Environment Act Proposal

Document no: 240603164250_2c5426a5
Revision no: Final

RSRWC

Red-Seine-Rat Wastewater Treatment Facility & Conveyance System
June 12, 2024

Environment Act Proposal

Client Name:	RSRWC		
Project Name:	Red-Seine-Rat Wastewater Treatment Facility & Conveyance System		
Project No:	CE839600		
Document No:	240603164250_2c5426a5	**Project Manager:**	Barry Williamson
Revision No:	Final	**Prepared By:**	Jacobs
Date:	June 12, 2024	**File Name:**	eap_rsrwc_wasterwater_treatment_facility_and_conveyance_system_public.docx

Document History and Status

Revision	Date	Description	Author	Checked	Reviewed	Approved
FINAL	June 12, 2024	EAP for Submission	Jacobs			

CH2M HILL Canada Limited

Unit 700 – One Research Road
Winnipeg, MB, R3T 6E3
Canada

T +1.431.489.9050
www.jacobs.com

Executive Summary

In 2020, the rural municipalities (RMs) of Hanover, Ritchot, and Taché, and the Town of Niverville, signed a memorandum of understanding to establish the Red-Seine-Rat Wastewater Cooperative (RSRWC). The RSRWC aims to create a regional wastewater collection system and a mechanical wastewater treatment facility (WWTF) to improve wastewater management, meet new environmental standards, and make utility rates affordable for taxpayers.

The wastewater collection system consists of approximately 100 km of pipeline to connect the RSRWC communities to the WWTF. At each of the existing RSRWC community wastewater treatment lagoons, a new lift station will be constructed. The existing RSRWC wastewater treatment lagoons will no longer function to treat wastewater. The WWTF will be located on a parcel of land adjacent to the existing Niverville wastewater treatment lagoon. The WWTF will utilize membrane bioreactor (MBR) technology to provide biological nutrient removal and solids-liquid separation. The facility will be composed of the following processes:

- Influent Screening: bar screens, grit removal, fine screens
- Transfer station (septic and holding tank waste)
- Bioreactors: three (3) trains with anoxic, anaerobic, and aerobic zones
- Membrane Tanks: three (3) tanks with room for additional membrane cassettes
- Sludge Thickening: rotary drum thickeners (RDTs)
- Sludge Digesters: anaerobic and post-aerobic digestion (PAD)
- Biogas Utilization System
- Sludge Lagoons
- Odour Control System
- Water Reclamation
- Outfall to the Red River

The purpose of this report is to conduct an environmental assessment of the effects of the Project on soils and terrain, vegetation, water resources, groundwater, wildlife and wildlife habitat, and socioeconomic elements. For most of the elements identified that interact with the proposed Project, the adverse residual environmental effects were found to be negligible to low in magnitude for construction and operations with the application of the proposed mitigation measures.

The WWTF effluent concentration of total iron is expected to consistently exceed the Tier III Water Quality Guideline of 300 µg/L due to its presence in concentrations higher than the guideline in the influent wastewater. Additionally, some potential exists for the WWTF treated effluent to be above the Tier II Water Quality Objective for dissolved copper, and above the Tier II Water Quality Guideline for aluminum, total iron, total silver, chloroform, total phenols, and toluene. The magnitude of this risk will be better understood as the Project moves into detailed design and membrane selection is completed.

The construction of a centralized WWTF and regional wastewater collection system, designed for the horizon of 2040, will support growth at the regional level. The RSRWC will be the owner and operator of the system. It will result in the regionalization of wastewater treatment, providing an improvement on the wastewater treatment infrastructure currently available in the RSR communities, and will support further residential, industrial, and commercial growth within the region.

Contents

Appendices

Tables

Figures

Acronyms and Abbreviations

ºC	degrees Celsius
≤	less than or equal to
µg/L	microgram per liter
µm	micrometre
AE	Associated Engineering (Sask) Ltd.
AGS	aerobic granular sludge
AIS	aquatic invasive species
bgl	below ground level
BNR	biological nutrient removal
BOD	biochemical oxygen demand
BTEX	benzene, toluene, ethylbenzene, and xylenes
Ca	calcium
$CaCO_3$	calcium carbonate
CALA	Canadian Association for Laboratory Accreditation Inc.
$cBOD_5$	carbonaceous 5-day biochemical oxygen demand
CCME	Canadian Council of Ministers of the Environment
CCTV	closed-circuit television
CH2M HILL	CH2M HILL Canada Limited
CH_4	methane
CIP	clean-in-place
cm	centimetre(s)
CNR	Canadian National
CO_2	carbon dioxide
COD	chemical oxygen demand
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPKCR	Canadian Pacific Kansas City Railway (formerly Canadian Pacific Railway)
CSA	Canadian Standards Association

CWCS	Canadian Wetland Classification System
D	depth
DFA	designated flood area
DFO	Fisheries and Oceans Canada
DNA	deoxyribonucleic acid
DO	dissolved oxygen
DOC	dissolved organic carbon
E. coli	*Escherichia coli*
EA	environmental assessment
EAP	environment act proposal
ECCC	Environment and Climate Change Canada
FOG	fat, oil, grease
g/cap/d	gram per cap per day
g COD/m^3	gram chemical oxygen demand per cubic metre
g O_2/m^3	gram oxygen per cubic metre
g N/m^3	gram nitrate and nitrite per cubic metre
gal/d	gallons(s) per day
GIN	ground information network
H_2S	hydrogen sulphide
ha	hectare
HDD	horizontal directional drilling
HDPE	high-density polyethylene
HRB	Historic Resources Branch
HRIA	heritage resources impact assessment
HRPP	heritage resources protection plan
HRT	hydraulic retention time
HVAC	heating, ventilation, and air conditioning
I&C	instrumentation and controls
ICI	institutional, commercial, and industrial

kg BOD/c/d	kilogram biochemical oxygen demand per capita per day
kg/c/d	kilogram per capita per day
kg/d	kilogram per day
kg/T	kilogram per tonne
kgO_2/d	kilogram(s) oxygen per day
kgTSS/d	kilogram(s) total suspended solids per day
$kgVS/m^3/d$	kilogram(s) volatile solids per cubic metre per day
km	kilometre
kPa	kilopascal(s)
kV	kilovolt(s)
kVA	kilovolt ampere(s)
kW	kilowatt
L	length
L/cap/d	litres per capita per day
L/s	litres per second
LIES	load interconnection evaluation study
LIFS	load interconnection facilities study
LPS	low pressure sewer
LSA	local study area
m	metre
m/s	metres per second
m^3	cubic metre
m^3/d	cubic metres per day
$m^3/ha/d$	cubic metre per hectare per day
$m^3/ha/d$	cubic metre per hour
MB	Manitoba
MBR	membrane biological reactor
MCC	motor control center
Mg	magnesium

mg/L	milligram per liter
$mgO_2/L/h$	milligram(s) oxygen per litre per hour
mL	millilitre
ML	million litres
ML/d	million litres per day
MLSS	mixed liquor suspended solids
MLVSS	mixed liquor volatile suspended solids
mm	millimetre(s)
MMF	Manitoba Métis Federation
MOU	memorandum of understanding
MPN	most probable number
MTBE	methyl-tert-butyl ether
MVA	megavolt-ampere(s)
MWQSOG	Manitoba Water Quality Standards, Objectives, and Guidelines
N	nitrogen
NBC	National Building Code
ND	non-detectable
NFPA	National Fire Protection Association
NH_3-N	ammonia nitrogen
Nm^3/h	normal cubic metre(s) per hour
No.	number
NO_2	nitrogen dioxide
NO_3	nitrate
NS	narrative specified
NTU	nephelometric turbidity units
OGLA	Ontario-Great Lakes area
ORP	oxygen reduction potential
OUR	oxygen utilization rate
P&ID	process and instrumentation diagram

PAD	post-aerobic digestion
PAHs	polycyclic aromatic hydrocarbons
PCF	Project Construction Footprint
PFD	process flow diagram
PHC	petroleum hydrocarbons
PLC	programmable logic controllers
PO_4-P	phosphate
PR	Provincial Road
Project	Red-Seine-Rat Wastewater Treatment Facility and Conveyance System
PTH	Provincial Trunk Highway
PVC	polyvinyl chloride
PVDF	polyvinylidene fluoride
QC	quality control
RAP	restricted activity period
RAS	return activated sludge
RDT	rotary drum thickeners
RM	Rural Municipality
ROW	right-of-way
RRAFN	Roseau River Anishinabe First Nation
RSA	regional study area
RSR	Red-Seine-Rat
RSRWC	Red-Seine-Rat Wastewater Cooperative
SARA	Species at Risk Act
SC	specific conductance
SCADA	supervisory control, and data acquisition
SOTE	standard oxygen transfer efficiency
SOTR	standard oxygen transfer rate
SRT	solids retention time
SWD	side water depth

TBC	to be confirmed
TBD	to be determined
TC	TransCanada
TCE	trichloroethylene
TCU	total colour units
TDH	total dynamic head
TDS	total dissolved solids
TKN	total kjedahl nitrogen
TN	total nitrogen
TOC	total organic carbon
T/d	tonne per day
TP	total phosphorus
TREK	TREK Geotechnical Inc.
TS	total solids
TS	total sulphur
TSS	total suspended solids
TWAS	thickened waste activated sludge
USA	United States of America
UV	ultraviolet
UVT	ultraviolet transmittance
V	volt
VFA	volatile fatty acid
VFD	variable frequency drive
VS	volatile solids
VSS	volatile suspended solids
WAS	waste activated sludge
WHMIS	Workplace Hazardous Materials Information System
WHSRN	western hemisphere shorebird reserves

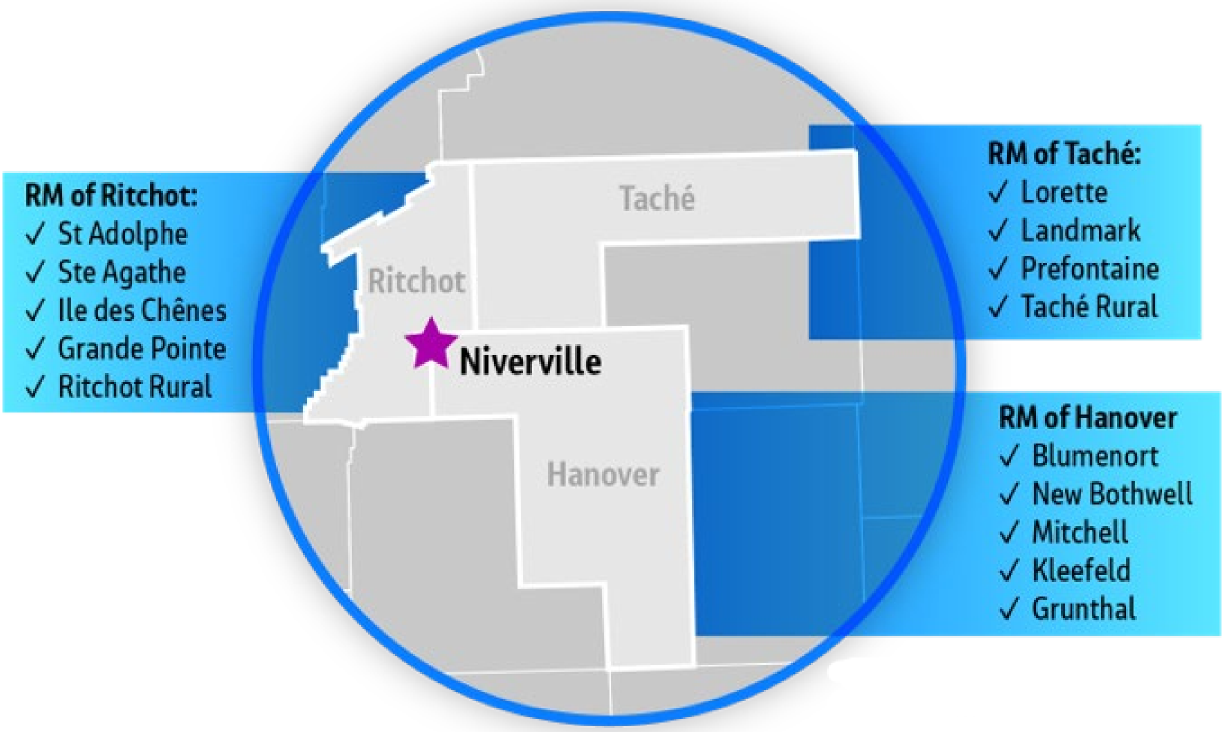
WQ	water quality
WWTF	wastewater treatment facility

1 Introduction and Background

1.1 Red-Seine-Rat (RSR) Wastewater Cooperative

In 2020, the rural municipalities (RMs) of Hanover, Ritchot, and Taché, and the Town of Niverville, signed a memorandum of understanding (MOU) to establish the Red-Seine-Rat Wastewater Cooperative (RSRWC). The RSRWC aims to create a regional wastewater collection system and a mechanical wastewater treatment facility (WWTF) to improve wastewater management, meet new environmental standards, and make utility rates affordable for taxpayers. The list of RSRWC members is captured in Figure 1-1.

Figure 1-1. RSRWC Member Overview



The motivation for establishing the cooperative is the observed population growth, expected commercial and residential advancement, and continued investment interest from industries in the RSR communities. Many of the existing wastewater treatment lagoons servicing these communities are approaching their treatment or hydraulic-related design capacities, and do not have the capacity for the anticipated growth. Additionally, as the population expands in the medium to long term, many of the larger communities, including the Town of Niverville, could see significant growth that may push their populations (or equivalent population) above 10,000 residents. In accordance with the Tier 1 Water Quality Standards (from the Manitoba Water Quality Standards, Objectives, and Guidelines, MWQSOG), the Province of Manitoba includes an effluent limit on nitrogen (that is, total nitrogen less than or equal to [≤] 15 mg/L) for new and expanding wastewater facilities when the service population exceeds 10,000. To meet this standard, biological nutrient removal in a full mechanical WWTF would be required, involving a significant capital investment at the community scale.

The RSRWC provides the opportunity to coordinate the development and sharing of infrastructure to overcome these near- and long-term challenges. The construction of a centralized WWTF and regional wastewater collection system, designed for the horizon of 2040, will support growth at the regional level.

1.2 Existing Wastewater Treatment Infrastructure

The RSRWC communities are currently serviced by wastewater treatment lagoons, and wastewater in these communities is collected by gravity and low pressure sewer systems, lift stations, and force mains. A summary is provided below in Table 1-1.

Table 1-1. Wastewater Collection Systems in the RSRWC Communities.

Community Name		Wastewater Collection System	Wastewater Hauling
Town of Niverville		Gravity sewer system	Holding Tanks, Septic Tanks
RM of Ritchot	Ste. Agathe	Gravity sewer system	None
	St. Adolphe	Gravity sewer system	Holding Tanks
	Île-des-Chênes	Gravity sewer system Low-pressure sewer	None
RM of Taché	Landmark	Low-pressure sewer Gravity sewer system (new development)	Septic Tanks
	Lorette	Gravity sewer system	None
RM of Hanover	Blumenort	Gravity sewer system Low-pressure sewer	Septic Tanks
	New Bothwell	Low-pressure sewer	Septic Tanks
	Kleefeld	Low-pressure sewer	Septic Tanks
	Mitchell	Low-pressure sewer	Septic Tanks
	Grunthal	Gravity sewer system	Septic Tanks

Many of the wastewater treatment lagoons are currently experiencing hydraulic and/or organic overload, and others expect near-term lagoon upgrades due to the expected rate of population growth. Summarized in Table 1-2 is the status of current wastewater treatment lagoon operations. The proposed regional WWTF will alleviate the existing and future expected operational challenges for the communities within the RSRWC.

Table 1-2. Status of Current Operations

Community Name		Limitations of Current Operations
Town of Niverville[a]		▪ Operating at the limit of the design capacity of the existing wastewater treatment lagoon. ▪ Future growth will be limited without upgrades to wastewater treatment infrastructure.
RM of Ritchot	Ste. Agathe	▪ Primary and secondary cells are not riprapped, resulting in erosion issues.[b] ▪ The wastewater treatment lagoon is outside of the ring dike.[b] ▪ Future growth will be limited without upgrades to wastewater treatment infrastructure. The wastewater treatment lagoon is expected to reach its design capacity by ~2035.[c]
	St. Adolphe	▪ Future growth will be limited without upgrades to wastewater treatment infrastructure. A previously developed report indicated that the primary cell capacity of the lagoon will be reached by ~2023.[c]
	Île-des-Chênes	▪ Upgrades to the wastewater infrastructure are required to support future growth. The wastewater treatment lagoon is expected to reach its design capacity by ~2027.[c] ▪ An Environment Act Proposal was submitted in March 2022 for a wastewater treatment lagoon expansion.
RM of Taché	Landmark[b]	▪ No riprap on many of the cells with some history of erosion issues. ▪ Slow discharge can result in backup of effluent into the ditch alongside the wastewater treatment lagoon.
	Lorette[b]	▪ Filter building constructed for the wastewater treatment lagoon in 2017/18 is not operational due to under sized filters. [b] ▪ Issues with recurring weeds in Secondary Cell 1. ▪ Some wastewater treatment lagoon cells are not riprapped.
RM of Hanover	Blumenort[b]	▪ Some issues with weeds in the older lagoon cells.
	New Bothwell[d]	▪ Future growth will be limited without upgrades to wastewater treatment infrastructure. The wastewater treatment lagoon is currently experiencing hydraulic stress.
	Kleefeld[e]	▪ Future growth will be limited without upgrades to wastewater treatment infrastructure. The wastewater treatment lagoon is currently experiencing organic and hydraulic stress.
	Mitchell	▪ Due to the high level of the primary cell, trickle draining is required to avoid flooding adjacent fields. ▪ Predicted that the wastewater treatment lagoon could begin to exceed its design capacity by 2026.[f]

Community Name		Limitations of Current Operations
	Grunthal[a]	▪ Future growth will be limited without upgrades to wastewater treatment infrastructure. ▪ Significant inflows are experienced during wet weather events.

Sources:

[a] Associated Engineering (AE). July 2019. 2018 Wastewater Treatment Feasibility Study, Version 2.0. Prepared for the Town of Niverville and the Manitoba Water Services Board.

[b] Jacobs Lagoon Site Visits. Fall 2022.

[c] WSP. Organic Loading Study. Prepared for the RM of Ritchot.

[d] WSP. March 2019. New Bothwell Wastewater Treatment Lagoon Expansion. Prepared for the Rural Municipality of Hanover.

[e] WSP. April 2021. Community of Kleefeld Wastewater Treatment Lagoon Assessment Study. Prepared for the Rural Municipality of Hanover.

[f] Associated Engineering (AE). May 2017. 2017 Wastewater Infrastructure Study. Prepared for the RM of Hanover.

The existing wastewater treatment lagoons in the RSRWC are seasonally discharged to drainage ditches, drains, canals, and creeks that flow directly to the Red River or into the Seine River Diversion, which ultimately empty into the Red River. The proposed WWTF will also discharge to the Red River; however, the quality of the effluent is expected to be higher than is currently achievable with the operation of the existing wastewater treatment lagoons.

Additionally, the WWTF effluent will be subject to additional and/or more stringent effluent limits than those in the current Environment Act Licenses. A summary of the current effluent discharge limits is provided below in Table 1-3. Section 2.4.1.1 Design Effluent Criteria, provides an overview of the effluent limits of the proposed WWTF.

Table 1-3. Summary of Effluent Discharge Limits in Existing Environment Act Licenses.

Community Name		Current Environmental Act License	Effluent Discharge Limits
Town of Niverville		No. 2712 (Jan. 23, 2006)	▪ BOD$_5$: <30 mg/L ▪ Fecal Coliform: <200 per 100 mL (MPN) ▪ Total Coliform: <1,500 per 100 mL (MPN)
RM of Ritchot	Ste. Agathe	No. 2036 (Dec. 9, 2020)	▪ BOD$_5$: <25 mg/L ▪ Fecal Coliform: <200 per 100 mL ▪ TSS: < 25 mg/L ▪ NH$_3$: <1.25 mg/L
	St. Adolphe	No. 2776 R (Jul. 22, 2016)	▪ BOD$_5$: <25 mg/L ▪ Fecal Coliform: <200 per 100 mL ▪ TSS: < 25 mg/L ▪ NH$_3$: <1.25 mg/L ▪ TP: < 1.0 mg/L

Community Name		Current Environmental Act License	Effluent Discharge Limits
	Île-des-Chênes	No. 2577 RR (Oct. 11, 2013)	▪ BOD_5: <25 mg/L ▪ Fecal Coliform: <200 per 100 mL ▪ Total Coliform: <1,500 per 100 mL (MPN) ▪ TSS: <25 mg/L ▪ TP: < 1.0 mg/L
RM of Taché	Landmark	No. 2025 RR (Apr. 9, 2008)	▪ BOD_5: <30 mg/L ▪ Fecal Coliform: <200 per 100 mL (MPN) ▪ Total Coliform: <1,500 per 100 mL (MPN)
	Lorette	No. 2439 R (Dec. 13, 2004)	▪ BOD_5: <30 mg/L ▪ Fecal Coliform: <200 per 100 mL (MPN) ▪ Total Coliform: <1,500 per 100 mL (MPN)
RM of Hanover	Blumenort	No. 2550 (Dec. 4, 2022)	▪ BOD_5: <30 mg/L ▪ TSS: <30mg/L ▪ Fecal Coliform: <200 per 100 mL (MPN) ▪ Total Coliform: <1,500 per 100 mL (MPN)
	New Bothwell	No. 1524 (Jun. 28, 2010)	▪ BOD_5: <25 mg/L ▪ Fecal Coliform: <200 per 100mL (MPN) ▪ Total Coliform: <1,500 per 100 mL (MPN) ▪ TSS: <25mg/L ▪ TP: <1.0 mg/L ▪ Total Residual Chlorine: <0.02mg/L
	Kleefeld	No. 1985 R (Jun. 16, 2009)	▪ BOD_5: <30 mg/L ▪ Fecal Coliform: <200 per 100 mL (MPN) ▪ Total Coliform: <1,500 per 100 mL (MPN)
	Mitchell	No. 2765 (Apr. 12, 2007)	▪ BOD_5: <30 mg/L ▪ Fecal Coliform: <200 per 100 mL (MPN) ▪ Total Coliform: <1,500 per 100 mL (MPN)
	Grunthal	No. 2984 (Apr. 25, 2013)	▪ BOD_5: <25 mg/L ▪ TSS: < 25mg/L ▪ Fecal Coliform: <200 per 100 mL (MPN) ▪ Total Coliform: <1,500 per 100 mL (MPN) ▪ NH_3: <10 mg/L ▪ TP: <1.0 mg/L

1.3 Development Overview

The two components of the Project are the WWTF and the regional wastewater collection system.

1.3.1 Wastewater Treatment Facility

The WWTF will be located on a parcel of land adjacent to the existing Niverville wastewater treatment lagoon. The WWTF will utilize membrane bioreactor (MBR) technology to provide biological nutrient removal and solids-liquid separation. The facility will be composed of the following processes:

- Influent Screening: bar screens, grit removal, fine screens
- Transfer Station (septic and holding tank waste)
- Bioreactors: three (3) trains with anoxic, anaerobic, and aerobic zones
- Membrane Tanks: three (3) tanks with room for additional membrane cassettes
- Sludge Thickening: rotary drum thickeners (RDTs)
- Sludge Digesters: anaerobic and post-aerobic digestion (PAD)
- Biogas Utilization System
- Sludge Lagoons
- Odour Control System
- Water Reclamation

Additional components of the wastewater treatment facility include:

- Chemical storage and dosing
- Power supply and standby power generation infrastructure
- Ancillary features (i.e., site work for flood protection, road development, building construction)
- Outfall to the Red River

Additional details are provided in Section 2: Description of Proposed Development.

1.3.2 Wastewater Collection System

The wastewater conveyance system consists of approximately 100 km of pipeline to connect the RSRWC communities to the WWTF. At each of the existing RSRWC community wastewater treatment lagoons, new lift stations will be constructed. The existing community wastewater treatment lagoons will no longer function in a wastewater treatment capacity; rather, a portion of the wastewater treatment lagoons will be re-purposed to provide secondary equalization of peak wastewater flows.

In addition to the transfer station at the WWTF, there will be two remote transfer stations within the RSRWC network for the collection of hauled septage and sewage. These remote stations will be located within the communities of Lorette and Kleefeld.

Additional details are provided in Section 2: Description of Proposed Development.

1.4 Summary of Alternatives

Alternatives to the Project included the evaluation of different wastewater conveyance strategies, various plant design configurations and technologies, and several outfall route options.

1.4.1 Conveyance System

The objective of the conveyance design was to size it to accommodate the flows when the system comes online in 2028 as well as through the design horizon of the plant. Once installed, it becomes impractical and cost-prohibitive to upsize the pipeline. Consideration has been given to confirm that minimum velocities are maintained throughout the system to limit deposition of solids, while also keeping a reasonable pressure profile.

At the current 30% design stage, the sizing of the conveyance network is still subject to change, however, the proposed conveyance path has been established. Segments of the RWRWC network may be upsized at this design stage to accommodate small, additional communities in the vicinity of the WWTF (see Section 2.4.5: Add-on Communities to the RSRWC for details).

The pipeline routing from each community to the regional WWTF was selected to maximize use of municipal rights-of-way, and to eliminate the requirement for easements. The routing also considered factors such as minimizing the pipeline distance and establishing the most direct route to the WWTF and mitigating the impact on heritage resources.

1.4.2 Wastewater Treatment Facility (WWTF)

Jacobs evaluated three advanced secondary treatment options for the WWTF serving the RSRWC. The treatment options were Conventional Biological Nutrient Removal (Westbank Configuration), Membrane Biological Reactor (MBR), and Aerobic Granular Sludge (AGS). The evaluation criteria consisted of treatment performance, expandability, commercial considerations for equipment procurement, operation and maintenance complexity, and plant footprint. Based on these factors, the MBR option was selected as the preferred alternative as it provides the desired flexibility for future expansion, produces the highest quality effluent for potential reuse in the future, and has the lowest estimated capital cost of the three options considered.

The WWTF will be located on a parcel of land adjacent to the existing Niverville wastewater treatment lagoon. This location was a strategic choice for several reasons, including that the Town of Niverville is the largest community within the RSRWC, so conveyance of the wastewater flow to an alternate location is counterintuitive. Additionally, the site is centrally located among the RSR communities, and has reasonable proximity to the Red River. The existing Niverville wastewater treatment lagoon is part of the WWTF design, as several of the Niverville wastewater treatment lagoon cells will be repurposed to provide storage of digested sludge.

1.4.3 Outfall

The WWTF requires an outfall location that can receive a continuous discharge of treated effluent. In the Town of Niverville, the Red River is the only water body with sufficient flow to sustain year-round discharge operation. The Red River is approximately 6 km from the proposed WWTF.

Four (4) outfall alignments were considered and evaluated for the length of the route and number of bends, congestion, the number of crossings, right of way access to the Red River, and the possibility for erosion. Ultimately, a discharge route along Stott Road was selected as it avoids the congestion of crossing PR 200, resulting in a less challenging installation and fewer crossings. Stott Road also has a developed municipal right away that extends to the river’s edge. Additionally, this outfall location will allow for successful operation, even in flood conditions.

1.5 Population, Hydraulic Loading, and Organic Loading

1.5.1 Sources of Wastewater

Within the RSRWC, wastewater is produced from various sources, including residential, commercial, industrial, and septage hauling. Each of these sources has been accounted for to derive the design average hydraulic and organic loading for 2040. The sources of wastewater in each community are summarized below in Table 1-4.

Table 1-4. Sources of Wastewater in the RSRWC

Community	Residential/ Commercial	Large Industrial	Wastewater Hauling
Town of Niverville	✓	×	✓ holding tanks/septic tanks
RM of Ritchot	✓	✓ Viterra – Canola Processing	✓ holding tanks
RM of Taché	✓	×	✓ septic tanks
RM of Hanover	✓	✓ 1. Exceldor – Poultry Production 2. Blue Water Wash – Livestock Truck Washing Facility 3. Country Meat and Sausage – Meat Processing 4. Bothwell Cheese – Cheese Production 5. Lactalis – Dairy Processor	✓ holding tanks/septic tanks

The following subsections provide an overview of the current and future serviced population, hydraulic loading, and organic loading of the proposed wastewater collection system and WWTF. Additional details are provided in Section 2.4.1, Design Effluent Criteria.

The population, hydraulic loading, and organic loading are provided in the following sections for 2023, 2028 and 2040; 2023 represents the year that the design basis was developed, 2028 represents the proposed year that the plant should be operational, and 2040 is the design year of the plant.

1.5.2 Population

Within the RSRWC, the serviced population includes the residential population directly connected to the wastewater infrastructure through gravity or low-pressure sewer system. In 2023, the population is about 29,100, increasing to about 50,250 by the design year (2040). A summary of the serviced population is provided in Table 1-5. From the start of operation in 2028, the serviced population is expected to increase by over 16,000 by the design year of 2040.

There is an additional population equivalent for wastewater contributions from industrial loading and the rural population that contributes hauled wastewater (septage, sewage). The total population equivalent, based on a standard BOD loading rate of 0.085 kg BOD/c/d, is also shown in Table 1-5. The BOD loading is heavily influenced by several major industries within the RSR communities.

Table 1-5. Current and Projected Population of the RSRWC

Year	Serviced Population	Total Population Equivalent
Current Population (2023)	29,104	50,157
Future Population (2028)	34,225	58,137
Design Population (2040)	50,231	87,808

1.5.3 Hydraulic Loading

The WWTF design is based on a 2040 projected average wastewater flow of 19 million liters per day (ML/d), and a corresponding peak wastewater flow of 28.5 ML/d. Table 1-6 shows the average day flow contributions at the design basis development year, and future years. From the start of operation in 2028, the average day flow is expected to increase by over 6,600 cubic meters per day (m^3/d) by the design year of 2040.

Table 1-6. Average Day Wastewater Generation (All Sources)

Year	Average Day Flow (m^3/d)
Current Population (2023)	10,386
Future Population (2028)	12,393
Design Population (2045)	19,024

1.5.4 Organic Loading

The design organic load is 7,464 kilogram per day (kg/d) in 2040. Table 1-7 shows the average day organic loading contribution at the design basis development year and future years. From the start of operation in 2028, the average day organic load is expected to increase by over 2,500 kg/d by the design year of 2040.

Table 1-7. Average Day Organic Loading (All Sources).

Year	Average Day Loading (kg-BOD/d)
Current Population (2023)	4,263
Future Population (2028)	4,942
Design Population (2040)	7,464

1.6 Environment Act Proposal Scope

The scope of this Environment Act Proposal (EAP) includes the following:

- Regional conveyance network, including the repurposing of existing wastewater treatment lagoons, and the construction of new lift stations.
- Wastewater treatment facility, including the outfall.

At a later date, a separate EAP will be submitted for the proposed land application of biosolids.

Not included within the scope of the EAP is the wastewater infrastructure within each of the RSR communities that conveys wastewater to the existing wastewater treatment lagoons (e.g. gravity sewer, low pressure sewer, lift stations). This wastewater infrastructure upstream of the wastewater treatment lagoons will continue to be managed by each individual community and will not be transferred to the RSRWC.

1.7 Previous Studies and Information Sources

The following memorandum provided a proof-of-concept for a regional WWTF servicing the Town of Niverville and the RMs of Hanover, Ritchot, and Taché:

- Regional Wastewater Concepts Technical Memorandum prepared by Associated Engineering (2019).
- Red-Seine-Rat Wastewater Cooperative Wastewater Treatment Facility & Distribution System Project Greenhouse Gas Mitigation Assessment prepared by Associated Engineering (2020)

The following information sources were reviewed in preparation of this EAP:

- Statistics Canada Census of Population
- Manitoba Contaminated/Impacted Sites database
- Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status reports
- Government of Canada *Species at Risk Act* (SARA) Public Registry, Recovery Strategies, and Action Plans
- Government of Canada Hydrometric Database
- Government of Manitoba Integrated Watershed Management Plans
- Parks or protected areas (digital layer)
- National wildlife areas and Migratory Bird Sanctuaries
- Important Bird Areas
- Western Hemisphere Shorebird Reserves
- Ramsar Wetlands
- Manitoba Conservation Data Centre
- General nesting periods for migratory birds
- The Endangered Species and Ecosystems Act of Manitoba

1.8 Community Consultation

Community consultation for this Project has been initiated and will continue throughout the course of the multi-year project. Additional information on the scope of the community consultation is provided in Section 2.9.1: Summary of Engagement Activities Undertaken.

Open House: To date, there has been one public open house in March 2023 that was attended by the media, members of council in the region, local residents, and potential contractors. The purpose of the meeting was to bring awareness to the scope and purpose of the Project and the Project timeline. Additional open houses are expected over the source of the Project.

Indigenous Engagement: The RSRWC has initiated Indigenous engagement through reaching out to the Manitoba Métis Federation (MMF) and the Roseau River Anishinabe First Nation (RRAFN). As the project progresses, the MMF and RRAFN will continue to be informed on any new developments.

Industry Market Sounding: A market sounding meeting is being planned for the conveyance portion of the Project to understand the current market perspective and to solicit feedback from potential bidders for the regional conveyance system.

2 Description of Proposed Development

The proposed Project involves the construction of a regional conveyance network and WWTF. At the time that this EAP was developed, both the conveyance system and the WWTF, including the outfall, were at the 30% design stage. At this stage, the key design details have been established (e.g., conveyance routing, process unit selection for the WWTF, outfall location). As the Project progresses, there will be modifications to the design and Jacobs will consult the regulator on any changes to determine if they represent a fundamental change to the Project and if they require further public consultation.

2.1 Status of Title and Mineral Rights

2.1.1 Wastewater Conveyance System

At each of the existing wastewater treatment lagoon sites within the RSR network, a new lift station will be constructed, and one or more lagoon cells will be repurposed to provide secondary equalization of peak wastewater flow; details are provided in Section 2.4.2.2.1: Lagoon Equalization. The Status of Title number is provided in Table 2-1 for each site, and a copy of the title is provided in Appendix A.

Under title 2729241/1 for Ile des Chênes, the mines and minerals ownership are reserved by the Crown. For all other existing wastewater treatment lagoon sites, the mines, minerals, sand, and gravel lie with the current surface ownership.

Table 2-1. Location and Status of Title for Existing Wastewater Treatment Lagoon Sites in the RSR

Community		Location and Land Information
Town of Niverville		Location: SW 7-8-4EPM within the RM of Ritchot Status of Title No.: 2194825/1
RM of Ritchot	St. Adolphe	Location: River Lot 239 and 240 in the Parish of St. Norbert Status of Title No.: 1906349/1
	Ste. Agathe	Location: River Lot 567 in the Parish of Ste. Agathe Status of Title No.: 1579857/1
	Ile des Chênes	Location: SE 32-8-4 and NE 29-8-4 within the RM of Ritchot Status of Title No.: 2729241/1
RM of Taché	Lorette	Location: River Lot 8 in the Parish of Lorette Status of Title No.: 1712839/1
	Landmark	Location: NE 28-8-5 EPM within the RM of Taché Status of Title No.: 2348978
RM of Hanover	Blumenort	Location: NE and SE 32-7-6 EPM and NW and SW 33-7-6 EPM within the RM of Hanover Status of Title Nos.: 1398798/1, 1398799/1, 140037/1, 1756240/1
	New Bothwell	Location: NE and SE 29-7-5 EPM within the RM of Hanover Status of Title Nos.: 1261388/1, 2420052/1

Community	Location and Land Information
Mitchell	Location: SW and SE 12-7-5 EPM within the RM of Hanover Status of Title No.: 2160390/1
Kleefeld	Location: NW 19-6-5 EPM within the RM of Hanover Status of Title Nos.: 1388685/1, 1751659/1
Grunthal	Location: NW, SW, and SE 20-55E within the RM of Hanover Status of Title Nos.: 1352717/1, 2558841/1, 2601769/1

2.1.1.1 Regional Pipeline

New lift stations at each existing wastewater treatment lagoon site will pump wastewater flows to the regional WWTF. The route of the conveyance network, as shown in Figure 2-1, is described below in Table 2-2.

Figure 2-1. Proposed Conveyance Network.

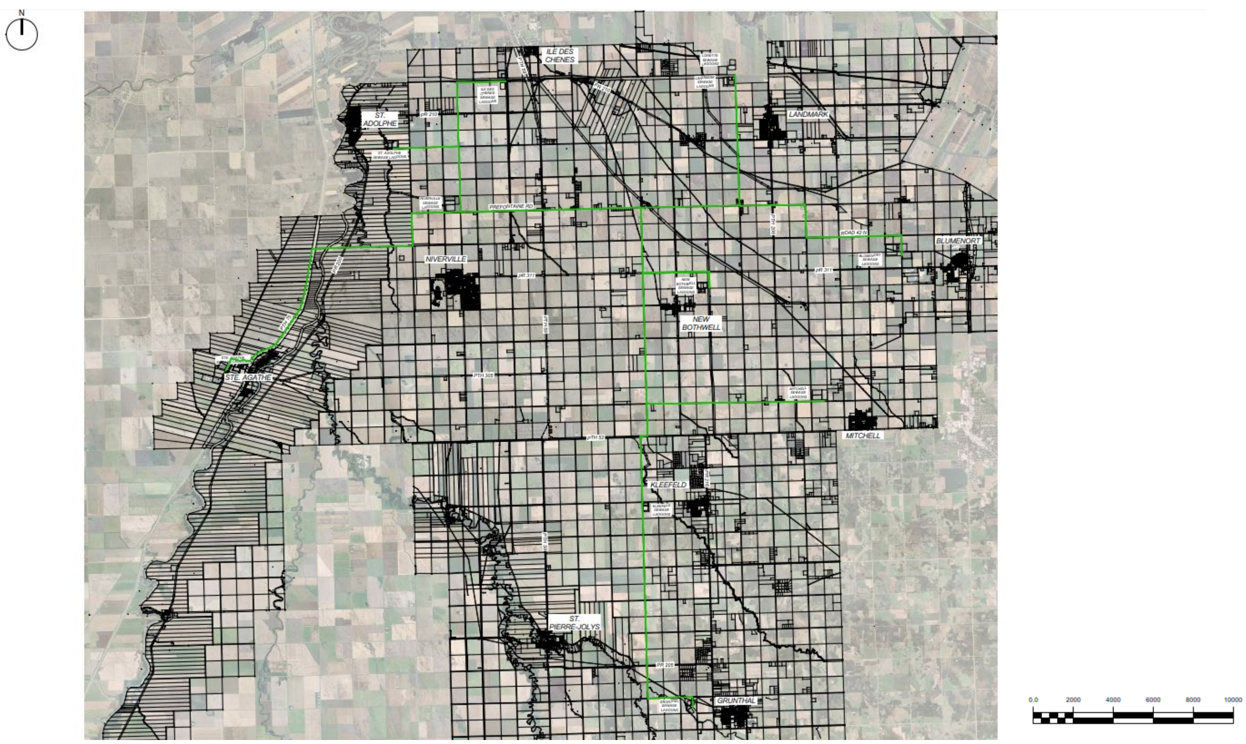


Table 2-2. Summary of Proposed Conveyance Pathway

Community		Conveyance Pathway
RM of Ritchot	St. Adolphe	1. From the St. Adolphe wastewater treatment lagoon east along Leblanc Rd. to Nanka Rd 2. South along Nanka Rd to the WWTF
	Ste. Agathe	1. From the Ste. Agathe wastewater treatment lagoon north to Provincial Rd 305 2. East along Provincial Rd 305 to Lord Selkirk Hwy (75) 3. North-East along Lord Selkirk Hwy (75) to Stott Rd 4. East along Stott Rd to Sood Rd 5. North along Sood Rd to Prefontaine Rd 6. East along Prefontaine Rd to the WWTF
	Ile des Chênes	1. From the Ile des Chênes wastewater treatment lagoon west along Twin Creek Rd to Nanka Rd 2. South along Nanka Rd to the WWTF
RM of Taché	Lorette/Landmark	1. From Lorette/Landmark wastewater treatment lagoons south along Municipal Rd 27 E to Prefontaine Rd 2. West along Prefontaine Rd to the WWTF
RM of Hanover	Blumenort	1. From Blumenort wastewater treatment lagoon north along Rd 32E to Rd 42 N 2. West along Rd 42 N to Municipal Rd 29 E 3. North along Municipal Rd 29 E to Prefontaine Rd 4. West along Prefontaine Rd to the WWTF
	New Bothwell	1. From the New Bothwell wastewater treatment lagoon north along Rd 26 E to Provincial Rd 311 2. West along Provincial Rd 311 to Willow Ridge Rd 3. North along Willow Ridge Rd to Prefontaine Rd 4. West along Prefontaine Rd to the WWTF
	Mitchell	1. From Mitchell wastewater treatment lagoon west along Randolph Rd to Willow Ridge Rd 2. North along Willow Ridge Rd to Prefontaine Rd 3. West along Prefontaine Rd to the WWTF
	Kleefeld	1. From Kleefeld wastewater treatment lagoon north along 24 Rd E then north along Willow Ridge Rd to Prefontaine Rd 2. West along Prefontaine Rd to the WWTF
	Grunthal	1. From Grunthal wastewater treatment lagoon west along Gnadenfeld Rd to 24 Rd E 2. North along 24 Rd E then north along Willow Ridge Rd to Prefontaine Rd 3. West along Prefontaine Rd to the WWTF

2.1.2 Regional Wastewater Treatment Facility

The land on which the WWTF is to be constructed is owned by the Town of Niverville. The Status of Title is number 2194825/1. A copy of the title is available in Appendix A.

2.2 Owner of the Land

The regional conveyance system will be within road ditches, municipal rights-of-way, and the existing wastewater treatment lagoon sites owned by the RMs of Hanover, Ritchot, and Taché.

The approximately 9 ha parcel of land for the proposed WWTF is adjacent to the existing Niverville wastewater treatment lagoon and is owned by the Town of Niverville.

Much of the outfall from the WWTF (see Section 2.4.4: Outfall) will be along municipal rights-of-ways. The exception to this is the discharge to a drainage ditch that flows through private land. The RM of Ritchot and Jacobs have met with the landowner to discuss this future use and any required easements to facilitate the work.

2.3 Description of Existing Land Use Designation and Proposed Changes

The proposed conveyance network will involve the construction of new lift stations and repurposing of wastewater treatment lagoon cells at each of the existing RSR wastewater treatment lagoons. The existing land use designation for the existing wastewater treatment lagoon sites is summarized in Table 2-3. The existing land use designation is not expected to change as a result of this Project.

Table 2-3. Summary of Land Use Designation – Existing Wastewater Treatment Lagoon Sites

Community[a]		Land Use Designation
Town of Niverville		Lagoon Site: Agricultural General and is deemed a Public Utility Surrounding Land: Agricultural Policy Area
RM of Ritchot[b]	St. Adolphe	Lagoon Site: Environmental Policy Area Surrounding Land: Green/Agricultural Policy Area (N, S, E), Urban Centre Policy Area (W)
	Ste. Agathe	Lagoon Site: Environmental Policy Area Surrounding Land: Green/Agricultural Policy Area (N, W), Enterprise Centre Policy Areas/Enterprise Centre Hold Policy Areas (E, S)
	Ile des Chênes	Lagoon Site: Environmental Policy Area Surrounding Land: Green/Agricultural Policy Area (N, S, E, W)
RM of Taché	Lorette	Lagoon Site: Agriculture General Surrounding Land: Agriculture General (N, S, E, W)
	Landmark	Lagoon Site: Agriculture General Surrounding Land: Agriculture General (N, S, E, W)

Community[a]		Land Use Designation
RM of Hanover[c]	Blumenort	Lagoon Site: Agriculture General Surrounding Land: Agriculture General (S, W), Agriculture Limited (E), Agricultural Area (N)
	New Bothwell	Lagoon Site: Agriculture Limited Surrounding Land: Agriculture General (N), Agriculture Limited (S, E), Mixed Residential/Commercial/Other (W)
	Mitchell	Lagoon Site: Agriculture Limited Surrounding Land: Agriculture General (N, W), Agriculture Limited/General (S), Agriculture Limited (E)
	Kleefeld	Lagoon Site: Agriculture Limited Surrounding Land: Agriculture Limited (N, S), Mixed Residential/Commercial/Other (E), Agriculture General (W)
	Grunthal	Lagoon Site: Agriculture Limited Surrounding Land: Agriculture Limited (W, S), Agriculture Limited/Residential (N), Mixed Residential/Commercial/Other (E)

[a] Government of Manitoba n.d.g.
[b] WSP, March 2023
[c] Landmark Planning & Design Inc., October 2018

N = North
S = South
E = East
W = West

2.3.1 Regional Pipeline

The regional pipeline network, conveying wastewater to the WWTF will be constructed within existing road rights of way. The predominant land use along these roadways is agricultural. There are isolated residential homes along portions of the conveyance route.

2.3.2 Regional Wastewater Treatment Facility

The parcel of land for the regional WWTF is currently designated as Agricultural General and is deemed a Public Utility. The land designation will not change.

The land surrounding the proposed WWTF is designated as an Agricultural Policy Area, and the land designation will not change.

The land use immediately surrounding the proposed WWTF is agricultural with a few isolated residential homes. To the east is a business, Cold Country Spray Foam. The predominant residential area is in the Town of Niverville and is located about three (3) kilometers south of the proposed WWTF.

2.4 Overview of the Proposed Development

This Project includes two components, the regional wastewater conveyance network and the regional wastewater treatment facility. This section outlines the design criteria for the Project, and an overview of the design of these two components.

2.4.1 Project Design Criteria

The following sections provide a summary of the basis of design for the conveyance system and wastewater treatment facility. The design effluent criteria are provided, along with the 2045 design population, hydraulic loading, and organic loading.

2.4.1.1 Design Effluent Criteria

The effluent discharge criteria are defined by the following regulations that govern the quality of treated effluent to be discharged from the new RSRWC WWTF:

- Manitoba Environment, Climate and Parks (now Environment and Climate Change). 2011. Manitoba Water Quality Standards, Objectives, and Guidelines.
- Environment Canada. 2012. Fisheries Act. Wastewater Systems Effluent Regulations SOR/2012-139.

The treated effluent from the new RSRWC WWTF must meet the parameters outlined in Table 2-4.

