water Technologies & Solutions

Winflows Version 4.02 DataBase Version 4.00

Results Summary

Flow Data	gpm	Analytical Data	mg/l
Raw Feed	250.50	Raw Feed TDS	911.66
Product	206.09	Product TDS	161.59
Concentrate	44.41	Concentrate TDS	4368.76

System Data **Single Pass Design**

Temperature: °C RO-1: 5 System Rec. 82.3%

Average Flux (gfd), Pass and Stage

Pass	Average	Stage 1	Stage 2
Pass 1	10.69	11.76	9.08

Array Data Pass 1

Recovery %: 76.6 Conc. TDS(mg/l): 4368.76 Conc. Flow: 54.41 gpm

Stage	Total Housing	Total Element	Element Type	Flow, gpm Feed	Flow, gpm Perm	Pressure psi Feed	Pressure psi DP	Perm TDS mg/l
1	6	36	AK8040F 400	232.50	117.59	109.96	14.08	26.00
2	4	24	AK8040F 400	114.91	60.50	95.88	8.53	76.57
Total	10	60						

Analytical Data

	mg/l					mg/l	
Cation	Product	Feed	Conc	Anion	Product	Feed	Conc
Ca	13.38	89.34	370.55	SO4	9.82	80.69	343.07
Mg	15.48	104.03	431.87	Cl	7.62	51.37	213.34
Na	4.52	28.73	118.37	F	0.04	0.27	1.14
K	0.84	5.34	21.98	NO3	6.33	22.27	81.29
NH4	0.00	0.01	0.04	Br	0.01	0.05	0.21
Ba	0.01	0.07	0.30	PO4	0.00	0.00	0.00
Sr	0.08	0.50	2.09	B	0.08	0.09	0.12
Fe	0.00	0.01	0.05	SiO2	3.56	17.04	66.96
Mn	0.00	0.00	0.00	H2S	0.00	0.00	0.00
TDS mg/l	161.59	1060.78	4368.76	HCO3	99.75	656.21	2675.47
pH	7.38	8.24	8.45	CO2	9.31	7.61	16.11
				CO3	0.08	4.74	41.92
Saturation Data							
BaSO4 %	15.99	169.78	876.42	CaF2 %	0.01	0.69	27.40
CaSO4 %	0.16	2.01	11.99	SiO2 %	3.88	18.45	72.03
SrSO4 %	0.08	0.74	3.58	LSI	-1.14	1.08	2.07
Struvite %	0.00	0.00	0.00	Pi psi	1.15	6.72	26.54

Design Error(s) and Warning(s)

WARNING!! High LSI. LSI > 0.0. Concentrate CaCO3 exceeds saturation in RO1 Conc.
WARNING!! High SDSI. SDSI > 0.0. Concentrate CaCO3 exceeds saturation in RO1 Conc.
WARNING!! Concentrate BaSO4 exceeds saturation in RO1 Conc.

Disclaimer This projection is provided as a complimentary service and does not constitute a performance warranty.

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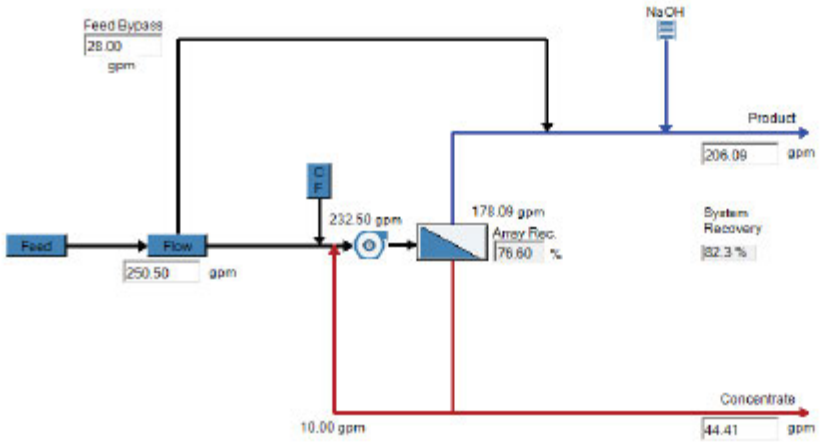
Winflows Version 4.02 **DataBase Version 4.00**

Process Data Sheet



Flow Data	gpm	Analytical Data	mg/l
Raw Feed	250.50	Raw Feed TDS	911.66
Product	206.09	Product TDS	161.59
Concentrate	44.41	Concentrate TDS	4368.76

System Data		Single Pass Design
Temperature: °C	RO-1:	5

		Pass 1	Pass 2	Pass 3
Feed Flow to 1st Stage Housing	gpm	232.50		
Feed Pressure	psi	109.96		
Array Recovery	%	76.6		
Permeate Flow	gpm	178.09		
Split Permeate Flow	gpm	0.00		

Pump Summary

Main Pump			Pass 1	Pass 2	Pass 3
	Feed Flow	gpm	232.50		
	Inlet Pressure	psi	0.00		
	Discharge Pressure	psi	109.96		
	Total Efficiency	%	64.90		
	Power	kW	17.14		

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Winflows Version 4.02 **DataBase Version 4.00**

