







Long-Term Expansion Town of Lunenburg Wastewater Treatment Plant



Final Report

210803.01 • August 2021

0	Issued for Use		August 12, 2021	
B	Reissued for Review	DAT	July 30, 2021	SHE
A	Issued for Review	DAT	July 7, 2021	SHE
Issue or Revision		Reviewed By:	Date	Issued By:
 <p>This document was prepared for the party indicated herein. The material and information in the document reflects CBCL Limited's opinion and best judgment based on the information available at the time of preparation. Any use of this document or reliance on its content by third parties is the responsibility of the third party. CBCL Limited accepts no responsibility for any damages suffered as a result of third party use of this document.</p>				



August 12, 2021

Dennis MacPherson, P.Eng.
Town Engineer
Town of Lunenburg
177 Cumberland Street
Lunenburg, NS B0J 2C0

Dear Mr. MacPherson:

RE: Town of Lunenburg - WWTP Long-Term Expansion Conceptual Design Report

CBCL Limited (CBCL) was engaged by the Town of Lunenburg (the Town) to complete a conceptual design for the long-term expansion of the Lunenburg Wastewater Treatment Plant (WWTP). The long-term expansion will increase the capacity of the plant to accommodate a 50% increase in loading to the plant.

This report describes and evaluates five possible expansion options to accommodate the increase in loading. The evaluation is based on factors including expected effluent quality, the effects on operations, constructability and construction sequencing, and capital and operational costs.

Yours very truly,

CBCL Limited

Prepared by:
Sarah Ensslin, M.Sc., P.Eng.
Process Engineer
E-Mail: sensslin@cbcl.ca

Erica Hart, EIT
Process Engineer-in-Training

Reviewed by:
David Trudel, P.Eng.
Process Engineer

Project No: 210803.01

This document was prepared for the party indicated herein. The material and information in the document reflects CBCL Limited's opinion and best judgment based on the information available at the time of preparation. Any use of this document or reliance on its content by third parties is the responsibility of the third party. CBCL Limited accepts no responsibility for any damages suffered as a result of third party use of this document.

Contents

Chapter 1 Introduction	1
1.1 Background	1
1.2 Purpose	1
Chapter 2 Design Criteria	3
2.1 Existing Conditions	3
2.1.1 Flows	3
2.1.2 Loads	4
2.2 Future Conditions	5
2.3 Effluent Limits	6
Chapter 3 Existing Treatment Plant Capacity	7
3.1 Description of Existing Facility	7
3.2 Capacity	7
3.2.1 Inlet Screen	7
3.2.2 MBBR	8
3.2.3 DAFs	8
3.2.4 Ultraviolet Disinfection	9
3.2.5 Rotary Press	10
Chapter 4 Options for Expansion	11
4.1 Option 1: Expanded MBBR and Existing DAF units	11
4.1.1 Technology Overview	11
4.1.2 Description and Design Criteria	12
4.1.3 Operational Discussion	14
4.1.4 Construction Sequencing	14
4.2 Option 2: Expanded MBBR and New DAF Units	15
4.2.1 Technology Overview	15
4.2.2 Option Description and Design Criteria	15
4.2.3 Operational Discussion	17
4.2.4 Construction Sequencing	17

4.3	Option 3: Sequencing Batch Reactor	18
	4.3.1 Technology Overview	18
	4.3.2 Option Description and Design Criteria.....	20
	4.3.3 Operational Discussion	21
	4.3.4 Construction Sequencing.....	22
4.4	Option 4: MBR.....	22
	4.4.1 Technology Overview	22
	4.4.2 Option Description and Design Criteria.....	24
	4.4.3 Operational Discussion	25
	4.4.4 Construction Sequencing.....	27
4.5	Option 1A: Polishing with a Disk Filter	27
	4.5.1 Technology Overview	27
	4.5.2 Option Description and Design Criteria.....	28
	4.5.3 Operational Discussion	29
	4.5.4 Construction Sequencing.....	29
	Chapter 5 Evaluation of Options	30
5.1	Capital Cost Comparison	30
5.2	Operational Cost Comparison.....	31
5.3	Technological Fit Comparison	32
5.4	Regulatory Risk Comparison	33
5.5	Operational Risk Comparison.....	33
5.6	Construction Risk Comparison.....	35
5.7	Summary of Options	36
	Chapter 6 Recommended Upgrade	37
6.1	Description of Upgrade.....	37
6.2	Key Reasons for Recommendation.....	37
6.3	Risks to be Mitigated	38
6.4	Next Steps	38
	Chapter 7 References.....	39

Appendices

A Sketches: Options for Expansion

Table of Acronyms

Acronym	Definition
ACWGM	Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment, and Disposal
ADF	Average Daily Flow
CBOD	Carbonaceous Biochemical Oxygen Demand
DAF	Dissolved Air Flotation
DO	Dissolved Oxygen
%DS	Percent Dry Solids
E. coli	Escherichia Coli
EQ	Equalization
H ₂ S	Hydrogen Sulphide
HVAC	Heating, Ventilation and Air Conditioning
I&I	Inflow and Infiltration
MBBR	Moving Bed Bio-reactor
MBR	Membrane Bioreactor
MLSS	Mixed Liquor Suspended Solids
NSECC	Nova Scotia Environment and Climate Change
ODRC	Operator in Direct Responsible Charge
O&M	Operations and Maintenance
PDF	Peak Daily Flow
PLC	Programmable Logic Controller
RAS	Return Activated Sludge
SBR	Sequencing Batch Reactor
SCFM	Standard Cubic Feet per Minute
TBA	Temporary Bypass Authorization
TKN	Total Kjeldahl Nitrogen
TOL	Town of Lunenburg
TSS	Total Suspended Solids
UV	Ultraviolet
WAS	Waste Activated Sludge
WWTP	Wastewater Treatment Plant
WSER	Wastewater Systems Effluent Regulations

Chapter 1 Introduction

1.1 Background

The Lunenburg Wastewater Treatment Plant (WWTP) was constructed in 2002-2003 and is located on the South Shore of Nova Scotia, serving the Town of Lunenburg (the Town). In early 2021 the Town initiated a project for Wastewater Treatment and Outfall Pre-design. The project includes four main elements: pre-design of the treatment plant outfall, pre-design of the near-term capital upgrades at the WWTP, a building condition assessment report for the WWTP, and a conceptual design for the expansion of the WWTP. This report will focus on the conceptual design for the expansion of the WWTP with the goal of increasing the treatment capacity to meet the Town's future growth plan.

The WWTP receives and treats an Average Daily Flow (ADF) of 766,000 USgpd (2,900 m³/d) and a Peak Daily Flow (PDF) of 3,000,000 USgpd (11,400 m³/d). The treatment train includes influent screening, grit removal, biological treatment using a Moving Bed Bioreactor (MBBR), solids removal using Dissolved Air Flotation (DAF), and Ultraviolet (UV) disinfection.

The WWTP is sized appropriately to meet the current flows and loadings to the plant. The Town approved the Project Lunenburg Comprehensive Community Plan (Project Lunenburg) in May 2021. Project Lunenburg is a plan that encompasses the Town's vision for the next forty years and provides a framework for the anticipated growth in the community. Through several initiatives, the Town's population is predicted to increase by 50%, which would substantially increase loading the WWTP.

1.2 Purpose

The purpose of this report is to identify and develop an expansion plan for the WWTP to accommodate the anticipated growth (population increase) within the Town over the next forty years, as laid out by Project Lunenburg. The expansion plan must consider the following factors:

- Potential for improvements to the Town's collection system;
- Project Lunenburg planned population growth;
- Potential changes to regulatory requirements;
- Proven technologies for wastewater treatment;

- Possibility for operations and maintenance using current operations staff;
- Potential to maximize use of existing infrastructure; and
- Cost-effectiveness.

These factors have been discussed in the following sections. Possible options have been identified, discussed, and evaluated, in order to lay out a feasible expansion plan the Town can use to accommodate planned growth.

This report should be read in conjunction with the Town of Lunenburg WWTP Town of Lunenburg WWTP Near-Term Upgrades Report (CBCL Limited, 2021) and the Town of Lunenburg Wastewater Outfall Extension Pre-Design (CBCL Limited, 2021).

Chapter 2 Design Criteria

2.1 Existing Conditions

Historical records were reviewed to determine the flows and loads currently experienced by the plant and identify any trends or changes in recent years. The key parameters analyzed were ADF, PDF, as well as Carbonaceous Biochemical Oxygen Demand (CBOD) and Total Suspended Solids (TSS) loadings.

2.1.1 Flows

Current flows to the WWTP were determined from the analysis of flow entering the DAFs for the period of June 2020 to June 2021. The ADF during this period was determined to be 672,000 USgpd, while the PDF was 2,500,000 USgpd. The data is shown in Figure 1 below.

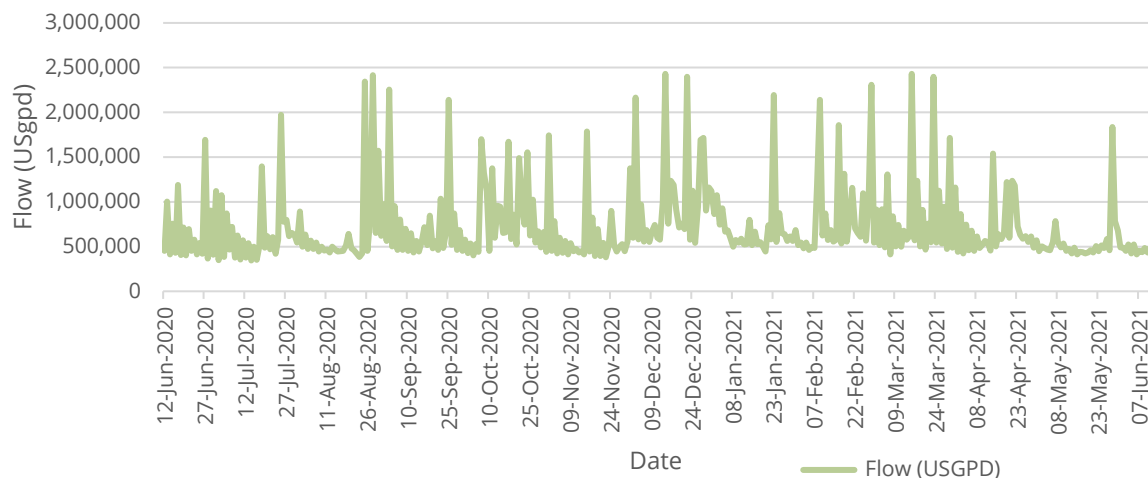


Figure 1: Flow data from June 2020 to June 2021

The WWTP services a population of approximately 2,263 people. At current ADF, this equates to an average daily per capita flow of approximately 300 USg/capita/day. For comparison, the Atlantic Canada Wastewater Guidelines Manual (ACWGM), (ACWWA, 2006) suggests a typical per capita flow of 90 USg/capita/day. The Town's per capita flow rate is very high, indicating a high level of inflow and infiltration (I&I) to the sewer system, which

likely results from both combined sewers and seawater infiltration. The previous study (CBCL Limited, 2019) indicated a higher ADF of 760,000 USgpd and a PDF of 3,000,000 USgpd. Figure 2 shows the average daily flows on a monthly basis for the period from June 2018 to June 2021, to show the variation over this time period.

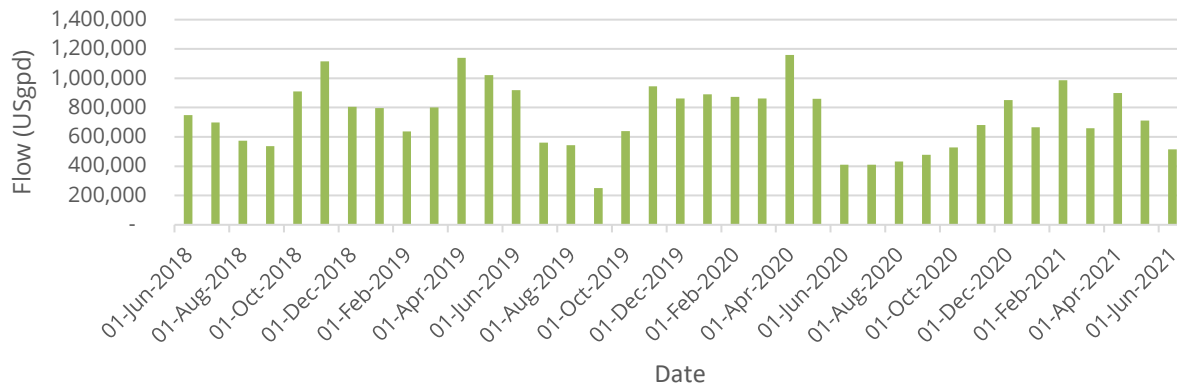


Figure 2: Flow Data from June 2018 to June 2021

Figure 2 indicates that the flow in 2020 was significantly lower than previous years. The flow appears to decrease substantially starting in Summer 2020. The decrease in overall plant flow may be as a result of the ongoing sewer separation work to reduce sea water infiltration but may also indicate decreased tourist numbers during the past year due to the pandemic, or drier weather conditions. Due to the uncertainty of the cause of the flow reductions measured, the values identified in the previous study will be used for design purposes. This provides for a factor of safety on the design basis.

