Appendix G

Meaford WWTP Treatment Technology Alternatives

Municipality of Meaford Wastewater Treatment Plant Class EA Update

Technical Memorandum

Treatment Technology Alternatives

Prepared For:

The Municipality of Meaford

September 2023

CREATING QUALITY SOLUTIONS TOGETHER

TREATMENT TECHNOLOGY ALTERNATIVES

PROJECT NO. 121027

Prepared For:

THE MUNICIPALITY OF MEAFORD

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1 Introduction

This Technical Memorandum (TM) has been prepared in support of a Schedule 'C' Class EA for the expansion of the Meaford Wastewater Treatment Plant (WWTP EA), building from the 2015 Meaford Water and Wastewater Master Plan (the Master Plan). Planning for expansion of the Meaford WWTP was initiated in 2007 with the completion of a previous Schedule 'C' EA, the Master Plan reinforced the historical general alternative that recommended increasing the capacity of the plant by expanding within the existing property upon which the plant is situated. In order to implement the recommended design alternative, and satisfy the requirements of the Ministry of Environment, Conservation and Parks (MECP), this study was initiated to complete Phase 3 and Phase 4 of the Class EA process following from the Master Plan. The Municipality has retained the Ainley Group to conduct the EA, review the previous design recommendations and investigate new technologies.

The WWTP was built in 1969 as a "High Rate Activated Sludge" process, a designation which is no longer defined in the current design guidelines. Previous reporting has considered the plant to be a cross between an Extended Aeration Activated Sludge (EAAS) and a Conventional Activated Sludge (CAS) process. The plant does not include grit removal or primary clarification. The rated capacity of the plant is 3,910 m^3/d, per its Environmental Compliance Approval (9036-AZFPV6) with a peak flow capacity of 11,730 m^3/d with no dedicated specific tertiary process for phosphorous removal. **Figure 1** shows the location and components of the plant. It should be noted that the property line shown on the figure is taken from the plant's as-built drawings (1997).

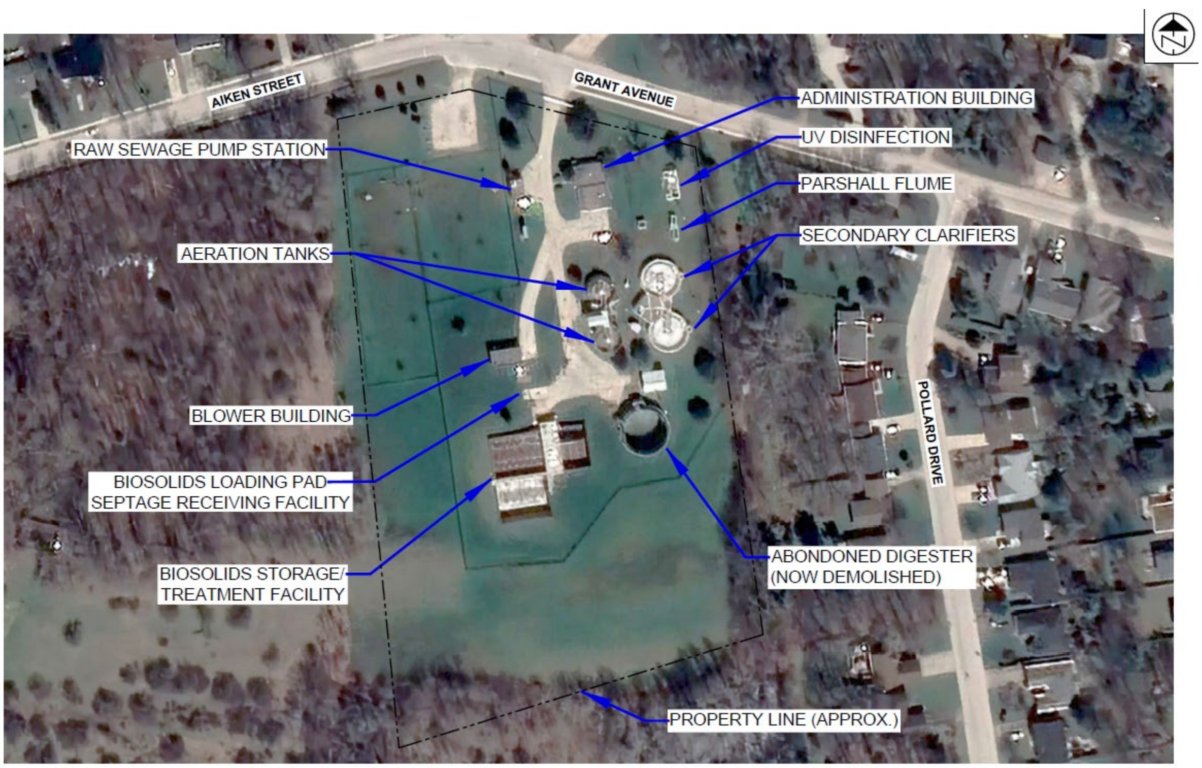
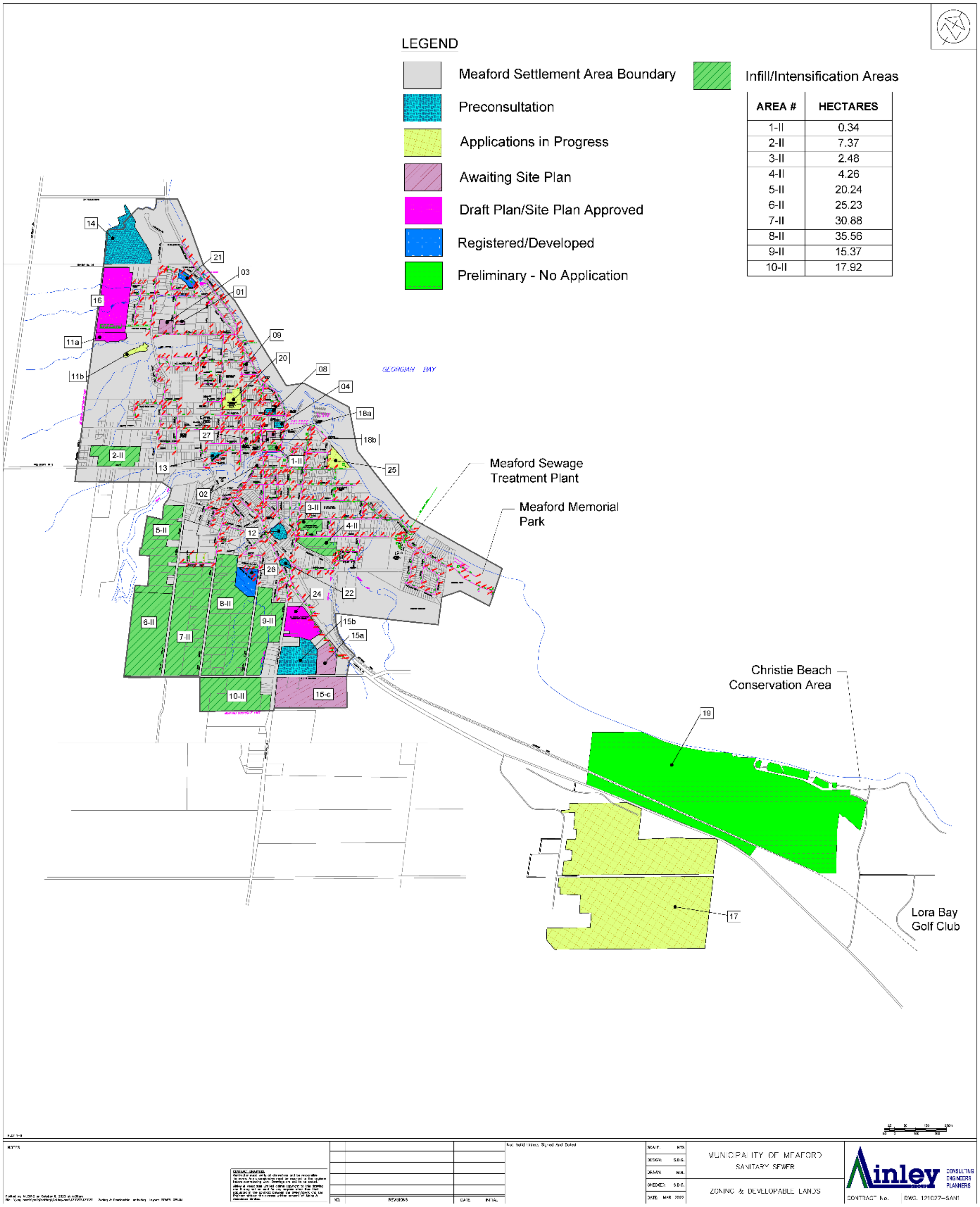


Figure 1– Meaford WWTP

1.1 Service Area & Service Population

The majority of the project study area is urban area and future urban expansion areas. However, the service area includes some agriculture, institutional, shoreline, harbour and commercial area. **Figure 2** shows the map of potential growth areas within the urban area boundary of the Municipality.

The existing population in the urban area of the Municipality is 5,078, per the 2021 census.



AREA #	HECTARES
1-II	0.34
2-II	7.37
3-II	2.48
4-II	4.26
5-II	20.24
6-II	25.23
7-II	30.88
8-II	35.56
9-II	15.37
10-II	17.92

Figure 2 - 2021 Potential Growth Areas

2 Objectives

This TM presents the evaluation of the different treatment technology alternatives available for the unit processes of the Meaford WWTP. The information presented in this TM constitutes a component of Phase 3 of the MCEA process, which involves examination of alternative methods of implementing the preferred solution(s) as determined in the previous phases of the MCEA. The expanded WWTP will be designed to service the existing community plus projected residential and industrial, commercial, and institutional (ICI) growth in the study area.

3 Design Basis

The basis of design for the Meaford WWTP was developed using information from the following documents:

- Ainley technical memorandum entitled "Meaford WWTP Existing and Future Wastewater Flows, 2023";
- Ainley technical memorandum entitled "Meaford WWTP Capacity Assessment, 2023";
- "Proposed Effluent Criteria Memorandum, 2023", to the MECP and their response;
- "EarthTech - Municipality of Meaford WWTP MCEA, 2007";
- "EarthTech - Assimilative Capacity Study Report, 2007".

Based on review of the previous studies and upon revisiting the projected population to the year 2054, and subsequently the 30-year projected wastewater flow for the Municipality of Meaford (summarized in **Appendix A**), it was determined that the projected average wastewater flow at the end of the study period will be 4,400 m^3/d (ADF).

It should be noted that the previous planning efforts identified ultimate expansion to 6,000 m^3/d (ADF). The ultimate expansion to 6,000 m^3/d was taken into consideration in terms of site planning, capital cost and the ability of the plant to meet the anticipated future design criteria based on historical discussions with the MECP. However, the focus of this study is on expansion to 4,400 m^3/d (end of study period) and the Net Present Value (NPV) analysis has been conducted on expansion to 4,400 m^3/d.

3.1 Meaford WWTP Capacity and Phasing

Per the WWTP's approved ECA, the rated capacity of the plant is 3,910 m^3/d, however, the results of the WWTP capacity assessment, summarized in **Appendix B**, show that the actual capacity of the plant is less than the rated capacity and is limited by the secondary treatment capacity to 2,700 m^3/d. It was also determined that the total capacity of the digesters is 2,900 m^3/d for the maximum month loading, and 1,526 m^3/d for the plant ADF with the maximum month peak factor of 1.9. The biosolids storage has a capacity for 3,600 m^3/d average influent daily flow.

It is envisaged that the expansion of the Meaford WWTP would be constructed in the following three phases:

1. Phase 1: Expand the existing secondary treatment capacity of the WWTP by an additional 1,700 m^3/d to achieve full capacity of 4,400 m^3/d. Expand sludge digestion and sludge storage by 2,900 m^3/d, and 1,200 m^3/d respectively. Construct a new headworks to achieve

capacity of 6,000 m³/d. Construct a new blower/RAS/WAS building to achieve full capacity of 4,400 m³/d.

2. Phase 2: Demolish the plant's existing secondary treatment train and replace with new secondary treatment train for the capacity of 2,700 m³/d.
3. Phase 3: Expand the plant's secondary treatment capacity by an additional 1,600 m³/d to achieve projected capacity of 6,000 m³/d. Expand the plant's sludge digestion and sludge storage by 1,600 m³/d, and 1,200 m³/d, respectively, to achieve projected capacity of 6,000 m³/d. Potentially, add tertiary treatment.

3.2 WWTP Historical Flows and Influent Characteristics

Table 1 shows the average influent sewage quality of the plant between years 2016 to 2022. The historical flows and influent characteristics will be used for the selection of the potential treatment technologies.

Table 1 – Monthly Average Influent Parameters

Year	Flow (m^3/d)	Peak Day Flow (m^3/d)	Peak Instantaneous Flow (m^3/d)	$CBOD_5$ (mg/L)	TSS (mg/L)	Total Phosphorus (mg/L)	Ammonia Nitrogen (mg/L)
2016	2,777	13,075	18,573	190	166	3.0	
2017	3,141	11,113	13,285	137	123	2.4	
2018	2,811	11,864	16,974	157	156	3.1	22.0
2019	2,951	11,952	14,268	110	108	2.2	18.6
2020	2,891	9,731	14,005	110	66	1.7	15.2
2021	2,681	12,623	13,997	126	111	2.6	19.8
2022	2,335	8,648	13,997	114	87	2.5	18.4
7-Year Average	**2,798**	**11,289**	**15,014**	**123**	**106**	**2.4**	**18.8**

3.3 Effluent Limits

In 2022, Ainley Group contacted the MECP to discuss the effluent limits for the Meaford WWTP, and to confirm that limits proposed in the 2007 Class EA remain acceptable to the MECP. According to the Assimilative Capacity Study completed in 2007 by EarthTech, the proposed monthly average Total Phosphorous (TP) effluent limit and objective were 0.8 mg/L and 0.5 mg/L for the ultimate expansion capacity of 6,000 m³/d (ADF).

Upon revisiting the population projection to the year 2054, and subsequently the 30-year projected wastewater flow for the Municipality of Meaford, it was determined that the projected average wastewater flow at the end of the study period is 4,400 m³/d (ADF), approximately 26% lower than the previously proposed ADF of 6,000 m³/d. Accordingly, a new effluent limit of 1.0 mg/L TP was proposed to the MECP and was agreed to in principle for the increased capacity of 4,400 m³/day. The record of consultation with the MECP and their response can be found in **Appendix C**.

It should be noted that achieving a TP limit of 0.8 mg/L and resulting objective of 0.5 mg/L may require addition of a tertiary treatment unit to the Meaford WWTP, depending on the performance of the WWTP observed as flows approach 4,400 m^3/d.

Table 2 summarizes the new effluent limits for the plant expansion to 4,400 m^3/d. **Table 3** shows the full listing of effluent limits determined for the 6,000 m^3/d expansion.

Table 2 – Effluent Limits for Updated Capacity of 4,400 m^3/day

Effluent Parameter	Monthly Average Concentration (mg/L)	Annual Average Loading (kg/d)
$CBOD_5$	15.0	66
TSS	15.0	66
Total Phosphorus	1.0	4.4
Total Ammonia Non-Freezing Period* Freezing Period*	3.0 5.0	13.2 22
pH of the effluent maintained between 6.0 to 9.5, inclusive, at all times		
*Note: Freezing Period: October 1 to May 14, Non-Freezing Period: May 15 to September 30		

Table 3 – Effluent Limits for Future Capacity of 6,000 m^3/day

Effluent Parameter	Monthly Average Concentration (mg/L)	Annual Average Loading (kg/d)
$CBOD_5$	15.0	90
TSS	15.0	90
Total Phosphorus	0.8	4.8
Total Ammonia Non-Freezing Period* Freezing Period*	3.0 5.0	18 30
pH of the effluent maintained between 6.0 to 9.5, inclusive, at all times		
*Note: Freezing Period: October 1 to May 14, Non-Freezing Period: May 15 to September 30		

4 Evaluation Methodology

An evaluation methodology to identify a recommended treatment technology alternative for Meaford's WWTP has been developed based on methodologies and guidelines outlined in the Municipal Class Environmental Assessment. This evaluation was performed on two distinct wastewater treatment processes, which are outlined below:

- Liquid Treatment
- Sludge/Biosolids Treatment

Liquid Treatment refers to the process (treatment train) that treats the raw sewage to produce the liquid effluent that can be released to the receiving water body.

Sludge/Biosolids Treatment refers to the system that will treat the residual solids component of the wastewater. Treatment can be to a level where the final product can be used or disposed of off-site, for example, to agricultural land, or treatment can be to the minimum level required to allow trucking the sludge/biosolids to an off-site, privately owned, facility for final treatment and use and/or disposal.

Evaluation of each of the two (2) treatment processes involved two main steps:

- Identification of a long list of all potential alternatives and the screening of this list down to a shortlist of viable alternatives.
- A detailed evaluation of the short-listed alternatives to identify a recommended preferred alternative solution.

To achieve this goal, the following steps were undertaken:

- Develop a set of long-list screening criteria to screen the long list of technology alternatives to a short list. This set of criteria is meant to capture features that are considered essential to the success of the WWTP and to establish viability of the alternative.
- Develop a set of short-list evaluation criteria to evaluate the short-listed alternatives. This set of criteria consists of primary and secondary criteria and weightings. These criteria provide a more in-depth analysis of the technologies, sufficient to identify the recommended technology.
- Generate a long list of technologies that could be used for the process being evaluated.
- Use the long-list screening criteria to screen the long list to a short list.
- Develop design concepts (treatment trains) using the short-listed technologies.
- Perform detailed evaluations of each design concept, including a life-cycle cost analysis, using the short-list evaluation criteria.
- Identify the recommended treatment technology alternative, based on the results of the detailed evaluation.

Separate sets of screening/evaluation criteria will be used for each of the processes since the objectives for each process are different.

4.1 Approach to Life-Cycle Cost Analysis

A life-cycle cost analysis was carried out on each short-listed alternative as part of the detailed evaluation. The analyses incorporated factors such as equipment costs, construction costs, annual operating and maintenance costs, and the NPV over the expected life of the facility.

Equipment and operating costs for each alternative were obtained from budgetary quotes, solicited from relevant equipment suppliers. Construction costs for common systems were estimated from data in Ainley's possession from projects of a similar nature and scope. Estimates for general contracting, site works, and yard piping were based on a percentage of equipment and building/tankage construction costs.

Actual costs associated with each alternative may be significantly affected by inflation and market conditions, however, changes in the conditions that affect these cost estimates would affect all alternatives proportionately, since the same assumptions and rationale were used to evaluate all alternatives. In this regard, the results of the comparative cost evaluation should remain the same.

5 Liquid Treatment

5.1 Overview of Liquid Train Treatment Processes

Treatment of the liquid component of wastewater involves several stages, typically starting with the removal of grit and larger particles and ending with disinfection of the treated effluent just prior to release into the environment. The stages traditionally associated with treating the liquid train are described below.

Preliminary Treatment (Headworks)

Raw sewage arriving at the treatment plant by gravity or from a pumping station is first subjected to preliminary treatment which involves the removal of larger objects and grit from the wastewater. Technologies used for preliminary treatment include various types of screens and grit removal systems. This process results in screenings and grit waste that is typically sent to a landfill.

Although a new preliminary treatment facility is necessary to be added to the Meaford WWTP, for the purposes of the evaluation, preliminary treatment evaluation and selection were not considered since the alternatives available will not vary appreciably in terms of environmental impact or cost.

The new preliminary treatment will include the following:

- New mechanical screening system
- New grit removal system
- New headworks building
- New odour control unit

Primary Treatment

Primary treatment is geared towards the removal of particles that can be easily removed without the addition of chemicals or biological means. Typically, gravity settling technologies, such as clarification, are used for primary treatment. However, other technologies, such as filters, can be used. Some secondary treatment technologies do not require primary treatment. The primary treatment produces primary sludge, which is sent to the sludge treatment system. For the Meaford WWTP, only the secondary treatment technology alternatives that do not require primary treatment are considered. Therefore, primary treatment systems were not evaluated.

Secondary Treatment

Once solids, grit, and settles are removed from the wastewater, secondary treatment is implemented to remove organics and other contaminants such as phosphorous, nitrogen, and ammonia. Technologies used for secondary treatment are usually biological in nature, including aeration tanks, biological filters, and moving bed bioreactors. The biological sludge resulting from biological treatment is commonly referred to as “activated sludge”. Secondary treatment produces secondary sludge (waste activated sludge), which is sent to the sludge treatment system. According to the results of the Meaford WWTP capacity assessment, the plant’s secondary treatment system does not have enough capacity to accommodate the projected plant capacity of 4,400 m^3/d. Therefore, secondary treatment technology alternatives were evaluated for the Meaford WWTP.

Tertiary Treatment

Where secondary treatment alone cannot meet a facility's required effluent limits for particular parameters, it may be necessary to add a further treatment stage referred to as tertiary treatment. Tertiary treatment typically focuses on the removal of parameters with low effluent limits, including phosphorous, nitrogen, and suspended solids. Examples of tertiary treatment technologies include membrane filtration and sand filters.

Achieving a TP limit of 0.8 mg/L and resulting objective of 0.5 mg/L in Phase 3 of the expansion may require addition of a tertiary treatment unit to the Meaford WWTP. Therefore, tertiary treatment systems were evaluated for the Meaford WWTP, to be established at the WWTP under the scenario where the TP limit and objective cannot be met based on the existing plant's performance. A tertiary treatment unit is envisaged to be constructed in Phase 3 of the expansion.

Disinfection

Disinfection is performed to deactivate and/or kill pathogenic micro-organisms found in the liquid stream. Typically, E. coli is used as the indicator organism to measure the effectiveness of the disinfection process and the plant has a compliance limit for E. coli. Traditionally, chlorination has been used for disinfection, however, ultra-violet radiation and ozonation are becoming more common. According to the results of the Meaford WWTP capacity assessment, the plant's UV disinfection system does not have enough capacity to accommodate the projected wastewater flows. Therefore, disinfection alternatives were evaluated for the Meaford WWTP.

5.2 Liquid Train Evaluation Criteria

5.2.1 Long-List Screening Criteria

The criteria selected for the long-list screening of the liquid train alternatives are presented in **Table 4**.

Table 4 – Liquid Train Long-List Screening Criteria

Criteria	Description
Proven Reliability	Demonstrated track record of consistently meeting and/or exceeding the treatment objectives set forth for the MCEA.
Ease of Expansion	The ability of the system to be easily expanded.
Operation and Maintenance (O&M)	The simplicity of operation and maintenance and level of staffing required.
Cost	Have benefits/value in-line with the anticipated capital costs and operation and maintenance costs.

Proven Reliability

In order for a technology to be carried forward for detailed analysis, the technology must have a demonstrated history of being reliable and able to meet the performance requirements set out for the MCEA.

For secondary treatment, technology would have to have been successfully used in at least three operating plants of a similar size and capacity, located in a similar climate and with comparable effluent limits in order to be considered for implementation in Meaford.

Other factors taken into consideration include the technology's ability to adjust to changing influent conditions, such as high/low flows or fluctuations in sewage characteristics.

Ease of Expansion

This criterion reviews how easily the technology can be expanded to match the facility's planned expansion. Alternatives that require minimal component upgrades and financial investment were rated more favourably.

Operation and Maintenance (O&M)

This criterion reviews how complex the technology/system is to operate and maintain. It also reviews the required operator skill level and staffing requirements. Technologies that are deemed very complex to operate or have intensive maintenance schedules were excluded from the list of alternatives, as are technologies that require a large staff contingent or highly skilled operators.

Cost

The cost criterion looks at the capital cost of the equipment and costs associated with operation and maintenance. Capital costs include equipment purchase and installation. Operation and maintenance aspects include costs related to utilities (electricity, gas, potable water), chemicals, etc. It should be noted that labour costs associated with the number of operators required were considered equivalent for all alternatives.

5.2.2 Short-List Evaluation Criteria

The criteria and weightings selected as short-list criteria are presented in **Table 5** and descriptions follow.

Table 5 – Short-List Screening Criteria

Primary Criteria	Weight	Secondary Criteria	Weight
Social / Culture	10%	Aesthetic Impacts (plant appearance)	10%
		Traffic Impacts (during construction and operation)	10%
		Noise Impacts (during operation)	35%
		Odours Impacts (during operation)	35%
		Archaeological and Cultural Heritage Impacts	10%
Technical	40%	Ability to Meet Regulatory Objectives	30%
		Technology / Process Robustness	30%
		Ease of Expansion and Phasing to Buildout	20%

Primary Criteria	Weight	Secondary Criteria	Weight
		Energy Requirements	5%
		Operation & Maintenance Requirements (simplicity, operator skill level/quantity)	10%
		Site Requirements (plant footprint)	5%
Environmental	20%	Public Health and Safety	30%
		Sustainability	20%
		Climate Change Impacts / Greenhouse Gas Generation	20%
		Natural Environment Impacts	10%
		Waste Generation	20%
Economic	30%	Capital Cost	30%
		Operation and Maintenance Costs	40%
		Net Present Value	30%

Social/Culture

Aesthetic Impacts: Aesthetic impacts relate to the technology's or facility's physical appearance and how aesthetically pleasing it might be. Alternatives that are more likely to blend in with the area and/or future development scored higher in the evaluation.

Traffic Impacts: This criterion captures the level of traffic disruption that could exist during the facility's construction and day-to-day operation. Factors considered would be the delivery of large amounts of concrete during construction, which would result in numerous concrete trucks travelling to the site. Pre-fabricated units have a lesser impact on the local traffic during construction. Traffic impacts during operation would include increased traffic due to such activities as frequent chemical deliveries. A higher score was given to technologies/systems that would minimize traffic disruptions.

Noise Impacts: This criterion relates to the amount of noise that would be generated during the normal operation of the facility. For example, systems with blowers tend to emit more noise, unless appropriate attenuation measures are taken. Technologies with lower noise generation were scored higher.

Odours Impacts: The odours criterion relates to the likelihood for a technology to emit/generate odours during normal operation. For example, odours from systems housed in an enclosed space/building may be more easily controlled than odours from open tanks. Technologies that minimize odours were scored higher than those prone to emitting odours.

<u>Archaeological and Cultural Heritage Impacts:</u> The criterion looks at the level of risks posed to the archaeological potential and cultural heritage resources of the site. Processes with higher risks will be scored lower in the evaluation.

Technical

<u>Ability to Meet Regulatory Objectives:</u> The ability to meet regulatory objectives relates to a technology's ability to consistently achieve the effluent limits and objectives.

<u>Process Robustness:</u> The robustness of technology refers to its ability to cope with or adjust to changing operational demands and adverse events. Examples include the system's ability to cope with unexpected high flow events, variations in sewage strength, temperature variations, weather events, or utility interruptions. A higher score was applied to technologies/systems that are more flexible to operational fluctuations.

<u>Ease of Expansion and Phasing to Buildout:</u> The technology chosen for the plant must be able to expand relatively easily to grow with the municipal population. The technology will also need to be able to facilitate expansion under a phased development plan to Meaford's ultimate population. Processes or technologies which require minimal component upgrades as the system expands were rated more favourably.

<u>Energy Requirements:</u> The energy requirements for some technologies can be higher than others and would have a higher environmental and cost impact. Alternatives with lower energy requirements were scored higher in the evaluation.

<u>Operation and Maintenance Requirements:</u> This criterion captures the level of effort required by operations staff to operate and maintain the system as well as staffing requirements and operator skill level. Systems that require minimal operational intervention, standard operator skill level, and fewer staff were rated more favourably.

<u>Site Requirements:</u> Site requirements relate to the space that will be needed for the technology/system as compared to the space available for the treatment facility.

Environmental

<u>Public Health and Safety:</u> This criterion looks at the level of risks posed to the public, such as accidents, spills, fires, etc. Examples of these risks include high temperature/pressure operations or increased handling of hazardous chemicals.

<u>Sustainability:</u> This criterion captures a technology's ability to meet current needs for performance and protection of the environment in a way that will not negatively impact the environment in the future. It also includes the ability of the alternative to maintain its performance over the life of the facility.

<u>Climate Change Impacts:</u> The criterion relates to how the technology might contribute to climate change. Factors such as minimization of greenhouse gas emissions and the generation of wastes, including waste chemicals, filter media, etc. are considered. Processes with lower impacts on climate change triggers were scored higher in the evaluation.

<u>Natural Environment Impacts:</u> This criterion captures impacts on the local flora and fauna during construction and operation. If the construction will require the removal of a large number of trees or significant disturbances to local wildlife, it scored lower in the evaluation.

<u>Waste Generation Impacts:</u> This criterion captures the amount of waste sludge produced during operation. If less waste sludge is generated during operation, it scored higher in the evaluation.

Economic

Capital Cost: This criterion relates to the financial investment required to purchase and install the technology/system. Factors such as equipment cost, installation costs, and construction costs of any ancillary infrastructure that may be required are considered. Technologies/systems with lower capital costs were rated more favourably.

Operation and Maintenance Costs: This criterion captures the estimated cost to operate and maintain the system. Aspects considered include the cost of utilities (electricity, gas, water), cost of chemicals, such as coagulants, and frequency of major equipment replacements.

Net Present Value: The Net Present Value analysis captures the present value of all costs associated with the initial construction and operation and maintenance of the technology/system for the expected life span of the technology/system. The net present value analysis in the report used a 25-year life cycle.

5.3 Screening of Long List of Liquid Treatment Train Technologies

The long list of technologies considered for the secondary, tertiary and disinfection treatment process of the liquid treatment train are listed, described, and evaluated in **Table 6**.

Table 6 – Evaluation of Long List of Liquid Treatment Train Technologies

No.	Technology	Description	Screening Criteria					Rationale
			Track Record	Ease of Expansion	O&M	Cost	Carry Forward	
Secondary Treatment								
S1	Conventional Activated Sludge System (CAS)	The traditional CAS process involves primary settling via a standard clarifier, followed by aeration, and completed by secondary clarification. The CAS process is a flexible process that can be modified to denitrify (if needed) by adding one or more anoxic tanks and/or perform phosphorous removal by dosing with a coagulant at one or multiple locations in the process.	✓	x	✓	x	**No**	▪ Well-established and extensively used technology ▪ Not easily expandable within existing footprint. Needs primary treatment and there is not enough space for additional primary clarifier tanks within the existing plant property line. ▪ Well established and understood O&M requirements ▪ Costs are high due to the need for additional tanks for primary treatment
S2	Extended Aeration	The extended aeration process is similar to the CAS process with longer hydraulic retention time and sludge retention time, except the primary clarification step is removed. Preliminarily treated sewage is fed directly to the aeration tank. The sludge retention time is between 20 to 40 days compared to 5 to 15 days in a CAS process. Aeration tank effluent flows to a secondary clarifier for solids separation.	✓	✓	✓	✓	**Yes**	▪ Well-established technology ▪ Easily expandable ▪ O&M requirements comparable with other technologies ▪ Costs are comparable with other technologies
S3	Sequencing Batch Reactor (SBR)	The SBR process performs BOD and nitrogen removal and settling in the same tank. The phases in the SBR process are filled, react, settle, decant, and idle. During the react stage, the air is introduced into the reactor to facilitate biological growth. Separated primary treatment and secondary clarification are not required in an SBR system. SBRs can accommodate fluctuations in flows by adjusting cycle times and can also achieve advanced nutrient removal.	✓	✓	✓	✓	**Yes**	▪ Well-established technology, especially for smaller plants ▪ Easily expandable due to the minimal number of tanks/reactors in the process ▪ O&M requirements comparable with other technologies ▪ Costs are low due to fewer reactors/tanks in the process
S4	Rotating Biological Contactors (RBC)	An RBC consists of a cylinder of plastic discs that are mounted on a rotating shaft. The cylinder is partially submerged in the wastewater and continuously rotated. Micro-organisms attach to and grow on the discs. Exposure to air when portions of the discs are out of the wastewater provides oxygen to the organisms and submergence causes the organisms to take up the nutrients in the wastewater. Nitrification and denitrification both occur on the RBC.	x	✓	x	✓	**No**	▪ Not a well-established technology compared to others ▪ Easily expandable ▪ Large footprint due to low aeration intensity ▪ Not good record in high loading environment ▪ O&M difficulties in high flow periods where biomass tends to get washed off the discs ▪ Costs are comparable with other technologies
S5	Membrane BioReactors (MBR)	An MBR is a modified CAS process with membranes submerged in the aeration tank or installed downstream of the aeration tank. The membranes combine microfiltration or ultrafiltration with a suspended growth process. The combination provides high nutrient and suspended solids removal. A secondary clarifier is not required in an MBR system. MBRs also remove phosphorous, so a tertiary stage	✓	✓	x	x	**No**	▪ Relatively good track record in wastewater treatment ▪ Relatively easy to expand by adding membrane cartridges and no secondary clarifier or tertiary system to expand ▪ Relatively higher O&M requirements than other technologies. More complex to operate and require skilled personnel with specialized knowledge

No.	Technology	Description	Screening Criteria					Rationale
			Track Record	Ease of Expansion	O&M	Cost	Carry Forward	
		may not be needed. Treatment capacity is affected at lower wastewater temperatures.						▪ High capital and operational costs ▪ Level of performance is significantly higher than what is needed
S6	Membrane Aerated Biofilm Reactor (MABR)	An MABR delivers oxygen into the wastewater through a set of modules/membranes submerged into the biological reaction tank. The oxygen passively passes through the membrane tubes and is not lost via bubbles rising to the surface as with traditional aeration. A layer of aerobic bacteria forms against the oxygen-rich membrane surface and anoxic bacteria develops in the rest of the tank, where anoxic conditions exist. In this way, an MABR simultaneously nitrifies and denitrifies. MABR can also provide a drop-in solution for increasing the capacity of existing treatment Plants without new tank construction.	✓	✓	✓	✓	**Yes**	▪ Relatively newer technology, but now have a relatively good track record in wastewater treatment ▪ Intensify the existing aeration process and increase capacity within the existing assets ▪ The MABR module can be dropped in the aeration tank in a non-disruptive development ▪ Lower O&M compared to other technologies ▪ Lower capital and operational cost
S7	Moving Bed BioReators (MBBR)	An MBBR uses plastic media, suspended in an aeration tank. Micro-organisms attach to and grow on the media. Nitrification takes place in the aeration tank and the medium surface.	✓	✓	x	x	**No**	▪ Established technology ▪ Easily expanded by adding media to void space ▪ O&M requirements comparable with other technologies ▪ Construction costs are comparable with other technologies ▪ Replacing medium every 10 years increases the operation cost and operation complexity ▪ Examining diffusers system is difficult because the medium has to be completely taking out of tank, store, and reinstall
S8	Aerobic Granular Sludge (AGS)	In this process, wastewater is mixed with granulated activated sludge in an aeration tank, where the microorganisms consume the organic pollutants as a food source and convert them into carbon dioxide, water, and new bacterial cells. The granules provide a higher biomass density for higher organic loading and removal efficiency, and better and more stable settling properties than traditional activated sludge. The granular structure of AGS allows for better separation of solids from the treated wastewater, reducing the need for clarification and improving the quality of the effluent. The AGS process is known for its high treatment efficiency, stable operation, and low sludge production.	✓	✓	✓	✓	**Yes**	▪ Relatively newer technology, but now have a good track record in wastewater treatment in European markets ▪ Easily expandable within existing footprint ▪ Low sludge production ▪ Lower capital and operational cost
Tertiary Treatment								
T1	Tertiary Membrane Filters	Use of ultrafiltration membranes to remove phosphorous. Commonly used in drinking water systems. Membranes can remove phosphorous down to 0.02 mg/L. Sewage temperature will impact treatment capacity of tertiary membranes.	✓	✓	✓	x	**No**	▪ Relatively high capital cost and operating cost

No.	Technology	Description	Screening Criteria: Track Record	Ease of Expansion	O&M	Cost	Carry Forward	Rationale
T2	Two-Stage Continuous Backwash Up-Flow Sand Filters (e.g., DynaSand)	Two stage filtration refers to up-flow filters that use sand as the filter media. Chemical addition is used to facilitate phosphorous removal. The majority of removal occurs in the first stage. The second stage is a polishing step.	✓	✓	✓	✓	**Yes**	▪ Shown effective in pilot test studies, with one full-scale installation in Ontario ▪ High chemical usage.
T3	Cloth Disc Filters (e.g., Aqua-Aerobic)	Cloth disc filters consist of a cartridge of circular filters that are made of a specialized cloth material. Solids accumulate on both sides of the filters. When solids accumulation reaches the upper limit, a backwash cycle is initiated to clean the filters	✓	✓	✓	✓	**Yes**	▪ Vertically oriented cloth media disks reduce required footprint. ▪ Higher solids and hydraulic loading rates. ▪ Low backwash rate. ▪ Low life-cycle cost.
T4	High-Rate Clarification (e.g., Actiflo)	High-rate clarifiers employ flocculation then use of micro-sand and a polymer. Coagulant is added to the secondary treatment effluent after which polymer and micro-sand are introduced into the wastewater stream. The flocs are then settled out of the water using a lamella clarifier.	✓	✓	✓	✓	**Yes**	▪ No impact on treatment efficiency during sudden flow or raw water quality fluctuations. ▪ Quick response to treatment adjustments. ▪ Possible of frequent shutdowns and restarts without affecting treated water quality. ▪ Reduction in construction costs with compact footprint. ▪ Saving chemical consumption up to 50% compared to conventional clarifiers.
T5	Adsorptive Deep Bed Filtration	A deep bed filtration process where a hydrous ferric coating is continuously applied to the sand media. Phosphorous in the wastewater chemically binds with the coating on the sand particles. The sand is continuously washed to remove adsorbed phosphorous and then recycled to the filter, where it is recoated with the ferric coating and reused.	✓	✓	x	x	**No**	▪ High cost of adsorbent. ▪ Hard separation of the absorbent from dye. ▪ Low surface area.
Disinfection								
D1	Chlorination / Dechlorination	A chlorination/dechlorination system uses sodium hypochlorite to disinfect the wastewater. The chlorinated wastewater is sent through a contact chamber to provide the required contact time. Sodium bisulphite is added to the contact tank effluent to remove residual chlorine, which is harmful to the environment.	✓	✓	✓	✓	**Yes**	▪ Well established technology ▪ Easily expanded ▪ Dosing systems can be complex to operate but familiar to the operators and manageable ▪ Costs are comparable with other technologies
D2	Ultra-Violet Radiation	High-intensity ultra-violet lamps are used to irradiate the wastewater with ultraviolet radiation which inactivates pathogens.	✓	✓	✓	✓	**Yes**	▪ Well established technology ▪ Easily expandable ▪ Relatively simple operation and maintenance requirements ▪ Costs are comparable with other technologies
D3	Ozonation	An on-site ozone generator is used to generate ozone, which is then dosed into the wastewater. Ozone inactivates pathogens and quickly degrades, leaving no by-products in the wastewater.	✓	✓	x	✓	**No**	▪ Newer but, a proven technology ▪ Easily expandable ▪ Ozone is very reactive and more hazardous than chlorination/dechlorination chemicals. ▪ Costs are comparable with other technologies

5.3.1 Summary of Short-List Technologies

The technologies that were short-listed for detailed evaluation for the liquid train treatment are listed below:

Secondary Treatment

- Extended Aeration
- Sequencing Batch Reactor (SBR)
- Membrane Aerated Biofilm Reactor (MABR)
- Aerobic Granular Sludge (AGS)

Tertiary Treatment

- Up-flow Sand Filter
- Cloth Disc Filter
- High-rate Clarifier

Disinfection Treatment

- Chlorination/Dechlorination
- Ultra-Violet Radiation

5.4 Detailed Description of Liquid Train Short-Listed Technologies

5.4.1 Technology Alternatives for Secondary Treatment

5.4.1.1 Alternative 1: Extended Aeration

In the extended aeration process, wastewater flows directly from the preliminary treatment system into the aeration tank, where BOD levels are reduced and ammonia and ammonium are converted to nitrate. Extended aeration process would not require primary treatment. Alternatives for aeration as applicable to all secondary treatment processes involve installation of high efficiency fine bubble diffusers systems and high efficiency blowers. If chemical phosphorous removal is included in this system, the coagulant can be added at multiple points in the process.

The final step in the extended aeration process is removal of solids, which is typically done by a secondary clarifier. Sludge that is not recycled as recycle activated sludge (RAS) to the aeration tank, is classified as waste activated sludge (WAS) and can be pumped directly to the sludge/biosolids treatment system.

Figure 3 shows a flow schematic of the extended aeration process.

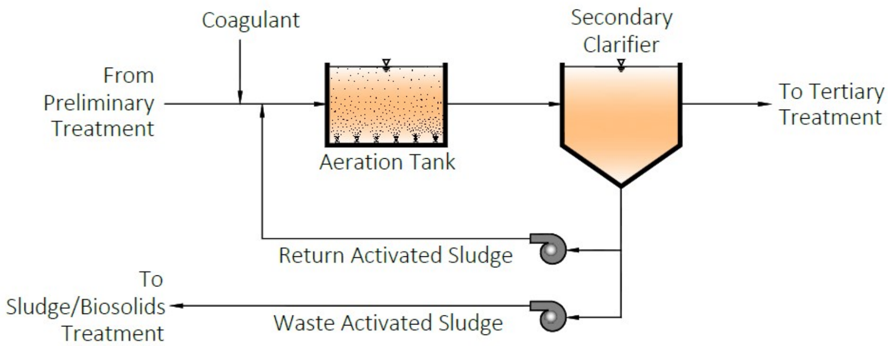


Figure 3 – Extended Aeration Process Flow Schematic

Three aeration tanks would be constructed to accommodate the wastewater flows, one in each phase of expansion.

Rectangular clarifiers are chosen based on the ease of construction and expansion compared with circular clarifiers. However, circular clarifiers have equivalent benefits and are also viable. Selection of rectangular or circular clarifiers can be made during the design phase.

Advantages and disadvantages of the extended aeration process are listed in **Table 7**.

Table 7 – Advantages and Disadvantages of Extended Aeration Process

Advantages	Disadvantages
▪ Well understood process and easy to operate. ▪ Straightforward construction. ▪ Relatively easy to expand if clarifiers and biological system constructed as rectangular tanks.	▪ Tertiary treatment stage would be needed for the required advanced phosphorous removal. ▪ Requires large amount of chemical if phosphorous removal is required in the secondary treatment stage to facilitate advanced removal in the tertiary treatment stage.

5.4.1.2 Alternative 2: Sequencing Batch Reactor (SBR)

The SBR system uses a single tank/reactor as the anoxic tank, the aerobic tank, and the settling tank required for biological removal of nutrients from the wastewater. Primary clarification is not required in an SBR system. Wastewater flows directly from the preliminary treatment system to the SBR reactor. Figure 2 shows a flow schematic of a SBR system. All phases of the treatment by the SBR occur in the reactor.

The SBR reactor is divided into two sections, a “pre-react” zone, where no aeration is provided and a main zone, which includes an aeration system. In general, there are four stages in the operation of an SBR, all of which occur in a single reactor. The typical stages are: fill, react, settle, decant, which are shown in **Figure 4**. There are several variations to the sequence and duration of each cycle, depending on the vendor.