Streams Analytical Data

Ions, mg/l		Total Feed	Feed Bypass	RO1 Feed	Final RO Permeater
Calcium		76.70	76.70	89.34	3.42
Magnesium		89.30	89.30	104.03	3.87
Sodium		24.70	24.70	28.73	1.34
Potassium		4.59	4.59	5.34	0.25
Ammonia - N (NH4)		0.01	0.01	0.01	0.00
Barium		0.06	0.06	0.07	0.00
Strontium		0.43	0.43	0.50	0.02
Iron		0.01	0.01	0.01	0.00
Manganese		0.00	0.00	0.00	0.00
Sulfate		68.90	68.90	80.69	0.53
Chloride		44.09	44.09	51.37	1.88
Fluoride		0.24	0.24	0.27	0.01
Nitrate		19.62	19.62	22.27	4.24
Bromide		0.04	0.04	0.05	0.00
Phosphate		0.00	0.00	0.00	0.00
Boron		0.08	0.08	0.09	0.08
Silica		14.80	14.80	17.04	1.79
Hydrogen Sulfide		0.00	0.00	0.00	0.00
Bicarbonate		564.59	564.59	656.21	25.72
Carbon Dioxide		7.54	7.54	7.61	9.93
Carbonate		3.49	3.49	4.74	0.00
TDS, mg/l		911.66	911.66	1060.78	43.18
Flow	gpm	250.50	28.00	232.50	178.09
Temperature	°C	5.00	5.00	5.00	5.00
Pressure	psi	0.00	0.00	109.96	0.00
Osm. Pressure	psi	5.81	5.81	6.72	0.37
pH		8.18	8.18	8.24	6.77
Conductivity at 25C	µS/cm	1111.00	1111.00	1276.00	59.00
Saturation Data					
BaSO4	%	142.00	142.00	169.78	0.73
CaF2	%	0.47	0.47	0.69	0.00
CaSO4	%	1.66	1.66	2.01	0.01
SiO2	%	16.04	16.04	18.45	1.85
SrSO4	%	0.62	0.62	0.74	0.00
Struvite	%	0.00	0.00	0.00	0.00
LSI		0.92	0.92	1.08	-2.76
S&DI		0.61	0.61	0.80	-3.45

Ions, mg/l		Product	Concentrate	Product Dosed 2
Calcium		13.38	370.55	13.38
Magnesium		15.48	431.87	15.48
Sodium		4.52	118.37	8.24
Potassium		0.84	21.98	0.84
Ammonia - N (NH4)		0.00	0.04	0.00
Barium		0.01	0.30	0.01
Strontium		0.08	2.09	0.08
Iron		0.00	0.05	0.00
Manganese		0.00	0.00	0.00
Sulfate		9.82	343.07	9.82
Chloride		7.62	213.34	7.62
Fluoride		0.04	1.14	0.04
Nitrate		6.33	81.29	6.33
Bromide		0.01	0.21	0.01
Phosphate		0.00	0.00	0.00
Boron		0.08	0.12	0.08
Silica		3.56	66.96	3.56
Hydrogen Sulfide		0.00	0.00	0.00
Bicarbonate		99.75	2675.47	109.02
Carbon Dioxide		9.31	16.11	2.42
Carbonate		0.08	41.92	0.36
TDS, mg/l		161.59	4368.76	174.86
Flow	gpm	206.09	44.41	206.09
Temperature	°C	5.00	5.00	5.00
Pressure	psi	0.00	87.35	0.00
Osm. Pressure	psi	1.15	26.54	1.20
pH		7.38	8.45	8.00
Conductivity at 25C	µS/cm	219.00	4537.00	234.00
Saturation Data				
BaSO4	%	15.99	876.42	15.31
CaF2	%	0.01	27.40	0.00
CaSO4	%	0.16	11.99	0.15
SiO2	%	3.88	72.03	3.87
SrSO4	%	0.08	3.58	0.07
Struvite	%	0.00	0.00	0.00
LSI		-1.14	2.07	-0.52
S&DI		-1.68	2.12	-1.01

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Stage Permeate Data RO 1

Permeate, mg/l		RO 1 Stage 1	RO 1 Stage 2
Calcium		2.04	6.11
Magnesium		2.32	6.89
Sodium		0.80	2.39
Potassium		0.15	0.45
Ammonia - N (NH4)		0.00	0.00
Barium		0.00	0.00
Strontium		0.01	0.03
Iron		0.00	0.00
Manganese		0.00	0.00
Sulfate		0.34	0.90
Chloride		1.07	3.46
Fluoride		0.01	0.02
Nitrate		2.58	7.47
Bromide		0.00	0.00
Phosphate		0.00	0.00
Boron		0.07	0.09
Silica		1.18	2.98
Hydrogen Sulfide		0.00	0.00
Bicarbonate		15.41	45.77
Carbon Dioxide		8.61	12.49
Carbonate		0.00	0.01
TDS	mg/l	26.00	76.57
Flow	gpm	117.59	60.50
Temperature	°C	5.00	5.00
Pressure	psi	0.00	0.00
Osm. Pressure	psi	0.25	0.62
pH		6.47	6.78
Conductivity at 25C	µS/cm	36	104

