Village of Caroline Lagoon Upgrade Feasibility Study

April 25, 2018

Prepared for:

Village of Caroline

Prepared by:

Stantec Consulting Ltd.

Prepared by ______________________

(signature)

Johnny Ke, M.SC., P.Eng.

Reviewed by ______________________

(signature)

Liang Liu, M.Eng., P.Eng.

Approved by ______________________

(signature)

James Coates, M.SC., P.Eng.

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1.0 INTRODUCTION

1.1 BACKGROUND

The Village of Caroline (the Village) is located 40 km south east of Rocky Mountain House. The Village has had a stable population of approximately 500 people over the last decade, however, the Village is expecting a major development in the north east area. Stantec has reviewed the development concepts in the NE area and recommended to increase the infrastructure capacities to support the development. The wastewater treatment lagoon is cited as municipal infrastructure which will require upgrading in the future to accommodate future growth. Furthermore, the current Village's wastewater treatment plant (WWTP) approval also requested the Village to conduct a Receiving Water Quality study to ensure the current treatment process can meet the provincial and federal wastewater treatment effluent discharge regulations.

This report presents the capacity expansion options that can increase the treatment capacity to meet both goals. However, the final decision on the selection of the proposed solutions cannot be finalized before the Receiving Water Quality study is completed.

1.2 EXISTING SYSTEM

The existing WWTP is an aerated lagoon system, which consists of two aerated lagoon ponds. The lagoons discharge into the Raven River located in the NE 11-36-6-W5M. The following table presents the design parameters of the two aerated cells.

Table 1 Existing Caroline Lagoon Cells

Cell No.	Cell Type	Water Depth (m)	Water Volume (m^3)
1	Partial Mix Aerated	2.5	11,792
2	Partial Mix Aerated	2.5	19,051
Total			**30,843**

The aeration system consists of submerged lineal aeration tubes and three 10 HP blowers in a blower building on-shore. The aeration system was upgraded in 2006. The aerated lagoon was designed to treat 400 m^3/day wastewater from the Village.

2.0 REGULATIONS AND EFFLUENT DISCHARGE

2.1 CURRENT APPROVAL

The Village is operating the existing aerated lagoon system according to Approval # 494-03-00 under the Alberta Environmental Protection and Enhancement Act (EPEA). The Approval stipulates that the Caroline aerated lagoon

WWTP shall treat the wastewater collected in the Village to meet the following criteria before it is discharged continuously to Raven River:

Table 2 Limits for Treatment Wastewater

Parameter	Limit
CBOD	≤ 25 mg/L monthly arithmetic mean of weekly samples

Although the expiry date of the Approval is from March 6,2017 to March 1, 2027, the Approval stipulates that the Village shall conduct a Receiving *Water Quality Assessment (RWQA)* and *Wastewater Treatment Plant Capacity Assessment Study* to determine if the existing Caroline WWTP has the capacity to treat the wastewater to meet the *Environmental Quality Objectives(EQOs)* and *Effluent Discharge Objectives (EDOs)*, which are defined in the Canadian council of Ministers of the Environment (CCME) *Canada-wide Strategy for the Management of Municipal Wastewater Effluent* and AEP's *Water Quality Based Effluent Limits Procedures Manual*. The study results will determine if an upgrade is needed to improve the existing WWTP. The Village obtained another consultant to conduct the RWQ study and the results should be available at the end of 2018.

The Environment Canada's *Wastewater Systems Effluent Regulation* (WSER 2016) under the Fisheries Act also applies to the existing aerated lagoon systems. The Caroline WWTP falls into the continuous discharging wastewater system classifications with annual average daily volume under 2,500 m^3/day category. The annual average CBOD concentration in the effluent samples should be less than 25 mg/l, and TSS should be less than 25 mg/L with exception from July to October. The maximum un-ionized ammonia level should be less than 1.25 mg/L. The samples should be also tested to pass the acute toxicity tests according to the frequency defined in WSER.

2.2 FUTURE DISCHARGE CRITERIA

It is expected that the RWQA study will come up with the following possible scenarios:

Scenario 1: Continuous discharge is allowed with the current treatment level

If the RWQ study indicates that the current 25 CBOD mg/L as in Table 2 is sufficient to meet the EQOs and EDOs, the wastewater treatment plant will be able to treat the flows for the next 30 years. However, due to the limitation of the aerated lagoon systems, ammonia degradation will be slow in winter time, which will lead to high ammonia concentrations in the treatment effluent. It is most possible that the samples taken from the discharge effluent might not pass the acute toxicity tests as per the test procedure regulated in WSER.

Scenario 2: Continuous discharge is allowed with improved treatment

The RWQ study might find that the flow in the Raven river is sufficient to meet the 1:10 dilution requirement and the discharge effluent impact on the receiving environment is negligible if the ammonia level is brought down by post-lagoon nitrification process. The other possibility of the RWQ might require phosphorous removal to avoid downstream eutrophic conditions.

Table 3 Proposed Discharge Criteria for Scenario 2

Parameter	Limit
CBOD	≤ 25 mg/L monthly arithmetic mean of weekly samples
TSS*	≤ 25 mg/L monthly arithmetic mean of weekly samples
Ammonia	5 mg/L in summer and 10 mg/L in winter

Total phosphorus**	1 mg/L
Unionized Ammonia -N	< 1.25 mg/L
Acute Toxicity Test	Pass
*E.coli***	200 CFU/100 ml

* *With July to Oct exempt if lagoon-based technology is selected.*

***TP and E.coli is less likely regulated in Scenario 2 due to it's the very small population in the village, however, the final decision will be depended on the RWQ findings and Alberta Environment and Parks approval writer's decision.*

Scenario 3: <u>Continuous discharge is not allowed. Multiple discharges are permitted with high level of treatment.</u>

If multiple discharges are allowed, the criteria in Table 2 will most possible apply. However, a certain amount of storage volume after the treatment process will be required to hold the treated effluent for amount of time before it can be released. Most likely, twice a year discharge schedule is permitted. The treated effluent will be stored up to half of year and discharge when there is sufficient flow in the Raven creek for 10:1 dilution.

<u>Scenario 4: Continuous discharge is not allowed. Only once a year discharge is permitted</u>

RWQA study might indicate that the current continuous discharge is not acceptable due to the lower flow rate in the Raven river or the discharge of effluent will affect the high-quality background water quality negatively. EQOs and EDOs cannot be met. In this case, the discharge will switch to an intermittent schedule. The intermittent discharge will require storage cells to hold the treated effluent for a certain period before it can be released into the river.
If once a year discharge is determined, the conventional lagoon can be selected as the solution. The operation of the conventional lagoon is subject to the terms in the *Code of Practice*.

3.0 FLOW AND LOADING PROJECTIONS

3.1 HISTORICAL DATA ANALYSIS

The Caroline WWTP has been collecting raw and treated wastewater flow and quality data according to the requirements in the current approval. Raw data from 2010 to 2017 have been reviewed and analyzed. The following table presents the influent wastewater characteristics as a result of the raw data analysis.

Table 4 Caroline WWTP Influent Characteristics

Parameter	Value	Unit
Flow	300	Lcpd
TSS	220	mg /L
BOD	220	mg /L
TKN	40	mg /L
TP	6.5	mg /L
MM/AA*	1.25	-

** MM= maximum month average daily flow; AA= Annual Average flow*

3.2 FLOW AND LOADINGS PROJECTIONS

Unlike other Central Alberta communities, the population in the Village has not experienced significant growth in last 10 years. It is expected that the population will grow at a rate of less than 1.4%, which is the official provincial growth rate. However, a light industrial and commercial development (Northeast County Development) has been planned in the Village. It is expected that the wastewater flow will increase by about 2% a year. In the next 30 years, the annual average flow will increase from the current 155 m^3/d to 280 m^3/d, which is equivalent to wastewater generated by 933 people. The following table presents the projected flow and loadings. Depending on the process technologies selection, the AA or the MM values will be chosen as the design flow and loadings.

Table 5 Design Flows and Loadings

	AA	MM	Unit
Flow	280	350	m3/d
TSS	62	77	kg/d
BOD	62	77	kg/d
TKN	11	14	kg/d
TP	2	2	kg/d

4.0 UPGRADE OPTIONS

If the RWQ results dictate that the current aerated lagoon can meet the EQOs and EDOs, i.e. Scenario 1 outcome, there is no need to upgrade the existing system. However, the Village should consider replacing the existing aeration system, which has been in service for 12 years.

Below are options that can be considered to upgrade the existing aerated lagoon WWTP to meet the possible discharge criteria in Scenarios 2,3 and 4 in Section 2.2. These options are:

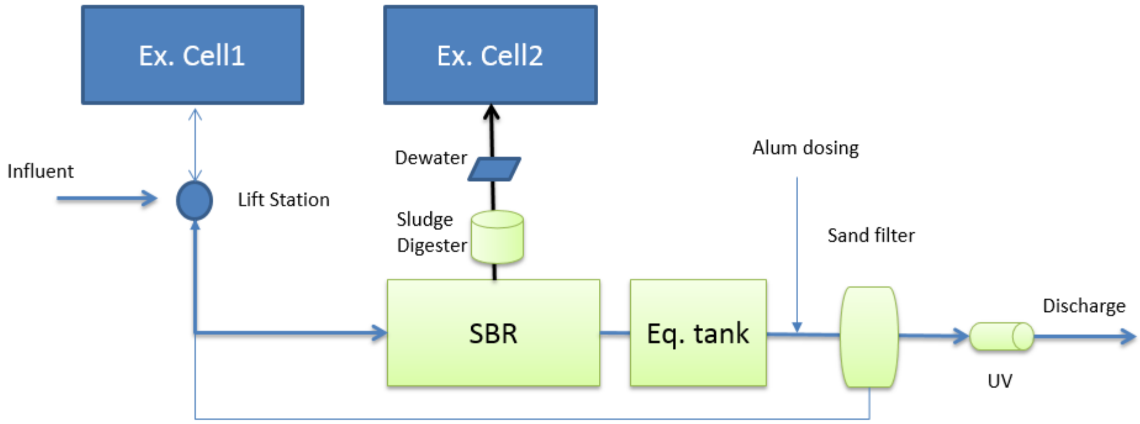
- Mechanical Plant: e.g. Sequencing Batch Bioreactor (SBR) with disc filtration, UV disinfection
- Submerged Attached Growth Reactor (SAGR) for post lagoon nitrification with Alum dosing
- Moving Bed Bioreactor (MBBR) for post lagoon nitrification with Alum dosing
- Conventional Lagoon.

The mechanical plant technology and two lagoon based post-nitrification technologies are analyzed to study their eligibility to meet the discharge in Scenarios 2 and 3. Extra storage will be needed to store the treated effluent for half a year to meet the Scenario 3 storage requirement. For Scenario 4, a passive conventional lagoon system is proposed. The following sections present the proposed treatment systems description and configurations, the process flow diagrams and the opinion of probable costs (OPCs in 2018 Canadian dollars).

4.1 SBR MECHANICAL PLANT

A Sequencing Batch Reactor (SBR) mechanical plant utilizes fill-and-draw single “batch” reactors to treat and discharge wastewater. It is an activated sludge (AS) system which operates in time rather than in space hence it has a more compact configuration and footprint than other AS systems, e.g. conventional biological AS plant, Membrane Biological Reactor (MBR) plant. Primary clarifier and secondary clarifiers are not needed in a typical SBR design. The existing two lagoon cells can be converted to peak flow an equalization pond and dewatered sludge storage cell. For the design flow and loadings scale in Caroline, it can be more economical and simpler to operate than MBR. The following process flow diagram presents the proposed SBR plant concept.

Figure 1 Proposed SBR Process Flow Diagram



The SBR tank, effluent equalization tank, sand filters, digester tanks, press filter for sludge dewatering process and the associated blowers, diffusers, electrical and control equipment can be supplied by a supplier e.g. Napier-Reid Inc. The budgetary quotation of the all the equipment is approximately $1.2 M. A 20X30X8m building with proper ventilation is needed to accommodate the above tanks and equipment. The proposed site layout of the proposed SBR Plant is presented in Figure 2. The opinion of probable cost for the supply, installation and construction of the SBR plant is $4.7M.

Table 6 OPC for the Proposed SBR Plant

Item	Description	Costs ($)
1	General, mob/demob	236,000
2	Civil Works	200,000
3	Prefab. Building (20X30X8)	1,300,000
4	SBR tanks and equipment	1,200,000
4.1	SBR reactor 11.7X3.7X4.95 m	Included
4.2	EffluentTank 4.7X3.7X4.9m	Included
4.3	Aerobic Digester 5X3.7X4.9m	Included
4.4	Blowers and Pumps/motors	Included
5	Process, electrical, control equipment and instruments installation	300,000
6	Building Electrical and HVAC	200,000
7	**Subtotal**	**3,436,000**
8	Engineering and Contingency (35%)	1,202,000
9	**Total**	**4,638,000**

The half-year storage cell required in Scenario 3 will cost approximately $1.9 M, which is also applicable to the next two options (SAGR and MBBR options) if half-year storage is required.