2.1.2 Loads

The wastewater loadings to the plant appear to be generally consistent with the ACWGM guidelines for per capita loadings. The ACWGM (ACWWA, 2006) recommends minimum wastewater per capita loadings of 0.08 kg CBOD/capita/day, 0.09 kg TSS/capita/day, and Wastewater Engineering (Metcalf & Eddy, Inc, 2003) recommends an allowance of 0.016 kg TKN/capita/day, where TKN is a measure of nitrogen in wastewater. The WWTP receives an average of 0.07 kg CBOD/capita/day, 0.13 kg TSS/capita/day, and 0.017 kg TKN/capita/day.

Additionally, the Town experiences significant increases in the peak loadings, likely as a result of the Town’s strong summer tourism season. The population is reported to increase significantly during the summer months.

Representative flows and loads for the existing population are shown in Table 1.

Table 1: Flows and Loads with Current Population

Parameters	Average	Peak
Population	2,263	
Flow (USgpd)	766,000	3,000,000
CBOD (kg/d)	160	320
TSS (kg/d)	300	600
TKN (kg/d)	40	75

2.2 Future Conditions

Project Lunenburg was developed to provide guidance for most aspects of the community including land use, housing, transportation, and the environment over the next forty years, with the goal of strengthening the community and promoting growth. Project Lunenburg includes an increase in development in several areas within the Town. The planned new development areas can accommodate approximately 1,100 new residents which would result in a revised total population of approximately 3,360 people, increasing the service demand and wastewater loadings by about 50%.

Project Lunenburg documents identify that one of the challenges in accommodating this growth is the combined sewer system in some areas of the Town, which collects both sanitary wastewater and stormwater. Similar to other harbour communities, the Town historically used a combined sewer system that originally discharged directly into Lunenburg Front and Back Harbours. At the time of construction of the WWTP, the collection system was redirected to the WWTP. The combined sewers capture substantial amounts of rainfall which are then conveyed to the WWTP for treatment.

As part of Project Lunenburg, sewer separation work is recommended within the existing collection system and will be required in all areas of new development. If carried out strategically, the reduction in I&I paired with the expected growth in population is assumed to have a net-zero effect on the overall wastewater flows to the plant. However, the wastewater loads will increase by 50% overall. The resulting design wastewater flows and loads to the plant are summarized in Table 2.

Table 2: Predicted Future Wastewater Flows and Loads

Parameters	Average	Peak
Population	3,360	
Flow (USgpd)	766,000	3,000,000
CBOD (kg/d)	240	400
TSS (kg/d)	450	750
TKN (kg/d)	60	110

2.3 Effluent Limits

The effluent requirements are determined based on a combination of the Federal Wastewater Systems Effluent Regulations (WSER) and the Nova Scotia Environment and Climate Change (NSECC) Approval to Operate for the WWTP.

The receiving environment for the WWTP discharge is the Lunenburg Front Harbour. The outfall location is also being reviewed as part of this project. The outfall may be relocated to a position that promotes better mixing and dilution within this harbour. No changes are anticipated to the effluent requirements at this time, though over the course of the next forty years it is possible that effluent limits may become more stringent. The current effluent requirements are outlined in Table 3.

Table 3: Effluent Limits

Parameter	Limit	Notes
CBOD (mg/L)	20	Quarterly Average
TSS (mg/L)	20	Quarterly Average
<i>E. coli</i> (count per 100 mL)	1000/100mL	Quarterly geometric average

Chapter 3 Existing Treatment Plant Capacity

3.1 Description of Existing Facility

The existing treatment plant was constructed in 2002-2003 and consists of influent screening, grit removal, biological treatment using a Moving Bed Bioreactor (MBBR), solids removal via DAF, and UV disinfection. Solids from the DAF units are pumped to the sludge holding tank located in the aeration building. The sludge holding tank acts as a buffer tank to feed the rotary press for dewatering.

3.2 Capacity

The existing treatment plant is currently operating close to its rated capacity and would require significant upgrades to accommodate a 50% increase in organic loading while maintaining the hydraulic throughput as discussed above. The following sections review the key unit processes affected by the increase in loading, to identify any unit operations with available capacity to treat the additional load.

3.2.1 Inlet Screen

Wastewater flow from the catchment area is pumped to the headworks building to the influent bar screen. An emergency bypass channel is provided to direct influent to the MBBR in the event of a screen blockage. The influent is screened with a 0.1" (3 mm) continually-raked bar screen that collects the screenings and discharges to a compactor for disposal offsite. The existing screen has several operational issues and is recommended to be replaced as part of the near-term capital upgrades. The proposed replacement screen is a 0.2" (6 mm) perforated plate screen that is sized based on the current PDF. The performance of the inlet screen would not be significantly influenced by the increase in loading to the plant but would require upgrades or replacement if peak flows were to increase. If a treatment system is selected where the downstream processes require a finer influent screen, then an alternative or additional screen would be required.

Screened wastewater flows to aerated grit tanks that aim to remove the heavier grit particles, while keeping the lighter organic particles in suspension. The grit tanks are sized

adequately for the current flows and no increase in capacity is required, but like the screens, would need consideration if peak flows increased.

3.2.2 MBBR

The existing MBBR consists of two trains of four stages each, and has a total volume of 13,824 ft³ (391 m³, or 103,400 USgal). The MBBR cells are filled with an unconventional type of plastic media. The existing media were supplemented with new media in 2020 during the aeration upgrades. The capacity of the system is limited by the media's surface area to volume ratio. The existing media has a much lower surface area to volume ratio than would be expected for conventional media and has poor durability (visible reduction in size over the years as the plastic has worn down).

Both MBBR trains feed into the equalization tank that acts as a batch tank ahead of the DAFs. The equalization tank is equipped with aerators fed from the blowers to avoid settling of solids and septicity within the tank.

Air is supplied to the MBBR system by three (3) 50 hp blowers. Each blower has a rated capacity of 1050 SCFM at 7.5 psig. The blowers are recommended to be replaced as part of the near-term upgrades, due to age and spare part availability. Air from the blowers is also supplied to the equalization tank, sludge tank, and aerated grit tank. The current total air requirement of the MBBR system is 960 SCFM and can be supplied by one blower.

The design parameters of the existing MBBRs are summarized in Table 4 below.

3.2.3 DAFs

The wastewater flows from the equalization tank through the DAF influent channel where it is dosed with a polymer to enhance solids removal. Dissolved air flotation is a clarification process that uses air to float solid particles to the water surface for removal. Air is dissolved in the wastewater stream under pressure and then released at atmospheric pressure in a flotation tank or basin. This produces tiny air bubbles that adhere to the suspended solids in the water and float the solids to the surface of the water, where they are removed by a skimming device.

The existing DAF units were designed based on a flow rate of 1,040 USgpm, per unit, and a maximum solids loading rate of 200 mg/L. The DAF units are equipped with lamella plates to increase the rise rate in the DAF. This allows the DAF to operate at a higher capacity in a smaller footprint, but the lamella plates are difficult to clean. The design parameters of the existing DAF units are summarized in Table 4 below.

Table 4: Existing MBBR and DAF Capacity

Parameter	Existing	Typical
No. of Blowers	2 Duty+1 Standby	2 Duty+1 Standby
Air flow per blower (SCFM)	1050	-
Air pressure (psig)	7.5	-
No. of MBBR Trains	2	2
No. of MBBR Stages	4	-
Total MBBR Bioreactor Volume (USgal)	103,400	-
MBBR Average/Peak Hydraulic Retention Time (hr)	1.7/0.4	-
MBBR Side Water Depth (ft)	12.6	-
MBBR Media Area to Volume Ratio (ft ² /ft ³)	30	180-300
MBBR Media Fill Fraction (%)	37.5	50
MBBR Media Area (ft ²)	155,000	-
MBBR Average/ Peak CBOD Loading (g/ft ² d)	1.03/2.06	0.33-0.65
No. of DAF units	2	2
Average Solids Concentration (mg/L)	100	-
DAF Volumetric Loading Rate (USgpd/unit)	1,500,000	-
DAF Flotation Area (ft ² /unit)	150	-
DAF Side Water Depth (ft)	7.9	-
Peak Hydraulic Loading Rate (USgal/ft ² /h)	416	-

3.2.4 Ultraviolet Disinfection

The Ultraviolet (UV) disinfection system consists at a single bank containing a total of 32 bulbs. As part of the near-term upgrades an additional UV bank is recommended, to improve compliance with provincial effluent requirements. The measured UV Transmittance (UVT) of the effluent entering the UV unit is lower than the design value. UVT is a measure of how easily UV light passes through the effluent. Low UVT can be caused by a number of factors, including colour, polymer carryover, foaming, and high concentrations of solids in the effluent. The low UVT of the effluent means that the installed equipment cannot emit enough UV light to successfully disinfect the effluent. The additional UV bank will double the capacity of the system, to provide the required UV dose, even at lower UVT values.

The UV capacity is based on the peak flow of the WWTP (i.e., 3,000,000 USgpm). As noted in Section 2, the overall flow to the plant is assumed not to increase. The UVT of the effluent wastewater is also not expected to deteriorate. The UV system, as recommended in the near-term upgrades, has sufficient capacity for disinfection requirements following WWTP expansion.

3.2.5 Rotary Press

Sludge dewatering is accomplished via a Fournier Rotary Sludge Press (Fournier Press). The Fournier Press includes two channels, each with the capacity to dewater sludge at a rate of 40 kg/h. The Fournier Press operates by feeding sludge at a low pressure into one of the two channels, which wrap around the Fournier Press. The sludge is rotated between two parallel revolving stainless steel filter elements. This slowly presses water out of the sludge through the filters. The process can produce a very dry sludge cake, depending on sludge characteristics.

The Fournier Press currently operates when the operator is present, in 8-hour shifts, about 5 days a week. The design capacity of the Fournier Press is summarized in Table 5 below.

Table 5: Existing Fournier Press Capacity

Parameter	Existing
Solids Capacity per Channel (kg/h)	40
No. of Channels	2
Weekly capacity (kg/week)	3,200
Typical Cake Solids (%DS)	20-30%

Chapter 4 Options for Expansion

Five different expansion options of the WWTP are discussed and evaluated below. The options were identified based on ability to provide reliable and effective wastewater treatment for a moderate sized facility. Four different technologies were explored including MBBR & DAF, Membrane Bio-Reactor (MBR), Sequencing Batch Reactor (SBR), and disk filtration polishing. The technologies for consideration were chosen based on their reliability and were evaluated for ease of retrofit, impacts on operations, and capital and lifecycle costs. All these expansion options are developed on the basis that the relevant Near-Term items have been completed prior to the WWTP expansion. These are listed in each Option description.

4.1 Option 1: Expanded MBBR and Existing DAF units

4.1.1 Technology Overview

The patented MBBR process was developed by the Norwegian company Kaldnes Miljøteknologi. MBBRs are a system based on a biofilm reactor with no requirement for backwashing or return activated sludge. The MBBRs contain “carrier” (typically plastic) media with a high surface area for biofilm growth. The specific gravity of the carrier is slightly less than that of water so that aeration will keep the contents in suspension and completely mixed. The movement of the media is normally caused by coarse-bubble aeration. Aeration abrasion of the media carriers allows for biofilm to slough off, to maintain optimal biofilm thickness.

Similar to the existing arrangement, wastewater from preliminary treatment (screened and de-gritted) flows to the influent channel of the MBBR tanks. Following biological treatment in the MBBR, the wastewater flows to a secondary clarifier or DAF for solids removal, while the carrier material is kept in the reactor by a media retention sieve at the outlet of each MBBR tank. A typical MBBR and DAF process schematic and installation is shown in Figures 3 to 5.