Page 7 of 9

SUEZ Water Technologies & Solutions

Winflows Version 4.02 **DataBase Version 4.00**

Element detail Data

Element By Element Data

Pass 1 Stage 1	Elem 1	Elem 2	Elem 3	Elem 4	Elem 5	Elem 6
Flow, gpm						
Feed	38.75	35.16	31.71	28.40	25.20	22.12
Perm	3.59	3.44	3.32	3.20	3.08	2.96
Pressure, psi						
Feed	109.96	106.50	103.55	101.06	98.97	97.26
Net Driving	100.34	96.35	92.68	89.24	85.94	82.63
Delta P	3.45	2.95	2.50	2.08	1.71	1.38
Feed Osm. Press	6.72	7.37	8.12	9.02	10.10	11.43
Other						
Recovery, %	9.27	9.80	10.46	11.27	12.23	13.41
Beta (Conc. Pol.)	1.13	1.16	1.16	1.16	1.17	1.18
Flux, gfd	12.90	12.41	11.95	11.52	11.11	10.69
A-Value, µm/(s-MPa)	8.80	8.81	8.82	8.83	8.84	8.85
Permeate Ions, mg/l						
Calcium	1.29	1.52	1.79	2.13	2.58	3.16
Magnesium	1.47	1.73	2.04	2.43	2.93	3.59
Sodium	0.51	0.60	0.71	0.84	1.01	1.24
Potassium	0.10	0.11	0.13	0.16	0.19	0.23
Ammonia - N (NH4)	0.00	0.00	0.00	0.00	0.00	0.00
Barium	0.00	0.00	0.00	0.00	0.00	0.00
Strontium	0.01	0.01	0.01	0.01	0.01	0.02
Iron	0.00	0.00	0.00	0.00	0.00	0.00
Manganese	0.00	0.00	0.00	0.00	0.00	0.00
Sulfate	0.23	0.26	0.30	0.36	0.42	0.51
Chloride	0.66	0.78	0.93	1.12	1.37	1.71
Fluoride	0.00	0.00	0.01	0.01	0.01	0.01
Nitrate	1.64	1.93	2.27	2.71	3.26	3.99
Bromide	0.00	0.00	0.00	0.00	0.00	0.00
Phosphate	0.00	0.00	0.00	0.00	0.00	0.00
Boron	0.07	0.07	0.07	0.07	0.08	0.08
Silica	0.81	0.93	1.07	1.24	1.45	1.72
Hydrogen Sulfide	0.00	0.00	0.00	0.00	0.00	0.00
Bicarbonate	9.81	11.51	13.57	16.14	19.45	23.83
Carbon Dioxide	7.71	7.99	8.33	8.75	9.26	9.91
Carbonate	0.00	0.00	0.00	0.00	0.00	0.00
TDS, mg/l	16.60	19.46	22.91	27.22	32.76	40.09
pH	6.47	6.52	6.58	6.63	6.68	6.74
Conductivity at 25C, µS/cm	23.00	27.00	31.00	37.00	45.00	55.00
Saturation Data						
BaSO4, %	0.27	0.32	0.38	0.46	0.56	0.69
CaF2, %	0.00	0.00	0.00	0.00	0.00	0.00
CaSO4, %	0.00	0.00	0.00	0.00	0.00	0.01
SiO2, %	0.78	0.91	1.06	1.24	1.47	1.76
SrSO4, %	0.00	0.00	0.00	0.00	0.00	0.00
Struvite, %	0.00	0.00	0.00	0.00	0.00	0.00
LSI	-3.95	-3.72	-3.50	-3.29	-3.07	-2.85
S&DI	-4.60	-4.41	-4.21	-4.01	-3.79	-3.55

Page 8 of 9

Element By Element Data						
Pass 1 Stage 2	Elem 1	Elem 2	Elem 3	Elem 4	Elem 5	Elem 6
Flow, gpm						
Feed	28.73	25.87	23.14	20.54	18.08	15.76
Perm	2.86	2.73	2.60	2.46	2.32	2.16
Pressure, psi						
Feed	95.88	93.73	91.92	90.41	89.17	88.15
Net Driving	79.56	75.93	72.32	68.62	64.67	60.36
Delta P	2.14	1.81	1.51	1.25	1.01	0.81
Feed Osm. Press	13.10	14.46	16.07	17.99	20.30	23.09
Other						
Recovery, %	9.95	10.55	11.23	12.00	12.84	13.71
Beta (Conc. Pol.)	1.14	1.15	1.15	1.15	1.16	1.16
Flux, gfd	10.30	9.84	9.38	8.91	8.40	7.84
A-Value, µm/(s-MPa)	8.86	8.87	8.88	8.88	8.89	8.89
Permeate Ions, mg/l						
Calcium	3.69	4.39	5.28	6.43	7.98	10.11
Magnesium	4.19	4.97	5.97	7.26	8.98	11.33
Sodium	1.45	1.72	2.07	2.51	3.11	3.93
Potassium	0.27	0.32	0.39	0.47	0.58	0.73
Ammonia - N (NH4)	0.00	0.00	0.00	0.00	0.00	0.00
Barium	0.00	0.00	0.00	0.01	0.01	0.01
Strontium	0.02	0.02	0.03	0.04	0.05	0.06
Iron	0.00	0.00	0.00	0.00	0.00	0.00
Manganese	0.00	0.00	0.00	0.00	0.00	0.00
Sulfate	0.57	0.67	0.79	0.94	1.15	1.42
Chloride	2.02	2.43	2.95	3.64	4.58	5.88
Fluoride	0.01	0.01	0.02	0.02	0.03	0.03
Nitrate	4.63	5.48	6.54	7.89	9.66	12.02
Bromide	0.00	0.00	0.00	0.00	0.00	0.01
Phosphate	0.00	0.00	0.00	0.00	0.00	0.00
Boron	0.08	0.08	0.08	0.09	0.09	0.09
Silica	1.96	2.27	2.65	3.14	3.76	4.59
Hydrogen Sulfide	0.00	0.00	0.00	0.00	0.00	0.00
Bicarbonate	27.75	32.98	39.60	48.20	59.68	75.45
Carbon Dioxide	10.57	11.21	11.97	12.87	13.96	15.26
Carbonate	0.01	0.01	0.01	0.01	0.02	0.03
TDS, mg/l	46.66	55.37	66.39	80.66	99.67	125.70
pH	6.78	6.83	6.88	6.93	6.98	7.04
Conductivity at 25C, µS/cm	64.00	75.00	90.00	109.00	134.00	168.00
Saturation Data						
BaSO4, %	0.79	0.95	1.15	1.42	1.78	2.29
CaF2, %	0.00	0.00	0.00	0.00	0.00	0.00
CaSO4, %	0.01	0.01	0.01	0.01	0.02	0.02
SiO2, %	2.03	2.38	2.81	3.36	4.08	5.01
SrSO4, %	0.00	0.00	0.01	0.01	0.01	0.01
Struvite, %	0.00	0.00	0.00	0.00	0.00	0.00
LSI	-2.68	-2.50	-2.31	-2.10	-1.88	-1.64
S&DI	-3.38	-3.19	-2.98	-2.75	-2.51	-2.25

