Operation & Maintenance Manual
Sewage Treatment Plant (STP)

Prepared by:
Agnico Eagle Mines Limited – Meadowbank Division – Whale Tail Pit Project

EXECUTIVE SUMMARY

Agnico Eagle has prepared the following document which summarizes the operational and maintenance procedures to be followed at the Sewage Treatment Plant (STP).

This report documents the stand alone Operation & Maintenance Manual – Sewage Treatment Plant, includes the following requirements:

- The manual was prepared in accordance with the "Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories, 1996", and adapted for the use of a mechanical contact water treatment facility;
- The manual includes contingency measures in the event of a plant malfunction; and
- The manual includes sludge management procedures.

IMPLEMENTATION SCHEDULE

This Plan will be implemented upon Board approval and subject to any modifications proposed by the NWB as a result of the review and approval process.

DISTRIBUTION LIST

Agnico Eagle Internal:

- Energy & Infrastructures Services Superintendent
- Energy & Infrastructures Services General Foreman
- Environmental Superintendent
- Senior environmental Coordinator
- Environmental Compliance Counselor
- Sewage Treatment Plant Operator

DOCUMENT CONTROL

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2	2019/02/19			Comment from ECCC, CIRNAC

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

1.1 PURPOSE

This Sewage Treatment Plant (STP) Operation and Maintenance Manual (OMM) for the Whale Tail Gold Project (the Project) has been prepared based on the "*Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories, 1996, prepared by the Department of Municipal and Community Affairs, NWT*". The OMM has been adapted for the use of a mechanical contact water treatment facility.

This manual is a component of the Whale Tail Environmental Management System. The objectives of this plan are summarized as follows:

1. To define the location, design and operating procedures to be used in the treatment of sewage generated at the Project; and
2. To provide monitoring requirements for the STP.

The STP purpose is to treat domestic sewage from the camp and adjacent building which are not connected to the STP directly (sucker truck will discharge sewage from this building directly into the STP).

1.2 BRIEF DESCRIPTION OF THE PROJECT

Agnico Eagle Mines Limited—Meadowbank Division (Agnico Eagle) is developing Whale Tail Pit and Haul Road Project, approximately 55 km north of the Meadowbank mine, on a satellite deposit located on the Amaruq property in the Kivalliq Region of Nunavut (65°24'25" N, 96°41'50" W), to extend mine operations and milling at Meadowbank Mine. The 99,878-hectare Amaruq property is located on Inuit-owned and federal crown land.

A conventional open pit mining operation is forecasted on the Whale Tail deposit. Access to the site is via a 64-kilometer road from Meadowbank mine. On-site facilities will include a power plant, maintenance facilities, tank farm for fuel storage, Arsenic water treatment plant, sewage treatment plant (STP), drinking water treatment plant, as well as accommodation and kitchen facilities for approximately 400 people.

Figures 1, 2 and 3 illustrate the location and general arrangement of the STP.