Table 2-4. Effluent Quality Parameters

Parameter	Effluent Limit	Comments
Carbonaceous Biochemical Oxygen Demand, $cBOD_5$ (mg/L)	≤25 mg/L[a]	Monthly average
Total Suspended Solids, TSS (mg/L)	≤25 mg/L[a]	Monthly average
Total Phosphorus, TP (mg/L)	≤1 mg/L[b]	30-day rolling average
Total Nitrogen, TN (mg/L)	≤15 mg/L[b]	30-day rolling average
Un-ionized ammonia (mg/L)	<1.25 mg/L[a]	Expressed as nitrogen (N) at 15°C
Fecal coliform organisms or *E. coli* (MPN/100 ml)	<200[b]	
Total ammonia (mg/L total ammonia as N)	TBD[b]	Will not exceed a site-specific limit derived from the Manitoba Water Quality Objectives
Total residual chlorine (mg/L)	0.02 mg/L[a]	If chlorine or one of its compounds is used in the treatment process

Source:
[a] Environment Canada. 2012. Fisheries Act. Wastewater Systems Effluent Regulations SOR/2012-139.
[b] Manitoba Environment, Climate and Parks (now Environment and Climate Change). 2011. Manitoba Water Quality Standards, Objectives, and Guidelines.

°C = degree(s) Celsius
< = less than
MPN = most probable number
TBD = to be determined

Acute lethality testing will be required for the new facility. Effluent is considered acutely lethal when at 100 percent concentration (undiluted), it kills more than 50 percent of the Rainbow Trout subjected to it during a 96-hour period, in accordance with the federal Wastewater Systems Effluent Regulations. For a facility of the size of the RSRWC WWTF, quarterly testing is required.

In addition, the provincial *Water Quality Standards, Objectives, and Guidelines* state that for all new and expanding facilities, the best practical technology for beneficial use of valuable resources, such as nutrients, organic matter, and energy contained within municipal biosolids and sludge, is to be used.

2.4.1.1.1 Total Ammonia

The effluent from the WWTF is expected to be within a range of 6.8 to 7.2, and the temperature is expected to be within a range of 12ºC to 25ºC.

Applying the equation for a 30-day averaging period for the Tier II – Water Quality Objectives for Total Ammonia, the limits at different pH and temperatures, are captured in Table 2-5. The lowest total ammonia limit of 2.7 mg/L would be observed at a pH of 7.2 and temperature of 25ºC, while the highest total ammonia limit of 6.3 mg/L would be observed at a pH of 6.8 and temperature of 12ºC.

Table 2-5. 30-Day Average Total Ammonia Limit

Effluent pH and Temperature	Total Ammonia Limit (mg/L)
6.8 pH, 12 ºC	6.3
6.8 pH, 25 ºC	3.2
7.2 pH, 12 ºC	5.4
7.2 pH, 25 ºC	2.7

2.4.1.1.2 Other Effluent Guidelines and Objectives

The Manitoba Water Quality Standards, Objectives, and Guidelines (MWQSOG), also includes additional Tier II Water Quality Objectives, and Tier III Water Quality Guidelines. Section 2.4.3.3.4: Predicted Effluent Quality, includes a discussion of these parameters for the predicted effluent.

2.4.1.2 Sources of Wastewater

Within the RSRWC, wastewater is produced from various sources, including residential, commercial, industrial, and septage hauling. Each of these sources has been accounted for to derive the design average hydraulic and organic loading for 2040. The sources of wastewater in each community are summarized below in Table 2-6.

Table 2-6. Sources of Wastewater in the RSRWC

Community	Residential/ Commercial	Large Industrial/ Commercial	Wastewater Hauling
Town of Niverville	✓	✗	✓ holding tanks/septic tanks
RM of Ritchot	✓	✓ Viterra – Canola Processing	✓ holding tanks

Community	Residential/ Commercial	Large Industrial/ Commercial	Wastewater Hauling
RM of Taché	✓	×	✓ septic tanks
RM of Hanover	✓	✓ 1. Exceldor – Poultry Production 2. Blue Water Wash – Livestock Truck Washing Facility 3. Country Meat and Sausage – Meat Processing 4. Bothwell Cheese – Cheese Production 5. Lactalis – Dairy Processor	✓ holding tanks/septic tanks

2.4.1.3 Serviced Population

The capacity of the lift stations, force mains, and treatment facility for the regional system are to be designed to meet the ultimate residential and industrial population design horizon for 2040. To determine the ultimate residential population, the existing populations of each community were provided together with an assessment of the potential growth until 2040. These 2040 projections were developed in consultation with each community, and through review of census information from Statistics Canada and review of previous reports and studies.

The populations in Table 2-7 include those that will be directly connected to the wastewater conveyance network and wastewater treatment facility. The population from rural settlements producing hauled waste (i.e., not directly connected) in the RM of Ritchot and the RM of Taché have not been included in this table. The contribution of flows and loads from hauled waste, including that from the RM of Ritchot and the RM of Taché, is accounted for in Table 2-9 and Table 2-16, respectively.

The approximate serviced population of the RSRWC in 2023 is 29,104, increasing to a projected serviced population of 50,231 by 2040. The anticipated annual average growth rate is 3.3% across all communities in the 17-year period from 2023 to 2040.

Table 2-7. Existing Serviced Population (2023) and Projected Serviced Population (2040)

Community/ Municipality		Existing Population (2023)	Projected Population (2040)	Annual Avg. Growth Rate (%)
Town of Niverville		6,494	13,725	4.5%
RM of Hanover	Blumenort	2,935	4,110	2.0%
	New Bothwell	929	1,138	1.2%
	Mitchell	3,532	5,837	3.0%
	Kleefeld	2,143	3,542	3.0%
	Grunthal	2,157	2,449	0.7%
	Hanover Total	**11,696**	**17,076**	**2.3%**

Community/ Municipality		Existing Population (2023)	Projected Population (2040)	Annual Avg. Growth Rate (%)
RM of Ritchot	St. Adolphe	2,136	3,897	3.6%
	Ste. Agathe	955	1,251	1.6%
	Île-des-Chênes	2,200	4,014	3.6%
	Grande Pointe	364	2,183	+107 persons per year
	Ritchot Total	**5,655**	**11,344**	**4.2%**
RM of Taché	Landmark	1,394	1,517	0.5%
	Lorette[a]	3,865	6,568	3.2%
	Taché Total	**5,259**	**8,085**	**2.6%**
Total Serviced Population		**29,104**	**50,231**	**3.3%**

[a] Includes the Prefontaine Road Development

2.4.1.4 Hydraulic Loading

Jacobs completed a detailed review of previous reports and available lift station data to establish the 2045 average day flows for the Project. A general observation across the RSR communities was that of a relatively low per capita flow (unit flow rate) when compared to catchments observed in prior projects. However, consultation with representatives from each community confirmed the validity of these lower per capita flows. Additionally, the lower per capita flows represent the level of water conservation being adopted nationally.

For the purpose of deriving the flows and loads from the various municipalities in the RSRWC, a per capita flow (unit flow rate) of 250 litres per capita per day (L/c/d) was adopted. For some communities, an alternate per capita flow was used based on flow monitoring results and discussion with community representatives:

Kleefeld 200 L/c/d

Grunthal 435 L/c/d

New Bothwell 280 L/c/d

Mitchell 280 L/c/d

The flows and loads determined for each major catchment generally include some fraction associated with institutional, commercial, and industrial (ICI) wastewater generation. Institutional customers include schools, hospitals, colleges, and similar establishments. Commercial customers include retail and wholesale operations, food and beverage facilities, hotels and motels, and similar. Industrial customers include light industrial (relatively dry) operations. Large, wastewater-generating industrial operations are generally considered as unique operations. In the case of RSR, these operations include the following:

- New Bothwell: Bothwell Cheese (cheese production)
- Ste. Agathe: Viterra (canola processing)
- Blumenort: Country Meat and Sausage (meat processing)

- Blumenort: Blue Water Wash (livestock truck washing facility)
- Blumenort: Granny's Poultry (poultry production)
- Grunthal: Lactalis (dairy processor)

Typically, ICI contributions account for 5 to 25 percent of the flows and loads conveyed to a treatment plant. For this work, 15 percent contributions have been assumed and have been assumed to be consistent across the catchment. Therefore, for a per capita flow of 250 L/c/d, 212.5 L/c/d is assumed to be from the residential population, and the remainder is from ICI flows.

On a per area basis, it has been assumed that ICI flows would be approximately 15 cubic metres per hectare per day (m^3/ha/d) in communities that had per capita wastewater generation rates of 250 L/c/d; for communities with higher or lower per capita flows, the ICI flows have been prorated proportionally. For example, in Kleefeld the wastewater generation rate is 200 L/c/d which is 20% lower than 250 L/c/d. Therefore, the ICI flows are 20% lower at 12 m^3/ha/d.

The base value of 15 m^3/ha/d is slightly less than the value recommended in the City of Winnipeg's *Wastewater Flow Estimation and Servicing Outlines* (2020), which suggests that a flow of 16.8 m^3/ha/d be used for commercial development. However, 15 m^3/ha/d was selected for the ICI flows, as this lower value reflects more recent advances in water use efficiency.

Accordingly, the residential and ICI components for each of the RSR communities would be as summarized in Table 2-8.

Table 2-8. Residential per Capita Flows and ICI Unit Flows

Community	Residential per capita flow (L/c/d)	ICI unit flow (m^3/ha/d)
Niverville	212.5	15
St. Adolphe	212.5	15
Ste. Agathe	212.5	15
Île-des-Chênes	212.5	15
Grande Pointe	212.5	15
Landmark	212.5	15
Lorette	212.5	15
Blumenort	212.5	15
New Bothwell	238	16.8
Kleefeld	170	12
Mitchell	238	16.8
Grunthal	370	26.1

According to these assumptions, 1.0 hectare of ICI land would be associated with a population of 400 people. This approach was taken to account for the large ICI developments planned in several communities that would exceed the development that might be expected through organic growth in proportion to the increases in the community population.

The current flows from the existing large wastewater-generating operations that are listed above, were quantified from available lift station data. The projected 2040 flows were determined through discussion with community and industry representatives. A general assumption was made that the 2040 wastewater flows would be consistent with current operations, unless industry indicated that they were expecting to expand their operations.

Another wastewater contribution to the system is expected from septage haulers that empty septic and holding tanks in areas not serviced by central collection systems, mostly consisting of rural settlement.

Summarized in Table 2-9 is the projected design average flows for 2040 from all wastewater sources. The 2040 design average flow is 19,024 m^3/d (19.0 ML/d). The largest wastewater contributor is the RM of Hanover due to its projected population and significant industry presence. The Town of Niverville and the RM of Ritchot are expected to each contribute around a quarter of the total flow, and the RM of Taché is expected to contribute the least at 13% of the total flow.

Table 2-9. Projected Design Average Hydraulic Loading for 2040.

Source	Town of Niverville	RM of Ritchot	RM of Taché	RM of Hanover	Total
Residential (m^3/d)	2,917	2,411	1,718	4,041	**11,087**
Base ICI (m^3/d)	515	445	303	713	**1,976**
Additional ICI (m^3/d)	1,307	1,327	389	123	**3,146**
Industry (Existing) (m^3/d)	0	230	0	2,514	**2,744**
Wastewater Hauling (m^3/d)	1.4	38.9	4	26.3	**70.6**
Total (m^3/d)	**4,740**	**4,452**	**2,414**	**7,417**	**19,024**
Contribution (%)	25%	23%	13%	39%	

2.4.1.4.1 Peak Hydraulic Loading

The instantaneous peak flow is the critical flow that a wastewater treatment plant must be designed to handle. The plant must pass this flow without flooding and without suffering significant treatment deterioration. However, in the case of the RSRWC facility, wastewater flows directed to the plant will be buffered to minimize the peak flows that need to be conveyed to the plant. The collection and transmission system design will limit the flow from any one main contributor to 1.3 times the average annual flow from their specific catchment. Flows exceeding this amount will be equalized using temporary storage. The storage contents will be pumped to the plant when the influent flow from that catchment declines to less than 1.3 times the average flow. Details on the conveyance system design are provided in Section 2.4.2, Wastewater Conveyance System.

A typical peaking factor for a relatively small catchment would range from 2.5 to 5.0 depending on the age and condition of the sewage system, the proportion of the system that could be subjected to flooded conditions (for example, maintenance hole flooding), and sewer installation practices that limit extraneous flow entry into the collection system, for instance, prohibition of discharges from roof drains or building perimeter weeping tiles to the sanitary sewer system.

It is prudent to design the plant for a slightly greater peak flow. Accordingly, the design peak flow will be 28.5 ML/d, which is about 1.5 times the average annual flow. During wet weather periods, this peak could extend longer than 7 days and even as many as 20 days given that the flows will remain high as stored wastewater inventories are emptied.

Other peak flow factors for maximum month conditions have been estimated based on experience elsewhere. Peaking factors for maximum week and maximum day conditions are assumed to equal the maximum flow to the plant given that the flows will be buffered upstream, but the resulting maximum flows will extend for relatively long periods.

Table 2-10 summarizes the peaking factor for various periods.

Table 2-10. Peaking Factors

Condition	Ratio of Flow Condition to Average Annual
Average Annual	1.0
Maximum Month	1.3
Maximum Week	1.5
Maximum Day	1.5
Instantaneous Peak	1.5

Based on these peaking factors, the design flows for the WWTF are shown in Table 2-11.

Table 2-11. Design Flows for the RSRWC WWTF

Parameter	Value
Flows	
Average annual, ML/d	19.0
Maximum month, ML/d	24.7
Maximum week, ML/d	28.5
Peak instantaneous, ML/d	28.5

2.4.1.5 Organic Loading

To derive the loads from the various municipalities in the RSRWC, the values in Table 2-12 have been adopted.

Table 2-12. Load Values

Parameter	Per Capita Load (g/c/d)
BOD	85
TSS	90
TKN	14
TP	2.1

BOD = biochemical oxygen demand
g/c/d = gram(s) per capita per day
TKN = total kjedahl nitrogen
TP = total phosphorus
TSS = total suspended solids

The per capita loads are based on those determined for several larger jurisdictions in Western Canada, but are relatively consistent given the relative level of affluence throughout the region. As with the flows, 85 percent of the load was attributed to residential contributions; the remaining 15 percent was associated with the ICI contribution. Accordingly, the per capita loads for residential wastewater generation and per area loads for ICI wastewater were partitioned to determine the values listed in Table 2-13. Based on available sampling data in the RSRWC, these loading rates provide a conservative estimate.

Table 2-13. Partitioned Residential and ICI Unit Loads

Parameter	Residential per capita loads (g/c/d)	ICI per capita flow (kg/ha/d)
BOD	72.25	5.10
TSS	76.25	5.40
TKN	11.90	0.84
TP	1.78	0.13

kg/ha/d = kilogram(s) per hectare per day

For communities with a large existing population that is serviced by low pressure sewer (LPS), where the wastewater is delivered to the collection system from the second chamber of a septic tank, the values in Table 2-13 were slightly modified, with a reduction in the BOD by 20 percent and a reduction in the TSS by 10 percent. These reduced loads were applied only to the portion of the population that is currently serviced by LPS and all population growth was considered serviced by gravity sewer; therefore, the complete loads in Table 2-13 were applied.

The projected loadings for the existing large industrial wastewater producers were generally based on historical sampling results, and sampling results collected in 2023. In certain circumstances, more conservative concentrations were applied based on Jacobs' experience on other projects. A summary of the concentrations used to develop the loadings of the industrial contributors are included in Table 2-14.

Table 2-14. Industrial Wastewater Contributions

Parameter	BOD (mg/L)	TSS (mg/L)	TKN (mg/L)	TP (mg/L)
Bothwell Cheese	1,050	400	50	20
Viterra	800	300	5	0.25
Country Meat and Sausage	800	400	300	20
Blue Water Wash	100	300	20	5
Granny's Poultry (Exceldor)	700	400	100	20
Lactalis	1,200	400	100	25

The loading contribution from hauled wastewater sources (holding tanks, septic tanks) was determined from limited sampling data, standard wastewater characteristics (Ministry of the Environment, 2023), and based on Jacobs' experience on other projects. A summary is provided in Table 2-15.

Table 2-15. Holding Tank and Septic Tank Contribution

Parameter	Holding Tanks	Septic Tanks
BOD (mg/L)	200	6,000 – 7,000
TSS (mg/L)	195	15,000
TKN (mg/L)	40	700
TP (mg/L)	6	250

The unit loads described above were used to derive the projected loading in kilograms per day (kg/d) for each community as summarized in Table 2-16.

Table 2-16. Projected Future (2040) Wastewater Loads

Community	BOD Load (kg/d)	TSS Load (kg/d)	TKN Load (kg/d)	TP Load (kg/d)
Niverville				
Residential	991.6	1,050.0	163.3	24.4
Base ICI	175.0	185.3	28.8	4.5
Additional ICI	444.4	470.6	73.2	11.3
Septage Hauling (holding/septic tanks)	8.2	20.5	1.0	0.3
Niverville Subtotal	1,619.2	1,726.4	266.3	40.5
RM of Ritchot				
Residential	819.6	867.8	135.0	20.2
Base ICI	151.3	160.2	24.9	3.9
Additional ICI	451.2	477.7	74.3	11.5
Hauling (holding tanks)	7.8	7.6	1.6	0.2
Industrial (Viterra)	183.8	68.9	1.1	0.1
RM of Ritchot Subtotal	1,613.7	1,582.2	236.9	35.9
RM of Taché				
Residential	566.3	609.0	96.2	14.4
Base ICI	99.9	107.5	17.0	2.6
Additional ICI	132.2	139.9	21.8	3.4
Hauling (septic tanks)	28.1	60.3	2.8	1.0
RM of Taché Subtotal	826.5	916.7	137.8	21.4
RM of Hanover				
Residential	1,116.2	1,244.1	203.2	30.4
Base ICI	197.0	219.6	35.9	5.6
Additional ICI	40.4	42.8	6.7	1.0

Community	BOD Load (kg/d)	TSS Load (kg/d)	TKN Load (kg/d)	TP Load (kg/d)
Industrial (Granny's, Blue Water Wash, and Country Meat and Sausage, Lactalis)	1,892.8	976.5	225.7	46.4
Hauling (septic)	158.0	394.9	18.4	6.6
RM of Hanover Subtotal	3,404.4	2,877.9	489.9	90.0
Total	**7,463.8**	**7,103.2**	**1,130.9**	**187.8**

Other wastewater characteristics can be derived from ratios between those parameters and the BOD, TSS, TKN, and TP. Various ratios have been used for the residential and ICI components of the wastewater as follows:

Chemical oxygen demand (COD):BOD	2.15
Volatile suspended solids (VSS):TSS	0.88
Ammonia-nitrogen (NH_3-N):TKN	0.66
Phosphate (PO_4-P):TP	0.70

The COD:BOD ratio for the specific industrial loads (for example, Viterra or Bothwell Cheese) were based on available information to the degree possible; where not available, the values were based on literature values for similar wastes or experience with similar wastes in other locations.

2.4.1.5.1 Maximum Loading

Wastewater treatment plants are designed to handle sustained loads that are higher than average. The degree to which loads "peak" is a function of the catchment size, ICI contributors, and various other factors. Because of the degree of flow buffering that will be practiced upstream of the wastewater treatment plant, the key sustained load is considered the maximum monthly value.

The contaminant loads that arrive at a wastewater treatment plant vary diurnally, monthly, and seasonally. Generally, those contaminants where the majority are found in particulate matter (such as TSS) experience greater variability than those that consist of a more significant soluble fraction. This phenomenon occurs because maximum loading events are often caused by the scouring of particulate material from the collection system during high-flow periods. Accordingly, maximum month loads of the various constituents of concern were assumed to equal the following:

Maximum Month:

BOD	1.20
TSS	1.25
TKN	1.20
TP	1.20

These ratios are slightly higher than generally found in larger municipalities given that smaller catchments experience greater load fluctuations.

The possibility exists that slug loads from industries will impact short term performance of the plant. The design of a BNR plant has some ability to deal with these slug loads given the longer solids retention times (SRTs) employed in the process and the contingency elements incorporated in design (backup chemical addition for phosphorus removal). Nonetheless, some industrial slug loads could cause operational upsets. It will be important for the RSRWC to monitor industrial loads and work with the industrial dischargers to buffer potential load peaks that could cause operational issues at the plant. The design loads for the WWTF are shown in Table 2-17.

Table 2-17. Design Loads for the RSRWC WWTF.

Parameter	Value
Flows	
Average annual, ML/d	19
Maximum month, ML/d	24.7
Maximum week, ML/d	28.5
Peak instantaneous, ML/d	28.5
BOD Loads	
Average annual, kg/d	7,465
Maximum month, kg/d	8,955
COD Loads	
Average annual, kg/d	15,205
Maximum month, kg/d	18,245
TSS Loads	
Average annual, kg/d	7,105
Maximum month, kg/d	8,880
VSS Loads	
Average annual, kg/d	6,040
Maximum month, kg/d	7,550
TKN Loads	
Average annual, kg/d	1,130
Maximum month, kg/d	1,355
NH_3-N Loads	
Average annual, kg/d	746
Maximum month, kg/d	895
TP Loads	
Average annual, kg/d	188
Maximum month, kg/d	225

Parameter	Value
PO_4-P Loads	
Average annual, kg/d	132
Maximum month, kg/d	158

2.4.1.5.2 Loading Fluctuations

There are no significant seasonal loading fluctuations expected. The wastewater generation from the residential population is continuous, and each of the existing major industries are year-round wastewater contributors.

The existing major industries are generally operating four to five days per week, with no process operations on the weekend or holidays. Cleaning of the process operations typically occurs during the weekday evenings and on the weekends. This schedule results in some fluctuation to the incoming wastewater flow and composition for a weekday compared to a weekend, resulting in some variability to the quality of the effluent that will be sent for treatment at the regional WWTF.

2.4.1.6 Industrial Service Agreements

Summarized in Table 2-18 are the existing industrial service agreements (ISA) in in the RSRWC.

Table 2-18. Existing Industrial Service Agreements.

Rural Municipality	Industry	Type of Industry
Ritchot	Viterra	Canola processing
Hanover	Exceldor	Poultry Production
	Country Meat and Sausage	Meat Processing
	Bothwell Cheese	Cheese Production
	Lactalis	Dairy Processor

For several industries, there is some pre-treatment of wastewater before it is discharged to the existing wastewater treatment lagoons for treatment. A summary of the pre-treatment is provided in Table 2-19.

Table 2-19. Summary of Industry Pre-treatment

Industry	Pre-treatment
Viterra	▪ No pre-treatment
Exceldor	▪ Primary and Secondary Dissolved Air Floatation ▪ Sludge does not enter the RSR system
Country Meat and Sausage	▪ Dissolved Air Floatation ▪ Sludge does not enter the RSR system
Bothwell Cheese	▪ Dissolved Air Floatation ▪ Sludge does not enter the RSR system
Lactalis	▪ No pre-treatment

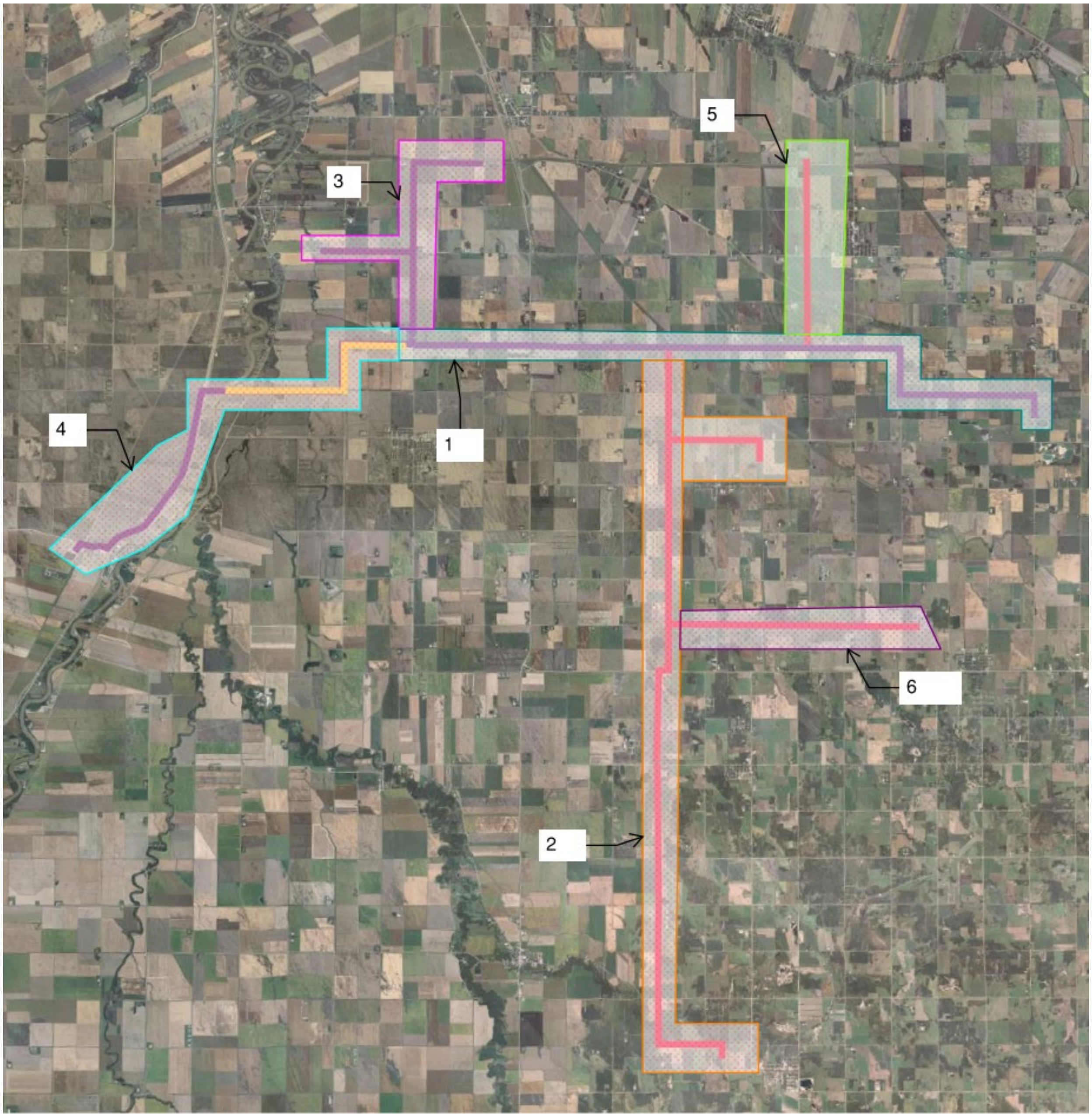
With the operation of the regional WWTF, it is envisioned that a single, general ISA agreement will be established to replace the existing, individual ISAs. The agreement will be between industry and the RSRWC. Any new industry in the network would also be required to sign onto the agreement.

2.4.2 Wastewater Conveyance System

2.4.2.1 Conveyance System Overview

The proposed wastewater conveyance system will include the construction of new lift stations at each of the RSRWC communities existing wastewater treatment lagoon sites and to transfer the wastewater flows to a wastewater treatment facility on the site of the existing wastewater treatment lagoon facility in the Town of Niverville. Transferring the flows to a central facility will allow the existing wastewater treatment lagoons to be abandoned or repurposed. The network for the new regional system is shown on Figure 2-2.

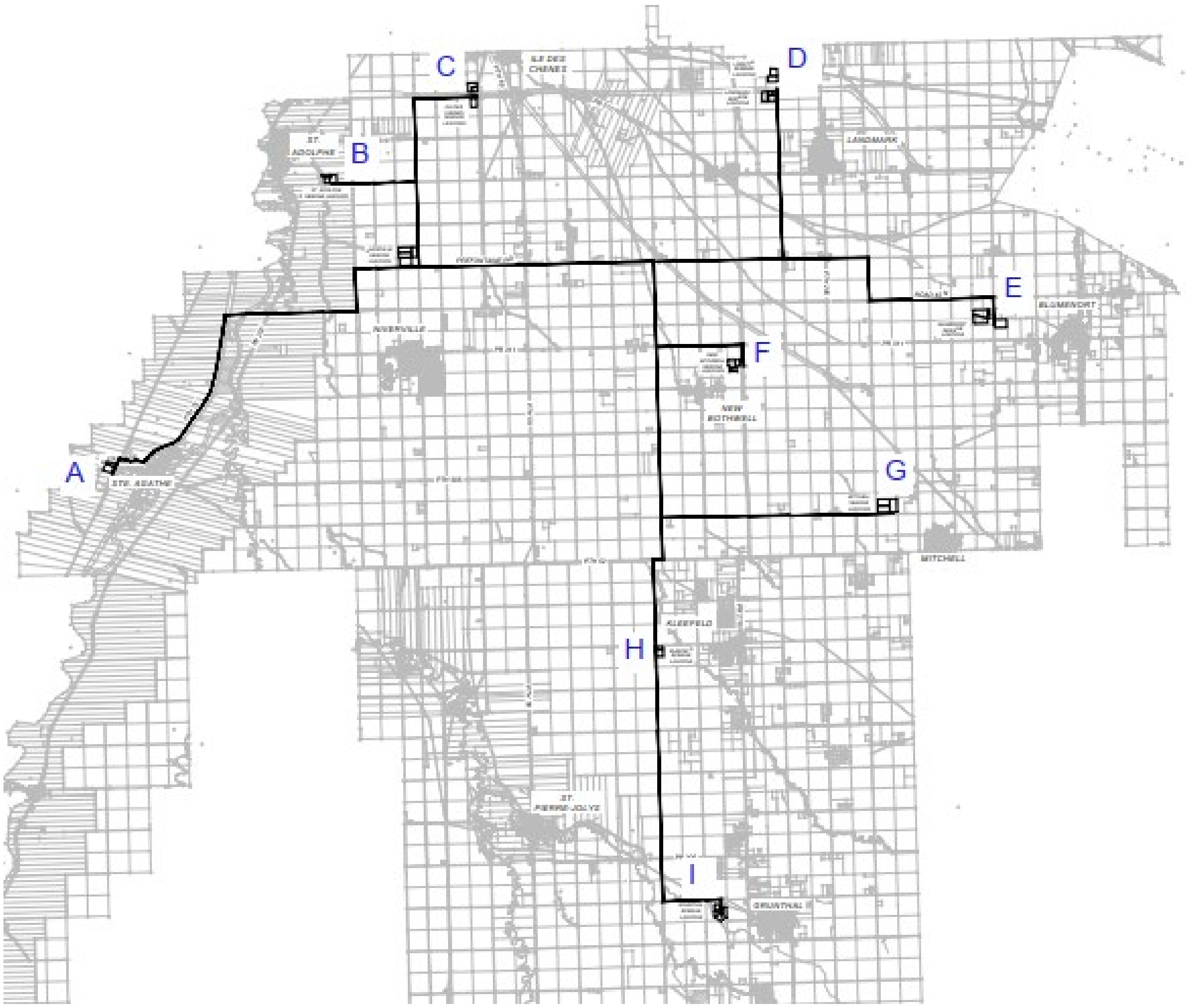
Figure 2-2. Conveyance System Configuration



1. *RSRWC to Blumenort*
2. *Prefontaine Road to Grunthal*
3. *St. Adolphe and Île-des-Chênes*
4. *Ste. Agathe*
5. *Landmark and Lorette*
6. *Willow Ridge Road to Mitchell*

Each community will have a singular lift station constructed to convey wastewater to the WWTF. The locations of these lift stations are shown on Figure 2-3.

Figure 2-3. Project Lift Station Locations



A.	*Ste. Agathe*	*D.*	*Lorette/Landmark*	*G.*	*Mitchell*
B.	*St. Adolphe*	*E.*	*Blumenort*	*H.*	*Kleefeld*
C.	*Île-des-Chênes*	*F.*	*New Bothwell*	*I.*	*Grunthal*

2.4.2.1.1 Conveyance Network – Crossings

The conveyance network spans a large regional area, and includes crossings of waterways, highways, and rail networks. These crossings are described briefly below. The Province of Manitoba's Historic Resources Branch has been engaged and is in dialogue with the Jacobs team to determine what monitoring efforts are required during construction; see Section 9.1.5, Heritage Resources for details.

2.4.2.1.1.1 Manitoba Infrastructure

Manitoba Infrastructure is the approval authority for crossing and parallel installations of pipe in the rights-of-way for provincially owned highways and waterways.

2.4.2.1.1.2 Waterways

The Province of Manitoba's Transportation and Infrastructure Department regulates the crossing of provincially controlled waterways under the authority of the *Water Resources Administration Act*. Crossings must occur at 3.0 m below the lowest point of the water body and be maintained throughout the right-of-way.

2.4.2.1.1.3 Highways

Typical installation requirements involve the use of a casing pipe around the carrier pipe for crossings extending 3.0 m away from the paved surface as well as for parallel installations within 3.0 m of the paved surface.

2.4.2.1.1.4 Rail

Multiple Canadian Pacific Kansas City Railway (CPKCR) and Canadian National Railway (CNR) rail crossings occur within the project. Crossings are to follow each utility's guidelines.

2.4.2.2 Development of Flow Through the Network

As there is significant growth expected in the RSR between now and the design horizon of 2040, consideration was given to how to design the conveyance network so that it has the flexibility to service the existing population as well as the future growth.

The 30% conveyance design has been sized based on 1.3 times the projected average day flow for 2045. Rather than the design year of 2040, the conveyance system will be sized for 2045, to confirm that the system contains sufficient capacity to serve the RSRWC over a sufficient time horizon since a pipeline cannot be easily expanded once installed. Given the large geographical footprint of the conveyance network, this design allows the construction of the network to be limited in the near-term, reducing the potential for disturbance to the surrounding communities.

2.4.2.2.1 Lagoon Equalization

One main objective of the wastewater conveyance strategy is to deliver a relatively consistent flow of wastewater to the regional WWTF, while minimizing temperature losses of the wastewater. A consistent flow of wastewater at the facility is optimal for maintaining performance and reducing the operational complexity of the facility. To achieve this objective, the existing wastewater treatment lagoons will be reconfigured to provide primary and secondary equalization of wastewater flows.

Primary equalization will consist of an underground chamber that provides temporary storage of wastewater when the wastewater flows exceed the available capacity of the new lift station. Wastewater will be intercepted before entering the lift station, and will temporarily remain in the primary equalization chamber until the lift station pump has capacity. This primary equalization design will reduce the peaks and troughs in the diurnal flow from each community, providing greater consistency in the flow at the WWTF. Additionally, the underground chamber design will mitigate significant wastewater temperature losses.

It is expected that during the spring (with snow melt) and during wet weather events, the rate of inflow would exceed the pumped flow rate of the lift station and the capacity of the primary equalization would be insufficient. In these scenarios, secondary equalization would occur with the wastewater overflowing and equalizing in one or more or the existing wastewater treatment lagoon cells. The number of cells required is community dependent.

After the high-flow event has passed, the pumps will continue to operate at the designed flows and head while the level in the primary and secondary equalization systems are drained to normal operation. Secondary equalization is not anticipated to occur during the winter months, so it is not expected that the temperature of the wastewater in the secondary equalization chambers would be reduced below the minimum 12ºC operating temperature of the WWTF.

The primary and secondary equalization strategy described above will be applied to all RSRWC communities. The final equalization strategy for the Town of Niverville may be altered, given its proximity to the proposed WWTF; the equalization strategy will be confirmed during detailed design in conjunction with the WWTF.

2.4.2.3 Conveyance Design Criteria and Considerations

As described above, the conveyance design strategy is to provide a consistent flow of wastewater to the plant while minimizing the pumping requirements for the conveyance system.

Sizing of the conveyance system was completed iteratively modify the sizes of pipes in the system and seeing a point of equilibrium where the desired flow rate is delivered, and the predicted pumping head is near a target of 35 metres (m). These two objectives facilitate pump selection and allow common pump models across lift stations for a given flow range. In addition, scouring velocities are achieved with a minimum requirement of 0.6 metre per second (m/s). The pumping stations will include elements to improve operation and maintenance as follows:

- Program pumping stations to provide regular "flushes" by pumping simultaneously with both pumps at least once per day.
- Size primary equalization to facilitate near continual pump operation, limiting opportunities for settlement during no or low-flow periods.

2.4.2.3.1 Lift Station Design

The work associated with the new lift stations (at each of the existing wastewater treatment lagoon sites) will include the following:

- Connection to the existing wastewater treatment lagoon, including new access gate, etc.
- Level control manhole and primary equalization chamber
- Lift station wet well, including pumps, valves, flow meter, etc.
- Controls and electrification

One of the prime considerations of the design is to standardize components, materials, and other elements to facilitate construction and maintenance. The lift stations will be prefabricated as described in Section 2.4.2.3.1.1: Pre-Fabrication.

2.4.2.3.1.1 Pre-Fabrication

To further leverage the standardization of lift stations across the existing wastewater treatment lagoon sites, the lift stations are anticipated to be prefabricated offsite in a fibreglass wet well. Prefabricated lift stations can be installed directly into an augured shaft adjacent to the existing wastewater treatment lagoon sites, limiting excavation footprint and duration.

2.4.2.3.1.2 Configuration

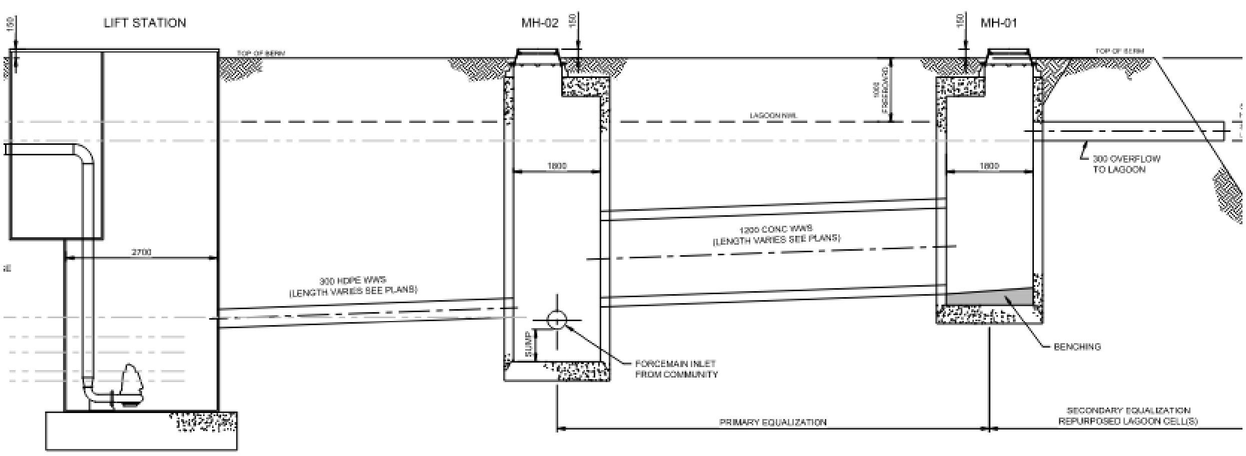
The prefabricated pump stations will have the following features:

- Side-mounted valve chamber for ease of maintenance
- Interior mechanical piping to accommodate triplex pumping (third pump socket to remain unused)
- Duplex submersible pumps, operating in a duty/standby configuration
- Flow meter on the discharge forcemain

2.4.2.3.2 Wastewater Treatment Lagoon Site Repurposing

Figure 2-4 illustrates the configuration of the lift station and wet well shown in a section view. The objective in selecting the proposed components for the primary equalization chamber was to select readily available and standard municipal construction products that can be obtained locally and constructed by a wide variety of sewer and water contractors.

Figure 2-4. Proposed Primary Equalization



Community wastewater treatment lagoons will require partial decommissioning of unused cells and redundant treatment systems, such as aeration or other tertiary treatment processes. Upon connecting to the RSRWC, the existing wastewater treatment lagoons with aeration will have their blowers powered down. Both aerated and facultative wastewater treatment lagoons will have their cells isolated from each other to limit the volume exposed to secondary equalization. Refer to Section 2.6.1: Decommissioning for further information.

At each existing wastewater treatment lagoon site, the existing lagoon cells will be repurposed to provide equalization of peak wet weather flows. The liner of the repurposed lagoon cells will not be modified.

2.4.2.3.3 Forcemain Design

The forcemain network was modelled using Bentley WaterGEMS. In the simulations, pipe sizes were incrementally changed to optimize the conditions throughout the model across all pumping points.

The following design criteria are represented in the model:

- High-density polyethylene (HDPE) DR17 pipe will be used throughout.
- A Hazen-Williams C-factor of 135 is applied, with best- and worst-case scenarios to be considered in subsequent design stages.
- The minimum depth of burial is 2.75 m to obvert of pipe unless otherwise indicated.
- Lagoon water levels are as indicated in available drawings.
- Pumping heads are balanced across the network to facilitate pump selection using a similar model series.

2.4.2.3.3.1 Appurtenances

Appurtenances (such as gate valves, cleanouts, and air release valves) will be used throughout the network. Gate valves will be installed at junction points, such as tees and crosses, where each leg will have a valve installed to provide full control to isolate flow. Air release/vacuum breaker valves will be installed at high points in the forcemain network.

The ultimate discharge point at the Niverville WWTF site is among the lowest elevations within the RSRWC catchment area, with some pumping points, such as Blumenort and Grunthal being 15 m and 25 m higher in elevation, respectively. This downhill change in elevation presents challenges to pumping characteristics and will require pressure-sustaining valve installation at critical locations.

Cleanout or flush-out assemblies are generally recommended for installation at key points in the pressure sewer system. Cleanouts allow maintenance staff to flush the lines periodically to remove deposited sediments from sections of the sewer line.

Cleanout locations are generally placed at the following spots to facilitate cleaning:

- End of every line
- Every connection to a branch line
- Every sharp bend in the system
- In the middle of long lengths of pipe (lengths greater than 1,000 m)

2.4.2.3.3.2 Lift Station Pumps and Forcemain Sizing

Table 2-20 provides a summary of the anticipated pipe sizing and associated length of segments that were determined from the model simulations. The sizing of the pumps at the new lift stations will be finalized as the conveyance design progresses.

Table 2-20. Anticipated Pipe Sizes and Lengths

ID	Description	Pipe Diameter (mm)	Length (m)
A	Ste Agathe to Niverville	200	17,500
B	St Adolphe to Krahn Road	150	3,200
C – 1	Île-des-Chênes to Niverville Leg 1	200	5,500
C – 2	Île-des-Chênes to Niverville Leg 2	300	2,800
D	Lorette to Prefontaine Road	300	6,600
E	New Bothwell to Willow Ridge Road	200	4,000
F	Mitchell to Willow Ridge Road	300	8,800

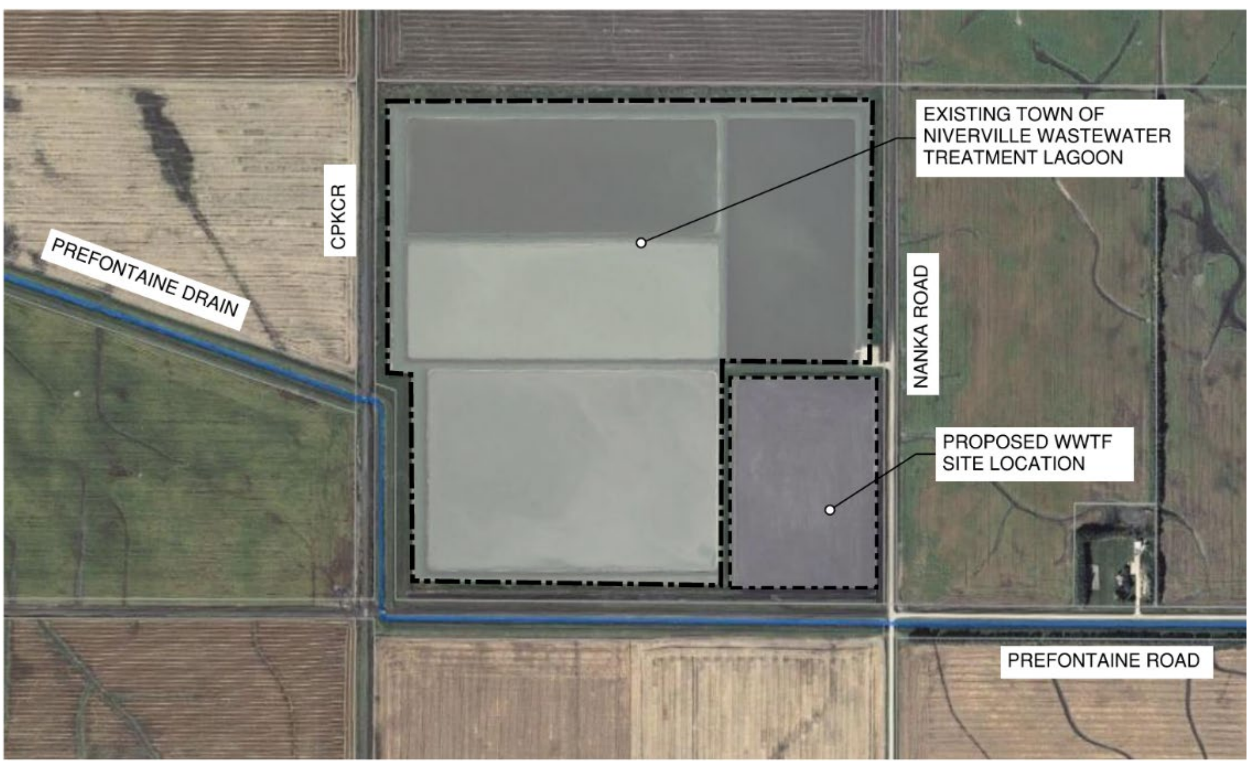
ID	Description	Pipe Diameter (mm)	Length (m)
G	Kleefeld to Willow Ridge Road	200	350
H	Grunthal to Prefontaine Road		
H – 1	Grunthal to Kleefeld	200	17,160
H – 2	Kleefeld to Mitchell	350	5,300
H – 3	Mitchell to New Bothwell	350	6,500
H – 4	New Bothwell to Prefontaine	400	3,300
I-1	Blumenort to Lorette tie-in	300	8,000
I-2	Blumenort to Lorette tie-in	250	1,600

2.4.3 Regional Wastewater Treatment Facility

2.4.3.1 Site Location

The site for the proposed RSR Wastewater Treatment Facility is at the existing Niverville wastewater treatment lagoon site, north of Niverville. A land parcel at the southeastern corner of the Niverville wastewater treatment lagoon site is allocated for the new facility's construction. The proposed site location for the new facility is shown on Figure 2-5.

Figure 2-5. Wastewater Treatment Facility Location



2.4.3.2 Facility Overview and Layout

The capacity of the WWTF will be designed to handle about 1.5 times the 2040 average daily flow of 19.0 ML/d for a total of 28.5 ML/d. Wet weather flow management will occur upstream of the WWTF through flow equalization, using the existing network of lagoons as described in Section 2.4.2, Wastewater Conveyance System.

The facility will be constructed for the initial 2040 flow and loading condition described in Section 2.4.1, Project Design Criteria. Further expansion of the plant, beyond the 2040 design, will be done by incorporating additional treatment process units when triggered by population thresholds or by a need to improve on treatment performance.