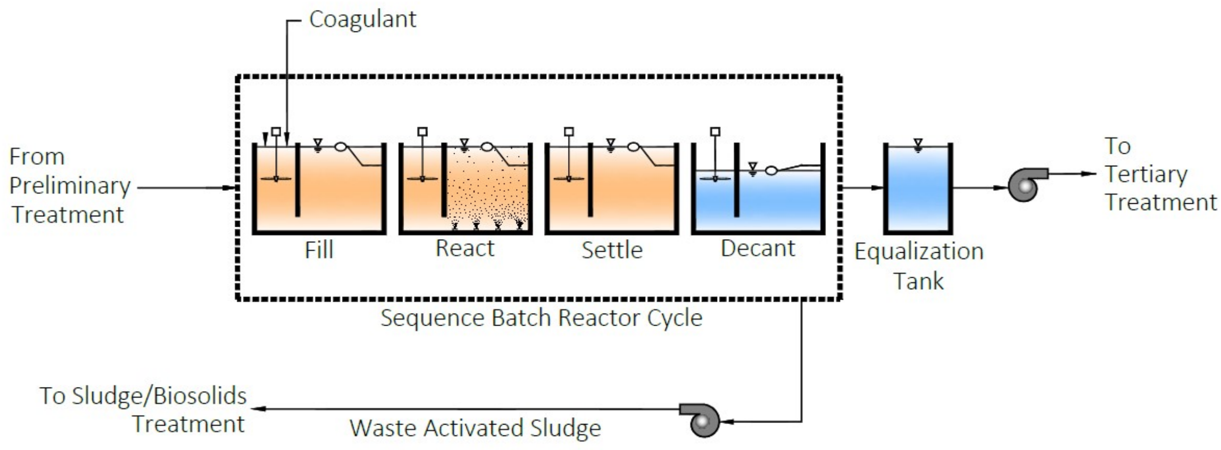


Figure 4 – Sequencing Batch Reactor Process Flow Schematic

During the fill stage, wastewater is introduced into the reactor into the pre-react zone along with a coagulant to precipitate phosphorous and a carbon source for the denitrifying bacteria, if needed.

The react phase occurs next where wastewater flows to the main zone and air is introduced into the reactor to support the micro-organisms that convert ammonia to nitrite and nitrate. Once the react phase is complete, the settle phase takes place, where the aeration system is de-activated and denitrification takes place. The settle phase also is a quiescent period that allows solids to settle to the bottom of the reactor. The final step is the decant phase in which the treated wastewater is decanted out of the SBR, via a decanter at the effluent end of the reactor.

Effluent from the SBR flows to an equalization tank designed to allow secondary effluent to be pumped to the tertiary treatment stage at an even flow rate.

The SBR includes two sets of pumps in the main zone. The pumps and their functions are described below:

- RAS Pumps: Pumps activated sludge from the main zone to the pre-react zone to keep the micro-organisms required to convert nitrates to nitrogen gas in the reactor.
- WAS Pumps: Pumps waste activated sludge from the main zone in the settle phase to the sludge/biosolids treatment system.

In systems where the BOD levels in the SBR influent wastewater is not high enough to sustain the denitrifying micro-organisms, an external carbon, such as methanol, would be needed as supplemental carbon source.

To achieve the total phosphorous limit of 0.8 mg/L, a coagulant is added in to the reactor to precipitate phosphorous and reduce loading to the tertiary treatment system.

The SBR system would be constructed as three treatment trains. Flows for each Phase would be treated using one SBR.

Table 8 presents the advantages and disadvantages of the SBR treatment process.

Table 8 – Advantages and Disadvantages of the SBR Process

Advantages	Disadvantages
▪ Simple construction as reactors systems can come as prefabricated modules. ▪ Adjusting cycle times and/or adding an equalization tank upstream of the SBR to operate in peak flow condition. ▪ Relatively easy to expand. ▪ Small footprint as primary and final clarifiers not required.	▪ Operation is slightly more complex than extended aeration system, but automatically controlled by the vendor PLC system. ▪ Tertiary treatment stage would be needed for the required advanced phosphorous removal. ▪ Equalization tank is required prior to downstream treatment processes. ▪ More frequent sludge wasting compared with extended aeration process. ▪ Conservative capacity design is needed for peak flow condition to meet discharge limits.

5.4.1.3 Alternative 3: Membrane Aerated Biofilm Reactor (MABR)

The MABR process combines activated sludge treatment with biological treatment with gas transfer through specially designed membranes. In this process, air is introduced into hollow-fiber, composite membranes submerged in the wastewater to be treated. Microorganisms grow on the surface of the membrane and create a biofilm. Oxygen from the introduced air diffuses through the membrane to support the microbial activity, allowing efficient removal of organic contaminants and nutrients from the wastewater.

Figure 5 shows a flow schematic of a MABR system.

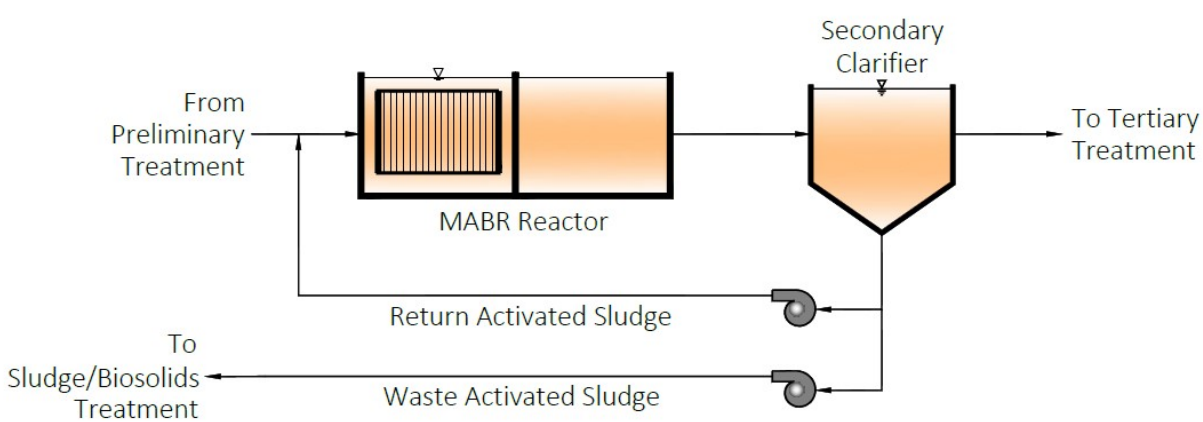


Figure 5 – MABR Process Flow Schematic

The technology is being evaluated for its potential to enhance existing treatment capacity of the Meaford WWTP using the existing footprint of the plant to achieve full capacity of 4,400 m^3/d (Phase 1); and plan to replace the entire plant in the future when it reaches the end of its service life (Phase 2).

Table 9 presents the advantages and disadvantages of the MABR technology.

Table 9 – Advantages and Disadvantages of the MABR Process

Advantages	Disadvantages
▪ Smaller footprint. ▪ Reduced energy consumption (very efficient, lower pressure oxygen transfer across membrane). ▪ Simultaneous nitrification/denitrification (reduced effluent nitrate). ▪ Easy to increase the existing tank capacity by simply dropping new modules.	▪ Developing technology – limited full-scale applications. ▪ Capital and long-term O&M costs not well understood. ▪ MECP approvals may require pilot testing.

5.4.1.4 Alternative 4: Aerobic Granular Sludge (AGS)

The AGS process represents an aerobic biological treatment method that produces dense sludge pellets. In this process, wastewater flow into a bioreactor where specially cultivated microbial aggregates called "granules" are formed.

The AGS process operates under aerobic conditions. Oxygen is supplied to the bioreactor through aerators/diffusers that introduce air into the system. Microorganisms within the granules use this oxygen to metabolize and break down the organic pollutants present in the wastewater.

Within the granules, various simultaneous biological processes occur, allowing efficient removal of organic contaminants and nutrients from the wastewater.

One of the key features of the AGS process is the rapid settling of granules in the bioreactor. This rapid settling allows for effective separation of treated water from the microbial biomass, reducing the need for secondary clarifiers.

Figure 6 shows a flow schematic of a AGS system.

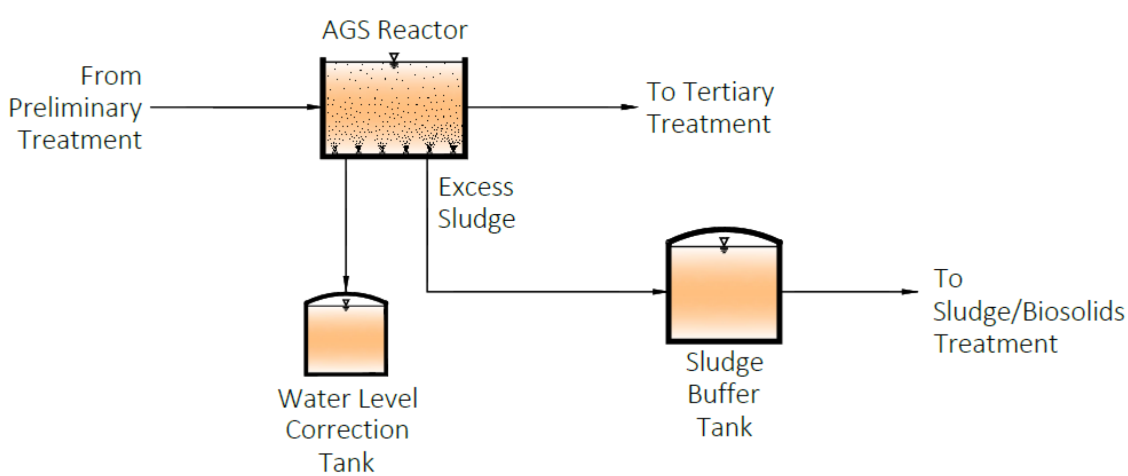


Figure 6 – Aerobic Granular Sludge Process Flow Schematic

Table 10 presents the advantages and disadvantages of the SBR treatment process.

Table 10 – Advantages and Disadvantages of the AGS Process

Advantages	Disadvantages
▪ Smaller footprint. ▪ Simultaneous nitrification/denitrification and lower energy due to operating regime (reduced effluent nitrate). ▪ Higher effluent quality comparing to other secondary treatment.	▪ Developing technology – limited full-scale application in North America; but a number of plants using batch technology worldwide. ▪ Capital and long-term O&M costs not well understood. ▪ MECP approvals may require pilot testing.

5.4.1.5 Cost Comparison of Short-Listed Secondary Treatment Alternatives

Table 11 summarizes the results of the life-cycle cost analyses for the four, short-listed secondary treatment alternatives. Estimates have been rounded to the nearest thousand dollars. Details of the life-cycle cost analysis can be found in **Appendix D**.

As mentioned before, NPV analysis was conducted on expansion to 4,400 m^3/d.

Table 11 – Cost Estimates for Secondary Treatment Alternatives

	Extended Aeration	Sequencing Batch Reactor (SBR)	Membrane-Aerated Biofilm Reactor (MABR)	Aerobic Granular Sludge (AGS)
NPV Capital Cost	$ 37,041,000	$ 21,278,000	$ 56,841,000	$ 29,211,000
NPV Annual Operation and Maintenance Cost	$ 2,584,000	$ 3,565,000	$ 1,296,000	$ 3,597,000
Total Net Present Value	**$ 39,625,000**	**$ 24,843,000**	**$ 58,137,000**	**$ 32,808,000**

5.4.2 Technology Alternatives for Tertiary Treatment

5.4.2.1 Alternative 1: Up-flow Sand Filter

The up-flow sand filter is an up flow, deep bed, granular media filter with continuous backwash. Wastewater from the secondary treatment system would enter at the top of the filter and flows downward through the filter bed. The solids are captured by the media while the treated water rises and exits at the top of the filter.

The media is cleaned by an internal washing system that does not require backwash pumps and storage tanks, which contributes to lower power consumption. The filter is available in various sizes and configurations, which allows for customization to fit specific site and application requirements.

5.4.2.2 Alternative 2: Cloth Disc Filter

The cloth disc filter treatment process uses cloth media to reduce phosphorus and capable of producing reuse quality effluent. Backwash and solids wasting are accomplished in filter tank with continuous filtration operation.

Wastewater from the secondary treatment system enters the filter tank by gravity. The filtrate is collected inside the disks and discharged to the effluent chamber. The solids are captured by media with heavier solids settled to the tank bottom. The backwash shoes contact the media directly and solids are removed by vacuum pressure using the backwash pump. The heavier solids on the tank bottom are removed on an intermittent basis while the solids collected on the media will be pumped back to the solids collection system.

The technology is used in multiple wastewater treatment plant across Canada and would produce a high-quality effluent.

5.4.2.3 Alternative 3: High-rate Clarifier

High-rate clarifier is a proven, compact and robust wastewater clarification system. The technology can be implemented at all stages of the treatment of municipal effluents and real-time treatment of wet weather flows.

The coagulant and polymer are dosing into the clarifier influent to create hydroxide flocs and to ballast the flocs with Microsand. The sludge and Microsand slurry is pumped to a hydro cyclone where the sludge is separated from the Microsand. The clean Microsand is recycled back to the tank while the sludge is continuously discharged.

5.4.2.4 Cost Comparison of Short-Listed Tertiary Treatment Alternatives

Table 12 presents the capital cost and the annual operation and maintenance costs for the three, short-listed tertiary treatment alternatives. Estimates have been rounded to the nearest thousand dollars. As noted in Section 5.1, the tertiary treatment unit is envisaged to be constructed in Phase 3 of the expansion, which is beyond the study period. Therefore, a life-cycle cost analysis was not conducted for the tertiary treatment alternatives. Details of the cost estimates can be found in **Appendix E**.

Table 12 – Cost Estimates for Tertiary Treatment Alternatives

	Up-flow Sand Filter	Cloth Disc Filter	High-rate Clarifier
Capital Cost	$ 6,342,000	$ 5,579,000	$ 4,173,000
Annual Operation and Maintenance Cost	$ 24,000	$ 12,000	$ 16,000

5.4.3 Technology Alternatives for Disinfection

5.4.3.1 Alternative 1: Chlorination/Dechlorination

A chlorination/dechlorination disinfection system achieves disinfection by dosing the treated wastewater with a chlorine solution. Typically, a solution of chlorine gas or sodium hypochlorite is used as the chlorinating agent. Chlorine released into the receiving water stream negatively impacts all forms of life in the stream. For this reason, a dechlorination process is needed to remove residual chlorine prior to discharge to the river. For the purposes of this evaluation, sodium hypochlorite was assumed as the disinfecting agent and sodium bisulphite was used as the dechlorinating agent.

Treated wastewater from the tertiary treatment system would enter a chlorine contact tank, where chlorine would be metered into wastewater at the contact tank's inlet channel. The contact tank would be designed to provide the required amount of contact time between the chlorine and wastewater to allow the disinfection process to take place.

Residual chlorine would be removed by adding a dechlorinating agent to the contact tank effluent channel. Sodium bisulphite is often used as the dechlorinating agent.

Advantages and disadvantages of the chlorination/dechlorination alternative are listed in **Table 13**.

Table 13 – Advantages and Disadvantages of Chlorination/Dechlorination

Advantages	Disadvantages
▪ Proven effective and historically, extensively used. ▪ Well understood process. ▪ Effectiveness is not affected by water characteristics, such as turbidity.	▪ Over-dosing with the dechlorination chemical can reduce the dissolved oxygen concentrations in the wastewater and lower effluent DO levels. ▪ Operation requires skilled operators with a good understanding of chlorination chemistry. ▪ Added risk to worker health and safety due to handling of liquid or gaseous chlorine. ▪ Requires a building to house chemical dosing and storage systems.

5.4.3.2 Alternative 2: UV Disinfection

Disinfection via UV radiation involves exposing micro-organisms in wastewater to UV light within the 200 to 300 nanometer wavelength range. This range is called the germicidal range because micro-organisms, such as bacteria, viruses, and protozoa, are deactivated and lose the ability to reproduce after exposure.

A UV disinfection system consists of a bank of UV radiation emitting tubes, which are submerged in the wastewater, usually a concrete channel. As the wastewater flows across the UV tubes, micro-organisms are exposed to the radiation and become deactivated.

Advantages and disadvantages of the UV disinfection alternative are listed in **Table 14**.

Table 14 – Advantages and Disadvantages of UV Disinfection

Advantages	Disadvantages
▪ Proven effective on multiple installations in Ontario. ▪ Smaller footprint than chlorination.	▪ Effectiveness depends on water quality, i.e., transmissivity and turbidity.

Advantages	Disadvantages
▪ Effective against a wide range of micro-organisms. ▪ Does not produce harmful by-products.	▪ Not very flexible to large variations in water quality. ▪ Requires building to house UV system.

5.4.3.3 Cost Comparison of Short-Listed Disinfection Alternatives

Table 15 summarizes the results of the life-cycle cost analysis of the short-listed disinfection system alternatives. Estimates have been rounded to the nearest thousand dollars. Details of the life-cycle cost analysis can be found in **Appendix F**.

Table 15 – Cost Estimate for Disinfection Alternatives

	Chlorination / Dechlorination	UV Disinfection
NPV Capital Cost	$ 1,598,000	$ 1,604,000
NPV Annual Operation and Maintenance Cost	$ 1,993,000	$ 405,000
Total Net Present Value	**$ 3,591,000**	**$ 2,008,000**

5.5 Development of Preferred Alternative Solution for Liquid Treatment Train

5.5.1 Detailed Evaluation of Short-Listed Secondary Treatment Technologies

The evaluation criteria and weightings used to evaluate the short-listed secondary treatment technology alternatives were those presented in section 5.2.2.

Table 16 summarizes the results of the detailed evaluation of the secondary treatment alternatives.

The full evaluation matrix can be found in **Appendix H**.

Table 16 – Detailed Evaluation of Secondary Treatment Alternatives

PRIMARY CRITERIA		SECONDARY CRITERIA		ABSOLUTE WEIGHT (WT)	SHORT LISTED ALTERNATIVES							
					Alternative 1 Extended Aeration		Alternative 2 SBR		Alternative 3 MABR		Alternative 4 AGS	
CRITERIA	WEIGHT	CRITERIA	WEIGHT		SCORE*	WT SCORE	SCORE*	WT SCORE	SCORE*	WT SCORE	SCORE*	WT SCORE
Social/Culture	10%	Aesthetic Impacts (plant appearance)	10	1	◑	0.6	◑	0.7	●	1	◕	0.8
		Traffic (during construction and operation)	10	1	◑	0.6	◑	0.7	◑	0.6	◕	0.8
		Noise Impacts (during operation)	35	3.5	◔	1.4	◔	1.4	◕	2.8	◑	2.1
		Odour Impacts (during operation)	35	3.5	◑	2.1	◕	2.8	●	3.5	◑	2.1
		Archaeological and Cultural Heritage Impacts	10	1	●	1	●	1	●	1	●	1
Technical	40%	Ability to Meet Regulatory Objectives	30	12	●	12	●	12	●	12	●	12
		Technology / Process Robustness/Capacity to handle high peak flow	30	12	●	12	◔	4.8	◑	7.2	○	2.4
		Ease of Expansion and Phasing to Buildout	20	8	●	8	●	8	●	8	●	8
		Energy Requirements	5	2	◑	1.2	◔	0.8	●	2	◕	1.6
		Operation & Maintenance Requirements (simplicity, operator skill level/quantity)	10	4	●	4	◔	1.6	◕	3.2	◑	2.4
		Site Requirements (plant footprint)	5	2	◔	0.8	◑	1.2	●	2	◕	1.6
Environmental	20%	Public Health	30	6	◕	4.8	○	1.2	◔	2.4	○	1.2
		Sustainability	20	4	◑	2.4	◔	1.6	●	4	◕	3.2
		Greenhouse Gas Generation / Climate Change Impacts	20	4	◔	1.6	◔	1.6	●	4	◕	3.2
		Natural Environment Impact	10	2	◔	0.8	◑	1.2	●	2	◕	1.6
		Waste Generation	20	4	◑	2.4	◑	2.4	◕	3.2	●	4
Economic	30%	Capital Cost	30	9	◕	7.2	●	9	○	1.8	◔	3.6
		Operation and Maintenance Costs	40	12	●	12	◔	4.8	○	2.4	◔	4.8
		Net Present Value	30	9	◕	7.2	●	9	○	1.8	◔	3.6
			TOTAL SCORE	100	●		◑		◑		◔	

*Score is a number from 1 to 5 (1 -○, 2 -◔, 3 -◑, 4 -◕, 5 -●)

5.5.2 Preferred Alternative for Secondary Treatment

Based on the detailed evaluation of the short-listed secondary treatment alternatives, the preferred alternative is the Extended Aeration system.

5.5.3 Detailed Evaluation of Short-Listed Tertiary Treatment Technologies

The weightings used for detailed analysis of the tertiary treatment alternatives were revised to more closely reflect the impacts related to the tertiary treatment system. At the point of tertiary treatment, the wastewater would be almost fully treated. Most of the solids and nutrients would be removed. Accordingly, it was decided that the Social/Cultural impacts of the tertiary treatment would not be as great as with the secondary treatment and the weighting assigned to the Social/Culture criterion was reduced.

Weightings assigned to the Technical and Environmental criteria were increased to reflect the relative importance of these criteria for tertiary treatment.

Table 17 shows the criteria and weightings used to evaluate the tertiary treatment alternatives.

Table 17 – Tertiary Treatment Short-List Screening Criteria

Primary Criteria	Weight	Secondary Criteria	Weight
Social / Culture	5%	Aesthetic Impacts (plant appearance)	10%
		Traffic Impacts (during construction and operation)	10%
		Noise Impacts (during operation)	35%
		Odours Impacts (during operation)	35%
		Archaeological and Cultural Heritage Impacts	10%
Technical	40%	Ability to Meet Regulatory Objectives	30%
		Technology / Process Robustness	30%
		Ease of Expansion and Phasing to Buildout	20%
		Energy Requirements	5%
		Operation & Maintenance Requirements (simplicity, operator skill level/quantity)	10%
		Site Requirements (plant footprint)	5%
Environmental	25%	Public Health and Safety	30%
		Sustainability	20%

Primary Criteria	Weight	Secondary Criteria	Weight
		Climate Change Impacts / Greenhouse Gas Generation	20%
		Natural Environment Impacts	10%
		Waste Generation	20%
Economic	30%	Capital Cost	60%
		Operation and Maintenance Costs	40%

Table 18 summarizes the results of the detailed evaluation of the tertiary treatment alternatives. The full evaluation matrix can be found in **Appendix H**.

Table 18 – Detailed Evaluation of Tertiary Treatment Alternatives

PRIMARY CRITERIA		SECONDARY CRITERIA		ABSOLUTE WEIGHT (WT)	SHORT LISTED ALTERNATIVES					
					Alternative 1 Up-flow Sand Filter		Alternative 2 Cloth Disc Filter		Alternative 3 High-rate Clarifier	
CRITERIA	WEIGHT	CRITERIA	WEIGHT		SCORE*	WT SCORE	SCORE*	WT SCORE	SCORE*	WT SCORE
Social/Culture	5%	Aesthetic Impacts (plant appearance)	10	0.5	◕	0.4	●	0.4	◕	0.5
		Traffic (during construction and operation)	10	0.5	◕	0.4	◕	0.4	◕	0.4
		Noise Impacts (during operation)	35	1.8	◕	1.6	◕	1.6	◕	1.6
		Odour Impacts (during operation)	35	1.8	◕	1.6	◕	1.6	◕	1.6
		Archaeological and Cultural Heritage Impacts	10	0.5	●	0.5	●	0.5	●	0.5
Technical	40%	Ability to Meet Regulatory Objectives	30	12	●	12	●	12	●	12
		Technology/Process Robustness	30	12	◕	9.6	◕	10.8	◕	10.8
		Ease of Expansion and Phasing to Buildout	20	8	◕	6.4	◕	6.4	◕	6.4
		Energy Requirements	5	2	●	1.4	●	2	◕	1.6
		Operation & Maintenance Requirements (simplicity, operator skill level/quantity)	10	4	◕	3.6	◕	3.6	◕	3.2
		Site Requirements (plant footprint)	5	2	◕	1.6	●	1.2	◕	1.6
Environmental	25%	Public Health	30	7.5	●	7.5	●	7.5	●	4.5
		Sustainability	20	5	◕	4	◕	4	◕	4
		Greenhouse Gas Generation / Climate Change Impacts	20	5	◑	3	●	5	◕	4
		Natural Environment Impact	10	2.5	◕	2	●	1.8	◕	2.3
		Waste Generation	20	5	◕	4	◕	4	●	3
Economic	30%	Capital Cost	60	18	◕	14.4	◕	16.2	●	18
		Operation and Maintenance Costs	40	12	●	7.2	●	12	●	7.2
			TOTAL SCORE	100	◔		◕		◑	

*Score is a number from 1 to 5 (1 -○, 2 -◔, 3 -◑, 4 -◕, 5 -●)

5.5.3.1 Preferred Alternative for Tertiary Treatment

Based on the detailed evaluation of the short-listed tertiary treatment alternatives, Cloth Disc Filter would be the preferred tertiary treatment alternative.

5.5.4 Detailed Evaluation of Short-Listed Disinfection Alternatives

The evaluation criteria and weightings used for evaluating disinfection alternatives were those presented in section 5.2.2. Results of the evaluation are presented in **Table 19**.

The full evaluation matrix can be found in **Appendix H.**

Table 19 – Detailed Evaluation of Disinfection System Alternatives

PRIMARY CRITERIA		SECONDARY CRITERIA		ABSOLUTE WEIGHT (WT)	SHORT LISTED ALTERNATIVES			
					Alternative 1 Chlorination/ De-Chlorination		Alternative 2 UV Disinfection	
CRITERIA	WEIGHT	CRITERIA	WEIGHT		SCORE*	WT SCORE	SCORE*	WT SCORE
Social/Culture	10%	Aesthetic Impacts (plant appearance)	10	1	◑	0.6	●	1
		Traffic (during construction and operation)	10	1	◑	0.6	◕	0.9
		Noise Impacts (during operation)	35	3.5	◑	2.1	◑	2.1
		Odour Impacts (during operation)	35	3.5	◑	2.1	◕	2.8
		Archaeological and Cultural Heritage Impacts	10	1	●	1	●	1
Technical	40%	Ability to Meet Regulatory Objectives	30	12	◕	9.6	◕	9.6
		Technology/Process Robustness /ability to treat unanticipated high peak flow	30	12	◕	9.6	◑	7.2
		Ease of Expansion and Phasing to Buildout	20	8	◑	4.8	◕	6.4
		Energy Requirements	5	2	●	2	◑	1.2
		Operation & Maintenance Staffing Requirements (skill level/number)	10	4	◑	2.4	◕	3.6
		Site Requirements (plant footprint)	5	2	◑	1.2	◕	1.6
Environmental	20%	Public Health and Safety	30	6	◑	3.6	◕	5.4
		Sustainability	20	4	◑	2.4	◕	3.2
		Greenhouse Gas Generation / Climate Change Impacts	20	4	◑	2.4	◑	2.8
		Natural Environment Impact	10	2	◑	1.2	◕	1.6
		Waste Generation	20	4	◑	2.4	◕	3.2
Economic	30%	Capital Cost	30	9	◑	5.4	●	9
		Operation and Maintenance Costs	40	12	◑	7.2	◕	10.8
		Net Present Value	30	9	◑	5.4	●	9
			TOTAL SCORE	100	◑		◕	

*Score is a number from 1 to 5 (1 -○, 2 -◔, 3 -◑, 4 -◕, 5 -●)

5.5.5 Preferred Alternative for the Disinfection System

Based on the detailed evaluation of the short-listed disinfection system alternatives, the preferred alternative is UV disinfection.

5.6 Preferred Alternative for the Liquid Treatment Train

Based on the results of the detailed analyses of the alternatives for the liquid treatment processes, the preferred alternatives are:

- Secondary Treatment – Extended Aeration
- Tertiary Treatment – Cloth Disc Filter
- Disinfection – UV Radiation

Figure 7 presents the flow schematic for the preferred alternative for the liquid treatment train.

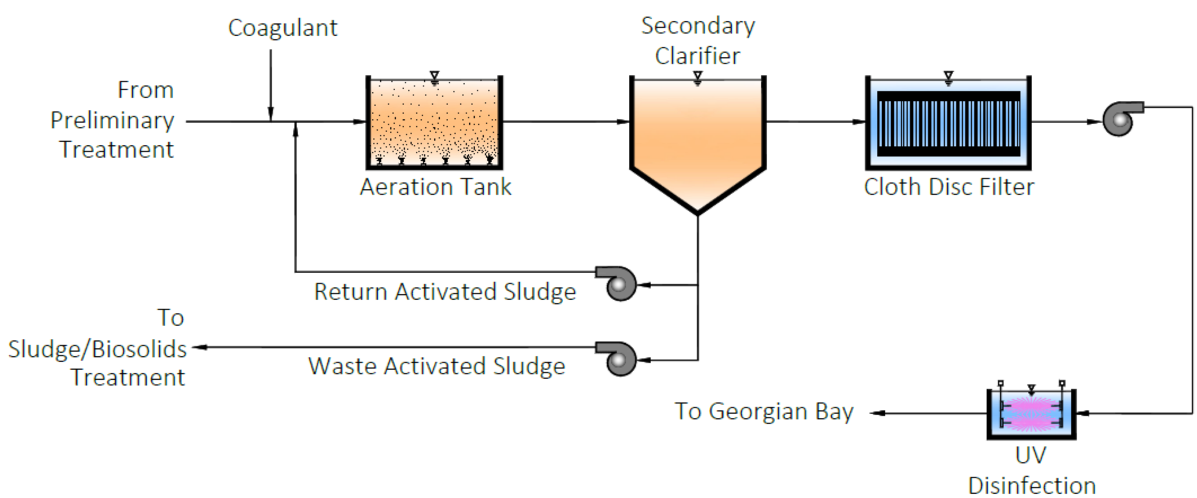


Figure 7 – Preferred Liquid Treatment Train Process Flow Schematic

6 Sludge/Biosolids Treatment and Management

6.1 Objectives and Overview

The objective of the sludge/biosolids component of the evaluation is to develop alternatives for treating and managing the sludge/biosolids generated at the Meaford WWTP.

Sludge/biosolids refers to the solid component in the wastewater. For the purposes of this assessment, sludge refers to wastewater solids that have not been stabilized and biosolids refers to wastewater solids that have been stabilized and are suitable for removal from the WWTP. Sludge does not include grit or solids that have been removed during preliminary treatment, as these solids are typically hauled off site for disposal at a landfill.

Sludge is progressively removed from the liquid stream during primary, secondary, and tertiary treatment. The quantity of sludge removed and/or generated in each process depends on the process itself. For example, processes that add coagulants to the liquid system will generate more sludge than processes that do not use coagulants.

Sludge from the WWTP is collected and can either be stabilized on site or hauled off-site for treatment by a biosolids management contractor. Sludge that is stabilized on site would be hauled off-site for use and/or disposal. If the sludge/biosolids were to be managed by a contractor, the contractor would choose the treatment and disposal methods.

Biosolids is a nutrient-rich product of the wastewater treatment process, with many options available for recovering and using the nutrients in a beneficial way, often termed as "beneficial reuse". Biosolids can be treated by various methods to produce products that can be used agriculturally, commercially marketed, or used as an energy source. Some of the possible end-use options for biosolids include:

- Applied to agricultural land as fertilizer;
- Used as a soil amendment, such as with compost;
- Commercially marketable fertilizer;
- Incinerated for heat and the ash used in the cement industry.

6.2 Sludge/Biosolids Train Evaluation Methodology

For the purpose of this project only the on-site stabilization technologies are evaluated.

6.2.1 On-Site Sludge Stabilization Alternatives

Unlike unstabilized sludge, stabilized sludge can be readily land applied to suitable agricultural lands. There are numerous contractors that offer land application services. End-use options for stabilized sludge do not entail the risk of dependence on a third party, unlike the situation with unstabilized sludge.

Due to the flexibility associated with stabilizing the plant's sludge on site, it was decided that this alternative would serve the Municipality well and a long-list/short-list evaluation, as described previously in Section 4, was performed for sludge stabilization technologies.

6.2.2 Evaluation of On-Site Sludge Stabilization Technologies

The methodology used to evaluate the technologies available for on-site sludge stabilization was a modified version of the approach used for the liquid train evaluation. A long-list set of screening criteria, specific to sludge/biosolids, was developed and used to short list the technology alternatives. This approach was used because the objectives for sludge/biosolids management vary from those associated with the liquid train. For example, the ability for beneficial reuse is a criterion that is specific to sludge/biosolids and is not relevant to the liquid treatment process.

6.2.3 Long-List Screening Criteria

The criteria selected for screening the long list of sludge stabilization technologies are presented in **Table 20** and descriptions of each criterion follow.

Table 20 – Sludge Stabilization Long-List Screening Criteria

Criteria	Description
Regulatory Compliance	Ability to meet current and anticipated future regulations for processing and end-use / disposal.

Criteria	Description
Proven Reliability and Sustainability	Demonstrated successful projects of similar size and high level of flexibility to variations in sludge/biosolids quality and adverse weather conditions.
Staging / Phasing	Ability to easily expand to meet Meaford WWTP's Full Buildout capacity.
Cost	Have value in terms of performance and/or operation and maintenance that are reflective of the capital costs.
Resource Recovery / Revenue Generation	Ability for end product to be used beneficially (e.g., land application) or to generate revenue (e.g., sold commercially as compost or fertilizer)

Regulatory Compliance

In order for an alternative to be carried forward for detailed analysis, the alternative must be one that produces a final product that meets the current and anticipated regulations for the intended use of the end product. For example, processes that produce compost must be able to adhere to the stringent metals content as prescribed by the Guidelines for the Production of Compost in Ontario, if the compost is to be commercially marketed in Ontario.

Proven Reliability and Sustainability

The preferred alternative must have a demonstrated history of reliably processing biosolids from a facility or facilities of a similar scale. The preferred alternative must be sustainable and be able to provide year-round treatment and/or storage, where required.

Staging/Phasing

The staging / phasing criterion reviews how easily an alternative can be expanded to match the planned expansion of the facility. Alternatives that require minimal component upgrades and financial investment were rated more favourably.

Cost

The cost criterion looks at the capital cost of the alternative and the costs associated with its operation and maintenance. Capital costs involve all initial construction costs including equipment purchase and installation. Operation and maintenance aspects include costs related to utilities (electricity, gas, potable water), chemicals, and the level of effort required for regular maintenance of the equipment.

Beneficial Use / Revenue Generation

This criterion relates to whether or not the final product produced by the alternative can be beneficially reused and/or commercially marketed. Alternatives that do not provide nutrient recovery or revenue generation from biosolids are excluded from the short-list.

6.3 Screening of Long List of Sludge Stabilization Technologies

The long list of technologies considered for sludge stabilization are listed, described, and evaluated in **Table 21**.

Table 21 – Evaluation of Long List of Sludge Stabilization Technology Alternatives

No.	Technology	Description	Screening Criteria: Regulatory Compliance	Proven Reliability & Sustainability	Staging / Phasing	Cost	Beneficial Use / Revenue Generation	Carry Forward	Rationale
1	Anaerobic Digestion	▪ This alternative involves stabilizing by anaerobic digestion. The digester is heated to a temperature between 35°C to 38°C and bacteria break down the organic matter in the sludge. The process produces methane gas as a by-product, which can be converted to heat and/or energy. ▪ Complete sealed anerobic environment is required for the process. During the process. ▪ Biogas (methane) pretreatment, reuse or burning system to treat the explosive gas product. ▪ The biosolids produced is suitable for land application only. A local contractor would be retained for the services of land application. ▪ Regulations require that the facility include a means to store biosolids during the winter months when land application is not feasible. At least 240 days of storage is mandated, unless alternate methods of disposing of the biosolids are in place.	✓	✓	✓	x	✓	**No**	▪ Anaerobic digestion not economically sound for smaller plants ▪ Digesters need specialized components, such as gas-tight covers ▪ Needs tank insulation, sludge heating, mixing, gas collection and treatment systems ▪ Equipment needs to be designed for isolation and service in an explosive environment due to the presence of methane ▪ Risk of explosion presents if operated improperly. ▪ Digester performance severely hindered if operated improperly ▪ Requires fairly knowledgeable and specially trained operators ▪ Generally higher construction and operation cost unless the biogas is reused. Energy reuse needs complicated boiler, gas collection and treatment systems
2	Aerobic Digestion	▪ This alternative involves stabilizing the sludge using aerobic digestion. Micro-organisms consume the organics in the presence of oxygen. ▪ Generally considered unsuitable for primary sludge because of higher oxygen demand and larger amount of biomass produced ▪ The biosolids produced is suitable for land application only. A local contractor would be retained for the services of land application. ▪ This alternative also includes an on-site biosolids thickening system and 240 days of on-site biosolids storage.	✓	✓	✓	✓	✓	**Yes**	▪ Commonly used and well understood technology, especially for small plants. Operation and maintenance are easier to manage ▪ Expansion is straightforward ▪ Capital costs are not high, but operating costs can be due to requirement for aeration ▪ Digested product can be land-applied in Ontario

No.	Technology	Description	Screening Criteria						Rationale
			Regulatory Compliance	Proven Reliability & Sustainability	Staging / Phasing	Cost	Beneficial Use / Revenue Generation	Carry Forward	
3	Alkaline Stabilization	▪ This alternative involves stabilizing the sludge through the addition of alkaline material (typically lime) to raise and maintain the pH at 12 to destroy the pathogens. ▪ The biosolids produced is suitable for land application and unrestricted use as a fertilizer product. A local contractor would be retained for the services of land application. ▪ This alternative also includes an on-site biosolids thickening system and 240 days of on-site biosolids storage. ▪ Regular importing of lime to the WWTP would be needed. ▪ Process produces 15% to 50% more material to be hauled off-side, due to the addition of lime.	✓	x	✓	x	✓	**No**	▪ Potential for significant odour generation if system not operated properly ▪ It could be operational trouble to store and operate lime as it is easy to absorb moisture and react to water. ▪ Health and safety issues related to high PH. ▪ Higher haulage costs due to lime addition ▪ Product has lower nitrogen content than other stabilization processes – may be less desirable as fertilizer
4	Stabilization with Autothermal Thermophilic Aerobic Digestion (ATAD)	▪ This alternative involves stabilizing the sludge using an auto-thermal aerobic digester (ATAD), which uses the heat generated by the digestion process to keep the digester temperature between 55°C and 65°C. No external heat source is required. ▪ The required hydraulic retention time is between 6 and 10 days as compared with 15 to 30 days for anaerobic or traditional aerobic digestion. ▪ Underground tank with insulation is required to maintain operation temperature. ▪ Odour collection and control is required. ▪ The volatile solids destruction is higher than traditional aerobic and anaerobic digestion, which means less biosolids to haul off site. ▪ A sludge thickening system would be needed upstream of the ATAD, since the ATAD feed has to be above 3%. ▪ The biosolids produced is suitable for land application and unrestricted use as a fertilizer product. A local contractor would be retained for the services of land application. ▪ This alternative includes 240 days of on-site biosolids storage.	✓	✓	✓	✓	✓	**Yes**	▪ Well understood technology with several installations in Ontario ▪ No external heating system required ▪ Short hydraulic retention time results in smaller digester and lower construction costs ▪ Digested product can be land-applied in Ontario

6.3.1 Summary of Short-Listed Sludge/Biosolids Alternatives

The on-site sludge stabilization technologies that were short-listed for detailed evaluation were:

- Aerobic Digestion
- Stabilization with Autothermal Thermophilic Aerobic Digestion (ATAD)

6.3.2 Detailed Description of Short-Listed Sludge Stabilization Alternatives

6.3.2.1 Alternative 1: Aerobic Digestion

Figure 8 shows a flow schematic of the process steps associated with the aerobic digestion alternative. Sludge and scum from the liquid train are directed to the aerobic digester, which is equipped with an aeration and mixing systems.

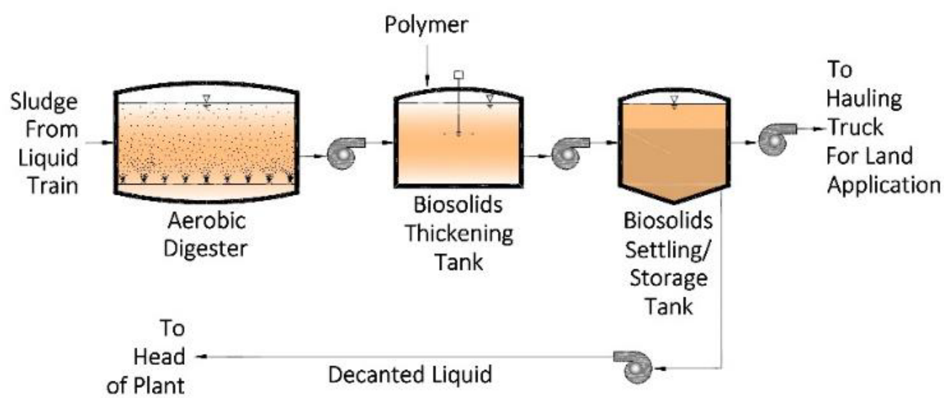


Figure 8 – Conventional Aerobic Digester Process Flow Schematic

Stabilized sludge is pumped from the digester to the biosolids thickening tank at approximately 1.5% solids. Polymer is added to the thickening tank, which is equipped with a mixing system to allow the polymer to react with the biosolids. From the thickening tank, the biosolids is pumped to the biosolids settling tanks.

The biosolids settling tank provide quiescence for settling and will be equipped with decanting systems to facilitate gravity thickening. Decanted liquid from the biosolids settling tank will be pumped to the head of the plant and thickened biosolids will be pumped to the biosolids storage tanks.

During summer months, thickened biosolids is pumped from the biosolids storage tanks then to the haulage trucks and hauled off-site for land application.

This alternative involves land applying of the biosolids as a liquid product rather than a biosolids cake, so the biosolids will need to be thickened to no more than 6%, as pumping of biosolids beyond this concentration, using traditional sludge pumps, becomes problematic. It is anticipated that thickening via polymer addition and gravity settling will achieve the desired solids concentration.

Advantages and disadvantage of this alternative are presented in **Table 22**.

Table 22 – Advantages and Disadvantages of the Aerobic Digestion Alternative

Advantages	Disadvantages
▪ Requires simplest thickening system. ▪ Least amount of process equipment required. ▪ Biosolids produced is relatively odour-free. ▪ Well understood technology.	▪ Higher operation costs due to requirement of aeration. ▪ Degree of stabilization is weather dependent, with lower levels seen in the colder months.

6.3.2.2 Alternative 2: Auto-Thermal Thermophilic Aerobic Digestion (ATAD)

Figure 9 presents a flow schematic of the steps associated with the ATAD alternative. Unlike Alternative 1, sludge and scum cannot be pumped directly to the ATAD. It needs to be thickened to approximately 5% solids.