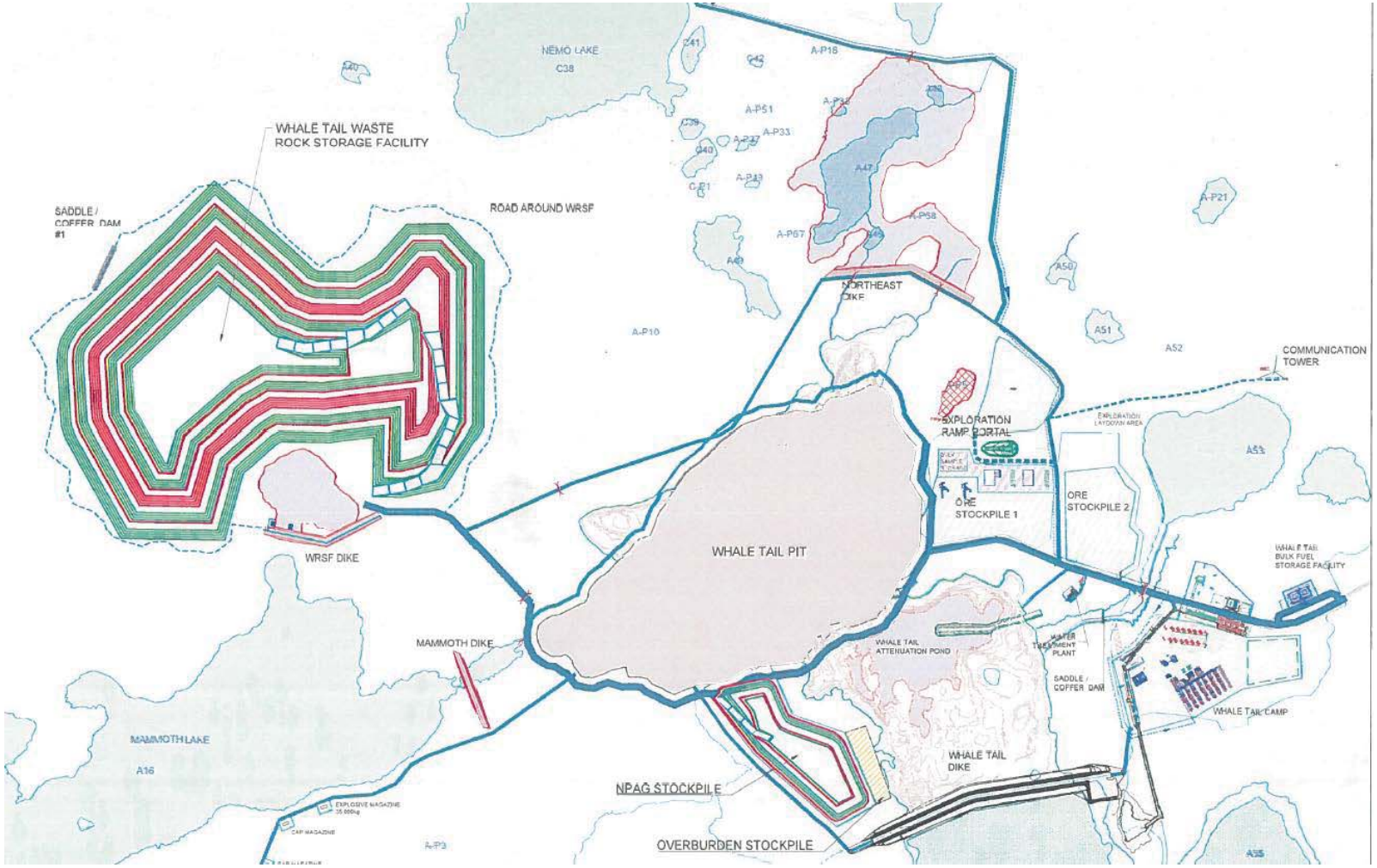

Figure 1 – Site Layout

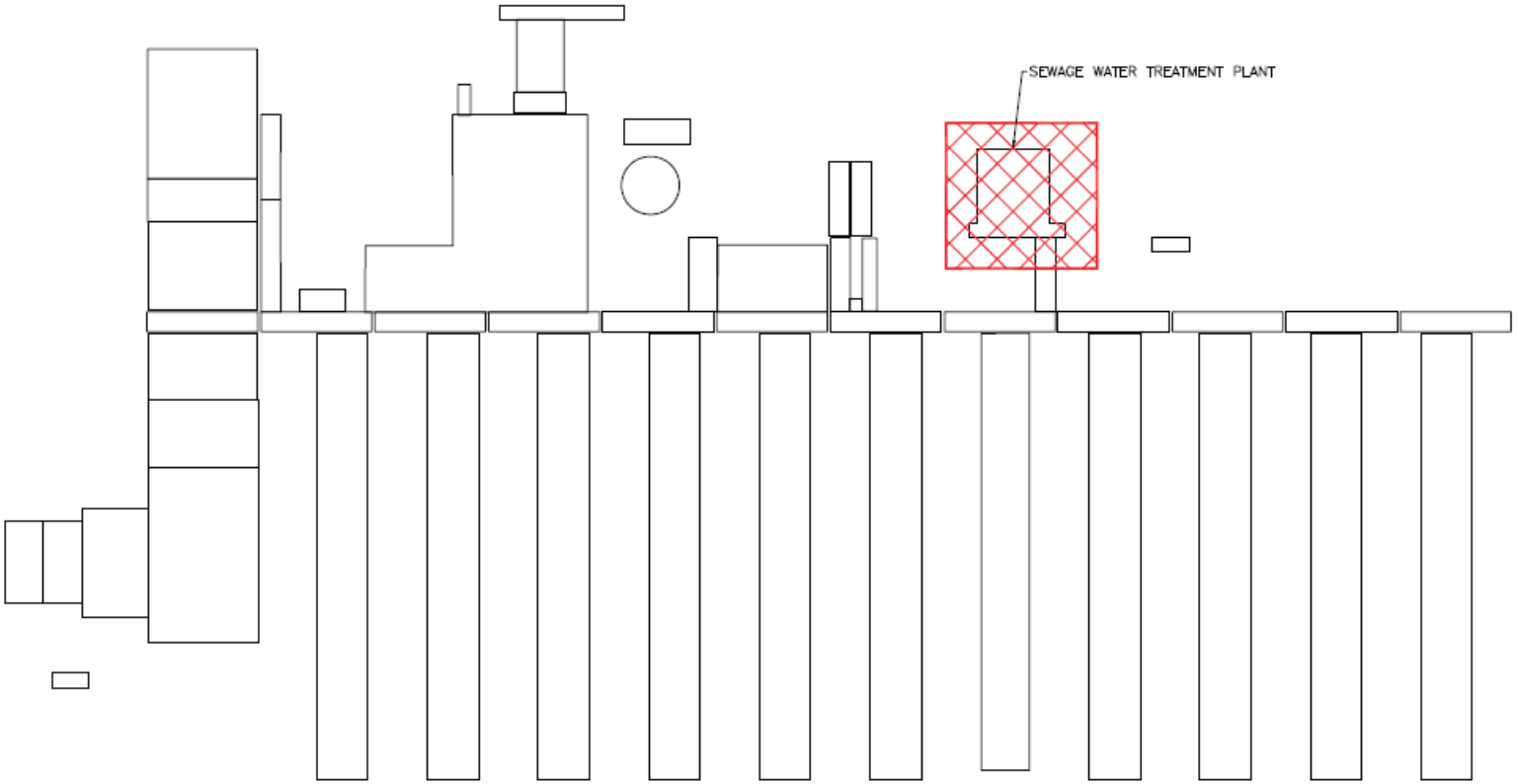

Figure 2 – Location of STP in the Whail Tail Camp

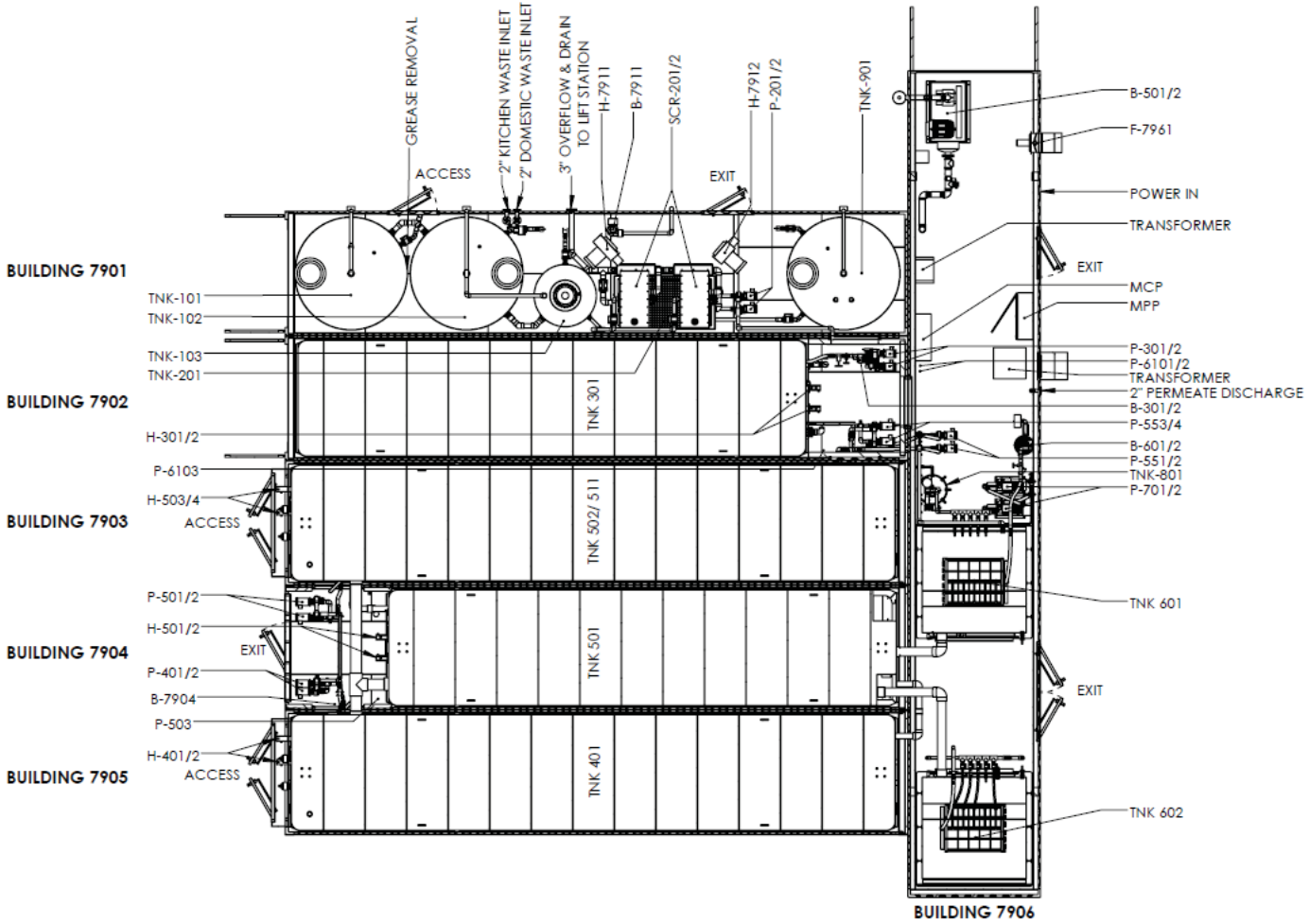

Figure 3 – General Arrangement of STP

1.3 CONTACT INFORMATION

The individuals responsible for the operation of the sewage treatment plant for the Project are the following:

Energy and Infrastructure Superintendent	819-856-3073
Energy and Infrastructure Supervisors	819 759-3555 ext 6731 or 6902

2 DESCRIPTION

2.1 SEWAGE TREATMENT PLANT (STP)

The plant is designed based on the occupation maximum of the camp for 400 persons (240L per day and per person). The design flows are presented in Table 1.

Table 1: Design flow rate

Parameters	Design Value	Unit
Per capita design flow	240	L/p/d
Number of persons	400	People
Average daily flow (ADF)	96	m^3/d
Maximum Daily Flow (MDF)	192	m^3/d
Peak Hourly Flow (PHF)	24	m^3/h
Overall time for speak to occur	2	hours