Appendix F

Water Treatment Plant Property Title

STATUS OF TITLE

Manitoba Land Titles Registry

Title Number	**2153304/1**
Title Status	**Accepted**
Client File	East Selkirk Treatment Plan

1. REGISTERED OWNERS, TENANCY AND LAND DESCRIPTION

THE RURAL MUNICIPALITY OF ST. CLEMENTS

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

LOT 4 PLAN 25033 WLTO
EXC PUBLIC ROAD PLAN 45022 WLTO
IN RL 72 TO 79 PARISH OF ST. CLEMENTS

The land in this title is, unless the contrary is expressly declared, deemed to be subject to the reservations and restrictions set out in section 58 of *The Real Property Act*.

2. ACTIVE INSTRUMENTS

Instrument Type:	Caveat
Registration Number:	222850/1
Instrument Status:	Accepted
Registration Date:	1972-07-11
From/By:	MANITOBA TELEPHONE SYSTEM
To:	
Amount:	
Notes:	AFF: N5.029 METRES PERP
Description:	No description

3. ADDRESSES FOR SERVICE

R.M. OF ST. CLEMENTS
BOX 2, GRP 35, R.R. #1
EAST SELKIRK MB
R0E 0M0

4. TITLE NOTES

No title notes

5. LAND TITLES DISTRICT

Winnipeg

Status as of 2021-05-07 14:31:28 Title Number 2153304/1 Page 1 of 2

6. **DUPLICATE TITLE INFORMATION**

Duplicate not produced

7. **FROM TITLE NUMBERS**

1154333/1 Balance

8. **REAL PROPERTY APPLICATION / CROWN GRANT NUMBERS**

No real property application or grant information

9. **ORIGINATING INSTRUMENTS**

Instrument Type:	**Request To Issue Title**
Registration Number:	3285139/1
Registration Date:	2006-05-04
From/By:	THE RURAL MUNICIPALITY OF ST-CLEMENTS
To:	
Amount:	