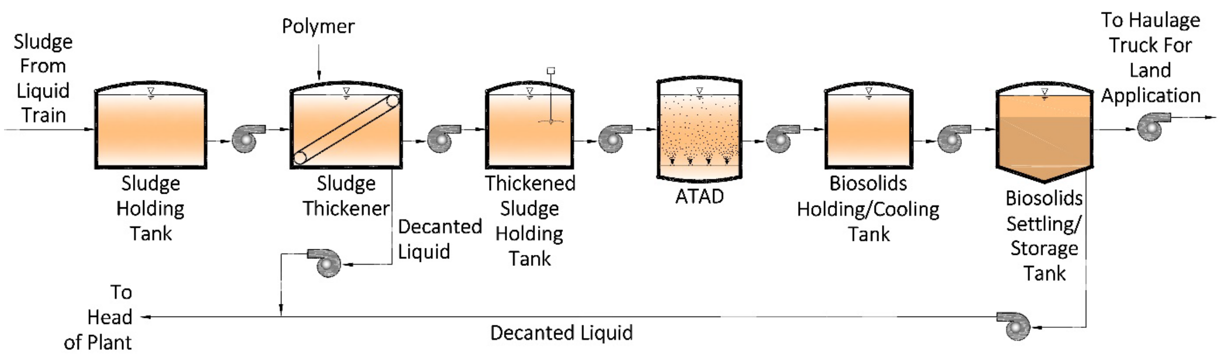


Figure 9 – Auto-Thermal Thermophilic Aerobic Digestion Process Flow Schematic

From the liquid train, sludge and scum are pumped to an equalization tank then to a mechanical thickener. Polymer is added to the mechanical thickening process to improve thickening. Since sludge fed to the ATAD must be at a prescribed solids concentration, mechanical thickening is incorporated in this alternative to ensure that the required solids concentration can be achieved in a reasonable length of time.

Thickened sludge is then pumped to the ATAD for stabilization. The ATAD unit can be a single stage or double stage digestion system. A single stage process achieves sludge stabilization and the product is suitable for land application. If followed by a second stage, the second stage pasteurizes the biosolids to a quality level where the biosolids can be used as fertilizer without restrictions, as compared to land application only with the single stage ATAD. However, the pasteurized end-product has a lower nitrogen content, potentially making them a less desirable product in areas where high ammonia nitrogen fertilizer is desired.

From the ATAD, biosolids are transferred to biosolids holding/cooling tank, where excess heat from the stabilization process is removed to avoid possible over-heating.

Biosolids from the holding/cooling tank are pumped to the biosolids storage tanks, which provide the required 240 days of storage.

Advantages and disadvantage of this alternative are presented in **Table 23**.

Table 23 – Advantages and Disadvantages of the ATAD Alternative

Advantages	Disadvantages
▪ Smaller digester size due to shorter retention times. ▪ Degree of stabilization is not weather dependent. ▪ Can produce a pasteurized biosolids product if second stage used.	▪ Higher capital costs due to requirement for mechanical thickening system and tank insulation, and more process units. ▪ More complex operation. ▪ Biosolids product have higher odour than conventional aerobic digestion – odour control system may be needed.

6.3.3 Cost Comparison of Short-Listed Sludge Stabilization Alternatives

Table 24 summarizes the results of the life-cycle costs analysis for the sludge stabilization alternatives. Details of the life-cycle cost analysis can be found in **Appendix G**.

Table 24 – Cost Estimates for Sludge Stabilization Alternatives

	Aerobic Digestion	Autothermal Thermophilic Aerobic Digestion (ATAD)
NPV Capital Cost	$ 8,802,000	$ 22,591,000
NPV Annual Operation and Maintenance Cost	$ 2,035,000	$ 1,373,000
Total Net Present Value	**$ 10,837,000**	**$ 23,963,000**

6.3.4 Sludge Stabilization Alternatives Detailed Evaluation

The criteria and weightings used to evaluate the sludge stabilization alternatives were those presented in section 5.2.2. Results of the evaluation are presented in **Table 25**.

The full evaluation matrix can be found in **Appendix H.**

Table 25 – Detailed Evaluation of Sludge Stabilization Alternatives

PRIMARY CRITERIA		SECONDARY CRITERIA		ABSOLUTE WEIGHT (WT)	SHORT LISTED ALTERNATIVES			
					Alternative 1 Aerobic Digestion		Alternative 2 ATAD	
CRITERIA	WEIGHT	CRITERIA	WEIGHT		SCORE*	WT SCORE	SCORE*	WT SCORE
Social/Culture	10%	Aesthetic Impacts (plant appearance)	10	1	●	1	◑	0.5
		Traffic (during construction and operation)	10	1	◕	0.9	●	1
		Noise Impacts (during operation)	35	3.5	●	3.5	◑	2.1
		Odours Impacts (during operation)	35	3.5	●	3.5	◔	1.4
		Archaeological and Cultural Heritage Impacts	10	1	●	1	●	1
Technical	40%	Ability to Meet Regulatory Objectives	30	12	◕	10.8	●	12
		Technology/Process Robustness	30	12	◕	10.8	●	12
		Ease of Expansion and Phasing to Buildout	20	8	●	8	◑	4.8
		Energy Requirements	5	2	◕	1.6	●	2
		Operation & Maintenance Staffing Requirements (skill level/number)	10	4	●	4	○	1.2
		Site Requirements (plant footprint)	5	2	●	2	◑	1.2
Environmental	20%	Public Health and Safety	30	6	◕	4.8	◕	4.8
		Sustainability	20	4	◕	3.2	●	4
		Greenhouse Gas Generation / Climate Change Impacts	20	4	◕	3.2	●	4
		Natural Environment Impact	10	2	●	2	◕	1.6
		Waste Generation	20	4	◑	2.4	◑	2.4
Economic	30%	Capital Cost	30	9	●	9	◑	5.4
		Operation and Maintenance Costs	40	12	◕	9.6	●	12
		Net Present Value	30	9	●	9	◕	7.2
			TOTAL SCORE	100	◕		◑	
*Score is a number from 1 to 5 (1 -○, 2 -◔, 3 -◑, 4 -◕, 5 -●)								

6.3.5 Preliminary Preferred Alternative for Sludge Stabilization

Based on the detailed evaluation of the short-listed sludge stabilization alternatives, stabilization by aerobic digestion would be the preferred alternative.

7 Preliminary WWTP Preferred Design Concept

The results of the technologies alternative evaluation show that the extended aeration technology and the cloth disc filter technology were the preferred alternatives for secondary and tertiary treatment, respectively.

UV radiation was the preferred alternative for disinfection.

On-site stabilization of sludge via an aerobic digestion system was selected as the preferred alternative.

Figure 10 shows the flow schematic of the preferred alternative for the liquid treatment train.

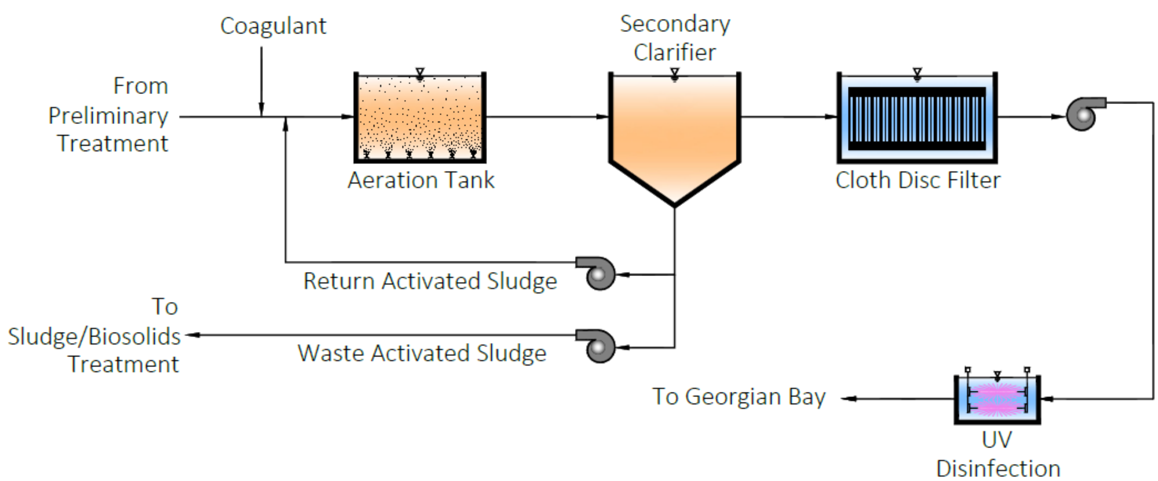


Figure 10 – Preliminary Preferred Treatment Train Process Flow Schematic

7.1 Meaford WWTP Site Plan

Figure 11 presents a conceptual plant layout, which is based on the preliminary preferred treatment alternatives. The plant layout includes common facilities such as the administration building, raw sewage pump station, and the effluent water pump chamber. The site plan is colour coded based on the planned expansion of the Meaford WWTP in 3 phases.

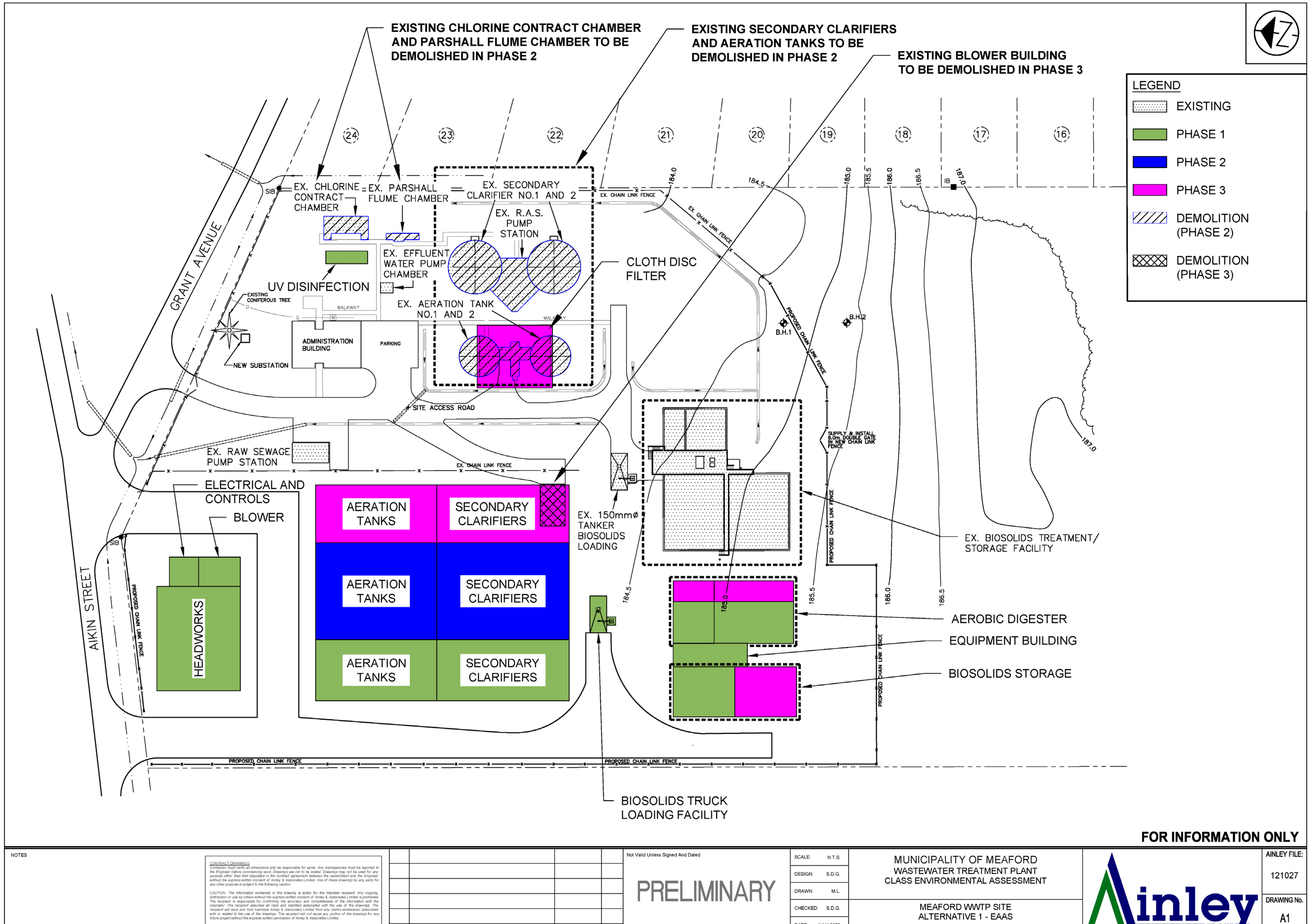


Figure 11 – Conceptual Site Layout of Preliminary Preferred Alternatives

7.2 Capital Costs of Meaford WWTP Construction

Ainley Group has prepared a rough order of magnitude capital construction cost estimate (Class 5) for the Meaford WWTP based on the following assumptions:

- Costing of common equipment and construction materials has been based on Ainley's past project experience.
- Supplier quotations for major equipment.
- Structural and Architectural cost estimate is based on Ainley's past experience with similar scope projects as Geotechnical investigation is not available at this time.
- No contaminated soils have been assumed onsite.
- Cost for any required site investigations is not included in the estimate.
- This estimate does not include costs associated with any required upgrades at the on-site sewage pumping station and off-site sewage pumping stations.
- Any direct costs from utilities and required permits will be paid by the Municipality directly.

A breakdown of the cost estimate is presented in **Table 26**.

Table 26 – Estimated Capital Construction Cost of Meaford WWTP

	PHASE 1 CAPITAL COST ESTIMATE (2023 Dollars)	PHASE 2 CAPITAL COST ESTIMATE (2023 Dollars)	PHASE 3 CAPITAL COST ESTIMATE (2023 Dollars)
Preliminary Treatment / Headworks	$ 12,836,000	$ -	$ -
Secondary Treatment (Extended Aeration)	$ 11,944,000*	$ 13,228,000	$ 8,414,000
Tertiary Treatment (Cloth Filter Media)	$ -	$ -	$ 5,579,000
Disinfection (UV Radiation)	$ 760,000	$ -	$ 134,000
Biosolids Treatment (Aerobic Digestion)	$ 5,194,000	$ -	$ 3,424,000
SUB TOTAL	**$ 30,734,000**	**$ 13,228,000**	**$ 17,551,000**
General Requirements including Mobilization and Demobilization, Insurance and Bonding, etc. (20%)	$ 6,147,000	$ 2,646,000	$ 3,511,000
Contractors Profit (8%)	$ 2,459,000	$ 1,059,000	$ 1,405,000

	PHASE 1 CAPITAL COST ESTIMATE (2023 Dollars)	PHASE 2 CAPITAL COST ESTIMATE (2023 Dollars)	PHASE 3 CAPITAL COST ESTIMATE (2023 Dollars)
Contingency (40%)	$ 12,294,000	$ 5,292,000	$ 7,021,000
Engineering Fees (15%)	$ 4,611,000	$ 1,985,000	$ 2,633,000
TOTAL CAPITAL COST	**$ 56,245,000**	**$ 24,210,000**	**$ 32,121,000**

* Including cost for construction of the blower/RAS/WAS building

8 Conclusions and Recommendations

- The 2007 MCEA recommended increasing the capacity of the Meaford WWTP by expanding the plant within the existing property upon which the plant is situated.
- In order to implement the recommended design alternative, Ainley Group conducted the MCEA update, reviewed the previous design recommendations and investigated new technologies.
- Results of the WWTP capacity assessment showed that the actual capacity of the plant is less than the rated capacity of the plant (3,910 m^3/d per the WWTP's approved ECA) and is limited by the secondary treatment capacity to 2,700 m^3/d.
- Results of the WWTP capacity assessment also showed that the total capacity of the digesters is 2,900 m^3/d for the maximum month loading, and 1,526 m^3/d for the plant ADF with the maximum month peak factor of 1.9. The biosolids storage has a capacity for 3,600 m^3/day average influent daily flow.
- Based on review of the previous studies and upon revisiting the projection population of year 2054, and subsequently the 30-year projected wastewater flows, it was determined that the projected average wastewater flow at the end of the study period will be 4,400 m^3/day (ADF).
- Previous planning efforts identified ultimate expansion to 6,000 m^3/d (ADF).
- To achieve the Meaford WWTP's projected capacity of 4,400 m^3/d and 6,000 m^3/d, it is envisaged that the expansion of the Meaford WWTP would be constructed in the following three phases:

It is envisaged that the expansion of the Meaford WWTP would be constructed in the following three phases:

  - Phase 1: Expand the existing secondary treatment capacity of the WWTP by an additional 1,700 m^3/d to achieve full capacity of 4,400 m^3/d. Expand sludge digestion and sludge storage by 2,900 m^3/d, and 1,200 m^3/d respectively. Construct a new headworks to achieve capacity of 6,000 m^3/d. Construct a new blower/RAS/WAS building to achieve full capacity of 4,400 m^3/d.

  - Phase 2: Demolish the plant's existing secondary treatment train and replace with new secondary treatment train for the capacity of 2,700 m^3/d.
  - Phase 3: Expand the plant's secondary treatment capacity by an additional 1,600 m^3/d to achieve projected capacity of 6,000 m^3/d. Expand the plant's sludge digestion and sludge storage by 1,600 m^3/d, and 1,200 m^3/d, respectively, to achieve projected capacity of 6,000 m^3/d. Potentially, add tertiary treatment.

- This MCEA update evaluated technology alternatives for the secondary, tertiary, disinfection, and sludge/biosolids treatment stages of the wastewater treatment plant.
- Life-cycle cost analysis was performed for each treatment stage considered in the evaluation. Life cycle analysis included equipment costs, building and tankage construction costs, operating cost associated with energy and chemical consumption, and a net present value analysis.
- The preferred treatment technologies for the wastewater treatment plant are summarized below:

Treatment Stage	Preferred Alternative
Secondary Treatment	Extended Aeration +Secondary Clarifier
Tertiary Treatment	Cloth Disc Filters
Disinfection	UV Radiation
Biosolids Treatment	Aerobic Digestion

- It is recommended that the Town evaluate the potential for revenue generation through marketing of biosolids once Phase 1 is in operation and the nature and quantity of biosolids are known as well as market conditions at the time of production, as these factors are difficult to accurately assess at this time.
- The estimated total capital construction cost for Phase 1 is $ 56,245,000 (2023 dollars).
- The estimated total capital construction cost for Phase 2 is $ 24,210,000 (2023 dollars).
- The estimated total capital construction cost for Phase 3 is $32,121,000 (2023 dollars).
- The estimated total cost for the wastewater treatment plant to Full Buildout is $112,576,000 (2023 dollars).
- Based on a conceptual plant layout, the proposed sites for the WWTP would be large enough to accommodate the preliminary preferred treatment alternatives.

Appendix A

Meaford WWTP Existing and Future Wastewater Flows TM

Municipality of Meaford Wastewater Treatment Plant Class EA Update

Technical Memorandum
Existing and Future Wastewater Flows

Prepared For:

The Municipality of Meaford

September 2023

CREATING QUALITY SOLUTIONS TOGETHER

MUNICIPALITY OF MEAFORD WASTEWATER TREATMENT PLANT CLASS EA UPDATE

TECHNICAL MEMORANDUM
EXISTING AND FUTURE WASTEWATER FLOWS

PROJECT NO. 121027

Prepared For:

The Municipality of Meaford

By:

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1 Introduction

This Technical Memorandum has been prepared in support of a Schedule 'C' Class EA for the expansion of Meaford Wastewater Treatment Plant (WWTP EA), building from the 2015 Meaford Water and Wastewater Master Plan (the Master Plan). Planning for expansion of the Meaford WWTP was initiated in 2007 with the completion of a previous Schedule 'C' EA, the Master Plan reinforced the historical general alternative that recommended increasing the capacity of the plant by expanding within the existing property within the existing property upon which the plant is situated. In order to implement the recommended design alternative, and satisfy the requirements of the Ministry of Environment, Conservation and Parks (MECP), this study was initiated to complete Phase 3 and Phase 4 of the Class EA process following from the Master Plan. The Municipality has retained Ainley Group to conduct the EA, review the previous design recommendations and investigate new technologies.

This Technical Memorandum provides an overview of the past and current wastewater flows and a projection of future flows based on current development information. The analysis of anticipated future flows in the Meaford WWTP service area from development is provided using Ministry of Environment, Conservation and Parks (MECP) Design Guidelines for Sewage Works, in conjunction with standard assumptions used for new development flow estimation by the Municipality. Flow projections will be conducted for the 30-year planning horizon to 2051, as well as for the full build-out of the urban boundary. The service area of Meaford's WWTP is limited to the urban area, as such, growth in the rural area is not considered as a component of the evaluation.

The Meaford WWTP has an ECA rated capacity of 3,910 m^3/d with a peak flow capacity of 11,730 m^3/day. Flow projections and current flows will be compared to existing capacity.

2 Objectives

The objectives of this Technical Memorandum are as follows:

- Review of historical growth trends and planning documentation
- Confirm sanitary sewage collection system flows from the existing community
- Establish growth potential for the Municipality based on the Official Plan (OP) settlement area boundary and current projected growth targets
- Project future sanitary sewage collection system flows for the full build-out of the community and to the end of the planning period in 2054.
- Assess the impact of future wastewater flows on the capacity of the WWTP.

3 2014 Official Plan

The 2014 Municipality of Meaford Official Plan, outlines a growth projection from 2006 through to 2026. The projected growth plan is summarised in **Table 1**.

Table 1 - 2014 Official Plan Growth Projection

Year	Permanent Population Growth	Employment Growth	Household Growth
2006	11,400	3,100	4,400

Year	Permanent Population Growth	Employment Growth	Household Growth
2011	12,000	3,300	4,700
2016	12,500	3,500	5,000
2021	13,100	3,600	5,300
2026	13,300	3,600	5,500
Total Increase	1,900	500	1,100

In an effort to direct growth to settlement areas, the Municipality set out targets for development within the settlement area for residential growth via new lot/unit creation. The goal of the plan was to direct 90% of new development to the Settlement Area. As such, 990 of the total 1,100 units projected out to 2026 were anticipated to be within the Settlement Area.

In order to support the identified growth targets, the Official Plan established that, as a minimum target, 10% of new growth in the primary settlement area of Meaford is to be achieved through intensification. Further, an overall average development density of 20 units per hectare for development projects should be achieved.

The Municipality is completing an update to the Official Plan with work taking place concurrently with this Study Update.

4 Population and Employment Projection Information

Existing and historical population in the urban area of the Municipality are taken from Statistic Canada Census Data and are provided in **Table 2**.

Table 2 - Population Data, Statistic Canada Census Data

	2006	2011	2016	2021
Meaford Urban Area	4,686	4,860	4,945	5,078

Population and employment projection information is based on information provided in the Hemson report. The Hemson report provides a projection of future units in each Municipality within Grey County, however no specific breakdown of the allocation between the urban and rural areas is specified. Based on discussion with Meaford's Planning Department, and in following with the 2014 Official Plan assumptions, a 90% and 10% allocation for the urban and rural areas respectively was adopted. The projected new jobs are assumed to be within the urban boundary.

The Hemson report provides a Municipality wide assessment of current housing units and jobs as of 2021 and the 25-year projection to an assumed number of units and jobs in the year 2046. The values presented by Hemson are provided in **Table 3**.

Table 3 - Hemson Housing Units and Jobs Projection

Year	Number of Units	Jobs
2021	5,150	3,700
2046	6,270	4,350

Assuming growth occurs linearly over the planning period, the planning projection average 44.8 units/year in the Municipality. Following the rural/urban population distribution assumption, the Municipality should anticipate 40.3 units/year in the urban area. While the planning projection is based on a 25-year time period, the same rate of development will be assumed for a 30-year period for the purpose of this study. Similarly, the report projects 650 new jobs over the 25-year period for an average of 26 new jobs per year. This rate of growth will also be assumed over the 30-year planning period for this study.

5 Wastewater Flow Design Basis

5.1 Flows From Existing Service Area

The flow trends for the Meaford WWTP were reviewed over the 2011-2022 time period. The flow data used in this analysis was taken from the Parshall Flume at the outlet to the Meaford WWTP. The character of recorded flow data changes between 2018 and 2019. In 2019 the Municipality began using flow data from a strap-on flow meter on the pumping station discharge which is connected to the plant SCADA system. Previous to 2019, incoming flow information was interpreted from chart recorders.

Depending on the process, WWTP unit processes are be sized based on average daily flow (ADF), the peak (hourly/daily) flow, peak instantaneous flow (PIF) and maximum month flow (MMF). Generally, to calculate the capacity of a biological treatment system (e.g., aeration tanks) the hydraulic retention time (HRT) is an important factor. The HRT of a biological processes usually varies between 4 to 15 hours (depending on the process). Therefore, the average daily flow of the plant must be considered to allocate enough time for the micro-organism to degrade pollutants dissolved in the wastewater. On the other hand, in sedimentation tanks (with minimal biological processes) or sludge digester systems (with very high retention time) sizing, some other peak daily flow (PDF) or peak hourly flow (PHF) factors are important (for example: surface and weir loading rate and solid retention time).

Therefore, the capacity of a plant is calculated based on both average and peak flows. In summary, **Table 4** below describes the sizing basis of different units at the Meaford WWTP.

Table 4 - Meaford WWTP Unit Process Sizing Basis

Flow Type	Preliminary Treatment	Secondary Treatment		UV Disinfection	Sludge Digestion	Biosolids Storage
	Screening	Aeration	Secondary Clarifier			
ADF		✓				✓
PHF			✓	✓		
PDF						
PIF	✓					
MMF					✓	

The Meaford WWTP has experienced an average day flow (ADF) of 2,734 m^3/d over the last 5 years (2018-2022). The observed average day flow rate from the existing community, exceeds the typical design average day flow rates used for new development. The average day flow rate has remained relatively constant over the time period, a summary of the flow data for this period is presented in **Table 5**.

Peak day flows during the observation period are also provided. Over the observation period peak flows appear to generally trend upwards both in absolute terms and in terms of the ratio between peak and average day flow. Peak day flows in the Municipality have ranged in magnitude from 3.4 – 4.7 times ADF. The highest peak instantaneous flow was measured on March 31, 2016 at 6.7 times ADF.

Table 5 - Meaford Wastewater Flow Data Summary

Year	Average Day Flow (m^3/d)	Peak Day Flow (m^3/d)	Peak Instantaneous Flow (m^3/d)
2011	2,676	9,505	9,505
2012	2,346	8,715	8,715
2013	2,777	11,774	11,774
2014	2,662	9,910	9,910
2015	2,204	6,550	6,550
2016	2,777	13,075	18,573
2017	3,141	11,133	13,285
2018	2,811	11,864	16,974
2019	2,951	11,952	14,268
2020	2,891	9,731	14,005
2021	2,681	12,623	13,997
2022	2,335	8,648	13,997
5-Year Summary	2,734	12,623	16,974

Figure 1 displays the monthly average flow and monthly peak day flow from the 2011-2022 time period. Average monthly flow is relatively consistent year over year, with increased flow averages during the spring months, and very consistent low flow averages during the summer months. The highest observed peaks generally occur within February to April. Peak flow observations shown from 2019 appear to be much higher than previous years. However, this is possibly a function of the new flow meter than any actual change in flow conditions. The 2019 flow observations should be understood as peak instantaneous rather than peak day flows.

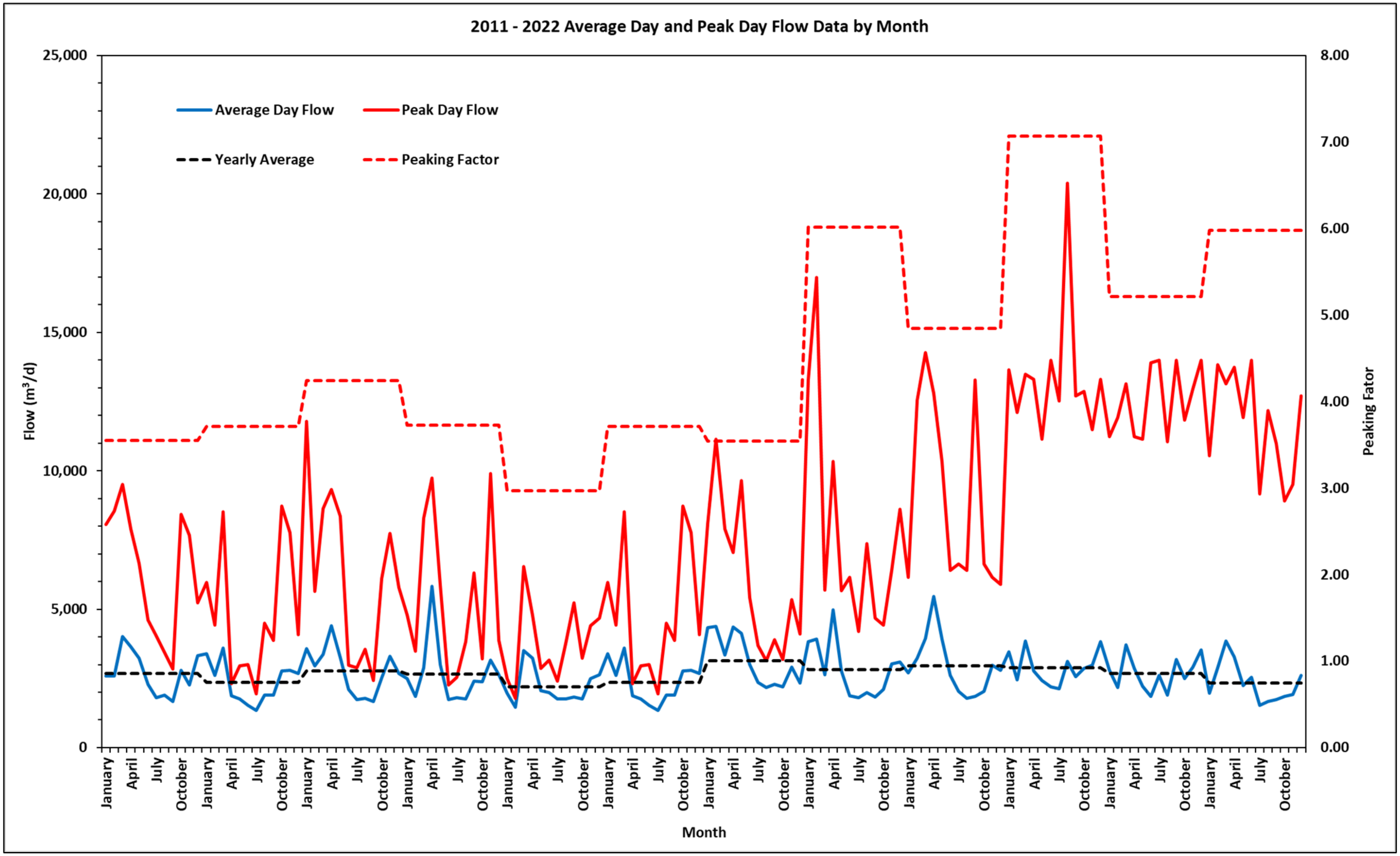

Figure 1 - Meaford Wastewater Flow Trend (2011-2022), Monthly Average

The Municipality has engaged in efforts to reduce inflow and infiltration (I&I) following recommendations in the 2015 Master Plan. A collapsed pipe identified on Sykes Street was repaired, and smoke testing was completed and successfully identified cross connections with stormwater collection which were remedied The Municipality has also completed extensive rehabilitation of maintenance holes.

One of the most notable issues with the Municipality's collection system is the connection of roof drains from the commercial area along Sykes Street between Collingwood Street and Trowbridge Street; the Municipality has engaged a consultant to plan for the disconnection of the roof drains and re-routing to a new storm sewer. Based on current estimates, this may relieve up to 50 m^3/d on ADF to the WWTP, and a substantial reduction in PDF.

The Municipality is committed to reducing I&I and has developed an I&I Reduction Strategy that has begun planning remedial action for 180 pipe deficiencies identified through the Municipality's CCTV inspection efforts. Currently the Municipality has anticipated $3.4 million in construction costs towards spot repairs, relining and replacement of sanitary sewer to reduce the infiltration component. In addition, the Municipality is planning on continued smoke testing to identify cross connections with storm collection and illegal downspout connections. Although the Municipality is making efforts to reduce I&I, planning should proceed on the basis of historical observations.

5.2 Flows from Future Development

In recent years it has been recognized, through changes to the plumbing code and additional efforts to reduce water use; that the wastewater flow rates historically used in Ontario for design of wastewater systems, are high and, where applied in design of collection systems, could result in unnecessary infrastructure spending. More typically, wastewater system capacities are being designed based on lower flows that reflect actual water use. That stated, the Municipality of Meaford has years of historical flow data which can be drawn upon to estimate future flow conditions. A balance must be struck between historical data from the existing community and the condition of the existing collection system and the lower flow rates that are expected from new development projects.

Table 6 outlines the assumptions which will be used to generate the estimated average daily flow for new residential, institutional, commercial and industrial development as well as inflow and infiltration from development in Meaford.

Table 6 - Flow Assumptions for New Development

Parameter	Assumption
Residential Flow	350 L/c/d[1]
Inflow and Infiltration	90 L/c/d
Industrial Flow	28 m^3/ha/d[2]
Commercial Flow	28 m^3/ha/d
Job (Factory Employee)[3]	125 L/shift
Peaking Factor	Harmon Formula

[1] L/c/d – Liter flow per capita per day
[2] m^3/ha/d – Cubic meter per hectare per day
[3] Ontario Building Code Table 8.2.1.3.B – Assumption for 8-hour Factory Shift with Shower

The volume of wastewater generation from new development areas and infill areas of Meaford presented in the following sections, are calculated on an area-by-area basis using the per capita flows established herein. Average day flows and peak day flows were calculated by area.

5.3 Planned Development

The build-out of the Municipality is defined as complete development of all available parcels within the settlement area boundary.

Based on housing unit counts and Census population data from 2016 which are the most definitive numbers available, the Municipality had 2,236 residential units and urban population of 4,945, which closely approximates the 2.21 person per unit assumption. The character of resident within the urban area is not expected to change within the planning period. Meaford serves primarily as a tourist center and retirement community with low occupancy rates.

Table 8 presents flow estimates for all development areas within the urban area, including residential and industrial, commercial, and institutional (ICI). Flow contributions from ICI growth areas are presented as an equivalent residential population. Equivalent population is determined by calculating the flows based on the flow assumptions outlined in **Table 7** and then dividing by the per capita flow contribution of 440 L/c/d (Residential + I&I). The growth areas considered within the analysis with a combined area of 147.68 ha are listed in **Table 8** and are reflected in **Figure 2**.

Figure 2 shows the geographical location of developments listed in **Table 8**.

Flow estimates are calculated on the following basis:

$$ADF = Area * Housing\ Density * Occupants\ Per\ Unit * Per\ Capita\ Flow$$

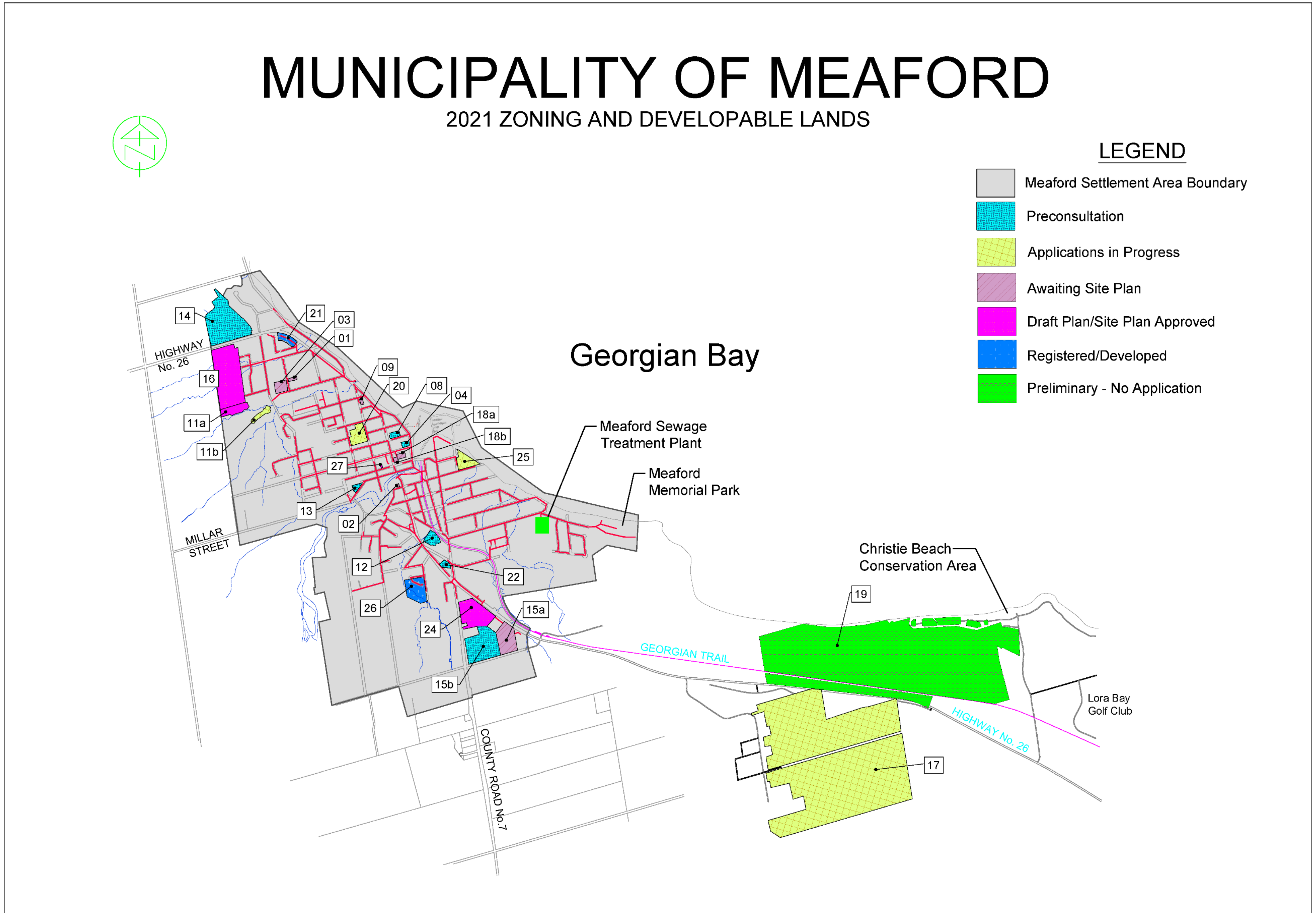

Figure 2 - 2021 Meaford Planned Development Areas

Table 7 - Wastewater Flows from New Growth Areas

	Identification	Designation	Units	Eq. Population	ADF Estimate (m^3/d)
1	142 Susan Street - Tosello	Industrial		17	7.45
2	18 Boucher Street West	Commercial	6	13	5.83
3	365 Sports	Industrial		84	36.74
4	74 Bayfield Street	Residential	60	133	58.34
8	Collingwood Street	N/A	70	155	68.07
9	Cook Street	Residential	11	24	10.70
11a	Golf Course	Residential	38	84	36.95
11b	Golf Course	Residential	51	113	49.59
12	Knights of Meaford	Industrial		98	43.34
13	Legion	Residential	150	332	145.86
14	Loon Call	Residential	201	444	195.45
15a	Mac-Lands	Industrial/ Commercial		303	133.43
15b	Mac-Lands	Industrial/ Commercial		566	248.85
15c	Mac-Lands	Industrial/ Commercial		1,142	502.5
16	Meaford Haven	Residential	400	884	388.96
18a	Nelson Street East	Commercial/ Residential	45	99	43.76
18b	Sykes Street	Commercial/ Residential	52	115	50.56
20	PeopleCare[4]	Commercial	275	608	267.41
21	Pinehurst	Residential	27	60	26.25
22	Plaza	Commercial/ Residential	20	44	19.45
24	School	Institutional		448	197.04
25	Skydevco	Commercial	54	119	52.51
25b	Skydevco	Residential	169	373	164.34
26	Terrace Wood	Residential	26	57	25.28
27	Trowbridge Street West	Commercial/ Residential	2	4	1.94
		Total:	1,657	6,320	2,781

* Note: Flows for Industrial and Commercial areas calculated on a gross area basis at 28 $m^3/ha/d$.

The number of units for planned developments are based on the development proposal, not based on assumed densities from Official Plan documentation. Unit assumptions are based on best available information at the time of writing this report and may not be final.

[4] Residential PPU assumed as 1 for 128 units, and as 1.5 for 147 units.

Table 7 provides an average day wastewater flow estimate for of planned development areas and does not reflect any allocations or timing of any development.

In addition to the development planned within the urban area there are two developments outside of the urban boundary with potential for future connection to the Meaford collection and treatment systems. Information for development areas outside of the urban boundary is provided in **Table 8**.

Table 8 - Development Areas Outside of the Urban Boundary

	Identification	Designation	Units	Eq. Population	ADF Estimate (m^3/d)
17	Meaford Highlands Resort	Industrial/ Commercial		N/A	N/A
19	Parkbridge	Unknown	1,000	2,210	972.40

5.4 Build-out of Infill and Intensification Areas

A map of potential growth areas was developed and is provided in **Figure 3**. The areas are within the urban area boundary of the Municipality and while current development plans are not existing for the sites, they are assumed to have long term development potential. The Municipality's Official Plan (OP) states that new development within the urban area shall be a minimum density of 20 units/ha, projections have been made for the infill and intensification areas on this basis.