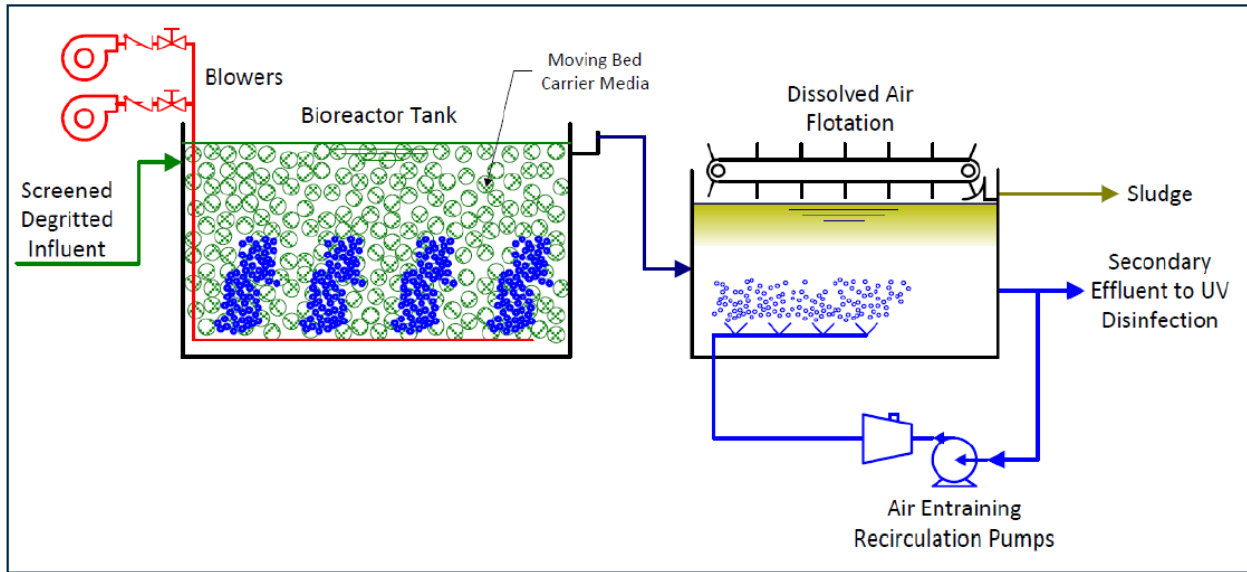


Figure 3: Typical MBBR and DAF Schematic



Figure 4 & 5: MBBR media and DAF unit

4.1.2 Description and Design Criteria

Option 1 would retain the same technology and maximize reuse of the existing infrastructure. The existing MBBR capacity would be expanded by replacing the existing media with new media with a better surface area to volume ratio. The increased surface area to volume ratio provides a greater area for biofilm growth. The existing DAFs can be retained as they appear to have sufficient capacity to handle the expected increase in load. The design criteria are summarized in Table 6 below.

Table 6: MBBR and Existing DAF Design Criteria

Parameter	Proposed	Typical
No. of Blowers	2 Duty+1 Standby	2 Duty+1 Standby
Air flow per blower (SCFM)	1,191	-
Air pressure (psig)	7.7	-
No. of MBBR Trains	2	2
No. of MBBR Stages	4	-
Total MBBR Bioreactor Volume (USgal)	103,400	-
MBBR Ave./Peak Hydraulic Retention Time (hr)	1.7/0.4	-
MBBR Side Water Depth (ft)	12.6	-
MBBR Media Area to Volume Ratio (ft ² /ft ³)	287	180-300
MBBR Media Fill Fraction (%)	46	
MBBR Media Area (ft ²)	1,825,000	
MBBR Average/ Peak CBOD Loading (g/ft ² d)	0.14/0.27	0.33-0.65
No. of DAF units	2	2
Average Solids Concentration (mg/L)	150	-
DAF Volumetric Loading Rate (USgpd/unit)	1,500,000	-
DAF Flotation Area (ft ² /unit)	150	-
DAF Side Water Depth (ft)	7.9	-
Peak Hydraulic Loading Rate (USgal/ft ² /h)	416	-

The media retention sieves between each stage of the MBBR must also be replaced with finer sieves to keep the smaller-diameter media in place. The existing aeration diffusers will be replaced with coarse-bubble diffusers that require less periodic maintenance. The DAF units can be retained with no additional upgrades beyond the recommended near-term upgrades to polymer dosing and weirs, although they will be operating closer to their design capacity than they are currently and there is a risk that peak solids loading may occasionally exceed the DAF design capacity.

Under this scenario, the existing sludge management system would require expansion to handle the additional solids load. This would be accomplished by adding a third channel to the Fournier Press, resulting in a 50% increase in capacity.

The proposed scope of work for this option includes the following:

- Removal/replacement of existing media with smaller diameter media (higher surface area to accommodate more biomass and increase biological treatment capacity);
- Removal/replacement of existing media retention sieves with finer sieves;
- Removal/replacement of existing fine-bubble aeration system with a corrosion-resistant coarse-bubble aeration system;
- Additional instrumentation including dissolved oxygen (DO) control within the bioreactor; and
- Addition of third channel to the Fournier Press.

This option assumes that the flood control berm, UV expansion, polymer pumps, aeration blowers, headworks screen and compactor, online instrumentation in the bioreactor, standby generator, mechanical upgrades, DAF manifolded manual weirs, polymer makedown equipment, and compressor pipework items have been completed already as per the Lunenburg WWTP Near-Term Upgrades Pre-Design Report (CBCL Limited, 2021). This Option 1 arrangement can be seen in PSK01 in Appendix A.

4.1.3 Operational Discussion

Operation of the upgraded MBBR and existing DAF would be very similar to the current operations. There are no additional components added that would require additional labour. The Fournier Press requires additional capacity to handle the increase in solids loading to the plant, but operation remains the same. The increase in solids loading to the plant will result in increased sludge hauling and disposal costs, but the sludge cake dryness should remain similar to existing.

The benefit of this option is that the operations are nearly identical and the operators are familiar with the equipment/process. Operators will be able to adapt to the upgrade with ease. The downside of this option is that any operational issues that are not resolved with proposed near-term upgrades to the existing system will also remain, such as the difficulty in cleaning the DAF lamella plates.

4.1.4 Construction Sequencing

The implementation and sequencing for this option is relatively straightforward, as most of the major equipment will be retained. The bioreactor trains can be taken out of operation, one at a time, to remove the old media and aeration equipment, and install the new media, aerators, and media retention screens. The first train can be commissioned and brought back online before taking the second train out of operation. No complete process bypasses would be required for this option, but depending on flows, some wastewater might bypass biological treatment if the flow exceeded the capacity of one train during wet weather.

A Temporary Bypass Authorization (TBA) will be required for any process bypasses, including taking one train out of service for construction. This must be obtained from Environment Canada under the terms of the WSER legislation. An Approval to Construct and Operate must be obtained from NSECC prior to construction. The overall construction and sequencing plan would be developed by the general contractor in close consultation with the Town's Engineering and Operations team to minimize process disruptions.

4.2 Option 2: Expanded MBBR and New DAF Units

4.2.1 Technology Overview

The technology for this option is very similar to Option 1. Principles of operation remain the same with organics removal occurring in the MBBR and solids removal occurring in the DAF. The primary differences are that the proposed DAF units do not include lamella plates, which means that cleaning of the units is easier, and that they are taller than the existing units. The proposed DAF units are depicted below in Figure 6 below. Please note that this is shown as an example and is subject to change during detailed design.

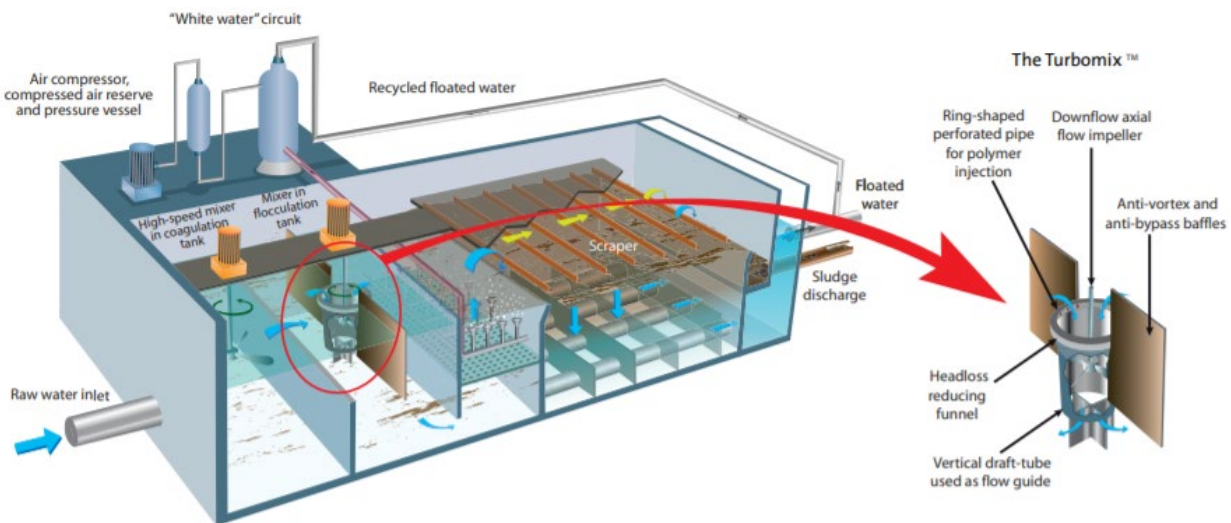


Figure 6: Alternate DAF

4.2.2 Option Description and Design Criteria

The MBBR upgrade will be similar to Option 1 with smaller, higher surface area media, media retention sieves, and coarse bubble aeration, but will be supplied by a different manufacturer. The manufacturer will also supply the DAF units, resulting in a single vendor supplying the core of the treatment process (integrated approach). The DAFs will be sized for the additional loading. The proposed DAFs are taller, which means they have a higher top water level than the existing DAFs so the MBBR effluent will no longer flow from the equalization (EQ) tank by gravity. It will be necessary to install pumps in the EQ tank to feed the DAF units and to pump all flows.

Additional instrumentation will be installed to provide better control of dosing and verification of effluent quality.

Under this scenario, the existing sludge management system would require expansion to handle the additional solids load. This would be accomplished by adding a third channel to the Fournier Press, resulting in a 50% increase in capacity.

The design criteria for the proposed system are shown below in Table 7.

Table 7: Design Parameters MBBR and DAF

Parameter	Proposed	Typical
No. of Blowers	2 Duty+1 Standby	2 Duty+1 Standby
Air flow per blower (SCFM)	710	-
Air pressure (psig)	6.5	-
No. of MBBR Trains	2	2
No. of MBBR Stages	4	-
Total MBBR Bioreactor Volume (USgal)	103,400	-
MBBR Ave./Peak Hydraulic Retention Time (hr)	1.7/0.4	-
MBBR Side Water Depth (ft)	12.6	-
MBBR Media Area to Volume Ratio (ft ² /ft ³)	240	180-300
MBBR Media Fill Fraction (%)	54	-
MBBR Media Area (ft ²)	1,808,000	-
MBBR Average/ Peak CBOD Loading (g/ft ² d)	0.27	0.33-0.65
No. of DAF units	2	2
Average Solids Concentration (mg/L)	150	-
DAF Volumetric Loading Rate (USgpd/unit)	1,500,000	-
DAF Flotation Area (ft ² /unit)	95	-
DAF Side Water Depth (ft)	11.3	-
Hydraulic Loading Rate (USgal/ft ² /hr) peak	660	-

The proposed scope of work for this option includes the following:

- Removal/replacement of existing media with smaller diameter media (higher surface area to accommodate more biomass and increase biological treatment capacity);
- Removal/replacement of existing media retention sieves with finer sieves;
- Removal/replacement of existing fine bubble aeration system with a corrosion-resistant coarse bubble aeration system;
- Additional instrumentation including DO control within the bioreactor;
- Installation of pumps in the EQ tank to feed the DAF units;
- Removal/Replacement of the existing DAF system with new DAF units, sludge skimmer, recirculation pumps and polymer make-down and dosing system (subsequent to the near term upgrades); and
- Addition of third channel to the Fournier Press

This option assumes that the flood control berm, UV expansion, polymer pumps, aeration blowers, headworks screen and compactor, online instrumentation in the bioreactor, standby generator, mechanical upgrades, and polymer makedown equipment, and compressor pipework items have been completed already as per the Lunenburg WWTP

Near-Term Upgrades Pre-Design Report (CBCL Limited, 2021). The Option 2 arrangement can be seen in PSK02 in Appendix A.

4.2.3 Operational Discussion

Similar to Option 1, operation would be very similar to the current arrangement at the WWTP. The biggest operational change will be the new DAFs. The principles of operation remain the same, though controls will vary from vendor to vendor. The new DAFs will not include the lamella plates that are currently an operational issue at the WWTP.

The benefit of this option is that the operations are nearly identical and the operators are familiar with the equipment/process, removing some of the current operational issues associated with the existing DAFs. An additional advantage is that the MBBR and DAF system will be supplied by one vendor. The MBBR and DAF are unit processes that are strongly linked and having a single vendor for both options could be beneficial in troubleshooting scenarios, not just on individual process units, but for the treatment system as a whole.

Similar to Option 1, the Fournier Press requires additional capacity to handle the increase in solids loading to the plant, but operation remains the same. The increase in solids loading to the plant will result in increased sludge hauling and disposal costs, but the sludge cake dryness should remain similar to existing. Additional pumping will be required from the equalization tank to the DAFs, which will incur additional electrical costs.