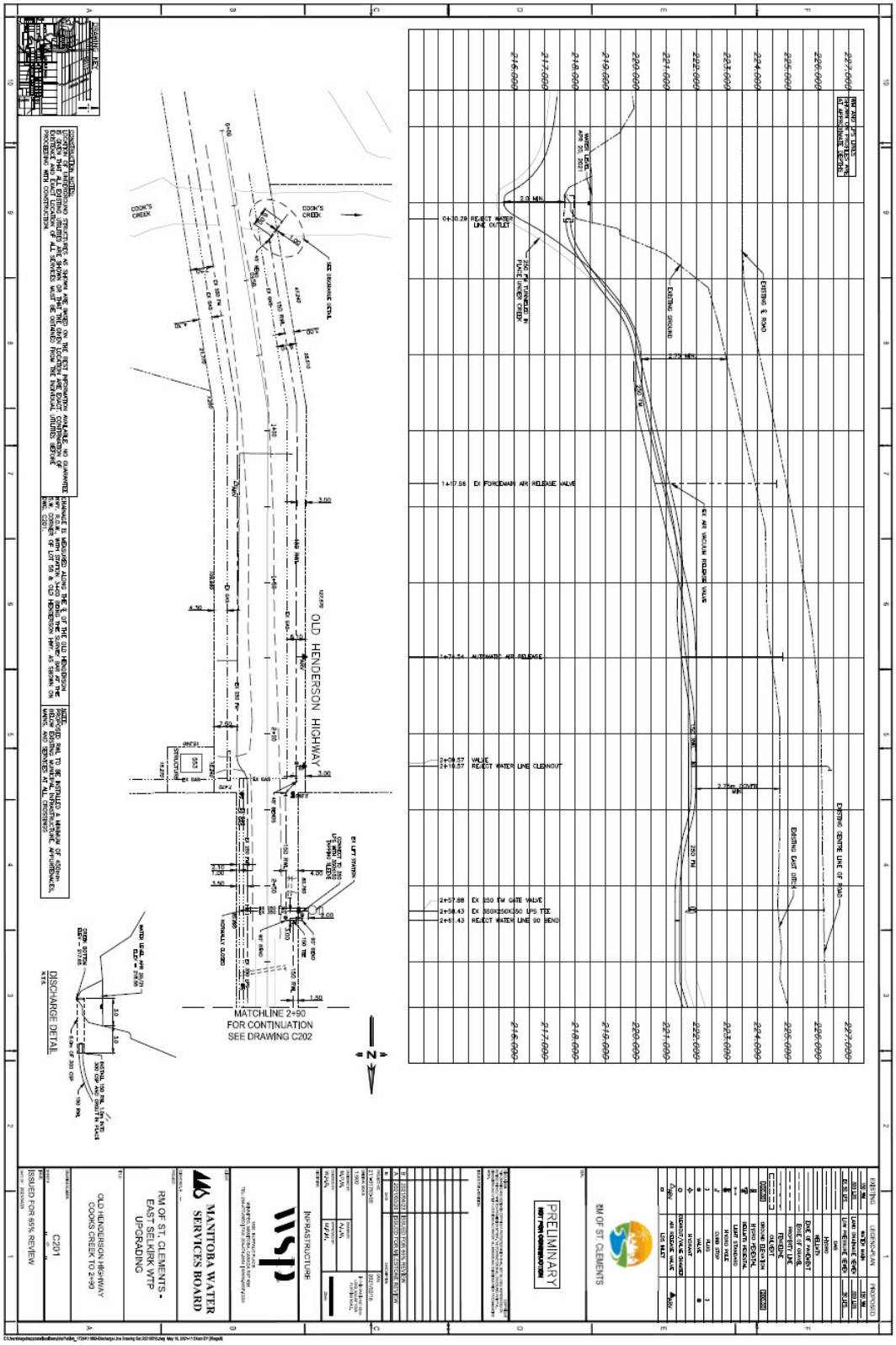
10. **LAND INDEX**

Lot 4 Plan 25033
EXC PL 45022

CERTIFIED TRUE EXTRACT PRODUCED FROM THE LAND TITLES DATA STORAGE SYSTEM OF TITLE NUMBER 2153304/1

Appendix G

Cooks Creek Outfall Structure – WSP


OLD HENDERSON HIGHWAY
COOK'S CREEK
MATCHLINE 2+90
FOR CONTINUATION
SEE DRAWING C202
DISCHARGE DETAIL
PRELIMINARY
NOT FOR CONSTRUCTION
RM OF ST. CLEMENTS
MANITOBA WATER SERVICES BOARD
RM OF ST. CLEMENTS - EAST SELKIRK WTP UPGRADING
OLD HENDERSON HIGHWAY COOKS CREEK TO 2+90
INFRASTRUCTURE
C201
ISSUED FOR 65% REVIEW

Appendix H

East Selkirk Hydrogeological Study – Friesen Drillers

Friesen DRILLERS

April 13, 2021

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

Dear Sir,

Subject **East Selkirk Water Supply Production Wells – Proposed Future Expansion Investigation**
RM of St. Clements – East Selkirk Water Supply System – RL 73 – Parish of St. Clements, Manitoba

Friesen Drillers is pleased to this report detailing our review of the existing water supply system for the community of East Selkirk, Manitoba for the purposes of expansion of the water supply. It is our understanding that the Rural Municipality (RM) of St. Clements intends to expand the water supply system to provide additional areas of service. The existing water supply was put into place in 2012, with little change or expansion occurring. The current allocation is for 161.33 acre feet/year (199 dam^3/year), of which about 37 acre feet/year (46 dam^3/year) is used. It is our understanding that the RM intends to expand the water supply to a maximum instantaneous flow rate of 30 L/s (475 U.S.G.P.M.). This would equate to an annual allocation of about 767 acre feet/year (946 dam^3/year).

The following report will detail the results of the investigation into the possible expansion, and the associated changes that would be required. The required regulatory changes would also be addressed. It should be noted that this proposed expansion is a fairly significant change to the system. Anytime the actual water supply use increases by a factor of nearly 20 in a populated area, careful investigation and assessment is required.

Project Background

For many years, the community of East Selkirk utilized individual private domestic water wells for water supplies. Many of these had multiple connections to several private residences. After a number of issues, a municipal water supply was developed for the community in 2012 by the RM working in partnership with the MWSB. A small treatment plant was built, along with the installation of two water wells into the carbonate aquifer. A distribution system was also installed. A complete description of the water well installation is discussed in Friesen Drillers letter dated March 19, 2012 to the MWSB. This work resulted in the issuance of a water rights license for the water supply.

Many aspects of the hydrogeology in the area have significantly changed in the last ten years. Through the pumping near the City of Selkirk by Gerdau Ameristeel (Manitoba Rolling Mills) and the City of Selkirk, a significant drawdown cone had developed in the area. After many years of pumping, static water levels in the area had declined well below the bedrock surface. Over the many years of pumping, water levels in the deepest part of the drawdown cone near the center of Selkirk were showing a slow steady decline. By 2014, the situation in Selkirk had become serious, and the City of Selkirk, with the assistance of the MWSB developed a new well field several miles northwest of town in the RM of St. Andrews. The test work built on the test work previously conducted by the province in the 1970's. As a result of the work, a water rights and environment act licenses were obtained, and the city began only using the existing well field for emergency backup. This situation in Selkirk is described in Friesen Drillers report dated November 30, 2015.