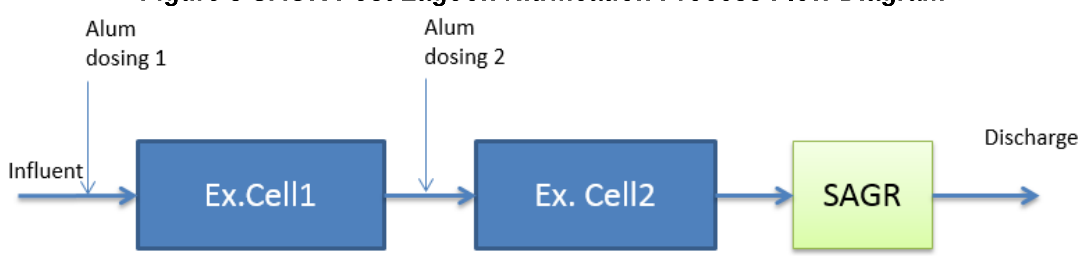
Figure 2. Proposed SBR Plant Site Layout

4.2 SAGR FOR POST LAGOON NITRIFICATION

As the existing aerated lagoon cells have the potential to treat the influent to lower the CBOD to 25 mg/L at the design horizon, the lagoon-based technology, SAGR (Submerged Attached Growth Reactor) for nitrification is proposed to treat the influent to meet the proposed ammonia discharge standards.

SAGR for nitrification in cold climate environment has been proved an effective process. SAGR utilizes washed gravel to allow nitrifying bacteria and other bacteria in biological treatment to grow in high density. Air is introduced through a blower and a linear diffuser system to supply oxygen for the biological treatment process. With mulch cover on top, the gravel based reactor will retain heat during the winter time and achieve a high level of ammonia, BOD and TSS removal in cold weather. As for total Phosphorus removal, Noxem Inc., the supplier of the SAGR technology, indicated that applying alum to the upstream lagoon cells can reduce TP to 1 mg/L in the SAGR effluent for such a small system. Although the alum dosing will be higher than using a dedicated coagulation plus disc filtration system downstream of the SAGR system, the saving in capital cost can offset the alum cost. A SAGR system can be installed downstream of the lagoon system as indicated in the following figure.

Figure 3 SAGR Post Lagoon Nitrification Process Flow Diagram



The existing aeration system has probably reached its design life span so a replacement of the aeration system is needed. The site layout of the proposed SAGR post lagoon nitrification system is presented in Figure 4. The following table presents the OPCs of existing aeration system upgrade, alum dosing system and SAGR system supply and installation.

Table 7 OPCs for SAGR Post Lagoon Nitrification System

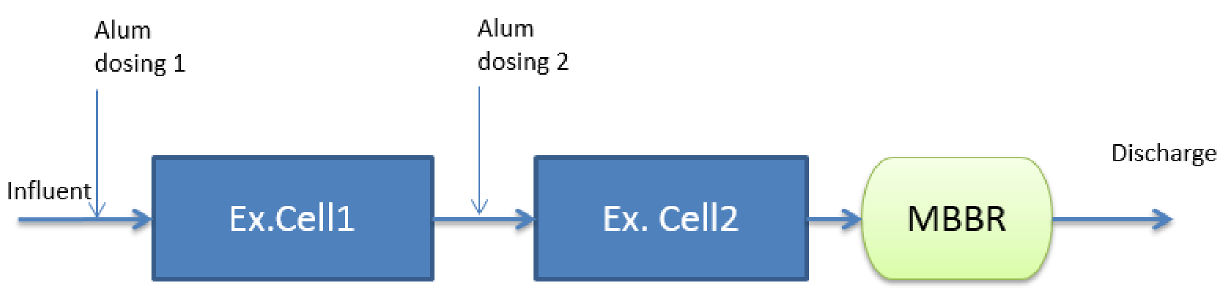
Item	Description	Costs ($)
1	General, mob/demob	119,000
2	Civil Works	100,000
3	Prefab. Blower and control Building (5X9X3m)	247,000
4	Existing Aeration System Upgrade	226,000
5	Alum dosing/storage system and building	350,000
6	SAGR process supply and installation	305,000
7	SAGR civil work	260,000
8	**Subtotal**	**1,607,000**
9	Engineering and Contingency (35%)	563,000
10	**Total**	**2,170,000**

Figure 4. Proposed SAGR Solution Layout

4.3 MBBR FOR POST LAGOON NITRIFICATION

Like SAGR for post lagoon nitrification technology, Moving Bed Biological Reactor (MBBR) utilizes floating media to increase the nitrifying bacteria population in the bioreactors. The media is manufactured in a controlled environment to contain large amount of surface area to allow the bacterial to grow. This technology has less installation costs than the SAGR technology but the recent pilot project in Ontario has supplied sufficient data to demonstrate its efficiency in post lagoon nitrification application. The following PFD presents the aerated lagoon and MBBR nitrification process concept.

Figure 5 MBBR Post Lagoon Nitrification Process Flow Diagram



The site layout of the proposed MBBR post lagoon nitrification system is presented in Figure 6. The OPC for the MBBR process is presented in the following table.

Table 8 OPC for MBBR Post Lagoon Nitrification System

Item	Description	Costs ($)
1	General, mob/demob	129,000
2	Civil Works	200,000
3	Prefab. Blower and control Building (5X9X3m)	247,000
4	Existing Aeration System Upgrade	226,000
5	Alum dosing/storage system and building	350,000
6	MBBR tank (D3X16m) and equipment supply	400,000
7	MBBR equipment installation	200,000
8	**Subtotal**	**1,752,000**
9	Engineering and Contingency (35%)	614,000
10	**Total**	**2,366,000**

Figure 6 Proposed MBBR Solution Site Layout

4.4 CONVENTIONAL LAGOON SYSTEM

A passive conventional lagoon is proposed to meet the discharge criteria in Scenario 3. The new wastewater lagoon system(s) will be designed in accordance with the requirements of the "*Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems*" (AEP Standards 2013), "*Design and Construction of Liners for Municipal Wastewater Stabilization Ponds*" and "*Code of Practice for Wastewater Systems Using a Wastewater Lagoon*". AEP Standards 2013 requires a 300 m setback from an occupied building.

In the latest AEP Standards 2013, the configuration of the conventional wastewater lagoon system, i.e. facultative lagoon system, should consist of anaerobic, facultative and storage cells. The design of the cells is not specified thoroughly in the AEP guideline; only water depth and Hydraulic Retention Time (HRT) are defined in the guidelines. The AEP Standards establishes the desired retention time for each of the cells to achieve the treatment requirements. Once the retention time is met, the treated wastewater is discharged from the storage cell. AEP currently does not define effluent quality standards for the conventional wastewater lagoons but requires the grab sample testing and reporting, and discharge notification as specified in the C*ode of Practice*. As stipulated in the C*ode of Practice*, the discharge of the treated wastewater is once a year and normally in the late spring or fall periods. The discharge duration is up to three weeks. The once a year discharge schedule gives the operators more control on the discharge to avoid adverse impact on the receiving environment.

The design requirements and the proposed new lagoon cell volumes of the proposed wastewater lagoon is listed in the following Table 9.

Table 9 Required Cell Volumes for The Proposed Caroline Lagoon System

Cell	Req. HRT (1)(days)	Req. Cell Volume (m^3)	Existing Cell Volume (m^3)	New Cell Volume (m3)	Water Depth (m)
Anaerobic Cells (1)	2	560	0	560	Minimum 3
Facultative Cell	60	16,791	17,498 (2)	0	Maximum 1.5
Storage Cell	365	102,147	0	102,147	Maximum 3

(1) HRTs were calculated based on the annual average day flow 280 m3/day.

(2) The existing two lagoon cells have water depth of 2.5 meters. To convert the existing cells into facultative cells, the water depth will be reduced by retrofitting the outlet manhole.

Due to the space limitation in the existing lagoon site, the storage cell cannot be added adjacent to the existing cells. The new stage cell will be constructed in a different area. Based on the satellite images of the Village and its surrounding area, it is challenging to find a space for the new lagoon cell to meet the 300 m setback requirement. The Village will need to purchase the land and the existing occupied buildings within the 300 m setback radius for the new lagoon cell construction.

The OPC of the new lagoon system construction is presented in Table 10. The land purchasing cost is not included in the OPC.

Table 10 OPC for Conventional Lagoon System

Item	Description	Est. Quantity	Unit	Unit Price	Total Cost
1	Mobilization/demobilization	1	EA	$181,000	$181,000
2	Clearing and Stripping	40,000	m2	$2	$80,000
3	Excavation/Embankment	127,000	m3	$7	$889,000
4	Fine grading	41,000	m2	$1	$41,000
5	Nonwoven layer	45,100	m2	$2	$90,200
6	Lining (HDPE 60 mil)	45,100	m2	$13	$586,300
7	Erosion control	1,000	m2	$15	$15,000
8	Lift station (8 l/s)	1	EA	$150,000	$150,000
9	Forcemain (HDPEDR11 100mm)	1500	m	$100	$150,000
10	Monitoring wells	5	EA	$2,000	$10,000
11	Barbed wire fence c/w gate and signs	1000	lm	$30	$30,000
12	Discharge outlet	1	LS	$200,000	$200,000
13	Seeding/sod	13,000	m2	$2	$26,000
14	**Sub Total**				**$2,448,500**
15	35% Contingency and Engineering				$856,975
16	**Total**				**$3,305,475**

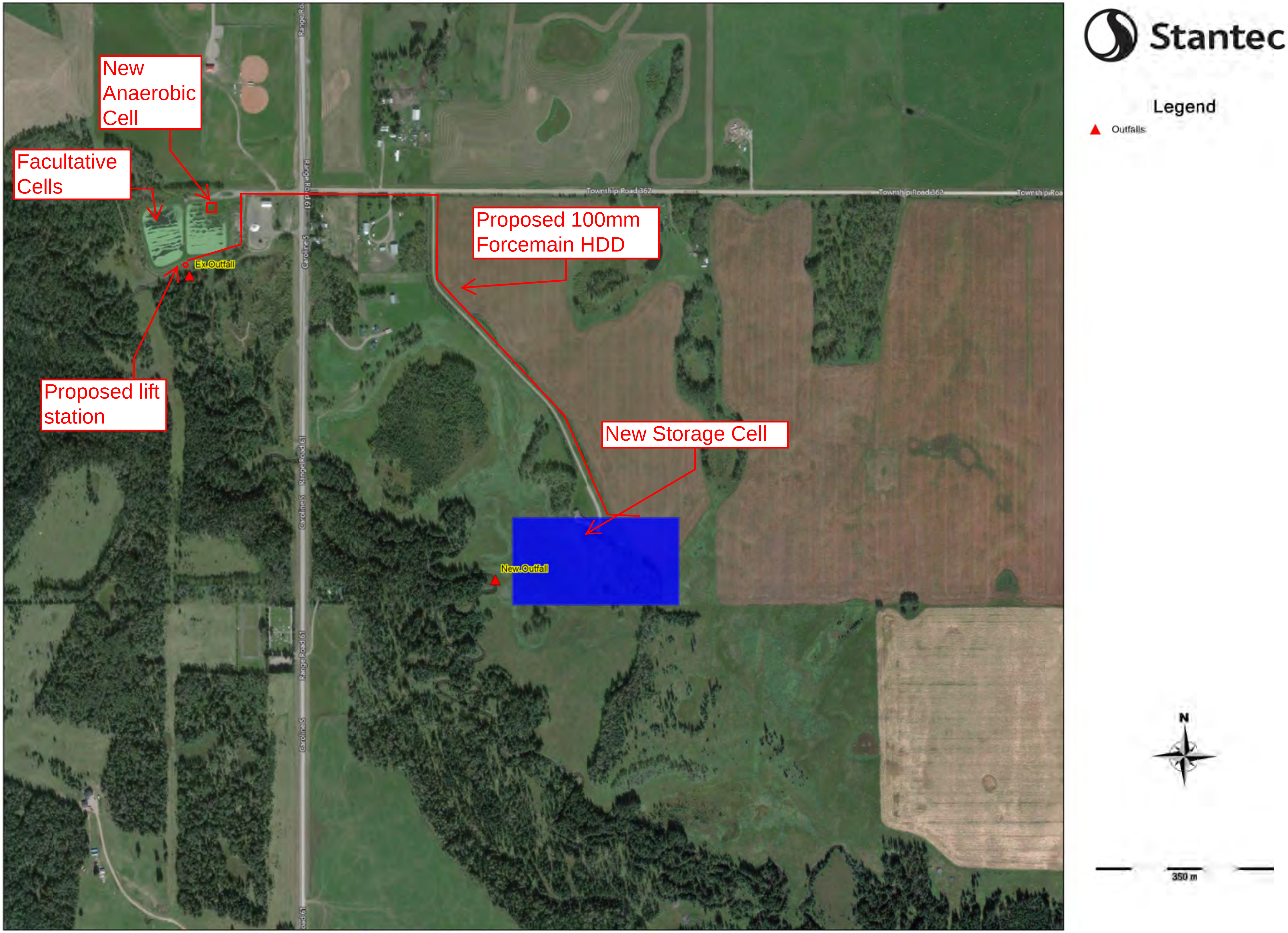


Figure Proposed Conventional Lagoon Expansion

5.0 UPGRADE OPTION EVALUATIONS

The following table presents the four solutions' system components, discharge and storage standards, their capital costs, and operation and maintenance (O&M) costs for comparison.