4.2.4 Construction Sequencing

The implementation and sequencing for this option is quite complex, due to the new DAF installation. The bioreactor trains can be taken out of operation one at a time to remove the old media and aeration equipment, and install the new media, aerators and media retention sieves. The first train can be commissioned and brought back online before taking the second train out of operation.

Removal of the existing DAFs and installation of new units will require the use of a crane. To facilitate this, the existing roof structure over a large section of the Process Room will need to be removed. The existing DAFs can be removed one at a time and the new ones put in place. While this is taking place, new pumps will be installed in the equalization tank. This will require a complete bypass of the bioreactor building for about two weeks. Altogether, three to six (3 – 6) weeks of process bypass will likely be needed to complete the work. This construction sequence has significant challenges.

The HVAC and existing roof in the process room will have to be significantly modified to accommodate the new, higher, DAFs. Significant controls modifications will also be required.

Similar to Option 1, a TBA will be required for any process bypasses and an Approval to Construct and Operate must be obtained from NSECC prior to construction. The overall construction and sequencing plan would be developed by the contractor in close consultation with the Town's Engineering and Operations team to minimize process disruptions.

4.3 Option 3: Sequencing Batch Reactor

4.3.1 Technology Overview

The Sequencing Batch Reactor (SBR) process is an aerobic suspended-growth (activated sludge) biological treatment process. The SBR process is a batch process whereby secondary biological treatment, including nitrification, and settlement/clarification is achieved in one reactor. This "fill and draw" type of treatment allows for aeration and clarification to occur in the same reactor. Settling is initiated after the aeration cycle, and clarified supernatant is withdrawn through a decanter mechanism.

A summary of the SBR process is provided below (note that there are some variations between different manufacturers):

1. Fill – Influent enters the anoxic pre-react zone in the SBR tank. The anoxic conditions favor the procreation of microorganisms with good settling characteristics. The wastewater then flows into the react zone of the SBR.
2. React – the microorganisms contact the substrate and a large amount of oxygen is provided to facilitate the substrate (CBOD) consumption. During this period aeration continues until complete biodegradation of CBOD is achieved. During this stage some microorganisms will die because the lack of food and will settle as sludge. The length of the aeration period determines the degree of CBOD consumption.
3. Settle – Aeration is discontinued at this stage and solids separation takes place leaving clear, treated effluent above the sludge blanket. During this clarifying period no liquids typically leave the tank to avoid turbulence in the supernatant.
4. Decant – This period is characterized by the withdrawal of treated effluent from the upper portion of the reactor by the floating solids excluding decanter. This maximizes the distance between the point of withdrawal and the settled sludge.
5. Idle – An idle period is provided as the reactor waits for the start of the next cycle. Sludge wasting typically occurs during this time.

The process is generally implemented using a minimum of two (2) reactors in parallel. It can be conducted as a true batch process where one reactor is filling while the other is settling, or as a continuous-feed SBR which receives influent during all phases of the treatment cycle and decants intermittently. A continuous-feed SBR is proposed for this option.

No Return Activated Sludge (RAS) circulation is required as the key microbes always remain in the reactor. Waste Activated Sludge (WAS) is withdrawn as necessary, to maintain a

healthy sludge age. The entire process is typically controlled using a Programmable Logic Controller (PLC). A typical process schematic and a photo of an SBR installation is shown in Figures 7 and Figure 8 respectively.

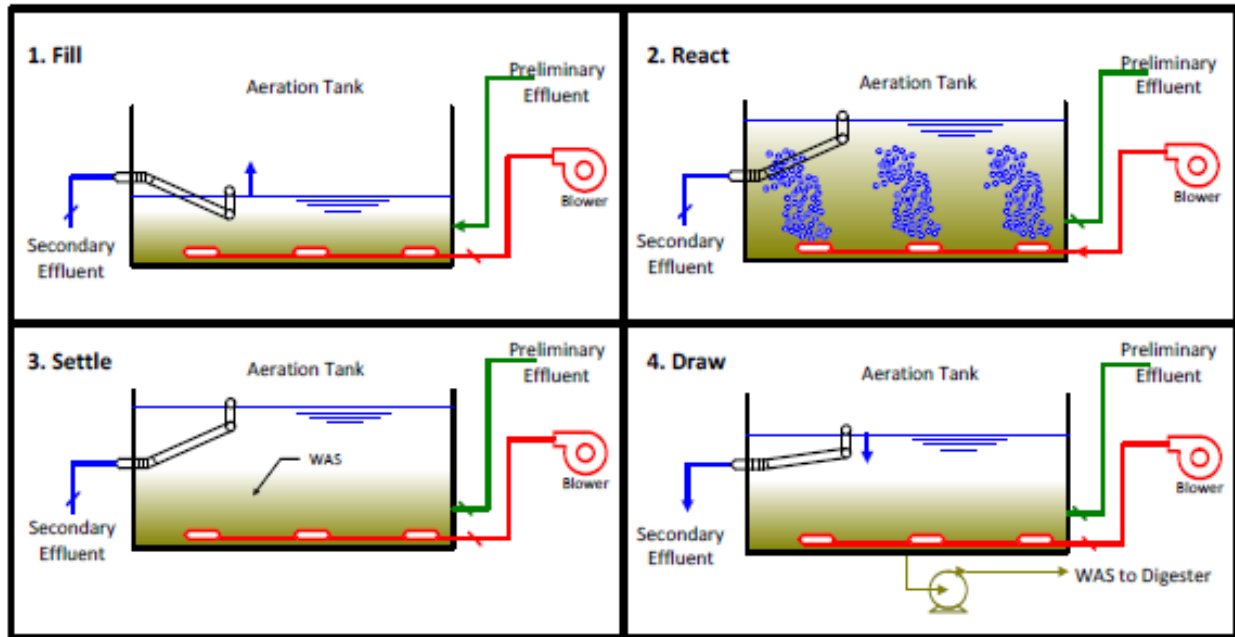


Figure 7: Typical SBR Schematic



Figure 8: Installation of a three-train SBR system

4.3.2 Option Description and Design Criteria

SBRs are operated at long solids and hydraulic retention times, resulting in large reactor volumes; however, the total number of tanks required is reduced, which can result in relatively compact site layouts. The flow equalization provided in SBR systems makes the process resistant to shock loadings. This process is often used for small to medium sized facilities similar to Lunenburg. There are a number of SBRs in communities throughout Nova Scotia.

This design criteria for this system are summarized in Table 8. The tank footprint is currently shown as approximately 70ft. by 90 ft. The tank geometry (basin length, width, and depth) may change significantly to suit geotechnical conditions (assessed during detailed design phase). The geotechnical conditions on the site are poor, largely attributed to the previous land use as a municipal landfill. This constitutes a risk for this option.

Table 8: SBR design parameters

Parameter	Proposed	Typical Design
No. of Blowers	2 Duty +1 Standby	2 Duty +1 Standby
Air flow per blower (SCFM)	740	-
Air pressure (psig)	9.1	-
No. of Basins	2	Minimum 2
Basin Length (inside, ft)	86.3	3 x width
Basin Width (inside, ft)	28.9	
Side Water Depth (ft)	18.0	12-18
Total Reactor Volume (USgal)	670,500	-
Design Hydraulic Retention Time (HRT, hr)	21	15-40
Cycles per Reactor per Day (average/peak)	4-6	4-6
React Time (min) (average/peak)	120/90	60-120
Settling Time (min) (average/peak)	60/30	30-60
Volumetric CBOD Loading (kg BOD/ft ³ /d)	0.006	0.003-0.008
Mixed Liquor Suspended Solids (MLSS, mg/L)	3000	2000-5000

All existing bioreactor tanks (aeration basins, equalization tank, and sludge tank) will be repurposed as an aerobic sludge digester. Similar to previous options, the solids management system will also require expansion.

The existing blower capacity appears sufficient to provide air flow to both the SBR system and the sludge digester, but this should be looked into in more detail to ensure that it will work. The SBR decant rate at peak flow exceeds the design flow of the UV. Therefore, a new effluent equalization tank must be installed after the SBR in order to balance the flow to the UV and keep it within hydraulic limits. The design criteria for the additional upgrades are described below in Tables 9 and 10.

Table 9: Equalization Tank Design Parameters

Parameter	Proposed
Peak Decant Flow Rate (USgpm)	3,138
Decant Time at PDF (hr)	1
UV Design Peak Flow Rate (USgpm)	2,083
EQ Tank Size (USgal) at 1.3-hour retention time	82,000

Table 10: Digester Design Parameters

Parameter	Proposed
Sludge to be Treated (kg/d)	631
Sludge Volume (USgpd)	8500
Digester Retention Time (days)	21
Digester Volume (USgal)	178,000
Aeration Requirement (SCFM)	306

The proposed scope of work for this option includes the following:

- Construction of new tanks to provide a continuous-feed SBR complete with in-tank instrumentation and decanter;
- Construction of an effluent equalization tank complete with discharge pumps;
- Construction of yard pipework to connect existing air pipework to the new SBR tanks; as well as the screened, degrittied influent to head of SBR tanks, and to pump SBR effluent to UV system;
- Removal of existing media from the MBBR bioreactor tanks.
- Modification of the bioreactor tankage to hydraulically connect all tanks to increase the sludge tank volume available;
- Removal of the existing DAF units including recirculation pumps and polymer make-down and dosing system; and
- Addition of third channel to the Fournier Press to increase capacity for sludge dewatering by 50%.

This option assumes that the flood control berm, UV expansion, polymer pumps, aeration blowers, headworks screen and compactor, online instrumentation in the bioreactor, standby generator, and mechanical upgrades have been completed already as per the Lunenburg WWTP Near-Term Upgrades Pre-Design Report (CBCL Limited, 2021). The Option 3 arrangement can be seen in PSK03 in Appendix A.

4.3.3 Operational Discussion

The operation of an SBR is relatively simple and does not require a high amount of operator intervention. The SBR eliminates the need for separate clarification mechanisms and reduces the amount of equipment requiring operating attention and maintenance. The SBR has highly automated controls that includes instrumentation, automatic valves,

and decanters. The increased level of automation requires that the critical items (decanter, valves, etc.) are well maintained to reduce the risk of failure.

Each of the two SBR tanks have operational settings to allow them to process the entire PDF flow temporarily when necessary, to be able to isolate the other tank for maintenance.

The key operational costs associated with a SBR system include labour, maintenance, power, and sludge disposal. Maintenance costs would be somewhat reduced compared to the existing as there is less equipment to maintain. Chemical addition is not required for the use of the SBRs, though it is still required for sludge dewatering.

The Fournier Press requires additional capacity to handle the increase in solids loading to the plant, but operation remains the same. The increase in solids loading to the plant will result in increased sludge hauling and disposal costs, and these will be further increased by a reduction in the sludge cake dryness, since SBR sludge does not dewater as well as DAF sludge. This increases the volume and weight of the sludge for an equivalent solids content.

4.3.4 Construction Sequencing

The new SBR and equalization tanks are proposed to be located behind the existing bioreactor building. These can be constructed while the existing plant is in operation. Tie-ins would require a complete bypass for approximately one week. Once connected, the next phase of construction would require bypassing of the bioreactor to allow the modification of the existing bioreactor building as required. This could take 3–6 weeks to complete. Sludge accumulation during this time would be relatively low and removal could be accomplished by vacuum truck. The third rotary press channel could be added at this time. Removals could be undertaken once the SBR process was fully operational. This option includes significant changes to the overall controls system. It includes a change in treatment technology (lack of operator familiarity). There are moderate challenges in the construction sequencing of this option.

Similar to other options, a TBA will be required for any process bypasses and an Approval to Construct and Operate must be obtained from NSECC prior to construction. The overall construction and sequencing plan would be developed by the contractor in close consultation with the Town's Engineering and Operations team to minimize process disruptions.

4.4 Option 4: MBR

4.4.1 Technology Overview

The Membrane Bio-Reactor (MBR) process uses an aerobic suspended-growth (activated sludge) biological treatment process followed by a membrane filtration system. The key

feature of the MBR system is the membrane filtration system that allows for elevated levels of biomass to remove organics from the wastewater, as well as very good solids removal. The effluent flows through the membrane, but the biomass and solids cannot pass through and are retained in the bioreactor system. The suspended biomass is recycled to the head of the biological reactor and mixed with the influent wastewater stream to effectively remove organic matter. The biomass in an MBR is suspended in the wastewater rather than being attached to plastic media as in an MBBR system. Similar to the SBR, sludge wasting is required periodically to reduce sludge build up and control the solids retention time within the MBR system. A typical schematic of the system is shown in Figure 9.