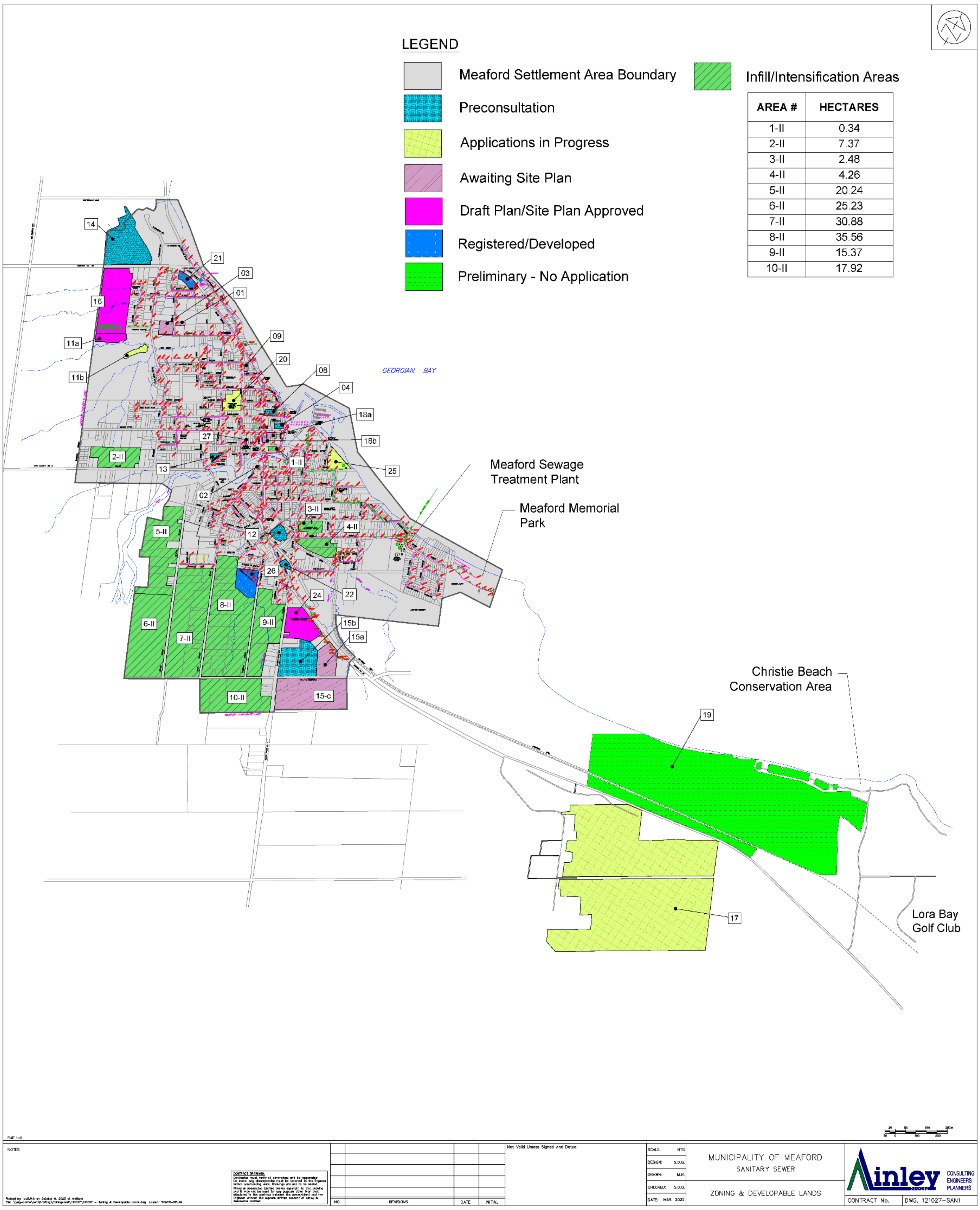

Figure 3 - 2021 Infill and Intensification Area Map

Table 9 summarises the population and average day flow projections for the infill and intensification areas identified in **Figure 3**.

Table 9 - Wastewater Flows from Infill Areas

Identification	Designation	Area (ha)	Eq. Population	ADF Estimate (m^3/d)
Existing Unserviced	Residential		178	62.2
Infill	Residential		32	11.2
1-II	Residential	0.34	15	6.6
2-II	Residential	7.37	326	143.3
3-II	Residential	2.48	110	48.2
4-II	Residential	4.26	188	82.8
5-II	Residential	20.24	895	393.6
6-II	Residential	25.23	1,115	490.7
7-II	Residential	30.88	1,365	600.6
8-II	Residential	35.56	1,572	691.6
9-II	Residential	15.37	679	298.9
10-II	Residential	17.92	792	348.5
	Total:	159.65	7,057	3,105

5.5 Build-out Wastewater Flow Summary

The total flow volume from the full build-out of the existing settlement area boundary is summarized in **Table 11**. Based on the estimated growth trends from the Hemson Report, the full build-out of the existing settlement area boundary will not be reached within the next 50 years, assuming development continues at a consistent pace.

Peak flows for new growth areas, and for infill and intensification areas are based on Harmon Peaking Factor. Harmon Peaking Factor for the new growth area population in the urban boundary of 6,320 is 3.1, peak factor for the infill area population of 7,057 is 3.1, peak factor for the new growth population outside the urban boundary of 2,210 is 3.6.

Table 10 - Wastewater Flow Summary for Build-out Development

	Population	Average Day Flow (m^3/d)	Peak Day Flow (m^3/d)
Existing System (2021)	5,078	2,734	12,623
New Growth Areas	6,320	2,781	8,758
Infill Areas	7,057	3,105	9,635
New Growth – Outside Urban Area	2,210	972	3,452
Total:	20,665	9,592	34,469

5.6 30-Year Wastewater Flow

An estimation of wastewater flow over time is provided in **Figure 4** and **Figure 5**. New development is estimated to proceed at a rate of 44.8 units/year, with 10% of all new units being constructed outside of the urban boundary and the catchment for the WWTP. New residential growth in the urban area is estimated at a rate of 40.3 units/year with an average occupancy of 2.21 person per unit. In addition, 26 new jobs per year are assumed with flow estimated using the Ontario Building Code assumption for an 8-hour work day in a factory with showers. On this basis, projected flow rate in the year 2054 is in the range of 3,694 - 4,309 m^3/d. The low estimate assumes the 5-year minimum as the basis of projection and the high estimate assumed the 5-year maximum as the basis for projection. For the purpose of maintaining a conservative planning approach, the upper bound flow projection is carried forward. On this basis, average daily flows (ADF) will exceed the plant rated capacity in the year 2044.

Table 12 summarises the population and flow projections anticipated for 2054 based on the assumptions outlined herein. Plant data does not provide a basis for the projection of peak hour flows, a peak hourly peak factor of 4 is assumed. A peak instantaneous flow factor of 5 is assumed for the study period.

Table 11 - Wastewater Flow Projections for 2054

2054 Population	2054 Average Day Flow	2054 Peak Day Flow	2054 Peak Hour Flow	2054 Peak Inst. Flow
8,019	4,400 m^3/d	17,000 m^3/d	17,600 m^3/d	22,000 m^3/d

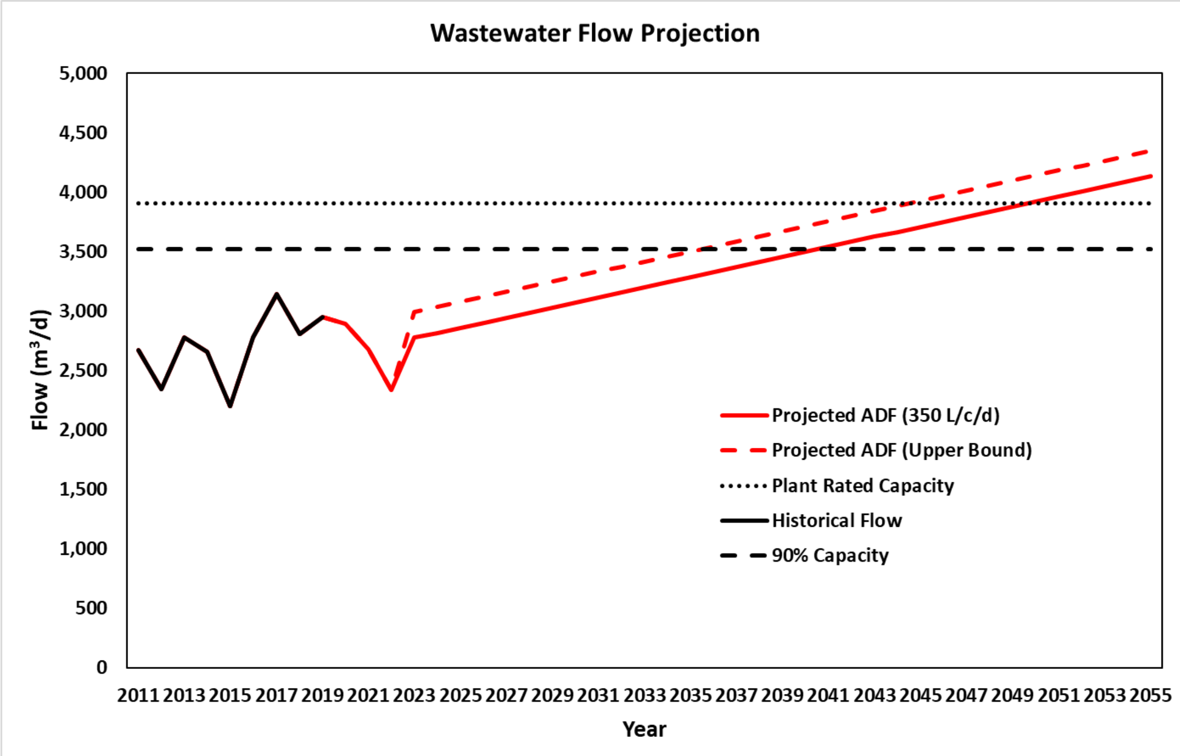

Figure 4 - Wastewater Flow Overtime Based on Growth Projection

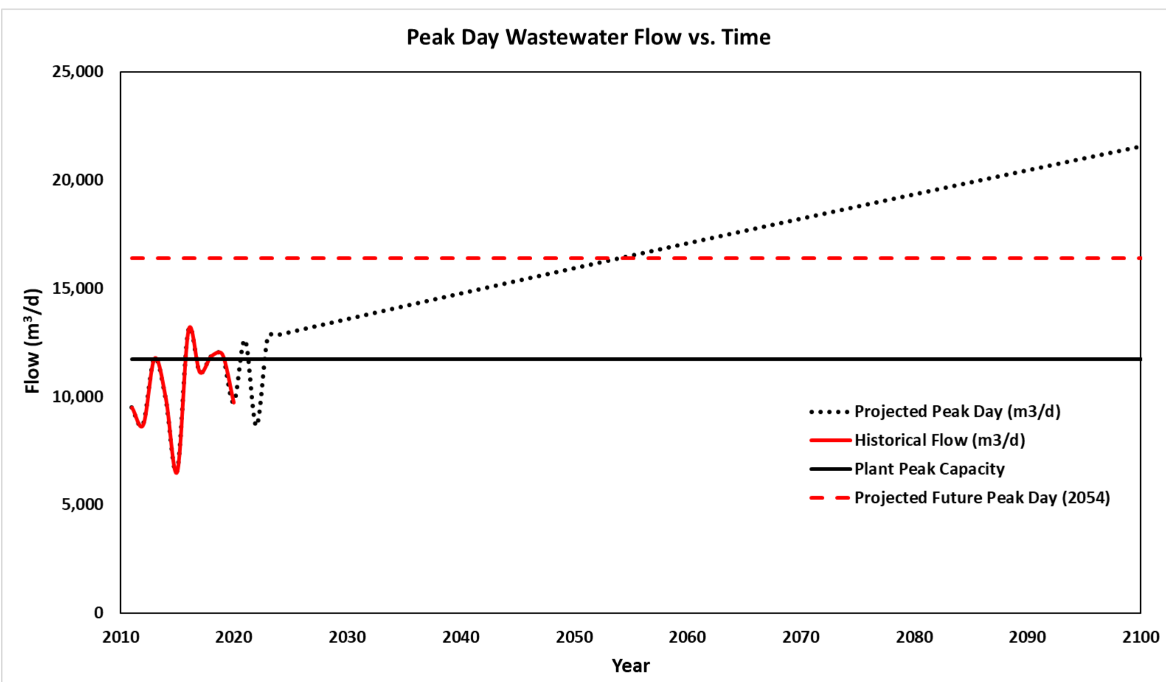

Figure 5 - Peak Day Wastewater Flow vs. Time Based on Growth Projection

6 Impact on Existing Infrastructure

6.1 ADF WPCP Flows

This section addresses the total wastewater flows from all of the existing developed areas currently serviced by the communal wastewater system in Meaford. Based on the projected pace of development the Meaford WWTP has sufficient ADF capacity until 2044 without any upgrades. The projected ADF in 2044 is 3,885 m^3/d, slightly below the current plant capacity (shown in **Figure 6**).

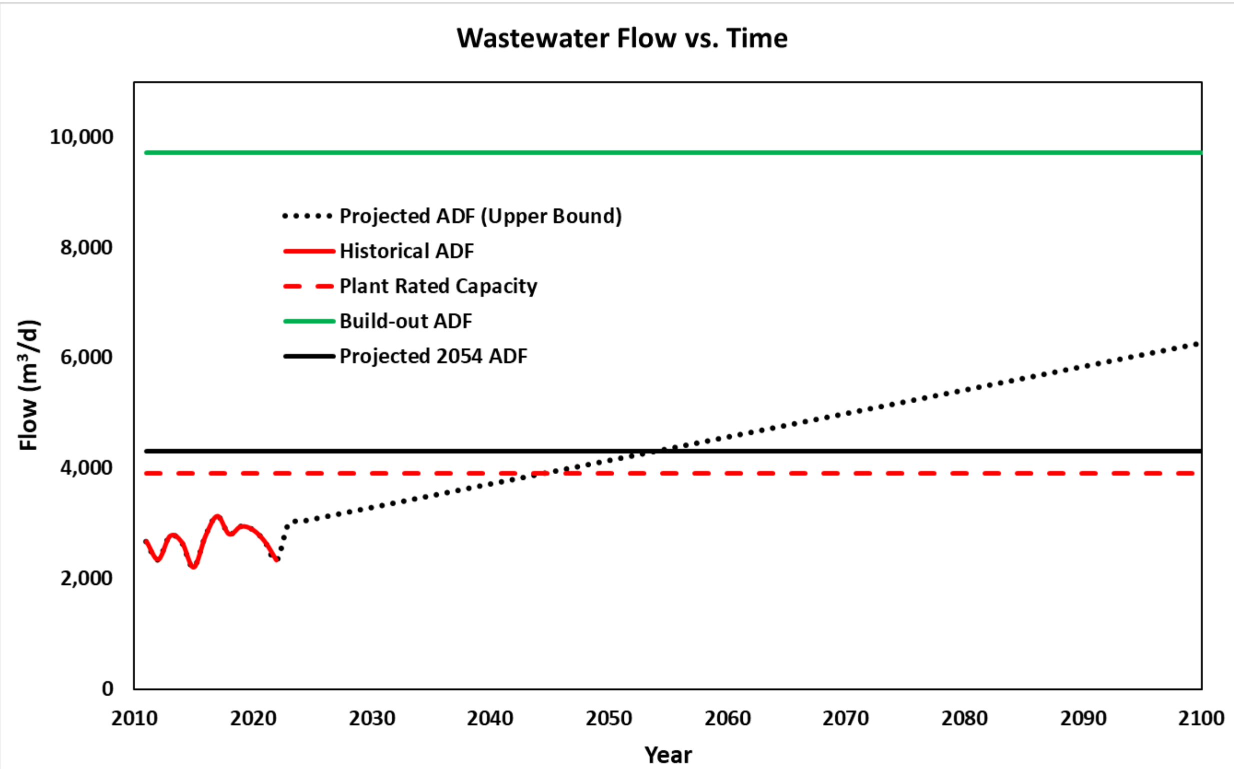

Figure 6 - Wastewater Average Day Flow Projection and WWTP Capacity

6.2 WPCP Peak Flows

While ADF flows to the WPCP are manageable and remain within the current rated capacity of the plant, the peak flows are a challenge for plant operation. The original design of the plant allowed for a peak flow factor of approximately 2.95 times the ADF and this factor is being exceeded, particularly during the spring freshet period. Currently the plant is operating, on average, at 70% of ADF capacity, however peak day flows have exceeded peak day capacity on numerous occasions since 2016. Peak day flow to the WWTP has varied between 3.4 – 4.7 times ADF. Peak instantaneous flows to the plant have reached as high at 6.7 times ADF.

7 Conclusions and Recommendations

This Technical Memorandum, prepared in support of the Meaford Wastewater Treatment Plant Environmental Assessment Amendment (Meaford WWTP Class EA), provides:

- A review of planning documentation.

- An overview of historical WWTP flows from the existing urban area wastewater collection system in Meaford.
- A comprehensive review of growth potential for the Municipality within the settlement area boundary to the year 2054.
- An assessment of the impact of future wastewater flows on the capacity of the WWTP.

This Technical Memorandum concludes the following:

- The Update to the County of Grey Growth Management Strategy (Hemson, 2021) is the best basis available for the projection of new residential units in the Municipality.
- The Hemson report projects 1,120 additional residential units within Meaford between 2021 and 2046, which equates to 44.8 new units per year.
- The Municipality of Meaford Official Plan identifies a split of 90%/10% new home construction between the urban and rural areas respectively.
- The density of development assumed for future development is 20 units/ha, based on the Municipality's Official Plan.
- Per the Municipality's Planning Department, the occupancy per housing unit is anticipated to remain at approximately 2.21 PPU as development proceeds.
- The existing wastewater flows indicate high rates of inflow and infiltration entering the collection system, with peak day flow ratios ranging between 3.4 – 4.7 over the review period between 2011-2022.
- Inflow and infiltration primarily impact the system primarily during the spring freshet period and has historically caused peak hour flows as high as 6.7 times ADF.
- The design parameters are proposed for future development flow estimation are provided in **Table 13**:

Table 12 - Flow assumptions for preliminary design

Parameter	Assumption
Residential Flow	350 L/c/d
Inflow and Infiltration	90 L/c/d
Industrial Flow	28 m^3/ha/d
Commercial Flow	28 m^3/ha/d
Job (Factory Employee)	125 L/shift
Peaking Factor	Harmon Formula

- The Municipality is currently engaged in efforts to reduce inflow and infiltration entering the collection system:
    - The Municipality is currently pursuing a project to redirect roof drains from the Sykes Street commercial area away from the sanitary collection system. Preliminary estimates suggest that an average day flow of 50 m^3/d of inflow could be reduced, this would represent a dramatic decrease in peak flows during high rainfall days.

    - Municipality is committed to inflow and infiltration reduction efforts; however, planning must proceed on the basis of actual conditions and consider the worst-case scenario that high I&I persists.
- A full accounting of planned development and potential for infill and intensification development was conducted and the preliminary design flow assumptions were applied; the resulting full build out flow projections are provided in **Table 14**:

Table 13 - Wastewater Flow Summary for Build-out Development

	Population	Average Day Flow (m^3/d)	Peak Day Flow (m^3/d)
Existing System (2021)	5,078	2,734	12,623
New Growth Areas	6,320	2,781	8,758
Infill Areas	7,057	3,105	9,635
New Growth – Outside Urban Area	2,210	972	3,452
Total:	20,665	9,592	34,469

- A total of 147.68 ha of new development area is identified within the existing settlement area.
- Projected flow at the end of the study period in 2054 is based on the rate of development projected by Hemson and the preliminary design factors. The projected flows are provided in **Table 15**:

Table 14 - Population and Flow Projections for 2054

2054 Population	2054 Average Day Flow	2054 Peak Day Flow	2054 Peak Hour Flow	2054 Peak Inst. Flow
8,019	4,400 m^3/d	17,000 m^3/d	17,600 m^3/d	22,000 m^3/d

- The full build-out of the existing settlement area boundary will not be reached within the next 50 years, assuming development continues at a consistent pace.
- Based on the projected pace of development the Meaford WWTP has sufficient ADF capacity until 2045 without any upgrades, assuming the ECA capacity is correct. The projected ADF in 2044 is 3,885 m^3/d, slightly below the current plant capacity.
- The peak flows are currently above the capacity of the plant and will need to be actively managed through the Municipality’s inflow and infiltration reduction efforts.

Appendix B
Meaford WWTP Capacity Assessment TM

Wastewater Class EA Update

Technical Memorandum
Wastewater Treatment Pant
Capacity Assessment

Prepared For:

The Municipality of Meaford

September 2023

CREATING QUALITY SOLUTIONS TOGETHER

WASTEWATER CLASS EA UPDATE
WASTE WATER TREATMENT PLANT CAPACITY ASSESSMENT REPORT

PROJECT NO. 121027

Prepared For:

THE MUNICIPALITY OF MEAFORD

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Appendices

1 Introduction

The collected sewage within the Municipality of Meaford is transferred to the Meaford Wastewater Treatment Plant (WWTP) through four (4) pumping stations. The WWTP was built in 1969 and is considered a cross between an Extended Aeration Activated Sludge (EAAS) and a Conventional Activated Sludge (CAS) process. The plant does not include grit removal or primary clarification. The rated capacity of the plant is 3,910 m^3/day with a peak flow capacity of 11,730 m^3/day with no process for phosphorous removal. **Figure 1-1** shows the location and components of the plant.

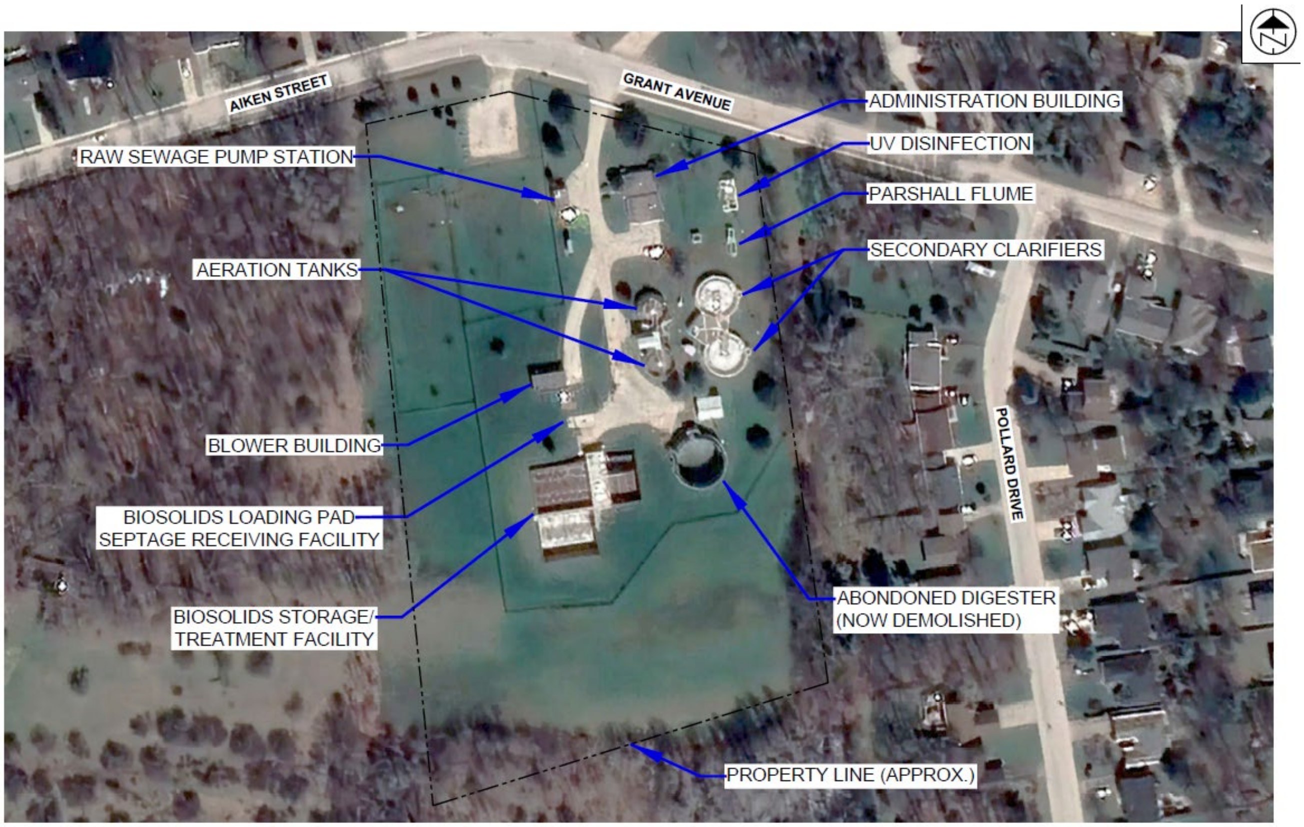

Figure 1-1: Meaford WWTP

There have been some studies on the plant capacity and effluent criteria recently which is listed chronologically in **Table 1-1**:

Table 1-1: Recent Studies on the WWTP

Year	Study	Summary of Findings
2006	Ainley Group - Capacity Analysis Report	The plant can be categorized as a CAS treatment plant. It has enough capacity to meet the average rated capacity with some hydraulic limitation at the peak flow.
2006	Hydromantis - Review of the Capacity Analysis Report	The plant is categorized as a blend of CAS and EAAS treatment plants with some deficiencies in the nitrification requirement as per the Environmental Compliance Approval (ECA) limit. Also, the effective capacity of the secondary clarifier is less than the official rated capacity of the plant.
2007	EarthTech – Environmental Study Report and Assimilative Capacity Study Report	Based on achieving an SRT of 10 days, it is suggested to derate the facility to 2,700 m^3/day. Assuming future ADF of 6,000 m^3/day, the effluent limit shall be set at $CBOD_5$ and TSS of 15 mg/d, Total Phosphorus of 0.8 mg/d, and Total Ammonia of 3.0 and 5.0 mg/d for Non-Freezing and Freezing conditions.
2010	Genivar - Alternative Upgrade Solutions	Different treatment processes are investigated to increase the plant rated capacity to 4,692 m^3/day.
2012	Genivar - Assimilative Capacity Study Update	It is estimated the future plant flows will be 4,692 m^3/day with a peaking factor of 3.5 for the peak daily flow. Accordingly, the effluent design objectives shall be set at $CBOD_5$ and TSS of 15 mg/d, Total Phosphorus of 1.0 mg/d, and Total Ammonia of 3.0 and 5.0 mg/d for Non-Freezing and Freezing conditions.
2015	Ainley - Water and Wastewater Servicing Master Plan	The effluent limit for Phosphorous is expected to change as a result of any upgrades to the plant. Some alternatives are suggested for the WWTP with an ultimate ADF capacity of 5,400 m^3/day.

1.1 Objectives

Below is the list of primary objectives of this Technical Memorandum:

- Review the capacity of the existing WWTP for existing and future (30-year) wastewater flows and effluent quality
- Review historical plant data for the WWTP

2 Flow and Effluent Limits

2.1 Raw Sewage Flow

As per the" Existing and Future Sewage Flow" Technical Memorandum, 2023 Ainley Report, the Average Daily Flow (ADF) of the plant over the 2018 to 2022 time period is 2,734 m^3/day. Also, the projected ADF at the end of the 30-year planned period (2054) is 4,400 m^3/day.

2.2 Influent Flow

Historical average influent sewage quality of the plant between years 2016 to 2022 is shown in **Table 2-1** below.

Table 2-1: Monthly Average Influent Parameters

Year	Flow (m^3/d)	$CBOD_5$ (mg/L)	TSS (mg/L)	Total Phosphorus (mg/L)	Ammonia Nitrogen (mg/L)	Kjeldahl Nitrogen (mg/L)
2016	2,777	190	166	3.0		25.6
2017	3,141	137	123	2.4		21.5
2018	2,811	157	156	3.1	22.0	27.5
2019	2,951	110	108	2.2	18.6	22.8
2020	2,891	110	66	1.7	15.2	19.0
2021	2,681	126	111	2.6	19.8	23.4
2022	2,335	114	87	2.5	18.4	
7-Year Average	**2,734**	**123**	**106**	**2.4**	**18.8**	**23.2**

Peaking factors (PF) for Peak Day Flow (PDF) and Peak Instantaneous Flow (PIF) for year 2016 to 2022 are summarized in **Table 2-2**.

Table 2-2: Peaking Factors

Year	Average Day Flow (m^3/d)	Peak Day Flow (m^3/d)	Peak Instantaneous Flow (m^3/d)	Hourly Peaking Factor (PDF/ADF)	Instantaneous Peaking Factor (PIF/ADF)
2016	2,777	13,075	18,573	4.7	6.7
2017	3,141	11,133	13,285	3.5	4.2
2018	2,811	11,864	16,974	4.2	6.0
2019	2,951	11,952	14,268	4.1	4.8
2020	2,891	9,731	14,005	3.4	4.8
2021	2,681	12,623	13,997	4.7	5.2
2022	2,335	8,648	13,997	3.7	6.0
7-Year Average	**2,798**	**11,289**	**15,014**	**4.0**	**5.4**

2.3 Effluent Requirements

Existing effluent objectives and effluent limits of the plant are summarized in **Table 2-3** and **Table 2-4,** respectively.

Table 2-3: Effluent Objectives

Effluent Parameter	Monthly Average Concentration (milligrams per litre)	Annual Average Loading (kilograms per day)
$CBOD_5$	15.0	58.7
Total Suspended Solids	15.0	58.7
Total Phosphorus	2.0	7.8
Total Ammonia Nitrogen Non-Freezing Period* Freezing Period*	 3.0 5.0	 11.7 19.6
pH of the effluent maintained between 6.0 to 9.5, inclusive, at all times		

*Note: Freezing Period: October 1 to May 14, Non-Freezing Period: May 15 to September 30

Table 2-4: Effluent Limits

Effluent Parameter	Monthly Average Concentration (milligrams per litre)	Annual Average Loading (kilograms per day)
$CBOD_5$	20.0	78.2
Total Suspended Solids	20.0	78.2
Total Phosphorus	4.0	15.6
Total Ammonia Nitrogen Non-Freezing Period* Freezing Period*	 3.0 5.0	 11.7 19.6
pH of the effluent maintained between 6.0 to 9.5, inclusive, at all times		

*Note: Freezing Period: October 1 to May 14, Non-Freezing Period: May 15 to September 30

3 Meaford Wastewater Treatment Plant

The WWTP has manual and mechanical fine screen, circular aeration tanks, circular secondary clarifiers, aerobic digesters, aerated sludge tanks, and UV disinfection unit with no chemical addition in processes. The plant was originally designed as a “High Rate” facility with aerobic design without nitrification and has been in operation since 1970 (ECA – No. 3697-62MGNC). The nitrification requirement was added in 2004 (Certification of Approval #3697-62MGNC). The latest Environmental Compliance Approval (ECA No. 9036-AZFPV6) listed the plant with an ADF of 3,910 m^3/day, with a nitrification requirement.

Previous studies (refer to **Table 1-1**) indicate that the plant is operating as a blend of CAS and EAAS processes. The average Hydraulic Retention Time (HRT), at the current ADF is approximately 10 to 11 hours which places the secondary treatment process between the criteria of CAS process (with HRT of 6 hours) and EAAS (with HRT of 15 hours).

A previous study (EarthTech – Environmental Study Report and Assimilative Capacity Study Report – 2007) suggested to derate the plant to 2,700 m^3/day to address the hydraulic bottlenecks of the plant.

3.1 Preliminary Treatment

The preliminary treatment systems of the plant are integrated into the aeration tanks structure, with the two process channels running between the aeration basins.

3.1.1 Screening

The screening system includes the following:

- Two (2) screening channels:
  - One (1) fine screen with 3 mm openings, with a peak instantaneous flow rate of 100 L/s
  - One (1) coarse bar screen with 25 mm bar spacing, with a peak instantaneous flow rate of 328 L/s
- One (1) transport screw conveyor
- One (1) bagging system

As per the manufacturer's specification, the system has a rated peak daily flow rate capacity of 9,842 m^3/day. There is also a bypass channel, which diverts the flows over 9,842 m^3/day. A copy of the manufacturer's information is provided in **Appendix A**.

Screening Unit Capacity = 9,842 m^3/day

3.1.2 Septage Receiving

The facility is equipped with in-ground Septage Receiving Station of 80 m^3 with a bubble diffuser. A submersible pump rated at 10.1 L/s at a 9.0 m TDH transfers the sewage from the station to the screening at the influent works.

3.2 Secondary Treatment

The secondary treatment consists of an extended aeration biological treatment system and a secondary clarifier system. Although the plant is recognized as a blend of CAS and EAAS, there are no design parameters of blended process to assess the aeration tank capacity. As such, the capacity of the secondary treatment has been calculated based on EAAS as a conservative approach.

3.2.1 Aeration Tank Biological Treatment

The aeration system has two tanks, each equipped with fine bubble diffusers as below.

- Two (2) 10.9 m internal diameter x 5.9 m Side Water Depth (SWD) aeration tanks each equipped with a fine bubble aeration system
- Three (3) positive displacement air blowers equipped with variable speed drives, rated at 482.4 m^3/h, two (2) blowers on duty, one (1) blower standby.

The total volume of the existing aeration tank is 1,101 m^3.

Check HRT – 15 hours:

According to MECP Design Guideline, the minimum HRT for the extended aeration process is 15 hr. Therefore, Q_{inflow} can be calculated as:

$$Q_{inflow} = \frac{V_{tank}}{HRT} = \frac{1{,}101\ m^3}{0.625\ day} \xrightarrow{calculating\ for\ Qinflow} Q_{inflow} = 1{,}762\ {m^3}/{day}$$

Check SRT – 15 days:

HRT calculation resulted in a total aeration tank capacity of 1,762 m^3/day for the EAAS process. This number should be checked against the required SRT to make sure that the calculated capacity leads to enough SRT of 15 days or more, as per the MECP guideline.

SRT can be calculated as:

$$SRT = \frac{Total\ Solids}{Daily\ WAS + Daily\ Effluent\ SS}$$

Total Solids:

There is no available plant data for the MLSS concentration for this study. However, as per the MECP Design Guideline, Table 12-1, the MLSS concentration for an EAAS process ranges from 3,000 mg/L to 5,000 mg/L. Based on the plant's operation team feedback, the MLSS is typically on the high end of the range. Higher MLSS would results in higher SRT.

$$Min\ MLSS = 3{,}000\frac{mg}{L} \xrightarrow{Tank\ Volume = 1{,}101\ m^3} Total\ Solid = 3{,}303\frac{kg}{day}$$

$$Max\ MLSS = 5{,}000\frac{mg}{L} \xrightarrow{Tank\ Volume = 1{,}101\ m^3} Total\ Solid = 5{,}505\ \frac{kg}{day}$$

Daily WAS Flow:

The plant's operational data shows an average of 267 kg/d WAS production for an average daily flow of 2335 m^3/day. Therefore, it can be assumed that a 1,762 m^3/day daily flow, would result in $\frac{1{,}762\ m3/day}{2{,}335\ m3/day} * 267\frac{kg}{day} = 201\frac{kg}{day}$ WAS production.

Daily Effluent SS:

$$Daily\ EFF\ SS = \ 6.8\frac{mg}{L}\ (section\ 4) \times ADF = 6.8 \times 1{,}762 \times 10^{-3} = 12\frac{kg}{d}$$

Therefore, SRT for the aeration tank can be calculated in a range as:

$$SRT_{min} = \ 15.5\ days$$

$$SRT_{max} = \ 25.8\ days$$

The SRT calculation confirms that there is enough SRT for the influent flow of 1,762 m^3/day.

Considering the aeration tanks process as EAAS results in a total biological capacity of 1,762 m^3/day. However, historical performance data of the plant (7 years) shows aeration tanks are capable of handling flow of 2,734 m^3/d which is much higher than desktop capacity assessment of the aeration tanks.

Aeration Tanks Capacity = 2,734 m^3/day

3.2.2 Secondary Sedimentation

The plant has two (2) secondary clarifiers equipped with activated sludge pumps, as below:

- Two (2) 12.2 m internal diameter x 2.9 m SWD secondary clarifiers, with sludge and scum removal mechanisms
- Two (2) return activated sludge pumps (one standby), each rated at 45 L/s, discharging to the headworks
- Two (2) waste-activated sludge/Scum pumps (one standby), each rated at 23 L/s discharging to the biosolids treatment facility.

Check Weir Loading – 250 m^3/ (m·d):

This provides a total surface area of 233.8 m^2 and the total length of the weir is 76.7 m. As per the MECP Design Guideline, Table 13-2, the recommended weir loading rate for the secondary clarifier for the plant with less than 4,000 m^3/day capacity is 250 m^3/(m·d). Therefore:

$$Q_{peak} = Loading\ Rate \times Weir\ Length = 250 \frac{m^3}{m.day} \times 76.7\ m = 19{,}164\ {m^3}/{day}$$

$$\xrightarrow{PHF=4.7\ ADF} Q_{Daily\ Average} = 4{,}166\ {m^3}/{day}$$

the weir is good for a peak hourly flow of up to 19,164 m^3/day.

Check Solid Loading – 170 kg/ (m^2·d):

As per the MECP guideline, Table 13-1, the peak solids loading rate for an Extended Aeration process is 170 kg/(m^2·d). Reviewing the recent plant Return Activated Sludge (RAS) shows that depending on the incoming flow, RAS is set at 3,000 to 4,000 m^3/day (approximately 150% of average influent flow). Therefore:

$$Max\ Solids\ Loading = (Q_{peak} + RAS) \times MLSS$$

$$\xrightarrow{MLSS=3\frac{kg}{m3} and PF=4.7} Q_{Daily\ Average} = \frac{170\ {kg}/{(m^3.day)} \times 233.8 m^2}{3 \times 6.1} = 2{,}172\ {m^3}/{day}$$

Check Surface Overflow Rate – 40 m^3/ (m^2·d):

As per the MECP guideline, Table 13-1, the Surface Overflow Rate at Design Peak Hourly Flow is 40 m^3/(m^2.day). Calculating for the Peak Hourly Flow and Day Average Flow results in:

$$Q_{peak} = Surface\ Rate \times Surface\ Area = 40 \frac{m^3}{m^2.day} \times 233.8\ m^2 = 9{,}352\ {m^3}/{day}$$

$$\xrightarrow{PHF=4.7\ ADF} Q_{Daily\ Average} = 2{,}033\ {m^3}/{day}$$

Therefore, the secondary clarifier capacity can be identified by the surface overflow rate as the limiting factor in the process unit.

Secondary Clarifier Capacity in EAAS Process = 2,033 m^3/day

3.3 Disinfection System

3.3.1 UV Light

The UV disinfection system was installed in the plant in 2004 and 2005. The UV system has two (2) channels, each equipped with a Trojan UV 3000 PTP disinfection system, each with a total Peak Hourly Flow Rate of 220.8 m³/h (5,299 m^3/day). A copy of the manufacturer's information is provided in **Appendix B**.

UV Disinfection System Capacity = 10,598 m^3/day

3.4 Sludge Management System

Meaford WWTP sludge management system is built to reduce the volume of the sludge and stabilize the organic material using a two stages sludge aerobic digestion system and a biosolids storage and disposal facility.

3.4.1 Sludge Digestion

Below is the description of the sludge digestion system:

- One (1) two-stage aerobic digester with Stage 1 digester tank (aerobic) with an approximate size of 9.5 m x 10 m x 4.35 m (total volume of 413 m^3), and Stage 2 digester tank (aerobic) with an approximate size of 4.9 m x 10 m x 4.35 m (total volume of 213 m^3), equipped with coarse bubble diffused aeration system and supernatant decanting facility. The total Digester volume is 626 m^3
- Two (2) sludge transfer pumps, each rated at 23 L/s at 7.5 m TDH for the transfer of sludge between the digesters and from the digesters to the biosolids storage
- One (1) duty decanting pump, rated at 23 L/sec at 7.5m TDH to transfer supernatant to inlet works

The capacity of the digestion system is calculated from operational data in 2022. The following are the WAS characteristics:

- Plant average daily flow = 2335 m^3/day
- Average WAS Total Solids = 1.56%
- Average WAS Generation = 17.14 m^3/day (267 kg/day)

Requirement for aerobic digester design is:

- Minimum total SRT 45 days, including the aeration tanks and the sludge digestion units SRT.
- The maximum month CBOD mass loading and flow rate shall be used in digester design.

The digester should be designed with 2% TS feeding and additional 25% of volume for decanting.

the plant is operated with MLSS on a higher range of 3,000 mg/L to 5,000 mg/L, and sometimes above 5,000 mg/L according to the operation team feedback. Therefore, as a conservative assumption, MLSS is set to 4,500 mg/L in capacity assessment. Also, the historical average MM peak factor is 1.9 for BOD loadings in 2017-2021.

Check Aeration Tanks SRT – Maximum Month Daily flow of 2,900 m³/day:

$$Aeration\ Tank\ SRT = \frac{Total\ Solids}{Wasted\ Solids} = \frac{MLSS\ \left(\frac{kg}{m^3}\right) \times Aeration\ Tank\ Volume(m^3)}{WAS\ Flow\ (\frac{kg}{d})}$$

Therefore, SRT can be calculated as:

$$\xrightarrow{MLSS=4.5\ kg/m3} SRT_{Aeration\ Tank} = 14.9\ days$$

Check Digesters SRT – Daily flow of 2,900 m³/day:

$$Digester\ SRT = \frac{Digester\ Volume\ (m^3)}{Digester\ Flow\ (\frac{m^3}{day})}$$

$$SRT_{Digester} = 30.2\ days$$

The total SRT is sum of aeration tank and digester SRT:

$$SRT_{total} = 45\ days$$

Therefore, based on the recent year WAS characteristics, and a conservative assumption of MLSS of 4500 mg/L, the total capacity of the digester is 2,900 m^3/day. However, a higher MLSS will result in a slightly higher digester capacity.

Sludge Digestion Unit Capacity = 2,900 m^3/day for the maximum month loading, and 1,526 m^3/day for the plant ADF with the BOD loadings MM peak factor of 1.9.

3.4.2 Biosolids Storage and Disposal

The biosolids storage tank details are provided in the following:

- One (1) two-celled liquid biosolids storage tank, each cell is approximately 18 m x 14.75 m x 4.35 m with an effective storage volume of 2,300 m^3, equipped with a coarse bubble diffused aeration system and supernatant decanting facility.

To calculate the capacity of the storage, the total sludge storage duration should be calculated and compared with the MECP design guideline. As per MECP design guideline, Section 18.1, a minimum of 240 days storage is required for incremental weather.

The historical operation data shows an average biosolids volume generation of 2,614 m^3/year, and average daily influent flow of 2,734 m^3/day, from 2018 to 2022. Therefore, a 3,600 m^3/day average daily flow would result in 3,442 m^3/year biosolids generation, with 244 days of storage days.

Hence, according to the recent years biosolids generation rate, the biosolids storage has a capacity for 3,600 m^3/day average influent daily flow.

Sludge Storage Unit Capacity= 3,600 m^3/day

4 WWTP Performance

Based on the review of the historical data, the WWTP has been consistently achieving all effluent limits and objectives mentioned in the latest Environmental Compliance Approval

(ECA). **Table 4-1** below shows the average effluent concentrations achieved by WWTP between 2016 to 2022.

Table 4-1: Monthly Average Effluent Parameters

Year	$CBOD_5$ (mg/L)	TSS (mg/L)	Total Phosphorus (mg/L)	Ammonia Nitrogen (mg/L)	Kjeldahl Nitrogen (mg/L)
2016	5.1	6.0	1.76	0.88	
2017	5.7	6.8	1.54	0.87	
2018	6.0	7.2	1.87	0.81	1.69
2019	4.4	7.9	1.67	0.47	1.25
2020	4.1	5.2	1.47	0.53	1.33
2021	4.3	6.8	2.05	0.54	1.29
2022	4.2	6.8	2.06	0.53	
7-year Average	**4.6**	**6.8**	**1.8**	**0.57**	**1.39**

5 Plant Capacity Summary and Conclusion

Table 5-1 and **Figure 5-1** below summarize the calculation of this study.