Maximum number of peak events per day	2	Qty

Table 2 presents the typical sewage composition used for the design (based on Meadowbank sewage quality).

Table 2: Sewage typical chemical composition

Parameters	Unit	Design Value
Biochemical Oxygen Demand (BOD_5)	mg/L	952
Total Suspended Solids (TSS)	mg/L	300
Total Kjeldahl Nitrogen (TKN)	mg/L	130
Ammonia nitrogen (NH_3-N)	mg/L	130
Oil and Grease	mg/L	30
pH	-	6 to 9.5
Water Temperature	^oC	10 to 25
Alkalinity	mg/L as $CaCO_3$	471.1

2.1.1 Process summary

The sewage treatment plant receives two streams of sewage as presented in Figure 4 (basic flowsheet of the STP). The first source is domestic sewage, which is fed directly to the fine screening process to remove any fibers or debris that might damage the membranes. The second source is kitchen sewage which is pre-treated in the oil and grease tanks to remove oil and grease prior to being fed into the fine

screens. The combined screened sewage is pumped to the equalization tank. The equalization tank buffers variability in the influent flow rate and concentrations of influent constituents, maintaining a consistent flow rate and sewage strength through the membrane bioreactor (MBR) system. Sewage is then pumped from the equalization tank to the pre-anoxic tank for denitrification.

In the pre-anoxic tank, screened sewage containing organics is combined with recycled mixed liquor from the aeration tank containing nitrates. Bacteria use some of the organics to drive the denitrification process, converting nitrate into nitrogen gas. This process occurs in an anoxic environment where there is minimal oxygen. As such a pump and eductors are used to mix the tank to prevent addition of oxygen. The denitrification process is used to meet the effluent nitrate operational target, reduce oxygen requirements and to recover alkalinity, thus reducing chemical consumption.