The facility is expected to be operational at the end of 2028. At this time, the wastewater flows and loads will be significantly lower than the 2040 design year. Through the equipment selection and detailed design process, the theoretical lowest and peak flows and loads that the facility could reasonably expect to receive over the course of operation between 2028 and 2040 will be taken into consideration. The upstream flow equalization will also support sending a more continuous and less intermittent flow of wastewater to the WWTF.

The Process Flow Diagrams for the liquid and solids steam process are provided in Appendix B.

2.4.3.3 Liquid Treatment

Wastewater from the RSRWC communities will be conveyed to the facility through a network of lift stations and sewer lines and will enter the facility's influent chamber. Additional sources of wastewater entering the influent chamber will be septage and flows from the septage receiving station, including sludge lagoon supernatant and filtrate from the rotary drum thickeners (RDTs). The wastewater will enter preliminary treatment consisting of influent bar screens, grit tanks, and influent fine screens. The debris collected by the bar screens will pass to a screenings washer and compactor, and the grit from the vortex grit tanks will pass to a grit classifier. The fine screen will remove the finer particles remaining in the wastewater. All debris and grit material removed in preliminary treatment will be collected in a grit and screenings bin for landfill disposal. Foul air from the influent and preliminary treatment will be collected and sent to the odour control system.

The degritted and screened wastewater will continue directly to the bioreactors, which are split into zones (pre-anoxic, anaerobic, anoxic, aerobic) to encourage biological nutrient removal (BNR). The bioreactors will contain a mixed liquor internal recycle stream and will receive return activated sludge (RAS) from the downstream membrane tanks. The mixed liquor from the bioreactors is pumped to a series of membrane tanks for solids-liquid separation. The recycle from the membrane tanks is returned by gravity to the bioreactors as RAS. Permeate is withdrawn under vacuum from the membranes and will be transferred to the outfall. A portion of the permeate is withdrawn and used in a reclaimed water system. Before its use in this system, a small amount of hypochlorite will be added to retain a chlorine residual before pumping the flow through the plant.

Each liquid stream process is described further in the following subsections. The information provided for the liquid treatment design is reflective of the 30% design stage. As the design progresses through 60% and 90% design, the design details are subject to change, but key unit processes are expected to remain the same.

2.4.3.3.1 Influent Chamber

The conveyance system proposed for the new WWTF will pump wastewater from the RSR member municipalities through a network of lift stations and sewer lines. The wastewater will discharge directly into the facility's influent chamber within the headworks building. This chamber also receives wastewater from the septage receiving station, which is used to accept hauled waste as well as all the plant's process recycle flows. Wastewater is pumped from the septage receiving station into the influent chamber.

With the exception of the Town of Niverville, each community has flow equalization, using the existing network of lagoons as described in Section 2.4.2: Wastewater Conveyance System. During wet weather events, if elevated flows are received from the Town of Niverville and surpass the design capacity of the plant, the wastewater overflows over a weir and is directed to the Niverville wastewater treatment lagoon for temporary storage. Once the event has passed, the additional flows stored at the Niverville wastewater treatment lagoon will be reintroduced into the plant for treatment.

2.4.3.3.2 Preliminary Treatment

Wastewater flows by gravity from the influent chamber to preliminary treatment. Preliminary treatment will remove debris and grit from the wastewater to minimize maintenance issues and operating difficulties in the downstream processes. Preliminary treatment will consist of the following processes:

- Coarse screening: Influent bar screens, screenings washer and compactor
- Grit removal: Grit tanks, grit classifier
- Fine screening: Influent fine screens

Foul air from the preliminary treatment building will be collected and sent to the odour control system.

2.4.3.3.2.1 Coarse Screening

This is the first stage of preliminary treatment which includes influent bar screening designed to remove large debris. There will be three channels constructed, each sized for 45 ML/d. For the initial 2040 design, only two of the three channels will be in use. For the initial 2040 construction, the first channel will contain a 30 ML/d mechanically raked screen with 6-millimetre (mm) openings. Channel 2 will be used as a bypass channel, and will contain a 45 ML/d manual screen with 12-mm openings. Channel 3 will be blocked off with knockout panels. For future plant expansions the 30 ML/d screen will be replaced by a 45 ML/d screen, and the third channel will be in use with a 45 ML/d screen.

Wet material removed through coarse screening will discharge directly to a screenings washer and compactor. The compacted screenings from the washer and compactor will be conveyed to a combined grit and screenings bin for offsite disposal.

A summary of the coarse screening design information is provided in Table 2-21.

Table 2-21. 2040 Coarse Screening Design Summary

Unit	Type	Description
Screens	Channel 1: Mechanically Raked Bar Screen Channel 2: Manually Raked Bar Screen	Number: 2 Capacity: 30 ML/d (Channel 1), 45 ML/d (Channel 2) Openings: 6 mm (Channel 1), 12 mm (Channel 2)
Screenings Washer and Compactor	Screw Conveyor	Number: 1 Dewatering Performance: 35% TS (minimum) Drive Type: Reversing
Coarse Screenings Conveyor	Shaftless Screw	Drive: Constant speed
Compacted Coarse Screenings	--	Daily Volume: 1.8 m^3/d average, 12.3 m^3/d peak Daily Volume: 1.5 T/d average, 15.4 T/d peak

mm = millimetre
ML/d = million litres per day
T/d = tonne per day
TS = total solids

2.4.3.3.2.2 Grit Removal: Grit Tanks, Grit Classifier

The effluent from the influent bar screens will flow by gravity to two 30 ML/d grit tanks that will remove grit composed of fine to coarse sand. The grit tanks are located upstream of the fine screens to protect the fine screens from grit. The grit tanks will also provide removal of fats, oil, and grease (FOG) from the influent wastewater. When the plant is expanded in the future to increase capacity, additional grit tanks will be added adjacent to the initial two grit tanks.

Screened wastewater will enter the concrete grit tanks, which are designed with two chambers. The first, small chamber contains fine bubble diffusion to raise floatable particles (FOG) in the wastewater to the surface. The particles accumulate and are removed by a paddle system before the outlet of the tank. The FOG is collected in a small pump that is pumped to combine with the Waste Activated Sludge (WAS) ahead of the anaerobic digesters.

The second chamber of the grit tank is unaerated and contains lamella units that serve to increase the surface area of the tank and promote solids settling. At the bottom of the tank, the collected grit is removed axially by a time-controlled horizonal screw conveyer. A grit pump for each tank transfers the grit slurry to a common grit classifier which washes the grit to remove organics, and subsequently dewaters the grit before it is discharged into the combined grit and screenings bin for offsite disposal. The organics from the dewatered grit are recycled to the front of the plant for treatment.

The grit removal tanks will be designed to achieve 95 percent removal of greater than 80 micrometre (μm) inorganic solids at average flows, and 95 percent removal of greater than 110 μm inorganic solids at peak flows. The grit classifier will be sized to capture more than 95 percent of the grit and produce a product that is greater than 90 percent solids and has less than 5 percent organics residual.

A summary of the grit tank design information is provided in Table 2-22.

Table 2-22. Grit Screening Design Summary

Unit	Type	Description
Grit Removal	Aerated/Unaerated Grit Trap Chamber With Lamella	Number: 2 Capacity: 30 ML/d Performance: ▪ 95% solids removal of > 80 µm at average flow ▪ 95% solids removal of > 110 µm at peak flow Tank Dimensions: TBD
Grit Pumping	Recessed Impeller	Number: 2 Capacity: 25.7 L/s Head: 9 m (TBC) Power: 5.625 kW (TBC)
Grit Classifier and Dewatering	Mechanically Mixed Vortex, High Efficiency	Number: 1 Performance: ▪ 95% minimum capture ▪ 90% minimum solids content ▪ 10% maximum volatile fraction
	Vertical Entry, Propeller Mixer	Power: 1.5 kW (TBC)
	Shafted Screw Conveyor	Power: 2.25 kW (TBC)
Dewatered Grit	--	Daily Volume: 0.4 m^3/d average, 1.9 m^3/d peak Daily Volume: 0.6 T/d average, 2.8 T/d peak

D = depth
L = length
T/d = tonne per day
TBC = to be confirmed during detailed design
VFD = variable frequency drive
W = width

2.4.3.3.2.3 Fine Screening: Influent Fine Screens

Following grit removal, fine screens will remove additional particles in the wastewater that could cause downstream operational problems or maintenance issues with the facility. Similar to the coarse screening, there will be three channels constructed, each sized for 45 ML/d. For the initial 2040 design, only two of the three channels will be in use, and will contain 30 ML/d fine screens. For future plant expansions the 30 ML/d screens will be replaced by 45 ML/d screens, and the third channel will be in use with a 45 ML/d fine screen.

For the initial 2040 construction, the Channel 1 and Channel 2 will contain 30 ML/d screens, with Channel 3 blocked off by a knockout panel. Each screen will be fitted with perforated plates with 2 mm openings, which is necessary to protect the membranes within the MBR. Both screens will be inclined rotary drums and incorporate an integral compactor in each unit. The screens will be staggered in their channel so the solids discharged by the integral compactors can be transported by separate conveyors to deliver compacted screenings to the combined grit and screening bin for disposal offsite.

A summary of the fine screening design information is provided in Table 2-23.

Table 2-23. Fine Screening Design Data

Unit	Type	Description
Fine Screens	Inclined Rotary Drum	Number: 2 Capacity: 30 ML/d Openings: 2 mm Driver Power: 2.25 kW (TBC)
Fine Screenings Compactor	Screw Conveyor, (integrated into screen)	Dewatering Performance: 35% TS (minimum) Drive Type: Reversible Power: 2.25 kW (TBC) Water Use: 2.5 L/s (TBC)
Fine Screenings Conveyor	Shaftless Screw	Length: 8 m (TBC) Diameter: 200 mm (TBC) Drive: Constant speed Power: 2.25 kW (TBC)
Compacted Fine Screenings	--	Daily Volume: 1.3 m^3/d average, 10.6 m^3/d peak Daily Volume: 1.1 T/d average, 9.0 T/d peak

kW = kiliwatt
L/s = litres per second
mm = millimetre
TS = total solids
TBC = to be confirmed during detailed design

2.4.3.3.2.4 Debris and Grit Handling

The solids collected from the coarse-screening, grit-removal, and fine-screening stages of preliminary treatment will discharge into a grit and screenings roll-off bin located within the headworks building. The headworks will be located above ground level, so the screenings and grit will be disposed of in the bin by gravity. There will be a door in the roll-off bin area to move the bins to the outside of the building so that the contents can be removed by an appropriately equipped truck. The truck will haul the contents to an approved landfill facility for disposal. The bin is expected to be emptied about twice per week.

The predicted average screenings load to be removed from the plant is 3.1 m^3/d, of which about 60 percent is related to the first stage screens. The predicted average grit load is 0.4 m^3/d. The peak loads will be 10 times the average values or potentially greater.

2.4.3.3.3 Advanced Secondary Treatment

In this WWTF design, no primary clarification is provided, so the membrane bioreactor (MBR) process will be directly downstream of the influent screening and grit removal. MBR provides secondary treatment and filtration, eliminating the requirement for secondary clarifiers.

2.4.3.3.3.1 Bioreactor Process Overview

The MBR process will consist of three bioreactors configured to achieve biological nutrient removal (nitrification, denitrification, and biological phosphorus removal) followed by the membrane tank for liquid-solids separation. For this WWTF, the bioreactors will be separated into eight zones with influent wastewater stream split between the pre-anoxic zone (about 10%), anaerobic zone (about 50%), and anoxic zone (about 40%). The return activated sludge (RAS) will be conveyed from the membrane tanks to the head of the pre-anoxic zone. A mixed-liquor recycle will transfer flow from the discharge end of Aerobic Zone 2 to the inlet end of the anoxic zone. The function of each bioreactor zone is summarized in Table 2-24.

Table 2-24. Function of the Bioreactor Zones

Zone	Description
Pre-Anoxic 1 and Pre-Anoxic 2	RAS denitrification using influent wastewater ($NO_3 \rightarrow NO_2 \rightarrow N_2$) COD consumption
Anaerobic 1 and Anaerobic 2	Fermentation of biodegradable COD Phosphorus release Absorption of simple substrates (VFAs)
Anoxic 1 and Anoxic 2	Internal recycle from Aerobic Zone 2 to the anoxic zone to supply nitrates for denitrification ($NO_3 \rightarrow NO_2 \rightarrow N_2$) COD consumption
Aerobic 1 and Aerobic 2	Nitrification ($NH_3 \rightarrow NO_2 \rightarrow NO_3$) Phosphorus uptake and storage COD assimilation and synthesis ($COD \rightarrow CO_2$ + Biomass)

CO_2 = carbon dioxide
N_2 = nitrogen
NH_3 = ammonia
NO_2 = nitrogen dioxide
NO_3 = nitrate
VFA = volatile fatty acid

The plant layout has been developed leaving space to the south of the three initial bioreactors for future expansion of the bioreactor area.

2.4.3.3.3.2 Membrane Filtration

Following the bioreactors, three (3) membrane tanks will operate in parallel. The tanks will house a series of individual membrane cassettes, each with several modules enclosed in a frame. Five membrane cassettes are provided in each tank, with space allowed for placing an extra cassette. Each membrane tank will be sized for an average flow of 6.5 ML/d and a sustained peak flow of 11.9 ML/d.

The membranes are anticipated to be hollow-fibre membranes connected to an upper and lower "pot." Permeate from the membranes will be drawn under vacuum by the permeate pumps and discharged to the outfall. Solids are retained within the membrane tank. These solids overflow the tank and either return by gravity to the pre-anoxic zone of the bioreactors as RAS or are pumped to rotary drum thickeners (RDTs) as waste activated sludge (WAS). The WAS rate will be selected to maintain the target solids retention time (SRT) of about 15 days.

The MBR process produces high-quality permeate with significantly reduced levels of microorganisms. The membranes selected for this Project will be capable of producing permeate that meets the effluent limits set out in Section 2.4.1.1: Design Effluent Criteria, including those for *E. coli*, thereby eliminating the need for supplemental disinfection.

A portion of the permeate from the membrane tanks will be used for backwash of the membranes. An additional portion of the permeate will be directed for use in the facility's reclaimed (non-potable) water system to offset the use of potable water at the plant. The following list summarizes potential uses for the reclaimed water:

- Commercial vehicles, driveway, and street washing
- Dust suppression and soil compaction
- Fire fighting
- Industrial use
- Internal use within the WWTF (seal water, tank washdown, toilet flushing, irrigation)
- Ponds and decorative use

The future WWTF design may consider the addition of a hose bib (i.e., exterior faucet) that will provide trucks access to the reclaimed water. Access to this water would be restricted and limited to applications that were consistent with non-potable water use such as landscape irrigation, dust control, etc. Use of reclaimed water outside of the plant site will need to meet the requirements for public health protection: signage, consideration of buffer zones from residences and waterways, etc.

2.4.3.3.3.3 Membrane Selection

For wastewater treatment, two types of membranes are available: (1) hollow-fibre membrane and (2) flat-sheet membrane. Generally, the membranes are manufactured of polyvinylidene fluoride (PVDF), although ceramic membranes have become available in flat-sheet arrangements. The type of membrane for this Project has not yet been determined; however, hollow-fibre membranes are most common for a facility of this size. Many of the design details for the membranes will be determined when the vendor and type of membrane is selected through the procurement process.

2.4.3.3.3.4 Membrane Fouling

Membrane performance is affected by fouling, which occurs from the accumulation of particulates or dissolved substances on the membrane surface or within the membrane pores. Fouling is managed through three pathways: (1) pre-treatment with screens, (2) operational fouling control, and (3) maintenance and recovery cleaning (Metcalf & Eddy 2014).

Air scouring is the primary method of operational fouling control, where a coarse-bubble aeration system applies air scouring to the membrane surface. The design of the air scour system is specific to the type of membrane and membrane supplier. Additionally, depending on the type of membrane and membrane supplier, a backpulse or relaxation operation may be used to detach solids from the membrane. Backpulsing is done by reversing the flow through the membrane using a backpulse of permeate water (Metcalf & Eddy 2014).

A chemical storage area will be used to house chemical tanks containing citric acid and sodium hypochlorite for membrane maintenance cleaning and recovery cleaning, in both instances as "Membrane clean-in-place (CIP)". Maintenance cleaning will be part of regular operation and will occur approximately once to twice per week using both citric acid and sodium hypochlorite. Recovery cleaning uses the same chemicals, but the chemicals are applied for a longer duration, with application occurring between one and four times per year (Metcalf & Eddy 2014).

2.4.3.3.3.5 Bioreactors and Membrane – Preliminary Design Details

The following tables, Table 2-25 through Table 2-27, summarize the preliminary design information for the bioreactors and membrane tanks. Many of the design details for the membranes will be determined when the vendor and type of membrane is selected through the procurement process.

Table 2-25. Bioreactor – Design Data

Parameter		Design Summary
Basic Design Criteria	SRT	15 d
	HRT	20.8 h
	MLSS Concentration	Average: 5,690 mg/L Maximum: 6,750 mg/L
Number of Trains		3
Volume, Dimensions	Total, per Train	5,500 m^3
	Nominal SWD	6.0 m
	Pre-Anoxic 1	275 m^3, 7.60 m (L) by 6.05 m (W)
	Pre-Anoxic 2	275 m^3, 7.60 m (L) by 6.05 m (W)
	Anaerobic 1	275 m^3, 7.60 m (L) by 6.05 m (W)
	Anaerobic 2	275 m^3, 7.60 m (L) by 6.05 m (W)
	Anoxic 1	335 m^3, 9.20 m (L) by 6.05 m (W)
	Anoxic 2	335 m^3, 9.20 m (L) by 6.05 m (W)
	Aerobic 1	1,865 m^3, 24.4 m (L) by 12.75 m (W)
	Aerobic 2	1,865 m^3, 24.4 m (L) by 12.75 m (W)
Mixers	Type	Hyperboloid
	Zones: Pre-Anoxic 1 Pre-Anoxic 2 Anoxic 1 Anoxic 2	Number: 1 per zone Drive Type: Constant speed Size: 1.0 kW (TBC)
	Zones: Anaerobic 1 Anaerobic 2	Number: 1 per zone Drive Type: VFD Size: 1.0 kW (TBC)

Parameter		Design Summary
Aeration	Aerobic 1	OUR: ▪ Average: 45.3 $mgO_2/L/h$ ▪ Maximum month: 54.1 $mgO_2/L/h$ ▪ Peak 75.7 $mgO_2/L/h$ Alpha: 0.45 SOTE: ▪ Average: 38.7% ▪ Maximum month: 37.9% ▪ Peak: 36.2% Residual DO: 2 mg/L SOTR: ▪ Average: 5,991 kgO_2/d ▪ Maximum month: 7,066 kgO_2/d ▪ Peak: 9,888 kgO_2/d Air Requirement: ▪ Average: 2,312 Nm^3/h ▪ Maximum month: 2,789 Nm^3/h ▪ Peak: 4,085 Nm^3/h Number of diffusers: ~1,500
	Aerobic 2	OUR: ▪ Average: 28.9 mgO2/L/h ▪ Maximum month: 35.3 $mgO_2/L/h$ ▪ Peak 49.4 $mgO_2/L/h$ Alpha: 0.50 SOTE: ▪ Average: 38.3% ▪ Maximum month: 37.4% ▪ Peak 35.7% Residual DO: 1.5 mg/L SOTR: ▪ Average: 3,261 kgO_2/d ▪ Maximum month: 3,950 kgO_2/d ▪ Peak: 5,528 kgO_2/d Air Requirement: ▪ Average: 978 Nm^3/h ▪ Maximum month: 1,185 Nm^3/h ▪ Peak: 1,658 Nm^3/h

Parameter		Design Summary
		Diffuser density: 0.118 Number of diffusers: ~900
Process Air Blowers	Air Requirements	10,750, 13,110, and 19,205 Nm^3/h (average, maximum month, and peak)
	Blowers	Number: 4 Type: High-speed turbo blowers Capacity: 6,400 Nm^3/h Backpressure: 64 kPa Power: 130 kW

~ = approximate
d = day(s)
DO = dissolved oxygen
h = hour(s)
kgO_2/d = kilogram(s) oxygen per day
kPa = kilopascal(s)
$mgO_2/L/h$ = milligram(s) oxygen per litre per hour
Nm^3/h = normal cubic metre(s) per hour
OUR = oxygen utilization rate
SOTE = standard oxygen transfer efficiency
SOTR = standard oxygen transfer rate

Table 2-26. Membrane Tanks – Design Data

Parameter		Design Summary
Number of Trains		3
Number of Membrane Cassettes		5, additional space for 1 cassette
Modules per Cassette		4 at 64 1 at 60
Surface Area per Module		49.24
Design Flux (net)		18.2 $L/m^2/h$ (avg.), 31.8 $L/m^2/h$ (peak)
Minimum Design Temperature		12°C
Mixed Liqour Suspended Solids Concentration		7,930 mg/L (avg.), 9,930 mg/L (max)
Membrane Tank	Volume	139 m^3
	Dimensions	12.5 m (L) by 3.05 m (W) by 3.65 m (SWD)
Air Scour Blowers	Number	4
	Type	Rotary Lobe
	Backpressure	34 kPa
	Blower Capacity	1,720 Nm^3/h
	Blower Power	22.5 kW (TBC)

Parameter		Design Summary
Membrane Cleaning	Hypochlorite	Storage: Chemical Totes Size: 1 m^3 per tote Number of Pumps: 2 (Duty/Standby)
	Citric Acid	Storage: Chemical Totes Size: 1 m^3 per tote Number of Pumps: 2 (Duty/Standby)

°C = degrees Celsius
D = depth
kPa = kilopascal
L = length
$L/m^2/h$ = litres per meter squared per hour
m = meter
m^3 = meter cubed
Nm^3/h = normal cubic metres per hour
SWD = side wall depth
TBC = to be confirmed during detailed design
VFD = variable frequency drive
W = width

Table 2-27. Membrane Bioreactor Pumps – Design Data.

Parameter	Design Summary
Nitrified Mixed Liquor Recycle Pumps	Number: 3 (1 per bioreactor train) Type: Horizontal propeller pump Drive: VFD Capacity: 530 m^3/h TDH: 1.0 m Power: 3.75 kW (TBC)
Membrane Feed Pumps	Number: 4 (1 per membrane train) Type: Solids handling pump Drive: VFD Capacity: 1,642 m^3/h TDH: 5.2 m (TBC) Power: 45 kW (TBC)
Permeate Pumps	Type: Rotary Lobe (reversible) Number: 3 (1 per membrane train) Drive: VFD Capacity: 495 m^3/h TDH: 40 m (TBC) Power: 45 kW

Parameter	Design Summary
Reclaimed Water Pumps	Type: End Suction Centrifugal Number: 4 (1 per membrane train, 1 future) Drive: VFD Capacity: 1,210 m^3/d TDH: 75.0 m Power: 7.5 kW

m^3/h = cubic metre(s) per hour
TDH = total dynamic head

2.4.3.3.4 Predicted Effluent Quality

At the design flow (19.0 ML/d) and peak flow (28.5 ML/d), the approximate monthly average effluent concentrations of the key effluent parameters are summarized in Table 2-28. The predicted effluent concentrations will be refined through the design process, including membrane selection.

In Section 2.4.3.12.1, Process Sampling Overview, is a summary of online and grab samples that will be taken throughout the treatment process. This includes a flow-proportional sampler on the membrane permeate analyzing for BOD, TP, TN, ammonia, TSS, and COD.

Table 2-28. Predicted Monthly Average Effluent Concentrations

Parameter	Average Permeate Concentration	Maximum Permeate Concentration
BOD_5	2 mg/L	<5 mg/L
TSS	1 mg/L (less than detection limit)	5 mg/L
TN	12 mg/L	<15 mg/L
NH_3-N	2 mg/L	<5 mg/L
TP	0.7 mg/L	<1.0 mg/L

BOD = Biochemical Oxygen Demand
TSS = Total Suspended Solids
TN = Total Nitrogen
NH_3-N = Ammonia Nitrogen
TP = Total Phosphorus

Other effluent characteristics are summarized in Table 2-29.

Table 2-29. Other Predicted Effluent Characteristics.

Parameter	Value
Temperature	Min: 12°C Max: 25°C
pH	Min: 6.8 Max: 7.2
Alkalinity	Target: 80 mg/L (measured as $CaCO_3$)
Chemical Oxygen Demand (COD)[1]	Avg.: 34 g-COD/m^3 Max Month: 27 g-COD/m^3
Dissolved Oxygen[1]	Avg: 1.6 g-O_2/m^3 Max Month: 1.3 g-O_2/m^3
Nitrate + Nitrite[1]	Avg: 6.8 g-N/m^3 Max Month: 6.1 g-N/m^3

$CaCO_3$ = Calcium Carbonate

1 Predicted effluent quality based on modelling in Sumo22 at steady-state.

2.4.3.3.4.1 Influent Sampling Campaign

In Spring 2023, the RSRWC conducted a sampling campaign to characterize the wastewater from the residential and industrial contributors in the RSRWC network. Sampling was conducted on the wastewater effluent from Bothwell Cheese, Exceldor, Viterra, Lactalis, and Country Meat and Sausage. Sampling of the residential wastewater was obtained from a source within the Town of Niverville, and was assumed to be representative of the residential contribution from all communities within the RSRWC.

The parameters selected for sampling included those that were expected in the residential and/or industrial wastewater streams, and included the following outlined in Table 2-30. Between one and eight or more sample results were obtained from each source for each parameter. Of the metals "3. Metals in Wastewater", and "4. Wastewater Sampling Parameters", typically only one analysis was completed. The residential wastewater was not tested for the "4. Wastewater Sampling Parameters".

Manitoba's Tier II Effluent Objectives and Tier III Effluent Guidelines contain different concentration limits depending on the water use and averaging period. For the purposes of this EAP, the water use considered was Aquatic Life for Surface Water. The cells in Table 2-30 highlighted in yellow, indicate the Tier II Effluent Objectives that influent samples are available. The cells highlighted in green, indicate the Tier III Effluent Guidelines that influent samples are available. In addition to the samples requested in the sampling campaign, some additional sample results for Tier II and Tier III parameters were available from the laboratory analysis.

Table 2-30. 2023 Influent Sampling Campaign Parameters.

1. Standard Sampling Parameters	
Chemical Oxygen Demand (COD)	Volatile Suspended Solids (VSS)
Carbonaceous 5-day Biochemical Oxygen Demand ($cBOD_5$)	Total Dissolved Solids (TDS)
pH	Total Phosphorus (TP)
Total Kjeldahl Nitrogen (TKN)	Total Sulphur (TS)
Total Suspended Solids (TSS)	Oil & Grease (O&G)
2. Additional Sampling Parameters	
Total Sulphides	
Dissolved and Total Calcium	Dissolved and Total Manganese
Dissolved and Total Magnesium	Dissolved and Total Potassium
Chlorides	Alkalinity
Sodium	
3. Additional Biological Parameters	
Soluble $cBOD_5$ ($scBOD_5$)	Ammonia Nitrogen (NH_3-N)
Soluble COD (sCOD)	Dissolved Phosphorus (orthophosphate – O-PO_4-P)
4. Metals in Wastewater	
Antimony	
Barium	
Beryllium	
	Tin
	Vanadium
Mercury	
5. Wastewater Sampling Parameters	
Acetone	Benzene
BTEX	Chloroform
Bromoform	Cyanide
Carbon Tetrachloride	Ethyl Benzene
Dibromochloromethane	Hexachlorobenzene

Ethylbenzene	Methyl Chloride
Methyl Ethyl Ketone	Phenolics
Methylene chloride	PCBs
Methyl-tert-butyl ether (MTBE)	Tetrachloroethylene
Styrene	Toluene
Tetrachloroethane	Trichloroethylene (TCE)
Dichlorobenzene	Vinyl Chloride
Dichloroethane	Xylene
Dichloropropene	

Note: The cells highlighted in yellow indicate the Tier II Effluent Objectives that influent samples are available. The cells highlighted in green indicate the Tier III Effluent Guidelines that influent samples are available.

These influent samples were reviewed to evaluate which of these parameters are already below the Tier II Objective or Tier III Guideline value in the influent. If more than one limit existed for a parameter, the comparison was made to the lower of the two limits. It's assumed that if the parameter is below the limit in the wastewater influent, then it will also be below the limit in the treated WWTF process effluent. A summary is provided below in Table 2-31.

Table 2-31. Evaluation of Influent Parameters for Effluent Limits

Sampled Parameter[b]	Limit	Averaging Period[c]	Above or Below Limit in Influent
Aluminum, total	100 µg/L	—	**Above**
Arsenic, dissolved	150 µg/L	4-days	Below
Benzene	370 µg/L	—	Below
Boron, total	1,500 µg/L	Long-term exposure	Below
Cadmium, dissolved	0.21 µg/L[a]	4-days	Below
Carbon tetrachloride	13.3 µg/L	—	Below
Chloroform	1.8 µg/L	—	**Above**[d]
Chromium, dissolved	72.7 µg/L[a],[e]	4-days	Below
Copper, dissolved	7.4 µg/L[a]	4-days	**Above**
Cyanide, strong acid dissociable (Total)	5.2 µg/L	4-days	Below
Dichlorobenzene, 1,2-	0.7 µg/L	—	Below
Dichlorobenzene, 1,3-	150 µg/L	—	Below
Dichlorobenzene, 1,4-	26 µg/L	—	Below
Dichloroethane, 1,2-	100 µg/L	—	Below
Dichloromethane	98.1 µg/L	—	Below
Ethylbenzene	90 µg/L	—	Below
Iron, total	300 µg/L	—	**Above**
Lead, dissolved	1.97 µg/L[a]	4-days	Below

Sampled Parameter[b]	Limit	Averaging Period[c]	Above or Below Limit in Influent
Methyl-tert-butyl ether (MTBE)	10,000 µg/L	—	Below
Molybdenum, total	73 µg/L	—	Below
Nickel, dissolved	43.1 µg/L[a]	4-days	Below
Phenols, total (4AAP)	4 µg/L	—	**Above**[d]
Selenium, total	1 µg/L	—	Below
Silver, total	0.1 µg/L	—	**Above**
Styrene	72 µg/L	—	Below
Tetrachloroethane, 1,1,2,2-	110 µg/L	—	Below
Thallium, total	0.8 µg/L	—	Below
Toluene	2 µg/L	—	**Above**[d]
Trichloroethane, 1,1,2-	21 µg/L	—	Below
Uranium, total	15 µg/L	Long-term exposure	Below
Zinc, dissolved	97.8 µg/L[a]	4-days	Below

Source of Limits: Manitoba Environment, Climate and Parks. 2011. *Manitoba Water Quality Standards, Objectives, and Guidelines*.

[a] Limit calculated using a hardness of 80 mg-$CaCO_3$/L
[b] For metals, unless specified as a limit for the dissolved portion of the metal, the limit was applied to the total metal.
[c] No averaging period specified for the limits for the Tier III parameters.
[d] Based on the industrial contribution only. No sampling of chloroform, toluene or phenols was completed for residential wastewater.
[e] Total of the limits for Chromium III and Chromium VI.

Most of the influent samples are below the effluent Tier II Objectives and Tier III Guidelines, with the exception of total aluminum, chloroform, dissolved copper, total iron, phenols, total silver, and toluene. The fate of each of these parameters in the wastewater treatment process is discussed below.

Total Aluminum

The removal of aluminum through an MBR process is variable. Based on analysis of an MBR facility in Western Canada, removal ranged from 5% to 80% with an average removal of about 50%; this variability was due to the addition of aluminum sulphate for chemical phosphorus removal. It is not expected that aluminum will be used in the RSR WWTF, rather ferric chloride will be used. Based on this reasoning, reduction of aluminum through the plant will occur, however, the extent of the reduction is unknown. A possibility exists for the aluminum effluent concentration to exceed the Tier III Water Quality Guideline of 100 µg/L.

Dissolved Copper

Analysis of an MBR facility in Western Canada shows that removal of total copper is typically upwards of 90%, but since dissolved copper is not measured, the soluble fraction of copper in the effluent is unknown. Based on this, at the RSR facility it is expected for there to be significant removal of total copper, but some minor risk remains for the dissolved copper concentration in the effluent to exceed the Tier II Water Quality Objective of 7.4 µg/L.

The elevated concentrations of dissolved copper in the RSR influent are most likely the result of the use of copper service lines and aggressive potable water.

Total Iron

Based on analysis of an MBR facility in Western Canada, total iron removal was typically upwards of 90%; however, this was with the addition of aluminum sulphate for phosphorus removal. The RSR WWTF design differs as it is based on the addition of ferric chloride to support the BNR process in the removal of phosphorus and the total iron concentration in the influent wastewater exceeds the guideline. It is likely that that the effluent will exceed the Tier III Water Quality Guideline of 300 µg/L for total iron.

Total Silver

It is anticipated that metals precipitation in the bioreactors will reduce the total silver concentration in the effluent to below the 0.1 µg/L Tier III Water Quality Guideline.

The following parameters (chloroform, phenols, and toluene) were identified in the industrial process effluent; a source of their production is likely from maintenance cleaning activities. These parameters were not sampled for the residential wastewater contribution, but it is anticipated that they would occur in low to negligible concentrations compared to industry. As summarized below, the MBR process may provide sufficient removal of these parameters, so that the WWTF effluent meets the applicable Water Quality Objectives and Guidelines. If required, the effluent from these industries may need to be controlled further to maintain reasonable concentrations in the influent wastewater.

Chloroform

As chloroform is a volatile compound, it is anticipated that significant removal will occur in the bioreactors at the RSR WWTF, and the residual in the effluent is expected to be below the Tier III Water Quality Guideline of 1.8 µg/L. However, information from the MBR facility in Western Canada is unavailable and cannot be used to confirm this hypothesis.

Total Phenols

Phenols have an affinity for biosolids and are likely to be retained in the solids matrix, while other phenols will be degraded due to the long retention time in an MBR. In Chapter 13 of the manual “Biological Wastewater Treatment: Principles, Modelling and Design”, significant removal of phenols was observed in full-scale MBR plants. If the same removal efficiency was observed at the RSR WWTF, it is anticipated that the residual phenol is likely to be below the Tier III Water Quality Guideline of 4 µg/L. However, there is still some possibility to exceed 4 µg/L of phenol, depending on factors such as the chemical species, and if the feed is intermittent which can result in breakthrough in the effluent.

Toluene

Toluene is typically stripped from solution and the residual is removed from the treated wastewater effluent with the solids. Therefore, even with the relatively high concentration of toluene in the influent, the effluent toluene concentrations may be below the Tier III Water Quality Guideline of 2 µg/L. Information from the MBR facility in Western Canada is unavailable and cannot be used to confirm this hypothesis.

2.4.3.4 Solids Management

Waste activated sludge (WAS) will be withdrawn either from the RAS flow or from the surface of the bioreactors for further processing. The WAS will be pumped directly to the Rotary Drum Thickeners (RDT). Polymer will be added to the WAS as it enters the RDT flocculation tank. Flocculated WAS transfers directly into the RDT drum. The filtrate from the RDT will be returned to the plant recycle flow chamber, whereas the thickened sludge will be pumped to the sludge stabilization. This process involves two mesophilic anaerobic digesters followed by two aerobic digesters (post-aerobic digestion [PAD]). Biogas produced by the anaerobic digesters will pass through a condensate separator and biogas compressor before being used in a dual-fuel boiler. Biogas flows that exceed the boiler's ability to accept that flow will be directed to a waste gas burner.

Anaerobically digested sludge will be pumped to PAD for further treatment. The two PAD reactors will be intermittently aerated and mixed to achieve nitrogen removal and further volatile solids (VS) destruction.

Digested sludge will be pumped to one of four sludge lagoons, where it will settle and mature over a several-year period before being withdrawn and land applied. Supernatant will be collected from the sludge lagoon and returned to the plant recycle flow chamber for treatment with the influent wastewater.

Each solid stream process is described further in the following subsections. The information provided for the solid treatment design is reflective of the 30% design stage. As the design progresses to 60% and 90% design, the design details may be adjusted.

2.4.3.4.1 Waste Activated Sludge

WAS from the membrane tank will be pumped using a rotary lobe pump to the RDTs. Table 2-32 lists the design information for the RDT feed pumps.

Table 2-32. Rotary Drum Thickener Feed Pump Design Data

Parameter		Design Summary
WAS Flows	Minimum	650 m^3/d
	Average	790 m^3/d
	Maximum	900 m^3/d
WAS Loads	Average	6,615 kgTSS/d
	Maximum Month	7,825 kgTSS/d
RDT Feed Pumps	Number	2
	Type	Rotary Lobe

kgTSS/d = kilogram(s) total suspended solids per day
kW = kilowatt(s)
m = meter(s)
m^3/d = cubic meter(s) per day
m^3/h = cubic meter(s) per hour
VFD = variable frequency drive

Waste-Activated Sludge (WAS) will be injected with polymer prior to the RDT system. Initially, the WAS enters a flocculation tank that overflows to the RDT. Conditioning of WAS with polymer improves the sludge's dewaterability and enhances particle capture. The polymer makeup unit will be prepackaged and will provide a polymer aging time of approximately 10 minutes. Aged polymer will be stored in feed tanks with about 60 minutes of retention time.

RDT units will be used to thicken the WAS ahead of the digesters. RDTs consist of drums fitted with perforated plate or mesh screens with fine openings. The flocculated solids are retained by the screens while filtrate passes through and is collected for return to the head of the plant. The captured solids are transferred by a series of flights within the screen to the discharge end where they drop into a hopper below. Thickened WAS (TWAS) is then pumped to the digesters.

Two separate process trains will provide 100% redundancy in case one train has to be removed from service. Each train consists of an RDT feed pump, an RDT flocculation pump, RDT, a TWAS hopper, and a TWAS pump. The RDT will be capable of producing around 5% TS concentrations.

Table 2-33 summarizes the design information for the WAS thickener equipment.

Table 2-33. Waste Activated Sludge Thickener Design Summary

Parameter		Design Summary
RDTs	Number	2
	Capacity	Rated Capacity, each: 50 m^3/h Operating Capacity, each: 40 m^3/h
	Capture	95%
	Target WAS Concentration	5% TS
	Drive	Type: VFD Size: 1.5 kW
	Spray Water	Capacity: 2.7 L/s Pressure: 276 kPa
	Thickening Polymer	Polymer Type: liquid Dosage ▪ Average: 3.5 kg/T ▪ Maximum: 7.5 kg/T
	Polymer System	Polymer Feed Rate ▪ Average: 23 kg/d ▪ Maximum: 60 kg/d Neat Concentration: 35% Feed Solution Concentration: 0.5% Aging Time: 10 minutes Storage Capacity: 60 minutes Dilution Water: 1.0 L/s
	Polymer Solution Feed Pumps	Number: 2 Type: Progressive cavity TDH: 20 m Drive: VFD Size: 0.75 kW (TBC)
TWAS Loads	Average	TS: 6,285 kg/d VS: 4,305 kg/d
	Maximum Month	TS: 7,435 kg/d VS: 5,155 kg/d

Parameter		Design Summary
	Maximum Week	TS: 8,925 kg/d VS: 6,185 kg/d
TWAS Flows	Average	157 m^3/d
	Maximum Month	186 m^3/d
	Maximum Week	225 m^3/d

kg/d = kilogram(s) per day
kg/T = kilogram(s) per ton
kPa = kilopascal(s)
kW = kilowatt(s)
L/s = litre(s) per second
m^3/d = cubic meter(s) per day
m^3/h = cubic meter(s) per hour
TS = total solids
TWAS = thickened waste activated sludge
VFD = variable frequency drive

Foul air from the WAS RDT will be collected and sent to the odour control system (refer to Section 2.4.3.5: Odour Control for details).

2.4.3.4.2 Mesophilic Anaerobic Digestion

Thickened sludge from the RDTs will be pumped to the mesophilic anaerobic digesters. The digesters stabilize the sludge, which produces the following results:

- Reduced density of pathogenic organisms
- Minimized odour potential
- Decreased organic solids content
- Reduced vector attraction

Mesophilic anaerobic digesters are completely mixed and operate at 35°C to 37°C. Facilitating these operating conditions requires that they be supported by a mixing system and a heating system. Further, feeding and withdrawal are configured to optimize treatment.

Mixing for the digesters will consist of mixing disks that oscillate upward and downward through a stroke of about 0.5 m. This technology has proven successful for this application while consuming lower energy than other mixing options.

The heating system consists of recirculation pumping that draws sludge from the base of the digester, conveys it through a pipe-in-pipe heat exchanger, and returns the heated sludge to the digester. The TWAS will be injected into this recirculation loop and immediately blended with the digesting sludge. Digested sludge will overflow the digester as volume is displaced by undigested material and conveyed to downstream PAD.

Anaerobic digestion generates biogas, predominantly a mixture of methane (CH_4) and CO_2, but with other trace gases present.

Table 2-34 summarizes the design information for the mesophilic anaerobic digesters.

Table 2-34. Mesophilic Anaerobic Digestion Design Summary

Parameter		Design Summary
Anaerobic Digestion	Number	2
	Type	Mesophilic Anaerobic
	Shape	Cylinder with 45° Cone
	Design Parameters	SRT (at maximum month loads): 15 d Temperature: 35°C VS Loading Rate: 0.77 kgVS/m^3/d (average with all in service) VS Loading Rate: 1.85 kgVS/m^3/d (maximum with one in service)
	Volume	2,790 m^3 (per digester)
	Dimensions	SWD: 13.3 m Total wall height: 13.35 m Diameter: 15 m
	Digester Mixing	Type: Oscillating disc Motor Drive: VFD Motor Power: 5.6 kW (TBC)
	Digester Heating	Number of Heat Exchangers: 2 Heat Exchanger Type: Tube-in-tube Capacity: 282 kW Recirculation Pump: Number: 2 ▪ Capacity: 11.7 L/s ▪ Type: solids handling, centrifugal ▪ TDH: 20 m ▪ Drive: constant speed ▪ Size: 3.8 kW
Anaerobically Digested Sludge	Flows	Average: 157 m^3/d Maximum Month: 186 m^3/d Maximum Week: 225 m^3/d
	Loads	TS ▪ Average: 4,515 kg/d ▪ Maximum month: 5,370 kg/d VS ▪ Average: 2,600 kg/d ▪ Maximum month: 3,165 kg/d

Parameter		Design Summary
	Concentration, Ammonia	Average: 835 mg/L Maximum Month: 840 mg/L

°C = degrees Celsius
kgVS/m^3/d = kilogram(s) volatile solids per cubic metre per day
kg/d = kilogram(s) per day
kW = kilowatt(s)
L/s = litre(s) per second
m = meter(s)
m^3 = cubic meter(s)
mg/L = milligram(s) per liter
VFD = variable frequency drive

2.4.3.4.3 Post-Aerobic Digestion (PAD)

The anaerobically digested sludge is suitable for agricultural land application; however, the supernatant, centrate, or filtrate produced from thickening or dewatering digested sludge contains significant concentrations of nitrogen and phosphorus. Recycling this flow to the treatment plant for treatment would hamper the liquid stream from meeting the effluent requirements for these constituents. PAD substantially reduces the ammonia concentration of anaerobically digested sludge and moderately reduces the phosphorus return loads. Further, supplemental solids destruction of 5 to 10% is obtained, reducing the solids that need management. Finally, the oxidation of reduced compounds in PAD will reduce odour potential in downstream sludge management.

PAD operates as a sequentially aerated and mixed reactor so that the environment alternates between aerobic and anoxic. During aerobic periods, ammonia is oxidized to nitrate, whereas during anoxic periods, the nitrates are converted to elemental nitrogen. Greater than 90% ammonia removal can be achieved in this manner. Unlike some other processes, PAD does not require any supplemental chemicals to achieve those removals.

The design of the PAD system is based on a proprietary system – DigestivorePAD – supplied by Ovivo. The final design of the system will be confirmed by the technology supplier.

Table 2-35 summarizes the tentative design information for the system to be confirmed by the technology supplier.

Table 2-35. Post-Aerobic Digestion Design Summary

Parameter		Design Summary
PAD Tanks	Number	2
	Volume	750 m^3
	Dimensions	10.0 m (L) by 12.5 m (W) by 6.0 m (SWD)
	Design Parameters	SRT: 8 d DO during Aeration: 1.5 mgO_2/L Ammonia Removal: 90%

Parameter		Design Summary
	Oxygen Demands	OUR: 20 $mgO_2/L/h$ (average) ▪ 25 $mgO_2/L/h$ (maximum month) ▪ 30 $mgO_2/L/h$ (peak) Alpha: 0.9 SOTE: 20.6% (average) ▪ 20.4% (maximum month) ▪ 20% (peak) Residual DO: 0.5 mg/L SOTR: 499 kgO_2/d (average) ▪ 546 kgO_2/d (maximum month) ▪ 632 kgO_2/d (peak) Air Requirements: 10,045 Nm^3/h (average) ▪ 11,115 Nm^3/h (maximum month) ▪ 13,135 Nm^3/h (peak) Diffusers Type: Medium Bubble Number of Diffusers: 192
	PAD Blowers	Air Requirements: 10,045 Nm^3/h (average) ▪ 11,115 Nm^3/h (maximum month) ▪ 13,135 Nm^3/h (peak) Blowers: Number: 3 Type: High-speed turbo blowers Capacity: 6,570 Nm^3/h (TBC) Backpressure: 61 kW (TBC) Power: 125 kW (TBC) PAD Mixing: Number: 2 (one per tank) Type: Hyperboloid (TBC) Size: 9.4 kW (TBC)
Digested Sludge Transfer Pumps	Number	2
	Type	Recessed Impeller
	Capacity	300 m^3/d
	TDH	20 m
	Drive	VFD
	Power	11.25 kW

Parameter		Design Summary
PAD Sludge	Flows	Average: 157 m^3/d Maximum: 186 m^3/d
	Loads	TS: 4,125 kg/d (average) ▪ 4,895 kg/d (maximum month) VS: 2,210 kg/d (average) ▪ 2,690 kg/d (maximum month)
	Concentration, Ammonia	Average: 85 mg/L Maximum Month: 85 mg/L

D = depth
kg/d = kilogram(s) per day
kPa = kilopascal(s)
kW = kilowatt(s)
L = length
m = meter(s)
m^3 = cubic meter(s)
mg/L = milligram(s) per liter
mgO_2/L = milligram(s) oxygen per liter
$mgO_2/L/h$ = milligram(s) oxygen per liter per hour
Nm^3/h = normal cubic metre(s) per hour
SWD = side wall depth
TBC = to be confirmed
VFD = variable frequency drive
W = width

2.4.3.4.4 Biogas Production and Utilization

Biogas production will occur in the mesophilic anaerobic digester where anaerobic bacteria will convert organic material in the sludge to volatile fatty acids and then to CH_4. The biogas produced will contain about 55 to 63% CH_4; the remainder is mostly CO_2 as well as small fractions of hydrogen sulphide (H_2S) and ammonia (NH_3). No biogas is produced by treatment in the PAD system.