Table 5-1: Treatment Capacity Summary (m^3/day)

Process	Primary Treatment	Secondary Treatment		UV Disinfection (Peak Hourly)	Sludge Digestion (MM)	Biosolids Storage (ADF)
	Screening (Inst. Peak)	Aeration (ADF)	Secondary Clarifier (ADF)			
EAAS	9,842	2,700	2,700	10,598	2,900 (MM) 1,526 (ADF)	3,600

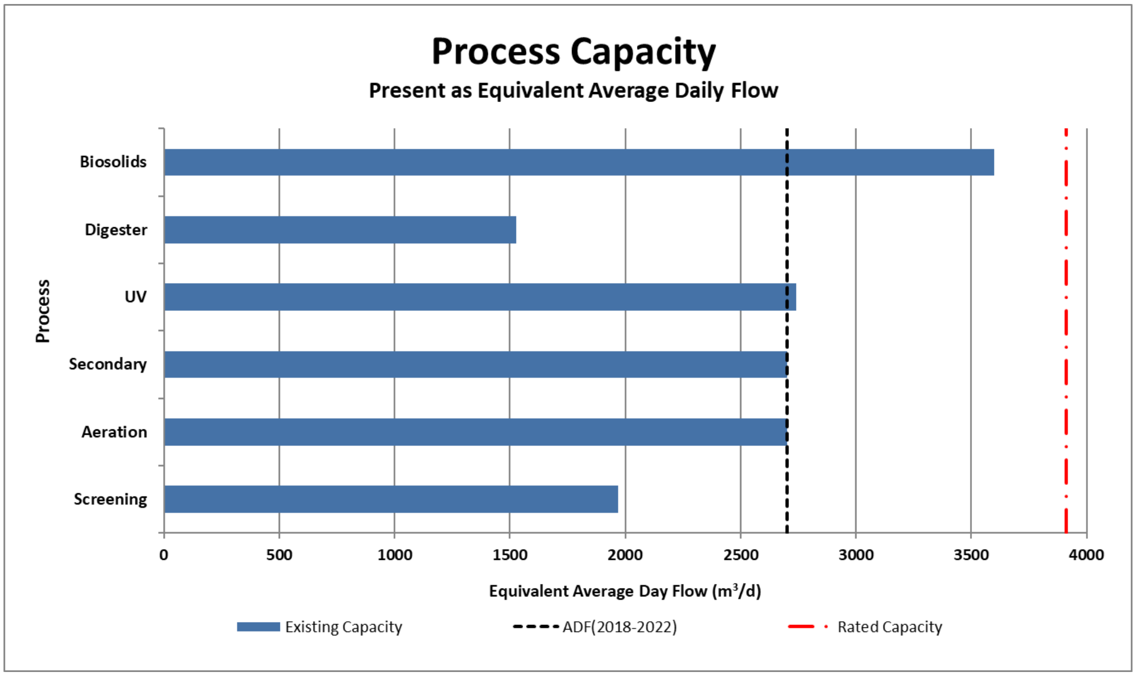

Figure 5-1: Process Capacity

Key findings of the report are:

- The lack of grit removal system causes lots of grit settlement in the aeration tank, which reduces the actual capacity of the aeration tanks by 10% to 15% annually as noted by the plant staff.
- The plant is unique in the way that it operates as a blend of CAS and EAAS processes and meet ECA discharge limits consistently in the last 7 years with the operation ADF significantly higher than calculated secondary capacity based on EAAS process
- The actual capacity of the plant is not as stated in the ECA as the rated capacity of the plant. Any decisions for the future upgrades of the plant should be based on either utilizing the plant as an EAAS plant, or upgrading the plant to operate as CAS.
- The plant is heavily constrained by biological capacity for nitrification.
- The plant is not equipped with phosphorous removal. A phosphorous removal system should be added to the requirement of the plant in case of any major upgrades.
- The digester has the maximum month capacity of 2,900 m^3/d.

Appendix A

Screening System Specification

Appendix B
UV Specification

Appendix C

Record of Correspondence with the MECP

AINLEY & ASSOCIATES LIMITED
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Memorandum

To: **Mark Badali, PMP, CET**

Copies To: **Rhonda Shannon, Hugh Geurts, John Ritchie, Mark Smith**

From: **Simon Glass, P.Eng.**

Date: April 3, 2023

Reference: Meaford Waste Water Treatment Plant Expansion Class Environmental Assessment (EA) Update
Proposed Effluent Limits- Revision
Ainley File No. 121027

BACKGROUND

The Municipality of Meaford completed a Class EA for the expansion of the existing wastewater treatment Plant (WWTP). Based on correspondence from the Ministry to the Municipality in 2012 an amendment to the Class EA was required, particularly to address potentially affected Indigenous Nations.

Ainley Group had a virtual meeting with the Ministry of the Environment, Conservation and Parks (MECP) on Feb. 23, 2022, to discuss the effluent limits for the Meaford Wastewater Treatment Plant (WWTP), and to confirm that limits proposed in the 2007 Class EA remain acceptable to the MECP.

Following the meeting with the Ministry, Ainley provided with a "Effluent Criteria Memorandum", dated March 2022 (refer to **Appendix A**). As per the memorandum, which was prepared according to the Ministry's technical guidance, monthly average Total Phosphorous (TP) concentration limit and objective of 0.8 mg/L and 0.5 mg/L were proposed for the final effluent for new capacity of 5,000 m^3/day. **Table 1** below shows the previously proposed final effluent criteria for plant capacity of 5,000 m^3/day which were agreed upon with the Ministry.

Table 1: Proposed Final Effluent Criteria (for New Capacity of 5,000 m^3/day)
March 2022 Memorandum

Effluent Parameter	Monthly Average Concentration (milligrams per litre unless otherwise indicated)	Annual Average Loading (kilograms per day unless otherwise indicated)
$CBOD_5$	15.0	75
Total Suspended Solids	15.0	75
Total Phosphorus	0.8	4.7
Total Ammonia Nitrogen Freezing Period*	3.0	15

Non-Freezing Period*	5.0	25
pH of the effluent maintained between 6.0 to 9.5, inclusive, at all times		

*Note: Freezing Period: October 1 to May 14, Non-Freezing Period: May 15 to September 30

OBJECTIVE 1 – PHASED PHOSPHORUS LIMITS

Upon revisiting the projection population of year 2051, and subsequently the 30-year projected wastewater flow for the Municipality of Meaford, it was determined that average wastewater flow at the end of the study period is now projected to be 4,400 m^3/day (ADF), approximately 12% lower than the previously proposed ADF of 5,000 m^3/day. Therefore, this memorandum is seeking to propose new plant effluent limits for the Ministry's review.

The project team is interested in the potential for a phased effluent limit which will allow the Municipality to work towards a fully expanded plant in stages, without immediately triggering the effluent limit requirement of the fully expanded capacity of the plant. The structure of this approach would be intended to maintain or improve the annual average phosphorus loading of the plant at each stage.

The project team understands the position of the Ministry in trying to protect the Georgian Bay by limiting the effluent limits to the Bay and maintaining the chemical, physical, and biological integrity of the water. Also, it is recognized that the previous TP effluent limit of 0.8 mg/L agreed to with the Ministry resulted from the 2007 Assimilative Capacity Study. However, it should be noted that a TP limit of 0.8 mg/L and resulting objective of 0.5 mg/L would require addition of a tertiary treatment unit to the Meaford WWTP; this requirement imposes a significant cost burden on the Municipality. In addition, a TP limit of 1.0 mg/L was proposed in the 2007 ACS was developed on the basis of an ADF capacity of the WWTP of 6,000 m^3/d, significantly higher than the proposed expansion capacity currently proposed. It is on this basis that the Municipality is requesting the MECP consider agreeing to a phased approach towards the phosphorus discharge limit which takes phosphorus loading into consideration as opposed to concentrations.

The Town of Meaford is a smaller municipality with an approximate population of 5,000 and limited revenue. A phased approach for phosphorus discharge limits will satisfy the mutually shared goal of environmental stewardship while also providing the Municipality the necessary time to generate capital reserves for tertiary expansion.

METHODOLOGY

To propose the effluent limits for Meaford WWTP, specifically TP limit, a logical and scientific approach is followed, considering:

- The previous approved studies: 2007 Assimilative Capacity Studies (ACS)
- Great Lakes Water Quality Agreement (2012)
- Historical effluent data
- The size of the municipality and budgetary limitation

As the previously approved effluent limits and objectives for BOD, TSS, and Nitrogen (Ammonia) are reachable through the existing treatment units in the plant, this memorandum focuses on the effluent limit for TP only.

To set up the baseline, the following clauses from the Great Lakes Water Quality Agreement (GLWQA) is considered:

PRINCIPLES AND APPROACHES – Clause L
"science-based management – implementing management decisions, policies and programs that are based on best available science, research and knowledge, as well as traditional ecological knowledge, when available."

ANNEX 4 – NUTRIENTS – Clause C-1-a
"determine appropriate phosphorus loading allocations, apportioned by country, necessary to achieve Substance Objectives for phosphorus concentrations for each Great Lake"

ANNEX 4 – NUTRIENTS – Clause D-1-c
"programs to ensure that construction and operation of municipal wastewater treatment facilities that discharge one million liquid gallons or more per day achieve a maximum effluent concentration of 1.0 milligram per litre total phosphorus for plants in the basins of Lakes Superior, Michigan, and Huron, and of 0.5 milligram per litre total phosphorus for plants in the basins of Lakes Ontario and Erie"

PHOSPHORUS LIMIT CALCULATION (5-YEAR AVERAGES, PRO-RATED):

The 5-year average flow at the WWTP is 2,935 m^3/d (75% of rated capacity of the plant (3,910 m^3/day)) at the observed average discharge rate of phosphorus from 2016 to 2020 (1.66 mg/L), the average daily plant load of TP can be calculated as:

$$\text{Phosphorus Loading at 80\% Capacity} = 2{,}935\ \frac{m^3}{day} \times 1.66\ \frac{mg}{L} \times\ 10^{-3} = 4.87\ \frac{kg}{day}$$

To maintain the TP loadings at the current discharge rate for the proposed flow rate of 4,400 m^3/day, the proposed TP limit can be calculated as follow:

$$\text{Proposed Phosphorus Limit} = \frac{4.87\ \frac{kg}{day}}{4{,}400\ \frac{m^3}{day}} =\ 1.1\ \frac{mg}{L}$$

PROPOSED EFFLUENT LIMITS

It is understood, through the Great Lakes Agreement that the maximum allowable limit for discharge phosphorus concentration is 1 mg/L and that the Ministry is not in a position to grant approval for new discharge limits in exceedance of this agreement. As such, any expansion of the WWTP will require improvement of the effluent phosphorus to 1 mg/L.

Table 2 documents the current and future effluent loading limits, and current conditions. In order to meet the requirements of the Great Lakes Agreement, an interim phosphorus limit of 1.0 mg/L is proposed which represents improvement on the existing conditions and results in an annual average loading that is lower than the loading limit proposed in the 2007 ACS. The scientifically determined limits for phosphorus loading obtained through the ACS will be improved upon during the interim period at the 1.0 mg/L phosphorus limit. The limit for the interim phosphorus loading proposed represents an approximate 9% improvement on the overall loading proposed in the 2007 ACS and ESR for the 6,000 m^3/d expansion.

Table 2: Existing and Proposed Interim Effluent Limits for New Capacity of 4,400 m^3/day

Phase	Phosphorus Concentration	Effective Phosphorus Loading	Proposed/ Existing Phosphorus Loading Limit
Existing - 3910 m^3/d	4 mg/L	15.64 kg/day	15.64 kg/day
Current Conditions[1]	1.66 mg/L	4.87 kg/day	15.64 kg/day
Expansion 1 - 4,400 m^3/d	1.0 mg/L	4.4 kg/day	4.4 kg/day
Expansion 2 – 6,000 m^3/d	0.8 mg/L	4.8 kg/day	4.8 kg/day

Table 3 shows the full listing of effluent limits proposed for the interim expansion, Table 4 shows the full listing of effluent limits determined for the 6,000 m^3/d expansion from the 2007 ACS.

Table 3: Proposed Interim Effluent Limits for New Capacity of 4,400 m^3/day

Effluent Parameter	**Monthly Average Concentration** (milligrams per litre unless otherwise indicated)	**Annual Average Loading** (kilograms per day unless otherwise indicated)
$CBOD_5$	15.0	66
Total Suspended Solids	15.0	66
Total Phosphorus	**1.0**	**4.4**
Total Ammonia Nitrogen		
Freezing Period*	3.0	13.2
Non-Freezing Period*	5.0	22
pH of the effluent maintained between 6.0 to 9.5, inclusive, at all times		

*Note: Freezing Period: October 1 to May 14, Non-Freezing Period: May 15 to September 30

[1] Average discharge concentration of 1.66 mg/L phosphorus and average day flow of 2,935 m^3/d

Table 4: ACS Effluent Limits for Future Capacity of 6,000 m^3/day

Effluent Parameter	**Monthly Average Concentration** (milligrams per litre unless otherwise indicated)	**Annual Average Loading** (kilograms per day unless otherwise indicated)
$CBOD_5$	15.0	90
Total Suspended Solids	15.0	90
Total Phosphorus	**0.8**	**4.8**
Total Ammonia Nitrogen		
Freezing Period*	3.0	18.0
Non-Freezing Period*	5.0	30.0
pH of the effluent maintained between 6.0 to 9.5, inclusive, at all times		

*Note: Freezing Period: October 1 to May 14, Non-Freezing Period: May 15 to September 30

CONCLUSION:

Although previously the Ministry agreed upon the TP effluent limit of 0.8 mg/L, it should be noted that this requirement imposes the addition of a tertiary treatment unit to the plant. While the Municipality is planning to have a tertiary treatment unit in the future, currently, it is not financially feasible.

Approving a slightly more relaxed effluent limit of 1.0 mg/L, would give confidence to the Municipality that effluent requirements can be met through chemical intervention in the short term for a maximum plant capacity of 4,400 m^3/day. This will allow the Municipality to save toward adding a tertiary treatment for the full built out scenario with a maximum capacity of 6,000 m^3/day.

This is also consistent with the GLWQA requirement for facilities with capacity of 3,785 m^3/day or more to achieve a maximum effluent concentration of 1.0 mg/L TP for plants in the basins of Lake Huron.

Please advise if the proposed effluent limits and objectives are acceptable to the MECP and whether the Ministry believes this is a reasonable compromise the TP limit, based on a scientific approach and respecting existing legislative requirements. This approach will assist the Municipality in their efforts to gradually move toward the 0.8 mg/L TP limit.

OBJECTIVE 2 – PEAK FLOW MANAGEMENT

The Meaford wastewater collection system has significant peak wastewater flows resulting from inflow and infiltration (I&I). The 2007 ESR established that reduction of I&I and improvement of water conservation were components of the overall management of wastewater flow to the WWTP. The approach to reduce peak flows was reinforced by the Municipalities' 2015 Water and Wastewater Master Plan, in addition to a recommendation to construct equalization storage for peak flow management. The Municipality has pursued projects to reduce I&I in the intervening years, however peak wastewater flows remain excessive. The Municipality has documented peak day flows in excess of 5 times average daily flow (ADF) and peak instantaneous flows as high as 7.9 times ADF.

It is clear that operation of conventional secondary treatment processes are placed at risk during excessively high peak flow ratios due to the potential for wash-out of the biomass. Similarly, oversizing a secondary treatment process in order to manage excessive peak flows is problematic, causing operational challenges and potential for deposition in oversized channels. In addition, the cost to construct oversized treatment in order to manage peak flows could become cost prohibitive.

While the use of equalization storage has been recommended previously, the scale of storage needed to manage the excess flows the system experiences over multiple day spans may be impractical.

Understanding the history and challenges faced, we are seeking feedback from the Ministry on the potential for using a high-rate clarification system to manage peak flows. The intent of the high-rate clarification system would be to treat flows above the peak flow capacity of the plant (during peak flow/wet weather events only) and allow the effluent from high-rate clarification to bypass the secondary treatment process; disinfection would be maintained during by-pass events. It is understood that this approach is typically reserved for combined sewer systems following "F-5-5 Determination of treatment requirements for municipal and private combined" however, given the extent of extraneous flows in the Meaford collection system (5-7.9 times ADF) the wastewater is highly diluted during the peak flow periods.

We are proposing an overall solution which includes high-rate clarification for management of peak flows; we are seeking feedback from the Ministry on whether this solution will be acceptable before the alternative is explored further through the EA process.

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Appendix A

AINLEY & ASSOCIATES LIMITED
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Memorandum

To:	**Mark Badali, PMP, CET**
Copies To:	**Rhonda Shannon, Hugh Geurts, John Ritchie, Mark Smith**
From:	**Kamran Rahnama, P.Eng.**
Date:	April 1, 2022
Reference:	Meaford Waste Water Treatment Plant Expansion Class Environmental Assessment (EA) Update Proposed Effluent Limits Ainley File No. 121027

BACKGROUND

The Municipality of Meaford completed a Class EA for the expansion of the existing wastewater treatment facility. Based on correspondence from the Ministry to the Municiplaity in 2012 (**Attachment 1**), an amendment to the Class EA was required, particularly to address potentially affected Indigenous Nations.

Ainley Group had a virtual meeting with the Ministry of the Environment, Conservation and Parks (MECP) on Feb. 23, 2022, to discuss the effluent limits for the Meaford Wastewater Treatment Plant (WWTP), and to confirm that limits proposed in the 2007 Class EA remain acceptable to the MECP. The highlights of the plant and influent and effluent criteria as discussed in the meeting are:

- The plant is considered a cross between an Extended Aeration Activated Sludge (EAAS) and a Conventional Activated Sludge (CAS) process.

- The existing rated capacity per its ECA (#9036-AZFPV6 dated October 10, 2018) of the plant is 3,910 m^3/day.

- The plant outfall extends 450 m from the shore into the lake with a 15 m long diffuser. The lake depth at the diffuser is measured at 3.3 m.

- **Table 1** and **Table 2** show the existing effluent limits and effluent objectives as cited in the plant's ECA:

Table 1: Effluent Limits and Loadings

Effluent Parameter	Monthly Average Concentration (milligrams per litre unless otherwise indicated)	Annual Average Loading (kilograms per day unless otherwise indicated)
$CBOD_5$	20.0	78.2
Total Suspended Solids	20.0	78.2
Total Phosphorus	4.0	15.6
Total Ammonia Nitrogen (Oct 1 - May 14) (May 15 - Sep 30)	 3.0 5.0	 11.7 19.6
pH of the effluent maintained between 6.0 to 9.5, inclusive, at all times		

Table 2: Effluent Objectives and Loadings

Effluent Parameter	Monthly Average Concentration (milligrams per litre unless otherwise indicated)	Annual Average Loading (kilograms per day unless otherwise indicated)
$CBOD_5$	20.0	78.2
Total Suspended Solids	20.0	78.2
Total Phosphorus	4.0	15.6
Total Ammonia Nitrogen (Oct 1 - May 14) (May 15 - Sep 30)	 3.0 5.0	 11.7 19.6
pH of the effluent maintained between 6.0 to 9.5, inclusive, at all times		

- **Table** 3 summerizes the monthly average influent parameters from the annual performance reports of the plan.

Table 3: Monthly Average Influent Parameters

Year	Flow (m^3/d)	$CBOD_5$ (mg/L)	TSS (mg/L)	Total Phosphorus (mg/L)	Ammonia Nitrogen (mg/L)
2016	2,204	189.68	166.18	3.01	25.61
2017	2,780	137.33	122.75	2.42	21.52
2018	3,146	156.92	156.00	3.07	21.98
2019	2,946	110.33	108.08	2.16	18.59

Year	Flow (m^3/d)	$CBOD_5$ (mg/L)	TSS (mg/L)	Total Phosphorus (mg/L)	Ammonia Nitrogen (mg/L)
2020	2,884	109.50	66.00	1.69	15.20
Average	**2,797**	**128.52**	**113.21**	**2.36**	**19.32**

- **Table 4** shows the monthly average effluent parameters from 2016 to 2020.

Table 4: Monthly Average Effluent Parameters

Year	$CBOD_5$ (mg/L)	Total Suspended Solids (mg/L)	Total Phosphorus (mg/L)	Ammonia Nitrogen (mg/L)
2016	5.09	5.98	1.76	0.88
2017	5.84	6.78	1.54	0.89
2018	5.85	7.19	1.88	0.80
2019	4.36	7.84	1.66	0.46
2020	4.10	5.00	1.47	0.54
Average	**5.05**	**6.56**	**1.66**	**0.71**

- This Class Environmental Assessment update is proposing to increase the capacity of the plant to 5,000 m^3/day for the projected growth to the year 2050.

- The MECP stated that total phosphorus (TP) will be the primary driver for the determination of updated effluent limits. The MECP noted that the current objective of 2.0 mg/L for the Meaford WWTP is not reflective of a modern plant.

- As it has been more than 10 years between notice of completion of the 2007 MCEA and commencement of construction, an amendment is required to proceed with any major upgrade in the plant (e.g., increasing the plant capacity).

- The MECP advised that a new assimilative capacity study (ACS) would not be needed if the Municipality would be able to stay within the existing TP loadings at the projected future flow of 5,000 m^3/d. The previously completed ACS is provided (**Attachment 2**) The MECP stated that the Municipality can request TP loading limits based on theoretical loadings of the plant while operating at 80% capacity.

PHOSPHORUS LIMIT CALCULATION (5-YEAR AVERAGES, PRO-RATED):

Assuming 80% of rated capacity of the plant (3,128 m^3/day) at the observed average discharge rate of phosphorus from 2016 to 2020 (1.66 mg/L), the average daily plant load of phosphorus can be calculated as:

$$\text{Phosphorus Loading at 80\% Capacity} = 3{,}128\ \frac{m^3}{day} \times 1.66\ \frac{mg}{L} \times\ 10^{-3} = 5.19\ \frac{kg}{day}$$

To maintain the TP loadings that would exist at 80% plant capacity at the proposed flow rate of 5,000 m^3/day, the proposed TP limit can be calculated as follow:

$$\text{Proposed Phosphorus Limit} = \frac{5.19\ \frac{kg}{day}}{5{,}000\ \frac{m^3}{day}} = 1.04\frac{mg}{L}$$

PHOSPHORUS LIMIT CALCULATION (5-YEAR WORST CASE):

The year 2018 had the highest TP effluent concentration from the past 5-years. Using the 2018 avearge flow (3,146 m^3/d) and average effluent loadings for phosphorus (1.88 mg/L), the highest average daily plant loading of phosphorus can be calculated as:

$$\text{2018 Phosphorus Loading } = 3{,}146\ \frac{m^3}{day} \times 1.88\ \frac{mg}{L} \times\ 10^{-3} = 5.91\ \frac{kg}{day}$$

The TP limit required to maintain the TP loadings observed in 2018 at the proposed flow rate of 5,000 m^3/day can be calculated as follow:

$$\text{Proposed Phosphorus Limit} = \frac{5.91\ \frac{kg}{day}}{5{,}000\ \frac{m^3}{day}} = 1.18\frac{mg}{L}$$

PROPOSED EFFLUENT LIMITS

Reviewing the 2007 MCEA, the outcome of the meeting with the MECP team and email communications between Ainley and the MECP team, Ainley proposes effluent limits for the future flow rate of 5,000 m^3/day in **Table 5**.

The proposed $CBOD_5$, TSS and ammonia limits are those accepted in the 2007 ESR. Following communication from the MECP (**Attachment 3**), it is understood that no proposed effluent limit for Phosphors would be acceptable below previously agreed upon limits from the 2007 ESR. The 2007 ESR had an effluent concentration limit of 0.8 mg/L and a monthly average loading of 4.7 kg/d. The previously agreed upon limits represent an improvement on both the current 5-year worst cast and the pro-rated 5-year average.

Table 5: Proposed Effluent Limits for New Capacity of 5,000 m^3/day

Effluent Parameter	Monthly Average Concentration (milligrams per litre unless otherwise indicated)	Monthly Average Loading (kilograms per day unless otherwise indicated)
$CBOD_5$	15.0	75
Total Suspended Solids	15.0	75
Total Phosphorus	0.8	4.7
Total Ammonia Nitrogen		

Effluent Parameter	**Monthly Average Concentration** (milligrams per litre unless otherwise indicated)	**Monthly Average Loading** (kilograms per day unless otherwise indicated)
October 1 to May 14	3.0	15
May 15 to September 30	5.0	25
pH of the effluent maintained between 6.0 to 9.5, inclusive, at all times		

Please advise if the proposed effluent limits and objectives are acceptable to the MECP.

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Attachment 1

2012 MECP Letter

#108134 RS

Ministry of the Environment

733 Exeter Road
London ON N6E 1L3
Tel': 519 873-5000
Fax: 519 873-5020

Ministère de l'Environnement

733, rue Exeter
London ON N6E 1L3
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Ontario

January 3, 2012

Rakesh Sharma
Genivar Consultants LP
Suite 101
1450, First Avenue West
Owen Sound, Ontario
N4K 6W2

Dear Mr. Sharma:

RE: Proposed Upgrading of the Meaford Wastewater Treatment Facility

This acknowledges receipt of your correspondence of November 15, 2011 to the ministry with respect to a potential expansion/upgrade of the Meaford Sewage Treatment Plant. From your correspondence and our discussion of December 22, ministry staff understands that the municipality wishes to expand plant capacity by approximately 20% to accommodate projected future growth (the plant is currently operating at 87% capacity).

Proposed modifications include substantial upgrades to the plant design in order to afford greater treatment of waste and improved final effluent (namely reductions in phosphorous). The ministry is supportive of this goal.

The proposed works are subject to the Environmental Assessment Act. In November 2007, the municipality completed an Environmental Assessment to increase the rated average daily capacity to 6,000 m^3/day while retaining similar effluent criteria. Ministry staff notes that an Addendum to the existing 2007 Municipal Class Environmental Assessment ought to be completed for this proposed upgrading of the plant's capacity.

An important part of the Addendum process is the requirement for consultation with potentially affected Aboriginal and Métis communities. Our expectation is that all reasonable efforts will be undertaken to initiate meaningful and appropriate consultations. To assist, we believe the following communities are most likely to have interests in this project and should be contacted.

Jake Linklater, Case Manager
Saugeen Ojibway Nation Environmental Office
(519) 534-5507 jakelinklater@saugeenojibwaynation.ca

Ray Racicot, President
Great Lakes Métis Council
(519) 370-0435 rayr@greatlakesvoyageurs.com

It is the intent of ministry staff to proceed with our review process in tandem with the EA and its consultation processes.

Please note that any proposed future upgrade of the facility must also address the ability of the plant to improve upon combined sewer overflow (CSO) with respect to reducing the number of events where CSO's occur and the total volume discharged.

I trust the above provides you with sufficient information to proceed accordingly. If questions arise or if clarification is needed please contact the undersigned at (519) 873-5013 or via email at bill.armstrong@ontario.ca.

Yours truly,

W. Armstrong, M.E.S, RPP
Regional Environmental Planner
Southwestern Region

cc. H. Geurts
N. Champagne

Attachment 2

Latest Meaford WWTP Assimilative Capacity Study

GENIVAR

TECHNICAL MEMORANDUM

Date:	July 10, 2012
To:	Rakesh Sharma, GENIVAR
Copies:	
From:	Michelle Albert and Emily Ghosh, GENIVAR
Project No.:	OS-08-134-11-OS
Subject:	Meaford WWTP Assimilative Capacity Study Update

1. Introduction

The Meaford Wastewater Treatment Plant (WWTP) was constructed in 1969 to service the Municipality of Meaford and to provide treatment for hauled wastes from neighbouring areas. In 2007, a Schedule C Class Environmental Assessment (EA) was completed to address long term wastewater treatment requirements for the Municipality. It was assumed at the time of the Environmental Assessment Environmental Study Report (ESR) that the Municipality's current population would double by 2026, thus doubling the hydraulic capacity of Meaford WWTP. In the ESR, the WWTP's effluent limits and required treatment upgrades were determined based on this assumption. However, since the WWTP is currently operating below its rated capacity and based on the approved developments in Meaford at this time, a 20% increase in population would more likely represent future growth and future capacity requirements.

The objective of this Technical Memorandum is to confirm whether the effluent limits recommended in the 2007 ESR are still suitable for the Meaford WWTP if only a 20% increase to the rated capacity, from 3,910 m^3/d to 4,692 m^3/d, is undertaken.

2. Wastewater Treatment Facility Description

2.1 Description of Facilities

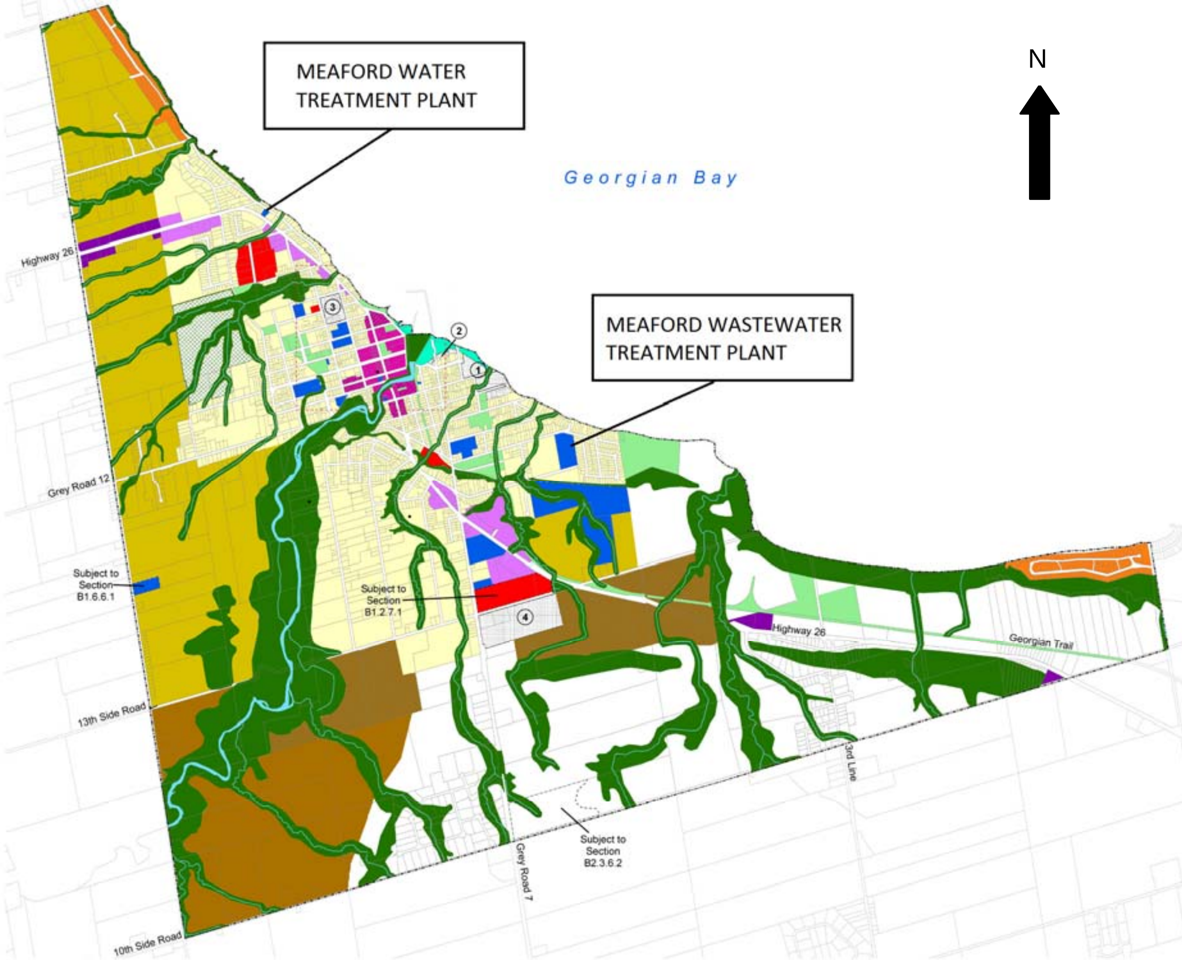
Meaford WWTP is located at 35 Grant Street in the Town of Meaford, as shown on Figure 2-1 on the following page. Meaford WWTP receives raw sewage from four pumping stations in the Meaford service area. The WWTP operates as an activated sludge plant with aerobic sludge stabilization and storage and Ultraviolet (UV) disinfection and is operated by the Ontario Clean Water Agency (OCWA). The key treatment processes and operations include:

- Raw wastewater pumping station
- Preliminary treatment (screening)
- Conventional Activated Sludge System (aeration tanks, secondary clarifiers)
- UV Disinfection System
- Outfall to Georgian Bay
- Aerobic Digestion with land disposal of biosolids

2.2 Wastewater Flows and Plant Treatment Capacity

The Meaford WWTP operates under Certificate of Approval #0440-6A4JXX issued by the Ministry of the Environment (MOE) on March 15, 2005. The current rated capacity of the plant is 3,910 m^3/d, however based on OCWA's 2011 Performance Report, the plant's 2011 annual average daily flow was only 2,679.3 m^3/d which is 68.5% of the design capacity. This was a 12% increase from flows recorded in 2010.

Figure 2-1 Location of Meaford WWTP (Source: *Municipality of Meaford Official Plan – Schedule A-1 Land Use Plan,* 2005)



In light of the current flows to the plant and approved subdivisions planned for the future, it has been estimated that future plant flows will increase by 20% above the current rated capacity of 3,910 m^3/d to 4,692 m^3/d.

In the 2007 ESR, the peaking factor was assumed to be 3.5. Also, based on the 2011 Performance Report, a maximum peak daily flow of 9,505 m3/d was recorded at the plant, which is 3.5 times the plant's annual average daily flow in 2011. Therefore, a peaking factor of 3.5 will also be used for this report.

2.3 Treated Water Effluent Quality as per the 2007 ESR

The current and earlier proposed effluent limit are summarized in Table 2-1.

Table 2-1 Current and Earlier Proposed Effluent Limits

Parameter	Current Effluent Limit (C of A at 3,910 m^3/d)Note1		Earlier Proposed Effluent Limit (2007 ESR at 6,000 m^3/d)Note 2	
	mg/L	kg/d	mg/L	kg/d
$CBOD_5$	20	78.2	15	90.0
TSS	20	78.2	15	90.0
Total Phosphorus	4	15.6	0.8	4.8
Total Ammonia non-freeze periodNote 3	3	11.7	3	18.0

Parameter	Current Effluent Limit (C of A at 3,910 m^3/d)[Note1]		Earlier Proposed Effluent Limit (2007 ESR at 6,000 m^3/d)[Note 2]	
	mg/L	kg/d	mg/L	kg/d
freeze period[Note 3]	5	19.6	5	30.0
pH	6.0 – 9.5		6.0 – 9.5	

[Note 1] Certificate of Approval #0440-6A4JXX

[Note 2] Municipality of Meaford Wastewater Treatment Municipal Class Environmental Assessment Environmental Study Report (EarthTech, November 2007) (Values in ESR are incorrect for 6,000 m^3/d, updated values shown)

[Note 3] Non-freeze period from May 15th to September 30th. Freeze Period from October 1st to May 14th.

3. Receiving Water Impact Assessment

The level of impact of wastewater plant effluent on the receiving waters is based on the ability of the receiving waters to assimilate substances. Assimilative capacity is defined as "the limit of a water body to transform and/or incorporate substances (e.g. nutrients) by the ecosystem, to the point that the water quality does not degrade below a predetermined level" (MOEE, 1994a). An assessment of the capacity of the receiving waters (Georgian Bay) to assimilate 5-day biochemical oxygen demand (BOD_5), effluent total suspended solids (TSS), total ammonia and total phosphorous (TP) is discussed in this section.

3.1 Provincial and Federal Guidelines used to Quantify Impacts to Receiving Waters

To quantify the impact of the Meaford WWTP discharges on Georgian Bay was evaluated based on Ministry of Environment Procedure B-1-5 "*Deriving Receiving Water Based Point Source Effluent Requirements for Ontario Waters"* (MOE 1994a) which includes water quality objectives (called the *Provincial Water Quality Objectives* or PWQOs) for various water quality parameters. Other important guidance and procedural documents utilized includes:

- Recreational Water Quality Guidelines and Aesthetics (CCME, 1998),
- Guidelines for Canadian Recreational Water Quality (Health Canada, 2009),
- Procedure F-5-1 "*Determination of Treatment Requirements for Municipal and Private Sewage Treatment Works Discharging to Surface Waters*",
- "*Derivation of Effluent Criteria for Certificates of MOE"* (MOE, 1992),
- "*Guide for Applying for Approval of Municipal and Private Water and Sewage Works*" (MOE, 2000)
- Canadian Water Quality Guidelines for the Protection of Aquatic Life, Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems (CCME, 2004)

Both federal and provincial regulations were utilized in this assessment and therefore in the situation that a parameter had different federal and provincial criteria, the more stringent criteria were used.

3.2 Objectives of Receiving Water Assessment

The objectives of a receiving water assessment are:

1. to determine the effectiveness of the Meaford WWTP outfall and diffusers
2. to determine the representative background water quality and current velocities of Georgian Bay in the vicinity of the Meaford WWTP outfall;
3. to determine the representative effluent conditions;
4. to conduct an assessment of the assimilative capacity of the Georgian Bay receiving waters based on worst case conditions; and
5. to confirm the effluent limits for the Meaford WWTP

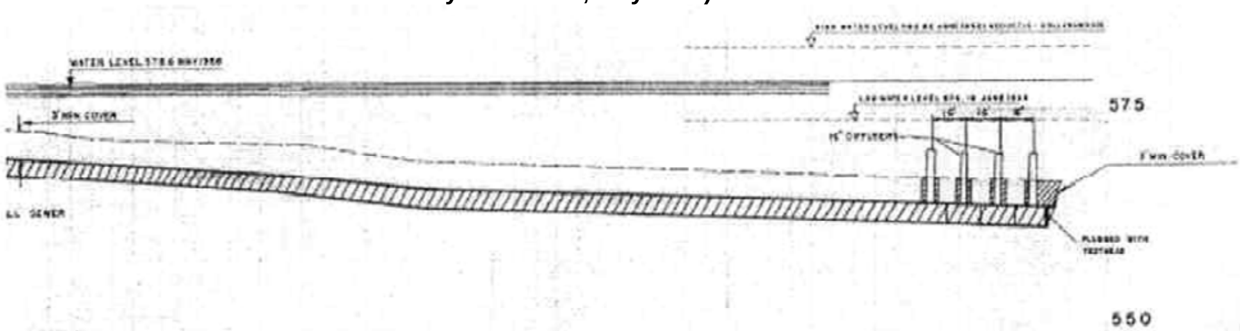
3.3 Previous Receiving Water Assessment at Higher Design Capacity (6,000 m^3/day)

As part of the 2007 EA, a Technical Memorandum called the *Evaluation of Near field Water Quality at the Outfall of the Meaford WWTP Diffuser* by EarthTech was completed to address receiving water impacts for future flows of 6,000 m^3/day. For this evaluation, data was gathered for the Meaford WWTP and Georgian Bay for integration into a CORMIX model to assess effluent impacts to the Bay. The background information gathered from the previous study and described in the following section will also be utilized for completing this tech memo. The results of the previous study will also be reviewed.

3.3.1 Meaford WWTP Outfall and Diffusers

The Meaford WWTP outfall consists of a 600 mm diameter concrete pipe and four (4) 450mm diffusers which discharges wastewater effluent into Georgian Bay. The outfall discharge point is located approximately 425 m from the shore and is approximately 3 km from the Meaford Water Treatment Plant Intake. As shown in Figure 3-1 below, the outfall pipe is buried below the lake bed with only the diffusers exposed above the lake bed surface. An underwater visual inspection completed by Watech Services in November 2006 as part of the 2007 EA Study found that the pipe was still under full cover and the diffusers were in good overall condition. However, the diffusers were covered in marine growth and zebra mussels and the caps were damaged or missing. Regular maintenance and removal of the remaining caps was recommended as part of the report.

Figure 3-1 Meaford WWTP Outfall and Diffuser Profile (Source: *Evaluation of Near field Water Quality at the Outfall of the Meaford WWTP Diffuser* by EarthTech, July 2007)



Other characteristics of the outfall, diffuser and ports are summarized in Table 3-1 below.

Table 3-1 Meaford WWTP Outfall and Diffuser Details (Source: *Evaluation of Near field Water Quality at the Outfall of the Meaford WWTP Diffuser* by EarthTech, July 2007)

Parameter	Value
Outfall Length	450 m
Diffuser Length	15 m
Number of Diffuser Ports	4
Port Diameter	400 mm
Port Distance to the shore	425 m
Port Vertical Angle	90º
Port Discharge Elevation	~0.9 m above lake bed
Lake Depth at Diffuser	3.3m in 2007, 3.7m long-term

Bathymetric data was also reviewed to establish circulation patterns near the outfall discharge ports. The bathymetry of Georgian Bay and local bathymetry near the outfall are shown on Figure 3-2 and Figure 3-3, respectively. As discussed in the 2007 Study and shown in the figures, it is likely that the receiving waters have an unstratified water column at the diffuser ports due to the shallow shelf in that area. Furthermore, the currents will mostly occur in the central part of the Bay, where the shelf is deeper.