Table 11 Four Proposed Upgrade Solutions for Caroline WWTP

Solution	**SBR Plant**	**Lagoon+ SAGR**	**Lagoon MBBR**	**Conventional Lagoon**
Description	Use existing cells for eq. and sludge storage	Aerated lagoon plus post lagoon nitrification	Aerated lagoon plus post lagoon nitrification	Convert existing cells to facultative cells, add one anaerobic cell, add one storage cell
Discharge Criteria Scenario	Scenario 2 and 3	Scenario 2 and 3	Scenario 2 and 3	Scenario 4
Capital OPC	$ 4.7 million	$ 2.2 million	$ 2.4 million	$ 3.3 million
Half-year storage cell OPC in Scenario 3	$ 1.9 million	$ 1.9 million	$ 1.9 million	Not required
O&M cost (30 years)	$ 4.5 million	$ 2.2 million	$ 3.0 million	$0.5 million
TOTAL	**$ 11.1 million**	**$ 6.3 million**	**$ 7.3 million**	**$ 3.8 million**

As indicated in the above comparison table, if the RWQ Study determines that high level treatment and half year storage are both needed (Scenario 3 requirements), the total capital cost and O&M cost can be as high as $11.1 million for 30 years of operation for a SBR mechanical plant or as low as a $6.3 million for the SAGR post nitrification solution. The O&M costs include the power costs, alum cost, biosolids dewatering and land application costs, labour and maintenance costs. The land purchase cost to construct the half-year storage cell has not been included in the capital cost for the worst-case scenario.

If a conventional lagoon is constructed for once a year discharge (Scenario 4), the capital and 30 years O&M will be the lowest at $ 3.8 million, plus the land purchase cost.

6.0 CONCLUSIONS AND RECOMMENDATIONS

To address AEP's concerns on the existing Caroline Lagoon system performance, and to service the existing and planned developments in the Village, Stantec reviewed the historical lagoon as-builts, operation data, census data and relevant development plans to conduct this feasibility study. The feasibility study has come up with the following:

- Four discharge standards and storage requirements scenarios have been identified for the Village WWTP upgrades based on the current provincial and federal regulations and experiences from previous projects.
- Four possible options have been proposed for the four possible discharge criteria scenarios.
- The best-case scenario (Scenario 1) will require the least capital cost for the existing aeration system upgrade, however, it is expected that the possibility of adapting the best-case scenario standard is low since the ammonia removal in aerated lagoons is very poor in winter time. The poor nitrification performance will lead to acute toxicity in the lagoon effluent.
- The worst-case scenario (Scenario 3) will have the highest capital and 30 years O&M costs at $ 11.1 M based on a SBR mechanical plant. If the effluent can be discharged continuously, the total cost can be lowered to $9.2 M.
- The second worst-case scenario (Scenario 3) will have the capital and O&M costs at $ 6.3 M based on a SAGR post nitrification system. If the effluent can be discharge continuously, the total cost for this option will be $4.4M.
- Due to the high capital and O&M costs for the proposed solutions to meet the discharge standards and storage requirements in Scenarios 2 and 3, a conventional lagoon may be more suitable for this application. However, finding a land for conventional lagoon construction is challenging due to the location of Raven River and the required 300m setback from occupied buildings.

We recommend the following to the Village:

- Discuss the results with AEP once the RWQA study report is made available. This discussion will help the Village to properly set up the discharge criteria.
- Set up financial provisions for the WWTP upgrades.
- The Village can be proactive to investigate the possibility of acquiring approximately 5 hectares of land, and any occupied building within the 300m setback for a conventional lagoon. As for now, the Village can consider the south of the Village to construct the proposed storage cell.

Appendix A Village of Caroline WWTP EPEA Approval 494-03-00

Alberta Environment and Parks

APPROVAL

PROVINCE OF ALBERTA

ENVIRONMENTAL PROTECTION AND ENHANCEMENT ACT
R.S.A. 2000, c.E-12, as amended.

APPROVAL NO.: 494-03-00

APPLICATION NO.: 006-494

EFFECTIVE DATE: MARCH 6, 2017

EXPIRY DATE: MARCH 1, 2027

APPROVAL HOLDER: VILLAGE OF CAROLINE

ACTIVITY: Construction, operation and reclamation of a wastewater system

for the Village of Caroline

is subject to the attached terms and conditions.

Designated Director under the Act ....
Todd Aasen, P.Eng.

Date Signed MARCH 6, 2017

TERMS AND CONDITIONS ATTACHED TO APPROVAL

PART 1: DEFINITIONS

SECTION 1.1: DEFINITIONS

1.1.1 All definitions from the Act and the regulations apply except where expressly defined in this approval.

1.1.2 In all PARTS of this approval:

(a) "Act" means the *Environmental Protection and Enhancement Act*, R.S.A. 2000, c.E-12, as amended;

(b) "application" means the written submissions to the Director in respect of application number 006-494 and any subsequent applications for amendments of approval number 494-03-00;

(c) "arithmetic mean" means the sum of all the sample analysis results divided by the total number of samples per reporting period;

(d) "BOD_5" means the Biochemical Oxygen Demand in milligrams per litre measured at 20°C over a 5 day period;

(e) "CBOD" means the carbonaceous BOD_5 in milligrams per litre which is measured after the nitrogenous demand has been inhibited with an inhibitory chemical;

(f) "chemical" means any substance that is added or used as part of the treatment process;

(g) "day" means calendar day;

(h) "Director" means an employee of the Government of Alberta designated as a Director under the Act;

(i) "grab sample" means an individual sample collected in less than 30 minutes and which is representative of the substance sampled;

(j) "ISO 17025" means the international standard, developed and published by International Organization for Standardization (ISO), specifying management and technical requirements for laboratories;

(k) "regulations" means the regulations issued pursuant to the Act and as amended;

TERMS AND CONDITIONS ATTACHED TO APPROVAL

(l) "TSS" means the total suspended solids or non-filterable residue (NFR) measured in milligrams per litre;

(m) "wastewater treatment plant" means the physical components of the wastewater system that are used to treat wastewater including components associated with the management of any wastes generated during treatment and includes the land located within NE of Section 11, Township 36, Range 6, West of the 5th Meridian, that is being or has been used or held for or in connection with the Village of Caroline wastewater treatment plant;

(n) "week" means any calendar week; and

(o) "year" means calendar year.

PART 2: GENERAL

SECTION 2.1: GENERAL

2.1.1 The approval holder shall immediately report by telephone any contravention of the terms and conditions of this approval to the Director at 1-780-422-4505.

2.1.2 In addition to reporting pursuant to 2.1.1, the approval holder shall submit, within 7 days from any contravention of the terms and conditions of this approval, a written report to the Director.

2.1.3 The terms and conditions of this approval are severable. If any term or condition of this approval or the application of any term or condition is held invalid, the application of such term or condition to other circumstances and the remainder of this approval shall not be affected thereby.

2.1.4 *Environmental Protection and Enhancement Act* Approval No. 494-02-00 is cancelled.

SECTION 2.2: RECORD KEEPING

2.2.1 The approval holder shall record and retain all the following information in respect of any sampling conducted or analyses performed for a minimum of three years:

(a) the place, date and time of sampling;

(b) the dates the analyses were performed;

(c) the analytical techniques, methods or procedures used in the analyses;

(d) the names of the persons who collected and analyzed each sample; and

TERMS AND CONDITIONS ATTACHED TO APPROVAL

(e) the results of the analyses.

SECTION 2.3: ANALYTICAL REQUIREMENTS

2.3.1 Collection, preservation, storage, handling and analysis of samples, and reporting shall be conducted in accordance with the following unless otherwise specified in writing by the Director:

(a) the *Standard Methods for the Examination of Water and Wastewater* published jointly by the American Public Health Association, American Water Works Association, and the Water Environment Federation, as amended; and/or

2.3.2 The approval holder shall analyze all samples that are required to be obtained by this approval in a laboratory accredited pursuant to ISO 17025, as amended, for the specific parameter(s) to be analyzed, unless otherwise authorized in writing by the Director.

2.3.3 The approval holder shall ensure that the monitoring equipment used is calibrated in accordance with the equipment or sampling kit manual specifications.

PART 3: CONSTRUCTION AND UPGRADING REQUIREMENTS

SECTION 3.1: CONSTRUCTION AND UPGRADE

3.1.1 The approval holder shall conduct a *Receiving Water Quality and Wastewater Treatment Plant Capacity Assessment* by following the recommendations and procedures described in the following documents:

(a) Canadian Council of Ministers of the Environment (CCME), *Canada-wide Strategy for the Management of Municipal Wastewater Effluent*; and/or

(b) Department of Environment and Parks, *Water Quality Based Effluent Limits Procedures Manual.*

3.1.2 The approval holder shall submit a "*Receiving Water Quality and Wastewater Plant Capacity Assessment*" report, regarding the assessment required in 3.1.1, to the Director on or before December 31, 2018 unless otherwise authorized in writing by the Director.

3.1.3 The report required in 3.1.2 shall include, but not limited to, the following:

(a) the wastewater characterization section which includes an assessment of:

TERMS AND CONDITIONS ATTACHED TO APPROVAL

(i) the raw water quality and

(ii) treated effluent quality;

(b) the receiving water section which includes an assessment of:

(i) the river water quality,

(ii) the river flow rate,

(iii) the ratio of river flow rate to effluent discharge rate, and

(iv) the aquatic health of the receiving stream;

(c) the Environmental Quality Objectives (EQO) and Effluent Discharge Objectives (EDO) section which includes:

(i) developing the EQO for the section of stream where the effluent is discharged into, and

(ii) developing the EDO so that corresponding EQO can be met;

(d) the effluent discharge analysis section which includes an assessment of:

(i) the impact from the current discharge,

(ii) the compliance or violation of the EDO developed; and

(e) the wastewater treatment plant capacity assessment section which includes:

(i) assessment of the capacity and treatment efficiency of the existing treatment plant;

(ii) upgrade options to the existing treatment plant to meet the EDO developed; and

(f) the conclusion section which includes:

(i) confirming any observations, findings, recommended changes, implementation plan, and timelines to upgrade the wastewater system if any major deficiencies are identified or the Treatment Plant needs to be upgraded to meet corresponding EDO and EQO.

TERMS AND CONDITIONS ATTACHED TO APPROVAL

3.1.4 The approval holder shall address any deficiencies of the "*Receiving Water Quality and Wastewater Plant Capacity Assessment*" report in a time frame identified in writing by the Director.

3.1.5 If the report in 3.1.2 indicates a plant upgrade is necessary for meeting the corresponding EDO and EQO, then approval holder shall submit an application to the Director on or before December 31, 2019 unless otherwise authorized in writing by the Director.

PART 4: OPERATIONS

SECTION 4.1: DRAINAGE SYSTEMS

WASTEWATER COLLECTION AND TREATMENT

4.1.1 The approval holder shall not release any substances from the wastewater system to the surrounding watershed except as authorized under this approval.

4.1.2 The approval holder shall operate a wastewater system which shall include:

(a) the wastewater collection system within the municipal boundary of the Village of Caroline, lift stations and the transmission line to the wastewater treatment facility;

(b) the aerated lagoon wastewater treatment plant, including all of the following:

(i) two aerated lagoon cells;

(c) a treated wastewater outfall discharging to Raven River located in the NE 11-36-6-W5M;

as described in the application, or as otherwise authorized in writing by the Director.

SECTION 4.2: FACILITY CLASSIFICATION AND CERTIFIED OPERATOR REQUIREMENTS

FACILITY CLASSIFICATION

4.2.1 The wastewater treatment facility in this approval is classified as Class I in accordance with the *Water and Wastewater Operators' Certification Guidelines*.

4.2.2 The wastewater collection system in this approval is classified as Class I in accordance with the *Water and Wastewater Operators' Certification Guidelines*.

TERMS AND CONDITIONS ATTACHED TO APPROVAL

CERTIFIED OPERATOR

4.2.3 At all times the operation of the:

(a) wastewater treatment plant shall be performed by, or under the direction of a person who holds a valid wastewater treatment certificate of qualification at a minimum of Level I; and

(b) wastewater collection system shall be performed by, or under the direction of a person who holds a valid wastewater collection certificate of qualification at a minimum of Level I.

SECTION 4.3: SLUDGE DISPOSAL

4.3.1 The approval holder shall only dispose of sludge at a registered or approved landfill or as otherwise authorized in writing by the Director.

SECTION 4.4: CHEMICALS USED

4.4.1 The approval holder shall not use any chemical in the wastewater treatment process unless authorized in writing by the Director.

SECTION 4.5: IRRIGATION

4.5.1 The approval holder shall dispose of treated wastewater by irrigation in accordance with the *Guidelines for Municipal Wastewater Irrigation*, as amended, or as otherwise authorized in writing by the Director.

PART 5: LIMITS

SECTION 5.1: WASTEWATER

5.1.1 Treated wastewater from the wastewater stabilization pond storage cell(s) shall be discharged, from the outfall, as follows:

(a) continuously to Raven River.