The average biogas production is anticipated to be about 1,725 Nm^3/d. The generated biogas will discharge from the gas space at the top of the anaerobic digesters through condensate separators, which remove moisture in the form of water vapour. The biogas will then be compressed in a biogas compressor for transfer to a dual-fuel boiler capable of combusting biogas or natural gas. The natural gas is used during periods with low biogas production. The produced heat will be used for process heating for the anaerobic digester as well as building heating, and will supplement other natural gas boilers for building heat. Biogas usage will offset some of the natural gas costs incurred.

The biogas management system will contain pressure- or vacuum-relief valves and a waste gas burner.

Table 2-36 summarizes the equipment requirements for biogas production and usage.

Table 2-36. Biogas Production and Usage Equipment Requirements

Parameter		Design Summary
Biogas Management		
Flows	Average	1,725 Nm^3/d
	Maximum Month	2,010 Nm^3/d
	Peak	2,700 Nm^3/d
Methane Content	Average	55%
	Minimum	53%
Waste Gas Burner	Number	1
	Type	Enclosed Flare
	Capacity	3,000 Nm^3/d
	DRE	99%

Notes:
DRE = destruction rate efficiency
Nm^3/h = normal cubic metre(s) per hour

2.4.3.4.5 Biosolids Maturation, Thickening and Beneficial Reuse

Biosolids generated through the anaerobic digestion and PAD processes are intended for agricultural land application as close to the treatment plant site as possible. However, agricultural land application is limited to warmer periods of the year. To provide storage during the remainder of the year and allow for some natural thickening of the biosolids, a portion of Niverville's wastewater treatment lagoon system will be converted to use as biosolids lagoons.

Four cells are envisioned, each with a width that is one-quarter of the current north-south dimension and the same length in the east-west direction. Each cell would be capable of holding one year's production of digested biosolids, assuming that the average solids thickness increases to about 5% TS and that a minimum of 0.5 m of clear water is retained above the thickened sludge. Secondary Cell No. 3 at the existing Niverville wastewater treatment lagoons has a total volume of about 168,000 m^3. This cell will be removed from service and partitioned into four equally sized cells with the berms raised to provide a total liquid depth of about 2.25 m (from the current liquid depth of 1.5 m).

The operating strategy would entail filling a cell over a year and allowing it to settle and mature for another year. Water is removed as the lagoon is filled. The volume of the sludge will be reduced by natural thickening, giving it the consistency of semi-solid material. In the third year, the captured solids will be loaded into trucks and included as part of biosolids beneficial reuse program. At a later date, a separate Environment Act Proposal will be submitted for the Biosolids Beneficial Reuse program that is being developed for the WWTF.

Piping will be installed so that sludge can be fed to, and withdrawn from, each cell. A truck-loading station will be connected to the piping to fill tanker trucks, which can then be used to transport the sludge to beneficial use (agricultural land application). Supernatant piping will also be installed so that the supernatant from the lagoon being filled can overflow to the supernatant pond or, alternatively, directly to the plant.

Table 2-37 summarizes the design data for the biosolids lagoons.

Table 2-37. Biosolids Lagoon Design Summary

Unit	Description
Lagoon	Number: 4 cells Depth: 2.25 m Volume per cell: 44,000 m^3 Cycle Duration: 3 years (1: fill, 2: settle and mature, 3: empty)
Lagoon Sludge	Average Loads: ▪ TS: 1,713 T/y ▪ VS: 932 T/y ▪ TKN: 58 T/y ▪ TP: 63 T/y Average Flow: 1,713 m^3/y
Lagoon Supernatant	Concentration: ▪ TSS: 1,555 mg/L ▪ VSS: 846 mg/L ▪ TKN: 177 mg/L ▪ NH3-N: 118 mg/L ▪ TP: 548 mg/L ▪ Ortho-P: 511 mg/L Average Flow: 159 m^3/y

Notes:
m = meter(s)
m3 = cubic meter(s)
mg/L = milligram(s) per liter
T/y = tonne per year

2.4.3.5 Odour Control

Odour control is a significant stakeholder consideration, and the plant will be designed with an odour-control system to collect and treat foul air. Foul air will be collected in the headworks building as well as in the sludge thickening and sludge digestion building.

The odour-control system will consist of a conservatively sized, enclosed biofilter with engineered media. The air is humidified and heated when necessary to remain above 5°C. Biological growth on the media will oxidize most of the odour-causing contaminants in the foul air; however, the exhaust from the biofilter will be expelled through a high-plume dilution fan to enhance dispersion so that nearby residents are not affected by odours from the plant.

The odour-control system's sizing and design will be finalized once details of various other plant systems are refined.

2.4.3.6 Chemical Systems and Storage

Several chemical systems will be employed at the WWTF, and are integral to a multitude of functions, including membrane maintenance cleaning and recovery cleaning. A summary of each chemical system is summarized in Table 2-38.

Table 2-38. Summary of Chemical Systems

Chemical	Location	Use	Chemical Storage/Dosing
Citric Acid (50%)	Membrane Tank	CIP	Tank, Chemical Cleaning Dosing Pumps (Duty/Standby)
Sodium Hypochlorite (12%)	Membrane Tank/ Reclaimed Water System	CIP/ Chlorination (disinfection)	Shared storage tank with chemical cleaning system for membranes, Dosing Pumps (Duty/Standby)
Emulsion Polymer	WAS Flocculation Tank prior to thickening	WAS Flocculation	Polymer Make Down and Aging Tanks, Feed Tank, Dosing Pumps (Duty/Standby)
Ferric Chloride (10 mg Fe/L)	Bioreactors	Chemical phosphorus removal (used on an as-needed basis)	Tank, Dosing Pump (Duty/Standby)

2.4.3.7 Utilities

A summary of the plant utilities design information is provided in Table 2-39.

Table 2-39. WWTP Utilities Design Summary

Parameter		Design Summary
Service/ Instrument Air Compressors	Number	2
	Type	Lubricated screw
	Capacity	1.15 (TBC)
	TDH	900 (TBC)
	Drive	Constant speed
	Power	7.5 (TBC)

2.4.3.8 Facility Hydraulics

Conceptual hydraulic profiles were developed to carry out the plant hydraulic calculations. The plant hydraulic profiles will be refined and updated during future design phases as Project details are further developed.

The effluent is pumped from the MBR secondary treatment process to the Red River. Permeate pump sizing is envisioned to be sufficient to allow the projected peak flow to be conveyed to the Red River at water elevations coincident with the 200-year return Red River elevation. Table 2-40 summarizes the main water level elevations through the plant.

Table 2-40. Water Level elevations Through the WWTF

Unit	Peak Water Level (m)
Influent chamber	239.84
Coarse screen discharge channel	239.69
Grit removal discharge channel	238.71
Fine screen discharge channel	237.61
Bioreactor, Aerobic Cell 2	236.06
Mixed liquor channel	235
Membrane tank	238.83
Flood protection level, 200-year flood elevation	238.68

During development of the facility's hydraulic profile, the planned outfall's hydraulics were investigated.

The investigation considered various plant flows, including a peak flow of 28.5 ML/d. The analysis also considered various river water levels, including a level of 236.68 m, which represents the 200-year high-water level in the Red River at the outfall. Further information on the outfall design is provided in Section 2.4.4: Outfall.

2.4.3.9 Fuel, Electricity and Gas Utilities

This subsection outlines the fuel, electrical, and gas utility requirements for the proposed WWTF.

2.4.3.9.1 Process Utility Requirements

The configuration of the electrical service supply will depend on the total load requirements. The power distribution equipment arrangement will be compatible with the utility service configuration and will incorporate provisions for redundancy. The customer-owned main switchgear will be designed to accept the service connection provided and its location will be selected to minimize the extent of feeder runs to the principal load centres on the site. The main service switchgear will be designed to include a minimum 20% spare electrical capacity rating plus space for future switchgear expansion.

The methods to be used for the physical distribution of power to plant loads around the site include the following:

- Individual runs of cable and cable in tray
- Direct buried cable or PVC conduit exterior to the facility
- Exterior PVC-type DB2 duct banks
- Combinations of these methods

Standby power, provided by generators, will be available should the loss of utility power occur. The site layout will consider the impact of noise from the generators on nearby receptors. Considerations for the design include noise attenuation in the inflow, and pointing the generators towards the north so noise isn't directed to nearby residences. The generators will be operated using either diesel fuel or natural gas, pending confirmation from the utility in its ability to provide the required natural gas flow.

2.4.3.9.2 Heating and Cooling Systems

Natural gas will be supplied to the WWTF by Manitoba Hydro and used as a fuel source for various plant space heating equipment. Natural gas-fired equipment for the WWTF includes a central hydronic boiler, a dual-fuel boiler, makeup air units or air-handling units, space unit heaters, and hot water tanks.

Glycol heating will be provided in areas of the facility considered hazardous or corrosive and where ignition sources from gas-fired appliances are prohibited. Space heating in hazardous areas will use hydronic heating as supplemental or backup heating. Ventilation and space heating for remote and nonhazardous facilities will be provided by natural gas through gas-fired air-handling units, gas-fired unit heaters, or both.

Space and ventilation heating for electrical rooms and MCC rooms will be provided using electrical unit heaters or duct heaters. Local electric baseboard heaters will be provided for washrooms, janitor rooms, and stairs.

A dual-fuel boiler that uses both digester gas and natural gas will serve to heat part of the process sludge train.

A direct-expansion, split air conditioning unit or air-handling unit with built-in direct-expansion refrigerant coils and outdoor air-cooled condenser will be provided for control rooms, server rooms, and electrical rooms for cooling in summer to meet required indoor design temperature. Air conditioning system sizing will be based on the heat gains from the electrical and control equipment in the associated space plus the ventilation loads and base loads from the building structures.

2.4.3.10 Site Water Usage

The design of the WWTF includes both the use of potable and non-potable water. Potable water will be provided for washroom and janitor room plumbing fixtures and combination shower and eyewash stations. Plant service water (non-potable cold water) will be used for hose washdown, pump seal water, and process solution preparations in process areas. Interior hose valves in process areas will be 25 mm or 40 mm globe valves with hose-thread adapters. Electric hot water heaters will be provided for potable hot water heaters where it is considered feasible. Where appropriate, piping will be insulated.

The WWTF design will use reclaimed water (membrane permeate) as a source of non-potable water. This is discussed further in Section 2.4.3.3.3.2: Membrane Filtration.

2.4.3.10.1 Water Conservation

Low-water consumption plumbing fixtures and trim will be specified and installed in accordance with the requirements of the Manitoba Building Code. High-efficiency plumbing fixtures for water use reduction will be provided. Water meters will be coordinated with RM of Ritchot standards and provided for the facility's main water usage as required.

2.4.3.10.2 Cross-Connection Control

Cross-connection control will be provided in accordance with CSA standards. Backflow prevention assemblies will be installed for the following: potable cold water main entrances into each new building with a double check valve backflow prevention assembly, and non-potable water main entrance into each new building with a reduced pressure backflow prevention assembly. Local reduced pressure backflow preventers will be provided for the HVAC heating system and glycol heat recovery system makeup water as required.

2.4.3.10.3 Fire Protection

A sprinkler system and standpipe system, if needed, will be coordinated with the architect to place the required fire pumps and fire protection water supply. Performance specifications will be provided in accordance with the NBC, NFPA 13 (for sprinkler system), and NFPA 14 (for standpipe system).

The fire protection water will be provided from an onsite storage tank with an attached fire flow pump. The water to this tank will be provided by the facility's reclaimed water system.

2.4.3.11 Instrumentation and Controls

Instrumentation and control (I&C) for the proposed WWTF, includes Programmable Logic Controllers (PLC), supervisory control, and data acquisition (SCADA) system, and field instrumentation for the WWTF. The design would encompass monitoring of remote lift stations with local controls. The control system is intended to continuously and reliably control and monitor all the facility treatment processes and monitor the lift stations. The major functions of the SCADA control system are as follows:

- Continuous measurement using instruments and provision of analog control and monitoring
- Continuous sequential and logic control (discrete equipment control) using PLCs
- Continuous monitoring and control from graphic display with trends and report generation
- Continuous alarm monitoring and notification using email or phone to WWTF Operations

The I&C design further covers the following on a facility-wide basis:

- Phone system
- Access control (card swipe), including closed-circuit television (CCTV) monitoring for critical areas
- Wi-Fi across the facility footprint

2.4.3.12 Facility Operations and Maintenance Activities

For the WWTF, common design conventions will be followed, where practical, to enhance the functionality, operability, and maintainability of equipment and piping. The systems' layout will be designed with the following considerations and order of priority:

1. Safety of operating personnel
2. Ease of operations
3. Capital and operating costs

The regional collection system and WWTF will both be continuously operated, except for periods where maintenance and repairs are undertaken.

Measures to minimize maintenance requirements, or measures to facilitate the safe and efficient delivery of maintenance activities, include:

- System redundancy to allow process units to be taken offline for periodic inspection and maintenance.
- Use of structural and building materials that are durable and require minimum maintenance requirements.
- Provision of adequate clearance for equipment operation, maintenance, removal, and replacement.
- Mounted equipment and panels on concrete housekeeping pads to protect them from washdown water.

- Sludge pumping arranged to minimize the distance and number of bends through which the liquid must be conveyed to the pump suction.
- Provision of ladders, service platforms, and access hatches where necessary to facilitate equipment maintenance and removal.
- Provision of a means to facilitate equipment maintenance and removal for equipment that cannot be carried by two persons and requires periodical lifting for maintenance.
- Provision of motorized hoists, monorails, or cranes where equipment component weights exceed 1,000 kg or when frequent lifting for maintenance is necessary.
- Washdown stations placement in logical areas to facilitate equipment cleanup and pipe flushing.

The maintenance activities anticipated for the WWTF are expected to be standard for an MBR facility of its size. Routine maintenance will include activities such as:

- Membrane Clean-in-Place (see Section 2.4.3.3.3.4, Membrane Fouling for details).
- Pump inspection and maintenance (e.g., visual inspections, oil change, periodic overhauls).
- Periodic shutdown and visual inspection of process units.

To facilitate the delivery of inspection and maintenance activities in accordance with manufacturer recommendations, Operations and Maintenance manuals for all equipment will be developed. Additionally, operator training on each major equipment will be conducted by qualified manufacturer representatives.

2.4.3.12.1 Process Sampling Overview

To provide monitoring of the process operations, and to confirm effluent limits are met, the design of the WWTF includes online sampling and grab sample points. The proposed monitoring points and parameters to be sampled are summarized in Table 2-41.

Table 2-41. Process Sampling

Number	Location	Sample Type	Proposed Parameters
Liquid Stream			
1	Return Steams to Influent Chamber (lagoon supernatant, recycle streams)	Online	BOD, COD, TSS/VSS, TKN, NH_3, TP, dissolved phosphorus, VFA, Mg, Ca, Alkalinity, total sulphur, sulphides, pH
2	Post Bar Screens Note: The return steams (#1) are backed out from this data to determine the contribution from the RSR forcemains.	Online	BOD, COD, TSS, TKN, NH_3, TP, VFA, Mg, Ca, Alkalinity, total sulphur, sulphides
3	Screenings, Grit, Scum Note: Occasional sample, approximately once monthly	Grab	All: Total volatile solids Scum: COD, O&G
4	Odour Control	Online	H_2S (Jerome meter)
5	Bioreactor (Pre-Anoxic Zone)	Grab	Nitrates

Number	Location	Sample Type	Proposed Parameters
6	Bioreactor (Anaerobic 2)	Grab	Orthophosphate
7	Bioreactor (Anoxic)	Grab	Nitrates
8	Bioreactor (Aerobic 1 / 2)	Online	Dissolved Oxygen
9	Bioreactor (Aerobic 2)	Online	NH_3, temperature, MLSS
10	Mixed Liquor Pump	Grab	MLSS/MLVSS
11	WAS Transfer Pumps	Grab	MLSS/MLVSS
12	Permeate	Online	Turbidity ChemScan wet chemistry analyzer (ortho-P (soluble), nitrates, NH3, UVT) Flow-proportional sampler for reportable parameters (BOD, TP, TN, ammonia, TSS, COD)
13	Reclaimed Water	Grab	Residual Chlorine
Solids Steam			
14	RDT Filtrate	Grab	TSS, VSS
15	Thickened WAS	Grab	TP, TN, soluble-P, NH_3, TS/VS
16	Anaerobic Digester Feed	Online	TS
17	Anaerobic Digester	Online	Temperature
18	Anaerobic Digester	Grab	TS/VS, TN, TP, soluble-P, TN, ammonia, Mg (periodically), VFA (daily), alkalinity (daily), pH, total sulphur, sulfides
19	Heat Exchangers	Online	Temperature
20	Biogas	Grab	H_2S, NH_3, CH_4
21	Biogas	Online	CO_2
22	Aerobic Digester	Grab	TS/VS, TN, TP, soluble-P, TN, ammonia, Mg (periodically), alkalinity (daily), pH, total sulphur
23	Aerobic Digester	Online	DO, ORP, pH, NH_3
24	Biosolids	Grab	TS/VS, TN, TP, ammonia, metals, complex organics

BOD = Biochemical Oxygen Demand
Ca = Calcium
CH_4 = Methane
CO_2 = Carbon Dioxide
COD = Chemical Oxygen Demand
DO = Dissolved Oxygen
H_2S = Hydrogen Sulfide

MG = Magnesium
MLSS = Mixed Liquor Suspended Solids
MLVSS = Mixed Liquor Volatile Suspended Solids
NH_3 = Ammonia
O&G = Oil and Grease
ORP = Oxygen Reduction Potential
TKN = Total Kjeldahl Nitrogen
TN = Total Nitrogen
TP = Total Phosphorus
TS = Total Solids
TSS = Total Suspended Solids
UVT = Ultraviolet Transmittance
VFA = Volatile Fatty Acids
VS = Volatile Solids

2.4.3.13 Waste Management

The main source of waste production at the WWTF will be from primary treatment. Large debris (e.g., sticks, stones, garbage, etc.) collected from the bar screens, as well as grit from the vortex grit tanks, and finer particles from the fine screens, will be removed from the wastewater. Details of the primary treatment design are provided in Section 2.4.3.3.2: Preliminary Treatment.

The materials from the bar screen will pass through a washer compactor to clean captured screenings, leading to a reduction in the odor, volume, and weight of the screenings. The screenings will be collected in a waste disposal bin. The grit from the vortex tank will pass through a grit classifier which will separate out the grit from the captured water and organics. The grit will also be collected in the waste disposal bin. The fine screens have a built-in compactor, and the compacted screenings will be disposed in the same waste disposal bin.

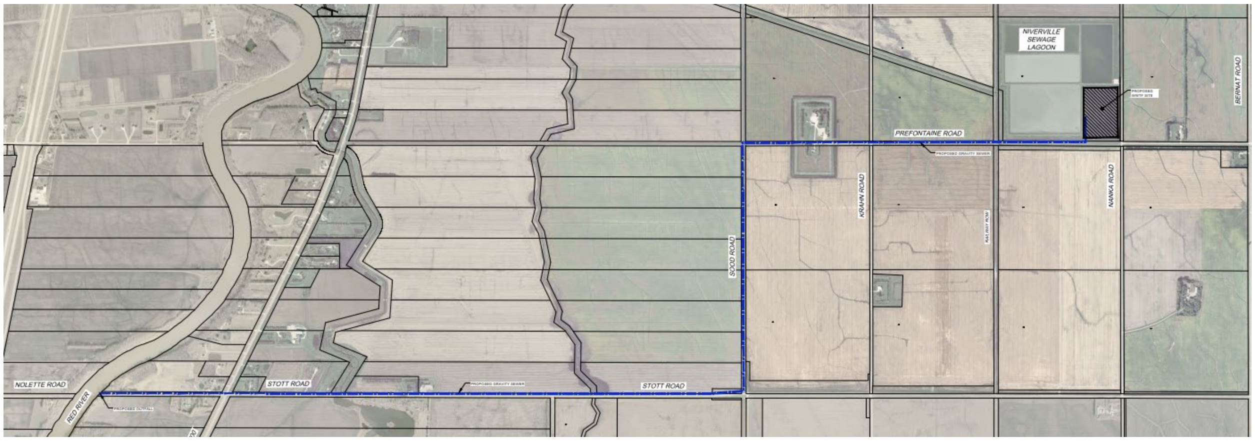
The waste disposal bin will be located in the headworks building. There will be a door in the roll-off bin area to move the bins to the outside of the building so that the contents can be removed by an appropriately equipped truck. The truck will haul the contents to an approved landfill facility for disposal. The bin is expected to be emptied about twice per week.

2.4.4 Outfall

The WWTF requires an outfall location that can receive a continuous discharge of treated effluent. In the vicinity of the Town of Niverville, the Red River is the only water body with sufficient flow to sustain year-round operations. The Red River is approximately 6-km from the proposed WWTF.

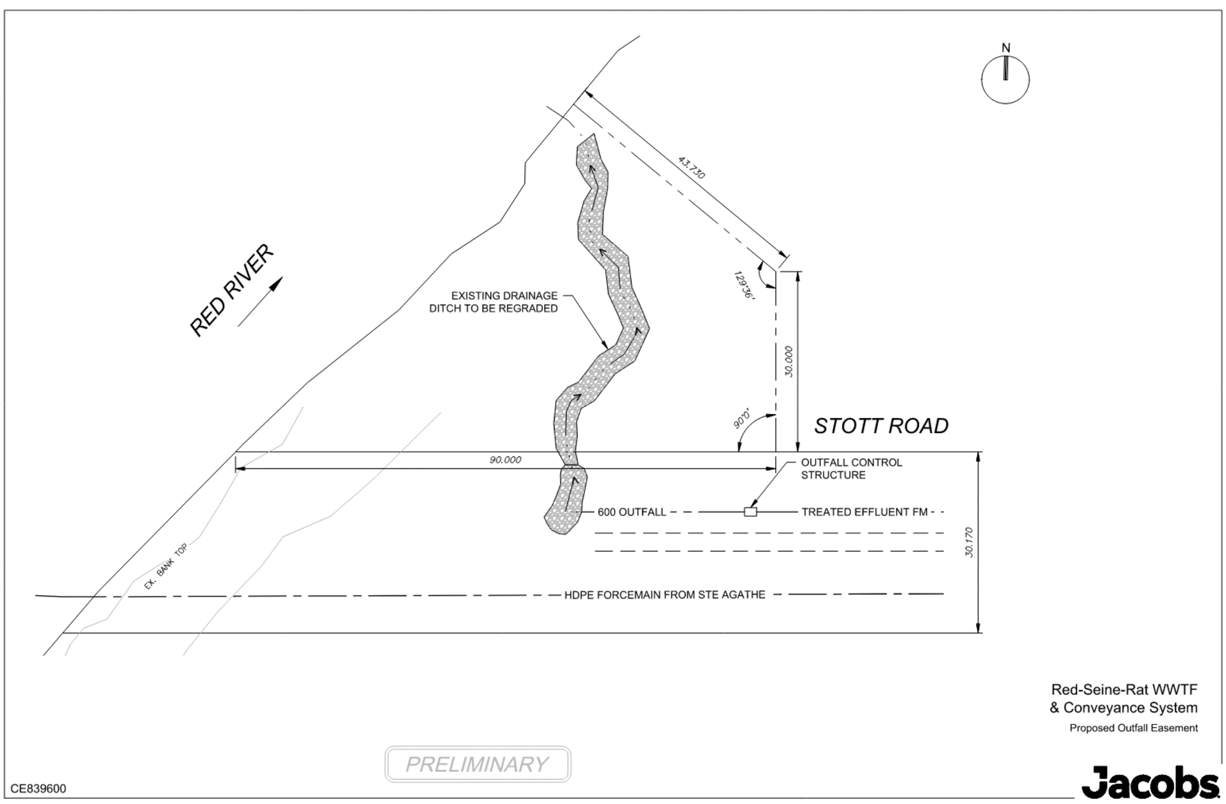
The outfall from the proposed WWTF is proposed to occur at the western terminus of Stott Road, approximately 650 m to the west of Provincial Road 200. Jacobs proposes that treated effluent be conveyed from the WWTF in a pressurized discharge parallel to the forcemain from Ste. Agathe and approximately 90 m east of the riverbank, transition to gravity flow, and finally conveyed via an existing ditch from Stott Road to the Red River. The location of the proposed outfall is within the RM of Ritchot. Figure 2-6 shows the routing of the outfall from the WWTF to the Red River.

Figure 2-6. Outfall Routing from the WWTF to the Red River



The location of the outfall relative to Stott Road and the river is shown in Figure 2-7. The proposed outfall generally follows similar projects that have been completed in the past decade in Manitoba, such as the City of Brandon's Water Reclamation Facility, and is intended to provide a balance between minimizing disturbance and providing an effective operational outfall.

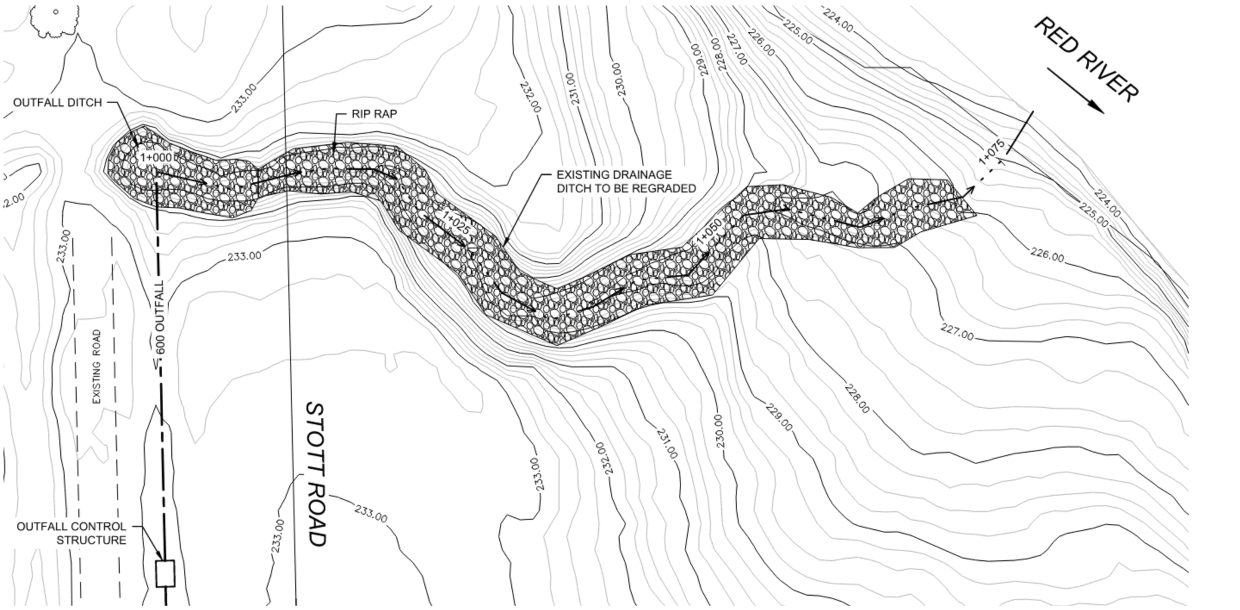
Figure 2-7. Proposed Outfall Location Plan



The outfall will rely on discharging to an existing drainage ditch, which will be improved by re-grading and the addition of erosion protection measures, that flows through private land. The RM of Ritchot and Jacobs have met with the landowner to discuss this future use and any required easements to facilitate the work.

Figure 2-8 shows the existing ditch and contours at the site and offers a closer look at the routing and proposed surface improvements.

Figure 2-8. Proposed Outfall Surface Discharge Portion



Jacobs recognizes that the Red River is subject to flood conditions and that its flooding will interact with the outfall. The outfall would be able to function as intended until it is submerged. Once submergence occurs, Jacobs proposes to redirect the discharge flow path to a surface discharge at the outfall control structure. By discharging to the surface, there is a greater degree of confidence of continued operation and less of a chance of the outlet's being covered or blocked. Provisions will be required at the plant to discharge to elevation up to the design flood elevation.

2.4.5 Add-on Communities to the RSRWC

The current Project includes the communities within the RMs of Hanover, Taché, Ritchot and the Town of Niverville that make up the RSR Wastewater Cooperative.

Other communities within the region have expressed interest to join the RSRWC. Jacobs is currently undergoing engineering services to assess the feasibility of incorporating these new facilities into the cooperative. The engineering assessments aim to evaluate the needs of the requesting community and assess the impacts on the RSRWC wastewater conveyance network and regional wastewater treatment plant.

The potential additions of these communities will be managed through one of several options. Either the community will join the RSRWC and will consume a portion of the available capacity from the existing RSR members, effectively reducing the design year of the WWTF. Alternatively, the additional communities will trigger an expansion to the WWTF at a future date to accommodate their additional flow; this is currently the preferred option. There is also the possibility of providing an interim connection of a community to the RSRWC conveyance network and WWTF; this option would allow the additional community to consume an unutilized portion of the capacity of the RSRWC conveyance network and WWTF in the short-to-medium term.

As a member of the RSRWC, the additional communities would be responsible for their portion of the capital costs, including their portion of the conveyance network, and the WWTF. The additional community would also pay their proportion of the annual operations and maintenance costs. The RSRWC would support the additional communities in obtaining grant funding.

The additional communities to the RSRWC will impact portions of the conveyance design. For the additional communities currently under consideration (Suncrest Colony, RM of La Broquerie, RM of De Salaberry), the potential impacts have been included in the following subsections.

In the future, there could be interest expressed from other additional communities to join the RSRWC. These will be considered on a case-by-case basis, and it is expected that these additions would be managed through a Notice of Alteration to the Environment Act License.

At the time of this EAP application, inclusion of these additional communities in the RSRWC has not been confirmed. As such, environmental or heritage surveys have not been conducted to assess if there are any unique factors that need to be considered for these additional communities.

2.4.6 Construction Activities

During construction of the new WWTF, typical construction materials will be used (e.g., rebar, concrete, gravel). The facility will be designed in compliance with the latest edition of the following codes and industry standards:

1. Manitoba Building Code (MR 78/2023) [National Building Code of Canada (NBC), 2020 with Manitoba Amendments]
2. Manitoba Fire Code (MR 82/2023) [National Fire Code (NFC), 2020 with Manitoba Amendments]
3. Manitoba Energy Code for Buildings (MR 79/2023) [National Energy Code of Canada for Buildings (NECB), 2020 with Manitoba Amendments]
4. Manitoba Plumbing Code (MR 80/2023) [National Plumbing Code (NPC), 2020 with Manitoba Amendments]
5. National Fire Protection Association (NFPA) standards, including the following:
    a. 3.1 NFPA 101 Life Safety Code
    b. 3.2 NFPA 820 Fire Protection in Wastewater Treatment and Collection Facilities

During construction of the regional conveyance network, typical construction materials will be used (e.g. high-density polyethylene (HDPE) DR17 pipe).

Any waste materials generated from construction of the WWTF and conveyance network will be disposed of according to applicable regulations.

2.4.6.1 Project Implementation Plan

A Project Implementation Plan will be developed for the regional conveyance and WWTF construction. At this stage in the design process, a detailed plan is not yet available.

The plan is expected to contain the following details:

- Details on how effluent requirements will be met during construction, commissioning, and start-up of the wastewater treatment facility.
- Contractor selection and construction approach.

- Safe work practices.
- Project management and an outline of proposed controls to achieve the Project on schedule and on budget.
- The expected number of site personnel, and number of construction hours.
- What temporary facilities will be required during construction, and where materials and equipment will be stored.
- How the regional conveyance network and WWTF construction will be staged.
- Timing and a plan on how the existing wastewater treatment lagoon sites will be connected to the proposed WWTF.

2.4.6.2 Meeting Effluent Limits During Construction, Commissioning, and Start-Up

The proposed WWTF is a greenfield Project, with no prior developments on the Project site. During construction of the WWTF, the existing wastewater treatment lagoons within each community will continue to operate and will treat wastewater to the standard set out in their existing Environmental Act License. The work to construct a new lift station at each of the existing wastewater treatment lagoon sites will not impact operations, and the new lift station will only be utilized once the WWTF is commissioned. Connection of each community to the WWTF will be completed in phases.

Section 6: Assessment of Effects on Surface Water Resources includes a discussion on mitigation measures that will be implemented during construction to limit any possible effects on the receiving water body for the WWTF. These include the development of a water quality monitoring plan by a water quality specialist. The monitoring will be used to evaluate the impacts of construction on the receiving water body, if additional mitigation is required, or if the work needs to be paused.

During commissioning of the plant, no untreated or partially treated wastewater will be discharged to the Red River from the WWTF. It is proposed that during the initial stages of commissioning, equipment testing would be conducted first with clean water, before the introduction of wastewater flow. Depending on water availability, this may require the contractor to coordinate the delivery of a supply of clean water to the site to be temporarily stored in storage tanks.

With the proximity to the Niverville lagoon site, it is proposed that further testing of the process operations will be completed with untreated or partially treated wastewater from the Niverville wastewater treatment lagoon cells. During testing, the wastewater flows will be discharged back into the Niverville wastewater treatment lagoon. Only once the treatment process has been tested and is operating reliably will plant start-up occur, and the wastewater will be directed to the outfall. Testing will be completed to confirm conformance to the effluent limits.

As discussed in Section 2.4.3.12.1: Process Sampling Overview, the effluent (membrane permeate) will incorporate online measurement of turbidity, a wet chemistry analyzer for various parameters (e.g. nitrates, ortho-phosphate), and a flow-proportional sampler for any reportable parameters (e.g., BOD, TP).

2.5 Operator Certification Requirements

Jacobs is developing a staffing plan which will become available at the 60% design stage. Preliminary staffing estimates range from 6 – 9 personnel, including operators, supervisors, and laboratory staff. Outsourcing and the delegating specific tasks or functions to external service providers, such as routine maintenance activities, specialized equipment inspections, cleaning, and calibration, rather than handling them in-house, the staffing requirements will drop to the range of 6 to 7 personnel.

An objective of the Project is to have an accredited operator employed prior to the final stages of the Project design and throughout the construction of the conveyance and WWTF. Early operator involvement allows the operator to participate in design decisions, and provide practical design and operational input.

Based on the population served and the current WWTF process design, both the wastewater conveyance system and the WWTF will require a Class 4 operator. RSRWC may consider the option of employing a Class 3 operator who will be able to upgrade to a Class 4 operator during the commissioning phase of the WWTF.

If a Class 4 operator cannot be employed during the desired timeframe, Jacobs shall supply a temporary Class 4 operator who shall remain in place until the RSRWC is able to secure an operator to fulfil the Class 4 Operator responsibility.

2.6 Project Schedule

The current schedule for each stage of the proposed Project is outlined in Table 2-42. Construction of the WWTF is anticipated to begin in early 2025, and will be completed over a four-year period, until the end of 2028. Connection of the individual communities is flexible and will be completed in phases, with all communities connected by the end of 2028.

Table 2-42. Proposed Schedule for Project Phases.

Component	Preliminary as per May 2024				
	Project Definition	Design	Construction	Commissioning	Operation
Wastewater Treatment Facility	Apr. – Jul. 2023	Mar. 2023 – Aug. 2024	2025 - 2028	Completion by end of 2028	End of 2028
Conveyance Network	Apr. – Jul. 2023	Mar. 2023 – Aug. 2024	2025 - 2028	Completion by end of 2028	End of 2028

2.6.1 Decommissioning

This Project involves the development of a new regional WWTF and conveyance network. Therefore, the only relevant decommissioning will be on the site of the existing wastewater treatment lagoons in each community.

As discussed in Section 2.4.2.3: Conveyance Design Criteria and Considerations, a portion of the existing wastewater treatment lagoons will be used for flow equalization. The ownership of this portion of the lagoon will be transferred to the RSRWC, as well as the new lift stations and the assets within 1 m of the new lift stations. Each municipality will be responsible for developing and carrying out a plan for lagoon maintenance, decommissioning, and repurposing; this is not within the current Project scope. The municipalities have indicated that where possible, lagoon cells that have been decommissioned will return to farmland.

An exception is for the existing wastewater treatment lagoon site for the town of Niverville. It is proposed that the entire lagoon will be transferred to the RSRWC to serve several purposes. Firstly, Cell 4 of the Niverville lagoon will be repurposed to provide storage and dewatering of digested sludge. Secondly, the existing lagoon cells will be used for wastewater storage through the transition period between current operation and start-up of the regional WWTF. Once the plant is operations, one of the existing lagoon cells at the Town of Niverville will be used for flow equalization. Refer to Section 2.4.6: Construction Activities for further information.

2.7 Project Funding

This Project has received funding under the Green Infrastructure Stream of the Investing in Canada Plan. The objective of the Green Infrastructure Stream is to support greener communities by contributing to climate change preparedness, reducing greenhouse gas emissions, and supporting renewable technologies in Canada. Specifically, this Project involves the enhancement of wastewater treatment infrastructure in the RSRWC, which will contribute to improvements in environmental quality.

Additional funding is provided by the Government of Manitoba, and the remainder of the funding will be from the RSRWC members via a Canada Investment Bank Green Infrastructure[1] loan. The funding and contribution from the RSRWC will be used for the construction of the regional conveyance network and WWTF.

As discussed in Section 2.4.5: Add-on Communities to the RSRWC, there is the possibility of other communities joining the RSRWC. These communities would be responsible for providing their own sources of funding to connect to the RSRWC regional conveyance network and WWTF.

2.8 Approvals and Permits

The potential permitting and regulatory requirements for this project are outlined in Table 2-43.

[1] https://cib-bic.ca/en/projects/green-infrastructure/brandon-and-red-seine-rat-water-and-wastewater-infrastructure

Table 2-43. Permitting and Regulatory Requirements Summary

Name	Cause	Exclusions/Exceptions	Permit Required	Notes/Status	Timeline
Municipal Permits					
Development Permits	Required to approve that the development complies with municipal standards, setbacks, and zoning.	Refer to each municipal bylaw for any exceptions.	YES	Can be submitted upon completion of 90% detailed design and prior to building permit application. Status: Not Submitted	Contractor to obtain post-award prior to building permit application and start of construction. The review process takes a minimum of 1 week (5 to 10 business days).
Building Permits	Required for development and construction (and in some cases, alteration, extension, renovation, repair, occupancy, demolishing, or removal) of a building, structure, or portion thereof.	Under 10 m^2 (RM of Taché) Under 11 m^2 (RMs of Ritchot and Hanover)	YES	Drawings must be sealed by a professional engineer. Status: Not Submitted	Contractor to obtain post-award prior to start of construction. The review process takes a minimum of 1 week (5 to 10 business days).

Name	Cause	Exclusions/Exceptions	Permit Required	Notes/Status	Timeline
Access (Driveway) Permit	Required by municipalities when installing an access driveway to property adjacent to a municipal road. Each RM has its own guidelines to follow.	None	YES	Applicants are responsible for sourcing and installing any culverts that may be required by the permit. This cost is borne by the applicant. Status: Not Submitted	Contractor to obtain post-award prior to start of construction. The review process takes 5 business days.
Provincial Permits					
Water Use Licence	Required when water is diverted (including dewatering).	Water withdrawals (surface and groundwater) of less than 25,000 L/d (5,500 gal/d).	YES	Submit a completed water use licence form through the online water licensing portal at 90% detailed design. Status: Not Submitted	Contractor to obtain post-award prior to start of construction. The review process takes a minimum of 5 to 10 business days.

Name	Cause	Exclusions/Exceptions	Permit Required	Notes/Status	Timeline
Electrical Studies and Drawing Review	Required by Manitoba Hydro so that they can provide adequate power service for the WWTF and remote conveyance sites. Detailed electrical load and site plans required.	LIES required for service connections >2.5 MVA or off the 66 kV transmission lines.	YES	LIES will be required for the RSRWC WWTF, but not the remote lagoon sites. Drawings must be sealed by a professional engineer. A LIFS is also required. Status: Not Submitted	Study and drawings reviewed by Manitoba Hydro. This step may take 90 to 150 days depending on the scope of the work and any requested changes.
Electrical Permit Application	Required by Manitoba Hydro when installing new electrical systems and upgrading existing systems. Electrical permits must be issued and received prior to beginning any work.	None	YES	Manitoba Hydro will require calculated load (for their determination of distribution and transmission equipment installed and revenues) as well as connected (actual) load, which is used for electrical distribution panels. Run times of equipment (i.e., pumps) are also required. Status: Not Submitted	Remote sites have standalone requirements; therefore, each site will have one application. Online applications take 5 business days to process.

Name	Cause	Exclusions/Exceptions	Permit Required	Notes/Status	Timeline
Electrical Inspection	Arranged with Manitoba Hydro after completed installation and commissioning of new electrical systems.	None	YES	Each individual site will be inspected on a standalone basis. Multiple inspectors are likely to be involved considering project breadth. Status: Not Started	This step may take 20 to 60 days depending on scope of work and site condition.
Commercial Electrical Service Application	Required by Manitoba Hydro for connecting electrical service to buildings and site infrastructure or equipment; required for a new service or upgrades to existing service.	None	YES	Application for each standalone site to indicate preferred voltage, service size (in amps), and estimated demand (in kVA); detailed loads (breakdown of demand and motor loads); Nonlinear load information; single-line diagram. Status: Not Submitted	Estimate an agreement will be provided 20 to 60 days after Manitoba Hydro has received completed application.

Name	Cause	Exclusions/Exceptions	Permit Required	Notes/Status	Timeline
Historic Resources Branch Review Request	Prior to construction, the locations affected by the project should be submitted to the Province of Manitoba's Historic Resources Branch (HRB) for review.	None	YES	Submitted during preliminary design Status: Complete	Completed
Heritage Resources Impact Assessment	Required if the Minister of Sport, Culture, and Heritage suspects that there may be heritage resources or human remains present on land affected by the Project.	If the Historical Resources Branch (HRB) Review determines that the Impact Assessment is not required.	YES	Heritage Permit A110-23 was issued. Monitoring is required during ground disturbance activities for some areas where the conveyance infrastructure from the communities to the facility will be installed. A Heritage Resource Protection Plan is required for all ground disturbance activities. Status: Complete	Completed
Fish and Wildlife Branch	Scientific Collection Permit and Live Fish Handling permit might be required based on site survey and the nature of the in-water work.		TBD	Application to be submitted at least 2 weeks prior to work requiring a permit. Status: Not Submitted	2 to 5 days to review application and issue permit.

Name	Cause	Exclusions/Exceptions	Permit Required	Notes/Status	Timeline
Provincial Access (Driveway), Signs, Structures, and Development Permits	Required by Manitoba Transportation and Infrastructure for development, including access to structures and signs adjacent to provincial highways.		YES	The permit application can be submitted once the plan (showing the location and details of the construction, including all existing access, structures, etc.) is finalized. Status: Not Submitted	The processing time for a permit is approximately 4 to 8 weeks.
Provincial Waterways Authorization	Required from Manitoba Infrastructure for any infrastructure and activities on Provincial Waterways.		YES	To be submitted at detailed design stage Status: Not Submitted	The processing time is estimated as 3 weeks
DFA Permit	Required under the *Water Resources Administration Act*, for any new permanent structure within a DFA.		YES	Manitoba Infrastructure will perform inspection and compliance surveys during and after the construction work. Status: Not Started	
Utility Installation within Highway Right-of-Way Permit	Permission is required from the Minister of Infrastructure for utility installations (temporary or permanent) within provincial highway rights-of-way.		YES	To be submitted at detailed design stage Status: Not Submitted	The processing time is 4 to 8 weeks.

Name	Cause	Exclusions/Exceptions	Permit Required	Notes/Status	Timeline
Federal Permits					
Fisheries Act Authorization	Required for projects that will result in the death of fish and/or harmful alteration, disruption, or destruction of fish habitat.	Project can avoid the death of fish and/or harmful alteration, disruption, or destruction of fish habitat by following the applicable DFO Measures to protect fish and fish habitat, or is unlikely to contravene one of the SARA prohibitions with respect to aquatic species, and is included under repairs to existing intakes. ▪ No new fill or other temporary or permanent structures below the high-water mark.	TBD	Submit a request for review to DFO upon completion of preliminary design. DFO will determine whether a *Fisheries Act* Authorization is required. Status: Not Submitted	At minimum, 12 months before start of construction for authorization.

Name	Cause	Exclusions/Exceptions	Permit Required	Notes/Status	Timeline
Species at Risk Act	Species listed in Schedule I receive federal protection under SARA, including the protection of individuals, populations, and their habitat from harm. SARA applies to federal lands and waters under the jurisdiction of the federal government, and federally funded projects. A Recovery Strategy, an Action Plan, and a Management Plan may be required if Schedule I listed species at risk are affected by the Project.	None	TBD	Submit during detailed design upon notice of EA requirement based on presence of species at risk. If no EA is required, follow best management practices. Status: Not Submitted	At minimum, 120 days before completion of detailed design.

Name	Cause	Exclusions/Exceptions	Permit Required	Notes/Status	Timeline
Navigation Protection Program	Required for projects that result in an impediment of the public's ability to navigate a water body by placing structures or objects in, over, under, through or across it.	Work legally constructed under previous legislation. Minor Works that comply with the legal requirements of the Minor Works Order. ▪ Erosion-protection works ▪ Docks and BOATHOUSES ▪ Boat ramps, slipways, and launch ramps ▪ Aerial cables – Power and telecommunication ▪ Submarine cables – Power and telecommunication ▪ Pipelines buried under the bed of navigable water ▪ Pipelines and power or communication cables attached to existing works ▪ Works within a boomed-off area upstream or downstream of an existing work for water control ▪ Outfalls and water intakes ▪ Dredging ▪ Mooring systems	TBD	Contact Transport Canada's Navigation Protection Program to confirm whether the Outfall Work falls under the Minor Works Order. If it does not, a completed Application for Approval will be submitted during the detailed design phase. Status: Not Submitted	If required, an Application for Approval is to be completed and submitted during the detailed design stage. The review process takes 90 days.

Name	Cause	Exclusions/Exceptions	Permit Required	Notes/Status	Timeline
Consultation with Indigenous Peoples	Infrastructure Canada reviewed the project information and determined that there is an obligation to consult with Indigenous peoples.	None	N/A	Infrastructure Canada requires a summary of communications, including any issues or concerns that may be raised by respective Indigenous groups and an indication of how the issues or concerns have been addressed or proposed to address. Status: In Progress	As soon as possible.
CPKCR Utility Crossing Permits/Agreement	Required for any over/under railway tracks and crossing.	None	YES	To be submitted at detailed design stage. Status: Not Submitted	Typical turnaround time is 30 to 60 business days.
CN Pipeline Crossing/Encroachment Application	Required for a pipeline installation crossing CN rail tracks.	None	YES	To be submitted at detailed design stage. Status: Not Submitted	Typically takes 30 to 60 business days to review.
TransCanada Energy	Required for a pipeline installation crossing TC Energy pipeline.	None	YES	To be submitted at detailed design stage. Status: Not Submitted	Typically takes 30 to 60 business days to review.