Figure 3-2 Bathymetry of Lake Huron and Georgian Bay with Topography (Source: National Oceanic and Atmospheric Administration (NOAA), http://www.ngdc.noaa.gov/mgg/greatlakes/huron.html)
[Blue>130m; Green 70-130m; Yellow 40-70m; Red<40m]

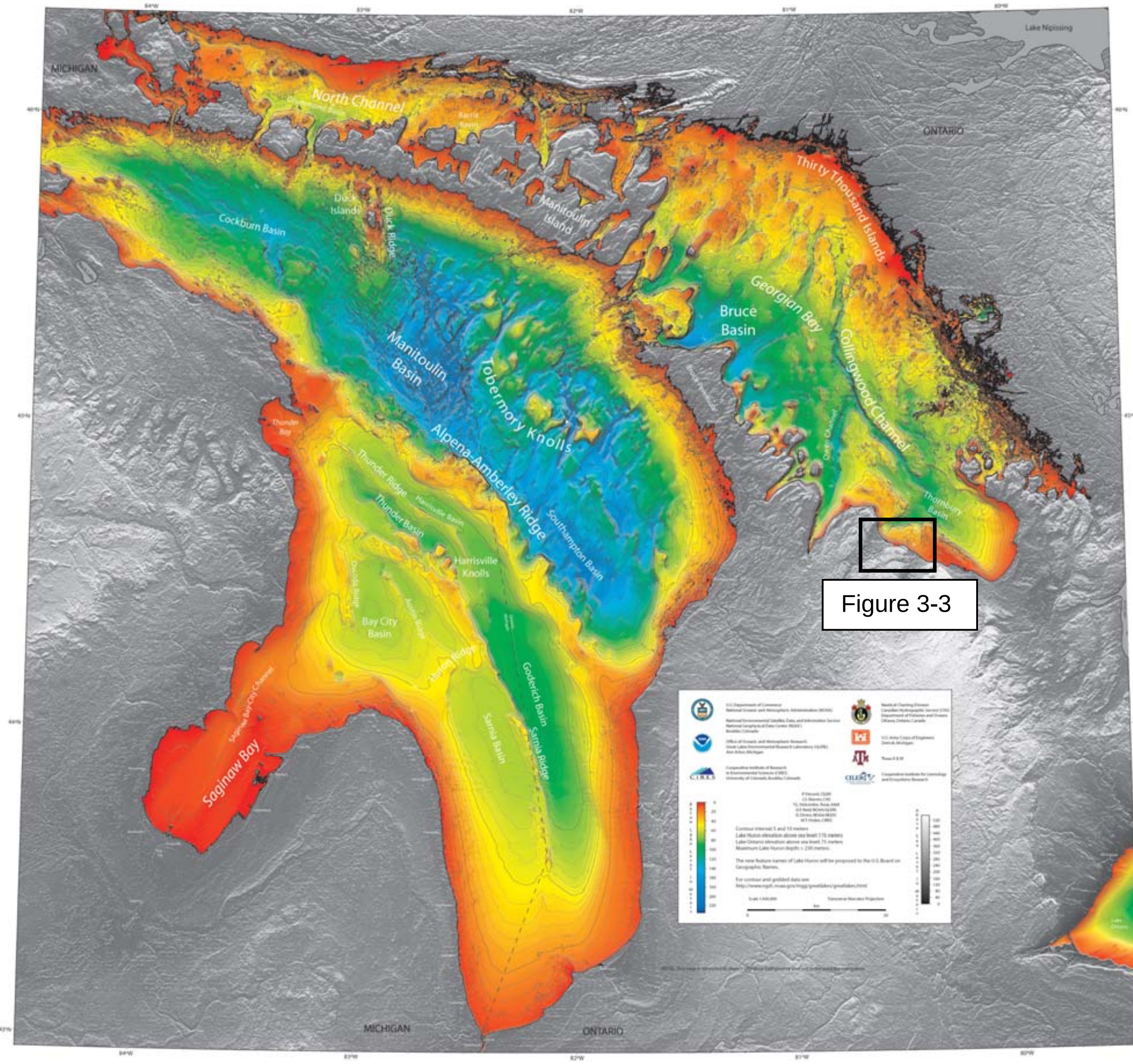
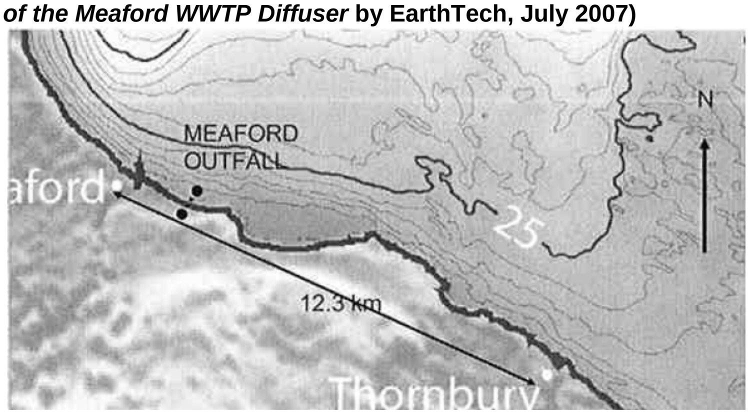


Figure 3-3 Bathymetry at Meaford WWTP Outfall (Source: *Evaluation of Near field Water Quality at the Outfall of the Meaford WWTP Diffuser* by EarthTech, July 2007)



3.3.2 Georgian Bay Background Water Quality and Current Conditions

The receiving water – Georgian Bay - ambient conditions and future effluent conditions were identified and used to simulate the impact on the receiving water by using LHOPS-POM and CORMIX modeling software. High background pollutant concentrations, pH levels and temperatures (75th percentile) in the receiving water body were determined in order to assess the suitability of wastewater effluent criteria under worst case conditions.

The ambient data that was reviewed included temperature, pH, and current velocities as summarized in Table 3-2. Ambient temperature values were provided by a 1974 study of Georgian Bay by E.A. Bennett (Department of Fisheries and Oceans) and ambient pH values by the Ministry of the Environment. The results from the LHOPS – POM model were used to estimate current velocities in the vicinity of the Meaford WWTP outlet. All of this data was then incorporated into CORMIX to conduct an assessment of the assimilative capacity of the Georgian Bay receiving waters for a wide range of ambient and effluent conditions.

Table 3-2 Georgian Bay Background Water Quality and Current Conditions

Parameter	Value	Source
Ambient Temperature	Min Temp = 0ºC Max Temp = 19ºC (August)	1974 study of Georgian Bay by E.A. Bennett (Department of Fisheries and Oceans)
Lake Temperature	Summer = 19 to 20ºC Winter = 0 to 4ºC Lake turn over = 4ºC (occurs in November and April)	2007 ESR Assimilative Capacity Study
Lake pH	8.3	2007 Ministry of the Environment Email Correspondence
Current Velocities	Summer currents are long shore with maximum speed of 50 cm/s NNW to SSE or SSE to NNW. Winter currents have a maximum speed of 30 cm/s.	Baird Associates

3.3.3 Meaford WWTP Effluent Water Quality

The Meaford WWTP Effluent Water conditions are summarized in Table 3-3.

Table 3-3 Georgian Bay Background Water Quality and Current Conditions

Parameter	Value	Source
Effluent Temperature	Summer = 22.2ºC Winter = 8 to 11ºC Fall Lake Turnover = 13ºC Spring Lake Turnover = 10ºC	2007 ESR Assimilative Capacity Study
Effluent pH	6.4 to 8.0 (75% Percentile value = 7.6)	2006 Meaford WWTP Operations Data

3.3.4 Determination of Assimilative Capacity of Georgian Bay

Various water quality parameters were assessed under the worst case conditions using CORMIX modeling software. In order to use this software, it was first necessary to determine the dilution ratio at various distances from the outfall and the shore using CORMIX 2 software. The dilution ratios at 100m and 200m are provided in the following table.

Table 3-4 Dilution Ratios (Source: *Evaluation of Near field Water Quality at the Outfall of the Meaford WWTP Diffuser* by EarthTech, July 2007)

Parameter	Dilution Ratio

Table 3-4 Dilution Ratios (Source: *Evaluation of Near field Water Quality at the Outfall of the Meaford WWTP Diffuser* by EarthTech, July 2007)

Parameter	Dilution Ratio
100m from outfall	70:1 (median dilution) 35:1 (75th percentile dilution)*
200m from shore (or half distance to the shore)	115:1 (median dilution) 70:1 (75th percentile dilution)

*assumed that the dilution ratio will reduce to 18:1 under winter conditions due to ice cover.

All of the parameters were then entered into CORMIX to analyze various scenarios. The study concluded that the water quality objectives set by the MOE were met for all of the key parameters tested and that objectives were met within one half of the distance to shore or 200 m from the outfall. The parameters, their respective objectives and CORMIX modeling results are shown in Table 3-5.

Table 3-5 2007 ESR Modeling Results for 6,000 m^3/d

Parameter	Objective	CORMIX Modeling Parameters / Results
Un-ionized ammonia	20 µg/L (PWQO at edge of near field for protection of aquatic life)	**Parameter (for worst case scenario):** - Max Summer month effluent temperatures - 75%-ile effluent pH - 75%-ile dilution - 75%-ile ambient pH and water temp. **Result:** - <4 µg/L at half distance to shore **(Objective met)**
Total Ammonia	500 µg/L (Great Lakes Water Quality Agreement (GLWQA) Objective at water supply intakes)	**Result:** - <300 µg/L at 100 m from outfall during winter period **(Objective met)**
E.coli	100 counts/100 mL (PWQO for Swimming at the Beach)	**Result:** - Highest in winter at 3 counts per 100 mL at half the distance to shore **(Objective met)**
Total Phosphorus	20 µg/L (Interim PWQO for the control of algae. Objective at the Regulated Mixing Zone; Typically half the distance from the diffuser to the shore)	**Parameter:** - Max Summer/Winter effluent temperatures - 75%-ile effluent pH - 75%-ile ambient pH and water temp. **Result:** - 7 µg/L in the summer **(Objective met)** - 14 µg/L in the winter **(Objective met)**

3.4 Evaluation of the Impact to Georgian Bay by the Newly Predicted Future Flow (4,692 m^3/day)

Presented in Table 3-6 below, are the new proposed effluent criteria (concentrations and loadings), which can be discharged into Georgian Bay from the Meaford WWTP with no adverse environmental impacts on the Bay and/or shoreline. These criteria were based on those proposed in the *Evaluation of Near field Water Quality at the Outfall of the Meaford WWTP Diffuser* by EarthTech in 2007 for 6,000 m^3/d because it is expected that the assimilative capacity model results will not worsen by lowering the effluent flows to 4,692 m^3/d, but will actually improve.

The only exception is the total phosphorus (TP) limit which is proposed to be 1.0 mg/L. As per the Ministry of Environment Guideline F-8 "*Provision and Operation of Phosphorus Removal Facilities at Municipal, Institutional and Private Sewage Treatment Works*" (April 2004), it is required that the majority of municipal wastewater treatment plants in Ontario discharge TP concentrations of a maximum 1.0 mg/L in their effluent. As shown in the table below, despite the increase in the TP concentration limit, the mass loadings are still lower than what was originally being proposed in the 2007 ESR. This is because the lower discharge volume (4,692 m^3/d) has a lesser impact on the Bay and/or shoreline.

Similarly, the other effluent parameters mass loadings are reduced more than 20% from the previous effluent limits due to the lower flow rate. Since the assimilative capacity study completed in 2007 meets all MOE water quality requirements, it is expected that the proposed effluent criteria for 4,692 m^3/d will also be within the lake's assimilative capacity limit and will satisfy the MOE water quality requirements.

Table 3-6 Effluent Limit Comparison

Parameter	Earlier Proposed Effluent Limit (2007 ESR at 6,000 m^3/d)[Note 1]		Newly Proposed Effluent Limit (at 4,692 m^3/d)		Difference in Mass Loadings	
	mg/L	kg/d	mg/L	kg/d	kg/d	%
$CBOD_5$	15	90.0	15	70.4	-19.6	-28%
TSS	15	90.0	15	70.4	-19.6	-28%
Total Phosphorus	0.8	4.8	1.0	3.7	-1.1	-30%
Total Ammonia						
non-freeze period[Note 2]	3	18.0	3	14.8	-3.2	-22%
freeze period[Note 2]	5	30.0	5	23.5	-6.5	-28%
pH	6.0 – 9.5		6.0 – 9.5			

[Note 1] Municipality of Meaford Wastewater Treatment Municipal Class Environmental Assessment Environmental Study Report (EarthTech, November 2007) (Values in ESR are incorrect for 6,000 m^3/d, updated values shown)

[Note 2] Non-freeze period from May 15th to September 30th. Freeze Period from October 1st to May 14th.

4. Conclusion

In conclusion, based on the findings of this Technical Memorandum which was developed using sound engineering principles, there should not be any adverse water quality impacts to the receiving waters by increasing the effluent flow from Meaford WWTP by 20% and following the effluent limits proposed in Table 3-6.

Attachment 3

MECP Communicaiton

From:	Shannon, Rhonda (MECP)
To:	Simon Glass; Preya Balgobin; Kamran Rahnama; ccollyer@meaford.ca; Jessica Wiley
Cc:	Geurts, Hugh (MECP); Badali, Mark (MECP); Ritchie, John (MECP); Smith, Mark (MECP)
Subject:	Meaford WWTP Class EA amendment - effluent limit discussion
Date:	February 24, 2022 1:55:26 PM
Attachments:	image003.png

Good afternoon all,

As discussed during the Teams meeting yesterday with Ainley Group consultants (Simon Glass, Preya Balgobin and Kamran Rahnama), I am forwarding a summary of the MECP Regional expectations for an effluent limit submission.

The Municipality will be responsible for determining how the Class EA process is to be followed. Please note that expanding a WWTP beyond its current rated capacity triggers a Schedule C Municipal Class EA. The MCEA process requires an addendum if 10 years have elapsed between Notice of Completion & commencement of construction, so the Municipality cannot proceed with implementing the preferred alternative from their 2007 Class EA. It is the proponent's decision on whether they can adequately address any changes to the environmental context of the project since 2007 through an addendum, or if the new proposed work would be more appropriately considered as a new undertaking and therefore require a new Class EA. Questions and correspondence on the Class EA process can be directed to Mark Badali, Environmental Resource Planner & EA Coordinator at mark.badali1@ontario.ca.

- We understand the plant is proposed to be upgraded to 5,000 m^3/day for projected growth to the year 2050. Discharge is to Georgian Bay with an outlet 425 meters off shore and a depth of 3.3 meters.

Phosphorus limits:

- Phosphorus limits will be the primary driver for determination of effluent limits. The Ministry notes that the current objective of 2.0 mg/l for the Meaford WWTP is not reflective of a modern plant.

- A full assimilative analysis need not be undertaken if the Municipality can work within the existing loadings of phosphorus currently coming from the plant (design objective at full build out in 2050). The Municipality, if need be, can request loadings based on calculated (prorated) 80% capacity of the plants existing performance .

- Of NOTE (not discussed at the meeting): If the 2007 Class EA was completed and a "Notice of Completion" finalized the EA, the Ministry will likely be held to the stricter of the two possible TP limits (the 0.8 mg/l limit from the 2007 class EA or the number to be calculated from above). The Ministry is not in a position to relax a number that a proponent has previously already agreed to meet.

- The Municipality is to determine the existing loadings as described above and apply the more stricter of the two to their proposed limit.

Total Ammonia Nitrogen

- Current limits for the facility are 3mg/l in summer and 5 mg/l in winter and proposed in the 2007 EA process; these will likely be appropriate for open water. Objectives of summer 2 mg/l - summer and 4.0 mg/ l - winter should be applied.

First Nations Consultation.

- The Municipality will be responsible for undertaking First Nations consultation with respect to the proposed effluent limits.

I hope this is helpful - thank-you to all for your input.
Have a great weekend.

Regards,

Rhonda Shannon
Water Inspector, Owen Sound District Office
Ministry of the Environment, Conservation and Parks
t: 226.668.5873 e: Rhonda.shannon@ontario.ca

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Masoumeh Sharafi

From:	Badali, Mark (MECP) <Mark.Badali1@ontario.ca>
Sent:	Tuesday, April 25, 2023 4:44 PM
To:	Simon Glass
Cc:	Jatin Singh; tperejmybida@meaford.ca
Subject:	RE: Meaford WWTP Class EA amendment - effluent limit discussion
Attachments:	2023-04-03_121027_MOE Proposed Effluent Criteria Memorandum.pdf

Hi Simon,

In response to the memorandum "*Meaford Waste Water Treatment Plant Expansion Class Environmental Assessment (EA) Update Proposed Effluent Limits – Revision*" prepared by Ainley and Associates, dated April 3, 2023 (attached), the ministry offers the following comments:

1. The attached document is asking for a pause on the originally proposed phosphorus limit of 0.8 mg/L. The proponent is asking for a limit of 1.0 mg/L total Phosphorus for the revised plant design from the 0.8 mg/L proposed in the memorandum dated April 1, 2022 (Appendix A of attached). The attached report notes the Municipality of Meaford currently does not have the financial resources to implement a tertiary component to the proposed plant design to meet the 0.8 mg/L limit. The report acknowledges that the Great Lakes Water Quality Agreement (GLWQA) Annex for Clause "D" targets a maximum concentration of 1.0 mg/L for direct discharge of sanitary wastewater to Lake Huron. The proponent proposes a two-phase/expansion approach where Expansion 1 addresses the immediate need for 4,400 m3/day that will be met with secondary treatment only (with Total Phosphorus of 1.0 mg/L)

2. Regardless of the phosphorus limit, the 400 meter offshore discharge will mean that 0.8 or 1.0 mg/L will have minimal impact on the mixing zone. Furthermore the Total Phosphorus Loading reductions from an upgraded plant over the existing plant will be substantial resulting in a net benefit to the Lake. If total phosphorus becomes a sticking point for proceeding with the new plant design and cause delay, the ministry is of the opinion that it is more important that the new plant be built as soon as possible. The proponent acknowledges that continued improvement in phosphorus (to 0.8 mg/L) will be addressed as Expansion 2 when the plant is upgraded to 6,000 m3/day (which is consistent with the 2007 Environmental Study Report).

3. The shallowness of the lake at the proposed discharge point (3.3 meters) does suggest the possibility that Cladophora algae may become established beyond the immediate port outlet. This is highly unlikely given lake currents and the proposed use of a port diffuser, but the ministry should request an algae inspection around the outlet to determine magnitude of algae growth. This inspection should be done within 3 years of the effluent release commencing.

4. In summary, the ministry does not foresee any substantial impact to the mixing zone by moving to a 1.0 mg/L Total Phosphorus limit for Phase/Expansion 1 of a two-phase approach. Furthermore, the development of a more modern plant will result in substantial reductions in phosphorus load to the lake over the current situation and that will result in the greatest net benefit.

Please do not hesitate to reach out to me if you have any technical questions, and I will coordinate with the surface water specialist supporting on the ministry's review of this Class EA project.

Please note that I recommend the proponent attach all relevant records of consultation with the ministry in the final Class EA report appendices.

In addition, regarding Objective 2 Peak Flow Management discussed on page 6 of the attached memo, the ministry will await the proponent's provision of a technical memo outlining the proposed peak flow management solution in greater detail for review by the ministry's Permissions staff, as discussed in our pre-consultation meeting held April 5th, 2023.

Best regards,

Mark Badali (he/him)
Regional Environmental Planner (REP) – Southwest Region
Project Review Unit | Environmental Assessment Branch
Ontario Ministry of the Environment, Conservation and Parks
Mark.Badali1@ontario.ca | (416) 457-2155

From: Badali, Mark (MECP)
Sent: March 17, 2023 1:26 PM
To: Simon Glass <simon.glass@ainleygroup.com>
Cc: Jatin Singh <jatin.singh@ainleygroup.com>; tperejmybida@meaford.ca
Subject: RE: Meaford WWTP Class EA amendment - effluent limit discussion

Hi Simon,

The ministry would be pleased to attend a follow-up consultation meeting to discuss requirements for effluent limits. Unfortunately due to staff capacity we are unable to make the proposed meeting times. MECP staff's current earliest availability is during the first week of April:

- Monday April 3 – 9:30am-12am
- Tuesday April 4 – 2-4pm
- Wednesday April 5 – 9:30-10:30am, 11am-12pm, 1:30-4pm
- Thursday April 6 – 9-10am, 11am-12pm, 1:30-3pm

If any of these dates/times work for your project team then please feel free to circulate a meeting invitation.

When you send out the meeting invitation please include the following MECP staff:

- Hugh Geurts, Surface Water Specialist, hugh.geurts@ontario.ca
- Rhonda Shannon, Water Inspector, rhonda.shannon@ontario.ca
- John Ritchie, Manager, Owen Sound District Office, john.s.ritchie@ontario.ca
- Mark Badali, Regional Environmental Planner, mark.badali1@ontario.ca

If there are any pertinent materials or information available that would be helpful for the ministry to review in order to prepare for this discussion, please provide them to me in advance of the meeting date.

Thank you,

Mark Badali (he/him)
Regional Environmental Planner (REP) – Southwest Region

Project Review Unit | Environmental Assessment Branch
Ontario Ministry of the Environment, Conservation and Parks
Mark.Badali1@ontario.ca | (416) 457-2155

From: Simon Glass <simon.glass@ainleygroup.com>
Sent: March 13, 2023 1:53 PM
To: Badali, Mark (MECP) <Mark.Badali1@ontario.ca>
Cc: Jatin Singh <jatin.singh@ainleygroup.com>; tperejmybida@meaford.ca
Subject: RE: Meaford WWTP Class EA amendment - effluent limit discussion

CAUTION -- EXTERNAL E-MAIL - Do not click links or open attachments unless you recognize the sender.

Hello Mark,

Hope all is well. We are hoping to have a follow up discussion around the Meaford WWTP EA upgrades to discuss the Ministry requirements around the effluent limits and options for the Municipality. Would you be available for a discussion in the coming weeks? We have provided a few alternative times that work for our team below.

Thursday March 23 – 3:30 – 4:30pm
Monday March 27 - 8:30am-12pm
Tuesday March 28 – 11am-4:30pm
Wednesday March 29 – 11am – 5:00

Regards,

Simon Glass, P.Eng
Project Engineer

Ainley GROUP

Tel: (905) 452-5172 Ext. 220
Cell: (289) 654-2865
Email: simon.glass@ainleygroup.com

WWW.AINLEYGROUP.COM

From: Badali, Mark (MECP) <Mark.Badali1@ontario.ca>
Sent: April 21, 2022 10:36 AM
To: Simon Glass <simon.glass@ainleygroup.com>
Cc: Preya Balgobin <preya.balgobin@ainleygroup.com>
Subject: RE: Meaford WWTP Class EA amendment - effluent limit discussion

Hi Simon,

I would be pleased to discuss ministry expectations for indigenous consultation with Ainley. For your reference I have reattached the "*Proponent's Introduction to… Consultation*…" document that was provided previously with the ministry's acknowledgement letter in response to the initial Notice of Commencement.

Here is my upcoming availability:

- Fri. Apr. 22, anytime before 3pm
- Mon. Apr 25, anytime except 11-11:30am
- Tues/Wed. Apr. 26-27, anytime

Please feel free to send me a virtual meeting invite if any of these times work.

Best regards,

Mark Badali (he/him)
Regional Environmental Planner (REP) – Southwest Region
Project Review Unit | Environmental Assessment Branch
Ontario Ministry of the Environment, Conservation and Parks
Mark.Badali1@ontario.ca | (416) 457-2155
I am currently unable to receive calls by phone – please feel free to email me to setup an online audio call

---

From: Simon Glass <simon.glass@ainleygroup.com>
Sent: April 20, 2022 3:54 PM
To: Badali, Mark (MECP) <Mark.Badali1@ontario.ca>
Cc: Preya Balgobin <preya.balgobin@ainleygroup.com>
Subject: RE: Meaford WWTP Class EA amendment - effluent limit discussion

Hi Mark,

Thank you for your response and (tentative) approval. Preya and I would like to discuss with you a bit more about timing and obligations surrounding indigenous consultation to ensure we have a proper understanding of the expectations and requirements under the new duty to consult atmosphere. Can we please arrange a meeting time to discuss?

Regards,

Simon Glass
Project Engineer

Tel: (905) 452-5172 Ext. 220
Cell: (289) 654-2865

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Ainley Group is committed to providing accessible customer service. Please inform us if you require this information in an alternative format or require communication supports.

From: Badali, Mark (MECP) <Mark.Badali1@ontario.ca>
Sent: April 7, 2022 11:29 AM
To: Simon Glass <simon.glass@ainleygroup.com>
Cc: Geurts, Hugh (MECP) <Hugh.Geurts@ontario.ca>; Ritchie, John (MECP) <John.S.Ritchie@ontario.ca>; Smith, Mark (MECP) <mark.smith@ontario.ca>; Shannon, Rhonda (MECP) <Rhonda.Shannon@ontario.ca>; Preya Balgobin <preya.balgobin@ainleygroup.com>; Kamran Rahnama <kamran.rahnama@ainleygroup.com>; ccollyer@meaford.ca; Jessica Wiley <jwiley@meaford.ca>
Subject: RE: Meaford WWTP Class EA amendment - effluent limit discussion

Good morning,

Thank you for providing the attached letter dated April 1, 2022 with respect to effluent criteria for the Meaford Wastewater Treatment Plant (WWTP) that are being proposed through the Addendum to the Meaford WWTP Expansion Municipal Class Environmental Assessment project. Please be advised that the proposed effluent limits presented in *Table 5* of this letter are acceptable to the MECP.

Furthermore, the ministry's expectation is that the WWTP will during normal operating conditions be able to achieve effluent objectives that will be established during the subsequent Environmental Compliance Approval process.

Please continue to engage with the Indigenous communities previously identified in the MECP's acknowledgement letter dated October 4, 2021 (attached, for reference) as appropriate with respect to these proposed effluent limits.

Please include a summary of this correspondence with the MECP regarding effluent criteria in the Addendum Report. The MECP recommends that the proponent attach all relevant records of consultation in the Report appendices.

As Rhonda mentioned in her last email, moving forward all correspondence related to the Class EA process, such as submission of a draft Addendum Report, should be directed to me. I will circulate internally for ministry review as appropriate. The final Notice of Filing of Addendum must also be sent to the Regional email (eanotification.swregion@ontario.ca).

Best regards,

Mark Badali (he/him)
Regional Environmental Planner (REP) – Southwest Region
Project Review Unit | Environmental Assessment Branch
Ontario Ministry of the Environment, Conservation and Parks
Mark.Badali1@ontario.ca | (416) 457-2155
I am currently unable to receive calls by phone – please feel free to email me to setup an online audio call

From: Simon Glass <simon.glass@ainleygroup.com>
Sent: April 1, 2022 2:44 PM
To: Shannon, Rhonda (MECP) <Rhonda.Shannon@ontario.ca>; Preya Balgobin <preya.balgobin@ainleygroup.com>; Kamran Rahnama <kamran.rahnama@ainleygroup.com>; ccollyer@meaford.ca; Jessica Wiley <jwiley@meaford.ca>
Cc: Geurts, Hugh (MECP) <Hugh.Geurts@ontario.ca>; Badali, Mark (MECP) <Mark.Badali1@ontario.ca>; Ritchie, John (MECP) <John.S.Ritchie@ontario.ca>; Smith, Mark (MECP) <Mark.Smith@ontario.ca>
Subject: RE: Meaford WWTP Class EA amendment - effluent limit discussion

CAUTION -- EXTERNAL E-MAIL - Do not click links or open attachments unless you recognize the sender.

Hello Rhonda,

Following our previous communication, please see our attached letter with respect to our proposed effluent criteria at the Meaford WWTP.

Regards,

Simon Glass
Project Engineer

Tel: (905) 452-5172 Ext. 220
Cell: (289) 654-2865

WWW.AINLEYGROUP.COM

From: Shannon, Rhonda (MECP) <Rhonda.Shannon@ontario.ca>
Sent: February 24, 2022 1:55 PM
To: Simon Glass <simon.glass@ainleygroup.com>; Preya Balgobin <preya.balgobin@ainleygroup.com>; Kamran Rahnama <kamran.rahnama@ainleygroup.com>; ccollyer@meaford.ca; Jessica Wiley <jwiley@meaford.ca>
Cc: Geurts, Hugh (MECP) <Hugh.Geurts@ontario.ca>; Badali, Mark (MECP) <Mark.Badali1@ontario.ca>; Ritchie, John (MECP) <John.S.Ritchie@ontario.ca>; Smith, Mark (MECP) <mark.smith@ontario.ca>
Subject: Meaford WWTP Class EA amendment - effluent limit discussion

Good afternoon all,

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- We understand the plant is proposed to be upgraded to 5,000 m^3/day for projected growth to the year 2050. Discharge is to Georgian Bay with an outlet 425 meters off shore and a depth of 3.3 meters.

Phosphorus limits:

- Phosphorus limits will be the primary driver for determination of effluent limits. The Ministry notes that the current objective of 2.0 mg/l for the Meaford WWTP is not reflective of a modern plant.

- A full assimilative analysis need not be undertaken if the Municipality can work within the existing loadings of phosphorus currently coming from the plant (design objective at full build out in 2050). The Municipality, if need be, can request loadings based on calculated (prorated) 80% capacity of the plants existing performance .

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- The Municipality is to determine the existing loadings as described above and apply the more stricter of the two to their proposed limit.

Total Ammonia Nitrogen

- Current limits for the facility are 3mg/l in summer and 5 mg/l in winter and proposed in the 2007 EA process; these will likely be appropriate for open water. Objectives of summer 2 mg/l - summer and 4.0 mg/ l - winter should be applied.

First Nations Consultation.

- The Municipality will be responsible for undertaking First Nations consultation with respect to the proposed effluent limits.

I hope this is helpful - thank-you to all for your input.
Have a great weekend.

Regards,
Rhonda Shannon
Water Inspector, Owen Sound District Office
Ministry of the Environment, Conservation and Parks
t: 226.668.5873 e: Rhonda.shannon@ontario.ca

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Appendix D

Life Cycle Cost Evaluation of Secondary Treatment Alternatives

MEAFORD CLASS EA
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 121027
EXTENDED AERATION

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	3%
General Requirements	20%
Contractors Profit	8%
Contingency	40%
Engineering Fees	15%
Year to Begin Construction	2026
Estimated Phase 1 Construction Complete	2028
Estimated Phase 2 Construction Complete	2043
Estimated Phase 3 Construction Complete	2055

CAPITAL COST	Phase 1					Phase 2					Phase 3				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT															
Extended Air Tank															
Blowers	1	$ 500,000	$ 500,000	60%	$ 800,000	1	$ 800,000	$ 800,000	60%	$ 1,280,000	1	$ 500,000	$ 500,000	60%	$ 800,000
Aeration piping, valves, and diffusers	1	$ 800,000	$ 800,000	60%	$ 1,280,000	1	$ 1,300,000	$ 1,300,000	60%	$ 2,080,000	1	$ 800,000	$ 800,000	60%	$ 1,280,000
Secondary Clarifiers															
Sludge and Scum Removal Mechanism (including drives) + Walkway	1	$ 400,000	$ 400,000	60%	$ 640,000	1	$ 636,000	$ 636,000	60%	$ 1,017,600	1	$ 400,000	$ 400,000	60%	$ 640,000
Weirs and Baffles	1	$ 50,000	$ 50,000	60%	$ 80,000	1	$ 80,000	$ 80,000	60%	$ 128,000	1	$ 50,000	$ 50,000	60%	$ 80,000
Scum pumps	1	$ 20,000	$ 20,000	60%	$ 32,000	1	$ 32,000	$ 32,000	60%	$ 51,200	1	$ 20,000	$ 20,000	60%	$ 32,000
RAS Pumps	1	$ 50,000	$ 50,000	60%	$ 80,000	1	$ 80,000	$ 80,000	60%	$ 128,000	1	$ 50,000	$ 50,000	60%	$ 80,000
WAS Pumps	1	$ 45,000	$ 45,000	60%	$ 72,000	1	$ 72,000	$ 72,000	60%	$ 115,200	1	$ 45,000	$ 45,000	60%	$ 72,000
Chemical Dosing															
Chemical Storage Tanks	2	$ 50,000	$ 100,000	60%	$ 160,000	0	$ 50,000	$ -	60%	$ -	0	$ 50,000	$ -	60%	$ -
Day Tanks	1	$ 10,000	$ 10,000	60%	$ 16,000	0	$ 10,000	$ -	60%	$ -	0	$ 10,000	$ -	60%	$ -
Chemical Dosing Skid including Dosing Pumps	1	$ 30,000	$ 30,000	60%	$ 48,000	1	$ 30,000	$ 30,000	60%	$ 48,000	1	$ 30,000	$ 30,000	60%	$ 48,000
Instrumentation and Control including SCADA Integration	1	$ 150,000	$ 150,000	60%	$ 240,000	1	$ 150,000	$ 150,000	60%	$ 240,000	1	$ 150,000	$ 150,000	60%	$ 240,000
Tank Interconnect Piping	1	$ 10,000	$ 10,000	60%	$ 16,000	1	$ 10,000	$ 10,000	60%	$ 16,000	1	$ 10,000	$ 10,000	60%	$ 16,000
Pipe Installation and Heat Tracing	1	$ 30,000	$ 30,000	60%	$ 48,000	1	$ 30,000	$ 30,000	60%	$ 48,000	1	$ 30,000	$ 30,000	60%	$ 48,000
Total Equipment Cost					$ 3,512,000					$ 5,152,000					$ 3,336,000
CONSTRUCTION															
Site Work			15%		$ 1,327,050			15%		$ 1,267,800			15%		$ 830,400
Yard Piping			20%		$ 1,769,400			20%		$ 1,690,400			20%		$ 1,107,200
Aeration Tanks	1	$ 1,000,000	$ 1,000,000	10%	$ 1,100,000	1	$ 1,500,000	$ 1,500,000	10%	$ 1,650,000	1	$ 1,000,000	$ 1,000,000	10%	$ 1,100,000
Secondary Clarifiers	1	$ 1,100,000	$ 1,100,000	10%	$ 1,210,000	1	$ 1,500,000	$ 1,500,000	10%	$ 1,650,000	1	$ 1,000,000	$ 1,000,000	10%	$ 1,100,000
Blower/ RAS/ WAS Building	1	$ 1,100,000	$ 1,100,000	10%	$ 1,210,000										
Building Mechanical	1	$ 825,000	$ 825,000	10%	$ 907,500										
Electrical and Instrumentation	1	$ 825,000	$ 825,000	10%	$ 907,500				15%	$ 1,267,800				15%	$ 830,400
Demolition						1	$ 500,000	$ 500,000	10%	$ 550,000	1	$ 100,000	$ 100,000	10%	$ 110,000
Total Construction Cost					$ 8,432,000					$ 8,076,000					$ 5,078,000
General Requirements including Mobilization and Demobilization, Insurance and Bonding, etc. (20%)					$ 2,388,800					$ 2,645,600					$ 1,682,800
Contractors Profit (8%)					$ 955,520					$ 1,058,240					$ 673,120
Contingency (40%)					$ 4,777,600					$ 5,291,200					$ 3,365,600
Engineering Fees (15%)					$ 1,791,600					$ 1,984,200					$ 1,262,100
Total Capital Cost					$ 21,858,000					$ 24,208,000					$ 15,398,000

OPERATIONAL COST	Phase 1				Phase 2				Phase 3			
	Rating	Units	Unit Cost	Yearly Cost	Rating	Units	Unit Cost	Total Cost	Rating	Units	Unit Cost	Total Cost
SYSTEM												
Power Consumption												
Clarifier Mechanisms	13	kWh/d	$ 0.15	$ 700.98	20	kWh/d	$ 0.15	$ 1,113.33	13	kWh/d	$ 0.15	$ 700.98
Blower Operation	296	kWh/d	$ 0.15	$ 16,200.50	470	kWh/d	$ 0.15	$ 25,730.21	296	kWh/d	$ 0.15	$ 16,200.50
WAS Pumps	3	kWh/d	$ 0.15	$ 155.77	5	kWh/d	$ 0.15	$ 247.41	3	kWh/d	$ 0.15	$ 155.77
RAS Pumps	30	kWh/d	$ 0.15	$ 1,655.10	48	kWh/d	$ 0.15	$ 2,628.69	30	kWh/d	$ 0.15	$ 1,655.10
Raw Sludge Pumps	4	kWh/d	$ 0.15	$ 233.66	7	kWh/d	$ 0.15	$ 371.11	4	kWh/d	$ 0.15	$ 233.66
Total Power Cost				$ 18,946				$ 30,091				$ 18,946
Chemical Consumption												
Alum Sulfate (48%)	260	L/d	$ 1.20	$ 113,880	260	L/d	$ 1.20	$ 113,880	400	L/d	$ 1.20	$ 175,200
Total Chemical Cost				$ 113,880				$ 113,880				$ 175,200
Total Operational Costs				$ 133,000				$ 144,000				$ 195,000

NPV CALCULATION	Total	2023	2024	2025	2026	2027	2028
CAPITAL COSTS							
Equipment	$ 15,855,120				$ 1,928,088	$ 2,570,784	$ 1,928,088
Construction Costs	$ 30,209,640				$ 4,629,168	$ 6,172,224	$ 4,629,168
Major Equipment Replacement Cost	$ -						
Total Capital Cost in 2023 Dollars	$ 46,064,760				$ 6,557,256	$ 8,743,008	$ 6,557,256
Total Capital Cost NPV	$ 37,041,208	$ -	$ -	$ -	$ 6,189,647	$ 8,095,666	$ 5,956,097
OPERATIONAL COSTS							
Power Consumption Cost	$ 704,346						
Chemical Consumption Cost	$ 2,960,880						
Total Operational Cost in 2023 Dollars	$ 3,665,226						
Total Operational Cost NPV	$ 2,584,315			$ -	$ -	$ -	$ -
Current Year Sub-total	$ 49,729,986				$ 6,557,256	$ 8,743,008	$ 6,557,256
Inflation Adjusted	$ 73,591,581				$ 7,165,291	$ 9,840,333	$ 7,601,657
NPV	**$ 39,626,000**			$ -	$ 6,189,647	$ 8,095,666	$ 5,956,097

NPV CALCULATION	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
CAPITAL COSTS												
Equipment												
Construction Costs												
Major Equipment Replacement Cost												
Total Capital Cost in 2023 Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS												
Power Consumption Cost	$ 18,946	$ 18,946	$ 18,946	$ 18,946	$ 18,946	$ 18,946	$ 18,946	$ 30,091	$ 30,091	$ 30,091	$ 30,091	$ 30,091
Chemical Consumption Cost	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$113,880	$113,880	$113,880
Total Operational Cost in 2023 Dollars	$ 132,826	$ 132,826	$ 132,826	$ 132,826	$ 132,826	$ 132,826	$ 132,826	$ 143,971	$ 143,971	$143,971	$143,971	$143,971
Total Operational Cost NPV	$ 118,351	$ 116,096	$ 113,885	$ 111,716	$ 109,588	$ 107,500	$ 105,453	$ 112,124	$ 109,988	$107,893	$105,838	$103,822
Current Year Sub-total	$ 132,826	$ 132,826	$ 132,826	$ 132,826	$ 132,826	$ 132,826	$ 132,826	$ 143,971	$ 143,971	$143,971	$143,971	$143,971
Inflation Adjusted	$ 158,601	$ 163,359	$ 168,260	$ 173,308	$ 178,507	$ 183,862	$ 189,378	$ 211,426	$ 217,769	$224,302	$231,031	$237,962
NPV	$ 118,351	$ 116,096	$ 113,885	$ 111,716	$ 109,588	$ 107,500	$ 105,453	$ 112,124	$ 109,988	$107,893	$105,838	$103,822

NPV CALCULATION	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
CAPITAL COSTS														
Equipment	$ 2,828,448	$ 3,771,264	$ 2,828,448											
Construction Costs	$ 4,433,724	$ 5,911,632	$ 4,433,724											
Major Equipment Replacement Cost														
Total Capital Cost in 2023 Dollars	$ 7,262,172	$ 9,682,896	$ 7,262,172	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ 5,137,232	$ 6,719,173	$ 4,943,392	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS														
Power Consumption Cost	$ 30,091	$ 30,091	$ 30,091	$ 30,091	$ 30,091	$ 30,091	$ 30,091	$ 30,091	$ 30,091	$ 30,091	$ 30,091	$ 30,091	$ 30,091	$ 30,091
Chemical Consumption Cost	$ 113,880	$ 113,880	$ 113,880	$113,880	$113,880	$113,880	$113,880	$113,880	$113,880	$113,880	$113,880	$113,880	$113,880	$113,880
Total Operational Cost in 2023 Dollars	$ 143,971	$ 143,971	$ 143,971	$143,971	$143,971	$143,971	$143,971	$143,971	$143,971	$143,971	$143,971	$143,971	$143,971	$143,971
Total Operational Cost NPV	$ 101,844	$ 99,904	$ 98,002	$ 96,135	$ 94,304	$ 92,507	$ 90,745	$ 89,017	$ 87,321	$ 85,658	$ 84,026	$ 82,426	$ 80,856	$ 79,316
Current Year Sub-total	$ 7,406,143	$ 9,826,867	$ 7,406,143	$143,971	$143,971	$143,971	$143,971	$143,971	$143,971	$143,971	$143,971	$143,971	$143,971	$143,971
Inflation Adjusted	$ 12,608,462	$ 17,231,470	$ 13,376,318	$267,828	$275,863	$284,139	$292,663	$301,443	$310,486	$319,801	$329,395	$339,276	$349,455	$359,938
NPV	$ 5,239,076	$ 6,819,078	$ 5,041,393	$ 96,135	$ 94,304	$ 92,507	$ 90,745	$ 89,017	$ 87,321	$ 85,658	$ 84,026	$ 82,426	$ 80,856	$ 79,316

MEAFORD CLASS EA
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 121027
SEQUENCING BATCH REACTOR PROCESS
AquaSBR

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	3%
General Requirements	20%
Contractors Profit	8%
Contingency	40%
Engineering Fees	15%
Year to Begin Construction	2026
Estimated Phase 1 Construction Complete	2028
Estimated Phase 2 Construction Complete	2043
Estimated Phase 3 Construction Complete	2055

CAPITAL COST	Phase 1					Phase 2					Phase 3				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT															
Sequencing Batch Reactor															
Packaged SBR System, including:															
Influent Valves															
Mixers															
Mixer Mooring															
Decanters															
Transfer Pumps/Valves	1	$ 576,000	$ 576,000	60%	$ 921,600	1	$ 720,000	$ 720,000	60%	$ 1,152,000	1	$ 576,000	$ 576,000	60%	$ 922,000
Fixed Fine Bubble Diffusers															
Positive Displacement Blowers															
Air Valves															
Level Sensor Assemblies															
Instrumentation															
Controls															
Chemical Dosing															
Chemical Storage Tanks	1	$ 15,000	$ 15,000	60%	$ 24,000										
Day Tanks	1	$ 2,000	$ 2,000	60%	$ 3,200										
Chemical Dosing Skid including Dosing Pumps	1	$ 25,000	$ 25,000	60%	$ 40,000										
Instrumentation and Control including SCADA Integration	1	$ 150,000	$ 150,000	60%	$ 240,000										
Tank Interconnect Piping	1	$ 8,000	$ 8,000	60%	$ 12,800										
Pipe Installation and Heat Tracing	1	$ 30,000	$ 30,000	60%	$ 48,000										
Total Equipment Cost					$ 1,290,000					$ 1,152,000					$ 922,000
CONSTRUCTION															
Site Work			15%		$ 1,026,750			15%		$ 387,300			15%		$ 352,800
Yard Piping			20%		$ 1,369,000			20%		$ 516,400			20%		$ 470,400
SBR Basins	1	$ 1,900,000	$ 1,900,000	10%	$ 2,090,000	1	$ 1,300,000	$ 1,300,000	10%	$ 1,430,000	1	$ 1,300,000	$ 1,300,000	10%	$ 1,430,000
Post-EQ Basin	1	$ 400,000	$ 400,000	10%	$ 440,000										
Blower/ RAS/ WAS Building	1	$ 1,100,000	$ 1,100,000	10%	$ 1,210,000										
Building Mechanical	1	$ 825,000	$ 825,000	10%	$ 907,500										
Electrical and Instrumentation	1	$ 825,000	$ 825,000	10%	$ 907,500				15%	$ 387,300				15%	$ 352,800
Demolition						1	$ 500,000	$ 500,000	10%	$ 550,000	1	$ 100,000	$ 100,000	10%	$ 110,000
Total Construction Cost					$ 7,951,000					$ 3,271,000					$ 2,716,000
General Requirements including Mobilization and Demobilization, Insurance and Bonding, etc. (20%)					$ 1,848,200					$ 884,600					$ 727,600
Contractors Profit (8%)					$ 739,280					$ 353,840					$ 291,040
Contingency (40%)					$ 3,696,400					$ 1,769,200					$ 1,455,200
Engineering Fees (15%)					$ 1,386,150					$ 663,450					$ 545,700
Total Capital Cost					$ 16,912,000					$ 8,095,000					$ 6,658,000