Benefits of an MBR system include a compact footprint and tertiary quality effluent without secondary clarification. However, they are often not cost-effective if regulatory effluent requirements do not specifically require their use. The membrane system can be damaged by large or stringy solids, therefore use of the MBR process requires a higher degree of fine screening (0.07", or 2 mm, drum screen) than the other options.

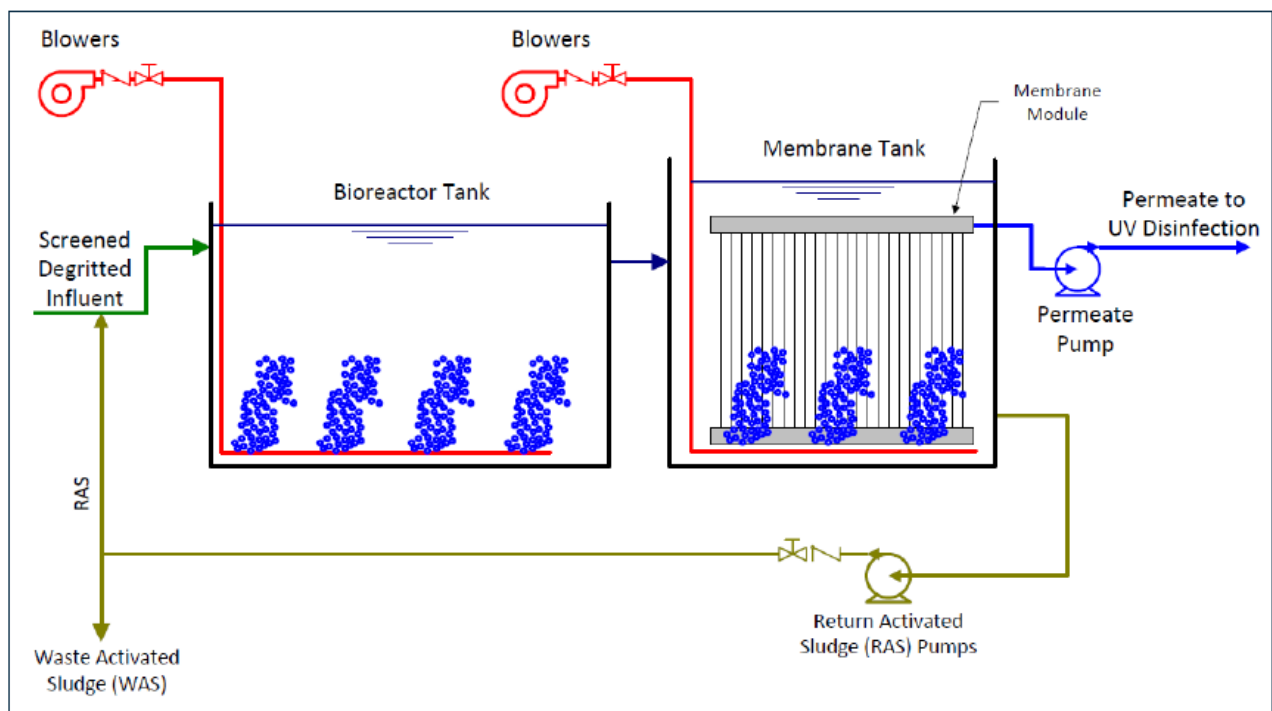


Figure 9: Typical MBR Operation

There are two basic configurations for membranes: hollow fiber bundles and plate membranes. The proposed installation includes hollow fibre tubular membranes bundled together. Bundles of membranes are grouped together and connected by manifolds into units that can be changed out for maintenance. Hollow fibre membrane systems are more common for wastewater applications than plate membranes.



Figure 10: Membrane Module for Installation

4.4.2 Option Description and Design Criteria

The MBR system would make use of the existing aeration tanks, equalization tank and sludge tank as a bioreactor tank. A new process building (approximately 70 ft. by 75 ft.) would be constructed to house the MBR equipment, including the membrane filtration trains, air compressor, blowers, back pulse water tank, sludge holding tank, and drum screening room. The building would include a general process area and electrical/control room.

The wastewater would first be screened and dewatered in the existing headworks, and then would flow to the new screening room located in the new process building for additional 2 mm fine screening. The wastewater would enter the repurposed bioreactor from the east side of the bioreactor building as it does now, and be aerated with the existing aeration system, though with aerator changes to the equalization and sludge tanks. Flow from the bioreactor building would flow to the membrane filtration trains for solids removal. The permeate from the membrane will then flow to the existing process room for UV disinfection and effluent pumping. WAS will be directed to the sludge holding tank, while backwash water is directed to the head of the plant.

The design criteria for this option are summarized below in Table 11. Similar to the SBR, the tank and building geometry (length, width, and depth) may change significantly to suit geotechnical conditions. This constitutes a risk for this option.

Table 11: MBR Design Parameters

Parameter	Proposed
No. of blowers	2 Duty +1 Standby
Air flow per blower (SCFM)	1050
Air pressure (psig)	7.5
No. of Trains	2
No. of Cassettes per Train	4
No. of Modules	320
Total Reactor Volume (USgal)	178,000
Mixed Liquor Suspended Solids (MLSS, mg/L)	8000

The proposed scope of work for this option includes the following:

- Removal of existing media from the MBBR bioreactor tanks;
- Modification of the bioreactor tankage to hydraulically connect all tanks to increase tankage
- Removal of existing coarse bubble aeration system from equalization and sludge tanks and replacement with a corrosion-resistant fine bubble aeration system for increased oxygen-transfer capacity;
- Installation of additional process instrumentation;
- Construction of new process building containing a 2 mm drum screen, a process area with blowers and compressors, a control room, a membrane filtration tank for the membrane cassettes, back-pulse water tank, and a sludge holding tank;
- Removal of the existing DAF units including recirculation pumps and polymer make-down and dosing system; and
- Addition of third channel to the Fournier Press

This option assumes that the flood control berm, UV expansion, polymer pumps, aeration blowers, headworks screen and compactor, online instrumentation in the bioreactor, standby generator, and mechanical upgrades have been completed already as per the Lunenburg WWTP Near-Term Upgrades Pre-Design Report (CBCL Limited, 2021). The Option 4 arrangement can be seen in PSK04 in Appendix A.

4.4.3 Operational Discussion

The operation of an MBR plant would be significantly different than the current MBBR and DAF process at the plant, though it is similar to the processes at the Town’s Water Treatment Plant. It would likely require the Town to support the Operator in Direct Responsible Charge (ODRC) to upgrade to a Class III Wastewater Treatment certification, or

to recruit a new Class III operator to take on the role of ODRC. Either way, an additional staff member would be required for maintenance of the added equipment and processes.

There would be very low risk of solids carryover in the effluent, and effluent quality would be enhanced to a target of 5 mg/L of both CBOD and TSS. There would be no requirement to use polymer in the wastewater treatment process, so risk of polymer carryover would be eliminated.

MBR systems require additional pumping to push the water through the membranes and to recirculate the solids through the bioreactor. The membrane filtration process also requires multiple cleaning systems to extend the membrane life and keep the system in operation. The primary cleaning system uses an air scour technique to reduce material build-up on the membranes, which uses air bubbles to move the membranes and dislodge solids. The secondary cleaning system uses a back-pulsing technique in which permeate is pumped backwards through the membranes to keep the pores clean. Finally, the membranes require periodic chemical clean-in-place operational procedures to remove scale and resistant organics. Clean in place chemicals and waste are recycled to the head of the plant.

The largest cost of the MBR system is the maintenance of the membrane units. Membrane units require periodic replacement. The period of replacement can be influenced by several factors, including effectiveness of upstream screening, operational throughput of the membranes, and proper cleaning. Effective upstream screening refers to the additional fine screening to prevent large solids from physically damaging the membranes. Operating the membranes at the appropriate throughput rate and operating within the system limits of design will reduce wear on the membranes.

The Fournier Press requires additional capacity to handle the increase in solids loading to the plant, but operation remains the same. The increase in solids loading to the plant will result in increased sludge hauling and disposal costs, and these will be further increased by a reduction in the sludge cake dryness, since MBR sludge does not dewater as well as DAF sludge. This increases the volume and weight of the sludge for an equivalent solids content.

Electricity and labour costs would increase significantly with an MBR system compared to the existing MBBR system. Electricity costs are typically higher with MBR systems due to the additional pumping and energy demand of the equipment. The labour costs increase as the MBR system would require an additional full-time Class III operator at the plant. Maintenance costs may also be high, to account for replacement membranes, maintaining additional equipment, clean-in-place chemicals, and the labour associated with these works.

4.4.4 Construction Sequencing

The new process building is proposed to be located behind the existing bioreactor building. It can be constructed while the existing plant is in operation. The new drum screen, sludge tank, and membrane equipment housed in the building can also be constructed without disruption to the existing plant. Once these are complete, the tie-ins and changeover would require complete bypass of the bioreactor and solids removal system to modify the existing bioreactor building as required. This could take 3–6 weeks of continuous bypass to complete. This option includes significant changes to the overall controls system. It includes a change in treatment technology and lack of operator familiarity. There are considerable challenges in the construction sequencing of this option.

4.5 Option 1A: Polishing with a Disk Filter

4.5.1 Technology Overview

A disk filter uses woven cloth filters mounted on multiple disks which provide a large filter area in a small footprint. The disk filter is used to remove TSS and excess polymer from the effluent prior to disinfection and discharge.

The proposed disk filter has an outside-in flow pattern and stationary disks. As the water passes from the tank through the cloth filter, it enters the core of each disk module. The water exits each disk through a discharge channel. By having a separate effluent port for each disk, each disk can be individually monitored and may be isolated for maintenance or replacement. Filtration can continue as normal with one or more disks isolated. Removal of a disk and replacement of the cloth media can be accomplished in about 1 hour, according to the manufacturer, minimizing downtime.



Figure 11: Disk Filter

4.5.2 Option Description and Design Criteria

The disk filter can be used as an addition to Option 1, or 2 if more stringent effluent criteria is expected at the plant in the future. The disk filter would provide effluent polishing for enhanced solids removal to produce effluent concentrations as low as 5 mg/L CBOD and TSS, depending on the upstream treatment and filter operations. This option would be most applicable to Options 1 and 2 as the expected effluent concentrations from either process is approximately 20 mg/L CBOD and TSS. The SBR could produce final effluent concentrations of 15 mg/L CBOD and TSS and would only require the disk filter option if the limits were below 15 mg/L, but would have a different arrangement, not detailed here.

The disk filter could also be used to reduce polymer discharge from the plant so that it cannot enter Lunenburg Front Harbour. This would not be an alternative to relocating the outfall, but could further reduce the effect of the effluent on the receiving water. Additional steps to better target polymer dosing and reduce polymer overdosing are recommended as well.

The disk filters would be implemented upstream of the UV to improve disinfection and reduce UV maintenance. This would require the disk filters, the UV system, and the effluent pumps to all be housed in a new building (approximately 44 ft. by 26 ft.) north of the existing bioreactor. In this option intermediate pumping of the clarified effluent from the DAF to the new disk filter building would be required.

The intermediate pumps could be installed in the existing effluent pump location. The existing UV units could possibly be relocated to the new disk filter building, though for construction sequencing purposes it might be preferable to replace some or all parts of the system.

The proposed design criteria for the disk filter is shown below in Table 12.

Table 12: Disk Filter Design Parameters

Parameter	Proposed
Filter Headloss (psi)	11
Total number of Filters	2
Configuration	2x 50% duty, no standby
Area per filter (ft ²)	430
Duty filtration area (ft ²)	860
Hydraulic Loading Rate (gal/ft ² h)	860
Surface solids loading rate (kg/ft ² d)	0.13

The proposed scope of work for this option includes the following:

- Construction of new process building containing two disk filter units, a control room, the UV system, and the relocated final effluent pumps;

- Installation of intermediate pumps in the existing final effluent pump wet-well; and
- Modification of the yard piping to provide an intermediate forcemain to the new process building, as well as reconnection of the final effluent pumps to the effluent forcemain.

This option assumes that the flood control berm, UV expansion, polymer pumps, aeration blowers, headworks screen and compactor, online instrumentation in the bioreactor, standby generator, mechanical upgrades, DAF manifolded manual weirs, polymer makedown equipment, and compressor pipework items have been completed already as per the Lunenburg WWTP Near-Term Upgrades Pre-Design Report (CBCL Limited, 2021). The Option 1A arrangement can be seen in PSK05 in Appendix A.

4.5.3 Operational Discussion

The operation of the disk filter is automated and designed to require little operator intervention. In normal operation, solids accumulate on the outer surface of the cloth media, and a thin filter cake forms, raising headloss through the media. The tank level gradually rises to a set point level that triggers backwash operation. The backwash cleaning system initiates automatically without operator action required. Electronically controlled backwash valves direct suction from a sequence of disks, minimizing peak backwash flow and required power consumption. Influent to the disk filter can continue throughout the backwash cleaning cycle allowing for uninterrupted filtration. Sludge from backwashing would be pumped to the sludge tank for dewatering with the DAF sludge.