5.1.1 The approval holder shall ensure the treated wastewater discharge complies with the limits specified in TABLE 5-1.

TERMS AND CONDITIONS ATTACHED TO APPROVAL

TABLE 5-1: LIMITS FOR TREATED WASTEWATER

Parameter	Limit
CBOD	≤ 25 mg/L monthly arithmetic mean of weekly samples

PART 6: MONITORING AND REPORTING

SECTION 6.1: WASTEWATER

6.1.1 The approval holder shall monitor the wastewater system as required in TABLE 6-1.

TABLE 6-1: MONITORING – WASTEWATER SYSTEM

Parameter	Frequency (Minimum)	Sample Type	Sampling Location
UNTREATED WASTEWATER			
BOD_5	Once a week	Grab	Untreated wastewater entering the wastewater treatment plant
TSS	Once a week	Grab	Untreated wastewater entering the wastewater treatment plant
Volume of Flow	Continuous, recorded daily	Calculated	Untreated wastewater entering the wastewater treatment plant
TREATED WASTEWATER (Wastewater Stabilization Ponds)			
CBOD	Weekly	Grab	Prior to the discharge of treated wastewater to Raven River
TSS	Weekly	Grab	Prior to the discharge of treated wastewater to Raven River
UNAUTHORIZED RELEASES			
Release Volume	Total Volume	Estimated	Wastewater bypassing the wastewater treatment plant, accidental spills or overflows
Release Volume	Total Volume	Estimated	Wastewater bypassing the lift station(s), accidental spills or overflows
Release Volume	Total Volume	Estimated	Wastewater bypasses, accidental spills or overflows from the wastewater collection system
BOD_5, TSS, Total Phosphorus, and Ammonia-Nitrogen	During the unauthorized discharge	Grab	At the release point

TERMS AND CONDITIONS ATTACHED TO APPROVAL

Parameter	Frequency (Minimum)	Sample Type	Sampling Location
SLUDGE DISPOSAL			
Sludge Volume	Total Volume	Estimated	Amount of sludge being trucked to a registered or approved landfill or as otherwise authorized in writing by the Director

6.1.2 The approval holder shall compile a Monthly Wastewater Report which includes, at a minimum, the following information:

(a) the results of the monitoring requirements of TABLE 6-1;

(b) the name and daily/weekly quantity of any chemical added to the wastewater in the wastewater treatment process;

(c) the name of the supervising operator responsible for the operation of the wastewater system; and

(d) a summary of any operational problems.

6.1.3 On or before the 15^{th} of the month following the month in which the information on which the report is based was collected, the approval holder shall:

(a) compile a Monthly Wastewater Report; and

(b) retain a copy of the Monthly Wastewater Report.

6.1.4 The approval holder shall compile an Annual Wastewater Report which shall include the following:

(a) the monthly arithmetic mean, including maximum and minimum values, of each parameter monitored, as outlined in TABLE 6-1;

(b) the date when the discharge of the wastewater stabilization pond storage cell(s) started and the date when discharge was completed;

(c) the name of the supervising operator responsible for the operation of the wastewater system;

(d) a summary of any incidents which required reporting in accordance with 2.1.1;

(e) a summary of any operational problems; and

TERMS AND CONDITIONS ATTACHED TO APPROVAL

(f) the monitoring requirements as outlined in SECTIONS 6.2.1 and 6.2.2.

6.1.5 The approval holder shall submit one copy of the Annual Wastewater Report to the Director on or before February 28 of the year following the year in which the information on which the report is based was collected.

6.1.6 If the approval holder monitors for any substances or parameters which are the subject of operational limits as set out in this approval more frequently than is required and using procedures authorized in this approval, then the approval holder shall provide the results of such monitoring as an addendum to the Annual Wastewater report required by this approval.

PART 6: RECLAMATION AND DECOMMISSIONING

GENERAL 6.1: GENERAL

6.1.1 Within six months of the wastewater treatment plant permanently ceasing operation, the approval holder shall:

(a) submit a decommissioning and land reclamation plan to the Director, and

(b) not commence reclamation or decommissioning until the approval holder has received written authorization from the Director.

DATED MARCH 6, 2017

DESIGNATED DIRECTOR UNDER ~~THE ACT~~

Appendix B Budgetary Quotations for SBR, SAGR and MBBR solutions

Certified to ISO9001:2008

10-2 ALDEN RD. MARKHAM, ON. CANADA L3R 2S1
Phone: (905) 475-1545 Fax: (905) 475-2021
Website: www.napier-reid.com

STANTEC	Date: Mar 15, 2018
Attn: Johnny Ke P. Eng.	File: PR-8127

BUDGETARY QUOTATION

Re: Sequencing Batch Reactor (SBR) Package
Caroline WWTP, Alberta

We are pleased to present this proposal for the design and supply of SBR package for the above referenced wastewater treatment plant.

Equalized flow will be pumped to the SBR system for secondary treatment. The SBR will be running at batch feed basis. Secondary effluent from the SBR system will be treated by the belt filter press and disinfected by UV system.

The SBR Tankage will be aboveground. All tanks will be made of carbon steel. The tanks will be housed in a building on concrete slab. Building and concrete slab are the supply of others.

Design Criteria

The plant is designed to treat the combined domestic wastewater with the following flows and strengths.

Average Daily Flow (ADF)	280 m^3/d
Maximum Daily Flow (MDF)	350 m^3/d
BOD_5	220 mg/L
TSS	220 mg/L
TKN	40 mg/L
TP	6.5 mg/L
Temperature (assumed)	11~18 °C

The treatment plant will produce an effluent of:

$cBOD_5$		< 25 mg/L
TSS		< 25 mg/L
NH_3-N	Summer:	< 5 mg/L
	Winter:	< 10 mg/L
TP		< 1 mg/L
E.coli.		< 200 CFU/100mL

Scope of Supply (By Napier-Reid Ltd.)

SBR Tank

ONE SBR tank, 11700 mm L x 3700 mm W x 4950 mm Deep, made of carbon steel plates no less than 6mm thickness, epoxy coated. The SBR tank will be aboveground.

The following equipment will be supplied for installation in SBR tank by others:

1 - Fine bubble aeration system, c/w fine bubble diffusers by EDI, 304 S.S. downcomer, PVC Sch. 40 manifold and headers. All supports will be supplied in 304 S.S.

1 - 100 mm dia. electrically actuated butterfly air inlet valve by Bray or equal.

1 - Submersible waste sludge pump (WAS pump), 0.75hp, 600/3/60, c/w 2” plug valve.

1 - Submersible return sludge pump (RAS pump), 0.75hp, 600/3/60, c/w 2” plug valve.

1 - Float level switch, for high level alarm.

1 - Pressure level transmitter.

1 - Dissolved oxygen monitoring system, c/w DO analyzer, DO sensor and Cable.

1 - Decanter assembly UD1200, 1.2 m L, 304 S.S. construction.

1 - Decanter actuator, c/w motor, gear reducer, worm gear assembly, limit switches and support.

1 - Local control station for decanter assembly, 304 S.S. construction.

Effluent Tank

ONE SBR effluent tank, 4700 mm L x 3700 mm W x 4950 mm Deep, made of carbon steel plates no less than 6mm thickness, epoxy coated. The effluent tank will be above ground.

The following equipment will be supplied for installation in the effluent tank by others:

2 - Submersible effluent transfer pumps, one duty one standby. Pumps are rated 3.3 L/s @ 5.5 m TDH, 1.5 hp, 600/3/60.

1 - Ultrasonic level transmitter by E+H or equal.

2 - Float level switches, for high and low level alarm.

Aerobic Digestion Tank

ONE Aerobic digestion tank, 5000mm L x 3700 mm W x 4950 mm Deep, made of carbon steel plates no less than 6mm thickness, epoxy coated. The digester will be aboveground.

The following equipment will be supplied for installation in the digester by others:

1 - Fine bubble aeration system, with fine bubble diffusers by EDI, 304 S.S. downcomers, PVC Sch.40 manifold and headers. All supports will be 304 S.S.

1 - Pressure level transmitter.

1 - Supernatant overflow with scum baffle and electrically actuated butterfly valve.

Blower Assemblies (in control building)

TWO SBR blower assemblies, one duty and one standby (common standby for digester), each will be rated for 100% of the air requirement, or 141 SCFM at 7.8 psi. Blowers are mounted on individual steel bases with bolt holes for mounting on a concrete pad. Each assembly is comprised of the following:

1 - Positive displacement blower
1 - 7.5 HP electrical motor, 600/3/60, 1770 RPM
1 - Motor slide base with two adjusting screws to adjust v-belt tension
2 - Flex connectors
1 - Pressure relief valve
1 - Wafer style dual flapper check valve
1 - Butterfly valve with latching handle
1 - Belt guard
1 - V-belt drive system
1 - Inlet filter/silencer

ONE Aeration blower assembly for digestion tank, rated 74 SCFM at 8.0 psi. Blower is mounted on individual steel bases with bolt holes for mounting on a concrete pad. Each assembly is comprised of the following:

1 - Positive displacement blower
1 - 5 HP electrical motor 600V/3/60, 1770 RPM
1 - Motor slide base with two adjusting screws to adjust v-belt tension
2 - Flex connectors
1 - Pressure relief valve
1 - Wafer style dual flapper check valve
1 - Butterfly valve with latching handle
1 - Belt guard
1 - V-belt drive system
1 - Inlet filter/silencer

Chemical Dosing Systems

ONE Chemical injection system for phosphorus removal, comprised of the following:

1 - Metering pump Grundfos or equal for injection of alum.

1 - Polypropylene chemical tank c/w containment tank.

ONE Chemical injection system for filter aid, comprised of the following:

1 - Metering pump Grundfos or equal for injection of polymer.

1 - Polypropylene chemical tank c/w containment tank.

Continuous Backwash Filter

ONE Continuous backwash sand filter for filtering secondary treated effluent rated for maximum daily flow of 350 m^3/day. Each filter consists of the following:

1 - Cylindrical stainless filter tank, 2.0m dia. x 5.0m high made of min. 3mm thick 304 SS c/w tapered bottom section.

1 - Feed inlet pipe c/w feed distributors.

1 - Drain connection with removable screen and bronze ball valve.

1 - Air lift pump in 304 SS, which will enable airlift pumps to be removed, & replaced without removing the filter sand.

1- Set of filter internals in SS 304 construction.

1 - Reject water compartment c/w reject water discharge pipe.

1 - LOT of filter sand supplied in bags for field installation by others.

1 - Effluent launder for collection of filtered effluent and outlet pipe.

1 - Compressed air supply system consisting of one 2 hp air compressors 600V/3/60 to supply air to filter c/w receiver tank and pressure switch.

1 - Air control panel to be mounted on top platform on the filter. The panel will include air filter, regulator and rota meter to measure air flow, and solenoid valves.

UV Disinfection System

One Ultraviolet disinfection system by Trojan or equivalent, designed for a max. flow rate of 14.6 m^3/hr consisting of stainless steel channel, module support rack, level control weir, transition boxes, monitoring system for UV intensity and cleaning/maintenance rack.

One Operator's kit including the following:

-1 pair of rubber gloves
-1 face shield
-4 L jug of cleaner

One Spare parts package including the following:

-2 UV lamps
-2 quartz sleeves
-2 lamp holder seals

Treated Effluent Tank

ONE Treated Effluent tank, 5500mm L x 3700 mm W x 4950 mm Deep, made of carbon steel plates no less than 6mm thickness, epoxy coated. The effluent tank will be aboveground, c/w closed top with vent, hatch and ladder.

The following equipment will be supplied for installation in the effluent tank by others:

1 - Level control system, c/w level transmitter and two float switches.

Sludge Dewatering System

ONE Filter press will be supplied for sludge dewatering. Filter press will be fully automated completed with all necessary components.

ONE Mobile Storage bin made from epoxy coated carbon steel plates will be supplied for filter press. The storage bin will be sufficient for one day's storage capacity for sludge cake storage.

ONE Polymer dosing system c/w one chemical storage tank and one metering pump.

ONE Filtrate return system for filtrate water from dewatering filter press, c/w one filtrate water tank and one transfer pump to return filtrate to the equalization tank.

ONE Potable wash pump to transfer water from effluent tank for filter cloth washing.

PLC Control Panel (in control building)

ONE EEMAC-12 (cold rolled steel) control panel, 120/1/60, complete with the following:

- Main disconnect
- Primary and secondary fusing
- Control relays complete with bases
- Wiring terminals
- PLC Allen Bradley Compact Logix with Ethernet communication
- Operator interface panel Allen-Bradley Panelview plus
- PLC and operator interface programming

The PLC control panel will provide automatic control and monitoring for all process equipment in SBR, digester, effluent tank, and blower room.

600V/120V transformer is by others.

All wiring to and from the control panel is the supply and installation of others.

Drawings and Manuals

Engineering drawings and O&M manuals will be supplied. Napier-Reid can supply AutoCAD format drawings on floppy disk for the consulting engineer's use in English or Metric measurements.

Site Services

Napier-Reid will provide the following field services:

Start-up and Commissioning:	Twelve (12) days in two (2) trips
Training and Follow-up:	Four (4) days in two (2) trips

Additional site visits can be provided at a rate of **$850.00** per day plus expenses if required.

Warranty

Napier-Reid Ltd. warrants all equipment manufactured or supplied by it to be free from defects in design, workmanship and material for a period of 12 months from successful start-up or 18 months from the day of shipment, whichever occurs first.

Exclusions

Napier-Reid's exclusions from its scope of supply are the following.