OPERATIONAL COST	Phase 1				Phase 2				Phase 3			
	Rating	Units	Unit Cost	Yearly Cost	Rating	Units	Unit Cost	Total Cost	Rating	Units	Unit Cost	Total Cost
SYSTEM												
Sequencing Batch Reactor												
Power	309	kWh/d	$ 0.15	$ 16,918	800	kWh/d	$ 0.15	$ 43,800	1,091	kWh/d	$ 0.15	$ 59,732
Ops Labor	832	hrs/year	$ 50.00	$ 41,600	832	hrs/year	$ 50.00	$ 41,600	936	hrs/year	$ 50.00	$ 46,800
Maintenance and Replacement (per year)		$/year	$ 1,182.00	$ 1,182		$/year	$ 1,182.00	$ 1,182		$/year	$ 2,736.00	$ 2,736
Total Power Cost				$ 59,700				$ 86,582				$ 109,268
Chemical Consumption												
Alum Sulfate (48%)	260	L/d	$ 1.20	$ 113,880	260	L/d	$ 1.20	$ 113,880	400	L/d	$ 1.20	$ 175,200
Total Chemical Cost				$ 113,880				$ 113,880				$ 175,200
Total Operational Costs				$ 174,000				$ 201,000				$ 285,000

NPV CALCULATION	Total	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
CAPITAL COSTS												
Equipment	$ 4,468,860				$ 708,210	$ 944,280	$ 708,210					
Construction Costs	$ 20,536,260				$ 4,365,099	$ 5,820,132	$ 4,365,099					
Total Capital Cost in 2023 Dollars	$ 25,005,120				$ 5,073,309	$ 6,764,412	$ 5,073,309	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ 21,277,945	$ -	$ -	$ -	$ 4,788,893	$ 6,263,567	$ 4,608,196	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS												
Power Consumption Cost	$ 735,566							$ 16,918	$ 16,918	$ 16,918	$ 16,918	$ 16,918
Ops Labor	$ 1,081,600							$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600
Maintenance and Replacement (per year)	$ 310,732							$ 1,182	$ 1,182	$ 1,182	$ 1,182	$ 1,182
Chemical Consumption Cost	$ 2,960,880							$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880
Total Operational Cost in 2023 Dollars	$ 5,088,778							$ 173,580	$ 173,580	$ 173,580	$ 173,580	$ 173,580
Total Operational Cost NPV	$ 3,565,253	$ -	$ -	$ -	$ -	$ -	$ -	$ 154,663	$ 151,717	$ 148,827	$ 145,992	$ 143,212
Current Year Sub-total	$ 30,093,898				$ 5,073,309	$ 6,764,412	$ 5,073,309	$ 173,580	$ 173,580	$ 173,580	$ 173,580	$ 173,580
Inflation Adjusted	$ 42,372,105				$ 5,543,742	$ 7,613,405	$ 5,881,356	$ 207,263	$ 213,481	$ 219,886	$ 226,482	$ 233,277
NPV	**$ 24,844,000**	$ -	$ -	$ -	$ 4,788,893	$ 6,263,567	$ 4,608,196	$ 154,663	$ 151,717	$ 148,827	$ 145,992	$ 143,212

NPV CALCULATION	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
CAPITAL COSTS											
Equipment								$ 632,448	$ 843,264	$ 632,448	
Construction Costs								$ 1,795,779	$ 2,394,372	$ 1,795,779	
Total Capital Cost in 2023 Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,428,227	$ 3,237,636	$ 2,428,227	$ -
Total Capital Cost NPV	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,717,718	$ 2,246,666	$ 1,652,905	$ -
OPERATIONAL COSTS											
Power Consumption Cost	$ 16,918	$ 16,918	$ 16,918	$ 16,918	$ 16,918	$ 16,918	$ 16,918	$ 16,918	$ 16,918	$ 16,918	$ 43,800
Ops Labor	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600
Maintenance and Replacement (per year)	$ 1,182	$ 1,182	$ 1,182	$ 1,182	$ 1,182	$ 1,182	$ 1,182	$ 1,182	$ 1,182	$ 281,182	$ 1,182
Chemical Consumption Cost	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880
Total Operational Cost in 2023 Dollars	$ 173,580	$ 173,580	$ 173,580	$ 173,580	$ 173,580	$ 173,580	$ 173,580	$ 173,580	$ 173,580	$ 453,580	$ 200,462
Total Operational Cost NPV	$ 140,484	$ 137,808	$ 135,183	$ 132,608	$ 130,082	$ 127,604	$ 125,174	$ 122,790	$ 120,451	$ 308,754	$ 133,856
Current Year Sub-total	$ 173,580	$ 173,580	$ 173,580	$ 173,580	$ 173,580	$ 173,580	$ 173,580	$ 2,601,807	$ 3,411,216	$ 2,881,807	$ 200,462
Inflation Adjusted	$ 240,275	$ 247,483	$ 254,908	$ 262,555	$ 270,432	$ 278,545	$ 286,901	$ 4,429,402	$ 5,981,587	$ 5,204,864	$ 372,918
NPV	$ 140,484	$ 137,808	$ 135,183	$ 132,608	$ 130,082	$ 127,604	$ 125,174	$ 1,840,508	$ 2,367,117	$ 1,961,658	$ 133,856

NPV CALCULATION	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
CAPITAL COSTS										
Equipment										
Construction Costs										
Total Capital Cost in 2023 Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS										
Power Consumption Cost	$ 43,800	$ 43,800	$ 43,800	$ 43,800	$ 43,800	$ 43,800	$ 43,800	$ 43,800	$ 43,800	$ 43,800
Ops Labor	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600
Maintenance and Replacement (per year)	$ 1,182	$ 1,182	$ 1,182	$ 1,182	$ 1,182	$ 1,182	$ 1,182	$ 1,182	$ 1,182	$ 1,182
Chemical Consumption Cost	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880
Total Operational Cost in 2023 Dollars	$ 200,462	$ 200,462	$ 200,462	$ 200,462	$ 200,462	$ 200,462	$ 200,462	$ 200,462	$ 200,462	$ 200,462
Total Operational Cost NPV	$ 131,307	$ 128,805	$ 126,352	$ 123,945	$ 121,584	$ 119,269	$ 116,997	$ 114,768	$ 112,582	$ 110,438
Current Year Sub-total	$ 200,462	$ 200,462	$ 200,462	$ 200,462	$ 200,462	$ 200,462	$ 200,462	$ 200,462	$ 200,462	$ 200,462
Inflation Adjusted	$ 384,106	$ 395,629	$ 407,498	$ 419,723	$ 432,315	$ 445,284	$ 458,643	$ 472,402	$ 486,574	$ 501,171
NPV	$ 131,307	$ 128,805	$ 126,352	$ 123,945	$ 121,584	$ 119,269	$ 116,997	$ 114,768	$ 112,582	$ 110,438

MEAFORD CLASS EA
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 121027
MEMBRANE-AERATED BIOFILM REACTOR

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	3%
General Requirements	20%
Contractors Profit	8%
Contingency	40%
Engineering Fees	15%
Year to Begin Construction	2026
Estimated Phase 1 Construction Complete	2028
Estimated Phase 2 Construction Complete	2043
Estimated Phase 3 Construction Complete	2055

CAPITAL COST	Phase 1					Phase 2					Phase 3				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT															
OxyFILM															
MABR Modules (x50)															
installation															
Process blowers	50	$ 180,000	$ 9,000,000	60%	$ 14,400,000										
Piping															
Instrumentation															
start-up, commissioning and training															
Extended Air Tank															
Blowers						1	$ 1,300,000	$ 1,300,000	60%	$ 2,080,000	1	$ 500,000	$ 500,000	60%	$ 800,000
Aeration piping, valves, and diffusers						1	$ 2,100,000	$ 2,100,000	60%	$ 3,360,000	1	$ 800,000	$ 800,000	60%	$ 1,280,000
Secondary Clarifiers															
Sludge and Scum Removal Mechanism (including drives) + Walkway						1	$ 1,036,000	$ 1,036,000	60%	$ 1,657,600	1	$ 400,000	$ 400,000	60%	$ 640,000
Weirs and Baffles						1	$ 130,000	$ 130,000	60%	$ 208,000	1	$ 50,000	$ 50,000	60%	$ 80,000
Scum pumps						1	$ 52,000	$ 52,000	60%	$ 83,200	1	$ 20,000	$ 20,000	60%	$ 32,000
RAS Pumps						1	$ 130,000	$ 130,000	60%	$ 208,000	1	$ 50,000	$ 50,000	60%	$ 80,000
WAS Pumps						1	$ 117,000	$ 117,000	60%	$ 187,200	1	$ 45,000	$ 45,000	60%	$ 72,000
Chemical Dosing															
Chemical Storage Tanks						2	$ 50,000	$ 100,000	60%	$ 160,000	0	$ 50,000	$ -	60%	$ -
Day Tanks						1	$ 10,000	$ 10,000	60%	$ 16,000	0	$ 10,000	$ -	60%	$ -
Chemical Dosing Skid including Dosing Pumps						2	$ 30,000	$ 60,000	60%	$ 96,000	1	$ 30,000	$ 30,000	60%	$ 48,000
Instrumentation and Control including SCADA Integration						2	$ 150,000	$ 300,000	60%	$ 480,000	1	$ 150,000	$ 150,000	60%	$ 240,000
Tank Interconnect Piping						2	$ 10,000	$ 20,000	60%	$ 32,000	1	$ 10,000	$ 10,000	60%	$ 16,000
Pipe Installation and Heat Tracing						2	$ 30,000	$ 60,000	60%	$ 96,000	1	$ 30,000	$ 30,000	60%	$ 48,000
Total Equipment Cost					$ 14,400,000					$ 8,664,000					$ 3,336,000
CONSTRUCTION															
Site Work								15%		$ 2,650,174			15%		$ 950,495
Yard Piping								20%		$ 3,533,565			20%		$ 1,267,327
Aeration Tanks						1	$ 2,588,235	$ 2,588,235	10%	$ 2,847,059	1	$ 941,176	$ 941,176	10%	$ 1,035,294
Secondary Clarifier						1	$ 2,847,059	$ 2,847,059	10%	$ 3,131,765	1	$ 1,035,294	$ 1,035,294	10%	$ 1,138,824
Blower/ RAS/ WAS Building						1	$ 1,100,000	$ 1,100,000	10%	$ 1,210,000					
Building Mechanical						1	$ 825,000	$ 825,000	10%	$ 907,500					
Electrical and Instrumentation						1	$ 825,000	$ 825,000	10%	$ 907,500				15%	$ 826,518
Demolition						1	$ 500,000	$ 500,000	10%	$ 550,000	1	$ 100,000	$ 100,000	10%	$ 110,000
Total Construction Cost					$ -					$ 15,738,000					$ 5,329,000
General Requirements including Mobilization and Demobilization, Insurance and Bonding, etc. (20%)					$ 2,880,000					$ 4,880,400					$ 1,733,000
Contractors Profit (8%)					$ 1,152,000					$ 1,952,160					$ 693,200
Contingency (40%)					$ 5,760,000					$ 9,760,800					$ 3,466,000
Engineering Fees (15%)					$ 2,160,000					$ 3,660,300					$ 1,299,750
Total Capital Cost					$ 26,352,000					$ 44,656,000					##########

OPERATIONAL COST	Phase 1				Phase 2				Phase 3			
	Rating	Units	Unit Cost	Yearly Cost	Rating	Units	Unit Cost	Total Cost	Rating	Units	Unit Cost	Total Cost
SYSTEM												
Power Consumption - MABR												
Process Blower	136	kWh/d	$ 0.15	$ 7,459.69								
Scour Blower	20	kWh/d	$ 0.15	$ 1,095.00								
Dutty Mixer	195	kWh/d	$ 0.15	$ 10,676.25								
Power Consumption - Extended Aeartion												
Clarifier Mechanisms					33	kWh/d	$ 0.15	$ 1,814.31	12	kWh/d	$ 0.15	$ 659.75
Blower Operation					766	kWh/d	$ 0.15	$ 41,930.71	278	kWh/d	$ 0.15	$ 15,247.53
WAS Pumps					7	kWh/d	$ 0.15	$ 403.18	3	kWh/d	$ 0.15	$ 146.61
RAS Pumps					78	kWh/d	$ 0.15	$ 4,283.79	28	kWh/d	$ 0.15	$ 1,557.74
Raw Sludge Pumps					11	kWh/d	$ 0.15	$ 604.77	4	kWh/d	$ 0.15	$ 219.92
Total Power Cost				$ 19,231				$ 49,037				$ 17,832
Chemical Consumption - MABR												
		kg/d	$ 0.60	$ -								
Chemical Consumption - Extended Aeration												
Alum Sulfate (48%)					260	L/d	$ 1.20	$ 113,880	400	L/d	$ 1.20	$ 175,200
Total Chemical Cost				$ -				$ 113,880				$ 175,200
Total Operational Cost				$ 20,000				$ 163,000				$ 194,000

NPV CALCULATION	Total	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
CAPITAL COSTS												
Equipment	$ 42,207,120		$ 26,352,000									
Construction Costs	$ 28,800,540		$ -									
Major Equipment Replacement Cost	$ -											
Total Capital Cost in 2023 Dollars	$ 71,007,660		$ 26,352,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ 56,841,035	$ -	$ 25,850,057	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS												
Power Consumption Cost	$ 904,792			$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231
Chemical Consumption Cost	$ 1,252,680			$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Operational Cost in 2023 Dollars	$ 2,042,087			$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231	
Total Operational Cost NPV	$ 1,295,533			$ 18,505	$ 18,153	$ 17,807	$ 17,468	$ 17,135	$ 16,809	$ 16,489	$ 16,175	$ -
Current Year Sub-total	$ 73,049,747		$ 26,352,000	$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231	
Inflation Adjusted	$ 109,694,018		$ 27,142,560	$ 20,402	$ 21,014	$ 21,645	$ 22,294	$ 22,963	$ 23,652	$ 24,361	$ 25,092	$ -
NPV	**$ 58,137,000**		$ 25,850,057	$ 18,505	$ 18,153	$ 17,807	$ 17,468	$ 17,135	$ 16,809	$ 16,489	$ 16,175	$ -

NPV CALCULATION	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
CAPITAL COSTS										
Equipment								$ 4,756,536	$ 6,342,048	$ 4,756,536
Construction Costs								$ 8,640,162	$ 11,520,216	$ 8,640,162
Major Equipment Replacement Cost										
Total Capital Cost in 2023 Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,396,698	$ 17,862,264	$ 13,396,698
Total Capital Cost NPV	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 9,476,772	$ 12,395,016	$ 9,119,190
OPERATIONAL COSTS										
Power Consumption Cost	$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231
Chemical Consumption Cost	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Operational Cost in 2023 Dollars						$ 19,231	$ 19,231	$ 19,231	$ 19,231	$ 19,231
Total Operational Cost NPV	$ -	$ -	$ -	$ -	$ -	$ 14,137	$ 13,868	$ 13,604	$ 13,345	$ 13,091
Current Year Sub-total						$ 19,231	$ 19,231	$ 13,415,929	$ 17,881,495	$ 13,415,929
Inflation Adjusted	$ -	$ -	$ -	$ -	$ -	$ 30,860	$ 31,786	$ 22,839,721	$ 31,355,310	$ 24,230,660
NPV	$ -	$ -	$ -	$ -	$ -	$ 14,137	$ 13,868	$ 9,490,376	$ 12,408,361	$ 9,132,281

NPV CALCULATION	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
CAPITAL COSTS											
Equipment											
Construction Costs											
Major Equipment Replacement Cost											
Total Capital Cost in 2023 Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS											
Power Consumption Cost	$ 49,037	$ 49,037	$ 49,037	$ 49,037	$ 49,037	$ 49,037	$ 49,037	$ 49,037	$ 49,037	$ 49,037	$ 49,037
Chemical Consumption Cost	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880
Total Operational Cost in 2023 Dollars	$ 162,917	$ 162,917	$ 162,917	$ 162,917	$ 162,917	$ 162,917	$ 162,917	$ 162,917	$ 162,917	$ 162,917	$ 162,917
Total Operational Cost NPV	$ 108,786	$ 106,714	$ 104,681	$ 102,687	$ 100,731	$ 98,812	$ 96,930	$ 95,084	$ 93,273	$ 91,496	$ 89,754
Current Year Sub-total	$ 162,917	$ 162,917	$ 162,917	$ 162,917	$ 162,917	$ 162,917	$ 162,917	$ 162,917	$ 162,917	$ 162,917	$ 162,917
Inflation Adjusted	$ 303,073	$ 312,165	$ 321,530	$ 331,176	$ 341,112	$ 351,345	$ 361,885	$ 372,742	$ 383,924	$ 395,442	$ 407,305
NPV	$ 108,786	$ 106,714	$ 104,681	$ 102,687	$ 100,731	$ 98,812	$ 96,930	$ 95,084	$ 93,273	$ 91,496	$ 89,754

MEAFORD CLASS EA
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 121027
AEROBIC GRANULAR SLUDGE
AquaNereda

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	3%
General Requirements	20%
Contractors Profit	8%
Contingency	40%
Engineering Fees	15%
Year to Begin Construction	2026
Estimated Phase 1 Construction Complete	2028
Estimated Phase 2 Construction Complete	2043
Estimated Phase 3 Construction Complete	2055

CAPITAL COST	Phase 1					Phase 2					Phase 3				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT															
Influent Buffer															
Level Sensor Assemblies															
AquaNereda															
Influent Valves															
Influent Distribution System															
Influent Weir Assembly															
Sludge Removal System															
Fixed Fine Bubble Diffusers															
Positive Displacement Blowers															
Air Valves															
Level Sensor Assemblies	1	$ 1,588,800	$ 1,588,800	60%	$ 2,542,080	1	$ 1,986,000	$ 1,986,000	60%	$ 3,177,600	1	$ 1,588,800	$ 1,588,800	60%	$ 2,542,080
Instrumentation															
Post-Equalization															
Level Sensor Assemblies															
Sludge Buffer															
Transfer Pumps/Valves															
Sludge Removal System															
Level Sensor Assemblies															
PLC Controls															
Controls wo/Starters															
Chemical Dosing															
Chemical Storage Tanks	1	$ 15,000	$ 15,000	60%	$ 24,000										
Day Tanks	1	$ 2,000	$ 2,000	60%	$ 3,200										
Chemical Dosing Skid including Dosing Pumps	1	$ 25,000	$ 25,000	60%	$ 40,000										
Instrumentation and Control including SCADA Integration	1	$ 150,000	$ 150,000	60%	$ 240,000										
Tank Interconnect Piping	1	$ 8,000	$ 8,000	60%	$ 12,800										
Pipe Installation and Heat Tracing	1	$ 30,000	$ 30,000	60%	$ 48,000										
Total Equipment Cost					$ 5,453,000					$ 3,178,000					$ 2,543,000
CONSTRUCTION															
Site Work			15%		$ 1,415,250			15%		$ 719,250			15%		$ 496,950
Yard Piping			10%		$ 943,500			10%		$ 479,500			10%		$ 331,300
AquaNereda Basin	1	$ 700,000	$ 700,000	10%	$ 770,000	2	$ 700,000	$ 1,400,000	10%	$ 1,540,000	1	$ 700,000	$ 700,000	10%	$ 770,000
Water Level Correction Tank	1	$ 100,000	$ 100,000	10%	$ 110,000										
Sludge Buffer Tank	1	$ 70,000	$ 70,000	10%	$ 77,000	1	$ 70,000	$ 70,000	10%	$ 77,000					
Blower/ RAS/ WAS Building	1	$ 1,100,000	$ 1,100,000	10%	$ 1,210,000										
Building Mechanical	1	$ 825,000	$ 825,000	10%	$ 907,500										
Electrical and Instrumentation	1	$ 825,000	$ 825,000	10%	$ 907,500				15%	$ 719,250				15%	$ 496,950
Demolition						1	$ 500,000	$ 500,000	10%	$ 550,000	1	$ 100,000	$ 100,000	10%	$ 110,000
Total Construction Cost					$ 6,341,000					$ 4,085,000					$ 2,206,000
General Requirements including Mobilization and Demobilization, Insurance and Bonding, etc. (20%)					$ 2,358,800					$ 1,452,600					$ 949,800
Contractors Profit (8%)					$ 943,520					$ 581,040					$ 379,920
Contingency (40%)					$ 4,717,600					$ 2,905,200					$ 1,899,600
Engineering Fees (15%)					$ 1,769,100					$ 1,089,450					$ 712,350
Total Capital Cost					$ 21,584,000					$ 13,292,000					$ 8,691,000

OPERATIONAL COST	Phase 1				Phase 2				Phase 3			
	Rating	Units	Unit Cost	Yearly Cost	Rating	Units	Unit Cost	Total Cost	Rating	Units	Unit Cost	Total Cost
SYSTEM												
Aerobic Granular Sludge												
Power	30	kWh/d	$ 0.15	$ 1,642.50	191	kWh/d	$ 0.15	$ 10,457.25	358	kWh/d	$ 0.15	$ 19,600.50
Ops Labor	832	hrs/year	$ 50.00	$ 41,600	832	hrs/year	$ 50.00	$ 41,600	936	hrs/year	$ 50.00	$ 46,800
Maintenance and Replacement (per year)		$/year	$ 2,468	$ 2,468		$/year	$ 2,468	$ 2,468		$/year	$ 3,239	$ 3,239
Total Power Cost				$ 45,711				$ 54,525				$ 69,640
Chemical Consumption												
Alum Sulfate (48%)	260	L/d	$ 1.20	$ 113,880	260	L/d	$ 1.20	$ 113,880	400	L/d	$ 1.20	$ 175,200
Total Chemical Cost				$ 113,880				$ 113,880				$ 175,200
Total Operational Cost				$ 160,000				$ 169,000				$ 245,000

NPV CALCULATION	Total	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
CAPITAL COSTS												
Equipment	$ 15,794,730				$ 2,993,697	$ 3,991,596	$ 2,993,697					
Construction Costs	$ 19,079,580				$ 3,481,209	$ 4,641,612	$ 3,481,209					
Total Capital Cost in 2023 Dollars	$ 34,874,310				$ 6,474,906	$ 8,633,208	$ 6,474,906	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ 29,211,347	$ -	$ -	$ -	$ 6,111,914	$ 7,993,996	$ 5,881,297	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS												
Power Consumption Cost	$ 139,667							$ 1,643	$ 1,643	$ 1,643	$ 1,643	$ 1,643
Ops Labor	$ 1,081,600							$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600
Maintenance and Replacement (per year)	$ 344,168							$ 2,468	$ 2,468	$ 2,468	$ 2,468	$ 2,468
Chemical Consumption Cost	$ 3,635,400							$ 113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880
Total Operational Cost in 2023 Dollars	$ 5,200,835				$ -	$ -	$ -	$ 159,591	$ 159,591	$ 159,591	$ 159,591	$ 159,591
Total Operational Cost NPV	$ 3,596,865	$ -	$ -	$ -	$ -	$ -	$ -	$ 142,198	$ 139,490	$ 136,833	$ 134,227	$ 131,670
Current Year Sub-total	$ 40,075,145			$ -	$ 6,474,906	$ 8,633,208	$ 6,474,906	$ 159,591	$ 159,591	$ 159,591	$ 159,591	$ 159,591
Inflation Adjusted	$ 57,134,119			$ -	$ 7,075,305	$ 9,716,752	$ 7,506,191	$ 190,559	$ 196,276	$ 202,164	$ 208,229	$ 214,476
NPV	**$ 32,809,000**	$ -	$ -	$ -	$ 6,111,914	$ 7,993,996	$ 5,881,297	$ 142,198	$ 139,490	$ 136,833	$ 134,227	$ 131,670

NPV CALCULATION	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044
CAPITAL COSTS											
Equipment								$1,744,722	$2,326,296	$1,744,722	
Construction Costs								$2,242,665	$2,990,220	$2,242,665	
Total Capital Cost in 2023 Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$3,987,387	$5,316,516	$3,987,387	$ -
Total Capital Cost NPV	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$2,820,662	$3,689,247	$2,714,232	$ -
OPERATIONAL COSTS											
Power Consumption Cost	$ 1,643	$ 1,643	$ 1,643	$ 1,643	$ 1,643	$ 1,643	$ 1,643	$ 1,643	$ 1,643	$ 1,643	$ 10,457
Ops Labor	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600
Maintenance and Replacement (per year)	$ 2,468	$ 2,468	$ 2,468	$ 2,468	$ 2,468	$ 2,468	$ 2,468	$ 2,468	$ 2,468	$ 282,468	$ 2,468
Chemical Consumption Cost	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$113,880	$113,880	$ 113,880	$ 113,880	$ 113,880	$ 113,880	$175,200
Total Operational Cost in 2023 Dollars	$ 159,591	$ 159,591	$ 159,591	$ 159,591	$159,591	$159,591	$ 159,591	$ 159,591	$ 159,591	$ 439,591	$229,725
Total Operational Cost NPV	$ 129,162	$ 126,702	$ 124,288	$ 121,921	$119,599	$117,320	$ 115,086	$ 112,894	$ 110,743	$ 299,231	$153,396
Current Year Sub-total	$ 159,591	$ 159,591	$ 159,591	$ 159,591	$159,591	$159,591	$ 159,591	$4,146,978	$5,476,107	$4,426,978	$229,725
Inflation Adjusted	$ 220,911	$ 227,538	$ 234,364	$ 241,395	$248,637	$256,096	$ 263,779	$7,059,952	$9,602,386	$7,995,614	$427,357
NPV	$ 129,162	$ 126,702	$ 124,288	$ 121,921	$119,599	$117,320	$ 115,086	$2,933,556	$3,799,990	$3,013,463	$153,396

NPV CALCULATION	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
CAPITAL COSTS										
Equipment										
Construction Costs										
Total Capital Cost in 2023 Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS										
Power Consumption Cost	$ 10,457	$ 10,457	$ 10,457	$ 10,457	$ 10,457	$ 10,457	$ 10,457	$ 10,457	$ 10,457	$ 10,457
Ops Labor	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600	$ 41,600
Maintenance and Replacement (per year)	$ 2,468	$ 2,468	$ 2,468	$ 2,468	$ 2,468	$ 2,468	$ 2,468	$ 2,468	$ 2,468	$ 2,468
Chemical Consumption Cost	$175,200	$175,200	$ 175,200	$ 175,200	$ 175,200	$ 175,200	$ 175,200	$ 175,200	$ 175,200	$ 175,200
Total Operational Cost in 2023 Dollars	$229,725	$229,725	$ 229,725	$ 229,725	$ 229,725	$ 229,725	$ 229,725	$ 229,725	$ 229,725	$ 229,725
Total Operational Cost NPV	$150,475	$147,608	$ 144,797	$ 142,039	$ 139,333	$ 136,679	$ 134,076	$ 131,522	$ 129,017	$ 126,559
Current Year Sub-total	$229,725	$229,725	$ 229,725	$ 229,725	$ 229,725	$ 229,725	$ 229,725	$ 229,725	$ 229,725	$ 229,725
Inflation Adjusted	$440,177	$453,383	$ 466,984	$ 480,994	$ 495,423	$ 510,286	$ 525,595	$ 541,363	$ 557,603	$ 574,332
NPV	$150,475	$147,608	$ 144,797	$ 142,039	$ 139,333	$ 136,679	$ 134,076	$ 131,522	$ 129,017	$ 126,559

Appendix E

Cost Estimate of Tertiary Treatment Alternatives

MEAFORD CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 121027
CLOTH MEDIA FILTERS

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	3%
General Requirements	20%
Contractors Profit	8%
Contingency	40%
Engineering Fees	15%
Year to Begin Construction	2026
Estimated Phase 1 Construction Complete	2029
Estimated Phase 2 Construction Complete	2043
Estimated Phase 3 Construction Complete	2055

CAPITAL COST	Phase 3				
	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT					
Cloth Media Filter Package					
Tanks/ Basins					
Centertubes					
Cloth Sets					
Drive Systems	1	$ 1,438,000	$ 1,438,000	60%	$ 2,300,800
Backwash Systems/ Pumps					
Valves					
Instrumentation and control					
Total Equipment Cost					$ 2,301,000
CONSTRUCTION					
Site Work		15%			$ 543,150
Yard Piping		20%			$ 724,200
Tertiary Treatment Building & Filter Structure (17.3m*14.2m*5.6m)	1	$ 1,100,000	$ 1,100,000	20%	$ 1,320,000
Building Mechnical		15%			$ 345,150
Electrical and instrumentation		15%			$ 345,150
Total Construction Cost					$ 3,278,000
General Requirements including Mobilization and Demobilization, Insurance and Bonding, etc. (20%)					$ 1,115,800
Contractors Profit (8%)					$ 446,320
Contingency (40%)					$ 2,231,600
Engineering Fees (15%)					$ 836,850
Total Capital Cost					$ 10,210,000

OPERATIONAL COST	Phase 3			
	Rating/ Number	Units	Unit Cost	Yearly Cost
SYSTEM				
Power Consumption				
Backwash/ Solids Waste Pump	4400	kWh/y	$ 0.15	$ 660
Disk Drive Motor	720	kWh/y	$ 0.15	$ 108
Power Control Panel	4200	kWh/y	$ 0.15	$ 630
Total Power Cost				$ 1,398
Total Operational Cost				$ 1,398

Replacement COST	Phase 3			
	Units	Unit Cost	Cost	Yearly Cost
SYSTEM				
Main "V-Ring Seal" (1/10 years)	3	$ 1,398	$ 5,000.00	$ 500
Filter Media Cloths (1/7 years)	144	$ 464	$ 70,000.00	$ 10,000
Total Replacement Cost				$ 10,500
Total Cost				$ 12,000

MEAFORD CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 121027
Upflow SAND FILTERS

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	3%
General Requirements	20%
Contractors Profit	8%
Contingency	40%
Engineering Fees	15%
Year to Begin Construction	2026
Estimated Phase 1 Construction Complete	2029
Estimated Phase 2 Construction Complete	2043
Estimated Phase 3 Construction Complete	2055

CAPITAL COST	Phase 3				
	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT					
Upflow Sand Filter Package					
Filtration System Compressor Package EcoWash System Process valves and piping Instrumentation and control	1	$ 2,035,000	$ 2,035,000	60%	$ 3,256,000
Total Equipment Cost					$ 3,256,000
CONSTRUCTION					
Site Work		15%			$ 650,400
Yard Piping		20%			$ 867,200
Filter Structure (322m3 concrete/ 149m3 grout)	1	$ 900,000	$ 900,000	20%	$ 1,080,000
Electrical and Instrumentation		15%			$ 488,400
Total Construction Cost					$ 3,086,000
General Requirements including Mobilization and Demobilization, Insurance and Bonding, etc. (20%)					$ 1,268,400
Contractors Profit (8%)					$ 507,360
Contingency (40%)					$ 2,536,800
Engineering Fees (15%)					$ 951,300
Total Capital Cost					$ 11,606,000

OPERATIONAL COST	Phase 3			
	Rating/ Number	Units	Unit Cost	Yearly Cost
SYSTEM				
Power Consumption				
Compressor/ Airlift Pumps Operation	358	kWh/d	$ 0.15	$ 19,597
Total Power Cost				$ 19,597
Total Operational Cost				$ 19,597

Replacement COST	Phase 3			
	Units	Unit Cost	Cost	Yearly Cost
SYSTEM				
Compressor/ Airlift Pumps (1/15 years)	1	$ 50,000	$ 50,000	$ 3,333
Sand (1/20 years)	428	$ 25	$ 10,700.00	$ 535
Total Replacement Cost				$ 3,868
Total Cost				$ 24,000

MEAFORD CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 121027
High-rate Clarification

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	3%
General Requirements	20%
Contractors Profit	8%
Contingency	40%
Engineering Fees	15%
Year to Begin Construction	2026
Estimated Phase 1 Construction Complete	2029
Estimated Phase 2 Construction Complete	2043
Estimated Phase 3 Construction Complete	2055

CAPITAL COST	Phase 3				
	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT					
High-rate Clarification Package					
Turbo model					
Coagulant dosing skid with pumps					
Polymer dosing skid with pumps	1	$ 1,575,000	$ 1,575,000	60%	$ 2,520,000
Process valves and piping					
Instrumentation and control					
Chemical Storage Tank	1	$ 15,000	$ 15,000	60%	$ 24,000
Total Equipment Cost					$ 2,544,000
Site Work		15%			$ 421,200
Yard Piping		20%			$ 561,600
Concrete Base Structure	1	$ 220,000	$ 220,000	20%	$ 264,000
Electrical and Instrumentation		15%			$ 381,600
Total Construction Cost					$ 1,629,000
General Requirements including Mobilization and Demobilization, Insurance and Bonding, etc. (20%)					$ 208,650
Contractors Profit (8%)					$ 125,190
Contingency (40%)					$ 834,600
Engineering Fees (15%)					$ 333,840
Total Capital Cost					$ 5,676,000

OPERATIONAL COST	Phase 3			
	Rating/ Number	Units	Unit Cost	Yearly Cost
SYSTEM				
Power Consumption				
Coagulation Mixer	32	kWh/d	$ 0.15	$ 1,752
Flocculation Mixer	81	kWh/d	$ 0.15	$ 4,435
Scraper Drive	13	kWh/d	$ 0.15	$ 712
Recirculation Pumps	79	kWh/d	$ 0.15	$ 4,325
Total Power Cost				$ 11,224
Chemical Consumption				
Ferric Sulfate	210	kg/d	$ 0.5	$ 38,325
Polymer	6	kg/d	$ 8	$ 17,520
Microsand	12	kg/d	$ 0.6	$ 2,628
Total Chemical Cost				$ 4,325
Total Operational Cost				$ 15,549

Replacement COST	Phase 3			
	Units	Unit Cost	Cost	Yearly Cost
SYSTEM				
	1		$ -	$ -
	1		$ -	$ -
Total Replacement Cost				$ -
Total Cost				$ 16,000

Appendix F
Life Cycle Cost Evaluation of Disinfection Alternatives

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	3%
General Requirements	20%
Contractors Profit	8%
Contingency	40%
Engineering Fees	15%
Year to Begin Construction	2026
Estimated Pahse 1 Construction Complete	2029
Estimated Phase 2 Construction Complete	2043
Estimated Phase 3 Construction Complete	2055

CAPITAL COST	Phase 1					Phase 3				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT										
Trojan UV3000Plus bank										
banks	1									
modules per bank	7					2				
lamps per module	8					8				
UV panels	1	$ 300,000	$ 300,000	60%	$ 480,000		$ 475	$ 15,200	60%	$ 24,320
level controller (ALC)	1									
Davit Crane	1									
Standard Spareparts/ Safety Equipment	1									
Total Equipment Cost					$ 480,000					$ 25,000
CONSTRUCTION										
Site Work			20%		$ 108,500			15%		$ 3,750
Yard Piping			20%		$ 108,500			20%		$ 5,000
UV Contact Tank (5m*1.5m*2m)	1	$ 50,000	$ 50,000	25%	$ 62,500					
Electrical and Instrumentation					$ 200,000					$ 100,000
Total Construciton Cost					$ 280,000					$ 109,000
General Requirements including Mobilization and Demobilization, Insurance and Bonding, etc. (20%)					$ 152,000					$ 26,800
Contractors Profit (8%)					$ 60,800					$ 10,720
Contingency (40%)					$ 304,000					$ 53,600
Engineering Fees (15%)					$ 114,000					$ 20,100
Total Capital Cost	$				1,391,000	$				246,000

OPERATIONAL COST	Phase 1				Phase 3			
	Rating/ Number	Units	Unit Cost	Yearly Cost	Rating/ Number	Units	Unit Cost	Yearly Cost
SYSTEM								
Power Consumption								
Overall Power Consumption	336	kWh/d	$ 0.15	$ 18,396	432	kWh/d	$ 0.15	$ 23,652
Total Power Cost				$ 18,396				$ 23,652
Total Operational Cost				$ 18,396				$ 23,652

Replacement COST	Phase 1				Phase 3			
	Units	Unit Cost	Cost	Yearly Cost	Units	Unit Cost	Cost	Yearly Cost
SYSTEM								
Lamp (1/1.5 year)	56	$ 475	$ 26,600	$ 17,733	72	$ 475	$ 34,200	$ 22,800
Total Replacement Cost				$ 17,733				$ 22,800
Total Cost				$ 37,000				$ 47,000

AINLEY: 121027
UV Disinfection

NPV Calculation	Total	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
CAPITAL COSTS											
Equipment	$ 878,400				$ 263,520	$ 351,360	$ 263,520				
Construction Costs	$ 512,400				$ 153,720	$ 204,960	$ 153,720				
Major Equipment Replacement Cost	$ 452,200							$ -	$ 26,600	$ -	$ 26,600
Total Capital Cost in 2023 Dollars	$ 1,843,000	$ -	$ -	$ -	$ 417,240	$ 556,320	$ 417,240	$ -	$ 26,600	$ -	$ 26,600
Capital Costs Total NPV	$ 1,603,475	$ -	$ -	$ -	$ 393,849	$ 515,129	$ 378,988	$ -	$ 23,250	$ -	$ 22,372
OPERATIONAL COSTS											
Power Consumption Cost	$ 578,160							$ 18,396	$ 18,396	$ 18,396	$ 18,396
Total Operational Cost in 2023 Dollars	$ 578,160	$ -	$ -	$ -	$ -	$ -	$ -	$ 18,396	$ 18,396	$ 18,396	$ 18,396
Operational Costs Total NPV	$ 404,380	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,391	$ 16,079	$ 15,773	$ 15,472
Current Year Sub-total	$ 2,421,160	$ -	$ -	$ -	$ 417,240	$ 556,320	$ 417,240	$ 18,396	$ 44,996	$ 18,396	$ 44,996
Inflation Adjusted	$ 3,423,928	$ -	$ -	$ -	$ 455,929	$ 626,143	$ 483,696	$ 21,966	$ 55,339	$ 23,304	$ 58,710
NPV	**$ 2,008,000**	$ -	$ -	$ -	$ 393,849	$ 515,129	$ 378,988	$ 16,391	$ 39,329	$ 15,773	$ 37,845

NPV Calculation	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043
CAPITAL COSTS											
Equipment											
Construction Costs											
Major Equipment Replacement Cost	$ 26,600	$ -	$ 26,600	$ 26,600	$ -	$ 26,600	$ 26,600	$ -	$ 26,600	$ 26,600	$ -
Total Capital Cost in 2023 Dollars	$ 26,600	$ -	$ 26,600	$ 26,600	$ -	$ 26,600	$ 26,600	$ -	$ 26,600	$ 26,600	$ -
Capital Costs Total NPV	$ 21,946	$ -	$ 21,118	$ 20,716	$ -	$ 19,934	$ 19,555	$ -	$ 18,817	$ 18,458	$ -
OPERATIONAL COSTS											
Power Consumption Cost	$ 18,396	$ 18,396	$ 18,396	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652
Total Operational Cost in 2023 Dollars	$ 18,396	$ 18,396	$ 18,396	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652
Operational Costs Total NPV	$ 15,178	$ 14,888	$ 14,605	$ 18,420	$ 18,069	$ 17,725	$ 17,387	$ 17,056	$ 16,731	$ 16,413	$ 16,100
Current Year Sub-total	$ 44,996	$ 18,396	$ 44,996	$ 50,252	$ 23,652	$ 50,252	$ 50,252	$ 23,652	$ 50,252	$ 50,252	$ 23,652
Inflation Adjusted	$ 60,471	$ 25,464	$ 64,154	$ 73,797	$ 35,776	$ 78,291	$ 80,640	$ 39,093	$ 85,551	$ 88,117	$ 42,718
NPV	$ 37,124	$ 14,888	$ 35,723	$ 39,136	$ 18,069	$ 37,659	$ 36,942	$ 17,056	$ 35,548	$ 34,871	$ 16,100

NPV Calculation	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
CAPITAL COSTS											
Equipment											
Construction Costs											
Major Equipment Replacement Cost	$ 26,600	$ 26,600	$ -	$ 26,600	$ 26,600	$ -	$ 26,600	$ 26,600	$ -	$ 26,600	$ 26,600
Total Capital Cost in 2023 Dollars	$ 26,600	$ 26,600	$ -	$ 26,600	$ 26,600	$ -	$ 26,600	$ 26,600	$ -	$ 26,600	$ 26,600
Capital Costs Total NPV	$ 17,762	$ 17,424	$ -	$ 16,766	$ 16,447	$ -	$ 15,826	$ 15,525	$ -	$ 14,939	$ 14,654
OPERATIONAL COSTS											
Power Consumption Cost	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652
Total Operational Cost in 2023 Dollars	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652	$ 23,652
Operational Costs Total NPV	$ 15,793	$ 15,493	$ 15,197	$ 14,908	$ 14,624	$ 14,345	$ 14,072	$ 13,804	$ 13,541	$ 13,283	$ 13,030
Current Year Sub-total	$ 50,252	$ 50,252	$ 23,652	$ 50,252	$ 50,252	$ 23,652	$ 50,252	$ 50,252	$ 23,652	$ 50,252	$ 50,252
Inflation Adjusted	$ 93,484	$ 96,288	$ 46,679	$ 102,152	$105,217	$ 51,008	$111,624	$114,973	$ 55,737	$121,975	$125,634
NPV	$ 33,555	$ 32,916	$ 15,197	$ 31,674	$ 31,071	$ 14,345	$ 29,898	$ 29,329	$ 13,541	$ 28,222	$ 27,685

MEAFORD CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 121027
Chlorination/De-Chlorination

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	3%
General Requirements	20%
Contractors Profit	8%
Contingency	40%
Engineering Fees	15%
Year to Begin Construction	2026
Estimated Phase 1 Construction Complete	2029
Estimated Phase 2 Construction Complete	2043
Estimated Phase 3 Construction Complete	2055

CAPITAL COST	Phase 1				
	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT					
Chemical Dosing System					
Chemical Feed Skids Chemical Storage Tanks Instrumentation and Control	1	$ 93,000	$ 93,000	60%	$ 148,800
Total Equipment Cost					$ 149,000
CONSTRUCTION					
Site Work			20%		$ 104,800
Yard Piping			20%		$ 104,800
Chlorine Contact Tank (15m*10m*2m)	1	$ 300,000	$ 300,000	25%	$ 375,000
Electrical and Instrumentation					$ 40,000
Total Construciton Cost					$ 625,000
General Requirements including Mobilization and Demobilization, Insurance and Bonding, etc. (20%)					$ 154,800
Contractors Profit (8%)					$ 61,920
Contingency (40%)					$ 309,600
Engineering Fees (15%)					$ 116,100
Total Capital Cost					$ 1,417,000