The addition of the disk filter requires daily inspection from the operator that will take approximately half an hour per day. It is assumed that this can be accommodated with the existing operations staff. The media elements require annual replacement.

4.5.4 Construction Sequencing

The new disk filter building could be constructed while the existing treatment plant is in full operation, but some shutdowns would be required for tie-ins and during relocation of the effluent pumps and UV. The plant would likely need to bypass disinfection and the final effluent pumps for two to three weeks. This means that the secondary quality, but non-disinfected effluent would go through the emergency overflow to Lunenburg Back Harbour. This construction sequence has moderate challenges.

A TBA will be required for any process bypasses, which must be obtained from Environment Canada under the terms of the WSER legislation. An Approval to Construct and Operate must be obtained from NSECC before beginning construction. The overall construction and sequencing plan would be developed by the contractor working together with the Town Engineering and Operations team with the goal of minimizing process disruptions.

Chapter 5 Evaluation of Options

5.1 Capital Cost Comparison

The opinion of probable costs have been developed based on experience, qualifications and best judgement. The probable costs have been prepared in accordance with acceptable principles and practices. Market trends, non-competitive bidding situations, unforeseen site conditions, unforeseen labour, material adjustments, and the like are beyond the control of CBCL. As such, we cannot warrant or guarantee that actual costs will not vary from the opinion provided.

The costs associated with the recommended upgrades to the WWTP are shown below, in 2021 dollars, with no allowance for inflation. The opinions of cost include allowances for engineering and contingencies for unforeseen changes during design and construction. The Engineering allowance is indicative only. The summarized costs are in Table 13.

Table 13: Opinion of Probable Costs

Summary Sheet	MBBR	MBBR + DAF	SBR	MBR	MBBR + DISK
	Option 1	Option 2	Option 3	Option 4	Option 1A
Mobilization	\$76,000	\$157,000	\$220,000	\$230,000	\$222,000
Building Modifications	-	\$181,000	\$26,000	\$293,000	\$385,000
Site Works/New Tanks	-	-	\$1,822,000	\$1,679,000	\$469,000
Metals	\$52,000	\$127,000	\$41,000	\$75,000	\$52,000
Process Equipment	\$851,000	\$2,718,000	\$937,000	\$1,923,000	\$2,307,000
Mechanical	\$75,000	\$416,000	\$615,000	\$601,000	\$358,000
Electrical	\$86,000	\$454,000	\$600,000	\$557,000	\$586,000
Sub Total	\$1,140,000	\$4,053,000	\$4,261,000	\$5,358,000	\$4,379,000
Design Development Contingency (20%)	\$228,000	\$810,600	\$852,200	\$1,071,600	\$875,800
Construction Contingency (10%)	\$114,000	\$405,300	\$426,100	\$535,800	\$437,900
Engineering (10%)	\$114,000	\$405,300	\$426,100	\$535,800	\$437,900
Total	\$1,596,000	\$5,674,200	\$5,965,400	\$7,501,200	\$6,130,600

All of the options assume that a number of Near-Term upgrade items have been completed. For Options 1 and 1A, all the Near-Term items are assumed to be complete. For Option 2, all Near-Term items except the DAF manifolded manual weirs are assumed to be complete. For Option 3 and 4, all Near-Term items except for the DAF manifolded manual weirs, DAF polymer makedown, and compressor pipework are assumed to be complete, and the cost of the Polymer pumps are reduced to \$40,000, to ensure they can operate until the expansion is complete.

The costs for each of these are laid out in Table 14, along with an Overall Total for the option. These totals are capital costs only and do not account for the potentially differing timing of the expenses.

Table 8: Overall Opinion of Probable Capital Cost for Long-Term Expansion with Near-Term items included

Summary Sheet	MBBR	MBBR + DAF	SBR	MBR	MBBR + DISK
	Option 1	Option 2	Option 3	Option 4	Option 1A
Long Term Expansion	\$1,596,000	\$5,674,200	\$5,965,400	\$7,501,200	\$6,130,600
Near-Term Items	\$3,604,000	\$3,444,000	\$2,948,000	\$2,948,000	\$3,604,000
Overall Total	\$5,200,000	\$9,118,200	\$8,913,400	\$10,449,200	\$9,734,600

5.2 Operational Cost Comparison

Operations and Maintenance (O&M) costs were developed for the options based on experience and operation of similar facilities, coupled with historical costs for the existing facility and details from equipment suppliers. A comparison of the operational costs are shown in Table 15 below. Operational Costs are broken into five (5) categories: power; labour; sludge disposal; supplies, equipment, parts; and chemicals.

Power refers to the anticipated electrical costs. Labour refers to costs associated with operational staff, and should be taken as comparative, rather than absolute. Sludge disposal refers to the cost to haul and dispose of sludge and varies based on amount and the sludge dryness. Supplies, Equipment & Parts refers to anticipated spare parts/supplies for maintenance of each option, including membrane replacement. Chemical costs refers to the cost of polymer or other chemicals used for each option. All costs are represented on an annual basis.

Table 9: Operational Cost Comparison (per year)

Category	Current	MBBR	MBBR+ DAF	SBR	MBR	MBBR+ DISK
	No Expansion	Option 1	Option 2	Option 3	Option 4	Option 1A
Power	\$219,000	\$219,000	\$225,000	\$189,000	\$264,000	\$227,000
Labour	\$140,000	\$140,000	\$140,000	\$140,000	\$200,000	\$140,000
Sludge Disposal	\$61,000	\$91,000	\$91,000	\$125,000	\$125,000	\$100,000
Supplies, Equipment & Parts	\$19,000	\$28,000	\$28,000	\$25,000	\$56,000	\$32,000
Chemicals	\$39,000	\$30,000	\$25,000	\$15,000	\$18,000	\$44,000
Total O&M Costs	\$478,000	\$508,000	\$509,000	\$494,000	\$663,000	\$543,000

5.3 Technological Fit Comparison

There are a variety of different processes proposed, which also vary in their technological fit with the Town’s wastewater treatment needs.

Either of the upgraded MBBR-DAF processes (Options 1 and 2) would be somewhat more complex than an SBR to operate, but would be similar to existing. Both would require consistent chemical dosing and good dosing control to meet wastewater quality objectives suited to a relocated outfall. This type of process is able to treat the wide range of flows and loads that the WWTP receives, because the microbes that make up the heart of the treatment process are attached to media so they are resistant to being flushed out during high flow conditions. Nonetheless, they require more equipment and they are unusual for this region, so maintenance requirements are higher and the operators cannot get advice on the process from local counterparts. The effluent quality from this process is comparable to that from an SBR process. In order to ensure that polymer is not entering the harbour, it is possible to add a polishing process such as a disk filter. This is also a future-proofing option if effluent standards rose in future to a level that this process could not reliably and continuously meet.

The most straightforward process of these is Option 3 (SBR), which uses only air and settling to produce good quality effluent that would be well suited to a relocated outfall. This process is largely automated and uses no chemicals. It reduces the amount of equipment to be maintained overall, resulting in simplified maintenance. This process is moderately resilient during quickly changing flows, but has programmed responses to allow it to adapt to the changing conditions. This is a very reliable process with low maintenance down-time required, because there are fewer pieces of equipment required.

The Option 4 (MBR) process is the most complex, even though it is also highly automated. By passing all flow through a membrane, it produces very good quality effluent, but this means that the membranes must be carefully protected from everything that could damage them, including from chemicals dumped inappropriately into the sewer. The membranes require additional headworks equipment to remove stringy material that can

wrap around the membrane fibres, as well as any sharp objects. The membrane banks have a dedicated cleaning system to remove excess bacterial build up from the membrane surface. This process is also well suited to variable flows and loads because the key microbes cannot pass through the membrane and are retained in the plant. A program to periodically replace the membrane modules is required to ensure that they are kept in good repair. This membrane filtration process is familiar to Town staff because it is similar to the process in the water treatment plant, though with the addition of a biological treatment process as well. This process produces the highest quality effluent, which in fact is higher than would be typically required by regulators for marine receiving water. If the Town does not want to relocate the outfall, then this process would be the best suited, though the existing location still risks public exposure to undiluted effluent and is not recommended.

5.4 Regulatory Risk Comparison

Option 1 (MBBR with existing DAF) has a moderate regulatory risk, because the DAF units would be operating closer to their capacity limit, and there is a risk that peak solids loads could exceed the DAF design capacity.

Option 2 (MBBR with replacement DAF) has a low regulatory risk. It is sized for the expanded load, and this technology can reliably meet the current effluent criteria.

Option 3 (SBR) has a low regulatory risk. SBRs normally produce effluent that meets or exceeds the current effluent criteria.

Option 4 (MBR) has the lowest regulatory risk, because the effluent quality produced is significantly better than that currently required by the regulators, so it is unlikely to produce non-compliant effluent as long as it is well maintained.

Option 1A (MBBR with existing DAF with added disk filter) has a low regulatory risk. This process would be able to produce very good, compliant effluent, and could be used to reduce regulatory risk of other options.

5.5 Operational Risk Comparison

Option 1 (MBBR with existing DAF) has a low-moderate operational risk. This process shows potential to use a lower polymer dose than the existing DAFs currently do, if ongoing experimental trials are successful, and combined with additional controls as presented in the parallel Near-Term Upgrades Pre-design Report (CBCL Limited, 2021). Lowering the dose could reduce the risk of solids and polymer carryover. The lamella plates in the existing DAFs will still need to be cleaned regularly, which is an ongoing maintenance issue.

No additional pumping would be required. The MBBR-DAF process is a reliable process, but has a fairly high number of pieces of equipment to maintain.

Option 2 (MBBR+DAF) has a low-moderate operational risk. The main process equipment would be supplied as a package in this case, which means that it is intended to work together as a unit, and gives one point of contact if there are process or maintenance issues. This process would use polymer less often than the existing DAFs currently do, and has a smaller risk of solids and polymer carryover. It would eliminate the current issue with cleaning the lamella plates in the DAFs. Pumping would be required from the MBBR to the DAFs, adding a new set of pumps to maintain. The MBBR-DAF process is a reliable process, but has a fairly high number of pieces of equipment to maintain. For Option 2 the Town could subscribe to a manufacturer program for online monitoring and process assistance in order to have additional notice of required maintenance, and ongoing technical support.

Option 3 (SBR) has low operational risk, and it is more resilient to the types of material coming into the plant that could damage an MBR. Since it requires no chemicals, then there are fewer supply chain risks than with a DAF process, and the risk of releasing polymer to the harbour is eliminated. However, SBRs are not as good as MBBRs at retaining the microbes in a high flow scenario because the microbes are suspended in the water rather than being attached to the media. Pumping would be required from the SBR to the UV, adding a new set of pumps to maintain. The SBR process is very reliable with low maintenance down-time required, partly because there are fewer pieces of equipment required, and also because they are very robust.

Option 4 (MBR) has a significant amount of operational risk, because the membranes can be damaged by chemicals, as well as stringy and sharp materials. Efforts to prevent chemicals entering the sewer or to remove stringy and sharp objects in the headworks are critical to managing the operational risk of membrane failure, which requires expensive replacement membranes, even though it does not usually result in rapid regulatory non-compliance. The WWTP has received material several times in the past that left sticky white residue all over equipment in the plant, as well as making the effluent cloudy, and visible in Lunenburg Front Harbour. It is likely (though not certain) that the membranes could remove this material, but also likely that they would be damaged by this or similar substances. Pumping would be required through the membranes, adding a new set of pumps to maintain, as well as additional blowers and chemical clean-in-place equipment. The MBR process is very reliable but has higher maintenance down-time required, and is vulnerable to failure of screening, as well as to non-standard influents such as that described above.

Option 1A (MBBR with existing DAF with added disk filter) has a low operational risk. This process would have low risk of polymer or solids carryover. The lamella plates in the existing DAFs will still need to be cleaned regularly, which is an ongoing maintenance issue, and there would be additional maintenance needed on the disk filter, as well as an

additional set of pumps to maintain for intermediate pumping. The disk filter adds reliability to the MBBR-DAF process by preventing solids or polymer carryover, but it also increases the amount of equipment to be maintained.

5.6 Construction Risk Comparison

Construction risks vary widely with these options, notwithstanding that some construction risks, by their nature, will not be identified until construction is underway. The option with the lowest apparent construction risk is Option 1 (MBBR with existing DAF), which requires the least amount of alterations to existing structures and processes. Very low bypass duration would be anticipated with this option, and the risk of encountering poor geotechnical conditions on the site is minimized.

Option 2 (MBBR+DAF) has moderate construction risks, requiring significantly more alterations to existing buildings and equipment, as well as longer process bypasses, but with low risk of encountering poor geotechnical conditions.