2.9 Public Engagement

2.9.1 Summary of Engagement Activities Undertaken

2.9.1.1 March 9, 2023: Open House, Niverville, Manitoba

An open house on March 9, 2023, provided the public with the opportunity to learn about the proposed regional conveyance network and WWTF. Information was provided on the scope of the project, the project timeline and milestones, how the project will support economic growth in the region, and conceptual plans for the conveyance network. The open house was hosted by Jacobs and the RSRWC.

The open house was attended by the media, members of council in the region, local residents, and potential contractors for the project. There was limited feedback received, but some concerns were raised regarding the potential for increased traffic, noise, and odour. Jacobs is considering these stakeholder concerns in the Project design and will be implementing measures to reduce the potential impact of these concerns.

2.9.1.2 Ongoing: Indigenous Engagement

The RSRWC has initiated Indigenous engagement through reaching out to the Manitoba Métis Federation (MMF) and the Roseau River Anishinabe First Nation (RRAFN). As the project progresses, the MMF and RRAFN will continue to be informed on any new developments.

2.9.2 Summary of Engagement Activities to be Undertaken in the Future

2.9.2.1 Industry Market Sounding Meeting – Conveyance System

Jacobs is planning for an Industry Market Sounding Meeting for the conveyance portion of the project. The purpose of this meeting will be to understand the current market perspective and solicit feedback from potential bidders for the regional conveyance system. The RSRWC is interested in obtaining feedback that will help frame the procurement process for the conveyance system. The meeting may be attended by any prospective bidders on the conveyance system, and attendance at this meeting will have no bearing on the eligibility of the company to particulate in future procurement opportunities related to the project.

2.9.2.2 Future Open Houses

It is anticipated that there will be one or two additional open houses over the course of the multi-year Project. These open houses will provide the public with the opportunity to receive updates on the status of the Project, as well as the opportunity to ask questions.

3 Scope of Assessment and Assessment Approach

The assessment evaluates the potential environmental and socioeconomic effects of the Project for the Project components outlined in the Project description (Section 2.4). The assessment method applied the following process:

1. Identify the environmental and socioeconomic elements to be considered
2. Determine the spatial and temporal boundaries for the assessment;
3. Identify the potential environmental and socioeconomic effects, based on the potential interactions of the Project with each element;
4. Develop appropriate technically and economically practical site-specific mitigation to avoid or reduce residual effects; and
5. Identify the predicted residual effects (i.e., those effects that remain once mitigation has been applied).

3.1 Selection of Environmental and Socioeconomic Elements

The assessment team identified potential interactions using professional experience, the results of the Project-specific desktop review and field studies, and applicable regulatory requirements. Environmental and socioeconomic elements potentially interacting with the Project are as follows:

1. Physical Environment
2. Vegetation
3. Water Resources
4. Groundwater Quality and Quantity
5. Wildlife and Wildlife Habitat
6. Socioeconomic elements including Human Health.

3.2 Spatial and Temporal Boundaries

The EAP predicts the potential effects of the Project on the environmental elements within defined spatial and temporal boundaries. These boundaries will vary with the biophysical or socioeconomic elements or interactions to be considered, and will reflect:

1. The biophysical and socioeconomic baseline setting within the spatial boundaries of the Project
2. The area potentially affected by construction and operations activities, including the proposed physical works and physical activities
3. The area in which an element occurs or functions, and within which a Project effect may be detected
4. The time required for an effect to become evident
5. The time required for an element to recover from an effect and return to a pre-effect condition

The spatial boundaries for the Project residual effects encompass the areas potentially affected by the Project, the areas within which a biophysical element occurs or functions, and the areas within which Project effects might occur. There are three categories of study areas:

1. **Project footprint:** the land area directly disturbed by the construction and operations activities, including associated physical works and activities (a wastewater treatment facility and a wastewater collection system consisting of approximately 100 km of pipeline to connect the RSRWC communities and existing wastewater treatment lagoons).
2. **Local Study Area (LSA):** varies with the environmental element being considered. The LSA includes the Project footprint and extends beyond it to incorporate the area within which the element is most likely to be affected by the Project.
3. **Regional Study Area (RSA)**: varies with the environmental element being considered. The RSA includes the Project footprint and LSA, and the area beyond the LSA boundaries where the predicted likely residual effects from the Project may act in combination with those of existing and reasonably foreseeable developments.

The timeframes used in the assessment of the Project are defined as the temporal extent of interactions between the Project and the biophysical elements. The temporal context encompasses:

1. Construction: the time period required to complete construction activities
2. Operations: the time period that the WWTF, wastewater conveyance system and lagoons will be in operation

For the purpose of this assessment, the decommissioning of any component of the Project was not assessed. When the decommissioning schedule is finalized and the end land use is determined for the lagoons outlined in Section 2.6.1: Decommissioning, a decommissioning plan will be developed in accordance with Provincial and local jurisdictional requirements at the time. The decommissioning plans will be developed by the RSRWC and are not included within the current Project scope.

3.3 Mitigation

Mitigation is considered the elimination, reduction, or control of a project's adverse environmental effects. To verify that potential adverse environmental effects are reduced, during all phases of the Project, general and site-specific mitigation have been proposed based upon current industry accepted standards, engagement with appropriate regulatory authorities, and the professional experience of the assessment team. Mitigation measures are identified for each element in the relevant element section.

3.4 Evaluation of Residual Effects

The predicted residual effects of the Project were characterized according to a set of qualitative and quantitative criteria outlined in Table 3-1.

Table 3-1. Characterization of Residual Effects

Assessment Criteria	Definition	
Direction		
Positive	Residual effect has a net benefit to the environment or human health.	
Neutral	Residual effect has no net benefit or loss to the environment or human health.	
Adverse	Residual effect has a net loss or is a detriment to the environment or human health.	
Spatial Boundary		
Project Footprint	The land area directly disturbed by the construction and operations activities including infrastructure sites and associated facilities. The Project footprint is the same for all elements included in this EAP.	
LSA	The LSA varies with the environmental element being considered. The LSA includes the Project footprint and extends beyond it to incorporate the area within which the element is most likely to be affected by the Project.	
RSA	The RSA varies with the environmental element being considered. The RSA includes the Project footprint and LSA, and an additional area beyond the LSA boundaries where the predicted likely residual effects from the Project may act in combination with those of existing and reasonably foreseeable developments.	
Temporal Context		
Duration (period of the predicted residual effect)	Immediate	Residual effect is limited to 2 days or less.
	Short-term	Residual effect is limited to the construction.
	Medium-term	Residual effect extends up to 10 years post-construction, including the operations phase.
	Long-term	Residual effect extends more than 10 years post-construction, including the operations phase.
Frequency (how often the predicted residual effect would occur)	Rare	Residual effect occurs uncommonly or unpredictably (e.g., because of an accident or malfunction) over the assessment period.
	Isolated	Residual effect is confined to a specified phase of the assessment period.
	Occasional	Residual effect occurs intermittently and sporadically over the assessment period.
	Periodic	Residual effect occurs intermittently, but repeatedly, over the assessment period.
	Continuous	Residual effect occurs without interruption throughout the assessment period.
Reversibility	Reversible	Residual effect is reversible to pre-construction or equivalent conditions.

Assessment Criteria	Definition	
	Irreversible	Residual effect is permanent.
Magnitude – Residual Environmental Effects		
Negligible	Residual effects may not be detectable or are within the range of natural variability or inconsequential to the function, health, performance, or sustainability of the element.	
Low	Residual effects are detectable; however, they are well within environmental or regulatory standards, or both.	
Medium	Residual effects are detectable and may approach, but are still within, the environmental or regulatory standards, or both.	
High	Residual effects are beyond environmental or regulatory standards, or both.	

For many of the elements under evaluation, there are no specific environmental or socioeconomic standards, guidelines, thresholds, targets, or objectives. Therefore, the determination of magnitude of the residual effects often entailed consideration of previous assessments of magnitude made by regulatory authorities. In addition, determination of magnitude relied on the experience of the assessment team, informed by outcomes of previous projects with similar conditions and potential issues.

4 Assessment of Effects on Physical Environment

Construction of the wastewater conveyance system and the WWTF will result in some disturbance to the Physical Environment, which for the purpose of the assessment includes climate, soils, and terrain.

4.1 Spatial Boundaries

The physical environment spatial boundaries for the residual effects assessment encompass the areas potentially affected by the Project, the areas within which a biophysical or socio-economic element occurs or functions, and the areas within which Project effects might occur. Table 4-1 describes the spatial boundaries for physical environment and the rationale for choosing these.

Table 4-1. Spatial Boundaries for Physical Environment

Element	Spatial Boundaries	Rationale
Physical Environment	**Physical Environment LSA:** 100 m corridor centred on the centreline of the conveyance system (extending 50 m from the centre the Project Construction Footprint (PCF)) or a 50 m buffer extending on all sides of the WWTF and outfall. **Physical Environment RSA:** Not Applicable	**Physical Environment LSA:** The Physical Environment LSA encompasses the Project Footprint and extends beyond it to include the surrounding area where there is a reasonable potential for Project-specific effects to occur to the physical environment. **Physical Environment RSA:** Potential adverse effects are not anticipated to extend beyond the LSA and, therefore, a Regional Study Area (RSA) has not been established for the Physical Environment

4.2 Description of Existing Conditions

The following subsections describe the climate, soils, and terrain within the Project area.

4.3 Climate

Climate normals and averages are available from Environment and Climate Change Canada's meteorological station at Glenlea and Steinbach, between 1981 and 2010. The two stations are well situated across the proposed Project area, with the Glenlea station in proximity to the St. Adolphe wastewater treatment lagoons, and the Steinbach station to the east of the Mitchell wastewater treatment lagoons. Climate data for the two stations was found to be comparable; therefore, station data from Steinbach is shown in Table 4-2.

Table 4-2. Climate Normals and Averages from the Steinbach Station

Station Name	Location (WGS 84)	Daily Average Temperature Range (°C)[a]	Yearly Total Precipitation (mm)	Maximum Average Monthly Rainfall (mm)	Maximum Average Monthly Snowfall (cm)
Steinbach	49.5333, −96.7666	−17 to 19	581	100 (June)	23 (December)

[a] The Daily Temperature Range are represented by the average temperature in July and in January from 1981 to 2010.

°C = degree Celsius
cm = centimetre(s)
mm = millimetre(s)

Emergency Preparedness Canada (1999a,b, 2009) provides information on major meteorological events across Canada from the beginning of the 20th century to 1999. During this period, a major hailstorm, tornado, and multiple flood events have impacted the City of Winnipeg, approximately 15 km away from the north extent of the proposed Project. The Red River has experienced several major flood events extending from the US-Canada border to the south and reaching beyond the City of Winnipeg. Flood events were recorded in the early 1800s. Eleven major floods have impacted the Red River between 1826 and 2011 (Government of Manitoba n.d.a).

4.4 Soils and Terrain

Offshore glaciolacustrine sediments comprise the largest area of surficial geology classification within the proposed Project area. These sediments consist of clay, silt, and a minor sand fraction, ranging from 1 metres (m) to20 m thick. Alluvial sediments (sand and gravel, sand, silt, clay, and organic detritus ranging 1 m to 20 m thick) are confined to the bed and banks of the Red River. Other surficial geological classifications occur in smaller areas and include the following: calcareous diamicton, proximal glaciofluvial sediments, and marginal glaciolacustrine sediments (Manitoba Government n.d.f).

The existing wastewater treatment lagoons within the RSR community network (where the new lift stations will be constructed and the lagoons repurposed) are located on previously disturbed land. Additionally, the land on which the proposed WWTF will be constructed is located on previously disturbed land as it was used as a former borrow pit site for the Town of Niverville wastewater treatment lagoon. Therefore, on these disturbed lands there is little to no native soil remaining in place.

Soils vary along the proposed wastewater conveyance system, which are dominantly chernozems, gleysols, and brunisols. Chernozemic and gleysolic soils are the primary soil type in the Project LSA and RSA, with brunisols occurring more frequently in the eastern edge of the proposed Project area near Steinbach. Soils along the outfall lie within the banks of the Red River and are typically Regosolic or Rego Gleysolic soils.

Chernozemic soils are well to imperfectly drained soil commonly found within grassland regions, where the surface horizon (that is, A horizon which is formed at or near the soil surface, typically referred to as topsoil) is darkened by the accumulation of organic matter. Surface horizons generally are >10 cm in depth (Soil Classification Working Group 1998).

Gleysolic soils are imperfect to poorly drained soil commonly found within low-lying or depressional areas where water saturation occurs for prolonged periods throughout the year. As a result of saturation, well-developed gley features are found within 50 cm of the soil surface (Canadian Society of Soil 2020).

Brunisolic soils are upland forested soils developed on medium to coarse textured parent materials. Brunisols are typically identified by having an underdeveloped Bm horizon, typically redder in colour than overlying horizons (Canadian Society of Soil 2020).

Regosolic soils are commonly associated with landforms where the land surface is unstable. Due to instability, soils have had limited time to develop and often have weakly expressed soil horizons. Commonly, there is a lack of upper subsoil development (i.e., B horizon or have a juvenile B horizon) (less than 5 cm thick).

The elevation ranges from 233 m in the northern extent of the Project near Ile des Chênes to 258 m at the southern extent of the Project near Grunthal. Numerous watercourses within the Project area drain to the northwest toward the Red River. The Red River, which is intersected by the wastewater conveyance system on the east extent of the proposed Project, is the largest watercourse in the Project area. Culverts, manmade ditches, and swales are present throughout the LSA along agricultural land and municipal roads. Lakes are located throughout the Project area and increase in occurrence toward the eastern half of the proposed Project. A large area extending north and south of Niverville contains 30 to 70 percent cover of multiple wetland classes, including marshes, swamps, and shallow open water complexes (Linnet Geomatics International 1997).

A search of federal and provincial contaminated sites identified contaminated sites within the Project LSA and RSA. The following federally-registered contaminated sites were identified in proximity to the proposed Project (Treasury Board of Canada Secretariat n.d.):

- approximately 7 km east of the Mitchell wastewater treatment lagoons, near Steinbach
- approximately 5 km west of the proposed wastewater conveyance system, in St. Pierre-Jolys
- approximately 2 km north of the proposed wastewater conveyance system near Glenlea, and in proximity to the Red River.

The Manitoba Contaminated Sites Registry returned the following provincially-registered impacted sites in proximity to the proposed Project (Government of Manitoba n.d.b):

1. A site impacted by polycyclic aromatic hydrocarbons (PAHs) approximately 5 km east of the Ile des Chênes wastewater treatment lagoons
2. A site impacted by benzene, toluene, ethylbenzene, and xylenes (BTEX) and PAH approximately 3 km east of the Blumenort wastewater treatment lagoons, in Blumenort
3. A site impacted by BTEX and petroleum hydrocarbons (PHCs) approximately 5 km east of the proposed wastewater conveyance system, north of Kleefeld
4. Six sites within 6 km of the Mitchell wastewater treatment lagoons in Steinbach; the sites are impacted by BTEX, volatile organic compounds, metals (including lead), and PHCs
5. Two sites within 6 km of the proposed wastewater conveyance system, in St. Pierre-Jolys impacted by undisclosed contaminants of concern.

Clubroot is a soil-borne pathogen that affects brassica species, such as canola, mustard, and cabbage. The root disease causes reduced crop yield and health, and once positive, the affected soil can remain infected for ten to twenty years. Clubroot was first detected in Manitoba in 2005 in a canola nursery. Since 2013, symptomatic observations and clubroot-positive tests have been rare. Laboratory testing of soil can detect clubroot deoxyribonucleic acid (DNA). Clubroot-positive agricultural lands require strict biosecurity protocols to prevent the movement of infected soil into non-symptomatic soil (Government of

Manitoba n.d.c). The Alternative Clubroot Distribution Map (Government of Manitoba n.d.d) for 2022 shows the results of clubroot testing across the province. The results are presented as the number of fields with clubroot symptoms in addition to fields where clubroot was detected but resulted in no symptoms. Clubroot was detected in the Rural Municipalities (RMs) of Ritchot, St. Pierre-Jolys, Taché, Hanover, and De Salaberry at 1,000 to 80,000 spores per gram of soil; however, the clubroot positive crops did not show any symptoms. Less than 1,000 spores per gram of soil were detected in the RM of Ste. Anne.

4.5 Potential Effects on Soils and Terrain

Potential effects to Soils and Terrain may occur as a result of construction and operation of the proposed wastewater conveyance system. The wastewater treatment lagoon upgrades and development of the WWTF will occur within existing disturbances, and as such, the land has little to no native soil or natural terrain remaining in place. The determination of potential effects has been made based on the results of desktop review of undisturbed lands within the proposed Project area.

Potential effects include a change in terrain or a change in soil productivity. Table 4-3 shows the potential effects and effect pathways that may occur during proposed Project activities and the corresponding effects indicators that may result without mitigation of the potential effects.

Effects are not anticipated to occur outside of the Project LSA, therefore, there will be no effect on climate and meteorological conditions and no further assessment is recommended.

Table 4-3. Project Activities, Effect Pathway, and Effects Indicators for Soil and Terrain

Potential Effect	Effect Pathway	Spatial Extent	Effects Indicator
Change in terrain	Ground disturbance during construction may result in terrain or slope instability, such as slumping, subsidence, or erosion	Project Footprint (outfall and conveyance system)	Altered topography following construction Terrain instability during and following construction
	Ground disturbance during construction may result in altered topography	Project Footprint (outfall and conveyance system)	Altered topography following construction
Change in soil productivity	A loss of topsoil quantity or quality during construction activities as a result of wind or water erosion or soil handling and storage methods	Project Footprint (outfall and conveyance system)	Wind and/or water erosion during and following construction Loss of topsoil Altered soil chemistry, increased coarse fragment content in topsoil
	Vehicle and equipment movement and soil handling may increase the risk of soil compaction, admixing, rutting, or pulverization during construction activities	Project Footprint (outfall and conveyance system)	Compaction and rutting, admixing, and pulverization
	The movement of soil on vehicle and equipment during proposed Project construction has the potential to spread soil-borne pathogens such as clubroot	Project Footprint (outfall and conveyance system)	Reduced crop yield and quality
	Clearing of vegetation or surface gravel, topsoil salvage, and grading may uncover previously unknown contamination, or incidental spot spills could occur as a result of fueling; use of hazardous substances (that is, lubricating fluid, hydraulic fluids, methanol, antifreeze, herbicides, and biocides); and fuel and hazardous substance storage and transport during construction activities.	Project Footprint (outfall and conveyance system)	Exposure to areas of previously unknown contamination Evidence of soil contamination from spills or leaks

4.6 Mitigation Measures and Residual Effects

Potential Project effects on terrain and soils from construction and operation of the wastewater conveyance system and the outfall components that will disturb native soil will be mitigated by implementing the following mitigation measures.

The following measures are the responsibility of a RSRWC representative or delegate:

- Work with the Contractor or Operations to develop new or alternative mitigation measures if the measures identified in this section are ineffective at avoiding or reducing environmental effects. New mitigation measures can be developed in co-operation with Resource Specialists, if warranted.
- Assess the erosion hazard along the Project and work with the Contractor to implement appropriate erosion control.
- Review and, if appropriate, approve the Contractor's planned seeding procedures, where applicable.

The following measures are the responsibility of the Contractor or Operations personnel:

- Limit their equipment and/or vehicular movements to designated roads and pathways within and around work areas, and limit construction equipment movement in riparian areas, where feasible.
- Limit the clearing of necessary vegetation and construction activities to the proposed Project Footprint.
- Re-establish vegetation on disturbed areas as soon as practical, where required.
- Salvage and stockpile topsoil for use in reclamation.
- Salvage topsoil in relation to the color change, or to a minimum of 10 centimetres; where soils are not readily distinguishable by color; and have a qualified person with knowledge of soils in their employ to provide direction to such methods.
- Implement alternative soil handling methods in areas where problem soils (soils that have strongly contrasting differences in upper and lower soil profile quality that would compromise soil capability) are encountered. This may include methods such as three-lift soil handling or overstripping topsoil (where shallow topsoil is observed).
- Install and maintain erosion and sediment control measures in areas as required.
- Adhere to site-specific mitigation constraints as instructed by a geotechnical engineer where there is the potential for terrain instability.
- Employ proper trench backfilling techniques (such as, compacting, removing large boulders, breaking large soil clumps, etc) to avoid subsidence due to settling.
- Prescreen all soil or fill material prior to importation and placement to confirm and confirm that comparable soil texture and chemical properties are comparable to surrounding lands. Contractor shall confirm imported material is free of weeds and contaminants.
- Adhere to all measures relating to the storage and handling of hazardous substances and prompt and thorough clean-up of spills and leaks in alignment with the Manitoba Regulation MR 188/2001 *Storage and Handling of Petroleum Products and Allied Products Regulation (Petroleum Storage Regulation)* under the Manitoba *Dangerous Goods Handling and Transportation Act.*
- Contractor shall not permit the refueling of vehicles and/or construction equipment within 100 m of water bodies.

- Store hazardous substances within an approved secondary containment capable of containing 1.5 times the quantity of the total volume of hazardous substances stored.
- Develop and implement measures to address known or suspected contamination.
- Water soil stockpiles, cover temporary stockpiles (using tarps or geotextiles), or use a short-lived annual cover crop to reduce the risk of wind and water erosion and to outcompete weed establishment.
- Reduce the spread of soil-borne pathogens; the development of mitigation plans that may include clubroot surveys to identify clubroot positive agricultural land, engagement with landowners, and biosecurity measures such as the cleaning of vehicles and equipment between clubroot positive fields.

With the above mitigation measures applied, there remains limited potential for the following residual effects:

- Subsidence, slumping, or erosion may occur following ground disturbance activities and result in altered terrain.
- Changes in topography and drainage can reduce soil quality by restricting water flow and increasing saturation that may lead to decreased vegetation cover. Given that the proposed Project is partially located within a soil series characterized as being poorly drained, changes in topography and drainage have the potential to affect soil quality.
- Compaction, rutting, and erosion can reduce soil capability. Coarse-textured soils are more susceptible to wind erosion, especially in dry conditions, whereas fine- to medium-textured soils (rich in clay) consist of more cohesive particles that are less likely to be influenced by wind. Water infiltrates coarse-textured soils faster than it can run off, reducing the risk of water erosion, whereas medium- to fine-textured soils, depending on pore size, are less likely to allow water infiltration and, therefore are more at risk for water erosion.
- Topsoil and subsoil mixing can alter the mineral composition, textural properties, and soil chemistry, affecting soil productivity and the success of vegetation establishment and crop growth. Admixing of topsoil with subsoil or other subsurface materials reduces soil productivity due to changes in factors such as soil texture and chemistry, reducing the ability for the topsoil to support vegetation.
- Changes in soil quality could result by encountering contaminated soils during ground disturbance; handling and storage of contaminated soils; spot spills as a result of fueling; use of hazardous substances (that is, lubricating fluid, hydraulic fluids, methanol, antifreeze, herbicides, and biocides); and fuel and hazardous substance storage and transport. Exposure to areas of previously unknown contamination and incidental spills during construction and operation could result in a reduction of soil productivity.
- Movement of soil from clubroot-positive agricultural lands on vehicles and equipment has the potential to spread the soil-borne pathogen. Clubroot infects crops such as canola causing decreased yield and crop quality. The spread of clubroot can be managed by identifying the clubroot-positive agricultural lands within the Soil LSA and conducting a biosecurity protocol to prevent the movement of contaminated soil.

It is anticipated that with the implementation of mitigation, effects to soil and terrain for the conveyance system are considered non-residual. Given the outfall will remain a permanent disturbance until decommissioning, the potential effect to soil and terrain cannot be completely avoided, reduced, or eliminated through the implementation of mitigation measures. The predicted residual effects to soil and terrain include the following:

- A change in terrain for the outfall
- Soil productivity for the outfall

It is anticipated that construction of the outfall will result in alteration of topography and loss in soil quantity throughout the lifetime of the Project until decommissioning.

4.7 Summary

Since the WWTF will be developed within land that has been previously disturbed, there is little to no native soil or natural terrain features remaining in place. As the end land use will remain a disturbed facility (WWTF), it is not intended for reclamation, and so, the effects related to the WWTF are considered negligible. Additionally, effects relating to changes in terrain and soil productivity are considered negligible in previously disturbed areas, which includes the existing wastewater treatment lagoons.

With implementation of the proposed mitigation measures, the effects of the conveyance system are anticipated to be non-residual following implementation of mitigation. Within the outfall, the potential effects are considered adverse. After implementation of the mitigation measures, the residual effects will be limited to the Project footprint, specifically the outfall and conveyance system; short to medium term for the conveyance system and long term for the outfall; continuous in duration, and low in magnitude. Effects are reversible following decommissioning.

5 Assessment of Effects on Vegetation

Construction of the wastewater conveyance system and the WWTF will result in some disturbance to vegetation, including riparian vegetation. Therefore, vegetation is considered in this assessment.

5.1 Spatial Boundaries

The vegetation spatial boundaries for the residual effects assessment encompass the areas potentially affected by the Project, the areas within which this biophysical element occurs or functions, and the areas within which Project effects might occur. Table 5-1 describes the spatial boundaries for Vegetation and the rationale for choosing these. The Vegetation LSA incorporates the area in which vegetation (i.e., species or communities) is most likely to be affected by potential temporary disturbance due to all phases of the Project. The Vegetation LSA encompasses the distance at which vegetation is predicted to be directly affected by all phases of the Project and includes vegetation within 100 m of the Project components, which may be susceptible to hydrologic, habitat, and biogeochemical alteration.

Table 5-1. Spatial Boundaries for Vegetation

Element	Spatial Boundaries	Rationale
Vegetation	**Vegetation LSA:** A 100 m buffer extending from the PCF. **Vegetation RSA:** A 1 km buffer extending from the PCF.	**Vegetation LSA:** The Vegetation LSA was established to incorporate the area in where there is reasonable potential for Project-specific effects to occur The Vegetation LSA considers the vegetation (i.e., species or communities) expected to interact with the Project, the effect pathways, and available information on vegetation sensitivity to disturbance (e.g., setback distances). **Vegetation RSA:** The Vegetation RSA was established to incorporate the area where the direct and indirect influence of other land uses and activities could interact within Project-specific effects and may cause cumulative effects on vegetation.

5.2 Description of Existing Conditions

The majority of the proposed Project Footprint (including the WWTF, wastewater treatment lagoons, outfall and wastewater conveyance system segments) is in the Lake Manitoba Plain Ecoregion within the Boreal Plains Ecozone. A short segment of wastewater conveyance system and the Grunthal wastewater treatment lagoons are in the Interlake Plain Ecoregion within the Prairie Ecoregion. The Interlake Plain Ecoregion reaches from the USA-Canada border northwest to the Saskatchewan border over low relief, flat-lying Palaeozoic limestone rock. Farmland in the southern extent tapers into mixedwood boreal forest in the northern extent. Summers are short and warm. Outside of agricultural lands, native vegetation consists of trembling aspen (*Populus tremuloides*) and balsam poplar (*Populus balsamifera*) with a well-established herbaceous and shrubby understory. Historically, fires prevented a climax community of white spruce (*Picea glauca*) and balsam fir (*Abies balsamea*) and have remained limited except on very dry sites. Poorly drained areas are dominated by sedges (*Carex* spp.), willows (*Salix* spp.), and sparse black spruce (*Picea mariana)* and tamarack (*Larix laricina*) (Smith et al. 1998).

Prior to extensive agricultural disturbance, the Lake Manitoba Plain Ecoregion was dominated by trembling aspen and oak (*Quercus* spp.) stands separating plains rough fescue (*Festuca hallii*) grasslands. In undisturbed habitats, trembling aspen and shrubs dominate moist sites, whereas native grasses (such as, plains rough fescue and June grass [*Koeleria macrantha*]) and agronomic grasses (such as, Kentucky bluegrass [*Poa pratensis*] and brome grasses [*Bromus* spp.]) dominate drier sites. Sedges (*Carex* spp.), willows (*Salix* spp.), and cattails (*Typha* spp.) are observed in poorly drained sites (Manitoba Conservation Data Centre 2021). Lake Manitoba Plain Ecoregion is bordered by the Manitoba Escarpment to the west and stretches from the USA-Canada border north to Lake Dauphin, MB. It is characterized as one of the warmest and most humid ecoregions within the prairies. Summers are historically short and warm, and winters are historically long and cold (Smith et al. 1998).

Most of the lands within the Project LSA and RSA occur within agricultural land uses or have existing disturbances such as roads and water treatment infrastructure. The existing wastewater treatment lagoons, proposed treatment facility, and outfall area are on previously disturbed land. The sewage conveyance system will traverse agricultural, disturbed, and isolated areas of native vegetation including grasslands, riparian areas, and wetlands.

Surveys for wildlife and wildlife habitat and aquatic resources were conducted on August 1 and 2, 2023. The following descriptions of vegetation were incidental observations collected during the field surveys.

Crops in the Project area mostly consisted of perennial forage (that is, alfalfa [*Medicago sativa*]) and cultivated crops (such as, sunflowers, canola, barley, and corn). Near the proposed outfall location, non-native species such as woolly burdock (*Arctium tomentosum*), rough cocklebur (*Xanthium strumarium*), virginia creeper (*Parthenocissus quinquefolia*), and spiny annual sow-thistle (*Sonchus asper*) were observed. Weeds such as wild parsnip (*Pastinaca sativa*) yellow and white sweet-clover (*Melilotus* spp.), dandelion (*Taraxacum officinale*) and Canada thistle (*Cirsium arvense*) were observed in ditches in the Project area (Manitoba Conservation Data Centre 2021). A high density of yellow and white sweet clover and Canada thistle were observed in proximity to the WWTF.

Outside of existing disturbances and agricultural land, undisturbed, well-vegetated areas were observed during the field survey at the proposed outfall location and along the proposed sewage conveyance system. Vegetation observed across the Project area included native trees (such as, trembling aspen, ash [*Fraxinus* spp.], and maple [*Acer* spp.]), shrubs (such as, black twinberry [*Lonicera involucrate]* and willow) and forbs (such as, goldenrod [*Solidago* spp.]). Riparian areas adjacent to the Red River, drainages, and proposed outfall location were dominated by riparian vegetation such as, trembling aspen, balsam poplar, sandbar willow (*Salix interior*), spotted water-hemlock (*Cicuta maculata*), water smartweed (*Persicaria amphibia*), and grasses (Manitoba Conservation Data Centre 2021).

Between NE 36-6-4 E and NW 31-6-6 E, north of the Kleefeld wastewater treatment lagoon and near the Grunthal wastewater treatment lagoon between SE 25-5-4 E and SW 30-5-5 E is an undeveloped municipal road right-of-way where native vegetation was observed during the field survey. Near the north extent of the road right-of-way, goldenrod, prairie sage (*Artemisia ludoviciana*), blanketflower (*Gaillardia* spp.) snowberry (*Symphoricarpos occidentalis),* and nuisance weeds (such as, sweet clover [*Melilotus* spp.], bird's-foot trefoil [*Lotus corniculatus*], and Russian olive [*Elaeagnus angustifolia*]) were observed.

Noxious weed management in Manitoba is divided into a tier system and weed designations may be applied to a geographic region, or throughout the province. Tier 2 invasive plants must be destroyed by the landowner under the Manitoba *Noxious Weeds Act* if the colonized area is less than 20 acres; areas greater than 20 acres must be controlled. Tier 3 weeds must be controlled by the landowner where the growth or spread is likely to affect the economy, environment, or the well-being of residents in proximity. Table 5-2 lists the noxious weeds that were observed within the Project area during the August 2023 field survey.

Table 5-2. Noxious Weeds Observed in the Project Area in August 2023

Common Name	Scientific Name	Manitoba *Noxious Weed Act* Designation[a]	Area Where the Designation Applies
Woolly burdock	*Arctium tomentosum*	Tier 3	Whole province
Dandelion	*Taraxacum officinale*	Tier 3	Whole province
Wild parsnip	*Pastinaca sativa*	Tier 3	Whole province
Spiny annual sow-thistle	*Sonchus asper*	Tier 3	Whole province
Canada thistle	*Cirsium arvense*	Tier 3	Whole province

[a] Province of Manitoba n.d.h

In addition to the Manitoba *Noxious Weeds Act,* the RM of De Salaberry, the RM of Ritchot, and the Village of St Pierre Jolys provide a list of permitted herbicides within the Red River Weed Control District 2021 Proposed Pesticide Program (RM of De Salaberry n.d.). Information about a current Pesticide Program was not available at the time of writing.

Data was acquired from the Manitoba Conservation Data Centre to determine the occurrence of previously observed rare plants and communities of concern. Table 5-3 shows the recorded rare plants within a 1-km buffer of the Project components.

Table 5-3. Rare Plants with Potential to Occur within 1-km of the Project Components

Common Name	Scientific Name	S-Rank[a]	Provincial Status	*SARA* Status	COSEWIC Status
Neglected milkvetch	*Astragalus neglectus*	S1	—	—	—
Bulbous bittercress	*Cardamine bulbosa*	SH	—	—	—
Virgin's-bower	*Clematis virginiana*	S2?	—	—	—
Woodland lettuce	*Lactuca floridana*	SH	—	—	—
Riddell's goldenrod	*Solidago riddellii*	S2S3	Threatened	Special Concern	Special Concern
Common agrimony	*Agrimonia gryposepala*	S1S2	—	—	—

[a] Provincial (S) ranks are assigned by the Manitoba Conservation Data Centre (MB CDC n.d.b) and are based on the NatureServe global conservation status ranks (NatureServe n.d.). Ranks range from 1 (critically imperiled) to 5 (secure).

— = not applicable
COSEWIC = Committee on the Status of Endangered Wildlife in Canada
SARA = Species at Risk Act

Riddell's goldenrod is listed under the *Species at Risk Act* as well as Manitoba's *Endangered Species Act.* Habitat for Riddell's goldenrod within the Manitoba Tall Grass Prairie Preserve is protected under the Manitoba *Endangered Species* Act. Riddell's goldenrod occurs in southeastern Manitoba from the United States border as far north as Kleefield and as far east as Giroux, in relatively undisturbed roadsides, especially in habitats supporting fen- or prairie-like communities or in areas where open conditions are maintained, such as along railway lines. Populations are observed in sites with moist to wet calcareous sandy loam soils where the water table is at or above the soil surface until mid-June. Suitable habitat for Riddell's goldenrod is present within the Project footprint.

Additional extant populations are known to occur in Hanover RM and Ste. Anne RM and historical populations were observed in De Salaberry RM in the 1950s. Populations have been mapped by MB CDC within rights-of-way and road ditches. Riddell's goldenrod is threatened by habitat loss or degradation, changes in ecological dynamics, and pressure from introduced species. MB CDC conducts outreach to RMs to provide management recommendations (Environment Canada 2015).

There were no incidental observations of rare plants or rare ecological communities within the Project area in August 2023. Photographs of the vegetation observed during the field survey are included in Appendix C – Site Photographs – Vegetation.

5.3 Potential Effects on Vegetation

Construction and operation of the conveyance system and the WWTF, including the outfall, may affect vegetation resources. The determination of potential effects has been made based on the results of desktop review conducted for the proposed Project.

Potential effects include a reduction in the number of plant species of conservation concern, and the introduction or spread of invasive plant species. These potential effects may contribute to habitat fragmentation and the loss of biodiversity. Table 5-4 shows the potential effects and effect pathways that may occur during proposed Project activities and the corresponding effects indicators that may result without mitigation of the potential effects.

Table 5-4. Project Activities, Effect Pathway, and Effects Indicators for Vegetation

Potential Effect	Effect Pathway	Spatial Extent	Effects Indicator
Change in vegetation species	Vegetation clearing and ground disturbance during construction or vegetation maintenance during operations have the potential to damage or result in a loss of plant species of conservation concern	Project Footprint	Loss or damage to plant species or communities of conservation concern
Introduction or spread of invasive plant species	Vegetation clearing and ground disturbance during construction or vegetation maintenance during operations have the potential to introduce or spread invasive plant species	Project LSA	Introduction or spread of invasive plant species
	The movement of equipment and materials to, from, and within the proposed Project Footprint has the potential to introduce or spread invasive plant species and/or their seeds	Project LSA	

5.4 Mitigation Measures and Residual Effects

Activities associated with the proposed Project construction and operation have the potential to result in residual effects to Vegetation. Where avoidance was not considered feasible, mitigation measures have been identified to minimize potential residual effects. Mitigation measures would be implemented prior to the initiation of, or during, the activities associated with construction and operation phases and as such, they are anticipated to be effective immediately upon implementation. Seeding and invasive species management measures, as well as mitigation measures requiring inspections, require medium- to long-term timelines before they are considered effective in reducing potential effect to Vegetation. Similarly, some mitigation measures may require time to function as predicted, such as in the case of revegetation measures.

Clearing of trees (such as, poplar, trembling aspen, and maple) and shrubs (such as, willows and black twinberry) will be required at limited locations; predominantly around the proposed outfall location where the existing ditch will be cleaned of debris, rip-rap materials added, and the regrading along the upper portions of the ditchwork. Other areas of clearing along the proposed sewage conveyance system alignments, include the undisturbed municipal road right-of-way between SE 25-5-4 E and SW 30-5-5 E.

To reduce potential effect during any phase of the proposed Project, general and site-specific mitigation measures are recommended based on current regulations, professional judgement, and from engagement with Indigenous communities and regulatory agencies.

The following measures are the responsibility of a RSRWC representative or delegate:

- Engage with the Red River Weed Control District to identify pesticides permitted within the Municipality of De Salaberry and the Rural Municipality of Ritchot
- Develop measures that are effective at managing the introduction and spread of invasive noxious plant species, as required under Provincial regulations and Municipal bylaws.

The following measures are the responsibility of the contractor:

- Limit construction equipment and vehicle movements to designated roads within and around work areas, and limit construction equipment within riparian areas.
- Conduct field surveys prior to the commencement of construction to identify potential rare plants; potential mitigation to include staking, flagging, barriers, and setbacks. If a vegetation species listed by the federal Species at Risk Act or Manitoba Endangered Species Act is observed prior to construction, site-specific mitigation will be developed in consultation with appropriate Government authorities.
- Limit the clearing of vegetation and confine the construction activities to the proposed Project Footprint.
- Reduce disturbed and exposed areas to the extent feasible and reclaim areas as soon as practical.
- Revegetate disturbed soils as soon as practical.
- Manage invasive plant species within the Project footprint prior to and following construction activities.
- Implement procedural measures related to the storage and handling of hazardous substances and clean-up of leaks and spills.

The mitigation measures are consistent with available and relevant guidelines and regulations and are anticipated to reduce adverse effects to vegetation.

Given the scope of the proposed Project, the potential effect to vegetation cannot be completely avoided, reduced, or eliminated through the implementation of mitigation measures. The predicted adverse residual effects to vegetation include the following:

- Loss or damage to plant species or communities of conservation concern
- Introduction or spread of invasive species

The potential for plant species or communities of conservation concern is generally low, considering the extent of existing disturbance within the Project footprint; however, habitat suitable for Riddell's goldenrod occurs along the Project footprint.

It is anticipated that construction will require the clearing of native vegetation within the proposed Project Footprint, which could result in a loss of plant species or communities of conservation concern within the proposed Project Footprint. The duration of a residual effect to plant species or communities of conservation is concern is predicted to be medium-term; however, the effect may occur periodically, depending on the frequency of vegetation management during the operations phase. Depending on the location of the vegetation management and the type of vegetation species or community, as well as the implementation of mitigation, vegetation management may or may not affect plant species or communities of conservation concern. For example, if a rare vegetation species was avoided by the Project Footprint, then vegetation management will not cause additional impacts during construction. During operation of the Project, vegetation management along the Project footprint will be completed as needed.

During operation, vegetation around the proposed WWTF and existing wastewater treatment lagoons will be routinely mowed. Vegetation along the constructed rights-of-way and within road ditches will be conducted by the owner (that is, the rural municipalities) following the commencement of the operations phase. Where the responsibility for the rights-of-way is turned over from RSRWC to other owners following commencement of operations, the assessment of potential effects to vegetation is considered out of scope of the Project.

Vegetation around the outfall structure will be gravelled and no vegetation will be permitted to establish along the discharge channel or at the outfall structure for the lifetime of the Project.

While the effects will extend over the life of the Project, the effect is considered reversible to preconstruction conditions following decommissioning, when vegetation will be permitted to regenerate in the Project footprint. However, ongoing disturbance to vegetation is anticipated during maintenance of the Project footprint during operations.

Overall, where mitigation measures are implemented, the magnitude to plant species or communities of conservation concern is considered negligible to low.

Weed introduction is difficult to control and may persist on the landscape even if mitigation measures are implemented. Along the water conveyance system, the primary pathway for weeds of concern to be introduced or spread is during construction or during decommissioning of the existing wastewater treatment lagoons; vegetation management (such as, mowing or herbicide application, where permitted) will resolve issues with weeds of concern over time following construction or decommissioning. Therefore, the effects are anticipated to be short- to medium-term in duration.

Weeds may also be introduced or spread throughout the operational life of the Project and have the potential to spread into the Vegetation LSA. Invasive species present during the operational period will require additional time to mitigate following decommissioning. However, with regular monitoring and corrective measures in place, the overall abundance and variety of weeds is expected to decrease throughout operations. Therefore, the effects are anticipated to be long-term in duration.

The potential residual effect of weed introduction and spread is periodic in frequency, reversible to preconstruction or equivalent conditions, and of low magnitude.

5.5 Summary

Vegetation surveys are one of the measures recommended to mitigate the potential effects to plant species or communities of conservation concern. The effects to vegetation are considered reversible to preconstruction or equivalent conditions following decommissioning. Plant species and communities of conservation concern have the potential for more periodic disturbance; however, the potential effects can be reduced through avoidance, setbacks, or staking during construction and vegetation management in the operations phase.

If a vegetation species listed by the federal Species at Risk Act or Manitoba Endangered Species Act is observed prior to construction, site-specific mitigation will be developed in consultation with appropriate Government authorities.

Overall, following the implementation of mitigation, the effects of the Project on vegetation are anticipated to be negligible to low considering the Project is mostly located within previously disturbed or cultivated land uses.

6 Assessment of Effects on Surface Water Resources

Construction and operation of the conveyance system and the WWTF, including the outfall, may affect surface resources, including wetlands and watercourses.

6.1 Spatial Boundaries

The surface water spatial boundaries for the residual effects assessment encompass the areas potentially affected by the Project, the areas within which this biophysical element occurs or functions, and the areas within which Project effects might occur. Table 6-1 describes the spatial boundaries for Surface Water Resources and the rationale for choosing these.

Table 6-1. Spatial Boundaries for Surface Water Resources

Element	Spatial Boundaries	Rationale
Wetlands	**Wetland LSA:** encompasses the distance at which wetland vegetation is predicted to be directly affected by all phases of the Project and includes wetlands within 100 m of the Project components, which may be susceptible to hydrologic, habitat, and biogeochemical alteration. **Wetland RSA:** The Wetlands RSA aligns with the Aquatics RSA since hydrology is the overall driver for both wetlands and aquatic ecosystems and includes wetlands within 10 km of the Project components.	**Wetland LSA:** The Wetlands LSA incorporates the area in which wetlands are most likely to be affected by potential temporary disturbance due to all phases of the Project. The Wetlands LSA aligns with the Vegetation LSA, since changes in vegetation (i.e., species or communities) are expected to be a gauge of the effects on wetland function. **Wetland RSA:** The Wetlands RSA incorporates the area in which other land uses could interact with wetlands in the Wetlands LSA and have the potential to be directly, indirectly, or cumulatively affected by the potential temporary disturbance due to all phases of the Project.
Aquatics	**Aquatics LSA:** The Aquatics LSA is centered on the project footprint and extends 100 m upstream and 300 m downstream of the identified watercourse and drainage interactions to account for potential Project-related activities that may affect Water Quality and Quantity and Fish and Fish habitat beyond the Project Footprint. **Aquatics RSA:** The Aquatics RSA is a 10 km radius buffer around the Project Footprint.	**Aquatics LSA:** The Aquatics LSA incorporates the area likely to be affected by disturbances during all phases of the Project to integrate the potential effects that may extend off the Project footprint. **Aquatics RSA:** The Aquatics RSA incorporates the area in which other land use could interact with the watercourses and drainages in the LSA and have the potential to directly or indirectly interact with the Project.

6.2 Description of the Existing Conditions

6.2.1 Wetlands

According to the Canadian Wetland Classification System (CWCS), wetlands are defined as:

> *"…land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity which are adapted to a wet environment."* (NWWG 1997).

Wetlands include a wide range of ecosystem types that vary in surface water permanence, hydrophytic vegetation, and soil saturation.

Wetland regions in Canada are areas defined by characteristic and similar wetland ecosystems that develop in locations with similar topography, hydrology, and nutrient regime. The Project encounters two wetland regions: the Mid-boreal Wetland Region and the Continental Prairie Wetland Region. Characteristic Transitional Mid-boreal wetlands include fens, bogs, swamps, and marshes. Peat accumulation ranges from 2 m to 3 m in bogs to little or no peat present in swamps and marshes. Characteristic Grassland Continental Prairie wetlands are primarily marshes; with some containing surface water for only a few weeks per year and others containing water more permanently. The substrate associated with Grassland Continental Prairie wetlands is typically mineral with little to no peat accumulation (Energy, Mines and Resources Canada 1986).

A desktop review was conducted using satellite imagery and publicly available datasets (Manitoba Habitat Heritage Corporation and Manitoba Conservation and Water Stewardship 2015, Natural Resources Canada 2007-2011) to determine wetland class and distribution within the Wetlands LSA. Satellite imagery was reviewed at varying scales of approximately 1:2,000 to 1:15,000 and was interpreted using key indicators (e.g., geomorphology, surficial hydrology, and vegetation type and cover).

Wetlands identified during the desktop review in the Wetland LSA were classified using Stewart and Kantrud (1971) and the CWCS (NWWG 1997). Stewart and Kantrud (1971) was used for the classification of marsh and shallow water wetlands (i.e., Class I, II, III, IV, V and VI wetlands), and the CWCS (NWWG 1997) was used when classifying treed and shrubby swamps located across the prairies. Prairie wetlands are highly complex and difficult to classify due to both spatial and temporal variability in their defining characteristics. For these wetlands, hydrology, water chemistry and biology can change dramatically throughout a season or from year to year as a result of changing weather conditions.

A total of 32 wetlands were encountered by the Project footprint during desktop review. Wetland classes encountered include swamps (shrub and hardwood treed), and marshes (Class I, II, III, and IV). Wetlands and artificial ponds encountered by the Project footprint and identified within the Wetlands LSA are summarized in Table 6-2.