Mixed liquor from the anoxic tank flows by gravity to the first aerobic tank followed by the second aeration tank for aerobic biological degradation of the influent constituents (organics and ammonia). In the aerobic tanks, the nitrification process converts ammonia to nitrate in order to meet the effluent ammonia operational target. This process consumes alkalinity, so a caustic soda or soda ash dosing pump is used to control the pH. Additionally, liquid alum is dosed into the anoxic zone to precipitate phosphorus in order to meet the effluent phosphorus operational target. Mixed liquor flows by gravity from the second aeration tank to the post-anoxic tank for final denitrification polishing. In the post-anoxic tank there are minimal dissolved influent organics to drive the denitrification process. As such, an external carbon source in the form of MicroC is dosed to supplement the organics and drive the denitrification process.

Mixed liquor is pumped from the post-anoxic tank to the membrane tanks. The membrane tanks serve as additional volume for aerobic biological treatment to remove any excess MicroC (which would otherwise increase BOD in the effluent) and house the membrane filters used for solid-liquid separation. A treated effluent is drawn through the membranes by vacuum pumps.

Since the solid-liquid separation process results in an accumulation of solids in the membrane tank, the mixed liquor (containing both solids and filtrate) is continuously recycled to the first aeration tank. This prevents excessive solids build-up in the membrane tank, and maintains sufficient biomass in the anoxic and aeration tanks. The solids that accumulate in the system consist of biomass that has grown from the influent organics and ammonia, as well as non-biodegradable solids from the influent sewage. In order to maintain an optimal concentration of mixed liquor suspended solids (MLSS) (typically 10 g/L), a portion of the mixed liquor is periodically wasted by pumping from the Aeration Tank to the sludge holding tank. Wasted sludge in the sludge holding tank is thickened by decanting supernatant back to the screen tank. Thickened sludge accumulates in the sludge holding tanks until it is eventually pumped out for disposal.

The STP general flow diagram is illustrated in Figure 4 and Piping and Instrumentation Diagram (PID) in Figures 5 to 8. The following sections describe the STP components.