Option 3 (SBR) has moderate construction risks. Most of the work can be done without interference with existing processes, and the process bypass requirements are low. However, the risk of encountering poor geotechnical conditions on the site is high. This would require a significant geotechnical investigation to determine appropriate design conditions, and may require substantial over-excavation and replacement with structural fill to provide a suitable base for the tanks. Groundwater may also pose challenges on the site.

Option 4 (MBR) has the highest construction risk. Much of the work can be done without interference with existing processes, but process bypass requirements would be relatively high, comparable to Option 2. The risk of encountering poor geotechnical conditions on the site is high, comparable to Option 3, with a similar footprint. This would require a significant geotechnical investigation to determine appropriate design conditions, and may require substantial over-excavation and replacement with structural fill to provide a suitable base for the tanks. Groundwater may also pose challenges on the site, though not to the same degree as with Option 3, because the tanks would be somewhat shallower.

Option 1A (MBBR with existing DAF with added disk filter) has moderate construction risks. Most of the work can be done without interference with existing processes, and the process bypass requirements are low, but the risk of encountering poor geotechnical conditions on the site is moderate compared to Options 3 and 4. This would still require a significant geotechnical investigation to determine appropriate design conditions, and may require substantial over-excavation and replacement with structural fill to provide a suitable base for the building. Groundwater may also pose challenges on the site, but to a lesser degree than Options 3 and 4.

5.7 Summary of Options

The following table summarizes the information in the sections above to give a simplified comparison of all the information.

Table 16: Summary of Options

Category	MBBR	MBBR + DAF	SBR	MBR	MBBR + DISK
	Option 1	Option 2	Option 3	Option 4	Option 1A
Capital Cost	\$1,596,000	\$5,674,200	\$5,965,400	\$7,501,200	\$6,130,600
Operational Cost	\$508,000	\$509,000	\$494,000	\$663,000	\$543,000
Technological Fit	No change	No change	Good	Acceptable	Acceptable
Regulatory Risk	Moderate	Moderate	Low	Lowest	Low
Operational Risk	Moderate	Moderate	Lowest	Highest	Low
Construction Risk	Lowest	Moderate	Moderate	Highest	Moderate

Chapter 6 Recommended Upgrade

A Kepner Tregoe Decision Analysis Workshop was held with Town Staff on July 20 and 21, 2021, to fully discuss, evaluate, compare, and score each of the options. The resulting team decision was that Option 3 (SBR), with the highest score, was the preferred expansion option.

6.1 Description of Upgrade

Option 3 (conversion to SBR) is the recommended option for expansion. This includes replacing the current MBBR-DAF process with a Sequencing Batch Reactor process. This option assumes that the flood control berm, UV expansion, aeration blowers, headworks screen and compactor, online instrumentation in the bioreactor, standby generator, and mechanical upgrades have been completed prior to the capacity expansion.

Wastewater would enter the headworks for screening using the upgraded screen, and then pass through the grit removal tanks. Screened, degritted wastewater would flow by gravity to new SBR tanks to be constructed behind the existing bioreactor building. Here the wastewater would be aerated by the recently replaced blowers for biological treatment and then the air would be turned off to allow solids to settle out. The clear supernatant would be decanted from the top of the tank to a new equalization tank. From here it would be pumped to the expanded UV system for disinfection, and then it would flow to the effluent lift station to be pumped to the outfall.

Waste sludge would be pumped from the SBR tanks to the Aerobic Digester, which would be created by modifying the existing bioreactor building. The sludge would be aerated to break it down and stabilize it, and then dewatered using an expanded Fournier Press with a third channel prior to disposal off-site.

6.2 Key Reasons for Recommendation

The following factors contributed to the recommendation of Option 3 as the preferred option:

- Very reliable and consistent operations;
- Good resilience to changing influent conditions;
- No polymer required for process, so no risk of polymer carry-over;

- Low risk of odour generation;
- Acceptably short tie-in shutdowns during construction;
- Widely used by municipalities in the Maritimes; and
- Reduced maintenance and annual operational costs.

6.3 Risks to be Mitigated

A key construction risk with this option is the high likelihood of encountering poor geotechnical conditions on the selected site, which is a former landfill. It is unlikely that this risk would prevent this option from being completed. The existing WWTP also sits on similarly poor geotechnical conditions and was successfully completed. However, it is recommended to reduce this risk proactively to prevent excessive unanticipated costs or severe delays from arising during construction.

To mitigate this risk, it is proposed to carry out a thorough and extensive geotechnical investigation prior to detailed design, in order to determine appropriate design conditions and a recommended technical approach to building these tanks. Construction of the SBR tanks may require substantial over-excavation and replacement with structural fill to provide a suitable base for the tanks, or it may be more cost-effective to use piles. A higher-than-typical design development contingency is recommended to be carried at this stage to ensure that funding is adequate to carry out the project. A strong construction contingency budget should also be considered, to adapt to unforeseen changes during construction.

6.4 Next Steps

The next steps for proceeding to detailed design and construction of this option are as follows:

1. Submit report to NSECC for comment;
2. Continue to collect routine influent samples to provide data for future process sizing;
3. Continue steps to exclude seawater from the collection system;
4. Develop plan to construct required Near-Term items;
5. Develop plan for strategic sewer separation;
6. Apply for funding;
7. Procure and carry out predesign of SBR expansion, including geotechnical investigation;
8. Procure and carry out detailed design of SBR expansion, to produce tender package;
9. Submit Application for Approval to NSECC;
10. Tender construction of the expansion; and
11. Construct SBR expansion.

Chapter 7 References

- ACWWA. (2006). *Atlantic Canada Wastewater Guidelines Manual for Collection, Treatment and Disposal*. Environment Canada.
- CBCL Limited. (2019). *Town of Lunenburg Wastewater Treatment Plant Evaluation and Options Identification*.
- CBCL Limited. (2021). *Town of Lunenburg Wastewater Outfall Extension Pre-Design*.
- CBCL Limited. (2021). *Town of Lunenburg WWTP Near-Term Upgrades*.
- Metcalf & Eddy, Inc. (2003). *Wastewater Engineering: Treatment and Reuse*. New Delhi: Tata McGraw-Hill.

APPENDIX A

Sketches: Options for Expansion



NEW MBBR MEDIA, AERATION PIPE WORK, AND OUTLET PLATES

GENERATOR AS PER NEAR TERM UPGRADES

ELECTRICAL ROOM EXPANSION AS PER NEAR TERM UPGRADES

HEADWORKS AS PER NEAR-TERM UPGRADES

BLOWER ROOM AS PER NEAR-TERM UPGRADES

POLYMER MAKE-DOWN AS PER NEAR-TERM UPGRADES

ADDITIONAL UV AS PER NEAR-TERM UPGRADES

PROCESS ROOM


THIRD CHANNEL TO FOURNIER PRESS

EXISTING BIOFILTER

NOTES:

1. NEW MBBR MEDIA, AERATION EQUIPMENT, AND MEDIA RETENTION SIEVES.
2. EXISTING DAF UNITS RETAINED.
3. EQUALIZATION TANK AND SLUDGE TANK RETAINED. NEW AERATION PIPEWORK PROVIDED IN THESE TANKS.
4. BLOWERS, POLYMER MAKE-DOWN, POLYMER DOSING, UV, INLET SCREEN AND GENERATOR PROVIDED AS PER NEAR-TERM UPGRADE.

DRAWING NAME: Y:\HALIFAX\DATA\PROJECTS\210803.01_TOL_WWTP & OUTFALL PREDESIGN AND BCA\44 CAD\06 PROCESS\210803.01_PSK01.LT OPTION 1.DWG LAYOUT NAME: PSK01.PLOT DATE: JULY 1, 2021 3:58:36 PM CAD OPERATOR: NOELM

Date JUL 02/21	Scale 1"=40'	Designed EH	Drawn NHM	Checked -	Approved -	CBCL No. 210803.01	Contract -
						TOL WWTP LONG TERM OPTIONS	
						OPTION 1 - MBBR UPGRADE	



NEW MBBR MEDIA, AERATION PIPE WORK, AND OUTLET PLATES

GENERATOR AS PER NEAR TERM UPGRADES

ELECTRICAL ROOM EXPANSION AS PER NEAR TERM UPGRADES

HEADWORKS AS PER NEAR-TERM UPGRADES

BLOWER ROOM AS PER NEAR-TERM UPGRADES

POLYMER MAKE-DOWN AS PER NEAR-TERM UPGRADES

THIRD CHANNEL TO FOURNIER PRESS

EXISTING BIOFILTER

PROCESS ROOM

NEW DAF UNITS


MODIFICATIONS TO ROOF STRUCTURE REQUIRED

ADDITIONAL UV AS PER NEAR-TERM UPGRADES

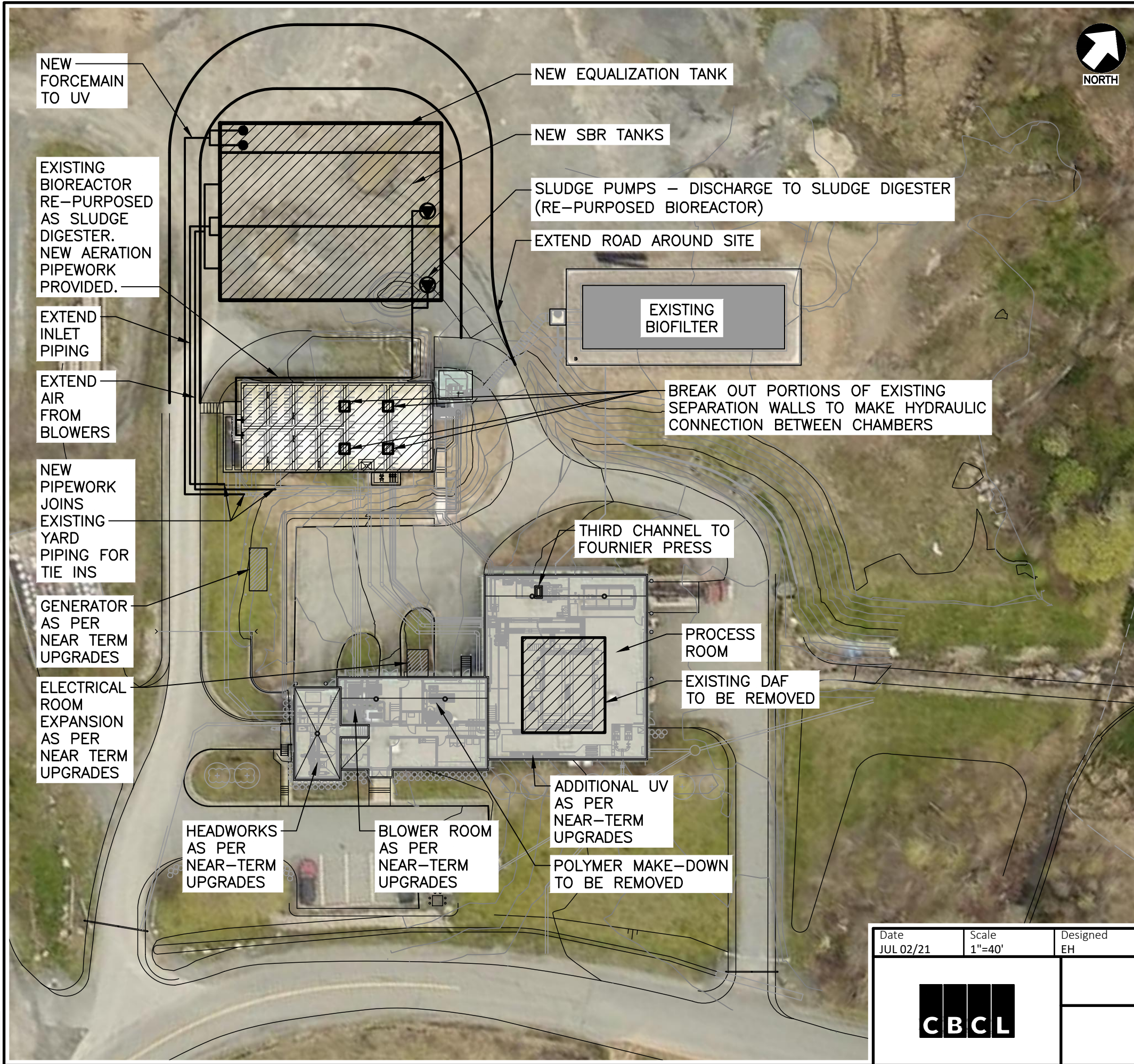
NOTES:

1. NEW MBBR MEDIA, AERATION EQUIPMENT, AND MEDIA RETENTION SIEVES.
2. NEW DAF UNITS INSTALLED.
3. EQUALIZATION TANK AND SLUDGE TANK RETAINED. NEW AERATION PIPEWORK PROVIDED IN THESE TANKS.
4. BLOWERS, POLYMER MAKE-DOWN, POLYMER DOSING, UV, INLET SCREEN AND GENERATOR PROVIDED AS PER NEAR-TERM UPGRADE.
5. MODIFICATIONS REQUIRED TO PROCESS ROOM ROOF STRUCTURE TO INSTALL NEW DAF UNITS.