- Equipment unloading and storage at the jobsite.
- Any concrete slabs, tanks or channels.
- Inlet bar screen
- Motor starters, VFD's and HOA switches, if required.
- Ladders, stairs, gratings and handrails.
- Any building, insulation and heat-tracing, if required.
- Excavation, backfill and any concrete design and installation.
- Any field installation. All equipment including valves, pumps, blowers, instrument, aeration systems, etc., are shipped loose to be installed by others.
- Any influent, effluent and sludge piping.
- Air supply piping and supports between the blower assemblies and the droplegs in the tanks.
- Field wiring and conduits, field wireways.
- Power, water, and labor for operating the equipment.
- Any field and laboratory testing.
- Field painting

- Sales taxes of any kind.
- Any equipment or service not specifically listed in this proposal.

TOTAL LOT BURGETARY PRICE...$967,000.00

<u>Terms and Conditions:</u>

- FOB truck nearest curb stop, jobsite, Caroline, Alberta
- HST not included
- Terms: Net 30 days after receipt of invoices.
- Progress Payment Schedule: 10% with order, 10% after approval of shop drawing submittal, 75% upon delivery; 5% upon start-up or 120 days from shipment whichever occurs first.
- Delivery: 18 to 24 weeks after drawing approval
- Approval submission: 4 to 6 weeks
- Purchaser must be approved by our credit department
- Price valid for 30 days
- Napier-Reid Ltd. reserves its right to withhold equipment and/or services when payment is not received as per our terms, without penalty, not withstanding the terms and conditions in the purchaser' purchase order, tender specifications, or any other documents.
- In the event the purchase order is cancelled, Napier-Reid Ltd. reserves the right to receive reimbursement from the purchaser for all costs incurred up to the date of cancellation including design and restocking charges and a prorated portion of profits.

NAPIER-REID LTD.

Linda Chen

Linda Chen (Ext: 264)
Project Manager
lindachen@napier-reid.com

Cc: Frank Li, P.Eng., Vice-president

STANTEC
Attention: Johnny Qingsheng Ke, M.Sc., P.Eng.

LAGOONGUARD BUDGET PROPOSAL

VILLAGE OF CAROLINE, AB

MARCH 20TH, 2018

PROPOSAL NUMBER: CA_18_03_18530

PREPARED BY:
ROBERT LAFOND, PROCESS ENGINEER
CHRIS HOWORTH P.ENG., SALES REPRESENTATIVE

Veolia Water Technologies Canada
ISO 9001: 2008
4105 Sartelon, St-Laurent (QC) H4S 2B3
Tél: 514 334-7230 ● Fax: 514 334-5070
www.veoliawatertechnologies.ca

WATER TECHNOLOGIES

March 20th, 2018

Johnny Qingsheng Ke, M.Sc., P.Eng.
Associate, Water
Stantec Consulting Ltd.
1100-4900 50 Street Red Deer AB T4N 1X7

Re: Village of Caroline, AB
MBBR™ for Lagoon Effluent Polishing –Budget Proposal

Dear Johnny,

Thank you for the opportunity to support Stantec with your evaluation of wastewater treatment solutions for the Village of Caroline, BC.

As per your request, please find herewith our budget proposal for a LagoonGuard process for ammonia removal from wastewater treatment lagoon effluent.

Our proposal is based on industry leading AnoxKaldnes MBBR technology. This technology is efficient and compact, contributing to economical overall project costs. Our proposed scope is to supply the process as a fully pre-fabricated solution, with all components pre-installed in a FRP tank for in-ground installation.

We hope this proposal helps you progress your evaluations for the Village of Caroline, and look forward to your feedback in due course.

Best Regards,

Chris Howorth

Sales Representative
604 562 0301

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APPENDIX A: TERMS AND CONDITIONS

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1. INTRODUCTION

Associated Engineering is working for the Village of Caroline, Alberta on treatment solutions to improve treated wastewater effluent quality from the Village's lagoon system. The primary focus is ammonia removal from lagoon effluent (throughout the year) to meet new federal WSER standards. Meeting a total phosphorus limit of 1 mg/L is also required. To do this we suggest coagulant addition into the front of the lagoon system. The coagulant dosing system is not currently included in our proposal, but can be added if required.

Veolia provides unique water and wastewater solutions to industrial and municipal clients. Veolia draws upon more than 500 technologies and over 3,000 patents to find the best solutions for each application. These resources, combined with Veolia's experience gained over the last 160 years in the water treatment industry, ensure that treatment needs are met through cost-effective, environmentally sound solutions implemented through projects focused on safety, quality and customer satisfaction.

This proposal is focusing on a base scenario (see Figure 1), which targets Ammonia-N removal.

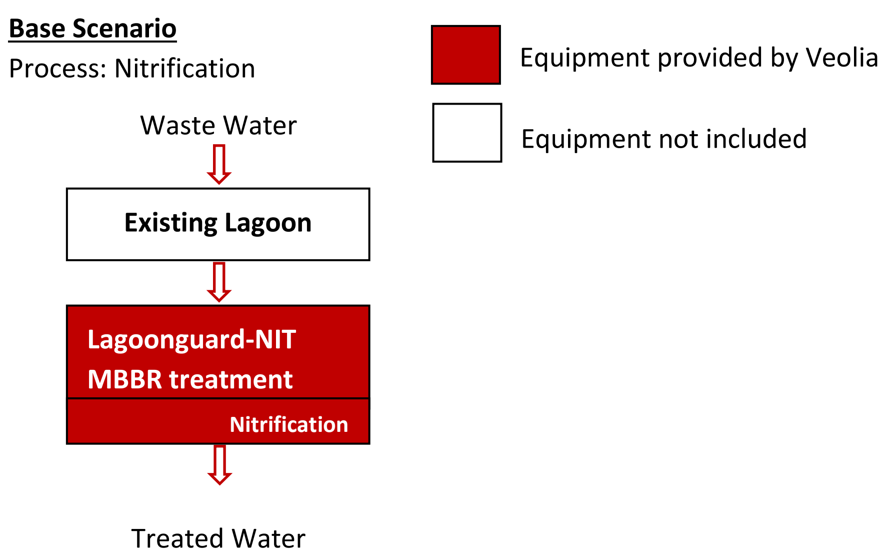


Figure 1 Waste water treatment chain

This budget proposal outlines our proposed system design, treatment technologies and scope of supply, together with our cost estimate.

2. DESIGN BASIS

2.1. Data and assumptions

The proposed design is based on the following data from Associated Engineering.

Table 1 Waste Water composition

Parameter	Unit	Value	
		Raw water	Lagoon effluent estimated by VEOLIA
Design Flow	m^3/d	280	280
BOD5	mg/l	220	20
TSS	mg/l	180	20
TKN	mg/l	40	40
Total-P	mg/l	6.5	1
Temperature	°C	6-20	0.5 - 20

The MBBR system will be designed based on the effluent objectives presented in Table 2.

Table 2 Effluent quality objectives

Parameter	Unit	Value Scenario #1
BOD5	mg/L	< 25
TSS	mg/L	< 25
Total N	mg N/L	---
NH4	mg N/L	< 10 (winter) < 5 (summer)
TP	mg/L	< 1

Assumptions:

- pH is in the neutral range 6 – 8 for biological and chemical treatment.
- Oil and Grease (O&G) concentration in the raw waste water is less than 50 mg/L, otherwise a grease removal treatment might have to be considered.
- Site elevation is at 1065 m altitude.
- It is assumed that the raw water alkalinity is high enough to get a final alkalinity above 50 mg $CaCO_3$/L after both the biological and clarification treatment. Design temperature for Nitrification is 0.5°C.

3. Proposed Treatment Chain

3.1. MBBR Reactors

The proposed biological treatment is composed of Moving Bed Biofilm Reactors (MBBR) with AnoxKaldnes™ media. The MBBR process design is based on over 20 years of experience in developing the Kaldnes Moving Bed biofilm technology. It is supported by pilot scale and full scale data from existing municipal treatment facilities using the Kaldnes Moving Bed™ biofilm technology for organic removal and nitrification. Over 800 AnoxKaldnes installations are in operation worldwide. The flexibility of this patented technology allows the design of very compact and efficient stand-alone MBBR solutions, as well as optimal upgrades of existing processes, often without the need for new basins.

The microorganisms treating the wastewater grow on the surfaces of the AnoxKaldnes™ media (or carriers) in the treatment reactor. The Moving Bed Biofilm Reactors (MBBR) process utilizes a cylindrical plastic carrier about 25 mm in diameter, as seen in Figure 2, to provide an environment in which bacterial populations and protozoa can grow very effectively.

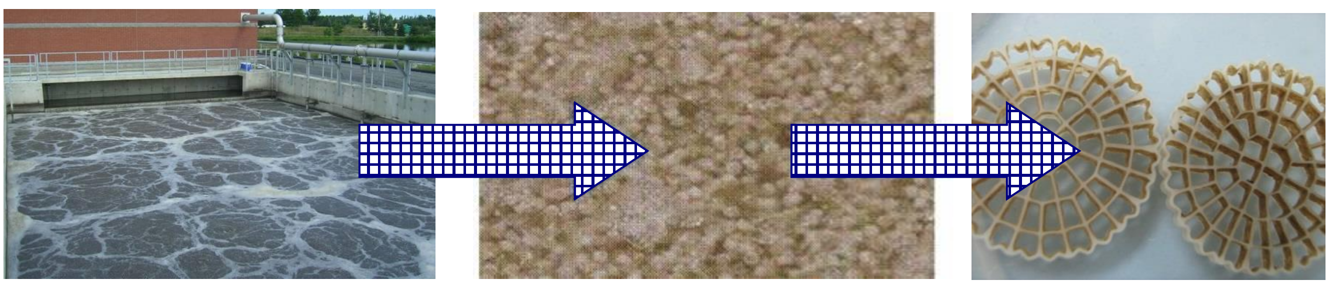


Figure 2 Biofilm Growth in MBBR Media

The carriers are retained in the tanks by sieves (see Figure 3) which allow the treated water to pass to downstream units for further processing. Stainless steel laterals and diffusers provided oxygen to the system for bacterial growth and also mixing energy.

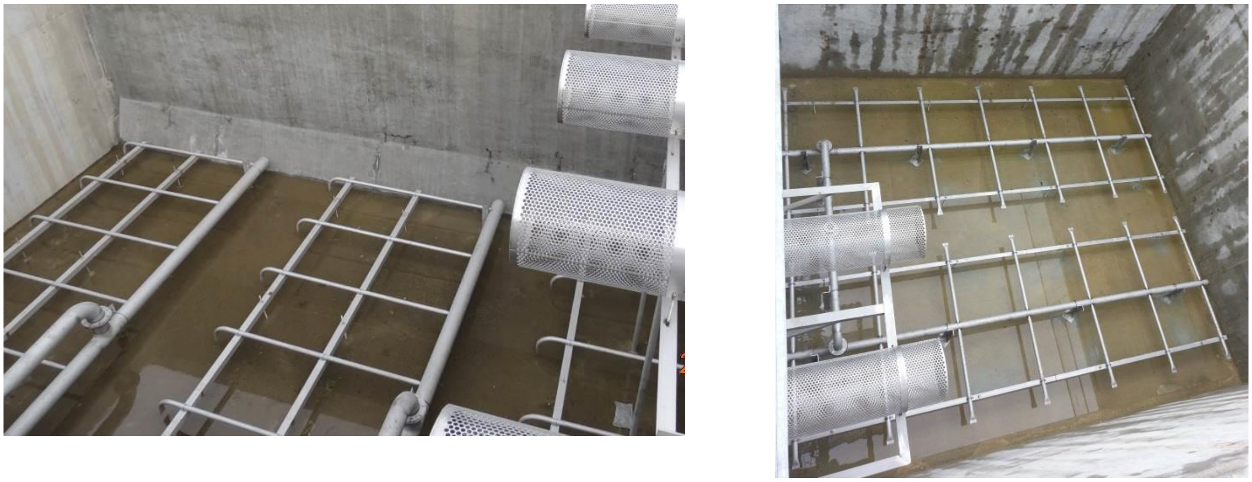


Figure 3 Aeration grids & MBBR Sieves

One of the important features of the process is that biofilm thickness is controlled by the movement of the media so that diffusion through the biofilm is optimal. Detached biofilm is suspended within the reactor and leaves the reactor with the treated wastewater. In the present treatment train, the slow growth rate of nitrifying bacteria means very little biomass sloughing will occur, hence no downstream TSS removal process is proposed for the base scenario. In conclusion, the MBBR is a stand-alone biological treatment system with no need for backwashing of the media. Unlike suspended growth treatment systems, the attached growth process means no return of activated sludge is needed either.

Figure 4 MMBR system in operation (media movement with aeration)

Table 3 shows the design characteristics of the MBBR process suggested.

Table 3 MBBR design parameter

Parameter	Unit	Value
Design flow	m^3/d	280
Design Temperature	°C	0.5
Total reactor volume	m^3	80
Number of trains	---	1
Number of reactors per train	---	1 (Nitrification)
Media type	---	K5
% fill of media in reactors	%	45
Side water depth	mm	2600
Total process air requirement	Nm^3/h	200
Blowers Operation Pressure	PSIg	4.5

The estimated alkalinity consumption of the MBBR for nitrification is 220 mg $CaCO_3$/L.