Table 6-2. Wetlands and Artificial Ponds Encountered by the Project Footprint

Environmental Feature	Conveyance Area (ha and % of Conveyance Footprint)[a], [b]	Wastewater Treatment Facility Area (ha and % of WWTF Footprint)[a]	Lift Station Area (ha and % of Lift Station Footprint)[a], [b]	LSA (ha and % of LSA)[a]
Total number of artificial ponds crossed [c]	4	1	0	13
Total number of wetlands crossed	27	4 [d]	1	225
Total area of wetland habitat encountered (ha)	0.59 ha (0.5%)	1.23 ha (12.4%)	0.01 ha (<0.01%)	1.83 ha (0.09%)

[a] Due to rounding, the sum of areas and the percentage of total areas may not add up to the actual total Project Footprint.

[b] A 5 m buffer was added to the conveyance and lift station centerlines to create the footprint.

[c] Artificial ponds are not considered wetlands.

[d] Of the 4 wetlands identified within the WWTF footprint, one wetland was classified as a Class III and will require compensation to offset permanent wetland loss in accordance to with the *Water Rights Act*. One Class II and two Class I wetlands were also identified within the WWTF footprint.

WWTF = Wastewater Treatment Facility

6.2.2 Water Quantity – Red River Basin

The Project is located in Manitoba within the Red River Basin. The Red River Basin is formed from the joining of the Ottertail and Bios de Sioux rivers located along the North Dakota/Minnesota border and is approximately 116,500 square km, exclusive of the Assiniboine River and its tributaries (Red River Basin Board 2000). The proposed wastewater conveyance system crosses the Red River along with various tributaries and drainages. The proposed outfall is located east of the Red River and would discharge into a 70 m-long, 1.0 m wide, unnamed drainage to the Red River. The Red River is approximately 114 m-wide at the confluence with the unnamed drainage.

The Red River is approximately 880 km in length and originates in the United States near Wahpeton North Dakota flowing north into Manitoba and through the City of Winnipeg, where a major tributary, the Assiniboine River, enters. It then empties into Lake Winnipeg (USGS 2019). These waters eventually reach Hudson Bay via the Nelson River. The Red River is a low gradient river and the flat topography and northward direction of flow accounts for the frequent and extreme flooding the Red River valley experiences. The snow-melt pattern in the spring typically moves from south to north in latitude. The high flows in the headwaters often coincide with flooding downstream and with higher levels of precipitation throughout the basin (Red River Basin Board 2000).

Currently there are no active hydroelectric dams in Manitoba on the Red River (Manitoba Hydro 2021). Numerous flood control structures exist throughout the Red River basin including the Red River Floodway, located south of the City of Winnipeg. The Red River Floodway was constructed between 1962 and 1968 and expanded in 2010 to protect the City of Winnipeg from a 1-in-700-year flood. It diverts water from the Red River into a 47 km long floodway channel around the City of Winnipeg and back into the Red River near the community of Lockport, Manitoba, approximately 28 km north of the City of Winnipeg. It also includes a 45 km long West Dyke located south of the City of Winnipeg that prevents the Red River floodwaters from flowing into the La Salle River (Government of Manitoba n.d.e). There is a diversion structure on the Seine River, near St. Adolphe, approximately 12 km south of the City of Winnipeg, which can be used to divert flows into the Red River during high water events (Government of Manitoba n.d.e). There are several communities with provincial ring dikes in the Red River Basin to provide protection against flooding in the watershed (i.e., Emerson, Gretna, Letellier, Rosenfeld, Dominion City, St. Jean Baptiste, Riverside, Rosenort, St. Pierre-Jolys, Aubigny, Morris, Lowe Farm, Ste. Agathe, Brunkild, St. Adolphe, Niverville, and Grande Pointe) (Government of Manitoba n.d.e).

Data for the Red River near Ste. Agathe hydrometric station (Station Number 05OC012) is available from 1958 to 2021. The hydrometric station is approximately 8 km upstream from the Project outfall location. The hydrograph for the Red River at Station Number 05OC012 from 1958 to 2021 shows peak flows in April (i.e., a monthly average of 638 cubic metres per second [m^3/s]), indicative of spring runoff (Table 6-3). Flows then decline over the late summer and fall. The annual mean flow over this time period was 193 m^3/s. More recent flood events measured at this station occurred in 2009, 2011, and 2019 when these years had an annual mean discharge over 440 m^3/s. The highest monthly discharge was recorded in April 2009 at 2,040 m^3/s (Government of Canada 2023a) during the flood event.

Table 6-3. 1958 to 2021 Streamflow Summary for Red River near Ste. Agathe (Station No. 05OC012)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Mean monthly discharge (m^3/s)	42.7	39.3	125	638	477	288	248	116	91.9	93.3	98.9	59.4
Maximum monthly discharge (m^3/s)	149	119	648	2,040	2,240	837	1,060	871	381	1,080	754	313
Minimum monthly discharge (m^3/s)	3.41	5.36	8.24	54.2	39.4	27.2	14.4	8.23	8.54	8.53	7.61	4.57

Monthly flow data is not available for January to April and November to December in 1958, January to February and November to December in 1959, January to February in 1960, and October in 2010.

Source: *Government of Canada 2023a*

6.2.3 Water Quality – Red River Basin

The Red River is surrounded by productive agricultural land. Due to agricultural and urban runoff the Red River contains higher than normal concentrations of nitrogen and phosphorus. In addition, treated municipal sewage discharge into the river also reduces the water quality (Government of Manitoba 2011). The Red River has high levels of suspended sediments which can accumulate chemicals and harm aquatic species. Several chemicals and physical parameters have tolerance ranges set by the Government of Manitoba (Government of Manitoba 2011) and the Canadian Council of Ministers of the Environment (CCME) for the protection of aquatic life (CCME 2020). The objective of the Project's surface water quality baseline studies was to characterize surface water quality in the Project.

6.2.3.1 Methods

The following sections describe the methods used to characterize surface water quality in the study area including a historical data summary, data quality review, and data analysis. Methods for data analysis include a general summary of the characterization of baseline historical water quality.

6.2.3.1.1 Baseline Data Sources

Regional baseline historical water quality data around the Project RSA wase obtained to characterize baseline conditions and natural variability. All the samples were collected using a discrete grab method from the center of the watercourse channel at an approximate depth of 0.5 m from the surface. Most of the locations were field-tested for temperature, pH, dissolved oxygen (DO), specific conductance (SC), and turbidity (NTU) using a Professional handheld multiparameter, and a turbidity meter. The samples were collected in laboratory-supplied containers and sent for laboratory analyses with standard chain-of-custody documentation.

All parameters (conventional parameters, nutrients, metals, and coliforms) were analyzed by a laboratory certified by a Canadian Association for Laboratory Accreditation Inc. (CALA).

Quality control (QC) protocols were followed for the sampling programs. The QC measures included the collection and analyses of duplicate samples, the preparation, and analyses of field and trip blanks, as well as a review of the laboratory QC sample results.

Sources of historical water quality data include:

- Government of Manitoba, Water Quality Monitoring Program Database (Government of Manitoba 2023a)
- Government of Canada, Water Quality in Canadian Rivers Database (Government of Canada 2023b)

6.2.3.1.2 Baseline Data Analysis

Quantitative methods (i.e., descriptive statistical methods) were used to evaluate spatial and seasonal patterns. The baseline data analysis included the relevant historical water quality data in 2020 to 2022. Summary statistics were calculated using the baseline and historical water quality data including the number of data (n), non-detects (ND) and the annual median, maximum, minimum, mean, and standard deviation (s) for each parameter.

6.2.3.1.3 Data Evaluation

Scientific thresholds and established/accepted protective standards discussed in the baseline data are the thresholds established by the following when discussing water quality (Table 6-4).

- Canadian Water Quality Guidelines (CCME 2020) provides threshold values intended to protect the various forms and life stages of aquatic life in the presence of anthropogenic stressors.
- Guidelines Canadian Drinking Water Quality (Government of Canada 2020) provides threshold values intended to protect drinking water sources using coliforms monitoring as indicator.
- Manitoba Water Quality Standards, Objectives, and Guidelines (Government of Manitoba 2011) provides general guidance in evaluating surface water quality throughout Manitoba. The toxicity to aquatic life of some of these substances is affected by water hardness or pH. For these substances, guideline values have been calculated for various levels of hardness and pH.

Table 6-4. Water Quality Guidelines

Parameter	Unit	Water Quality Guidelines for Manitoba [a]	Canadian Water Quality Guidelines – Freshwater[b]
Field Parameters			
pH		6.5-9.0	6.5-9.0
Dissolved oxygen (DO)	mg/L	5.0[c]/6.5[d]	6.5[e]/9.5[f]
Conventional Parameters			
pH		6.5-9.0	6.5-9.0
Total suspended solids (TSS)	mg/L	NS[g]	NS[h]
Colour	TCU	<15	NS[h]
Nutrients			
Nitrite (NO_2-N)	mg/L	(0.02-0.20 [i]/0.06-0.60[j])[k]	0.06
Nitrate (NO_3 -N)	mg/L	3[i]/124[j]	13[i]/550[j]
Nitrogen – Ammonia (NH_4-N)	mg/L	0.018[l]	0.017[m]
Total nitrogen (TKN + NO_3 + NO_2)	mg/L	NS[n]	NS
Phosphorus, total	mg/L	NS[n]	NS
BOD	mg/L	25	NS
Coliforms			
Coliforms, fecal	MPN/100 mL	0 per 100 mL; 1000 per 100 mL[o]	100 per 100 mL[p]

Parameter	Unit	Water Quality Guidelines for Manitoba [a]	Canadian Water Quality Guidelines – Freshwater[b]
Coliforms			
Coliforms, fecal	MPN/ 100 mL	0 per 100 mL; 1000 per 100 mL[o]	100 per 100 mL[p]
Metals			
Dissolved Copper	mg/L	NS	NS
Total Iron	mg/L	0.3	NG
Total Silver	mg/L	0.0001	0.00025
Organics			
Toluene	mg/L	0.002	0.002
Phenols	mg/L	0.004	0.004
Chloroform	mg/L	0.0018	0.0018[q]

[a] Manitoba Water Quality Standards, Objectives, and Guidelines (Government of Manitoba 2011)
[b] Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME 2020)
[c] 1-day minimum, acute aquatic life guideline
[d] 7-day mean, chronic aquatic life guideline
[e] For cold water biota: other life stages
[f] For cold water biota: early life stages
[g] Refer to Manitoba Water Quality Standards, Objectives, and Guidelines (Government of Manitoba 2011) for more information
[h] Refer to Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME 2020) for more information
[i] Long-term (chronic) exposure
[j] Short-term (acute) exposure
[k] Dependent on chloride concentrations. Manitoba Water Quality Standards, Objectives, and Guidelines (Government of Manitoba 2011)
[l] Dependent on pH/Temperature – most stringent value. Refer to Manitoba Water Quality Standards, Objectives, and Guidelines (Government of Manitoba 2011)
[m] Dependent on pH/Temperature – most stringent value. Refer to CCME (2020) for more information
[n] Refer to Manitoba Water Quality Standards, Objectives, and Guidelines (Government of Manitoba 2011)
[o] Refer to Manitoba Water Quality Standards, Objectives, and Guidelines (Government of Manitoba 2011)
[p] Refer to Guidelines Canadian Drinking Water Quality (CCME 2020) for more information
[q] Interim guideline

TCU=total colour units
NS = narrative specified
MPN= most possible number

6.2.3.2 Baseline Water Chemistry

The following sections include a detailed discussion on water chemistry results within the Project area, and the parameters of concern in the proposed discharge for the project. Summary statistics of historical data are provided in Appendix D.

6.2.3.3 Conventional Parameters

Often the variability and range of conventional parameters will have important effects on the concentration and distribution of many other parameters within the water column. These are discussed in the following sections.

6.2.3.3.1 Temperature

Temperature is an important parameter as it can affect other physical, chemical, and biotic components of the aquatic environment. Temperature affects the solubility and concentration of many chemical compounds, such as metals. Therefore, temperature can influence the effect of chemical parameters on aquatic life. Higher temperatures can result in an increase in metabolic oxygen demand and can have a negative effect on various aquatic species when combined with reduced oxygen solubility.

Natural sources of temperature variation include solar radiation, transfer from air, sediment, precipitation, surface runoff, and groundwater. Temperature patterns that develop in water bodies are determined by air temperature and wind (Mitchell and Prepas 1990). This was reflected in data collected from water bodies throughout the Project Area where variability in water temperature corresponded closely with seasonal temperature changes (Appendix D). The water temperature in the water bodies measured within the Project RSA ranged from -1.4°C in the winter, to 30.4°C in the summer, with an annual median of 11.0°C.

6.2.3.3.2 pH

Water pH is a measure of hydrogen ion activity in solution. Water with low hydrogen ion concentrations is alkaline, and water with higher concentrations are acidic. Neutral water has a pH of 7. Most aquatic organisms tolerate pH values from 6 to 9, and lethal effects on aquatic life typically occur below pH 4.5 and above pH 9.5 (Wetzel 2001). pH levels can alter how other elements react within the environment. Lower pH values tend to facilitate the solubility of heavy metals and salts, which increase their toxicity once dissolved in water. Photosynthesis, hydrolysis, dissociation, and oxidation are key processes that produce hydrogen ions in the natural waters of the that may affect the pH (Hounslow 1995). Humic and fulvic acids are also sources of hydrogen ions that may affect pH (Hounslow 1995).

Even when proper sample handling procedures are followed, the pH of collected water samples can change quickly due to degassing of CO_2, temperature change, and bacterial activity. Therefore, field measurements are the most representative of in situ conditions. pH within the Project RSA was generally neutral to moderately basic ranged from 7.3 to 9.4 with an annual median of 8.2 (Appendix D).

6.2.3.3.3 Dissolved Oxygen

Dissolved Oxygen (DO) is the amount of gaseous oxygen that is dissolved in the water column and is subject to diurnal and seasonal fluctuations that are related to temperature, atmospheric pressure, turbulence, aeration, photosynthesis and respiration, decomposition of organic matter, runoff, and ice cover. DO is essential to the respiratory metabolism of aquatic organisms and the response to low oxygen levels is organism-dependent. The maximum concentration of oxygen that can be dissolved in water is inversely proportional to water temperature. During the summer months, as the water temperature increases, the solubility of oxygen decreases. Although colder water can hold more DO, ice cover during winter blocks the exchange of gases between water and the atmosphere, reducing DO in the water (Hatfield et al. 2013). DO is typically lowest in winter due to ongoing decomposition of organic matter and the presence of ice cover.

Other factors, including aquatic ecology and streamflow characteristics also influence site-specific DO levels. DO concentrations affect the solubility and availability of nutrients that are released from bottom sediments; and will therefore affect the overall productivity of the ecosystem. Government of Manitoba has set the chronic guideline for DO for the protection of freshwater aquatic life at 6.5 mg/L, and the acute guideline at 4.0 mg/L (Government of Manitoba 2011). Seasonal changes in median DO concentrations were evident in the samples within the Project RSA. The surface water DO ranged from 0.5 mg/L (below the guidelines) to 13.8 mg/L (above the guidelines); with an annual median of 8.6 mg/L (Appendix D).

6.2.3.3.4 Total Suspended Solids

TSS are the particles that remain when a water sample is passed through a 0.45 µm pore size filter (Hatfield et al. 2013). TSS consists of organic and mineral particulate matter suspended in water and is strongly associated with other water quality parameters, including total phosphorus, total aluminum, and numerous other metals (Hatfield et al. 2013). Elevated TSS can compromise primary productivity through reduced light penetration and physical smothering or scouring of aquatic habitat (CCME 1999; CCME 2002). TSS levels over 25 mg/L are considered harmful to aquatic life (however, many organisms can tolerate higher levels for a short period of time (CCME 1999; CCME 2002).

TSS levels tend to peak during spring run-off in March and April, reaching several hundred mg/L at some sites, while minimum values tend to occur during winter low flow conditions (e.g., 10 mg/L; Anderson 1999). TSS concentrations within the Project RSA ranged from less than 1 to 1,310 mg/L with an annual median of 38 mg/L (Appendix D).

6.2.3.4 Nutrients

6.2.3.4.1 Carbon

Components of dissolved organic carbon (DOC) including humic compounds and other naturally-occurring organic acids (fulvic acids) give water a tea-coloured appearance. Hydrological links between groundwater and surface water occur in the hyporheic zone, the region below and along lakes and watercourses. DOC can be transferred in both directions between surface water affected by peatlands and groundwater in boreal systems (Bengtsson and Törneman 2004). DOC concentrations within the Project RSA ranged from less than 35.4 to 42.3 mg/L and an annual median concentration of 38.9 mg/L (Appendix D).

Total organic carbon (TOC) is composed of dissolved and particulate forms of carbon derived from decaying plant and animal materials (e.g., decaying macrophytes and algae). In some areas where plant decay is slow, humic materials accumulate and result in brown watercourses and lakes. These materials often include components that break down slowly from microbial decay (e.g., cellulose). Watercourses and lakes with TOC concentrations less than 3 mg/L are considered clear. Naturally-occurring TOC levels often vary between 1 and 30 mg/L, but higher values are typical in productive habitat such as shallow wetland environments (Wetzel 2001).

TOC concentrations within the Project RSA ranged from less than 7.3 to 28.1 mg/L and an annual median concentration of 14.0 mg/L (Appendix D).

6.2.3.4.2 Biochemical Oxygen Demand

Biochemical oxygen demand (BOD) is a standard microbial incubation procedure that measures the oxygen required to oxidize organic material and certain inorganic materials over a given time period. Alternatively, the measure for the amount of oxygen required to chemically oxidize reduced minerals and organic matter of a sample is termed chemical oxygen demand (COD) (CCME 1999). The Manitoba Water Quality Standards, Objectives, and Guidelines (Government of Manitoba 2011) Tier II, include Carbonaceous BOD and BOD standards that are intended to be applied as maximum concentrations not to exceed. However, some flexibility on a site-specific basis can be added to provide an allowance for low variability at continuously discharging facilities.

For facilities that discharge intermittently, carbonaceous BOD and BOD standards must be met before water is discharged and must be maintained throughout the discharge period. BOD concentrations within the Project RSA ranged from 0.2 to 2.0 mg/L with an annual median of 2.4 mg/L (Appendix D). These concentrations are below 25 mg/L, the standards for municipal wastewater effluents discharged to a watercourse (Government of Manitoba 2011).

6.2.3.4.3 Nitrogen

Nitrogen is a nutrient required for growth of primary producers and often contributes to increases in productivity in aquatic ecosystems. The availability of nitrogen is often described in terms of Total Kjeldahl Nitrogen (TKN), which includes organic particulate nitrogen and ammonia. Total nitrogen (TN) is composed of nitrite + nitrate (NO_2 + NO_3) and TKN concentrations. Rivers that are not affected by large organic inputs generally have TKN levels that range between 0.1 and 0.5 mg/L (McNeely et al. 1979). Nitrogen thresholds are in Table 6-5.

Table 6-5. Thresholds for Nitrogen

Thresholds[a]	Total Kjeldahl Nitrogen (mg/L)
Low	<0.1
Moderate	0.1 to 0.5
High	>0.5

[a] Based on McNeely et al. 1979.

Nitrogen concentrations were high in watercourses throughout the Project RSA (Appendix D). High nutrient concentrations are common in prairie areas and were frequently reported in the historical data. TN concentrations ranged from less than 0.03 to 11.7 mg/L with an annual median of 1.3 mg/L.

Nitrate-Nitrogen concentrations ranged from less than 0.04 to 3.89 mg/L with an annual median of 0.232 mg/L. Nitrite-Nitrogen concentrations ranged from less than 0.001 to 0.12 mg/L with an annual median of 0.002 mg/L (Appendix D).

Ammonia (NH_4-N) is a measure of the most reduced inorganic form of nitrogen in water and includes dissolved ammonia (NH_3) and the ammonium ion (NH_4^+). It can be used by most aquatic plants; therefore, it is an important nutrient. However, ammonia in its un-ionized form (NH_3) can be toxic to fish, while the ionized form (NH_4^+) is not; toxicity is affected by several factors including pH, temperature, and DO (CCME 2020).

Ammonia concentrations ranged from less than 0.002 to 1.590 mg/L within the Project RSA with an annual median of 0.037 mg/L below detection limits for most of the samples (Appendix D).

6.2.3.4.4 Phosphorus

Phosphorus is a nutrient required for growth of primary producers and often contributes to increased productivity in aquatic ecosystems. Trophic status can be used to identify the productivity of a watercourse or lake. Trophic status is used to describe the aquatic community and ecological nature of a water body. Trophic status can influence a number of water quality indicators such as DO and turbidity (Mitchell and Prepas 1990). Water quality can be affected by increased biological activity as increased algae and plant photosynthesis/respiration cycles can result in low DO levels and changes in some ion concentrations (e.g., calcium).

Trophic status is defined as one of four major categories (oligotrophic, mesotrophic, eutrophic, and hypereutrophic; (Table 6-6) or a combination thereof. Oligotrophic water bodies have low levels of biological production; mesotrophic water bodies have moderate levels; eutrophic water bodies have high levels; and hypereutrophic water bodies are very productive (Margalef 1983; Mitchell and Prepas 1990).

Table 6-6. Trophic Levels in Water Bodies and Watercourses

Trophic Level	Trigger Ranges for Total Phosphorus (mg/L)	
	Lakes[a]	Watercourses[b]
Ultra-oligotrophic	<0.004	n/a
Oligotrophic	0.004 – 0.01	<0.025
Mesotrophic	0.01 – 0.02	0.027 – 0.075
Meso-eutrophic	0.02 – 0.035	n/a
Eutrophic	0.035 – 0.1	>0.075
Hypereutrophic	>0.1	n/a

[a] Wetzel 2001
[b] Dodds et. al. 1998

n/a = not applicable

TP concentrations within the Project Area ranged between 0.002 to 1.240 mg/L with an annual median of 0.242 mg/L (Appendix D).

6.2.3.4.5 Coliforms

Coliforms are a group of bacteria that are naturally found on plants and in soils, water, and in the intestines of humans and warm-blooded animals. Because coliforms are widespread in the environment, they can be used as operational tools to determine the efficacy of a different water treatment systems (Government of Canada 2020). This is also the reason this group is discussed within this baseline historical data.

Monitoring of coliforms should be used, in conjunction with other indicators, as part of a source-to-tap approach to producing drinking water of an acceptable quality. Coliforms are naturally found in both fecal and non-fecal environments, so they are commonly present in both surface water and groundwater under the direct influence of surface water sources (Government of Manitoba 2011; Government of Canada 2023b). The guidelines for coliforms (fecal) include maximum acceptable concentrations for drinking water, irrigation, and human consumers (Government of Manitoba 2011; Government of Canada 2020).

Escherichia coli (*E. coli*) and fecal coliform concentrations for the baseline are summarized below and in Appendix D.

- *E. coli* concentrations within the Project RSA ranged between 0.5 to 2,420 MPN/100 mL with an annual median of 20 MPN/100 mL.
- Fecal coliforms concentrations within the Project RSA ranged between 5.0 to 1,150 MPN/100 mL with an annual median of 50 MPN/100 mL.

These concentrations are below 200 MPN/100 mL, the standards for municipal wastewater effluent discharged to a watercourse (Government of Manitoba 2011) and the Guidelines for Canadian Drinking Water Quality (Government of Canada 2020).

6.2.3.5 Metals

Metals are naturally present in Canada surface waters and are generally present in small quantities (i.e., less than 1 mg/L). They are frequently associated with suspended sediments and tend to settle out; however, a variable proportion of the total metals present consist of dissolved forms.

Most metallic elements play an important function in the aquatic ecosystem as trace elements but can be toxic to aquatic organisms at elevated levels. The extent to which metals are toxic varies by metal and is dependent on its availability for biological uptake. Uptake is affected by water pH, hardness, and DOC concentrations.

Changes in pH can affect the solubility and mobility of some metals. Increases in pH and hardness lead to the precipitation of metal ions. When metals bind to suspended particles in water (e.g., organic matter, clay particles) they become less available for uptake by plants and animals. Conversely, metals such as aluminum and iron are easily mobilized in the presence of fulvic acids. The widespread acidification due to precipitation (i.e., rain and snow) on poorly-buffered soils and freshwaters can result in higher rates of trace metals being leached into surface water and subsequently transported through a watershed.

Although the solubilities of metals vary somewhat, most metals (greater than 70%) adsorb to biologically-produced particulate matter and associated crystalline solids. Much of the remainder is in organic complexes, with low solubilities (Wetzel 2001).

Metallic soluble micronutrients are required for the development and growth of algae, macrophytes, and many invertebrates. For instance, dissolved silica (SiO_2) is crucial for the development of diatoms, which are a type of algae; dissolved magnesium is required as a component of chlorophyll molecules. However, the distribution of these trace elements among ionic (soluble), organically complex, and adsorbed fractions, as well as the amounts in living biota, is poorly understood (Wetzel 2001).

Seasonal trends in total metal concentrations were similar in watercourses and lakes; generally, elevated concentrations were observed in samples collected in the winter (Appendix D). Factors that may have contributed to seasonal variation include groundwater influence, natural mineralization processes, and biological processes such as uptake and release of metals by algae and aquatic vegetation. Total metals measured in open-water seasons may be influenced by dilution from runoff and precipitation.

Total iron concentrations within the project RSA ranged from 0.056 mg/L to 14.0 mg/L with an annual median of 0.721 mg/L in watercourses within the project RSA (Appendix D).

Total silver concentrations within the project RSA ranged from less than 0.000005 to 0.00008 mg/L with an annual median of 0.00003 mg/L in watercourses within the project RSA (Appendix D).

Total copper concentrations within the project RSA ranged from 0.1 µg/L to 8 µg/L with an annual median of 2.51 µg/L in watercourses within the project RSA (Appendix D). There is no guideline for total copper (CCME 2019). Dissolved copper was not reported in the baseline historical data (Government of Manitoba 2011).

6.2.3.6 Organics

The detectable toluene concentrations in a few samples are attributed to natural sources such as plant growth (White et al. 2009; Faubert et al. 2010; Guenther 2013) and microbial metabolism (Jüttner and Henatsch 1986; Fischer-Romero et al. 1996) as no other benzene, toluene, ethylbenzene, and xylenes (BTEX) fractions were detected.

Phenols occur naturally in the aquatic environment from the decomposition of aquatic vegetation, and from anthropogenic sources such as industrial effluents and domestic sewage (CCME 1999). Some Northen American forests are dominated by plants of the heat family (Ericacea) that contain naturally high tissue of phenolic compounds which contribute to phenol soil concentrations (Berglund 2004). Phenolic compounds are also found to occur in some soils (like peat), with concentrations being dependent on the degree of decomposition. Increase natural environment concentrations may also attributed to forest fires. Phenols are a major by-product of the pulp and paper, mineral (non- metallic), chemical, steel and metal, and petroleum industries (Environment Canada 1997).

Trichloromethane (chloroform) occur in the aquatic environment due to anthropogenic sources such as industrial effluents, domestic sewage, and process related chlorination of water (Environment Canada 1984; CCME 1991, 1992, 1999. The primary source of trichloromethane in natural aquatic environments is from the reaction of chlorine with organic chemicals in effluents and raw water wherein the amount of trichloromethane produced is proportional to the organic content of the water (USEPA 1978). High-level point sources include industrial effluents and accidental spills (NAS 1978; Thomas et al. 1979). The toxicity of trichloromethane varies across taxonomic groups, species of freshwater fish as most sensitive to trichloromethane.

6.2.4 Fish, Fish Habitat and Freshwater Mussels

The proposed Project scope that may impact fish, fish habitat, and freshwater mussels includes the wastewater conveyance system watercourse crossings, the outfall drainage channel modifications, and the outfall discharge. There were 22 potential watercourse or drainage interactions identified during desktop and field assessments for the wastewater conveyance system route (Table 6-7). Trenchless crossing methods will be used for all watercourse and drainage interactions and no instream work is anticipated for the wastewater conveyance system pipeline installation. Any additional watercourses or drainages identified during construction will also be crossed using trenchless methods.

Table 6-7. Potential Watercourse and Drainage Crossings on the Proposed Wastewater Conveyance System Route

Site No	Interaction Type	Watercourse Name	Latitude Longitude	Field Comments (August 2023)	Desktop Comments
WC-1	Crossing	Unnamed tributary (Red River)	49.585765, -97.1549309	No field assessment.	Cultivated through by landowner. No visible channel or drainage.
WC-2	Crossing	Unnamed tributary (Red River)	49.615041 -97.142916	No field assessment.	Drainage between cultivated fields under the Lord Selkirk Highway that drains into the Red River. Approximately 700 m upslope of the Red River.
WC-3	Crossing	Red River	49.620679, -97.130431	Large river, channel width approximately 115 m. Mussels observed, including a Mapleleaf mussel.	None
WC-4	Crossing	Tourond Creek	49.620914 -97.107726	No field assessment.	Large wetted area, multiple culverts visible under road. Drainage between fields with connectivity to the Red River.
WC-5	Crossing	Tourond Creek	49.620597 -97.107722	No field assessment.	Large wetted area, multiple culverts visible under road. Drainage between fields with connectivity to the Red River.
WC-6	Crossing	Unnamed tributary (Seine River Diversion)	49.620760 -97.084949	No field assessment.	Drainage between fields with connectivity to the Seine River Diversion.
WC-7	Crossing	Unnamed tributary (Seine River Diversion)	49.620504 -97.084979	No field assessment.	Drainage between fields with connectivity to the Seine River Diversion.
WC-8	Crossing	Prefontaine Drain	49.635510 -97.048529	No field assessment.	Same watercourse as WC-9, at 700 m downstream. Roadside ditch adjacent to Niverville Wastewater Treatment Lagoons.

Site No	Interaction Type	Watercourse Name	Latitude Longitude	Field Comments (August 2023)	Desktop Comments
WC-9	Parallels Drainage	Prefontaine Drain	Start: 49.635510 -97.037462 End: 49.635215 -97.00552	Roadside ditch, mostly dry during field visit. There were cattails and some pockets of standing water.	Wastewater conveyance system parallels road within drain for approximately 2.3 km.
WC-10	Crossing	Unnamed tributary (Seine River Diversion)	49.635300 -96.905673	No field assessment.	Roadside drainage between 2 roads. Drainage between fields with connectivity to the Seine River Diversion.
WC-11	Parallels Drainage	Unnamed tributary (Seine River Diversion)	Start: 49.66468 -97.087064 End: 49.664792 -97.037953	No field assessment.	Wastewater conveyance system parallels road within ditch for approximately 3.5 km.
WC-12	Crossing	Youville Drain	49.619363 -96.742074	No field assessment.	Drainage through private property and cultivated fields.
WC-13	Parallels Drainage	Youville Drain	Start: 49.651215 -96.844095 End: 49.657527 -96.844233	No field assessment.	Wastewater conveyance system parallels drainage between 2 fields for approximately 700 m.
WC-14	Crossing	Seine River Diversion	49.693407 -96.844469	No field assessment.	Drainage along the road.
WC-15	Crossing	Unnamed tributary (Seine River Diversion)	49.605342 -96.888835	No field assessment.	Drainage along the road.

Site No	Interaction Type	Watercourse Name	Latitude Longitude	Field Comments (August 2023)	Desktop Comments
WC-16	Parallels Drainage	Unnamed tributary (Seine River Diversion)	Start: 49.605120 -96.86748 End: 49.597910 -96.867377	No field assessment.	Wastewater conveyance system parallels roadside drainage for approximately 800 m.
WC-17	Crossing	Unnamed Manmade Drain (Canal Manning)	49.546774 -96.889099	No field assessment.	Drainage along the road.
WC-18	Crossing	Unnamed Manmade Drain (Canal Manning)	49.546329 -96.866302	Manmade drainage, mostly dry with only pools of standing water.	Drainage along the road.
WC-19	Crossing	Unnamed Manmade Drain (Canal Manning)	49.546061 -96.808830	Manmade drainage, mostly dry with only pools of standing water. Fish observed.	Drainage along cultivated fields.
WC-20	Crossing	Tourond Creek	49.526429 -96.916934	Standing water within an approximately 4 m-wide channel. Banks heavily vegetated with grasses and sedges.	Watercourse between Tourond Creek Discovery Center and cultivations.
WC-21	Crossing	Unnamed tributary (Ruisseau Joubert)	49.420162 -96.917226	Channel width approximately 2 m, with good cover. Watercourse was flowing in some areas and fish were observed.	Watercourse through an undisturbed patch of trees.
WC-22	Crossing	Unnamed tributary (Ruisseau Joubert)	49.413999 -96.902602	No flow observed; only standing water.	Same watercourse as WC-21 but along a road and cultivated field.

On August 1 and 2, 2023, Aquatic Biologists conducted a field assessment at the proposed outfall location and some of the proposed wastewater conveyance system route (Table 6-7). Photographs of the Project footprint and downstream habitat are included in Appendix E.

6.2.4.1 Proposed Wastewater Conveyance System Crossings

Most of the proposed wastewater conveyance system route is through disturbed habitat, typically roadside ditches or cultivated field drainages, except for WC-3 and WC-21. During the field visit, very little flow was observed; most sites were dry or just had pools of standing water (Appendix E). Fish and mussel sampling was not conducted; however, fish were observed at WC-19 and WC-21, and mussels, including a Mapleleaf mussel (*Quadrula* quadrula) were observed at WC-3. There are no documented permanent barriers to fish migration and the Project area is prone to overland flooding, so there is potential to encounter fish at any of the watercourse or drainage crossings sites, if water is present.

Due to water depth, soft substrate, and turbid conditions at the Red River (WC-3) measurements were estimated from the right bank. The Red River at WC-3 was approximately 115 m wide, water depth was over 2 m, and the moderately unstable banks were composed of fines and organics. The habitat was deep flats with mostly fine substrate and would provide suitable habitat for all life stages of fish. The Red River had uniform morphology so spawning, rearing, and wintering fish habitat would not be limited to the assessed reach.

The Unnamed tributary to Ruisseau Joubert (WC-21) was approximately 2 m wide with abundant cover from overhanging vegetation, woody debris, and instream vegetation. The riparian area was mixed deciduous trees with grasses and sedges. There were shallow flowing sections with small and large gravel substrate, and pools of standing water with mostly fine substrate. Due to shallow water depth and low flow, this watercourse likely only provides suitable habitat for small-bodied species, such as cyprinids.

6.2.4.2 Outfall Drainage

The 70 m long unnamed drainage near the proposed outfall structure was dry during the August 2023 assessment and is likely only flowing during high flow events since terrestrial vegetation was growing within the drainage (photographs in Appendix E). The drainage had a mean channel width of 1.5 m and sloping unstable banks composed of fines and organics. When flowing, the drainage likely provides shallow (less than 0.5 m deep) flat habitat with a few shallow pools with fine and organic substrate.

The drainage provides poor spawning and rearing habitat and no wintering habitat for fish because of the low flows. During high water events connectivity to the to the Red River is possible and fish may use the drainage near the confluence as an area of refuge from high flows. Due to the proximity to the Red River, instream work should be avoided during the restricted activity period (RAP, April 1 to June 30), if water is present.

6.2.4.3 Fish and Mussel Habitat Information

Within the Project footprint, historical fish information was only available for the Red River. The Red River supports an assemblage of coolwater an warmwater fish species (Table 6-8) These species are primarily spring and summer spawners, except for burbot (*Lota lota*), which spawn in the winter. Based on the previously documented fish species, the restricted activity period (RAP) for the Red River is April 1 to June 30 for spring and summer spawners (DFO 2013). The RAP is intended to help prevent instream disturbance during sensitive periods for fish and the organisms upon which they feed. Instream work for the Project should be avoided during the RAP if the watercourses or drainages are flowing. Since the fish species previously documented in the Red River could be encountered at all watercourse crossings if water is present, instream work should avoid the same RAP.

Table 6-8. Fish and Mussel Species Previously documented within the Red River

Common Name	Scientific Name	Spawning Season	COSEWIC Listing	*SARA* Listing
Sportfish				
Lake sturgeon (Saskatchewan-Nelson River population)	*Acipenser fulvescens*	Summer	Endangered	—
Rock Bass	*Ambloplites rupestris*	Spring to summer	—	—
Black bullhead	*Ameiurus melas*	Spring to summer	—	—
Brown bullhead	*Ameiurus nebulosis*	Spring to summer	—	—
Freshwater drum	*Aplodinotus grunniens*	Spring to summer	—	—
Northern pike	*Esox lucius*	Spring	—	—
Goldeye	*Hiodon alosoides*	Spring	—	—
Mooneye	*Hiodon tergisus*	Spring	—	—
Channel catfish	*Ictalurus punctatus*	Spring	—	—
Bigmouth buffalo	*Ictiobus cyprinellus*	Spring to summer	Special concern	Special concern
Burbot	*Lota lota*	Winter	—	—
White bass	*Morone chrysops*	Summer	—	—
Yellow perch	*Perca flavescens*	Spring	—	—
Black crappie	*Pomoxis nigromaculatus*	Spring to summer	—	—
Sauger	*Sander canadensis*	Spring	—	—
Walleye	*Sander vitreus*	Spring	—	—
Non-Sportfish				
Quillback	*Carpiodes cyprinus*	Spring	—	—
White sucker	*Catostomus commersonii*	Spring	—	—
Finescale dace	*Chrosomus neogaeus*	Spring	—	—
Brook stickleback	*Culaea inconstans*	Spring to summer	—	—
Spotfin shiner	*Cyprinella spiloptera*	Spring to summer	—	—
Common carp	*Cyprinus carpio*	Spring	—	—
Iowa darter	*Etheostoma exile*	Spring to summer	—	—

Common Name	Scientific Name	Spawning Season	COSEWIC Listing	*SARA* Listing
Johnny darter	*Etheostoma nigrum*	Spring to summer	—	—
Chestnut lamprey (Saskatchewan-Nelson River population)	*Ichthyomyzon castaneus*	Spring to summer	Data deficient	—
Silver lamprey (Saskatchewan – Nelson River population)	*Ichthyomyzon unicuspis*	Spring to summer	Special concern	—
Bluegill	*Lepomis macrochirus*	Summer	—	—
Common shiner	*Luxilus cornutus*	Spring to summer	—	—
Silver chub	*Macrhybopsis storeriana*	Spring to summer	Not at risk	—
Silver redhorse	*Moxostoma anisurum*	Spring	—	—
Golden redhorse	*Moxostoma erythrurum*	Spring	Not at risk	—
Shorthead redhorse	*Moxostoma macrolepidotum*	Spring	—	—
Golden shiner	*Notemigonus crysoleucas*	Spring to Summer	—	—
Emerald shiner	*Notropis atherinoides*	Summer	—	—
River shiner	*Notropis blennius*	Spring to Summer	—	—
Bigmouth shiner	*Notropis dorsalis*	Spring to Summer	Not at risk	—
Spottail shiner	*Notropis hudsonius*	Spring to Summer	—	—
Sand shiner	*Notropis stramineus*	Spring to Summer	—	—
Stonecat	*Noturus flavus*	Summer	—	—
Tadpole madtom	*Noturus gyrinus*	Summer	—	—
Logperch	*Percina caprodes*	Spring to Summer	—	—
Blackside darter	*Percina maculata*	Spring to Summer	—	—
River darter	*Percina shumardi*	Spring to Summer	Not at risk	—
Trout-perch	*Percopsis omiscomaycus*	Spring to Summer	—	—
Fathead minnow	*Pimephales promelas*	Spring to Summer	—	—
Flathead chub	*Platygobio gracilis*	Spring	—	—
Longnose dace	*Rhinichthys cataractae*	Spring to Summer	—	—
Creek chub	*Semotilus atromaculatus*	Spring	—	—
Central mudminnow	*Umbra limi*	Spring to Summer	—	—

Common Name	Scientific Name	Spawning Season	COSEWIC Listing	*SARA* Listing
Freshwater Mussels				
Threeridge	*Amblema plicata*	Spring to Summer	—	—
Cylindrical papershell	*Anodontoides ferussacianus*	Spring to Summer	—	—
Zebra mussel	*Dreissena polymorpha*	Spring to Summer	—	—
Wabash pigtoe	*Fusconaia flava*	Spring to Summer	—	—
Plain pocketbook	*Lampsilis cardium*	Spring to Summer	—	—
Fatmucket	*Lampsilis siliquoidea*	Spring to Summer	—	—
White heelsplitter	*Lasmigona complanata*	Spring to Summer	—	—
Creek heelsplitter	*Lasmigona compressa*	Spring to Summer	—	—
Flutedshell	*Lasmigona costata*	Spring to Summer	—	—
Black sandshell	*Ligumia recta*	Spring to Summer	—	—
Pink heelsplitter	*Potamilus alatus*	Spring to Summer	—	—
Giant floater	*Pyganodon grandis*	Spring to Summer	—	—
Creeper	*Strophitus undulatus*	Spring to Summer	—	—
Mapleleaf mussel (Saskatchewan-Nelson River population)	*Quadrula Quadrula*	Spring to Summer	Threatened	Threatened

Sources:

Stewart and Watkinson 2004, Aadland et al. 2005, Government of Manitoba 2023, Government of Canada 2023c
Hnytka S.M *et al.* 2022

6.2.4.4 Species of Management Concern

Two aquatic species at risk under the *SARA* have the potential to be encountered within the RSA. The Bigmouth buffalo Saskatchewan-Nelson Rivers population is federally listed as Special Concern (Government of Canada 2023c). The long-term objective of the Bigmouth buffalo management plan is to maintain existing population levels and distribution as well as conserve habitat within watersheds. In Manitoba, Bigmouth buffalo populations are considered secure while the Saskatchewan populations are thought to have decline due to the loss or degradation of spawning habitat due to water management practices. Studies are ongoing to determine species distribution and habitat requirements in Manitoba (DFO 2021). Mapleleaf mussel, which is a freshwater mussel species, of the Saskatchewan-Nelson Rivers population, is listed as Threatened (Government of Canada 2023c). No critical habitat for aquatic species at risk is identified in the Red River. Critical habitat is not yet established for Mapleleaf mussel and there is not a recovery strategy for the Saskatchewan-Nelson Rivers population. Lake sturgeon of the Saskatchewan-Nelson Rivers population, which are listed as Endangered under COSWIC are also a species of management concern, although not listed under *SARA* at this time (Government of Canada 2023c).

Bigmouth buffalo occur within the Red River and the lowermost reaches of its tributaries (Stewart and Watkinson 2004). Spawning, inferred by an assessment of spawning condition, takes place from mid-May to late-August in shallow, flooded lakeshores and river banks over vegetation (Johnson 1963, Hlasny 2003, Stewart and Watkinson 2004).

A Mapleleaf mussel was incidentally observed during the field assessment on the bank of the Red River. They are found on a wide variety of substrate types including mud, sand and gravel (COSEWIC 2016). Like other freshwater mussels in the family Unionida, Mapleleaf have a complicated life cycle and are an obligate parasite on fish during the larval stage (COSEWIC 2016). Female Mapleleaf release packets of glochidia (larva) called conglutinates, which may resemble fish prey and attract fish. Channel catfish are known to be a host (COSEWIC 2016). Females are considered short term brooders and the brooding season may range from late spring to early summer in Canada based on data from other locations (COSEWIC 2016). Mapleleaf habitat preferences are fairly general, as they are found in medium to large rivers on firmly packed coarse gravel, sand and clay/mud (COSEWIC 2016).

The original Red River lake sturgeon population (Designatable Unit 4) has essentially become extirpated (DFO 2010). Although historical stocking efforts have been made in the Assiniboine River to attempt to recover the species, there has been no evidence of naturally reproducing populations in the Red River and lake sturgeon are not anticipated to be encountered by the Project. Lake sturgeon spawn from early May to late June after spring break up, when water temperature approaches 11°C (Stewart and Watkinson 2004, DFO 2010). Spawning typically occurs in fast-flowing water below waterfalls or rapids over clay, sand, gravel, and boulders (COSEWIC 2017).

Aquatic invasive species are a concern in Manitoba, most notably, zebra mussel (*Dreissena polymorpha*). Within the Project area, zebra mussel have been detected in the Red River and the Red River floodway (Government of Manitoba 2023b).

6.3 Potential Effects on Surface Water Resources

Potential effects to surface water resources may occur as a result of construction and operation of the proposed Project. The determination of potential effects has been made based on the results of desktop review and field surveys conducted for the proposed Project, Table 6-9.

Table 6-9. Project Activities, Effect Pathways, and Indicators for Water Resources

Potential Effect	Project Activities and Effect Pathways	Spatial Extent	Effects Indicators
Loss of wetland function at the Wastewater Treatment Facility	Infilling of wetlands during construction of the Wastewater Treatment Facility	Project Footprint	Loss of wetland area
Change in wetland function	Grubbing, grading and clearing of trees and shrubs may reduce nesting and foraging habitat for wildlife.	Project Footprint	Alteration of wetland habitat function
	Grubbing, grading and clearing of trees and shrubs can cause changes in vegetative species compositions resulting in alteration of wetland type (e.g., a wooded wetland may become a sedge dominant marsh).		
	Changes in soil surface contours can alter surface water flow patterns and influence soil moisture levels, which affects the type of vegetation that re-establishes on the ROW, as well as the successional trajectory of a wetland.		
	Wetland grading, alteration of surface contours, soil compaction, raised seedbanks, and the creation of a trench crown can cause changes to hydrologic flow by diverting water away from a wetland or impeding natural flow through a wetland. Disruptions in vertical and horizontal water movements from issues such as admixing, compaction, and improper contouring can result in changes to the seasonal permanency of surface water (e.g., flooding upstream and drying downstream). These hydrologic alterations may result in changes in species composition and wetland type.	Project Footprint	Alteration of wetland hydrologic function
	Alteration of surface contours can cause changes in wetland hydrology that can affect wetland biogeochemical functions through, for example, changes in the decomposition rates of wetland substrates. Such changes can alter the sequestration, storage, cycling, and release of carbon and other nutrients.	Project Footprint	Alteration of wetland biogeochemical function

Potential Effect	Project Activities and Effect Pathways	Spatial Extent	Effects Indicators
Change in surface water quality and quantity	The outfall discharge may increase sediment, water temperature, water chemistry, and contaminant concentrations and transport in surface water.	RSA/LSA	Transport of contaminants Surface water quality parameters (e.g., TSS)
	Increased scour, erosion and sedimentation may result from the increased flows in outfall drainage.	RSA/LSA	Surface water quality parameters (e.g., TSS)
	Increased erosion and sedimentation may result from grading and armouring of the outfall drainage channel.	RSA/LSA	Surface water quality parameters (e.g., TSS)
	Accidental release sediment or drilling mud or spills of deleterious substances during the construction of trenchless crossings.	RSA/LSA	Transport of contaminants Surface water quality parameters (e.g., TSS)
	Compared to the baseline data, the waste discharge is expected to contain concentrated water parameters, higher ammonia, BOD, COD concentrations. Refer to Section 2.4.3.3.4 (effluent information) for more details.	RSA/LSA	Surface water quality parameters (e.g., TSS, TOC)
Change in fish/ mussel habitat	Brushing or clearing for access and terrestrial Project components may alter riparian habitat within the Project footprint.	Project Footprint	Area of riparian habitat disturbance and habitat in water bodies
	Construction activities, discharge, runoff, and erosion can introduce fine sediment and contaminants to watercourses and change water chemistry. Fine sediment can cause downstream sediment deposition and may alter substrate composition and modify the availability and suitability of habitat for spawning, overwintering, and rearing.	LSA	Surface water quality parameters (e.g., TSS)
	There may be a permanent alteration of fish and mussel habitat in the outfall drainage from re-grading and armouring activities, and consistent flow from the discharge.	Project Footprint	Total instream footprint of fish and mussel habitat altered.