The situation in Selkirk is extremely interesting from a hydrogeological point of view. In 2015, the potentiometric surface was mapped within the area of the City of Selkirk, which is shown on the following page as Figure 1.

The drawdown cone had developed in an interesting manner following the geological constraints in the area. In the East Selkirk area the bedrock is fairly shallow. With the presence of the recharge areas to the east, and the discharge points in the aquifer near the Red River, the drawdown cone tended to follow the course or the river. The drawdown cone on the west side of the river was much more broad, that extended out to the west. On the east side of the river, the levels tended follow the course of the river, with a much sharper gradient existing. The levels are much flatter on the east side. This situation has always been thought to result from the hydraulic connections of the river to the aquifer in the area.

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

Project Background (cont'd)

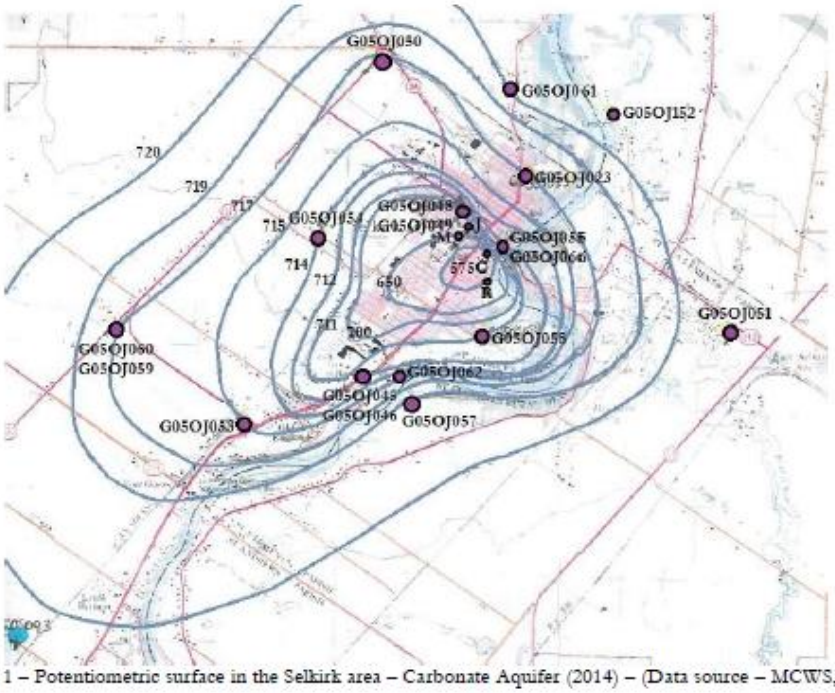


Figure 1 – Potentiometric surface in the Selkirk area – Carbonate Aquifer (2014) – (Data source – MCWS, 2014)

In 2017, the situation in Selkirk changed dramatically. The new Selkirk well field went online, and the old wells were placed on standby. When the new well field went online, there was a fairly dramatic recovery noted in the Provincial monitoring well. The other monitoring wells in the area did not match this dramatic recovery. The response is shown below as Figure 2.

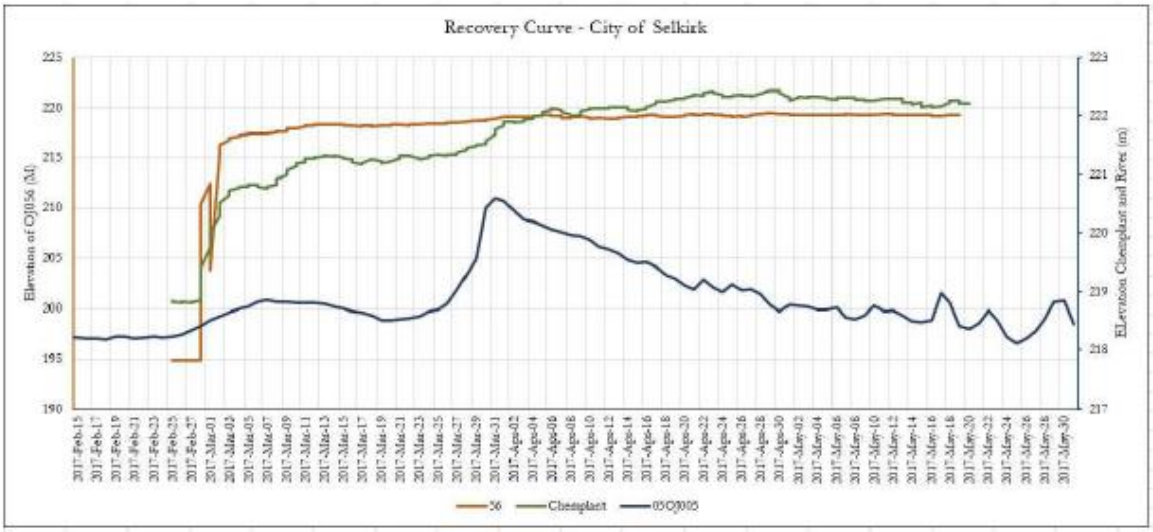


Figure 2 – Recovery response – City of Selkirk monitoring wells (2021)

Project Background (cont'd)

The differing recoveries are very interesting to note. With the impending shut down of the original Selkirk well field, a number of transducers were installed around the city. Two of these are depicted in Figure 2. One transducer was installed in G05OJ056, which is a provincial monitoring well nearest to the former main production well for the City of Selkirk. The second transducer was installed at the former Electro-Knit Fabrics plant, on the northwest side of the city.