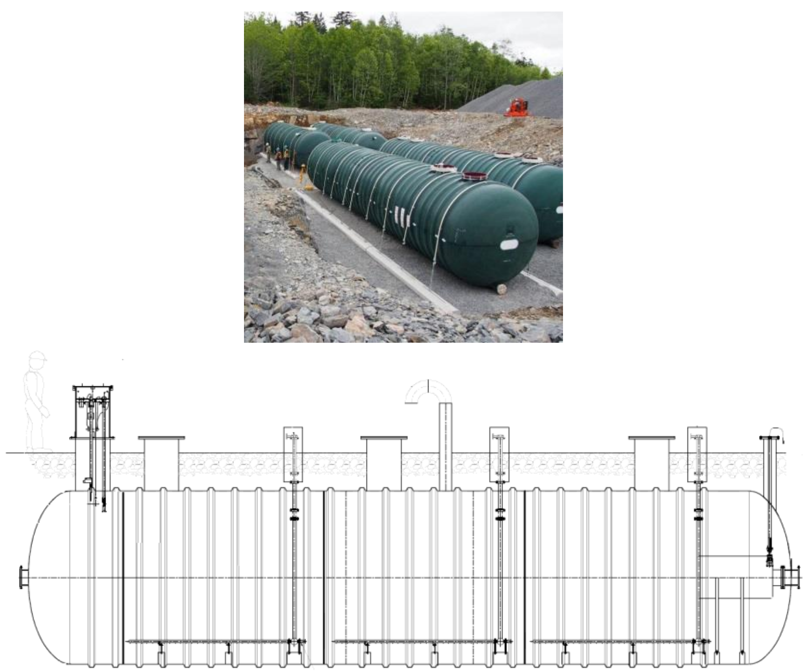


Figure 5 MBBR reactor sketch

The figure below shows how the MBBR reactors can be integrated on site, requiring minimal additional land:

Figure 6 MBBR reactors location on site (scale is approximate)

Control Panel

The entire processing chain will be controlled by a main panel made according to Veolia's standards. The panel includes two separate sections (power and control). The HMI interface for equipment operation is located on the front panel (see pictures below).

Figure 7 Control Panel

The control panel will be installed in the mechanical building.

4. SCOPE OF SUPPLY

Veolia proposes the following scope of supply. This can be revised as required.

<table>
<tr><th colspan="2"><u>MBBR Equipment</u></th></tr>
<tr><th>Scenario</th><th></th></tr>
<tr><td>Prefab MBBR reactor in FRP
of 3050 mm diam x 16 000 mm long</td><td>One (1)</td></tr>
<tr><td>Anoxkaldnes K5 Media</td><td>Lot</td></tr>
<tr><td>Medium Bubble aeration systems in 304L stainless steel including header and lateral piping within the reactors</td><td>Lot</td></tr>
<tr><td>Sieves assembly in 304L stainless steel to retain the carrier elements and to minimize head loss</td><td>Lot</td></tr>
<tr><td>Blower 10 HP including silencers and soundproof enclosures</td><td>Two (2)
1 in operation ;
1 stand-by</td></tr>
<tr><td>Instrumentation
- One (1) Ammonia probe with 4-20 mA signal
- One (1) Level float</td><td>Lot</td></tr>
<tr><th colspan="2"><u>Electrical Equipment</u></th></tr>
<tr><td>Control panel (NEMA 12) for the operation of equipment included in this proposal. Interface to allow equipment operation as per Veolia's standards.
- One (1) PLC Compact Logix, NEMA 12
- Control system engineering
- Programming (PLC and HMI)
- Testing at Veolia's shop</td><td>One (1)</td></tr>
</table>

These elements are included in the proposal:

- Services:
  - Process engineering and drawings showing outline tank requirements and equipment location
  - Maintenance manuals.

These elements are not currently included in this proposal:

- Permits, including certificate of authorization, necessary construction permits and licences.
- Unloading, storage, maintenance preservation and protection of all equipment and materials on-site.
- All site preparation, grading, finding foundation placement and excavation for foundation, underground piping, conduits and drains.
- Foundations, buildings, sumps, trenches and similar concrete works, site interferences, fencing and landscaping (including asphalt or paving).
- Supply and installation of interconnecting piping between the client's installations and the treatment system, and between the various skids that are part of the treatment system.
- All labor, material and utilities required to install the supplied equipment.
- Supply and installation of all electrical power and conduit to the treatment system main control panel plus interconnection between the treatment system main control panel and ancillary equipment as required, including wire, cable, junction boxes, fittings, conduit, etc.
- Chemicals for commissioning
- Sludge management system
- Equipment transportation to job site
- Equipment installation
- Veolia's equipment start-up and commissioning
- MCC, VFDs, Motor Starters, SCADA

5. BUDGET PRICE AND TERMS OF PAYMENT

Estimated cost

The estimated budgetary cost for the treatment option and associated equipment supply is **(**Currency: Canadian dollars & All taxes extra):

$ 350 000

This budgetary estimate is presented for project planning purposes only.

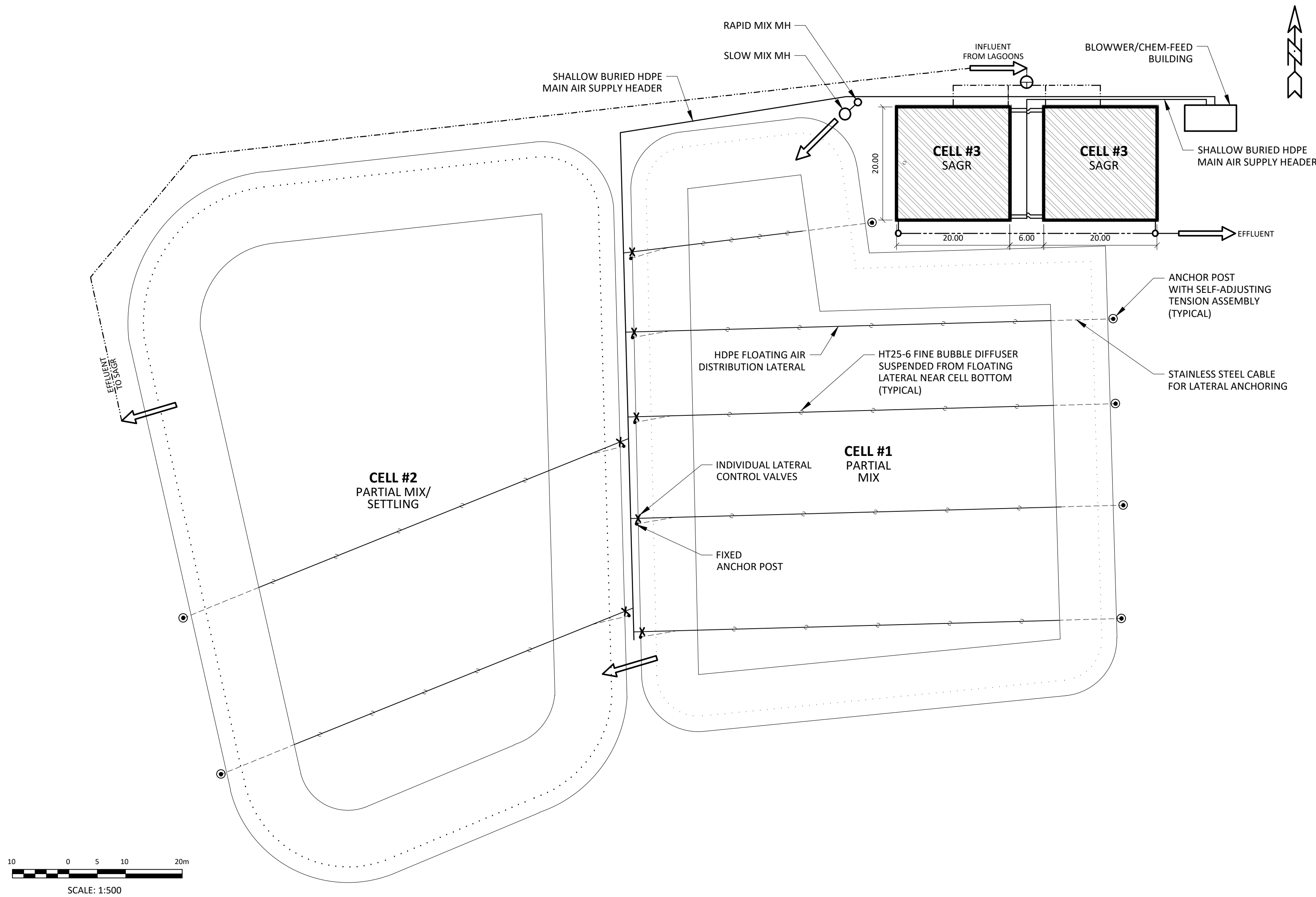
Suggested schedule

The projected schedule is shown in the following table:

Table 4 Schedule

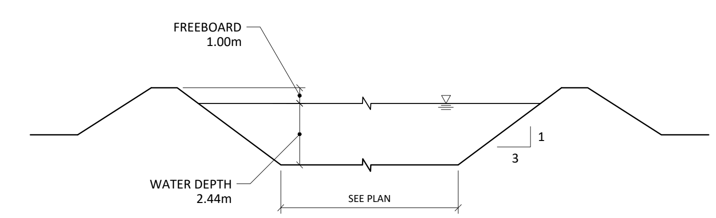
ITEM	TIMELINE	CONDITIONS
Shop drawings	6 weeks	Submission within designated timeline following receipt of a contract executed by all parties
Complete Equipment Delivery	20-26 weeks	After receipt of written approval of shop drawings

APPENDIX A: TERMS AND CONDITIONS

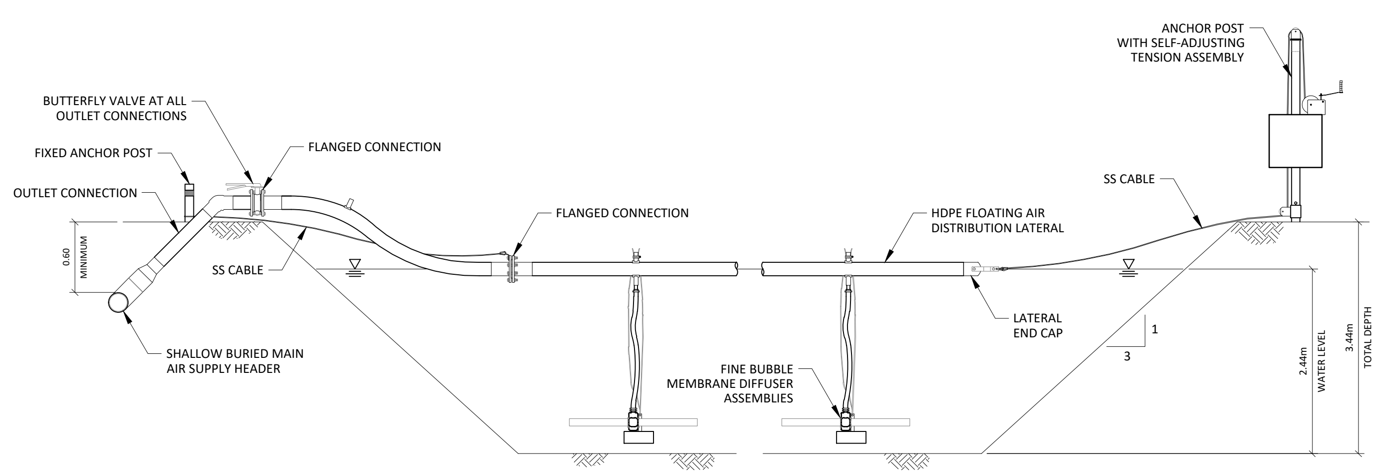


PROPOSED AERATION LAYOUT
SCALE: 1:500

LOCATION PLAN
SCALE: 1:750



TYPICAL SECTION - AERATED CELLS
SCALE: N.T.S.