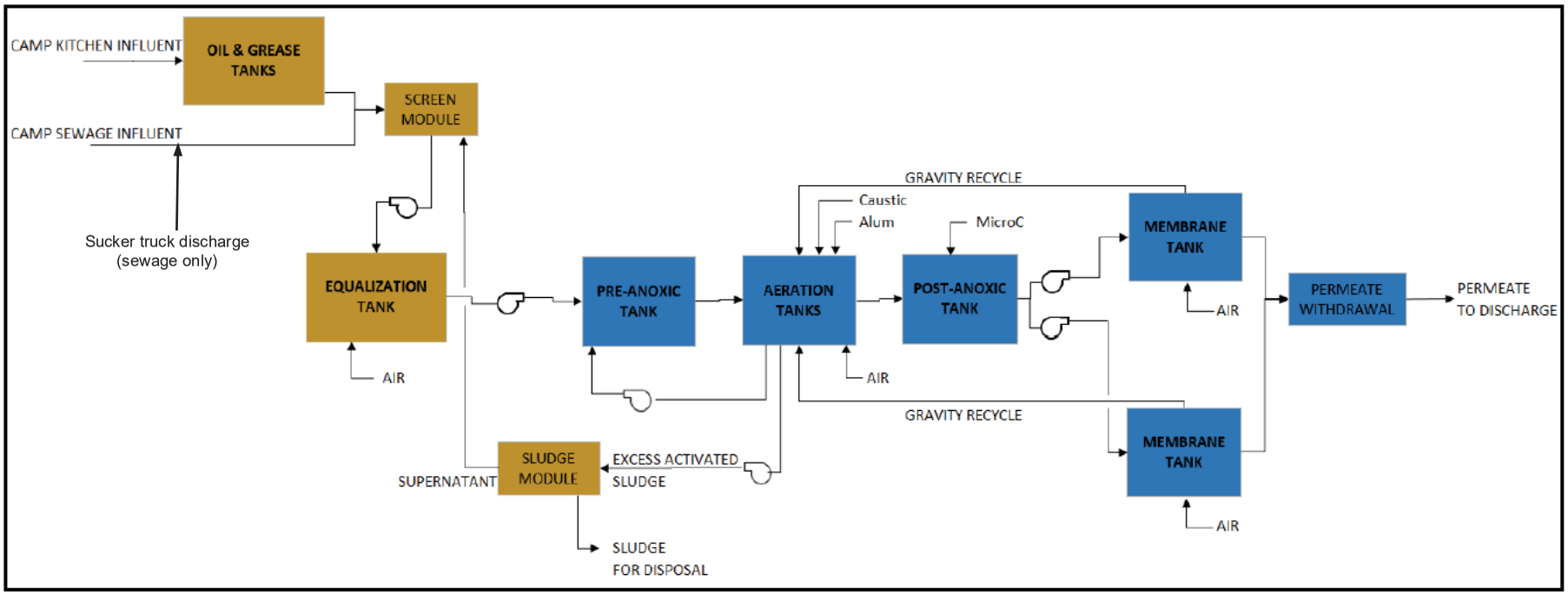

Figure 4 – Flowsheet

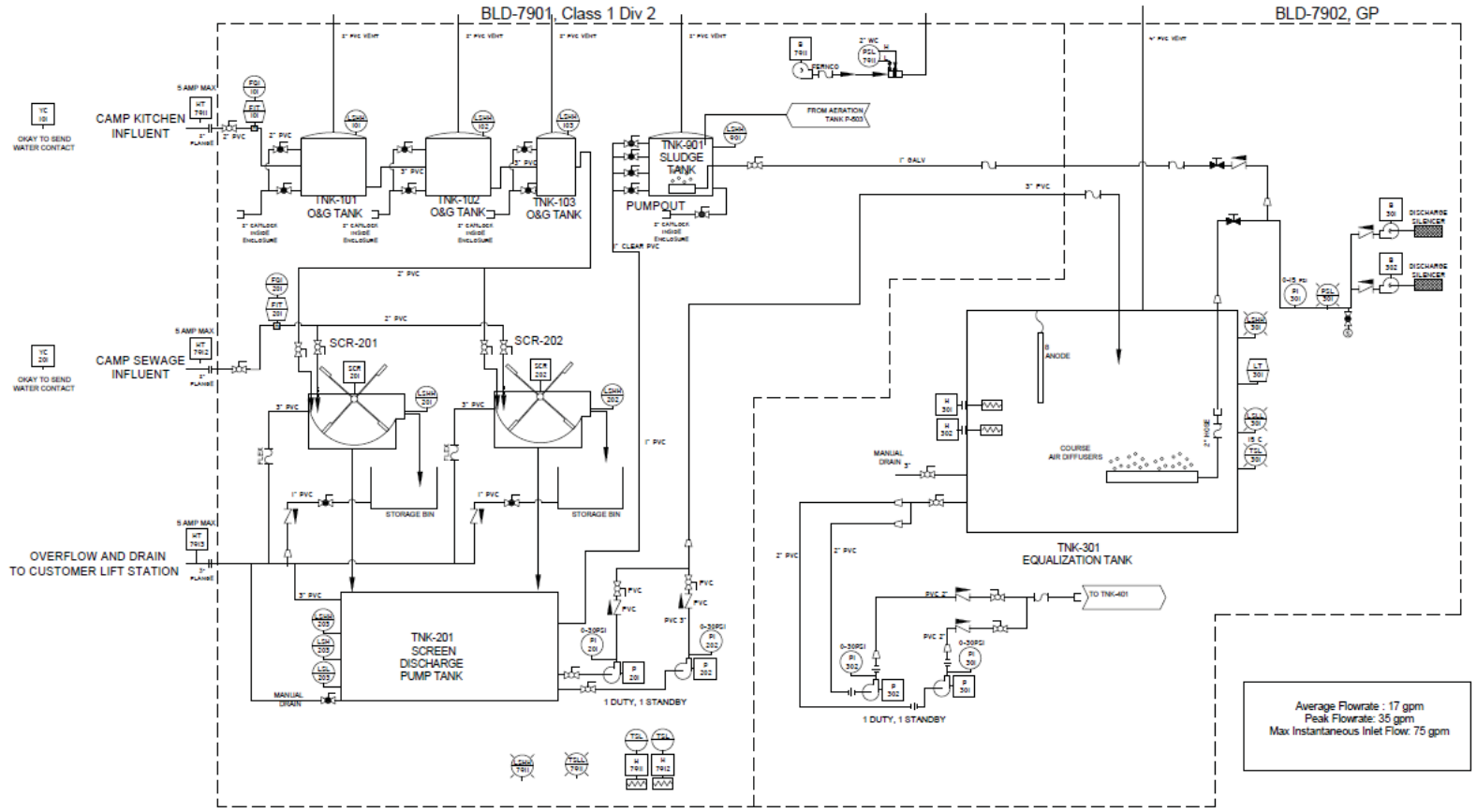