DRAWING NAME: Y:\HALIFAX\DATA\PROJECTS\210803.01_TOL_WWTP & OUTFALL PREDESIGN AND BCA\44 CAD\06 PROCESS\210803.01_PSK02.LT_OPTION 2.DWG LAYOUT NAME: PSK02 PLOT DATE: JULY 1, 2021 3:59:14 PM CAD OPERATOR: NOELM

Date JUL 02/21	Scale 1"=40'	Designed EH	Drawn NHM	Checked -	Approved -	CBCL No. 210803.01	Contract -
						Drawing	
						TOL WWTP LONG TERM OPTIONS	
OPTION 2 - MBBR UPGRADE AND DAF REPLACEMENT							

DRAWING NAME: Y:\HALIFAX\DATA\PROJECTS\210803.01_TOL_WWTP & OUTFALL PREDESIGN AND BCA\44 CAD\06 PROCESS\210803.01_PSK03.LT_OPTION 3.DWG LAYOUT NAME: PSK03.PLOT DATE: August 11, 2021 10:34:28 AM CAD OPERATOR: DGREEN



NOTES:

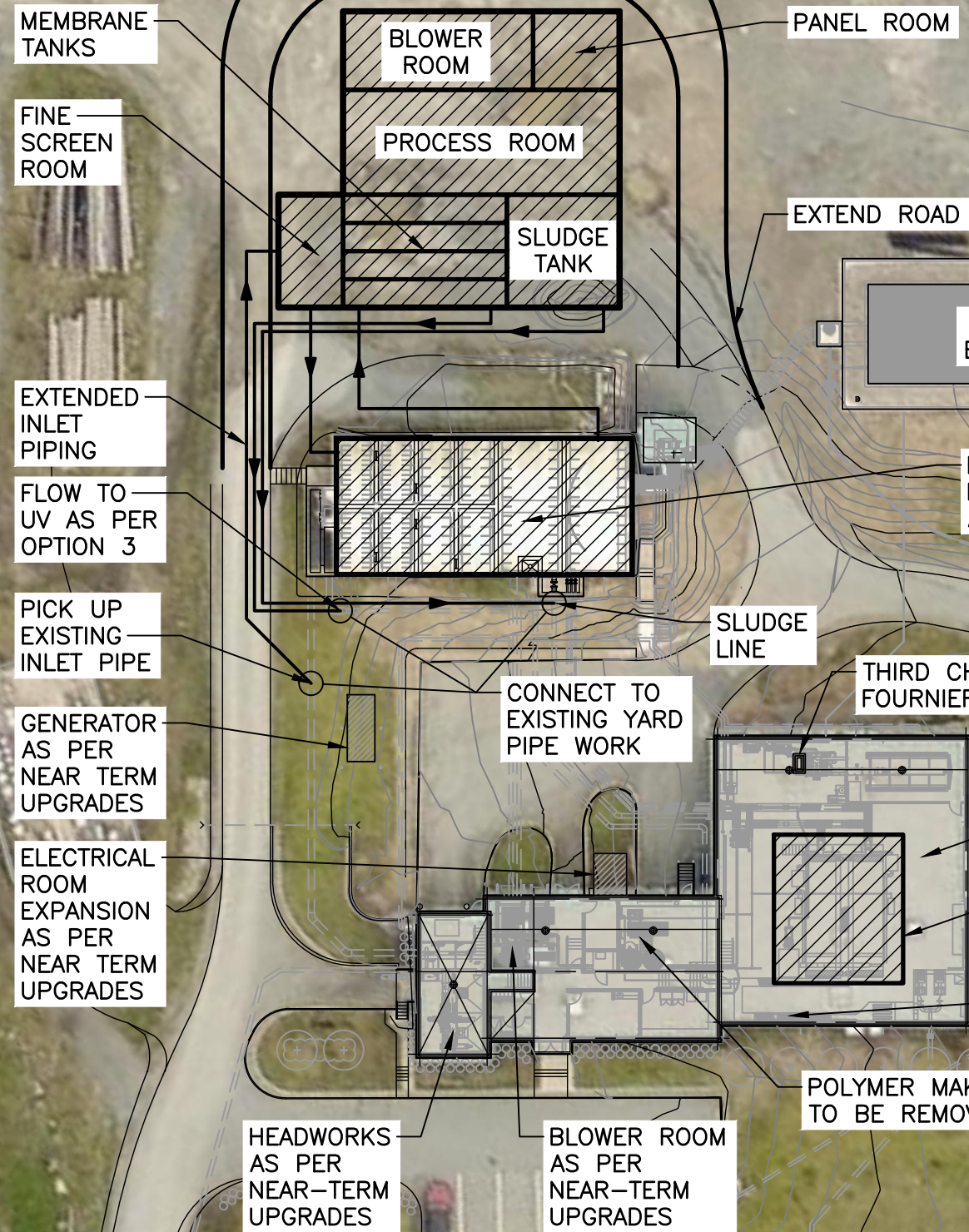
1. TWO-TRAIN SBR SYSTEM WITH EFFLUENT EQUALIZATION TANK.
2. EXISTING BIOREACTOR RE-PURPOSED AS A SLUDGE DIGESTER TANK.
3. BLOWERS, UV, INLET SCREEN AND GENERATOR PROVIDED AS PER NEAR-TERM UPGRADE.
4. EXISTING BLOWERS TO FEED SBR AND SLUDGE DIGESTER.
5. EXISTING DAFs, POLYMER MAKE-DOWN, AND POLYMER DOSING TO BE REMOVED.

Date JUL 02/21	Scale 1"=40'	Designed EH	Drawn NHM	Checked -	Approved -	CBCL No. 210803.01	Contract -
						TOL WWTP LONG TERM OPTIONS	
						OPTION 3 - SBR SYSTEM	

DRAWING NAME: Y:\HALIFAX\DATA\PROJECTS\210803.01.TOL.WWTP & OUTFALL PREDESIGN AND BCA\44 CAD\06 PROCESS\210803.01_PSK04.LT OPTION 4.DWG LAYOUT NAME: PSK04.PLOT DATE: August 11, 2021 10:35:14 AM CAD OPERATOR: DGREEN



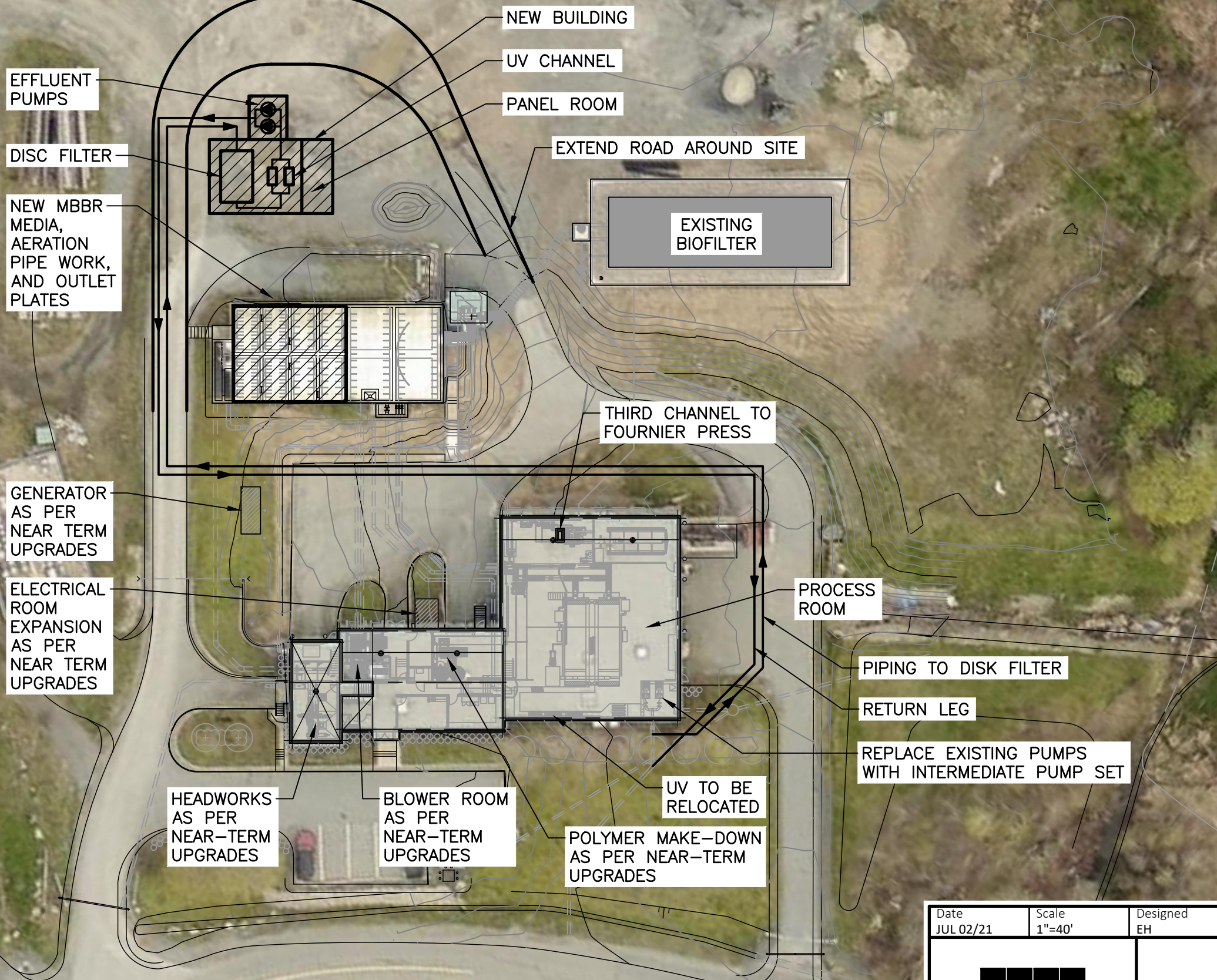
NORTH



NOTES:

1. NEW BUILDING PROVIDED TO HOUSE: MBR SYSTEM, ADDITIONAL BLOWERS, PROCESS PUMPS, SLUDGE TANK, AND A FINE SCREEN ROOM.
2. EXISTING BIOREACTOR WILL BE RE-USED FOR BIOLOGICAL TREATMENT. EXISTING MEDIA WILL BE REMOVED AND AERATION SYSTEM REPLACED.
3. BLOWERS ARE SUFFICIENT FOR BIOLOGICAL TREATMENT IN THE RE-PURPOSED BIOLOGICAL TANK. ADDITIONAL BLOWERS WILL BE REQUIRED FOR THE MBR SYSTEM ON A DEDICATED BASIS.
4. UV SYSTEM, GENERATORS, AND BLOWER PROVIDED DURING NEAR TERM UPGRADES.
5. EXISTING DAFs, POLYMER MAKE-DOWN, AND POLYMER DOSING SYSTEM TO BE REMOVED.


Date JUL 02/21	Scale 1"=40'	Designed EH	Drawn NHM	Checked -	Approved -	CBCL No. 210803.01	Contract -
						TOL WWTP LONG TERM OPTIONS	
						OPTION 4 - MBR UPGRADE	



NOTES:

1. DAF AND MBBR UPGRADES AS PER OPTION 1.
2. CONSTRUCTION OF NEW BUILDING TO HOUSE DISK FILTER AND UV SYSTEMS.
3. NEW PUMP STATION CONSTRUCTED BESIDE DISK FILTER BUILDING.
4. EXISTING EFFLUENT PUMPS RELOCATED TO NEW PUMP CHAMBER (SEE NOTE 3). INTERMEDIATE PUMPS TO BE FITTED IN PROCESS ROOM TO PUMP EFFLUENT TO DISK FILTER BUILDING.
5. UV UNITS REMOVED FROM PROCESS ROOM AND RELOCATED IN DISK FILTER ROOM.

DRAWING NAME: Y:\HALIFAX\DATA\PROJECTS\210803.01_TOL_WWTP & OUTFALL PREDESIGN AND BCA\44 CAD\06 PROCESS\210803.01_PSK05 LT_OPTION 5.DWG LAYOUT NAME: PSK05 PLOT DATE: August 11, 2021 10:35:45 AM CAD OPERATOR: DGREEN

Date JUL 02/21	Scale 1"=40'	Designed EH	Drawn NHM	Checked -	Approved -	CBCL No. 210803.01	Contract -
						TOL WWTP LONG TERM OPTIONS	
						OPTION 1A - MBBR, DAF AND DISK FILTER SYSTEM	



Solutions today | Tomorrow  mind

    in
www.CBCL.ca