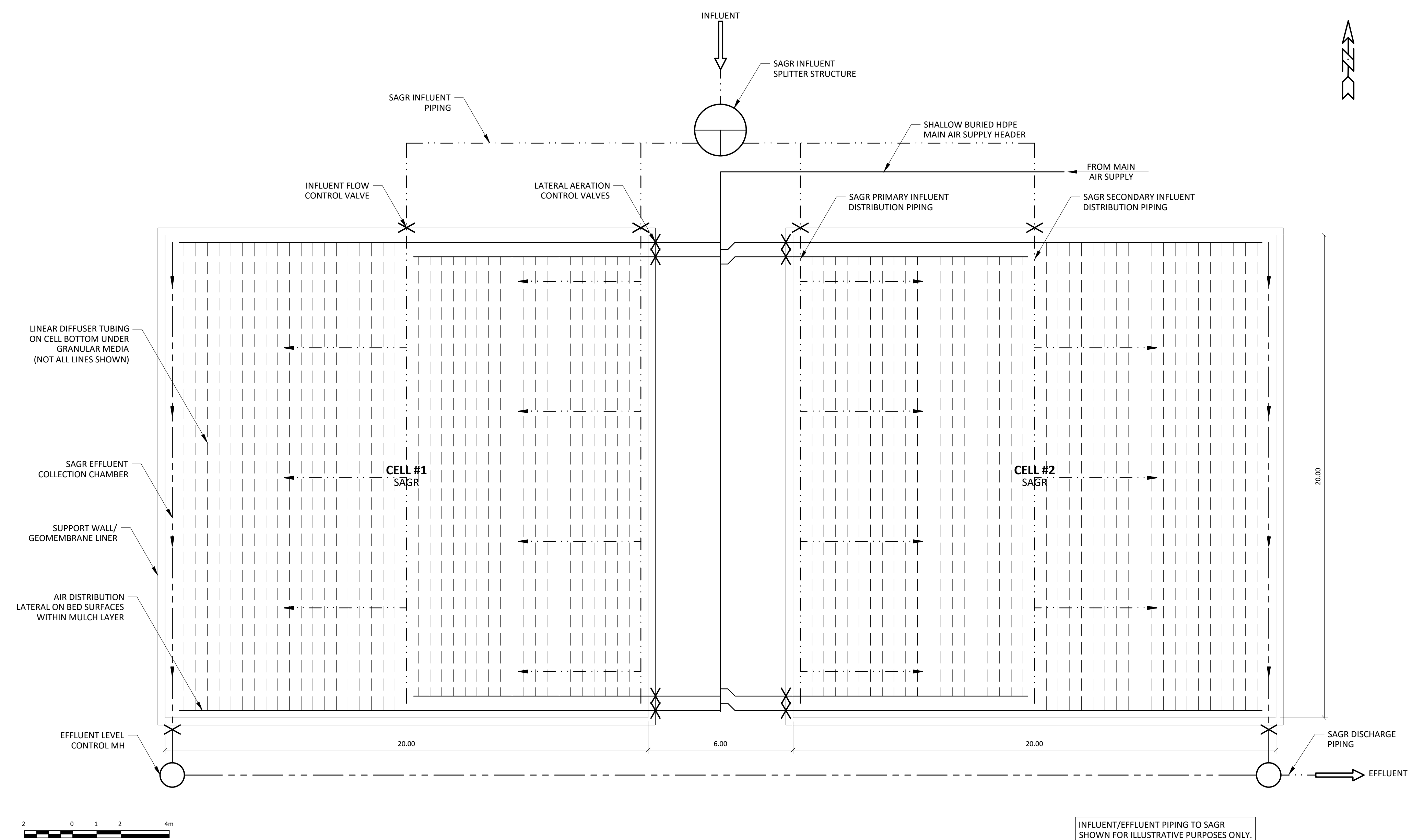
AERATED LAGOON SECTION
SCALE: N.T.S.

Nexom
technologies for cleaner water
5 Burks Way
Winnipeg, Manitoba
Canada R2J 3R8
888-426-8180
www.nexom.com

PROJECT:	CAROLINE, AB PROPOSED WASTEWATER TREATMENT SYSTEM
TITLE:	OPTAER SYSTEM AERATION LAYOUT, TYPICAL SECTION, LOCATION PLAN
DRAWN BY:	MR
APPROVED BY:	MH
SCALE:	AS NOTED
DRAWING NO.	NE01
SHT.	1 of 2
REV.	0
DATE:	2018/03/06
FILE #	CD688.04

PLOT SIZE: 610mm x 914mm (24" x 36")

REDUCED SIZE PLOT - DO NOT SCALE

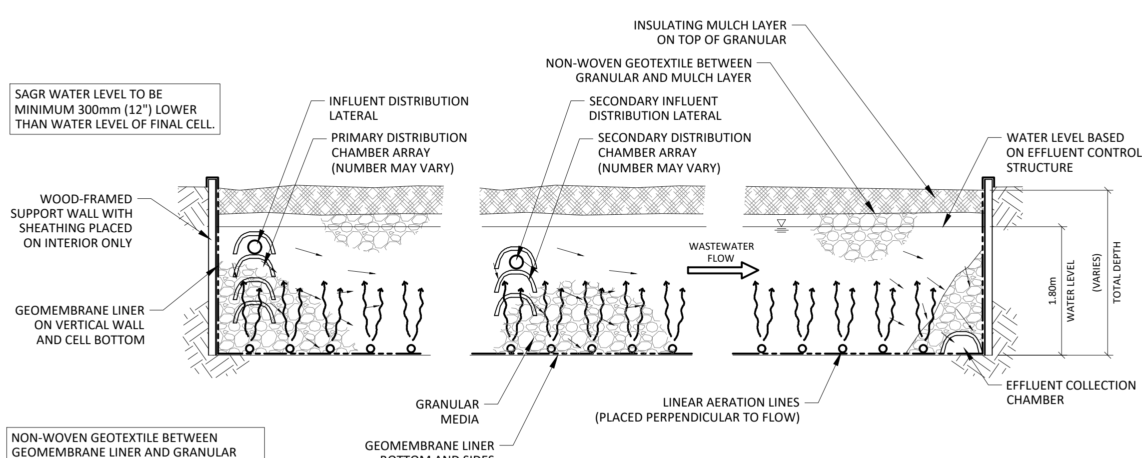


INFLUENT/EFFLUENT PIPING TO SAGR SHOWN FOR ILLUSTRATIVE PURPOSES ONLY. EXACT PIPING ROUTING TO BE DETERMINED BASED ON FINAL LOCATION OF SAGR.

PROPOSED SAGR LAYOUT

SCALE: 1:100

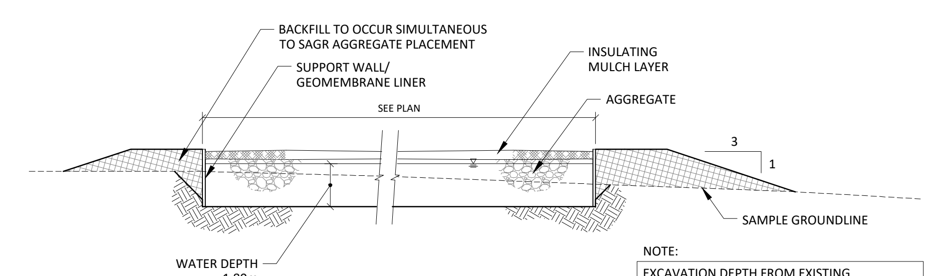
SAGR WATER LEVEL TO BE MINIMUM 300mm (12") LOWER THAN WATER LEVEL OF FINAL CELL.



NON-WOVEN GEOTEXTILE BETWEEN GEOMEMBRANE LINER AND GRANULAR LAYER (BOTTOM AND SIDES) AND BETWEEN MULCH LAYER AND GRANULAR LAYER (TOP)

HORIZONTAL FLOW SAGR - SECTION

SCALE: N.T.S.



NOTE:

EXCAVATION DEPTH FROM EXISTING GROUND LEVEL SHOWN FOR ILLUSTRATIVE PURPOSES ONLY. FINAL EXCAVATION DEPTHS TO BE DETERMINED AFTER SITE SURVEY

TYPICAL SAGR CONSTRUCTION

SCALE: N.T.S.

Nexom
technologies for cleaner water

5 Burks Way
Winnipeg, Manitoba
Canada R2J 3R8

888-426-8180
www.nexom.com

PROJECT: **CAROLINE, AB** PROPOSED WASTEWATER TREATMENT SYSTEM						
TITLE: OPTAER SYSTEM SAGR LAYOUT, TYPICAL SECTION, LOCATION PLAN						
DRAWN BY: MR	APPROVED BY: MH	SCALE: AS NOTED		DRAWING NO. **NE02**	SHT. 2 of 2	REV. 0
DATE: 2018/03/06	FILE # CD688.04					

Proposal for
Design, Supply and Installation of
OPTAER™ Wastewater Treatment System
March 7, 2018

CAROLINE, AB

technologies for cleaner water

5 Burks Way · Winnipeg MB · R2J 3R8
888·426·8180 · **www.nexom.com**

Project Overview

An OPTAER™ Wastewater Treatment system is proposed for Caroline, AB. The proposed system is designed for continuous discharge and would consist of the following processes, and technologies:

- Retain existing (2) cell aerated lagoon cells for BOD and TSS removal (condition and suitability to be determined by others)
- Implement OPTAER fine bubble partial mix aeration in Cells 1 and 2.
- Implement alum addition rapid/slow mix chambers for flocculation/coagulation at the front of cell 1, TP settling to occur in lagoon cells.
- Implement a dual-cell aerated SAGR® (Horizontal Flow Submerged Attached Growth Reactor) for nitrification (ammonia removal), BOD, and TSS polishing following the lagoon system. The SAGR process will also provide significant reductions in Fecal and Total Coliform.
- Construct a prefabricated blower building

System Design Parameters

Preliminary design loads, flows, and effluent objectives are presented in the following tables:

		Lagoon Influent	SAGR Influent	SAGR Effluent Requirements
Design Flow Average	m3/day	280	280	
cBOD5	mg/l	220	30	<20
TSS	mg/l	220	30	<20
TKN	mg/l	40	40	
Total Ammonia	mg/l			<1/5**
Unionized Ammonia	mg/l			<0.2*
TP	mg/l	6.5		<1
TP	kg/day			

* meets WSER toxicity requirements

** summer/winter

Approximate cell sizes and retention times are presented in the following table:

Cell	Reactor Type	Water Depth (m)	Water Volume (m3)	Retention time (days)
1	Partial Mix	2.5	11,792	42.1
2	Partial Mix	2.5	19,051	68.0
	SAGR	1.8		
	Total		30,843	110.1

Aeration design parameters are presented in the following table:

Aeration Design Parameters – OPTAER Lagoon Aeration System			
	Cell 1 (PM)	Cell 2 (PM)	Totals
Alpha	0.60	0.60	
Beta	0.95	0.95	
Theta	1.024	1.024	
Site elevation (m)	1055	1055	
Min. Dissolved Oxygen (mg/l)	2.0	2.0	
# HT25 diffusers (Fine Bubble)	24	10	34
SCFM per diffuser	8	8	
Total SCFM	192	80	272

SAGR design parameters are presented in the following table:

SAGR Design Parameters	
	Design
Alpha	0.70
Beta	0.95
Theta	1.024
Site elevation (m)	1055
SAGR Loading Rate (g BOD/m^2/day)	116.7
SAGR Loading Rate (lbs NH_3/1000 ft^3)	0.485
Min. Dissolved Oxygen (mg/l)	3.0
Total SCFM	200

OPTAER Partial Mix Process

Chemical Dosing and Mixing

A duplex chemical dosing skid will provide dosing into the rapid mix chamber using a variable speed peristaltic (positive displacement) pump. Pump speed can be manually set, or regulated by overall system flow.

The rapid mix chamber would be designed for an intense mixing environment to ensure good initial contact between the chemical and the wastewater. Following the rapid mix chamber, a larger chamber with a slow speed mixer would be provided for slow mixing and floc formation. The floc developed in the slow mix chamber would settle in the lagoon cell. The dosing pumps will be in the treatment building, and feed lines will run from the building to the rapid mix chamber. The dosing pumps will be designed for the design flow, and have the ability for turn-down during initial operation. Bench-scale testing with actual effluent is recommended to determine dosing rates, optimize chemical usage, and maximize removal efficiency.

A chemical dosing storage tank will provide storage based on design flows and assumed dosing rate. The tank will come complete with fill port, access hatch, venting, etc. Containment would be provided through double-wall tank construction. Assuming potable water is not available on site, a clean water tank (approx. 300 Gal) will also be provided for periodic flushing of the dosing pumps, manifold, and feed piping

Partial Mix (PM) Cell

The primary purpose of the aerated ponds is to provide oxygen, residence and contact time to natural bacteria which ultimately convert the wastewater contaminates (BOD5, ammonia (in warm temperatures), and TSS) to carbon dioxide, water, inert ash and nitrates. Aerated ponds effectively control odors and provide internal sludge digestion.

With aerated partial mix cells, the diffuser density is based upon oxygen demand. The OPTAER system does not rely on algae or natural surface aeration for providing oxygen to the wastewater.

The diffusers are suspended near the bottom of the cells. Through the rise of the bubbles and subsequent mixing, convection cells are created between the diffusers. Not only does the water rise with the bubbles, the solids settle out through the downward motion of the water between the diffusers where the circulation loop is completed. This combined with the slow rate of bubble rise contributes to the overall efficiency of the system. Because of low sludge production in the system, retention time is retained for long term BOD5 removal.

When the solids reach the bottom of the lagoon, additional oxygen for biodegradation is provided through the diffusers near the cell bottom. This process results in minimal organic bottom sludge accumulation. Aerobic digestion takes place within the aerated cells at the sludge water interface.

HT-25 Fine Bubble Membrane Diffusers

HT-25 fine bubble diffusers are used to provide oxygen to the wastewater. The diffusers consist of an HDPE air distribution body with individual tubular EPDM membranes extending outwards in a horizontal plane. This design prevents bubbles from coalescing, and results in an excellent oxygen transfer rate with minimal head loss.

The diffusers are suspended with a marine grade rope directly under the lateral, at a uniform depth. The rope is attached to the floating header for ease of diffuser retrieval. Each diffuser is attached to a small concrete weight, encased in HDPE pipe. Diffuser assemblies can be retrieved from a boat with no special equipment.

OPTAER Header System (Aerated Cell)

A metal manifold and discharge piping are used to dissipate the heat produced by the blowers. Shallow buried HDPE header piping connects to the galvanized steel manifold, and supplies air to the floating laterals. The header has flanged connections for each lateral as shown on the drawings. Each lateral is individually valved for ease of maintenance.