Figure 5 – Oils and grease removal, screening and equalization's tank

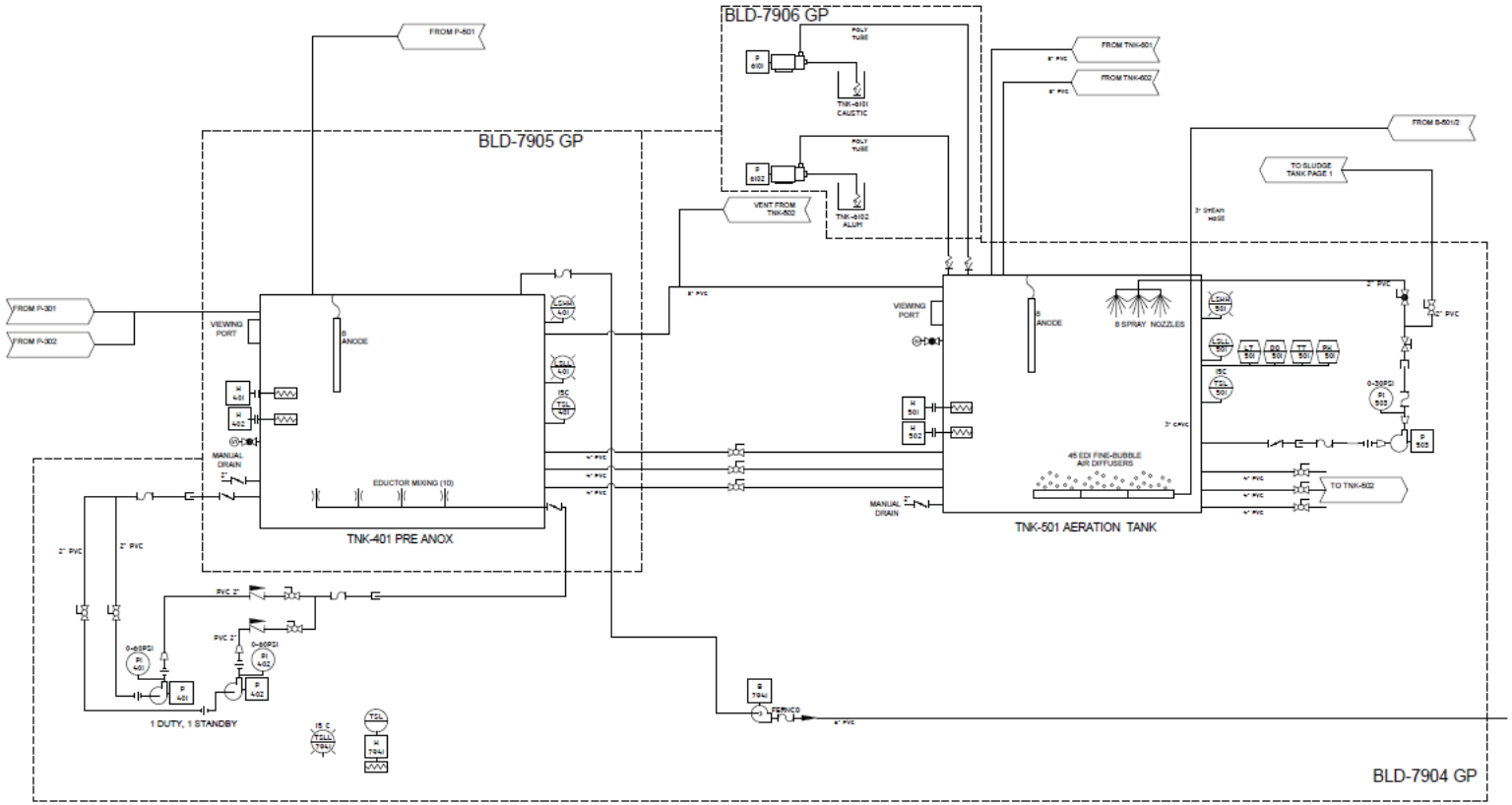