Potential Effect	Project Activities and Effect Pathways	Spatial Extent	Effects Indicators
Change in fish/mussel mortality risk	Instream work during the outfall drainage re-grading and armouring.	Project Footprint	Fish/freshwater mussel injury or mortality from instream construction.
Increase in aquatic invasive species	Instream activities may cause inter or intra-basin transfer of invasive aquatic organisms.	RSA	Transport of invasive aquatic organisms to other water bodies.

6.4 Mitigation Measures and Residual Effects

Jacobs has reviewed the preliminary outfall location, the Project footprint, and the construction plans to identify mitigation considerations; however, once the plans are finalized the Project may be reassessed for additional mitigation and residual effects. Consultation with regulators (DFO, Manitoba Environment and Climate, etc.) may be required. The following DFO and Provincial guidance are incorporated into the Project's mitigation plan:

- Measures to protect fish and fish habitat (DFO 2023b)
- Interim code of practice: End-of-pipe fish protection screens for small water intakes in freshwater (DFO 2020)
- End-of-Pipe Screen Size Tool (Di Rocco and Gervais 2024)
- Fish Screening Guide for Water Intakes (Katopodis 1992)
- Interim standard: in-water site isolation (DFO 2023a)

The following mitigation measures are to be implemented by RSRWC to avoid or reduce the potential for residual effects on Water Resources:

- **General Mitigation Measures for Surface Water Resources**
  - Do not wash equipment or machinery in any water body. Control wastewater from construction activities, such as equipment washing or concrete mixing, to avoid discharge directly into any water body.
  - Place swamp mats, rig mats, or similar materials over staging areas, access paths, and working pads to protect wetlands, riparian vegetation, prevent erosion, and limit sediment mobilization from equipment operation.
  - Bulk hazardous materials will be stored in temporary construction yards or other designated areas except for quantities required for the daily construction activities. Waste will be stored in temporary construction yards or other designated areas and removed during final clean-up. Fuel, oil, generators, or hazardous materials required to be stored onsite will be stored within secondary containment located a minimum of 100 m from water bodies.
  - Report environmental accidents according to provincial protocols. Environmental accidents which may or are likely to create a hazard to human life or health, to other living organisms, or to the physical environment must be reported to the provincial Environmental Emergency Response Program (Government of Manitoba 2022b)
  - Confirm sediment and erosion control materials are on site and ready to be installed where needed in the watercourses and wetlands.
  - Install erosion and sediment control measures (e.g., silt fence) according to the Erosion and Sediment Control Plan, environmental inspectors, or on-site qualified environmental professional.
  - Confirm that machinery arrives onsite clean, and is maintained free of fluid leaks, invasive species, and noxious weeds.
  - Use non-toxic, biodegradable hydraulic fluids in all equipment that will work in or around watercourses.

- Design and construct all temporary workspace, stand down, and storage locations so that they are set back from water bodies as much as feasible, and to limit the loss or disturbance to riparian vegetation.
- Clearing of riparian vegetation should be minimized. Use existing trails and roads wherever possible to avoid disturbance to riparian vegetation and prevent soil compaction.
- Remove all construction materials from the site upon Project completion.
- Revegetate banks, shorelines, and approach slopes with a native seed mix representative of the area or an erosion control mix, at the discretion of RSRWC or their delegate.
- Do not use fertilizer or herbicide in the immediate vicinity of a watercourse or wetland.

▪ Wetland Mitigation Measures

- Obtain necessary approvals, licences and permits as well as fulfill regulatory requirements prior to the commencement of the applicable activity or construction at that site.
- Narrow down the proposed area of disturbance through wetlands and protect wetlands by using silt fencing. Clearly mark the wetland boundaries using signage, flagging or fencing and limit traffic in the vicinity of the flagged or fenced off area, if feasible.
- Flag or fence-off any shrubs or trees to be salvaged and replaced at wetlands following construction.

Minimize the removal of vegetation in wetlands to the extent possible.

Reduce the width of grubbing through wetlands and low-lying wet areas during construction to reduce disturbance and facilitate the restoration of shrub communities.

Conduct grading away from wetlands, to the extent practical, to reduce the risk of sediment and other material entering a wetland. Keep wetland soils separate from upland soils. Do not place windrowed or fill material in a wetland during grading.

Salvage the upper surface material at all wetlands to maintain the root stock and seed bank for replacement following wetland crossing construction. Salvage surface material in mineral soils to a maximum depth of 50 cm or to the depth of colour change where there is less than 50 cm of surface material or as directed by RSRWC or their delegate.

Store trench spoil in a manner that does not interfere with natural drainage patterns. If necessary, haul trench spoil to a nearby location for storage.

Do not dewater any wetlands other than from within an isolated section, if applicable. Although temporary dewatering may be necessary during the construction of trenched wetland crossings, water is not to be permanently removed from the wetland. Note that low-lying disturbed areas (e.g., cultivated upland) may be dewatered, only with the approval of RSR or their delegate .

Replace salvaged topsoil and upper soil material over the area where salvage occurred. Confirm that a permanent trench crown is not created. Replace salvaged topsoil or upper surface material as evenly as practical over the area where salvage occurred.

Re establish preconstruction contours within wetland boundary to facilitate cross ROW drainage.

Recontour wetlands and restore surface hydrology patterns to as close to the preconstruction profile as practical during reclamation.

Allow wetlands to naturally regenerate following construction. Do not seed wetlands.

Replant salvaged trees and shrubs along the disturbed margins of the wetland as directed by RSRWC or their delegate.

- Monitor the immediate effects of crossing construction to assess the need for any additional mitigation measures required to reduce identified effects, if warranted.
- Monitor wetlands for hydrological function and implement remedial measures if there are indications of impeded wetland function.

- Watercourse and Drainage Mitigation Measures **Pre-Construction**
  - Adhere to all conditions in any permits, authorizations, and ‘avoid and mitigate’ letters or other advice from DFO pursuant to the *Fisheries Act* and the *SARA,* and approvals from Manitoba provincial regulators.
  - Obtain a *SARA* Permit from DFO for salvage of Mapleleaf mussel, if required.
  - Obtain the required Live Fish Handling Permit from the Manitoba government for fish and mussel salvage activities during outfall drainage construction. It must be applied for at least 10 working days prior to salvage.
  - Develop a Release Response Plan to be implemented immediately in the event of a sediment release (i.e., frac out) during a trenchless crossing or spill of a deleterious substance to the terrestrial or aquatic environment. Include a plan to contain and remediate any substance release that causes or may cause an adverse effect on the aquatic environment. Maintain an emergency spill kit onsite at all times. At a minimum, the kit should contain emergency contact numbers and readily accessible materials and supplies for containment (for all times and conditions). There will be access to approved disposal sites for contaminated materials.
  - Develop and implement an Erosion and Sediment Control Plan to reduce the risk of sediment entering water bodies.
  - Develop a Water Quality Monitoring Plan to be implemented during instream construction and drilling activities in consultation with the regulators.
  - Develop a Water Quality Monitoring Plan to be implemented during instream construction and drilling activities in consultation with the regulators.
- Watercourse and Drainage Mitigation Measures: Outfall Armouring – Instream Construction
  - Avoid instream activities during the RAP from April 1 to June 30, where water is present (standing or flowing). Schedule instream work during low flow periods to further reduce the risk to aquatic species and habitat and allow for flow isolation techniques.
  - Schedule work to avoid wet, windy, and rainy periods that may increase erosion and sedimentation, and postpone instream work if excessive flows or flood conditions occur or are anticipated.
  - Minimize the removal of natural woody debris, rocks, sand and other materials from the banks, shoreline, or bed of water bodies below the highwater mark. If material is removed from the water bodies, set it aside and return it to the original or similar location once construction activities are completed.
  - Complete all instream work with flow isolation or in dry sections of the channel. Isolate using dams of non-erodible materials, and maintain downstream flows at all times.
  - Whenever possible, operate machinery from land above the high water mark in a manner that avoids disturbance to the banks and bed of the water body.

  - If the water quality monitoring indicates that construction activities are causing potentially harmful changes in water quality, additional mitigation may be required, or activities may be paused until results return to appropriate levels.
  - For drainage armouring confirm that appropriately-sized, clean rock is used; and that rock is installed at a similar slope to maintain a uniform bank alignment.
  - Grey water pumped out from isolated areas should not cause erosion, scouring, or introduce sediment into the watercourses.
  - Conduct a fish and mussel salvage prior to any instream activities or dewatering, where water is present. If any sediment/substrate is removed from water bodies, the dredged material may also need to be searched for mussels.
  - Follow the mussel detection, handling and relocation guidelines in the Protocol For The Detection And Relocation Of Freshwater Mussel Species At Risk In Ontario-Great Lakes Area (OGLA) (Mackie et al. 2008).
  - Follow the relevant measures from the Manitoba Aquatic Invasive Species (AIS) checklists for any watercraft, sampling gear and in-water equipment to avoid the spread of AIS, including zebra mussels (Government of Manitoba 2023b).
  - If zebra mussels are observed outside of the Red River and the Red River Floodway, note the location, take photographs and immediately report the observation to the Manitoba Government's AIS Unit (1-877-867-2470 and AIS@gov.mb.ca).
  - Immediately stabilize shoreline or banks disturbed by any Project activity to prevent erosion or sedimentation, preferably through revegetation with native species suitable for the site. Re-establish vegetation in riparian areas as soon as practical.
- Watercourses and Drainages: Conveyance System - Trenchless Crossings
  - The water quality monitoring plan should be implemented by a water quality (WQ) specialist during construction. If monitoring indicates that construction activities are causing potentially harmful changes in water quality, additional mitigation may be required, or activities may be paused until results return to appropriate levels.
  - Implement the Release Response Plan in the event of an inadvertent fluid release during trenchless crossing activities.
  - Follow the relevant measures from the Manitoba Aquatic Invasive Species (AIS) checklists for any watercraft, sampling gear and in-water equipment to avoid the spread of AIS, including zebra mussels (Government of Manitoba 2023b).
  - If zebra mussels are observed outside of the Red River and the Red River Floodway, note the location, take photographs and immediately report the observation to the Manitoba Government's AIS Unit (1-877-867-2470 and AIS@gov.mb.ca).
- Operations and Maintenance
  - Follow standard operating procedures for the alarm system at the wastewater discharge locations and wastewater lift stations to monitor the likelihood of an overflow.
  - Complete required effluent sampling in accordance with the Environment Act License (EAL) for the WWTF. Report sampling results as required to all applicable regulatory bodies.

- Once the WWTF is operational, conduct continuous process monitoring to assess for the need to modify operational setpoints to confirm optimal plant performance and confirm conformance to effluent limits.
- Establish and carry out required plant maintenance to confirm that equipment is operating effectively.
- Establish Industrial Service Agreements between each major industry and the RSRWC, so there are standards in place for the quality of the industrial effluent that will be permitted at the WWTF.
- If required, consult with the industrial contributors to evaluate options to reduce concentrations of metals and/or organic in the incoming wastewater flows.

6.5 Residual Effects

6.5.1 Effects Not Carried Through for Further Assessment

The potential effect of permanent loss of wetland function by the construction of the Wastewater Treatment Facility will be offset by wetland compensation, in compliance with the *Water Rights Act*. The goal of no net loss of wetland function will be met, and as a result, a characterization has not been included.

The potential effect of an increase in aquatic invasive species is expected to be avoided with the successful implementation of mitigation, therefore no residual effect is anticipated and as a result a characterization has not been included.

Residual effects related to the other potential effects identified in Table 6-9 are described in the following subsections.

6.5.2 Change in Wetland Function

Although potential effects will be reduced with implementation of the mitigation in Section 6.4, residual effects on Wetlands may remain after the implementation of mitigation. The predicted residual effects of the conveyance on Wetlands are:

- alteration of wetland habitat function
- alteration of wetland hydrological function
- alteration of wetland biogeochemical function

Temporary disturbances from wastewater conveyance system construction and operations activities have the potential to cause changes in wetland vegetative species composition or successional pattern, stress on vegetative species, interruption of wildlife movements, and fragmentation of natural habitats. These potential effects can cause an alteration of wetland habitat function. However, the practices of minimizing surface disturbance, vegetation removal and grubbing in wetlands, using proper techniques to salvage and replace wetland substrate, and re-establishing preconstruction contours, will allow vegetated root mats, seedbanks, and natural hydrologic flow to be maintained, which facilitates natural regeneration of vegetation. The implementation of such mitigation will reduce the residual effects of Project activities and allow recovery of wetland habitat function in the medium-term to long-term (for herbaceous wetlands and shrub or woody wetlands, respectively).

Temporary disturbances from wastewater conveyance system construction and operations activities have the potential to cause direct and indirect changes to the hydrologic flow of wetlands, resulting in an unnatural decrease or increase in wetland hydrologic regime. These potential effects can cause an alteration of wetland hydrological function. However, using crossing techniques that reduce terrain disturbance and soil structure damage, replacing salvaged wetland substrate, and re-establishing preconstruction contours will maintain hydrologic flow across the construction ROW and workspace and prevent drying or ponding in wetlands. The implementation of such mitigation will reduce the residual effects of Project activities and allow recovery of wetland hydrological function in the short-term, or medium-term (for wetlands where removal of woody vegetation may prolong the recovery of natural hydrologic regime.

Temporary disturbances from wastewater conveyance system construction and operations activities in and near wetlands have the potential to cause direct and indirect changes in water quality (e.g., turbidity), and overall biogeochemical cycling by introducing sediment, or altering wetland hydrologic regime, soils, and plant community composition/structure. These potential effects can cause an alteration of wetland biogeochemical function. However, installing erosion control structures, minimizing vegetation removal and grubbing in wetlands, using crossing techniques that reduce terrain disturbance and soil structure damage, replacing salvaged wetland substrate, and re-establishing preconstruction contours will protect water quality and allow the recovery of natural vegetation and hydrology that influences biogeochemical cycling and carbon storage. The implementation of such mitigation will reduce the residual effects of Project activities and allow recovery of wetland biogeochemical function in the short-term to long-term.

The predicted residual effects of alteration to wetland habitat function, hydrological function and biogeochemical function are considered adverse, low magnitude and reversible.

6.5.3 Change in Surface Water Quality and Quantity

The waste discharge is expected to contain water parameters found in the baseline data (2012-2022), higher ammonia, and significantly lower TSS concentrations. Refer to Section 2.4.3.3.4 for more details.

As discussed above as well as in Section 2.4.3.3.4: Predicted Effluent Quality, the WWTF effluent concentration of total iron is expected to consistently exceed the Tier III Water Quality Guideline of 300 µg/L as it is present in concentrations that exceed the guideline in the influent. Additionally, some potential exists for the WWTF treated effluent to be above the Tier II Water Quality Objective for dissolved copper, and above the Tier II Water Quality Guideline for aluminum, total iron, total silver, chloroform, total phenols, and toluene. The WWTF effluent is expected to be between 12°C and 25°C. The waste discharge will increase the water quantity in the outfall drainage during operations which may increase the scour and erosion resulting in downstream sedimentation. A temporary increase in suspended sediment may occur from the instream work at the outfall drainage. This increase in suspended sediment may result from increase in bank erosion, material placement instream (coffer dam and channel armouring materials), dewatering of the work area, and channel grading.

The suspended sediment would move downstream through the zone of influence into the Red River. The sediment release can be reduced or avoided by completing works while the drainage is dry and the successful installation of the proposed channel armouring. It is anticipated that with the successful implementation of the proposed mitigation measures, the average TSS levels during instream construction will be below the CCME guideline for short term (24 hour) exposure of 25 mg/L above baseline levels (CCME 1999).

6.5.4 Change in Fish and Mussel Habitat

Most of the Project is located on already disturbed land and it is expected that the additional riparian disturbance will be minimal. An existing road can be used to facilitate access to the outfall location reducing the amount of vegetation clearing required to access the outfall location. All watercourse and drainage crossings will be crossed using trenchless construction methods so no effects to fish and mussel habitat is anticipated from the wastewater conveyance system.

The introduction of fine sediment during construction of the outfall drainage or sediment and erosions concerns during construction or operations may cause downstream sediment deposition that alters substrate composition and modifies the availability and suitability of fish habitat for spawning, overwintering and rearing (Anderson 1996; Newcombe and MacDonald 1991). Additionally, the deposition of sediment can alter invertebrate communities and thus, alter fish food supply (Harrison et al. 2007). As discussed for surface water quality and quantity, increased suspended solids concentrations during instream construction and operation are likely to be within CCME guidelines, with the successful implementation of mitigation. The potential deposition of sediment resulting from instream construction is expected to be reversed by the redistribution of sediment following typical annual spring freshets (Anderson et al. 1998; Reid and Anderson 1999).

There is a permanent alteration of approximately 750 m^2 of the bed and banks of the unnamed drain with the regrading and armouring activities; however, the drain is frequently dry and unlikely to be used by fish except possibly near the confluence with the Red River during high flow events. Fish will likely still be able to use the drainage during high flow events so no loss of fish habitat is anticipated. Grading of the riparian area for construction access is not anticipated to cause sediment or erosion issues with appropriate bank stabilization and erosion control materials.

6.5.5 Change in Fish and Mussel Mortality Risk

Some construction activities may lead to an increase in the risk of fish or mussel mortality or injury to adults, fry or larva, and eggs. Fish and mussel mortality from construction (i.e., armouring) will be minimized by conducting instream works when the unnamed drainage is dry, where possible. If that is not possible Qualified Personnel will be assigned to complete fish and mussel savages to reduce potential mortality, injury, and stress. Completing construction for the outfall outside of the RAP, if flowing, is expected to mitigate potential effects on eggs and larval stages within the Red River.

The introduction of fine sediment may also have adverse effects on fish and mussels (Anderson 1996; Newcombe and MacDonald 1991; Wilber and Clarke 2001; Tuttle-Raycraft et al. 2017). However, increases in suspended sediment are likely to be within guidelines and short term (i.e., less than 24-hours).

Table 6-10 summaries the predicted Project residual effects on Water Resources.

6.6 Summary

The predicted residual effects of alteration to wetland habitat function, hydrological function and biogeochemical function are reversible, isolated to the Project footprint, adverse, and low magnitude.

With consideration of the potential impacts to fish and fish habitat the potential effects on Aquatic Resources are considered to be neutral to adverse. After implementation of the mitigation measures, the residual effect on Aquatic Resources are expected to be negligible to low in magnitude, limited to the Project footprint or LSA, immediate to medium term in duration, rare to occasional, and reversible.

Table 6-10. Project Residual Effects on Water Resources

Predicted Residual Effects	Direction	Spatial Boundary	Temporal Context			Magnitude
			Duration	Frequency	Reversibility	
Change in wetland function	Adverse	Project Footprint	Short-term to long-term	Isolated to occasional	Reversible	Low
Change in surface water quality and quantity	Adverse	LSA	Immediate to long term	Rare to occasional	Reversible	Low
Change in fish/mussel habitat	Neutral to Adverse	LSA	Short-term to medium-term	Isolated	Reversible	Negligible to Low
Change in fish/mussel mortality risk	Adverse	Project Footprint	Short-term	Isolated	Reversible	Low

7 Assessment of Effects on Groundwater Quality and Quantity

This section examines the regional / local hydrogeological attributes of existing aquifers, project site conditions, possible effects on groundwater from construction activities over the Project footprint, and identification of relevant mitigation measures. Effects on groundwater include any changes that the proposed works may have on groundwater quality and quantity.

7.1 Description of Existing Conditions

7.1.1 Hydrogeology

Previous studies, along with the Ground Information Network (GIN) database, define that the two primary hydrogeological bedrock units under the proposed project footprint, as well as the greater project area (Rural Municipalities (RM) of Hanover, Ritchot, and Taché, and Town of Niverville) are the Ordovician Winnipeg Formation (composed of poorly lithified sandstones and shale) and the conformably overlying carbonate rocks of the Ordovician Red River Formation (Betcher et al. 1995; Rutulis 1986; GIN 2021). Regional dip of the bedrock units is gentle to the southwest. The Red River Formation (the Carbonate Aquifer) is regionally extensive through much of central and southern Manitoba and serves as a significant water supply resource for municipal, commercial, and private stakeholders. Groundwater flow in the Carbonate Aquifer is mainly through fractures, bedding planes and karst related dissolution features, which are especially well developed near the upper erosional surface (Wang et al., 2008). The Winnipeg Formation (Sandstone Aquifer) is most commonly used in the RM of Taché and the northeast portion of the RM of Hanover (Frost, 2007; GIN, 2021). A natural fresh water-salt water boundary exists within both the carbonate aquifer and the sandstone aquifer just east of the Red River. In Niverville, the water quality is brackish immediately below the townsite and becomes increasingly so towards the Red River to the west (in both bedrock aquifers). As noted by Grasby and Betcher (2002), the saline waters occur naturally and are attributed to deeply sourced Williston Basin waters which flow up dip and merge with fresh groundwater.

The bedrock units are unconformably overlain by a thick layer of Quaternary deposits, comprising tills and glaciofluvial material, followed by a layer of glaciolacustrine derived clays (Wang et al. 2008). Water well data indicates that the clays and underlying till have a combined total thickness between 17-25 m in the Niverville area (GIN 2021). It should be noted that there are also some localized, groundwater producing sand and gravel layers within the till that occur in parts of southeastern Manitoba, including the greater Project area (GIN 2021; Wang et al. 2008).

Freshwater recharge to regional bedrock aquifers is mainly attributed to the permeable Sandilands Moraine Complex located in southeastern Manitoba, which occurs over a localized topographic high (Ferguson 2004). Regional groundwater flow is to the west and northwest with natural discharge of the carbonate unit occurring to the Red River, the Winnipeg Floodway, and likely other streams and creeks. Discharge from the sandstone aquifer is thought to occur via slow seepage near or beneath Lake Winnipeg (Phipps et al. 2008).

7.1.2 Project Site Conditions

A subsurface investigation by TREK Geotechnical Inc. (TREK) was carried out over the proposed Red-Seine-Rat (RSR) Wastewater Treatment Facility (WWTF) site between February 2-3, 2023.

The focus of the investigation was (in part) to determine soil stratigraphy and groundwater conditions along with foundation recommendations. Five test holes were drilled (TH23-01 to 05) with final depths ranging between 17.7 m to 21.0 m below ground surface. The general soil profile reveals a thin surface topsoil layer underlain by a thick silty clay layer, followed by a silt till. The surface of the lower silt till was encountered at depths between 15.5 m and 17.2 m, and extends to the bottom of the test holes (bedrock was not intersected). Groundwater seepage and sloughing conditions were observed in all five test holes upon completion, ranging between depths of 15.8 m and 17.4 m in the silt till.

Three 25 mm diameter PVC standpipe piezometers were installed within the silt till layer in three of the test holes (TH23-02, TH23-04 and TH23-05 at depths of 19.9 m, 18.5 m and 20.1 m), respectively. A water level data logger was also installed with standpipe AP-04. At the time of writing, groundwater monitoring is currently underway through to late September 2023.

Initial results of monitoring data received from TREK (Pers. Comm, September 6th, 2023) include TH23-04 level logger data collected between January 29th and July 28th, 2023, and depth to groundwater levels recorded on August 2nd, 2023 (TH23-02, TH23-04, and TH23-05). The level logger indicates that the highest water level occurred in May at approximately 6 m below ground level (bgl), (or approximately 94 m above sea level), and monitoring results from August show static groundwater levels range between 6.77 m bgl and 7.25 m bgl. The complete set of monitoring data results will be available in the TREK Geotechnical final report. Detailed information pertaining to the Geotechnical report, including well installations, test hole locations, and geotechnical recommendations are documented in the current version of the report.

7.1.3 Groundwater Users (Area Water Supply)

Groundwater use within the greater Project area was investigated using the GIN database (2021), various research papers (Wang et al., 2008; Phipps et al., 2008; Betcher et al., 1995), and community water supply annual reports (Driedger, 2023; Duval, 2023; Hutlet, 2023; Frost et al., 2007). Groundwater is the primary source of water supply for domestic, municipal, and industrial use, with the carbonate aquifer and the sandstone aquifer as the primary sources, followed by localized producing lenses of sand/gravel overlying the carbonate aquifer. Water supplies specifically within the surrounds of the proposed RSRWC WWTF footprint (including Niverville and the RM of Ritchot) are mostly sourced from the Carbonate Aquifer.

7.2 Effects on Groundwater Quality and Quantity

Important considerations of the vulnerability of an aquifer to contamination from development are the type, thickness, and extent of geology / soils overlying the aquifer. Betcher et al. (1995) defined a pollution hazard zone as ‘an area where freshwater aquifers are overlain by less than 6 m of clays, tills or other low-permeability areas’.

Results of geotechnical drilling over the Project footprint indicate that there are thick layers of overburden above bedrock with most of the material comprising clays. The clay layer extends from immediately below topsoil (~0.15 m) to a minimum of 15.5 m depth.

Laboratory testing (including grain size determination -hydrometer method) of select samples from the clay layers in boreholes TH23-01 (7.5 m) and TH23-03, (7.0 m) confirms a significant clay fraction to the soils (i.e., ≥85%) with the balance of the fraction mostly fine grain size (silt ~14%). As such, it is not anticipated that the groundwater aquifers are located within a pollution vulnerable zone.

Surface mitigation measures will be in place and are necessary during construction activities. The Project footprint lies over a predominantly flat lying farm field which is bounded by shallow ditches along the edges. Changes to the surrounding area could result in alterations to the drainage patterns. Geotechnical drainage design recommendations were included in the geotechnical report.

Potential effects and effect pathways for the Project in relation to groundwater quality and quantity are provided in Table 7-1. No effects are expected considering the soil type (clays) and the considerable thickness of this unit (> 15 m) overlying aquifer.

Table 7-1. Project Activities, Effect Pathways, and Indicators for Groundwater Quality and Quantity

Potential Effect	Project Activities and Effect Pathways	Effects Indicators
Change in groundwater quality	Disturbance to physical hydraulic properties of soil and parent material above or below the water table due to grading and backfilling and particle transport may cause changes in ground water quality.	Presence of contaminants in groundwater
Change in groundwater quantity	Compaction of soils due to vehicle and equipment crossings could reduce permeability of materials along the groundwater flow path and may result in a rise in the groundwater table, though a change in groundwater quantity is not expected.	Groundwater levels rise
Groundwater contamination	Chemical leakage during chemical transport to the plants can contaminate groundwater and make it non drinkable	Presence of contaminants in groundwater

7.3 Mitigation Measures and Residual Effects

To reduce risks associated with groundwater quality and quantity, a detailed geotechnical investigation was conducted in February 2023 and the resultant ongoing groundwater monitoring of the associated boreholes is currently underway. The associated geotechnical recommendations and mitigation measures were provided in the geotechnical report. The following mitigation measures are also proposed to minimize the Project effects (it is the responsibility of the client - RSRWC representative - to confirm that these measures are followed):

- Use professional and licensed drillers during foundation installation.
- Limit construction equipment and vehicle movements to designated roads and pathways within and around work areas, and limit construction equipment in riparian areas, where feasible.
- Repair areas where equipment has compacted soils.
- Develop specific Emergency Response Plans to report chemical leakages and have pumping and sealing protocols in place.
- Monitor water table level in the process of drilling.
- Confirm proper containment and storage of chemical to avoid leakage.
- Control surface drainage by incorporating a minimum grading away from any proposed foundations, and direct runoff from the roofs away from the perimeter of the foundations to reduce the potential of excessive moisture near the buildings.
- Adhere to proper regulatory maintenance guidelines regarding the reservoir and conduct routine monitoring to confirm that the silt liners are functioning properly.

7.4 Residual Effects on Groundwater

With the implementation of the mitigation measures discussed above, the residual effects on groundwater are assumed to be of low magnitude. Although, it is still possible for chemical permeation through soil layers, following the successful implementation of mitigation measures, any contaminants will be of low toxicity and are not anticipated to affect the active aquifers.

7.5 Summary

The Ordovician Winnipeg Formation (composed of poorly lithified sandstones and shale) and the conformably overlying carbonate rocks of the Ordovician Red River Formation are the two primary hydrogeological aquifer units under the proposed project footprint, as well as the greater project area (Rural Municipalities (RM) of Hanover, Ritchot, and Taché, and Town of Niverville). The latter bedrock units are unconformably overlain by a thick layer of Quaternary deposits, comprising tills and glaciofluvial material, followed by a layer of glaciolacustrine derived clays.

A subsurface investigation by TREK Geotechnical was carried out over the proposed Red-Seine-Rat (RSR) Wastewater Treatment Facility (WWTF) which included five test holes drilled to a maximum of ~ 20 m depth (February 2-3, 2023). Initial results of monitoring data include level logger data collected between January 29th and July 28th, 2023, and depth to groundwater levels recorded on August 2nd, 2023. The level logger indicates that the highest water level occurred in May at approximately 6 m below ground level (bgl), (or approximately 94 m above sea level), and monitoring results from August show static groundwater levels range between 6.77 m bgl and 7.25 m bgl. Drilling also confirmed the soil profile which comprises thick layers of overburden above bedrock with most of the material comprising clays. The clay layer extends from immediately below topsoil (~0.15 m) to a minimum of 15.5 m depth.

It is not anticipated that development activities should adversely affect the active aquifers, in consideration of the regional extent and thickness of the clay overburden under the project footprint (>15 m thickness), along with stringent surface mitigation measures during construction. Surface mitigation measures will be in place and are necessary during construction activities. With implementation of the mitigation measures previously identified as a whole, the potential adverse residual effect to groundwater is considered negligible.

8 Assessment on Effects on Wildlife and Wildlife Habitat

Construction and operation of the new wastewater treatment facility and wastewater collection system will result in some disturbance to wildlife and wildlife habitat. Therefore, wildlife and wildlife habitat are considered in this assessment. The assessment team conducted a review to establish the existing conditions (i.e., baseline setting) for Wildlife and Wildlife Habitat from which the potential effects of the Project can be determined. The study was based on a review of existing literature, field surveys, and expert opinion.

8.1 Spatial Boundaries

The wildlife spatial boundaries for the residual effects assessment encompass the areas potentially affected by the Project, the areas within which this biophysical element occurs or functions, and the areas within which Project effects might occur. Table 8-1 describes the spatial boundaries for Wildlife and Wildlife Habitat and the rationale for choosing these.

Table 8-1. Spatial Boundaries for Wildlife and Wildlife Habitat

Element	Spatial Boundaries	Rationale
Wildlife and Wildlife Habitat	**Wildlife and Wildlife Habitat LSA:** A 1 km buffer extending from the Project footprint. **Wildlife and Wildlife Habitat RSA:** A 10 km buffer extending from the Project footprint.	**Wildlife and Wildlife Habitat LSA:** The Wildlife LSA was established to incorporate the area where there is reasonable potential for Project-specific effects to occur. The Wildlife LSA considers the wildlife species expected to interact with the Project, the effect pathways, and available information on wildlife sensitivity to disturbance (e.g., setback distances). **Wildlife and Wildlife Habitat RSA:** The Wildlife RSA was established to incorporate the area where the direct and indirect influence of other land uses and activities could interact within Project-specific effects, and may cause cumulative effects on wildlife with relatively large home ranges.

8.2 Description of Existing Conditions

Wildlife and Wildlife Habitat includes potentially suitable habitat for wildlife, including species at risk, species with special conservation status and species of management concern. The Project has the potential to alter wildlife habitat and wildlife movement or increase wildlife mortality risk; therefore, Wildlife and Wildlife Habitat has been selected as a biophysical element.

The scope of the assessment of the effects on Wildlife and Wildlife Habitat includes the range of wildlife species and habitats that are expected to occur in and around the Project and considers species at risk and species with special conservation status that have the potential to interact with the Project. Species at risk refers to species listed federally on Schedule 1 of the *Species at Risk Act* (*SARA*) (Government of Canada 2022) or by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (2023). Species of special conservation status include those with provincial conservation designations, including species listed as endangered or threatened under the Manitoba *Endangered Species and Ecosystems Act* (Government of Manitoba 2024). Species of management concern refers to species that have recommended timing and setback guidelines (MBCDC 2021; Manitoba Wildlife, Fisheries, and Enforcement Branch 2021).

The Project occurs primarily in the Lake Manitoba Plain Ecoregion within the Boreal Plains Ecozone (including the WWTF, wastewater treatment lagoons, and wastewater conveyance system segments). A small wastewater conveyance system segment and the Grunthal wastewater treatment lagoons are in the Interlake Plain Ecoregion within the Prairie Ecozone. The Project is located within generally level terrain that is used primarily for agricultural purposes as well as other disturbances (roads and existing water treatment infrastructure). The new wastewater treatment facility is located on previously disturbed land adjacent to the existing Niverville wastewater treatment lagoon and has been cleared of native vegetation. The wastewater conveyance system will traverse mostly disturbed areas and a small number of isolated areas of native vegetation including grasslands, treed patches, riparian areas, and wetlands. Areas within the greater Wildlife and Wildlife Habitat LSA and RSA have been heavily modified by human development and support infrastructure including agricultural development and roadways. Small areas that are not currently developed include isolated areas of native grasslands, treed patches, riparian areas, and wetlands.

The Project footprint does not encounter any designated parks or protected areas (Government of Manitoba 2017b), national wildlife areas (Government of Canada 2023d), Migratory Bird Sanctuaries (Government of Canada 2023e), Important Bird Areas (Bird Studies Canada 2015), Western Hemisphere Shorebird Reserves (WHSRN 2021), or Ramsar Wetlands (The Secretariat of the Convention on Wetlands 2021). The Project is located within migratory bird nesting zone B4 (ECCC 2018). The primary nesting period, when the majority (approximately 90%) of migratory bird species are expected to be nesting, is April 26 to August 14.

Species at risk (that is, species that are federally listed on Schedule 1 of the *SARA* [Government of Canada 2022] or COSEWIC [2023]) that have the potential to interact with the Project, were identified based on a desktop review of available information from the area, species ranges, habitat requirements, and professional judgment. Overall, the habitat along the Project is highly disturbed and lacks the habitat attributes for most grassland specialists that may have once been present in the area. A summary of species at risk that have the potential to interact with the Project include:

- American badger (listed as Special Concern on Schedule 1 of the *SARA* and by COSEWIC)
- Bank swallow (listed as Threatened on Schedule 1 of the *SARA* and by COSEWIC)
- Barn swallow (listed as Threatened on Schedule 1 of the *SARA* and Special Concern by COSEWIC)
- Bobolink (listed as Threatened on Schedule 1 the *SARA* and Special Concern by COSEWIC)
- Common nighthawk (listed as Threatened on Schedule 1 of the *SARA* and Special Concern by COSEWIC)
- Golden-winged warbler (listed as Threatened under the *Endangered Species and Ecosystems Act* and Threatened on Schedule 1 of the *SARA* and by COSEWIC)
- Little brown bat (listed as Endangered under the *Endangered Species and Ecosystems Act* and Endangered on Schedule 1 of the *SARA* and by COSEWIC)
- Loggerhead shrike (listed as Endangered under the *Endangered Species and Ecosystems Act* and Threatened on Schedule 1 of the *SARA* and by COSEWIC)
- Northern leopard frog (listed as Special Concern on Schedule 1 of the *SARA* and by COSEWIC)
- Short-eared owl (listed as Threatened under the *Endangered Species and Ecosystems Act* and Special Concern on Schedule 1 of the *SARA* and Threatened by COSEWIC)
- Yellow rail (listed as Special Concern on Schedule 1 of the *SARA* and by COSEWIC)

Field studies of the Project footprint were conducted in August 2023 and focused on the proposed outfall to the Red River, the WWTF site, and roadside assessments along the wastewater conveyance system routing. Detailed field notes were recorded throughout the Project and included observations of wildlife observations and wildlife habitat. There were 21 species of wildlife incidentally observed during the surveys including two species at risk (barn swallow and northern leopard frog). 20 species of bird were identified, including passerines (such as, American goldfinch, American robin, black-billed cuckoo, black-capped chickadee, cedar waxwing, clay-colored sparrow, common yellowthroat, eastern wood pewee, mourning dove, northern flicker, purple martin, red-winged black bird, sedge wren, song sparrow, and white-breasted nuthatch), waterbird and ally species (such as, greater yellowlegs and killdeer), and raptors (such as, red-tailed hawk). Waterfowl were observed at a few lagoons but were not identified to species due to distance and lack of land access. One species of amphibian, the northern leopard frog, was observed. No wildlife habitat features were observed during the field visit.

8.3 Potential Effects on Wildlife and Wildlife Habitat

The assessment team conducted a review to establish the existing conditions (i.e., baseline setting) for Wildlife and Wildlife Habitat from which the potential effects of the Project can be determined. The study was based on a review of existing literature, field surveys, and expert opinion.

During construction and operation, the Project will interact with three effect pathways for wildlife: alteration of wildlife habitat, and increased wildlife mortality risk, as outlined in detail in Table 8-2.

Table 8-2. Project Activities, Effects Pathways, and Effects Indicators

Project Effect	Project Activities and Effect Pathways	Spatial Extent	Effects Indicators
Loss or alteration of wildlife habitat	Brushing of vegetation and ground disturbance during construction and operation activities may cause direct habitat loss or alteration	Project Footprint	Direct habitat disturbance Alteration in habitat quality or effectiveness Disturbance of wildlife habitat features that may be occupied during construction, and are identified in the Project footprint or within recommended buffer distances
	Increased sensory disturbance caused by noise and activity during construction activities may reduce habitat effectiveness, causing indirect habitat loss or alteration	Project LSA	
Change in wildlife movement	Open excavations (e.g., pipeline trench, sumps, or bell holes), strung pipe, and material storage (e.g., soil or debris windrows) can create barriers to wildlife movement.	Project Footprint	The duration of barriers or filters to wildlife movement

Project Effect	Project Activities and Effect Pathways	Spatial Extent	Effects Indicators
Increased wildlife mortality risk	Traffic from transportation of Project personnel and equipment, and movement of equipment and machinery on the Project footprint during construction activities may increase the risk of wildlife collisions.	Project RSA	The overlap of activities with sensitive periods for wildlife Disturbance to wildlife habitat features that may be occupied during construction
	Human-wildlife conflict, such as attraction of wildlife to work during construction sites during construction activities may result in the need for removal or destruction of the animal.	Project Footprint	
	Open excavations (e.g., pipeline trench, sumps, or bell holes) during construction can increase mortality risk for wildlife that may become trapped.	Project Footprint	
	Vegetation removal, ground disturbance, and water impacts scheduled during sensitive periods for wildlife may increase the risk of wildlife mortality through disturbance of occupied habitats during construction and operations.	Project Footprint	
	Changes in soil contours at excavation areas required for construction activities may create artificial ponding of water following the completion of backfilling which may create breeding areas that become population sinks for some amphibians (e.g., ponded areas dry out before larvae completely develop).	Project Footprint	
	Reduced water quality from contamination or sedimentation may increase amphibian mortality risk within aquatic habitats.	Project RSA	

8.4 Mitigation Measures

The assessment team has reviewed relevant regulatory guidance to establish the effectiveness of the proposed mitigation to reduce potential effects on Wildlife and Wildlife Habitat. It was determined that the mitigation measures and construction practices for wildlife that have been established are effective in avoiding or reducing environmental effects. The Contractor shall limit potential Project effects on wildlife from construction activities by implementing the following mitigation measures:

- Avoid vegetation clearing during the Nesting Period for Migratory Birds (Nesting Zone B4 – April 26 to August 14 [ECCC 2018]) where possible.
- When activities are scheduled during the nesting period, mow or brush areas where vegetation removal and ground disturbance are required (i.e., pasture lands, riparian areas of wetlands) prior to the start of the migratory bird nesting period to discourage nesting, where possible.
- For activities scheduled during the nesting period, conduct a nonintrusive area search for evidence of nesting within seven days of activities and establish protective setbacks from active nests.
- In the event an active nest is found, the nest will be subject to appropriate site-specific mitigation measures determined in consultation with a Wildlife Resource Specialist. Confirm the accuracy of all setbacks and confirm that protective marking is maintained during construction.
- When construction preparation or construction activities are planned during the sensitive breeding, rearing, and dispersal period for amphibians (approximately April to October), a Wildlife Resource Specialist will conduct an amphibian survey prior to construction activities to identify breeding sites located on or near the Project. If an amphibian breeding site is identified, site-specific mitigation will be determined in consultation with a qualified Wildlife Resource Specialist and will vary depending on Project scheduling, the type of Project activities, and the amphibian species and life stage. Practical options and measures may include one or a combination of the following: amphibian salvage and relocation, onsite monitoring, or use of silt fencing or other suitable barriers installed between the breeding site and the Project construction footprint to reduce the potential for amphibians to enter the work area prior to construction.
- Confirm that noise abatement equipment on machinery is in good working order and reduce idling of equipment to limit noise emissions and air pollution.
- Leave gaps in soil and snow windrows and strung or welded pipe at obvious field drainages and trails to allow continued wildlife movement.
- Monitor the open excavations for trapped wildlife. Report any incidences of wildlife discovered in the open excavations, or in association with any other activity or facility.
- Cover or fence open excavations when construction is paused or delayed, to minimize hazards to wildlife.
- Confine construction activities to the allotted construction right-of-way and approved temporary workspace. Restrict construction traffic to existing roads, the construction right-of-way and approved shoo-flies.
- Educate all project personnel about species of interest as part of the contractor orientation and communicate wildlife potential at key habitat locations during the Tailgate Safety Talks, If Construction employees identify these species of interest during the course of their work, specific protection measures will be implemented, and the sighting will be recorded.
- Collect all construction garbage, food, industrial waste and debris, and dispose of at an approved facility to avoid the attraction of animals. Project personnel are prohibited from harassing, feeding, collecting, or possessing wildlife species from the construction footprint.
- Revegetate footprint with a native seed mix representative of the area, at the discretion of RSR or their delegate.

8.5 Residual Effects

In some cases, a residual effect on Wildlife and Wildlife Habitat may remain after the implementation of mitigation measures. The predicted residual effects are:

- Localized alteration of wildlife habitat during construction of the Project through vegetation removal during the nesting period for migratory birds and the amphibian activity period.
- Increased wildlife mortality risk during the Project construction and operations.

8.5.1 Localized Alteration of Wildlife Habitat

The Project will alter wildlife habitat and the new disturbance is limited mainly to areas of existing disturbance where vegetation is patchy or manicured. Habitat alteration during construction can cause the displacement of wildlife, and potentially result in use of less suitable habitat, reduced foraging ability (Bird et al. 2004), increased energy expenditure (Jalkotzy et al. 1997), and lower reproductive success (Habib et al. 2007).

The Project will likely require the clearing of some trees and shrubs around the proposed outfall location and along the proposed wastewater conveyance system. Following the construction of the WWTF, the Facility building will be largely unsuitable for wildlife and there will be low potential for wildlife to use any habitat within the building footprint; however, there may be resilient species that use the site, such as barn swallows or killdeer. Regenerating grass and shrub along cleared wastewater conveyance system segments is expected to regenerate relatively quickly following construction (medium-term) if allowed and may restore wildlife habitat. However, the habitat quality would be dependent on the vegetation composition and maintenance plans throughout wastewater conveyance system segments and adjacent to the WWTF infrastructure.

Potential wildlife habitat provided by native prairie, tame pasture, and non-treed wetlands along the wastewater conveyance system has potential to host wildlife features and will be impacted during construction, but with mitigation during construction to survey for and detect wildlife features and contingency measures for discovered wildlife and wildlife features, is expected to regenerate relatively quickly following construction (reversible in the medium-term). Habitat changes from clearing treed patches will be long- to extended-term in duration if trees are not permitted to regrow on the footprint. Depending on land use practices following reclamation, habitat changes following tree clearing are reversible following decommissioning of the Project.

Considering the spatial scope and limited value of the existing vegetated area within the WWTF footprint, and with mitigation during construction to detect and protect active migratory bird nests and implement contingency measures for discovered wildlife and wildlife features, the residual effect from habitat alteration due to vegetation removal and ground disturbance during construction of the WWTF is predicted to be long term in duration but negligible to low in magnitude and reversible upon decommissioning and reclamation of the facilities.

Indirect habitat effects occur when the quality or effectiveness of available habitat is altered such that wildlife avoid or reduce their use of the habitat. Habitat effectiveness may be affected by the changing noise, light, and human and industrial activity levels associated with Project construction and operations. Increased sensory effects on wildlife can cause avoidance, increased energy expenditure, changes in normal behaviours, and impaired communication between individuals. However, different species and even individuals of a given species are expected to respond differently to sensory disturbances. Wildlife that are present in the area are anticipated to have some level of tolerance to human activities given the level of existing anthropogenic disturbance in the local and surrounding areas.

Construction of the wastewater conveyance system may have a temporary indirect effect on wildlife habitat effectiveness during and directly following construction; however, the effects are expected to be short term. The ongoing residual effect of noise and light affecting wildlife habitat effectiveness will be localized to the Facility footprint and adjacent areas. The residual effect from habitat alteration due to sensory disturbance is expected to be long term (extending for the life of the Project), but reversible, and predicted to be low magnitude.

8.5.2 Increased Wildlife Mortality Risk

The construction and operation of the Project has the potential to increase wildlife mortality risk if occupied habitats are directly or indirectly disturbed during Project activities. Some activities during construction and operations may occur during seasons when wildlife may be migrating, breeding, rearing, or denning in habitats within or adjacent to the Project. Mitigation measures to reduce mortality risk include having Wildlife Resource Specialists conduct pre-disturbance surveys for evidence of occupied habitat and implementing protective buffers until habitat features are no longer active or other mitigation. The residual effect from disturbing occupied habitats is continuous and low-magnitude with the implementation of mitigation measures during construction and operations.