The two recoveries show a very interesting difference in the response. The OJ56 recovery occurs almost instantly, rising nearly 22 m in a very short time interval (days), while the Electro Knit Fabrics site has a much more slow and broad recovery, taking about 2.5 months. From a review of the data, it is speculated that the levels have been affected in this well by leakage from the casing. The recovery in this well is far too fast for the conditions.

The hydrographs in the area do reflect a very interesting aspect. All of the hydrographs recovered to the same level as the Red River. The river appears to be acting as a constant head boundary in the area. In the East Selkirk area, the shut down of the City of Selkirk former production wells does not appear to have changed conditions in a significant manner. The changes appear to be more extensive on the west side of the river. On the eastern side of the river, the hydrographs appear to be following seasonal and climatic conditions. Even the hydrograph stations closest to the river on the east side did not change appreciably with the shutdown of the former City of Selkirk Well field. It is evident from a review the hydrographs that the river is acting as a significant hydraulic control over the aquifer in the area.

Strong pumping on the west side of the river to the south of the town is continuing to maintain a drawdown cone around the Gerdau Ameristeel site, although the potentiometric surface to the northwest of the town is recovering. From a review of the regional hydrograph stations on the east side of the river do not appear to have been as strongly affected by the drawdown resulting from the City of Selkirk and Gerdau/Ameristeel pumping well fields.

With all the background and historical aspects of the hydrogeology of the area, it is apparent that the same recharge and discharge dynamics that exist on the west side of the river are also present on the east side of the river (Render, 1986 and Bell, 2015). It would not be ideal to allow the drawdown cone to develop in the area too deeply into the carbonate aquifer, as this could cause surface water intrusion. Therefore, it is especially critical that the proper pumping tests and evaluations be undertaken in the area for the proposed expansion of the RM of St. Clements – East Selkirk Water supply system.

Water Rights and Environmental Licensing

In 2012, the MWSB retained Friesen Drillers to undertake the installation of the supply wells for the East Selkirk water supply project. Included in this work was the preparation of the applications for the appropriate licensing for the water supply. Typically, for larger municipal water supplies, two licenses are required. The first one being the water rights license, while the second one is an Environment Act License.

During the initial planning for the project, it was determined that the water supply requirements for East Selkirk would be limited to less than 161.33 acre feet/year (199 dam^3/year). As the water supply would be for municipal purposes under the terms of the water rights act, it was determined that this licensing would be needed for the water supply. As such, a groundwater exploration permit (GEP) was obtained for the project prior to conducting the production well drilling. As detailed in the GEP for the project, a water rights license application was prepared for the project. These details are contained in Friesen Drillers letter dated March 19, 2012.

Licenses have been regularly issued for this water supply from water rights licensing since 2012. The most recent license was issued in 2012, with the following details:

- License No. 2017-147 – Rural Municipality of St. Clements – Water Supply for Municipal Use
- Maximum Instantaneous Rate of Diversion – 0.013 m^3/s (205 U.S.G.P.M.)
- Total Annual Diversion Rate (Yearly) – 199 dam^3/year (161.33 acre feet/year)
- Water shall not be diverted when water levels in the carbonate aquifer exceed the following:
    - Well #1 (North) – 30.48 (100.0 feet) below ground level.

Water Rights and Environmental Licensing (cont'd)

- Well #2 (South) – 27.13 m (89.0 feet) below ground level.

- The license currently expires on January 29, 2028

It is our understanding that the allocation has been more than sufficient for the current needs of the RM. According to the Water Rights Licensing staff, there have been no complaints registered with the department regarding this water supply (K. Wiesman, personal communication, 2021). As the water supply requirement falls below 200 dam^3/year, a Class 2 environment act license was not that the time, nor currently required for the project. If the RM were to request an increase in the allocation about the 200 dam^3/year, then a Class 2 environment act license will be required.

The Environment Act License for the site has numerous conditions relating to the construction and operation of the pipeline and various civil works. The only condition relating to the use of the water supply is that a water rights license is required, and the terms of the license must be followed. There are some additional monitoring and reporting requirements as well.

It should be also noted that the Environment Act process is a public process which includes advertisements, public reviews, discussions with municipal governments, and commentary. The water rights process is free of public consultation, and the record of the decision lies entirely within the department and the minister. As such, the scope of the investigations for projects involving allocations requiring both licenses can become somewhat larger than a smaller allocation request. By far, the largest aspect of concern relating to the issuance of a water rights license is third party impacts. Licensing conditions and allocation restrictions tend to be placed on water users to avoid third party impacts and impacts to other licensed users. These concerns increase rapidly for larger systems.

Over the last few years, the RM of St. Clements has reported the following water use to the province:

- 2014 – 40.99 dam^3/year
- 2015 – 43.88 dam^3/year
- 2016 – 44.16 dam^3/year
- 2017 – 44.26 dam^3/year
- 2018 – 30.48 dam^3/year
- 2019 – 46.30 dam^3/year
- 2020 – No data reported
- 2021 – No data reported.