Laterals connect to the shallow buried header, and float on the water surface. With floating laterals, there are no concrete weights required to be in contact with the bottom of the basin. Laterals are secured against wind action with a stainless-steel cable system. The cables are fastened to anchors in the berm using a self-adjusting lateral tensioning assembly. All header and lateral piping, joints, and fittings are thermally fused HDPE. With floating laterals, the cells do not have to be dewatered or taken out of service for system installation or maintenance.

All maintenance can be performed from a boat with a 2-person crew. All header, lateral, and feeder piping is designed to accommodate increased airflow for high pressure and volume cleaning without increasing header friction losses by more than 1 psi. This allows for management of additional organic load, improved diffuser maintenance and additional odor control.

OPTAER SAGR Process

Submerged Attached Growth Reactor (SAGR)

The Submerged Attached Growth Reactor (SAGR) is a patented process designed to provide nitrification (ammonia removal) in cold to moderate climates. The SAGR is a clean gravel bed with evenly distributed wastewater flow across the width of the cell, and a horizontal collection chamber at the end of the treatment zone. LINEAR aeration throughout the floor of the SAGR provides aerobic conditions that are required for nitrification. The gravel bed is covered with a layer of wood chips or mulch for insulation.

The following variables need to be considered during nitrification design:

- *Dissolved Oxygen Levels* - Nitrifying bacteria require aerobic conditions. A minimum dissolved oxygen concentration of 3 mg/L must be present for the process to occur.
- *BOD concentration* – Nitrifying bacteria require low BOD concentrations to be effective. Primary BOD removal occurs in the upstream lagoon system. The SAGR provides additional BOD polishing if necessary to reduce BOD concentrations below 25 mg/l.
- *Surface area* - Bacteria require a medium of some form to grow on. High surface area medium allows for higher-density nitrifying bacteria population.
- *Bacteria* - To convert ammonia (NH_3) to nitrite (NO_2^-) and ultimately nitrate (NO_3^-) (nitrification) sufficient quantities of two bacteria are required, Nitrosomonas and Nitrobacter.
- *Alkalinity* - The nitrification process reduces pH levels and consumes alkalinity. For nitrification to occur, 7.1 mg of alkalinity must be available for each mg of ammonia removed.
- *Temperature* - Nitrification in a Submerged Attached Growth Reactor occurs at water temperatures as low as 0.5oC. The long sludge age inherent in an attached growth system allows for full nitrification at temperatures where bacterial reproduction is greatly inhibited.
- *pH* - Nitrification is enhanced at higher pH level. pH levels of 7.5 to 8.5 are ideal, although nitrifying bacteria can adapt outside of this range.

- *Aggregate Media* – Locally available aggregate may be used, provided it conforms to the aggregate media requirements specified.
- *Insulating material* – Insulation may be required to prevent freezing. Peat Mulch, woodchips, or shredded rubber tires would be acceptable.

SAGR LINEAR Aeration System

LINEAR coarse bubble diffusers are used to provide oxygen to the wastewater. Diffuser lines are manufactured from LDPE (Low Density Polyethylene) with reinforced air releases along the tubing. The diffuser tubing is designed for direct burial in the SAGR bed. The diffuser locations have been spaced according to the projected oxygen demand in the SAGR. The design diffuser distribution is critical to ensure that nitrification occurs.

In addition to providing oxygen for nitrification the proposed aeration system brings numerous other long-term performance benefits to this sub-surface flow system.

- Full aeration grid ensures that wastewater channeling cannot occur in the gravel layer (maximize retention time and media contact).
- Sludge digestion in gravel layer is enhanced due to aerobic conditions.
- Year-around odor free operation.

SAGR HDPE Header & Feeder System

High Density Polyethylene (HDPE) laterals run along the top on each side of the SAGR. The laterals are in the top layer of insulating mulch. All HDPE piping connections and fittings are thermally fused to ensure maximum strength and durability. A shallow buried header connects blowers to the SAGR laterals. HDPE service saddles are thermally fused to the lateral piping for each diffuser line. HDPE drop legs provide air to the individual diffuser lines.

All header and feeder piping is designed to accommodate increased airflow for high pressure and volume cleaning without increasing header friction losses by more than 1 psi. This allows for management of additional organic load, improved diffuser maintenance and additional odor control.

OPTAER Blowers

Positive Displacement Blowers

Positive displacement blowers are used to provide air supply for the OPTAER treatment system. Blowers are designed to provide the required airflow at normal system operating pressure, and have the capability of operating at the maximum required pressure intermittently for diffuser purging. The blowers are equipped with sound attenuating enclosures. Blowers are summarized in the following table:

		Lagoon Blowers	SAGR Blowers
Number of blowers total		2	1
Number of blowers on duty		1	1
Number of blowers on standby		1	0*
Motor nameplate horsepower	hp	20	15
Design airflow per blower	SCFM	272	200
Normal operating pressure	psi	5.4	4.8
Maximum Required Pressure	psi	7.2	8.5
Actual Power Consumption	bhp	11.5	7.9
Actual Sound level	dB(A)	75	74

SAGR standby provided by Lagoon blowers

Prefabricated Blower and Chemical Feed Building

A 4.57 x 9.15 m (15’ x 30’) prefabricated steel sandwich panel building will be provided. The panels used for both wall and roof construction have the following characteristics.

- 38mm thick urethane injected panels (R-12 insulation rating)
- Pre-finished painted exterior metal finish
- 28 ga. galvanized steel skin
- Extruded aluminum channels to provide light, rigid frame for panel system

Engineered welded HSS internal frames provide the structural framework for the building, designed as dictated by local building codes and snow loading conditions.

The proposed building would be constructed on a cast in place concrete slab.

The building would come complete with all electrical, including blower panels, all wiring within building, and heating, lighting, and ventilation systems.

Operation and Maintenance

The anticipated operation and maintenance costs for the OPTAER system are presented in the following table:

						*Electrical Rate:	0.08	$/kW-h
	Quantity	Hours per day	Motor Power		Monthly cost	Unit cost	Annual Cost	
			bhp	kW				
Aeration Lagoon Blowers	**2**							
Normal Operating Conditions	1	24	11.5	8.6	$501	-	$6,012	
Filters, Oil and Belts	**-**		-	-	-		$368	
SAGR Blowers	**2**							
Normal Operating Conditions	1	24	7.9	5.9	$344	-	$4,130	
Filters, Oil and Belts	**-**		-	-	-		$300	
Life Cycle Annual Alum Addition (L)	**16,245**					$1	$16,245	
Diffuser Membrane Replacement	**204**		-	-	-	$35	$1,020	
Total Operation & Materials							$28,075	

* Electrical and chemical rates estimated by Nexom Inc

The aeration system will require one operator for approximately 0.5 hour per day for routine inspection & maintenance.

Budgetary Capital Cost

INCLUDED IN THE OPTAER WASTEWATER TREATMENT SYSTEM:

CHEMICAL DOSING AND MIXING SYSTEM

- Nexom System Process Design (Alberta P. Eng stamped)
    - CAD Drawings and specifications (Alberta P. Eng stamped)
- Duplex Alum Dosing skid
- Heat traced piping between alum dosing building and chemical conditioning chambers
- One (1) 4000L chemical storage tank including level monitoring instrumentation.
- One (1) 1100L clean water tank for system flushing
- Rapid mix tank mixer with mounting hardware
- Slow mix tank mixer with mounting hardware
- ***Equipment installation/ start-up/ commissioning/ training***
- Operation and maintenance manuals
- Project Record Drawings

OPTAER LAGOON AERATION SYSTEM:

- Nexom System Process Design (Alberta P. Eng. Stamped)
    - CAD Drawings and specifications (Alberta P. Eng stamped)
- Aeration header piping, feeder piping, diffusers, valves, and fittings as required
- HDPE shallow buried main header piping
- Lateral support hardware and anchors, self-tensioning lateral anchor assemblies
- Two (2) 20 hp positive displacement blowers with sound attenuating enclosures
    - Blower control panel
    - Galvanized metal blower header and connection pipe (heat dissipation)
- ***Equipment installation/ start-up/ commissioning/ training***
- Operation and maintenance manuals
- Project Record Drawings

SUBMERGED ATTACHED GROWTH REACTOR (SAGR)

- Nexom System Process Design (Alberta P. Eng. Stamped)
    - Process CAD drawings and specifications (Alberta P. Eng. Stamped)
- Aeration header piping, feeder piping, diffusers, valves, and fittings as required
- SAGR Influent flow distribution piping/chambers and effluent collection chambers
- One (1) 15 hp positive displacement blower with full sound attenuating enclosures
    - Blower control panel
    - Galvanized metal blower header and connection pipe (heat dissipation)

- *Equipment installation/ start-up/ commissioning/ training*
- Operation and maintenance manuals
- Operation and maintenance manuals
- Project Record Drawings

BUDGETARY COST FOR THE DESIGN, SUPPLY AND INSTALLATION AS IN THE SCOPE ABOVE:

Chem Dosing and mixing: $108,000

OPTAER lagoon aeration: $226,000

SAGR process equipment: $305,000

(FOB jobsite, plus applicable taxes) All prices are subject to final design review.

PREFABRICATED BLOWER BUILDING

- CAD Drawings and specifications (Alberta P. Eng stamped)
- One (1) 4.57 x 9.15 m (15’ x 30’) prefabricated steel sandwich panel building
    - Complete with electrical and HVAC
    - Wiring of building, blowers, control panel
    - CIP thickened edge concrete floor

BUDGETARY COST FOR PREFABRICATED BLOWER BUILDING AS IN THE SCOPE ABOVE:

$247,000 CDN (FOB jobsite, plus applicable taxes)

All prices are subject to final design review.

ITEMS SPECIFICALLY NOT INCLUDED:

- Material offloading and secure on-site storage
- Civil works including Lagoon Cells/ SAGR basin design and construction, liner, transport piping, inter-cell piping, discharge piping, manholes, valves, access roads to site, site roads and landscaping, lagoon desludging etc. if required
- Excavation and backfill for shallow buried aeration headers.

- Building subgrade preparation
- Rapid mix and slow mix chambers (typically precast concrete manholes)
- Initial alum fill
- Materials and construction required for the SAGR:
    - granular material
    - insulating wood chips or shredded rubber tires
    - Influent splitter structures with flow control weirs or standpipes
- Site Preparation and Restoration
- Electrical service to blower building

Civil Works Required for OPTAER Implementation

The intent of this proposal is not to provide details regarding civil works required but rather to provide a general overview as to the anticipated scope of work. The following quantities are not included in the Nexom scope of work, but are provided below for cost estimation purposes.

- Construct new SAGR cells
- Construct inter-cell piping for lagoon/SAGR
- Construct discharge control structure after SAGR
- Materials and construction required specifically for the SAGR (estimated material quantities are shown in the following table):

SUMMARY

Item Description	UOM	Quantity
Uniform Graded Clean Rock	m3	**1,730**
Insulating Wood Chips	m3	**280**
Non-Woven Geotextile (8oz)	m2	**2,190**
HDPE Liner (60mil)	m2	**1,310**
Wall Framing & Sheathing	m	**170**
Influent Flow Splitter Structure	ea	**1**
Piping, fittings, valves from splitter to SAGR	LS	**1**
Effluent Level Control MH	ea	**2**
Additional Civil Works (As Required)		
Common Excavation - Backfill	m3	**TBD**
New Berm Construction	m3	**TBD**
Piping from Lagoon to Splitter	LS	**TBD**
Piping from SAGR to discharge	LS	**TBD**

Certified to ISO9001:2008

10 Alden Road, Markham, ON, Canada L3R 2S1
Phone: (905) 475-1545 Fax: (905) 475-2021
Website: www.napier-reid.com

STANTEC | Date: Mar 16, 2018

Attn: Johnny Ke P. Eng. | File: PR-8127

OPERATION COST

Re: Estimation for Operation Cost
SBR Wastewater Treatment System, Caroline, AB

1. Power Consumption

Power consumption for SBR package are considered as below.

<table>
<tr><th colspan="2">Main Equipment (Kw)</th><th>Operation hours per day</th><th>Filter (kw)</th><th>Chemical pump (kw)</th><th>Filter Press (kw)</th><th>UV System (kw)</th><th>Control system, etc.(kw)</th><th>Typical Consumption (kw-hr/day)</th></tr>
<tr><td>SBR Pumps</td><td>1.0</td><td>6</td><td rowspan="4">1.5 x 8 hr</td><td rowspan="4">0.1 x 24 hr</td><td rowspan="4">2.0 x 24 hr</td><td rowspan="4">1.8 x 24 hr</td><td rowspan="4">1.0 x 24 hr</td><td rowspan="4">362.4</td></tr>
<tr><td>Effluent Pump</td><td>1.0</td><td>6</td></tr>
<tr><td>Air Blowers</td><td>9</td><td>24</td></tr>
<tr><td>Decanter</td><td>0.8</td><td>6</td></tr>
</table>

2. Chemical consumption of Alum Sulphate

Removal of phosphorus by assimilation to sludge is approximately 50% based on the design BOD level. Remaining phosphorus will be removed by chemical precipitation with alum.

Estimated alum dosage rate will be 158 mg/L. It is assumed the active matter of alum salt in solution is about 50%. Total daily consumption of alum salt will be:

$$280 \times 158 \times 10^{-3} / 50\% = 88.5 \text{ L/day}$$

Pump capacity is to be 88.5.0 L/day: 24 = 3.7 L/hr. at 50% of alum sulphate.