8.6 Summary

Some residual effects will carry forward into the operations phase. Effects on habitat suitability (alteration of sensory disturbance at the Project site, and ongoing vegetation maintenance), will be continuous in duration. While the effects will extend over the life of the Facility, sensory disturbance will cease and vegetation will regenerate on the construction footprint following Project decommissioning. Residual effects on wildlife mortality risk are possible, even after the implementation of mitigation measures during vegetation removal and maintenance at the WWTF and wastewater collection system infrastructure. Overall, the effects of the Project on Wildlife and Wildlife Habitat are anticipated to be negligible to low in magnitude given that the Project is located in a highly cultivated, agricultural environment, with the wastewater conveyance system segments mainly running alongside existing linear disturbances.

9 Assessment of Effects on Socioeconomic Elements including Human Health

9.1 Existing Conditions

9.1.1 Population

The Town of Niverville has a population of approximately 5,947 people and the population grew by 1,337 people (29.0%) between 2016 and 2021 (Statistics Canada 2021a). Of the total 2,010 private dwellings recorded in 2021, 1,971 were occupied. The total land area for Niverville is 8.70 km^2, with a population density of 23.6 persons per km^2 (Statistics Canada 2021a).

The RM of Hanover has a population of approximately 17,216 people (Statistics Canada 2021b). The population grew by 1,676 people (10.8%) between 2016 and 2021 (Statistics Canada 2021b). Of the total 5,305 private dwellings recorded in 2021, 5,141 dwellings were occupied. The total land area for the RM of Hanover is 730.44 km^2, with a population density of 23.6 persons per km^2 (Statistics Canada 2021b).

The RM of Ritchot has a population of approximately 7,469 people and the population grew by 790 people (11.8%) between 2016 and 2021 (Statistics Canada 2021c). Of the total 2,769 private dwellings recorded in 2021, 2,712 dwellings were occupied. The total land area for the RM of Ritchot is 332.23 km^2 with a population density of 22.5 persons per km^2 (Statistics Canada 2021c).

The RM of Taché has a population of approximately 11,916 people (Statistics Canada 2021d). The population grew by 348 people (3.0%) between 2016 and 2021 (Statistics Canada 2021d). Of the total 4,117 private dwellings recorded in 2021, 3,999 dwellings were occupied. The total land area for the RM of Taché is 580.64 km^2, with a population density of 20.5 persons per km^2 (Statistics Canada 2021d).

In total, the current population is approximately 42,548 people (urban and rural), with an average population growth of 10.8% between 2016 and 2021. It is anticipated that the population will continue to grow. The growth projections for the serviced population, as well as the wastewater contribution from rural and ICI sources is summarized in Section 2.4.1: Project Design Criteria.

9.1.2 Indigenous Communities

The closest First Nation community to the Project is the Roseau River Anishinabe First Nation (RRAFN), with the First Nation's main reserve, Roseau River 2, located on the banks of the Red River, approximately 55 km south of Niverville. The First Nation has six smaller reserves (Roseau Rapids 2A, B, C, D, E, and Roseau River 2B) located in southeast Manitoba in proximity to the Roseau River. Members of the RRAFN also reside in the urban reserve of Naawi-Oodena, located in Winnipeg (CIRNAC 2021). The population of RRAFN consists of 2,741 members (LABRC 2023), with approximately 670 members living on reserve (CIRNAC 2021).

The RSRWC has initiated Indigenous engagement through reaching out to the RRAFN and the Manitoba Métis Federation (MMF). As the Project progresses, the RRAFN and MMF will continue to be informed on any new developments.

9.1.3 Infrastructure and Services

The Town of Niverville is located approximately 20 km south of the City of Winnipeg, and is adjacent to the RMs of Hanover and Ritchot. Provincial Road 311 intersects the Town of Niverville, and the town also supports multiple smaller paved roads, some of which transition into gravel municipal grid roads outside of the town limits. The RMs of Hanover, Ritchot, and Taché are mostly rural, with many small communities. The area is serviced by multiple highways, including Provincial Trunk Highway 1, but the majority of road infrastructure is gravel municipal grid roads. Both Canadian Pacific Kansas City Rail and Canadian National Railway operate services in the area. Canadian Pacific Kansas City Rail operates a line which travels through RM of Hanover, RM of Ritchot, and the Town of Niverville while Canadian National Rail operates a rail line traveling through the Town of Ste. Agathe in the RM of Ritchot.

The RSRWC communities are currently serviced by wastewater treatment lagoons, and wastewater in these communities is collected by gravity sewer and low pressure sewer systems (see Section 1.2: Existing Wastewater Treatment Infrastructure). There is an abundance of affordable and reliable electricity to the RMs and Niverville generated by the publicly owned utility, Manitoba Hydro.

The Town of Niverville provides waste and recycling collection for residents, and has an agreement with the City of Steinbach to allow residents to deposit residential quantities of hazardous waste in city's landfill (Town of Niverville 2023). The RM of Hanover provides waste and recycling collection to seven communities (Blumenort, Kleefeld, New Bothwell, Roserville Drive area, Mitchell, Grunthal, ShadyLane/Green Acres Lane area), but does not extend these services to rural areas. The RM of Hanover Council has negotiated a waste disposal agreement specific to residential garbage with the City of Steinbach, allowing use of their facility (Hanover Municipality 2023). Similarly, the RM of Ritchot provides waste and recycling collection to four urban areas (St. Adolphe, Ste. Agathe, Ile des Chênes , Grande Pointe) but does not extend these services to rural areas. The RM of Ritchot provides a landfill for waste and recycling disposal (Ritchot Municipality 2023). The RM of Taché does not provide waste or recycling collection services, however, it operates two facilities where solid waste may be disposed of (Loretta Solid Waste Management Facility and Monominto Transfer Station) (Taché Municipality 2023).

The Town of Niverville and the RMs do not have a hospital, but the Southern Health-Santé Sud (SH-SS) Regional Health Authority provides a suite of health services to residents. Each RM and the Town of Niverville provide fire department services for their respective communities. Police services are provided by the RCMP.

9.1.4 Land and Resources Use

The Project area is approximately 20 km south of the City of Winnipeg. The economies of RMs of Hanover, Ritchot, and Taché are primarily based around agriculture (agri-food products and related services) and construction or manufacturing, which account for the bulk of businesses and jobs in the region. The lands in the Project area are primarily composed of private agricultural land.

The WWTF will be located on land in the RM of Ritchot that is owned by the Town of Niverville. This land is adjacent to the existing wastewater treatment lagoon for the Town of Niverville. The conveyance system will be along alignments primarily within municipal road rights-of-way typically beneath road ditches, and existing wastewater treatment lagoons owned by the RMs of Hanover, Ritchot and Taché. The predominant land use surrounding the new facility and conveyance system, as well as the existing wastewater treatment lagoons, is agricultural. The Project crosses the Red River approximately 5 km south of the community of St. Adolphe. Uses of the Red River include fishing and recreational activities.

The existing wastewater treatment lagoons in the RSRWC are seasonally discharged to drainage ditches, drains, canals, and creeks that flow directly to the Red River or into the Seine River Diversion, which ultimately empties into the Red River. The proposed WWTF will also discharge to the Red River, however, the quality of the effluent will be higher than is currently achievable with the operation of the existing wastewater treatment lagoons. Additionally, the WWTF effluent will be subject to additional or more stringent effluent limits than those in the current Environment Act Licenses.

The are numerous additional municipal and wastewater treatment facilities that discharge their effluent to the Red River in the relative vicinity of the Project's proposed outfall location. Many of these communities do not directly discharge, but rather discharge into a municipal ditch, drain, etc. that eventually flows into the Red River. The following is a list of notable contributors to the Red River:

- RM of Morris, Rosenort Wastewater Treatment Lagoon (>30 km upstream)
- City of Winnipeg, South End Water Pollution Control Centre (>30 km downstream)
- City of Steinbach, Wastewater Treatment Lagoon (unknown discharge point into the Red River)
- Town of Winkler, Wastewater Treatment Lagoon (unknown discharge point into the Red River)
- City of Morden, Wastewater Treatment Lagoon (unknown discharge point into the Red River)

The Government of Manitoba was contacted regarding Water Use Licences in the vicinity of the Project. No registered/licenses surface water projects were identified; however, licenses are not required if a project falls below the domestic exemption category of 25,000 litres per day. Therefore, the possibility exists for there to be domestic users in the vicinity of the Project, but this cannot be confirmed.

9.1.5 Heritage Resources

A Heritage Resource Impact Assessment (HRIA) was completed for the Red-Seine-Rat Wastewater Cooperative Wastewater Treatment Upgrade. Upon review of the Project, the Historic Resources Branch (HRB) determined that the proposed project is located near high potential areas of elevated terrain near prominent watercourses. In addition, parts of the Project are near historic burial locations and historic Mennonite settlement centers (HRB File No.: AAS-22-20012). An HRIA was required for right-of-way (ROW): NW 35-7-3 E, E 36-6-4 E, W 31-6-5 E, SE 25-5-4 E, SW 30-5-5 E, N 19-5-5 E, and river lots RL-0241-NO, RL-0624-AG, RL-0625-AG, and RL-0626-AG. An HRIA consisting of construction monitoring was required for ROW segments within SE 9-7-5 E and S 10-7-5 E.

Canada North Environmental Services Limited Partnership (CanNorth LP) completed the field assessment from September 20th to 23rd, 2023 and October 3rd to 7th, 2023, under Heritage Permit No. A110-23. Heritage sensitive segments of the project were assessed using a combination of pedestrian reconnaissance and the excavation of 162 subsurface shovel tests and 16 tests using a gas-powered auger. No heritage resources were identified in conflict with the proposed project during the HRIA.

The report recommended that RSRWC be provided with regulatory approval as per Section 12(2) of The Heritage Resources Act (GM 1986) for the proposed Project in NW 35-7-3 E, E 36-6 4 E, W 31-6-5 E, SE 25-5-4 E, SW 30-5-5 E, N 19-5-5 E, and river lots RL-0241-NO, RL-0624-AG, RL-0625-AG, and RL-0626-AG. The report also recommended that construction monitoring be carried out in HRIA areas within river lots RL-0624-AG and RL-0626-AG. If project plans are altered, or if heritage resources are discovered during construction, the HRB will be notified immediately. Should human remains or heritage objects be encountered during any subsurface activity, The Heritage Resources Act (1986) and the Policy Respecting the Reporting, Exhumation, and Reburial of Found Human Remains (1987) would take effect (GM 1986, 1987).

The archaeological construction monitoring will take place during Project construction. An HRPP will in place for the Project prior to the start of construction.

9.1.6 Human Health

The Project is located within SH-SS Regional Health Authority jurisdiction. Overall, general health conditions in the SH-SS Region are slightly better than the provincial average. Although the Project is situated in rural lands, a small number of residential buildings are located near the Project footprint. Noise effects from construction equipment and vehicles are anticipated at residences near the Project footprint.

9.2 Potential Effects on Socioeconomic Elements including Human Health

The Project is expected to have negligible adverse effects on human health. The operation of the new WWTF is expected to improve the quality of the treated wastewater effluent than is currently achievable with the existing individual wastewater treatment lagoons.

The archaeological construction monitoring will take place during Project construction. If significant heritage resources are identified during the HRIA within the Project footprint, impact will be minimized through avoidance or required mitigation measures issued by the HRB. An HRPP will also be implemented for the Project prior to the start of construction.

There is some potential for noise effects in the immediate area from the operation of construction equipment and vehicles. Noise effects from construction and operation of the RSRWC will be limited to the Project footprint and may carry at low levels to the few residences in the immediate area. Contractors engaged in the construction phase of the proposed Project will be subject to site specific health and safety plans and worker protection standards and procedures under the provincial *Workplace Safety and Health Act*. Operational worker health and safety programs and policies will be implemented for the Project.

There will be a temporary increase in traffic in the immediate vicinity of the Project during construction. During operations, there will be some increase in the traffic in the vicinity of the WWTF from truck haulers of septic and holding tank waste. It is estimated to be seven trucks per day between Monday and Saturday. Periodically, once every month or two, there will be chemical delivery via a truck.

During operation of the WWTF, there is the potential for odour effects within the vicinity of the WWTF.

9.2.1 Greenhouse Gas Emissions (GHG)

The Project is expected to contribute only nominally to greenhouse gas emissions during the construction period, but once in operation, the conveyance network and the WWTF with both contribute to greenhouse gas emissions.

In May 2020, a Wastewater Treatment Facility & Distribution System Project Greenhouse gas Mitigation Assessment was completed for the RSRWC (AE 2020). The assessment evaluated the GHG impact of a regional conveyance network and WWTF to replace the existing lagoons in the Town of Niverville and the communities of New Bothwell, Blumenort, Mitchell, St. Adolphe, Ste. Agathe, Ille des Chênes, Grande Pointe, Lorette, and Landmark. The assessment was based on a 2045 design horizon for a 17.7 ML/d mechanical wastewater treatment facility, with an organic load of 6,085 kg-BOD/d.

The assessment concluded that a net GHG reduction would be observed with the construction of the regional conveyance network and WWTF, compared to the baseline scenario of each community continuing to operate their individual wastewater treatment lagoons. An anticipated net reduction in GHG emissions was anticipated through replacing the community lagoons which are large GHG emitters, and eliminating emissions from the construction of upgraded community lagoons and smaller wastewater treatment facilities. Based on the assumptions in the report, a cumulative reduction of 54,312 tonnes of carbon dioxide equivalent (CO_2e) was anticipated.

Since the publication of the May 2020 report, the Project has evolved. The Project now includes the additional communities of Kleefeld and Grunthal in the RM of Hanover and is being designed for a flow of 19 ML/d and organic load of 7,464 kg-BOD/d. Additionally, rather than a mechanical wastewater treatment facility, the design is for an MBR WWTF. Despite these adjustments, it is still anticipated that a net reduction in GHG emissions will be observed. The design includes measures for lower energy consumption, as well as the use of biogas for process heating for the anaerobic digester as well as building heating, and will supplement other natural gas boilers for building heat.

It is expected that, once in operation, the regional conveyance network and WWTF will not contribute to GHG emissions in excess of the 10,000 tonnes of carbon dioxide equivalent that represents the reporting threshold set out in the Canada Gazette.

9.3 Mitigation Measures and Residual Effects

The proposed Project will be an improvement over the existing wastewater infrastructure. The improved quality effluent will benefit downstream communities and residents.

The effects of noise during construction will be mitigated by scheduling of construction activities during day-time hours to avoid sleep disturbance and disruption of evening residential activities, equipping vehicles with appropriate mufflers and maintaining vehicles in good working order. The RM of Hanover's Noise Bylaw requires that construction activities take place between 7:00 AM and 9:00 PM unless otherwise permitted (RM of Hanover, 2013). The RM of Ritchot's Noise Bylaw requires that construction activities take place between 7:00 AM and 9:00 PM Monday to Friday, 8:00 AM and 8:00 PM Saturday, and 9:00 AM and 8:00 PM Sunday or statutory or public holiday unless otherwise permitted (RM of Ritchot, 2023). The RM of Taché's Noise Bylaw requires that construction activities take place between 7:00 AM and 11:00 PM Monday to Saturday, with no work permitted on Sundays (RM of Taché, 2016). During operations, workers will be provided with hearing protection and clear signage will be posted for those areas where hearing protection is required. Warning signs will be installed on the Project site during construction to caution users of a navigational hazard, where appropriate.

RSRWC is committed to health and safety for the Project. Improvements to health and safety are one of the drivers for the Project. Construction teams will be required to prepare and submit a site Health and Safety Plan that meets the requirements of The *Workplace Safety and Health Act* and other applicable legislation and by-laws. The Construction team will also be required to submit copies of reports or directions issued by the Province, copies of incident and accident reports, and Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets as required. Appropriate fire protection equipment and measures will be maintained onsite during the performance of site work, as required by local municipal codes, regulations and by-laws.

Once the Project is constructed and commissioned a site health and safety program will be developed and implemented by RSRWC that will include chemical handling procedures, and worker health and safety requirements.

The archaeological construction monitoring will take place during Project construction. If significant heritage resources are identified during the HRIA within the Project footprint, impact will be minimized through avoidance or required mitigation measures issued by the HRB. A Heritage Resources Protection Plan (HRPP) will also be implemented for the Project prior to the start of construction.

The WWTF design includes an odour control system; refer to Section 2.4.3.5: Notes:

m = meter(s)
m3 = cubic meter(s)
mg/L = milligram(s) per liter
T/y = tonne per year

Odour Control for further information. This system will collect and treat foul air from various points within the wastewater treatment process. The treated foul air will be dispersed through a tall stack. With the odour control system, anticipated impacts to any nearby receptors are considered to be negligible.

The amount of traffic in the vicinity of the WWTF from truck haulers of septic and holding tank waste will be reduced with additional satellite septage receiving stations at other points in the conveyance network (Kleefeld Lagoon, Lorette-Landmark Lagoons). Traffic from other large vehicles (e.g., chemical trucks) will be infrequent.

With implementation of the previously identified mitigation measures, the potential adverse residual effect to socioeconomics is anticipated to be negligible in magnitude, limited to the Project footprint, short- term and reversible, and occurring within a disturbed socioeconomic context. No further operational effects on human health and safety are expected once the construction phase of the Project has been completed. As such, residual effects are considered not significant.

9.4 Summary

Overall, the effects of the Project on Socioeconomic Elements are anticipated to be negligible to low in magnitude given that the Project is located in a rural area.

The Project will provide improvements to existing wastewater infrastructure. The improved quality of the wastewater effluent will be a benefit to any Red River users downstream of the WWTF.

10 Follow-up Plans including Monitoring and Reporting

The regional conveyance system and WWTF will be operated by certified Class 4 operators. Specific training for the proposed plant operation and maintenance will be provided during start-up and commissioning. This includes facility monitoring, and laboratory techniques to monitor day-to-day treatment operations for meeting the water quality and treatment requirements. Follow-up plans including monitoring and reporting will be prepared for the following:

- Following commissioning and initial testing, continuous monitoring will occur to confirm that the treated wastewater effluent meets the effluent limits set out in the Environment Act Licence (EAL) for the facility.
- Continuous process monitoring of WWTF operations will be conducted confirm effective equipment operation and trigger the need for operational adjustments and equipment maintenance.
- A surface water quality monitoring, based on the EAP approval conditions, will be developed in consultation with the regulators. Watercourses will be inspected to confirm that sediment and erosion control measures are installed and the monitoring of parameters from the effluent. The program may include, but not limited to monitoring of effluent and release areas, sampling for TSS during construction activities, monitoring of drainages.
- During commissioning, sampling and monitoring will be conducted at a frequency to optimize the Facility operations.

Follow-up plans including monitoring and reporting for the effects of the Project on environmental elements include:

- Vegetation surveys are one of the measures recommended to mitigate the potential effects to plant species or communities of conservation concern. If a vegetation species listed by the federal Species at Risk Act or Manitoba Endangered Species Act is observed prior to construction, site-specific mitigation will be developed in consultation with appropriate Government authorities.
- Post-construction reclamation monitoring to assess the efficacy of the proposed mitigation measures and implement corrective measures, where warranted.
- DFO requirements for outfall drainage armouring and wastewater conveyance system pipeline construction, if requested by DFO during the Request for Review process.

11 Conclusions

Jacobs prepared this EAP application on behalf of the RSRWC.

For most of the elements identified that interact with the proposed Project footprint, the adverse residual environmental effects were found to be negligible to low in magnitude for construction and operations. With the application of the proposed mitigation measures for soils and terrain, vegetation, water resources, groundwater, wildlife and wildlife habitat, and socioeconomic elements including human health, the adverse effects can be avoided or reduced to low or negligible magnitude.

The RSRWC Project will result in an improvement to wastewater treatment capabilities within the region and will support current and future development within the Town of Niverville and the RMs of Ritchot, Taché, and Hanover.

12 References

Aadland, L.P., T.M. Koel, W.G. Franzin, K.W. Stewart, and P. Nelson. 2005. Changes in Fish Assemblage Structure of the Red River of the North. American Fisheries Society Symposium 45:293-321, 2005. https://fisheries.org/docs/books/x54045xm/16.pdf.

Anderson, P.G. 1996. Sediment Generation from Forestry Operations and Associated Effects on Aquatic Ecosystems. Proceedings of the Forest-Fish Conference: Land Management Practices Affecting Aquatic Ecosystems, Canadian Forest Service, Edmonton, Alberta.

Anderson, P.G., Fraikin, C.G.J., and Chandler, T.J. 1998. Natural Gas Pipeline Crossing of a Coldwater Stream: Impacts and Recovery. Proceedings of the International Pipeline Conference – 1998, Calgary, Alberta.

Anderson D.O., Kirk D.W., and E.J. Fast. 1999. Hydrometric Technician Career Development Program, Lesson Package No. 5.2 – Measurement of Stage: EDAS – Electronic Data Acquisition System. Water Survey of Canada, Environment Canada.

Associated Engineering. 2019. Regional Wastewater Concepts Technical Memorandum. Prepared for the Red-Seine-Rat Wastewater Cooperative.

Associated Engineering. 2020. Wastewater Treatment Facility & Distribution System Project Greenhouse Gas Mitigation Assessment. Prepared for the Red-Seine-Rat Wastewater Cooperative.

Bengtsson G. and N. Törneman. 2004. "Dissolved Organic Carbon Dynamics in the peat-streamwater interface." Biogeochemistry 70(1): 93-116. August 2004.

Berglund L. Disturbance, Nutrient Availability, and Plant Growth in Phenol-rich Plant Communities. Acta Universitatis Agriculturae Suecia. Silvestria 324. Doctoral thesis. Swedish University of Agricultural Sciences. 2004.Betcher, R.N., Grove, G., and Pupp, C., 1995. Groundwater in Manitoba Hydrogeology, Quality Concerns, Management. National Hydrology Research Institute Contribution No. CS-93017.

Bird Studies Canada. 2015. Important Bird Areas of Canada Database. http://www.ibacanada.org.

Bird, B.L., L.C. Branch, and D.L. Miller. 2004. "Effects of Coastal Lighting on Foraging Behaviour of Beach Mice." Conservation Biology. Vol. 18, No. 5. Pp. 1435-1439.Canadian Council of Ministers of the Environment. 2021. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Total Particulate Matter. Accessed March 2022. [https://ccme.ca/en/resources].

Canadian Council of Ministers of the Environment. 1991. CCME. Appendix IX- A protocol for the derivation of water quality guidelines for the protection of aquatic life. Canadian Environmental Quality Guidelines. Winnipeg, Manitoba.

Canadian Council of Ministers of the Environment. 1992. CCME. Canadian Water Quality Guidelines: Updates (March 1992) Organotin and Halogenated Methanes. Canadian Environmental Quality Guidelines. Winnipeg, Manitoba.

Canadian Council of Ministers of the Environment. 1999. CCME. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Canadian Environmental Quality Guidelines. Winnipeg, Manitoba.

Canadian Council of Ministers of the Environment. 2002. *Canadian Water Quality Guidelines for the Protection of Aquatic Life TOTAL PARTICULATE MATTER*. Accessed May 2024. https://ccme.ca/en/res/total-particulate-matter-en-canadian-water-quality-guidelines-for-the-protection-of-aquatic-life.pdf

Canadian Council of Ministers of the Environment. 2020. CCME. Water Quality Guidelines https://ccme.ca/en/current-activities/canadian-environmental-quality-guidelines

Canadian Society of Soil Science. 2020. Soils of Canada. [Online] Available: soilsofcanada.ca Accessed August 2023.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2016. COSEWIC assessment and status report on the Mapleleaf *Quadrula quadrula*, Great Lakes - Upper St. Lawrence population and Saskatchewan - Nelson Rivers population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 86 pp. https://wildlife-species.az.ec.gc.ca/species-risk-registry/virtual_sara/files//cosewic/sr_Mapleleaf_2016_e.pdf.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2017. COSEWIC assessment and status report on the Lake Sturgeon *Acipenser fulvescens*, Western Hudson Bay populations, Saskatchewan-Nelson River populations, Southern Hudson Bay-James Bay populations, and Great Lakes-Upper St. Lawrence populations in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxx + 153 pp. https://wildlife-species.canada.ca/species-risk-registry/virtual_sara/files/cosewic/sr_Lake%20Sturgeon_2017_e.pdf.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2023. COSEWIC Wildlife Species Assessment. https://www.cosewic.ca/index.php/en-ca/assessment-process.html.

Crown Indigenous Relations and Northern Affairs Canada (CIRNAC). 2021. First Nation Profile for Roseau River Anishanabe First Nation. Accessed August 2023. https://fnp-ppn.aadnc-aandc.gc.ca/FNP/Main/Search/FNMain.aspx?BAND_NUMBER=273&lang=eng

Di Rocco, R, and R. Gervais. 2024. *SPOT: Swim Performance Online Tools*. Available from https://fishprotectiontools.ca. Accessed May 2024.

Dodds W.K., Jones J.R., and E.B. Welch. 1998. Suggested classification of stream trophic state: Distributions of temperate stream types by chlorophyll, nitrogen, and phosphorus." Water Research 32(5): 1,455-1,462.

Driedger, R. 2023. Grunthal Public Water System Annual Report 2022. The Rural Municipality of Hanover.

Driedger, R. 2023. Kleefeld Public Water System Annual Report 2022. The Rural Municipality of Hanover.

Duval, M. 2023. Ritchot Regional Public Water System Annal Report 2022. Ritchot Regional Public Water System.

Emergency Preparedness Canada. 1999a. Major Hailstorms in Canada. Disaster Database. Accessed August 2023. https://open.canada.ca/data/en/dataset/ddbbfe4f-8893-11e0-b366-6cf049291510

Emergency Preparedness Canada. 1999b. Major Tornadoes in Canada. Disaster Database. Accessed August 2023. https://open.canada.ca/data/en/dataset/ddddde30-8893-11e0-8cfe-6cf049291510

Emergency Preparedness Canada. 2009. Major Floods, 1902 – 2005. Disaster Database. Accessed August 2023. https://open.canada.ca/data/en/dataset/dd258aae-8893-11e0-b965-6cf049291510

Energy, Mines and Resources Canada. 1986. “Canada – Wetland Regions” [map]. 1:7,500,000. The National Atlas of Canada. 5th Edition.

Environment Canada. 1997. 1997 Canadian Acid Rain Assessment. Volume III. The Effects on Canada’s Lakes, Rivers, and Wetlands.

Environment Canada. 2015. Management Plan for the Riddell’s Goldenrod (Solidago riddellii)in Canada. Species at Risk Act Management Plan Series. Environment Canada, Ottawa.iv + 18 pp. Accessed August 2023. https://publications.gc.ca/collections/collection_2016/eccc/En3-5-56-2015-eng.pdf

Environment Canada and Climate Change. 2018. General nesting periods of migratory birds. https://www.canada.ca/en/environment-climate-change/services/avoiding-harm-migratory-birds/general-nesting-periods.html.

Experimental Farms Service. 1954a. Soil Map. Reconnaissance Survey of Morris Area in Manitoba.

Experimental Farms Service. 1954b. Soil Map. Reconnaissance Survey of Winnipeg Area in Manitoba.

Faubert, P. et al. 2010. Non-methane Biogenic Volatile Organic Compound Emissions from a Subarctic Peatland Under Enhanced UV-B Radiation. Ecosystems 13: 860–873.

Fischer-Romero, B. et al., 1996. Tolumonas auensis gen. nov., sp. nov., a toluene-producing bacterium from anoxic sediments of a freshwater lake. International Journal of Systematic Bacteriology 46: 183-188.

Fisheries and Oceans Canada. (DFO). 2010. Recovery potential assessment of Lake Sturgeon: Assiniboine-Red Rivers – Lake Winnipeg populations (Designatable Unit 4). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/051. https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/342198.pdf.

Fisheries and Oceans Canada (DFO) 2013. Manitoba Restricted Activity Timing Windows for the Protection of Fish and Fish Habitat. https://www.dfo-mpo.gc.ca/pnw-ppe/timing-periodes/mb-eng.html.

Fisheries and Oceans Canada (DFO). 2020. Interim code of practice: End-of-pipe fish protection screens for small water intakes in freshwater. Accessed May 2024. https://www.dfo-mpo.gc.ca/pnw-ppe/codes/screen-ecran-eng.html.

Fisheries and Oceans Canada (DFO). 2021. Management Plan for the Bigmouth Buffalo (*Ictiobus cyprinellus*) in Canada (Saskatchewan-Nelson River populations). Species at Risk Act Management Plan Series. Fisheries and Oceans Canada, Ottawa. iv + 24 pp.

Fisheries and Oceans Canada (DFO). 2023a. Interim Standard: in-water site isolation. Accessed May 2024. https://www.dfo-mpo.gc.ca/pnw-ppe/codes/interim-provisoire/site-isolation-confinement-aire-travail-eng.html

Fisheries and Oceans Canada (DFO). 2023b. Measures to protect fish and fish habitat. Accessed May 2024. https://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures-eng.html.

Frost, L. 2007. Seine River Watershed – State of the Watershed Report. Groundwater Resource Information. Groundwater Management Section. Manitoba Water Stewardship.

GIN, 2021. Groundwater Information Network https://gin.gw-info.net/service/api_ngwds:gin2/en/gin.html Accessed August 2023.

Government of Canada. 2020. Guidelines for Canadian Drinking water Quality: Guideline Technical Document – Total Coliforms. https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-drinking-water-quality-guideline-technical-document-total-coliforms.html

Government of Canada. 2023a. "Historical Hydrometric Data Search." Accessed August 2023. https://wateroffice.ec.gc.ca/report/historical_e.html?stn=05OC012&dataType=Monthly&parameterType=Flow&year=2014&mode=Table&page=historical&start_year=1850&end_year=2023

Government of Canada. 2023b. Water Quality in Canadian rivers Database https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/water-quality-canadian-rivers.html

Government of Canada. 2023c Species at risk public registry. Species search. https://species-registry.canada.ca/index-en.html#/species?sortBy=commonNameSort&sortDirection=asc&pageSize=10. Accessed September 2023.

Government of Canada. 2023d. National wildlife areas. https://www.canada.ca/en/environment-climate-change/services/national-wildlife-areas.html.

Government of Canada. 2023e. Migratory bird sanctuaries across Canada. https://www.canada.ca/en/environment-climate-change/services/migratory-bird-Sanctuaries/locations.html

Government of Manitoba. 2011. Water Quality Standards, Objectives, and Guidelines https://www.gov.mb.ca/sd/pubs/water/lakes-beaches-rivers/mb_water_quality_standard_final.pdf

Government of Manitoba. 2017b. Conservation and Water Stewardship. https://mli2.gov.mb.ca/adminbnd/index.html.

Government of Manitoba. 2023a. Water Quality Monitoring Program Database. Government of Manitoba 2023. https://www.gov.mb.ca/contact/

Government of Manitoba. 2023b. Aquatic Invasive Species in Manitoba. Accessed August 2023. https://www.gov.mb.ca/stopais/aisinmanitoba/index.html.

Government of Manitoba. 2024. The Endangered Species and Ecosystems Act. https://web2.gov.mb.ca/laws/statutes/ccsm/e111.php?lang=enGovernment of Manitoba. n.d.a. History of Flooding in Manitoba. Accessed August 2023. https://www.gov.mb.ca/flooding/history/index.html

Government of Manitoba. n.d.b. Conservation Data Centre. Accessed May 2024. https://www.gov.mb.ca/nrnd/fish-wildlife/cdc/index.html.

Government of Manitoba. n.d.b. Contaminated Sites Registry Map. Accessed August 2023. https://manitoba.maps.arcgis.com/apps/webappviewer/index.html?id=fdb34ac36084481cb2eb0d46489337a7

Government of Manitoba. n.d.c. Clubroot of Canola: The Facts. Accessed August 2023. https://www.manitoba.ca/agriculture/crops/plant-diseases/clubroot-of-canola.html

Government of Manitoba. n.d.d. Clubroot Distribution in Manitoba. Accessed August 2023. https://www.manitoba.ca/agriculture/crops/plant-diseases/clubroot-distribution-in-manitoba.html

Government of Manitoba. n.d.e Manitoba Infrastructure – Red River Basin. Accessed August 2023. Water Management and Structures | Transportation and Infrastructure | Province of Manitoba (gov.mb.ca)

Government of Manitoba. n.d.f. Land Use and Development Map. Accessed December 2023.

Grasby, S.E. and R.N. Betcher. 2002. Regional Hydrogeochemistry of the Carbonate Rock Aquifer, Southern Manitoba. Can. J. Earth Sci. 39:1053-1063.

Guenther, A. 2013. Biological and Chemical Diversity of Biogenic Volatile Organic Emission In The Atmosphere. ISRN Atmospheric Sciences, Article ID 786290, Hindawi Publishing Corp. 27 p.

Habib, L., E.M. Bayne, and S. Boutin. 2007. "Chronic Industrial Noise Affects Pairing Success and Age Structure of Ovenbirds Seiurus aurcapilla." Journal of Applied Ecology. Vol. 44. pp. 176-184.

Hanover Municipality. n.d. Municipality Website. Accessed August 2023. https://www.hanovermb.ca/.

Harrison, E.T., R.H. Norris, and S.N. Wilkinson. 2007. The Impact of Fine Sediment Accumulation on Benthic Macroinvertebrates: Implications for River Management. Proceedings of the 5th Australian Stream Management Conference. Australian rivers: making a difference. Charles Sturt University, Thurgoona, New South Wales. 6pp.

Hatfield Consultants Partnership (HCP), Kilgour and Associates Ltd. (KAL), and Western Resource Solutions (WRS). 2013. Regional Aquatics Monitoring Program, 2012 Technical Report. Report prepared for RAMP Steering Committee by the RAMP 2012 Implementation Team consisting of HCP et al. April 2013.

Hlasny, R.E. 2003. Assessment of the Bigmouth Buffalo population of Pasqua Lake. Report to the Fish and Wildlife Branch of Saskatchewan Environment. 21 pp.

Hnytka, S.M., Watkinson, D.A., Enders, E.C., Friesen, C., Murray, C., and Church, C. 2022. The ecology, distribution, and identification of native freshwater mussels (Unionidae) of Manitoba. Can. Tech. Rep. Fish. Aquat. Sci. 3435: viii + 63 p. https://www.researchgate.net/profile/Chris-Friesen/publication/359269796_The_ecology_distribution_and_identification_of_native_freshwater_mussels_Unionidae_of_Manitoba/links/623230494ba65b24813565bb/The-ecology-distribution-and-identification-of-native-freshwater-mussels-Unionidae-of-Manitoba.pdf

Hounslow A.W. 1995. Water Quality Data Analysis and Interpretation. CRC Press Inc., Lewis Publishers, Boca Raton, Florida. Langmuir D. 1997. Aqueous Environmental Geochemistry. Prentice Hall, Upper Saddle River, New Jersey

Hutlet, C. 2023. Public Water System Annual Report 2022. Landmark Public Water System. The Rual Municipality of Taché

Hutlet, C. 2023. Public Water System Annual Report 2022. Lorette Public Water System. The Rual Municipality of Taché

Jalkotzy, M.G., P.I. Ross, and M.D. Nasserden. 1997. The Effects of Linear Developments on Wildlife: A Review of Selected Scientific Literature. Prep. for Canadian Association of Petroleum Producers. Arc Wildlife Services Ltd., Calgary. 115pp.

Johnson, R.P. 1963. Studies on the Life History and Ecology of the Bigmouth Buffalo, *Ictiobus cyprinellus* (Valenciennes). Journal of the Fisheries Board of Canada. Volume 20, Number 6, June 1963.

Jüttner, F. and J.J. Henatsch. 1986. Anoxic hypolimnion is a significant source of biogenic toluene. Nature 323: 797-798.

Katopodis, C. 1992. Fish Screening Guide for Water Intakes. Freshwater Institute, Central and Arctic Region, Department of Fisheries and Oceans. Winnipeg, Manitoba. + 4 pp. https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/357935.pdf.

Landmark Planning & Design Inc. Oct. 2018. RM of Hanover Development Plan. Prepared for the Rural Municipality of Hanover.

Lands Advisory Board and First Nations Land Management Resource Centre (LABRC). n.d. Roseau River Anishanabe First Nation. Accessed August 2023. https://labrc.com/first-nation/roseau-river-anishinabe-first-nation/.

Linnet Geomatics International Inc. 1997. Manitoba Wetlands. Accessed August 2023. https://www.gov.mb.ca/nrnd/forest/pubs/forestry_peatlands/mbwetlands_map_peatlands%20webpage.pdf

Mackie, G., Morris, T.J., and Ming, D. 2008. Protocol for the detection and relocation of freshwater mussel species at risk in Ontario-Great Lakes Area (OGLA). Can. Manuscr. Rep. Fish. Aquat. Sci. 2790: vi +50 p. Accessed May 2024. https://publications.gc.ca/collections/collection_2014/mpo-dfo/Fs97-4-2790-eng.pdf

Manitoba Conservation Data Centre. 2021. Vascular and Non-vascular Plants List. Wildlife, Fisheries, and Enforcement Branch. November 2021. Accessed August 2023. https://www.gov.mb.ca/nrnd/fish-wildlife/cdc/pubs/plant-list-mbcdc-2021-nov.pdf

Manitoba Government. n.d.f Map Gallery: Geoscientific Maps. Accessed August 2023. https://rdmaps.gov.mb.ca/Html5Viewer/index.html?viewer=MapGallery_Geology.MapGallery

Manitoba Habitat Heritage Corporation and Manitoba Conservation and Water Stewardship. 2015. Wetlands. ESRI Geodatabase. https://mhhc.maps.arcgis.com/apps/webappviewer/index.html?id=30b524ce95bd4f6da2041d066ec58233.

Manitoba Hydro. 2021. Generating Stations. Accessed August 2023. Generating stations (hydro.mb.ca)

Manitoba Wildlife, Fisheries, and Enforcement Branch. 2021. Recommended development setback distances and restricted activity periods for birds by wildlife feature type. 5pp.

Margalef R. 1983. Limnology. Barcelona (es). 1,010p.

McNeely R.N., Neimanis V.P. and L. Dwyer. 1979. Water Quality Sourcebook – A Guide to Water Quality Parameters. Inland Directorate, Water Quality Branch, Minister of Supply and Services Canada, Ottawa, Ontario.

Metcalf & Eddy, Inc. 2014. Wastewater Engineering: Treatment and Resource Recovery, 5th Edition. New York, NY: McGraw Hill Education. pp. 915 – 919.

Michalyna, W., Gardiner, Wm., Podolsky, G. 1975. Soils of the Winnipeg Region Study Area. Prepared for: Province of Manitoba, Department of Municipal Affairs, Municipal Planning Branch.

Mitchell P. and E. Prepas (Eds.). 1990. Atlas of Alberta Lakes. University of Alberta Press. Edmonton, Alberta.

National Academy of Sciences (NAS). 1978. Chloroforms, Carbon, Tetrachloride and other Halomethanes. Scientific and Technical Assessment of Environmental Pollutants, Washington DC.

National Wetlands Working Group (NWWG). 1997. The Canadian Wetland Classification System. Second Edition. B. G. Warner and C. D. A. Rubec (Eds.). Waterloo, Ontario: University of Waterloo, Wetlands Research Centre. vi + 68 pp.

Natural Resources Canada 2007-2011. Publication Date: January 1, 2007 (but updates vary by workunit)Acquired Date: April 20, 2012Update Interval: unknown/annually (Apr/May)Last Update Check: May 2012Acquired from: http://www.geobase.ca/geobase/en/data/nhn/index.htmlCitation: NRCan. 2007-2011. National Hydro Network (digital files). Sherbrooke, QC. Available: http://www.geobase.ca/geobase/en/data/nhn/index.html. Acquired: April 2012. Last Update Check: May 2012

NatureServe. n.d. "Definitions of NatureServe Conservation Status Ranks." Accessed May 2024. https://help.natureserve.org/biotics/content/record_management/Element_Files/Element_Tracking/ETRACK_Definitions_of_Heritage_Conservation_Status_Ranks.htm#National.Phipps, G., Betcher, R.N., and Wang, J., 2008. Geochemical and Isotopic Characterization of a Regional Bedrock/Surficial Aquifer System, Southeastern Manitoba. Conference proceedings of GeoEdmonton'08: 61st Canadian Geotechnical Conference and 9th Joint CGS/IAH-CNC Groundwater Conference, September 21-24, 2008, Edmonton, Canada.

Newcombe, C.P., and D.D. MacDonald. 1991. Effects of suspended sediments on aquatic ecosystems. North American Journal of Fisheries Management 11:72-82.

Province of Manitoba. n.d.a Declaration of Noxious Weeds in Manitoba. Accessed August 2023. https://www.gov.mb.ca/agriculture/crops/weeds/declaration-of-noxious-weeds-in-mb.html

Red River Basin Board. 2000. Inventory Team Report: Hydrology. Moorhead, MN. 71 pp.

Reid, S.M., and P.G. Anderson. 1999. Effects of Sediment Released During Open cut Pipeline Water Crossings. Canadian Water Resources Journal. Vol. 24, No. 3. pp. 235-251.

Ritchot Municipality. n.d. Municipality Website. Accessed August 2023. https://www.ritchot.com/.

Rural Municipality (RM) of De Salaberry. n.d. Red River Weed Control District. 2021 Proposed Pesticide Program. Accessed August 2023. https://www.rmdesalaberry.mb.ca/Home/DownloadDocument?docId=ae845392-f2b9-4617-9a9a-e6dd661e2ecf

Rural Municipality (RM) of Hanover. 2013. By-law No. 2332-13: Noise By-law. Accessed August 2023. https://www.hanovermb.ca/Home/DownloadDocument?docId=491d3b63-c196-433d-9764-cc60123b64f6.

Rural Municipality (RM) of Ritchot. 2023. By-law No. 4-2023. Accessed August 2023. https://ritchot.com/Home/DownloadDocument?docId=9a90fd00-a0a3-443c-be18-6d99692198ce.

Rural Municipality (RM) of Taché. 2016. By-law No. 15-2016. Accessed August 2023. https://www.rmtache.ca/Home/DownloadDocument?docId=f23a16ff-56d3-464d-b614-376f5d157898.

Rutulis, M. 1986. Bedrock Aquifers. Aquifer Map of Southern Manitoba. Department of Natural Resources, Water Resources Branch. Map M-482.

Smith, R.E., Veldhuis, H., Mills, G.F., Eilers, R.G., Fraser, W.R., Lelyk, G.W. 1998. Terrestrial Ecozones, Ecoregions, and Ecodistricts. An Ecological Stratification of Manitoba's Landscapes. Technical Bulletin 98-9E. Land Resource Unit, Brandon Research Centre, Research Branch, Agriculture and Agri-Food Canada, Winnipeg, Manitoba.

Soil Classification Working Group. 1998. The Canadian System of Soil Classification, 3rd ed. Agriculture and Agri-Food Canada Publication 1646, 187 pp.

Statistics Canada. 2021a. Census of Population: Niverville, Town. Accessed August 2023. https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/details/page.cfm?Lang=E&SearchText=niverville&DGUIDlist=2021A00054602046&GENDERlist=1,2,3&STATISTIClist=1,4&HEADERlist=0

Statistics Canada. 2021b. Census of Population: Hanover, Rural Municipality. Accessed August 2023. https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/details/page.cfm?Lang=E&SearchText=hanover&DGUIDlist=2021A00054602041&GENDERlist=1,2,3&STATISTIClist=1,4&HEADERlist=0

Statistics Canada. 2021c. Census of Population: Ritchot, Rural Municipality. Accessed August 2023. https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/details/page.cfm?Lang=E&SearchText=ritchot&DGUIDlist=2021A00054602075&GENDERlist=1,2,3&STATISTIClist=1,4&HEADERlist=0

Statistics Canada. 2021d. Census of Population: Taché, Rural Municipality. Accessed August 2023. https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/details/page.cfm?Lang=E&SearchText=tache&DGUIDlist=2021A00054602069&GENDERlist=1,2,3&STATISTIClist=1,4&HEADERlist=0

Stewart, K. and D. Watkinson. 2004. The Freshwater Fishes of Manitoba. University of Manitoba Press. Winnipeg, MB. 300 pp.

Stewart, R. E. and H. A. Kantrud. 1971. Classification of Natural Ponds and Lakes in the Glaciated Prairie Region. Resource Publication No. 92. Washington, DC: U.S. Fish and Wildlife Service. 57 pp.

Taché Municipality. N.d. Municipality Website. Accessed August 2023. https://www.rmtache.ca/.

Thomas. R.F., M.A. Feige and H.J. Brais 1979. Monitoring of Trihalomethanes and other Purgeable Compounds in a Water Supply Vulnerable to Industrial Contamination. Paper No.19. AM. Chem Soc. National Meeting. Washington DC.

Town of Niverville. N.d. Town Website. Accessed August 2023. https://www.whereyoubelong.ca/. Treasury Board of Canada Secretariat. n.d. Federal Contaminated Sites Inventory. Map Navigator. Accessed August 2023. https://map-carte.tbs-sct.gc.ca/map-carte/fcsi-rscf/map-carte.aspx?Language=EN&backto=www.tbs-sct.gc.ca/fcsi-rscf/kw-mc-eng.aspx#search

Tuttle-Raycraft S., Morris T.J., and Ackerman J.D. 2017. Suspended solid concentration reduces feeding in freshwater mussels. Science of The Total Environment. Vol. 598. pp 1160-1168.

U. S. Environmental Protection Agency (USEPA). 1978. In Depth Study of Health and Environmental Impacts of Selected Water Pollutants. Contract. 68-01-4646. USEPA. Cincinnati, OH.

U.S. Geological Survey. 2019. Red River Basin. Red River Basin. U.S. Geological Survey (usgs.gov) Accessed August 2023.

Wang, J., Betcher, R. B., and Phipps, G. C. 2008 Groundwater resource evaluation in southeastern Manitoba. Groundwater Management Section, Manitober Water Stewardship. GeoEdmonton'08.
Wetzel R.G. 2001. Limnology. Lake and River Ecosystems. Third Edition. Academic Press

Western Hemisphere Shorebird Reserve Network (WHSRN). 2021. WHSRN Sites. https://whsrn.org/whsrn-sites/map-of-sites/.

Wetzel R.G. 2001. Limnology. Lake and River Ecosystems. Third Edition. Academic Press.

White, M.L. et al. 2009. Are biogenic emissions a significant source of summertime atmospheric toluene in the rural northeastern United States? Atmospheric Chemistry and Physics 9: 81-92.

Wilber, D.H. and D. G. Clarke. 2001. Biological Effects of Suspended Sediments: A Review of Suspended Sediment Impacts on Fish and Shellfish with Relation to Dredging Activities in Estuaries. North American Journal of Fisheries Management, 21:4, 855-875.

WSP. March 2023. Macdonald-Ritchot Planning District Development Plan By-Law No. 2/22. Prepared for the Macdonald-Ritchot Planning District.

Xia Huang, Fangang Meng, Kang Xiao, Hector A. Garcia, Jiao Zhang, 2023. "Membrane bioreactors", Biological Wastewater Treatment: Principles, Modelling and Design, Guanghao Chen, Mark C.M. van Loosdrecht, George A. Ekama, Damir Brdjanovic.