Since the construction of the RM of St. Clements – East Selkirk water supply, it appears that the total annual allocation from the aquifer has not exceeded 50 dam^3/year. An allocation change from 50 dam^3/year to nearly 950 dam^3/year (767 acre feet/year) would constituent a significant effect on the aquifer in the area. From a review of the background geology and hydrogeology of the area, similar conditions exist on the east side of the river that also exist on the west side. For many years on the west side, the aquifer was pumped so heavily, that river water intruded the aquifer in many places. Basically, the well fields on the west side of the river were over pumping the transmissive condition of the bedrock aquifer (Render, 1986). The same condition could be created on the east side of the river.

It is also clear from the regulatory review that in addition to applying for an increase in the total annual allocation, a class two development environment act license would be required. As this is a public process, a fairly involved investigation would be required for this proposed increase.

Proposed Well Field Development

In 2012 when the well field was tested initially, the following aquifer parameters were obtained from the testing:

- Transmissivity – 52,800 U.S.G.P.D./ft.

- Storativity – 1.36×10^{-4}

Using these aquifer parameters and the proposed flow rate of 30 L/s (475 U.S.G.P.M.), drawdowns in the area were calculated using the Theis (1935) equation. This flow rate would equate to an annual allocation of about 767 acre feet/year (946 dam^3/year).

The drawdowns produced from the Theis (1935) equation would typically produce a circular drawdown effect around the well field. With the local experience, and the details contained in Render (1986), it is evident that the Red River is acting as a constant head boundary in

Proposed Well Field Development (cont'd)

many cases through the area. Very near to the site is the Lister Rapids, which is present at the St. Andrews Lock and Dam site. At these rapids, the Red River is running directly on the surface of the carbonate aquifer, and there is a significant connection with groundwater. These conditions are thought to occur in several areas along the Red Diver towards the City of Selkirk.

Assuming the conditions of Theis (1935), the predicted drawdowns are shown below as Table 1:

Table 1
Predicted Drawdown – 30 L/s (946 dam³/year)
RM of St. Clements – East Selkirk Groundwater Supply
* Calculations based on Theis (1935); Transmissivity of 52,800 U.S.G.P.D./ft.; Storativity of 1.36 x 10^{-4}

Radius	500 feet	1,500 feet	½ mile	1 mile	1 ½ mile	2 miles	3 miles
Drawdown	12.4 ft.	10.2 ft.	9.0 ft.	7.6 ft.	6.7 ft.	6.1 ft.	5.3 ft.

Table 1 – Calculated drawdown pumping at a rate of 475 U.S.G.P.M. for 365 days, following Theis (1935) equation.

The plotted drawdown is presented below as Figure 3.

Figure 3 – Predicted drawdown at 30 L/s (946 dam³/year) – RM. of St. Clements – East Selkirk water supply. Note the Red River would likely act as a constant head boundary in the area.

Overall, it is expected that the proposed expanded water supply would develop a drawdown cone similar to what was previously seen on the west side of the river. It can easily be seen that this predicted drawdown cone would have a fairly large aerial extent and would likely result in water level changes of several feet within several miles of the well field.

From a geochemical point of view, it is expected that the same conditions that developed on the west side of the Red River during the extensive pumping within the City of Selkirk would develop on the east side as well. These would include possible river water intrusion into the aquifer. This condition developed on the west side at the Gerdau site in 1986 (Render, 1986). Additional sampling in the area in 2017 confirmed the presence of evaporitic surface water in municipal groundwater wells. As such, a drawdown cone such as what is depicted in Figure 3 certainly has the abilities to create a similar condition from strong pumping on the east side of the river.

Proposed Well Field Development (cont'd)

One of the challenges of this area will be the extent of the population that exists in the area that is on private water wells. In 2012, there was approximately 240 properties lying within a 1.0 mile radius of the East Selkirk well field. It is expected that this number of wells would have increased over the last nine years in the area.

Recommendations

Any time a water supply is proposed to increase from an allocation of 50 dam^3/year to 950 dam^3/year, careful consideration is required. The area is well populated, with a long history of extensive groundwater development. In some of these cases, the groundwater development on the west side of the river has caused issues for surface water intrusion into the carbonate aquifer.

We recommend the following activities be undertaken:

- A public consultation/public awareness plan will be required to be in place prior to conducting any testing. This would help to identify where private wells are located, and which wells could potentially be an issue for increased drawdown. It is also assumed that the proposed water supply increases are due to the RM servicing a larger geographic area. This aspect would help to narrow down the issues for the existing water well users in the area. Regardless of which, a project as large as this is likely to create a lot of public interest that will have to be effectively managed, as the public process environment act license will be required.

- A Hydrogeological Engineer/Hydrogeologist should investigate and supervise a testing program in the area to determine how the proposed well field will respond to pumping at the increased rates. The following work should be considered:

    - Update the 2012 well inventory for an area that extends at least two miles from the proposed supply wells.

    - Perform a 72 hour pumping test on the north production well with monitoring in the bedrock aquifer. The monitoring should be undertaken at as many wells as possible. The testing should be conducted in long enough duration for the drawdown cone to expand outwards towards the Red River. During the monitoring, sampling should be conducted to determine the potential for surface water intrusion into the aquifer.

    - A detailed report of the analysis should be undertaken.

    - These results should be shared with the public.

- If the results from the testing are favorable, then an update to the water rights license can be applied for with the province. An environment act license will also be required.

Please call me at (204) 326-2485 if you have any questions or concerns,

Sincerely

Friesen Drillers Limited

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