OPERATIONAL COST	Phase 1				Phase 3			
	Rating/ Number	Units	Unit Cost	Yearly Cost	Rating/ Number	Units	Unit Cost	Yearly Cost
SYSTEM								
Power Consumption								
Chlorination Pump	6	kWh/d	$ 0.15	$ 329	9	kWh/d	$ 0.15	$ 493
De-Chlorination Pump	6	kWh/d	$ 0.15	$ 329	9	kWh/d	$ 0.15	$ 493
Total Power Cost				$ 657				$ 986
Chemical Consumption								
Sodium Hypochlorite	188	L/d	$ 1.50	$ 102,930	257	L/d	$ 1.50	$ 140,708
Sodium Bisulphite	16	L/d	$ 0.80	$ 4,672	21	L/d	$ 0.80	$ 6,132
Total Chemical Cost				$ 107,602				$ 146,840
Total Operational Cost				$ 108,259				$ 147,825
Replacement COST	Phase 1				Phase 3			
	Units	Unit Cost	Cost	Yearly Cost	Units	Unit Cost	Cost	Yearly Cost
SYSTEM								
Pumps (1/10 years)	1	$ 7,500	$ 7,500.00	$ 750	1	$ 7,500	$ 7,500.00	$ 750
Total Replacement Cost				$ 750				$ 750
Total Cost				$ 110,000				$ 149,000

NPV Calculation	Total	2023	2024	2025	2026	2027	2028	2029
CAPITAL COSTS								
Equipment	$ 570,670				$ 186,101	$ 198,468	$ 186,101	
Construction Costs	$ 1,143,750				$ 343,125	$ 457,500	$ 343,125	
Major Equipment Replacement Cost (Pumps)	$ 15,000							
Total Capital Cost in 2023 Dollars	$ 1,729,420	$ -	$ -	$ -	$ 529,226	$ 655,968	$ 529,226	$ -
Capital Costs Total NPV	$ 1,597,726	$ -	$ -	$ -	$ 499,557	$ 607,399	$ 480,707	$ -
OPERATIONAL COSTS								
Power Consumption Cost								$ 657
Chemical Consumption Cost	$ 2,797,652							$ 107,602
Total Operational Cost in 2023 Dollars	$ 2,814,734	$ -	$ -					$ 108,259
Operational Costs Total NPV	$ 1,992,655	$ -	$ -	$ -	$ -	$ -	$ -	$ 96,461
Current Year Sub-total	$ 4,544,154	$ -	$ -	$ -	$ 529,226	$ 655,968	$ 529,226	$ 108,259
Inflation Adjusted	$ 6,941,958	$ -	$ -	$ -	$ 578,300	$ 738,298	$ 613,518	$ 129,267
NPV	**$ 3,591,000**	$ -	$ -	$ -	$ 499,557	$ 607,399	$ 480,707	$ 96,461

NPV Calculation	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
CAPITAL COSTS												
Equipment												
Construction Costs												
Major Equipment Replacement Cost (Pumps)										$ 7,500		
Total Capital Cost in 2023 Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,500	$ -	$ -
Capital Costs Total NPV	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,514	$ -	$ -
OPERATIONAL COSTS												
Power Consumption Cost	$ 657	$ 657	$ 657	$ 657	$ 657	$ 657	$ 657	$ 657	$ 657	$ 657	$ 657	$ 657
Chemical Consumption Cost	$ 107,602	$ 107,602	$ 107,602	$ 107,602	$ 107,602	$ 107,602	$ 107,602	$ 107,602	$ 107,602	$ 107,602	$ 107,602	$ 107,602
Total Operational Cost in 2023 Dollars	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259
Operational Costs Total NPV	$ 94,624	$ 92,821	$ 91,053	$ 89,319	$ 87,618	$ 85,949	$ 84,312	$ 82,706	$ 81,130	$ 79,585	$ 78,069	$ 76,582
Current Year Sub-total	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 115,759	$ 108,259	$ 108,259
Inflation Adjusted	$ 133,145	$ 137,139	$ 141,253	$ 145,491	$ 149,856	$ 154,351	$ 158,982	$ 163,751	$ 168,664	$ 185,759	$ 178,936	$ 184,304
NPV	$ 94,624	$ 92,821	$ 91,053	$ 89,319	$ 87,618	$ 85,949	$ 84,312	$ 82,706	$ 81,130	$ 85,098	$ 78,069	$ 76,582

NPV Calculation	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
CAPITAL COSTS													
Equipment													
Construction Costs													
Major Equipment Replacement Cost (Pumps)								$ 7,500					
Total Capital Cost in 2023 Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 7,500	$ -	$ -	$ -	$ -	$ -
Capital Costs Total NPV	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,549	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS													
Power Consumption Cost	$ 657	$ 657	$ 657	$ 657	$ 657	$ 657	$ 657	$ 657	$ 657	$ 657	$ 657	$ 657	$ 657
Chemical Consumption Cost	$ 107,602	$ 107,602	$ 107,602	$ 107,602	$ 107,602	$ 107,602	$ 107,602	$ 107,602	$ 107,602	$ 107,602	$ 107,602	$ 107,602	$ 107,602
Total Operational Cost in 2023 Dollars	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259
Operational Costs Total NPV	$ 75,123	$ 73,692	$ 72,289	$ 70,912	$ 69,561	$ 68,236	$ 66,936	$ 65,661	$ 64,411	$ 63,184	$ 61,980	$ 60,800	$ 59,642
Current Year Sub-total	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 115,759	$ 108,259	$ 108,259	$ 108,259	$ 108,259	$ 108,259
Inflation Adjusted	$ 189,833	$ 195,528	$ 201,394	$ 207,435	$ 213,659	$ 220,068	$ 226,670	$ 249,645	$ 240,475	$ 247,689	$ 255,119	$ 262,773	$ 270,656
NPV	$ 75,123	$ 73,692	$ 72,289	$ 70,912	$ 69,561	$ 68,236	$ 66,936	$ 70,210	$ 64,411	$ 63,184	$ 61,980	$ 60,800	$ 59,642

Appendix G

Life Cycle Cost Evaluation of Sludge Stabilization Alternatives

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	3%
General Requirements	20%
Contractors Profit	8%
Contingency	40%
Engineering Fees	15%
Year to Begin Construction	2026
Estimated Phase 1 Construction Complete	2029
Estimated Phase 2 Construction Complete	2043
Estimated Phase 3 Construction Complete	2055

CAPITAL COST	Phase 1					Phase 3				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT										
Aerobic Digester										
Diffusers and Aeration Piping	1	$ 200,000	$ 200,000	60%	$ 320,000	1	$ 100,000	$ 100,000	60%	$ 160,000
Biosolis Thickening Tank Mixing System	1	$ 300,000	$ 300,000	60%	$ 480,000	1	$ 150,000	$ 150,000	60%	$ 240,000
Biosolids Transfer and Truck Loading Pumps	3	$ 100,000	$ 300,000	60%	$ 480,000	3	$ 50,000	$ 150,000	60%	$ 240,000
Total Equipment Cost					$ 1,280,000					$ 640,000
CONSTRUCTION										
General			20%		$ 645,400			20%		$ 645,400
Site Work			15%		$ 484,050			15%		$ 484,050
Yard Piping			20%		$ 645,400			20%		$ 645,400
Aerobic Digester	1	$ 400,000	$ 400,000	10%	$ 440,000	1	$ 400,000	$ 400,000	10%	$ 440,000
Biosolids Settling/Storage Tanks	1	$ 430,000	$ 430,000	10%	$ 473,000	1	$ 430,000	$ 430,000	10%	$ 473,000
Biosolids Building (fully built in Phase 1)	1	$ 860,000	$ 860,000	10%	$ 946,000					
Biosolids Truck Loading Pump Buidling (fully built in Phase 1)	1	$ 80,000	$ 80,000	10%	$ 88,000					
Electrical and Instrumentation			15%		$ 192,000			15%		$ 96,000
Total Construction Cost					$ 3,913,850					$ 2,783,850
General Requirements including Mobilization and Demobilization, Insurance and Bonding, etc. (20%)					$ 1,038,770					$ 684,770
Contractors Profit (8%)					$ 415,508					$ 273,908
Contingency (40%)					$ 2,077,540					$ 1,369,540
Engineering Fees (15%)					$ 779,078					$ 513,578
Total Capital Cost					$ 9,505,000					$ 8,036,000

OPERATIONAL COST	Phase 1				Phase 3			
	Rating/ Number	Units	Unit Cost	Yearly Cost	Rating	Units	Unit Cost	Total Cost
SYSTEM								
Power Consumption								
Digester Aeration	1238	kWh/d	$ 0.15	$ 70,000	1858	kWh/d	$ 0.15	$ 110,000
Biosolids Thickening Tank Mixing System	16	kWh/d	$ 0.15	$ 1,000	24	kWh/d	$ 0.15	$ 2,000
Biosolids Transfer and Truck Loading Pumps	16	kWh/d	$ 0.15	$ 1,000	24	kWh/d	$ 0.15	$ 2,000
Total Power Cost				$ 72,000				$ 114,000
Chemical Consumption								
Polymer	13	kg/d	$ 8.00	$ 38,544.00	20	kg/d	$ 8.00	$ 57,816.00
Total Chemical Cost				$ 38,544				$ 57,816
Total Operational Costs				$ 111,000				$ 172,000

AINLEY: 121027
AEROBIC DIGESTION SYSTEM

NPV CALCULATION	Total	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
CAPITAL COSTS														
Equipment	$ 2,342,400				$ 702,720	$ 936,960	$ 702,720							
Construction Costs	$ 7,162,346				$ 2,148,704	$ 2,864,938	$ 2,148,704							
Major Equipment Replacement Cost	$ -													
Total Capital Cost in 2023 Dollars	$ 9,504,746				$ 2,851,424	$ 3,801,898	$ 2,851,424	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ 8,801,980	$ -	$ -	$ -	$ 2,691,569	$ 3,520,401	$ 2,590,010	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS														
Power Consumption Cost	$ 1,872,000							$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000
Chemical Consumption Cost	$ 1,002,144							$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544
Total Operational Cost in 2023 Dollars	$ 2,874,144							$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544
Total Operational Cost NPV	$ 2,034,713	$ -	$ -	$ -	$ -	$ -	$ -	$ 98,497	$ 96,621	$ 94,780	$ 92,975	$ 91,204	$ 89,467	$ 87,763
Current Year Sub-total	$ 12,378,890	$ -	$ -	$ -	$ 2,851,424	$ 3,801,898	$ 2,851,424	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544
Inflation Adjusted	$ 15,789,300	$ -	$ -	$ -	$ 3,115,828	$ 4,279,070	$ 3,305,582	$ 131,995	$ 135,955	$ 140,034	$ 144,235	$ 148,562	$ 153,019	$ 157,609
NPV	**$ 10,837,000**	$ -	$ -	$ -	$ 2,691,569	$ 3,520,401	$ 2,590,010	$ 98,497	$ 96,621	$ 94,780	$ 92,975	$ 91,204	$ 89,467	$ 87,763

NPV CALCULATION	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
CAPITAL COSTS																			
Equipment																			
Construction Costs																			
Major Equipment Replacement Cost																			
Total Capital Cost in 2023 Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS																			
Power Consumption Cost	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000	$ 72,000
Chemical Consumption Cost	$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544	$ 38,544
Total Operational Cost in 2023 Dollars	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544
Total Operational Cost NPV	$ 86,091	$ 84,451	$ 82,843	$ 81,265	$ 79,717	$ 78,198	$ 76,709	$ 75,248	$ 73,814	$ 72,408	$ 71,029	$ 69,676	$ 68,349	$ 67,047	$ 65,770	$ 64,517	$ 63,289	$ 62,083	$ 60,901
Current Year Sub-total	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544	$ 110,544
Inflation Adjusted	$ 162,338	$ 167,208	$ 172,224	$ 177,391	$ 182,712	$ 188,194	$ 193,840	$ 199,655	$ 205,644	$ 211,814	$ 218,168	$ 224,713	$ 231,455	$ 238,398	$ 245,550	$ 252,917	$ 260,504	$ 268,319	$ 276,369
NPV	$ 86,091	$ 84,451	$ 82,843	$ 81,265	$ 79,717	$ 78,198	$ 76,709	$ 75,248	$ 73,814	$ 72,408	$ 71,029	$ 69,676	$ 68,349	$ 67,047	$ 65,770	$ 64,517	$ 63,289	$ 62,083	$ 60,901

MEAFORD CLASS EA: PHASE 3
WWTP TECHNOLOGY EVALUATION
LIFE CYCLE ANALYSIS

AINLEY: 121027
ATAD SYSTEM

Economic Factors	
Discount Rate (Interest):	5%
Inflation Rate	3%
General Requirements	20%
Contractors Profit	8%
Contingency	40%
Engineering Fees	15%
Year to Begin Construction	2026
Estimated Phase 1 Construction Complete	2029
Estimated Phase 2 Construction Complete	2043
Estimated Phase 3 Construction Complete	2055

CAPITAL COST	Phase 1					Phase 3				
	Units	Unit Cost	Cost	Installation	Total	Units	Unit Cost	Cost	Installation	Total
EQUIPMENT										
ATAD										
Aeration/Mixing System	1	$ 200,000	$ 200,000	60%	$ 320,000	1	$ 100,000	$ 100,000	60%	$ 160,000
Sludge Thickener	1	$ 450,000	$ 450,000	60%	$ 720,000	1	$ 225,000	$ 225,000	60%	$ 360,000
Sludge and Thickened Sludge Holding Tanks Mixing System	2	$ 400,000	$ 800,000	60%	$ 1,280,000	2	$ 200,000	$ 400,000	60%	$ 640,000
Sludge and Biosolids Transfer and Loading Pumps	5	$ 70,000	$ 350,000	60%	$ 560,000	5	$ 35,000	$ 175,000	60%	$ 280,000
Total Equipment Cost					$ 2,880,000					$ 1,440,000
CONSTRUCTION										
General			20%		$ 1,601,200			20%		$ 750,000
Site Work			15%		$ 1,200,900			15%		$ 562,500
Yard Piping			20%		$ 1,601,200			20%		$ 750,000
ATAD Tanks	1	$ 1,400,000	$ 1,400,000	10%	$ 1,540,000	1	$ 700,000	$ 700,000	10%	$ 770,000
Sludge Holding Tanks	1	$ 700,000	$ 700,000	10%	$ 770,000	1	$ 700,000	$ 700,000	10%	$ 770,000
Thickened Sludge Holding Tank	1	$ 700,000	$ 700,000	10%	$ 770,000	1	$ 700,000	$ 700,000	10%	$ 770,000
Biosolids Settling/Storage Tanks	1	$ 860,000	$ 860,000	10%	$ 946,000	0		$ -	10%	$ -
Thickening Building (built for Full Buildout in Phase 1)	1	$ 1,000,000	$ 1,000,000	10%	$ 1,100,000	0		$ -	10%	$ -
Electrical and Instrumentation			15%		$ 432,000			15%		$ 216,000
Total Construction Cost					$ 9,529,300					$ 4,372,500
General Requirements including Mobilization and Demobilization, Insurance and Bonding, etc. (20%)					$ 2,481,860					$ 1,162,500
Contractors Profit (8%)					$ 992,744					$ 465,000
Contingency (40%)					$ 4,963,720					$ 2,325,000
Engineering Fees (15%)					$ 1,861,395					$ 871,875
Total Equipment Cost					$ 22,710,000					$ 17,234,000

OPERATIONAL COST	Phase 1				Phase 3			
	Rating/ Number	Units	Unit Cost	Yearly Cost	Rating	Units	Unit Cost	Total Cost
SYSTEM								
Power Consumption								
ATAD Aeration and Mixing (Aspirators)	432	kWh/d	$ 0.15	$ 23,652.00	648	kWh/d	$ 0.15	$ 35,478.00
Sludge and Thickened Sludge Tanks Mixing	126	kWh/d	$ 0.15	$ 6,898.50	189	kWh/d	$ 0.15	$ 10,347.75
Thickeners (inc feed and discharge pumps)	16	kWh/d	$ 0.15	$ 876.00	24	kWh/d	$ 0.15	$ 1,314.00
Pumps	41	kWh/d	$ 0.15	$ 2,244.75	62	kWh/d	$ 0.15	$ 3,367.13
Total Power Cost				$ 33,671				$ 50,507
Chemical Consumption								
Polymer	14	kg/d	$ 8.00	$ 40,880	21	kg/d	$ 8.00	$ 61,320
Total Chemical Cost				$ 40,880				$ 61,320
Total Operational Costs				$ 75,000				$ 112,000

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ATAD SYSTEM

NPV CALCULATION	Total	2023	2024	2025	2026	2027	2028	2029	2030
CAPITAL COSTS									
Equipment	$ 5,270,400				$ 1,581,120	$ 2,108,160	$ 1,581,120		
Construction Costs	$ 17,438,619				$ 5,231,586	$ 6,975,448	$ 5,231,586		
Major Equipment Replacement Cost	$ -								
Total Capital Cost in 2023 Dollars	$ 22,709,019	$ -	$ -	$ -	$ 6,812,706	$ 9,083,608	$ 6,812,706	$ -	$ -
Total Capital Cost NPV	$ 21,029,951	$ -	$ -	$ -	$ 6,430,776	$ 8,411,047	$ 6,188,128	$ -	$ -
OPERATIONAL COSTS									
Power Consumption Cost	$ 875,453							$ 33,671	$ 33,671
Chemical Consumption Cost	$ 1,062,880							$ 40,880	$ 40,880
Total Operational Cost in 2023 Dollars	$ 1,938,333	$ -	$ -	$ -	$ -	$ -	$ -	$ 74,551	$ 74,551
Total Operational Cost NPV	$ 1,372,218	$ -	$ -	$ -	$ -	$ -	$ -	$ 66,427	$ 65,161
Current Year Sub-total	$ 24,647,352	$ -	$ -	$ -	$ 6,812,706	$ 9,083,608	$ 6,812,706	$ 74,551	$ 74,551
Inflation Adjusted	$ 28,997,819	$ -	$ -	$ -	$ 7,444,427	$10,223,680	$ 7,897,793	$ 89,018	$ 91,689
NPV	**$ 22,403,000**	$ -	$ -	$ -	$ 6,430,776	$ 8,411,047	$ 6,188,128	$ 66,427	$ 65,161

NPV CALCULATION	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
CAPITAL COSTS												
Equipment												
Construction Costs												
Major Equipment Replacement Cost												
Total Capital Cost in 2023 Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS												
Power Consumption Cost	$ 33,671	$ 33,671	$ 33,671	$ 33,671	$ 33,671	$ 33,671	$ 33,671	$ 33,671	$ 33,671	$ 33,671	$ 33,671	$ 33,671
Chemical Consumption Cost	$ 40,880	$ 40,880	$ 40,880	$ 40,880	$ 40,880	$ 40,880	$ 40,880	$ 40,880	$ 40,880	$ 40,880	$ 40,880	$ 40,880
Total Operational Cost in 2023 Dollars	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551
Total Operational Cost NPV	$ 63,920	$ 62,703	$ 61,508	$ 60,337	$ 59,188	$ 58,060	$ 56,954	$ 55,869	$ 54,805	$ 53,761	$ 52,737	$ 51,733
Current Year Sub-total	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551
Inflation Adjusted	$ 94,439	$ 97,272	$ 100,191	$ 103,196	$ 106,292	$ 109,481	$ 112,765	$ 116,148	$ 119,633	$ 123,222	$ 126,919	$ 130,726
NPV	$ 63,920	$ 62,703	$ 61,508	$ 60,337	$ 59,188	$ 58,060	$ 56,954	$ 55,869	$ 54,805	$ 53,761	$ 52,737	$ 51,733

NPV CALCULATION	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
CAPITAL COSTS												
Equipment												
Construction Costs												
Major Equipment Replacement Cost												
Total Capital Cost in 2023 Dollars	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Capital Cost NPV	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
OPERATIONAL COSTS												
Power Consumption Cost	$ 33,671	$ 33,671	$ 33,671	$ 33,671	$ 33,671	$ 33,671	$ 33,671	$ 33,671	$ 33,671	$ 33,671	$ 33,671	$ 33,671
Chemical Consumption Cost	$ 40,880	$ 40,880	$ 40,880	$ 40,880	$ 40,880	$ 40,880	$ 40,880	$ 40,880	$ 40,880	$ 40,880	$ 40,880	$ 40,880
Total Operational Cost in 2023 Dollars	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551
Total Operational Cost NPV	$ 50,747	$ 49,781	$ 48,833	$ 47,902	$ 46,990	$ 46,095	$ 45,217	$ 44,356	$ 43,511	$ 42,682	$ 41,869	$ 41,072
Current Year Sub-total	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551	$ 74,551
Inflation Adjusted	$ 134,648	$ 138,687	$ 142,848	$ 147,133	$ 151,547	$ 156,094	$ 160,777	$ 165,600	$ 170,568	$ 175,685	$ 180,955	$ 186,384
NPV	$ 50,747	$ 49,781	$ 48,833	$ 47,902	$ 46,990	$ 46,095	$ 45,217	$ 44,356	$ 43,511	$ 42,682	$ 41,869	$ 41,072

Appendix H
Technology Alternative Evaluation Matrices

Municipality of Meaford Class EA
Alternative Design Concepts for Treatment
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EVALUATION MATRIX FOR SHORT LISTED SECONDARY TREATMENT TRAIN ALTERNATIVES

PRIMARY CRITERIA		SECONDARY CRITERIA		ABSOLUTE WEIGHT (WT)	SHORT LISTED ALTERNATIVES: Alternative 1		Alternative 2		Alternative 3		Alternative 4		COMMENTS
CRITERIA	WEIGHT	CRITERIA	WEIGHT		SCORE*	WT SCORE	SCORE*	WT SCORE	SCORE*	WT SCORE	SCORE*	WT SCORE	
Social/Culture	10%	Aesthetic Impacts (plant appearance)	10	1	◑	0.6	◑	0.7	●	1	◕	0.8	Extended Aeration would have the greatest visual impact since it has the largest tanks. MABR alternative uses the existing aertaion tanks. AGS has the smallest tanks followed by SBR.
		Traffic (during construction and operation)	10	1	◑	0.6	◑	0.7	◑	0.6	◕	0.8	Extended Aeration would have the highest construction traffic due to increased tankage (concrete trucks) and equipment required for each tank/process and the lowest operation traffic due to chemical deliveries. MABR would have the least construction traffic as it uses the existing aertation tanks. AGS has the smallest tankage and does not require secondary clarification.
		Noise Impacts (during operation)	40	4	◔	1.6	◔	1.6	◕	3.2	◑	2.4	Noise impacts would be limited to effects on worker health and safety and be due largely to mechanical equipment like blowers, pumps and mixers. Extended Aeration produces moderate noise as it involves continuous aeration and mixing. SBR have noise levels similar to that of Extended Aeration. AGS system tend to produce relatively lower noise levels compared to Extended Aeration and SBR, because it often involves less continuous mixing and aeration, resulting in quieter operation. MABR typically generates very low noise levels compared to the other processes listed. MABR relies on membrane modules and diffusion for aeration, reducing the need for loud mechanical equipment.
		Odour Impacts (during operation)	40	4	◑	2.4	◕	3.2	●	4	◑	2.4	A higher potential for fugitive odours exist where there are open tanks. SBR alternative involves open tanks or basins that are exposed to the environment during different phases of the treatment cycle, followed by AGS and Extended Aeration. MABR typically has enclosed tankage due to the use of membrane modules for aeration, which helps prevent the release of odorous compounds into the environment.
Technical	40%	Ability to Meet Regulatory Objectives	30	12	●	12	●	12	●	12	●	12	All the alternatives are considered to have the same ability to meet regulatory objectives as they are all capable of meeting the advanced treatment required for Meaford.
		Technology / Process Robustness/Capacity to handle high peak flow	30	12	●	12	◔	4.8	◑	7.2	○	2.4	Extended Aeration is considered the most robust alternative as it is designed for stable and consistent operation. It provides long contact times between wastewater and microbes, which contributes to process stability. It is generally robust and can handle some fluctuations in influent characteristics. MABR is also known for its operational stability and robustness. The enclosed nature of the system with membrane modules helps maintain consistent oxygen levels and protect the biomass from fluctuations in oxygen availability, which makes MABR processes quite resilient to operational changes. SBR is designed for batch-wise operation, which can provide some flexibility in handling fluctuations. It can adapt to changing influent characteristics to some extent but may require careful adjustment of sequencing and operational parameters. AGS process is relatively sensitive to operational fluctuations, especially during its early stages of development. Sudden changes in influent characteristics or operational parameters can disrupt the stability of the granules. However, once the granules mature and the system stabilizes, it can exhibit reasonable robustness.
		Ease of Expansion and Phasing to Buildout	20	8	●	8	●	8	●	8	●	8	Extended Aeration system is typically modular and relatively straightforward to expand or phase in new components. It is designed with flexibility in mind, making it easier to adapt to changing treatment needs. Additional tanks or basins can be added as demand grows. SBRs are also modular in design and can be expanded by adding additional reactors or tanks. The sequential batch nature of the process allows for flexibility in accommodating increased flow rates or changing treatment requirements. MABR is generally modular and can be expanded relatively easily by adding more membrane modules or reactor units. The modular design lends itself to phased expansion to meet increasing treatment capacity. The ease of expansion for AGS system can vary depending on the specific design and technology used. Expansion may involve the addition of new reactors or adjustments to existing ones. The flexibility can depend on the particular implementation.
		Energy Requirements	5	2	◑	1.2	◔	0.8	●	2	◕	1.6	MABR system is known for its energy efficiency due to the use of membrane modules that reduce aeration requirements. AGS has lower energy demands compared to conventional treatment processes. Extended Aeration system tends to have lower energy requirements compared to SBR.
		Operation & Maintenance Requirements (simplicity, operator skill level/quantity)	10	4	●	4	◔	1.6	◕	3.2	◑	2.4	Extended Aeration system has moderate to low operational and maintenance requirements. It typically provides stable and consistent performance with minimal operator intervention. Regular maintenance may include simple tasks like sludge wasting and occasional equipment checks. MABR system is designed to be user-friendly and requires relatively lower operational and maintenance efforts compared to some other systems. The enclosed nature of MABR reactors helps reduce maintenance needs. Regular membrane cleaning and monitoring are necessary, but overall, the process tends to be more automated and requires fewer operator interventions. AGS process can be moderately complex to operate and maintain, particularly during the initial stages of reactor start-up and granule development. Operators need a good understanding of granule formation and control. Occasional cleaning and adjustments is required to maintain granule integrity. SBR system can be relatively complex to operate and maintain, as it involves multiple phases (fill, react, settle, decant) and require precise control and sequencing. Operators need a good understanding of the process and may require more training.
		Site Requirements (plant footprint)	5	2	◔	0.8	◑	1.2	●	2	◕	1.6	Extended Aeration alternative requires a relatively larger plant footprint compared to other processes. SBRs typically have a moderate to larger plant footprint, as they consist of multiple tanks and basins to accommodate the sequential batch process. The plant footprint for AGS process can vary but tends to be moderate in size. MABR system has a smaller plant footprint due to compact nature of MABR reactors.
Environmental	20%	Public Health	30	6	◕	4.8	○	1.2	◔	2.4	○	1.2	The risk to public health would be related to failure of the treatment systems, resulting in an environmental spill. Extended Aeration system typically provides a higher level of treatment and is designed to produce a high-quality effluent with low levels of contaminants. In the event of a failure that leads to an environmental spill, the discharged wastewater is likely to contain fewer pathogens and contaminants compared to other systems, reducing the immediate public health risk. MABR system provides effective treatment and can produce a high-quality effluent. The membrane modules used in MABR reactors help retain microorganisms and contaminants, reducing the risk of pathogens and pollutants being released in the event of a system failure. AGS processe is known for its efficient removal of organic matter and pollutants. In the event of a failure, the discharged wastewater may still contain contaminants but to a lesser extent compared to some other systems. SBR operates in a batch mode, which means that during certain phases of the cycle, the wastewater is exposed to the air. In the event of a failure during one of these phases, there is a potential for pathogens and odorous compounds to be released, which could pose a higher immediate public health risk compared to continuous-flow systems.
		Sustainability	20	4	◑	2.4	◔	1.6	●	4	◕	3.2	MABR system is often considered highly sustainable. It is known for its energy efficiency due to the use of membrane modules that reduce aeration requirements. MABR technology can also promote resource recovery, particularly in terms of producing high-quality effluent suitable for reuse. Additionally, their compact design can reduce land and infrastructure requirements, further enhancing sustainability. AGS is generally considered sustainable due to its efficient organic removal and potential for nutrient recovery. The system often has lower energy demands compared to conventional treatment processes, and can produce high-quality effluent suitable for reuse. Extended Aeration system can be sustainable, particularly when designed and operated efficiently. It is known for its long sludge age, which can lead to effective organic removal. However, its energy efficiency can vary depending on operational practices and the specific system design. SBR can be sustainable when well-designed and operated. It offers flexibility and can achieve high-efficiency treatment. However, its sustainability can be influenced by factors such as energy consumption during sequencing. Its suitability for resource recovery can also vary.
		Greenhouse Gas Generation / Climate Change Impacts	20	4	◔	1.6	◔	1.6	●	4	◕	3.2	Extended Aeration system requires continuous aeration and mechanical mixing, which can consume a significant amount of energy. This can result in relatively higher energy consumption and associated greenhouse gas emissions, making it potentially less environmentally friendly in terms of climate change impact. SBRs can be energy-intensive due to the need for intermittent aeration and mixing during various phases of the treatment cycle. Energy consumption and associated emissions can vary depending on system design and operation. AGS process can be more energy-efficient compared to Extended Aeration and SBR systems because they typically require less aeration and mixing. MABR system is generally considered more energy-efficient than traditional aerobic processes. The use of membranes for aeration can reduce energy consumption significantly. Additionally, MABR systems often produce higher-quality effluent, which can reduce the environmental impact downstream.
		Natural Environment Impact	10	2	◔	0.8	◑	1.2	●	2	◕	1.6	The alternative with the largest footprint would result in the greatest impact to the natural environment, due to clearing of trees and other site works. The Extended Aeration alternative has the largest footprint, followed by the SBR and AGS. MABR has the lowest impact on the natural environment as it will use the existing aeration tanks.
		Waste Generation	20	4	◑	2.4	◑	2.4	◕	3.2	●	4	Waste generated would be related to chemical usage and biological efficiency. MABR and AGS have more complicated biological cultures which makes them produce slightly less waste sludge compared to Extended Aeration and SBR. AGS needs less chemical usage.
Economic	30%	Capital Cost	30	9	◕	7.2	●	9	○	1.8	◔	3.6	Refer to NPV spreadsheets.
		Operation and Maintenance Costs	40	12	●	12	◔	4.8	○	2.4	◔	4.8	Refer to NPV spreadsheets.
		Net Present Value	30	9	◕	7.2	●	9	○	1.8	◔	3.6	Refer to NPV spreadsheets.
			TOTAL SCORE	100	◕		◑		◑		◔		

*Score is a number from 1 to 5 (1 -○, 2 -◔, 3 -◑, 4 -◕, 5 -●)

Municipality of Meaford Class EA
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EVALUATION MATRIX FOR SHORT LISTED TERTIARY TREATMENT ALTERNATIVES

PRIMARY CRITERIA		SECONDARY CRITERIA		ABSOLUTE WEIGHT (WT)	SHORT LISTED ALTERNATIVES						COMMENTS
					Alternative 1 Up-flow Sand Filter		Alternative 2 Cloth Disc Filter		Alternative 3 High-rate Clarifier		
CRITERIA	WEIGHT	CRITERIA	WEIGHT		SCORE*	WT SCORE	SCORE*	WT SCORE	SCORE*	WT SCORE	
Social/Culture	5%	Aesthetic Impacts (plant appearance)	10	0.5	◕	0.4	◑	0.35	◕	0.45	Aesthetic impacts would be related to the size of each technology. Alternative 3 has the most compact footprint. Alternative 2 has the largest footprint, followed by Alternative 1.
		Traffic (during construction and operation)	10	0.5	◕	0.4	◕	0.4	◕	0.4	for delivering construction materials (concrete trucks) and equipment. High-rate clarifier would have the least construction traffic as it has the smallest tankage but most traffic requirements
		Noise Impacts (during operation)	40	2	◕	1.8	◕	1.8	◕	1.8	No Significant noises expected during normal operation.
		Odour Impacts (during operation)	40	2	◕	1.8	◕	1.8	◕	1.8	No significant odours expected during normal operation.
Technical	40%	Ability to Meet Regulatory Objectives	30	12	●	12	●	12	●	12	All the alternatives are considered to have the same ability to meet regulatory objectives as they are all capable of meeting the effluent limit required for Meaford.
		Technology/Process Robustness	30	12	◕	9.6	◕	10.8	◕	10.8	operation.
		Ease of Expansion and Phasing to Buildout	20	8	◕	6.4	◕	6.4	◕	6.4	All the alternatives would be built to accommodate the flow for Phase 3.
		Energy Requirements	5	2	◑	1.4	●	2	◕	1.6	Alternative 2 has the least energy requirements. Alternative 1 has the most energy requirements, followed by Alternative 3.
		Operation & Maintenance Requirements (simplicity, operator skill level/quantity)	10	4	◕	3.6	◕	3.6	◕	3.2	Alternative 1 and 2 are equipped with internal washing system and long-lasting media. Routine maintenance on motor, pumps and valves are required for all the alternatives.
		Site Requirements (plant footprint)	5	2	◕	1.6	◑	1.2	◕	1.6	by Alternative 1.
Environmental	25%	Public Health	30	7.5	●	7.5	●	7.5	◑	4.5	The risk to public health would be related to failure of the treatment systems and trucking chemicals to site. Alternative 3 cosumes most chemicals.
		Sustainability	20	5	◕	4	◕	4	◕	4	Each option has the same level of sustainability.
		Greenhouse Gas Generation / Climate Change Impacts	20	5	◑	3	●	5	◕	4	Alternative 1 consumes more energy, which would have the biggest impact on climate change factors. Alternative 2 has less energy consumption requirements, followed by Alternative 3.
		Natural Environment Impact	10	2.5	◕	2	◑	1.75	◕	2.25	The alternative with the largest footprint would result in the greatest impact to the natural
		Waste Generation	20	5	◕	4	◕	4	◑	3	Waste generated would be related to media replacement.
Economic	30%	Capital Cost	60	18	◕	14.4	◕	16.2	●	18	Refer to NPV spreadsheets.
		Operation and Maintenance Costs	40	12	◑	7.2	●	12	◑	7.2	Refer to NPV spreadsheets.
			TOTAL SCORE	100	◔		◕		◑		

*Score is a number from 1 to 5 (1 -○, 2 -◔, 3 -◑, 4 -◕, 5 -●)

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EVALUATION MATRIX FOR SHORT LISTED DISINFECTION ALTERNATIVES

PRIMARY CRITERIA		SECONDARY CRITERIA		ABSOLUTE WEIGHT (WT)	SHORT LISTED ALTERNATIVES				COMMENTS
					Alternative 1 Chlorination / De-Chlorination		Alternative 2 UV Disinfection		
CRITERIA	WEIGHT	CRITERIA	WEIGHT		SCORE*	WT SCORE	SCORE*	WT SCORE	
Social/Culture	10%	Aesthetic Impacts (plant appearance)	10	1	◑	0.6	●	1	A chlorination system will require a contact tank and a building to house the chemical storage tanks and dosing systems. The UV system does not require as large a building and its contact tank is smaller than chlorination.
		Traffic (during construction and operation)	10	1	◑	0.6	◕	0.9	The chlorination alternative has more structures and tankage to construct than the UV alternative. Chlorination requires chemical deliveries during normal operation and UV does not.
		Noise Impacts (during operation)	40	4	◑	2.4	◑	2.4	Noise impacts are comparable.
		Odour Impacts (during operation)	40	4	◑	2.4	◕	3.2	The chlorination alternative has a higher potential for odour impacts in the event of accidental high chlorine dosing or chemical spills. In addition, the settlement in tank can also be a source of odour without routing cleaning.
Technical	40%	Ability to Meet Regulatory Objectives	30	12	◕	9.6	◕	9.6	Both are comparable.
		Technology/Process Robustness/ability to treat unanticipated high peak flow	30	12	◕	9.6	◑	7.2	The UV alternative is more responsive to fluctuations in system parameters, whereas, there is a 30 minute delay between the time a chlorination dose is changed and the the effect can be seen (react time in contact tank). However, temporary increase in Chlorine dosing can treat unanticipated high flow in the future operation.
		Ease of Expansion and Phasing to Buildout	20	8	◑	4.8	◕	6.4	The chlorination alterative would be more complex and costly to expand, due to the need for increased tankage and chemical storage. For the UV system, additional lamp modules would be needed. The contact tank is small enough that it can be constructed for Phase 2 flow in Phase 1. In order to reduce chlorine dosing, ORP control loop automatic control is needed, which is a complicated control sytsem during operation.
		Energy Requirements	5	2	●	2	◑	1.2	The chlorination alternative requires the less energy than the UV alternative.
		Operation & Maintenance Staffing Requirements (skill level/number)	10	4	◑	2.4	◕	3.6	The chlorination alternative requires more skilled operations staff and more maintenance attention than the UV alternative because it has more equipment and involves fairly complex chemistry.
		Site Requirements (plant footprint)	5	2	◑	1.2	◕	1.6	The chlorination alternative had a larger footprint.
Environmental	20%	Public Health and Safety	30	6	◑	3.6	◕	5.4	The chlorination system is considered to pose a greater risk to public health and safety due to the potential for accidental release of chlorine into the river if the de-chlorination system were to fail. In the natural environment, chlorine has been shown to produce by-products that are carcinogenic.
		Sustainability	20	4	◑	2.4	◕	3.2	The UV alternative is considered more sustainable since it does not use chemicals and is effective against micro-organisms that are resistant to chlorine.
		Greenhouse Gas Generation / Climate Change Impacts	20	4	◑	2.4	◑	2.8	The UV system uses 80% more energy than the chlorination system. However, the chemical deliveries required for chlorination/de-chlorination would generate comparable levels of greenhouse gases.
		Natural Environment Impact	10	2	◑	1.2	◕	1.6	The chlorination alternative has a larger footprint and would disrupt more of the natural environment.
		Waste Generation	20	4	◑	2.4	◕	3.2	The de-chlorination alternative could discharge excess sodium bisulphite, neutralized sodium, chloride and sulfate ion to the effluent re-oxygenation system, which would negatively affect performance of the effluent re-oxygenation system. The UV alternative does not generate wastes.
Economic	30%	Capital Cost	30	9	◑	5.4	●	9	Refer to NPV analysis
		Operation and Maintenance Costs	40	12	◑	7.2	◕	10.8	Refer to NPV analysis
		Net Present Value	30	9	◑	5.4	●	9	Refer to NPV analysis
			TOTAL SCORE	100	◑		◕		

*Score is a number from 1 to 5 (1 -○, 2 -◔, 3 -◑, 4 -◕, 5 -●)

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EVALUATION MATRIX FOR SHORT LISTED SLUDGE STABILIZATION ALTERNATIVES

PRIMARY CRITERIA		SECONDARY CRITERIA		ABSOLUTE WEIGHT (WT)	SHORT LISTED ALTERNATIVES				COMMENTS
					Alternative 1 Aerobic Digestion		Alternative 2 ATAD		
CRITERIA	WEIGHT	CRITERIA	WEIGHT		SCORE*	WT SCORE	SCORE*	WT SCORE	
Social/Culture	10%	Aesthetic Impacts (plant apperance)	10	1	●	1	◑	0.5	The ATAD system has higher sesthetic impact because of more above ground facilities.
		Traffic (during construction and operation)	10	1	◕	0.9	●	1	The ATAD sysetm would have more traffic during construction due to the higher concrete requiement. Traffic during operation would be comparable. The ATAD has a higher solids destruction ratio that would result in less sludge being hauled from site during normal operation.
		Noise Impacts (during operation)	40	4	●	4	◑	2.4	ATAD has more equipment than aerobic digestion and likely higher noise emissions.
		Odour Impacts (during operation)	40	4	●	4	◔	1.6	The additional processing of sludge required by the ATAD system results in a higher potential for fugitive odour emissions and ATAD biosolids are inherently more odourous.
Technical	40%	Ability to Meet Regulatory Objectives	30	12	◕	10.8	●	12	Since ATAD pasteurizes as well as stabilizes sludge, it achieves a higher standard of biosolids than aerobic digestion and is more likely to be able to comply if regulations become more stringent. But conservative design of aerobic digestion will meet the current regulatory objectives.
		Technology/Process Robustness	30	12	◕	10.8	●	12	The biosolid quality from ATAD is less affected by the sludge inflow and solid loading. However, conservatively designed aerobic digester can ensure the expected biosolid quality.
		Ease of Expansion and Phasing to	20	8	●	8	◑	4.8	The aerobic digestion process would be easier to expand since it has less equipment.
		Energy Requirements	5	2	◕	1.6	●	2	The aerobic digestion process requires less energy than the ATAD process due to less pumping and no mechanical thickener.
		Operation & Maintenance Staffing Requirements (skill level/number)	10	4	●	4	○	1.2	The ATAD system has more equipment to operate and maintain an ATAD unit is a more complex to operate and maintain than an aerobic digester.
		Site Requirements (plant footprint)	5	2	●	2	◑	1.2	The ATAD system has more equipment and requires more land.
Environmental	20%	Public Health and Safety	30	6	◕	4.8	◕	4.8	Public health and safety factors would be related to the amount off-site trucking of biosolids and operation conditions. The ATAD system produces a thicker biosolids due to the mechanical thickening process and would result in less sludge being transported from the site. ATAD operation environment involves equipment operation and maintenance in higher temperature.
		Sustainability	20	4	◕	3.2	●	4	The ATAD unit is more sustainable since it produces a product that can be used without restrictions, whereas biosolids from a conventional aerobic digester can only be land applied. ATAD would be able to comply if more stringent regulations were implemented in the future.
		Greenhouse Gas Generation / Climate Change Impacts	20	4	◕	3.2	●	4	For this high level evaluation, alternatives were scored based on energy usage and amount of tankage/construction required. Conventional aerobic digestion woud have a greater impact on climate change due to the significantly higher energy usage, even though it requires less construction.
		Natural Environment Impact	10	2	●	2	◕	1.6	The ATAD system would have a the greater impact on the natural environment due to the larger footprint required.
		Waste Generation	20	4	◑	2.4	◑	2.4	Waste generation would be similar for the two systems.
Economic	30%	Capital Cost	30	9	●	9	◑	5.4	Refer to NPV analysis spreadsheet
		Operation and Maintenance Costs	40	12	◕	9.6	●	12	Refer to NPV analysis spreadsheet
		Net Present Value	30	9	●	9	◕	7.2	Refer to NPV analysis spreadsheet
			TOTAL SCORE	100	◕		◑		

*Score is a number from 1 to 5 (1 -○, 2 -◔, 3 -◑, 4 -◕, 5 -●)