Figure 6 – Biological treatment

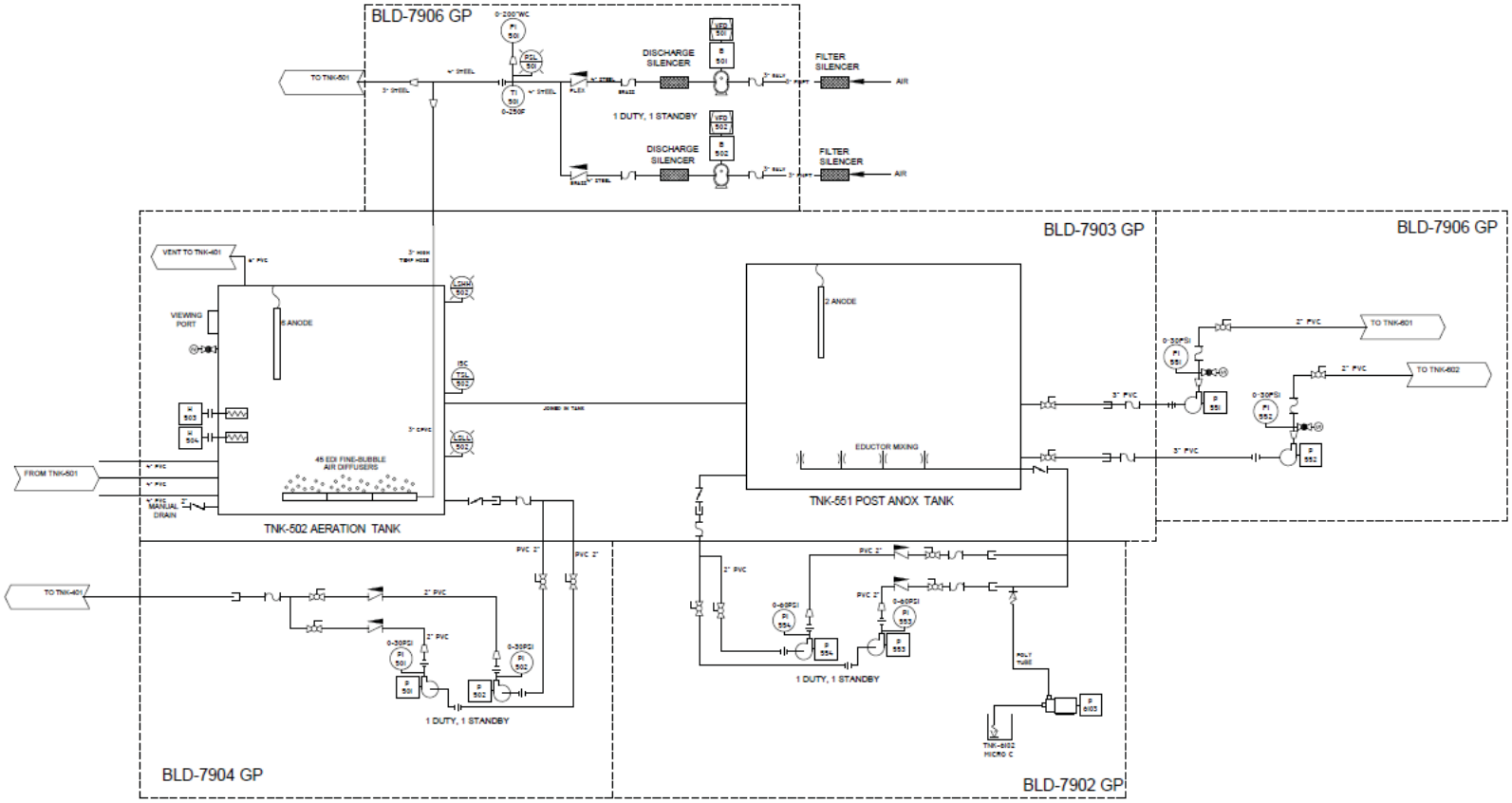

Figure 7 – Post Biological treatment

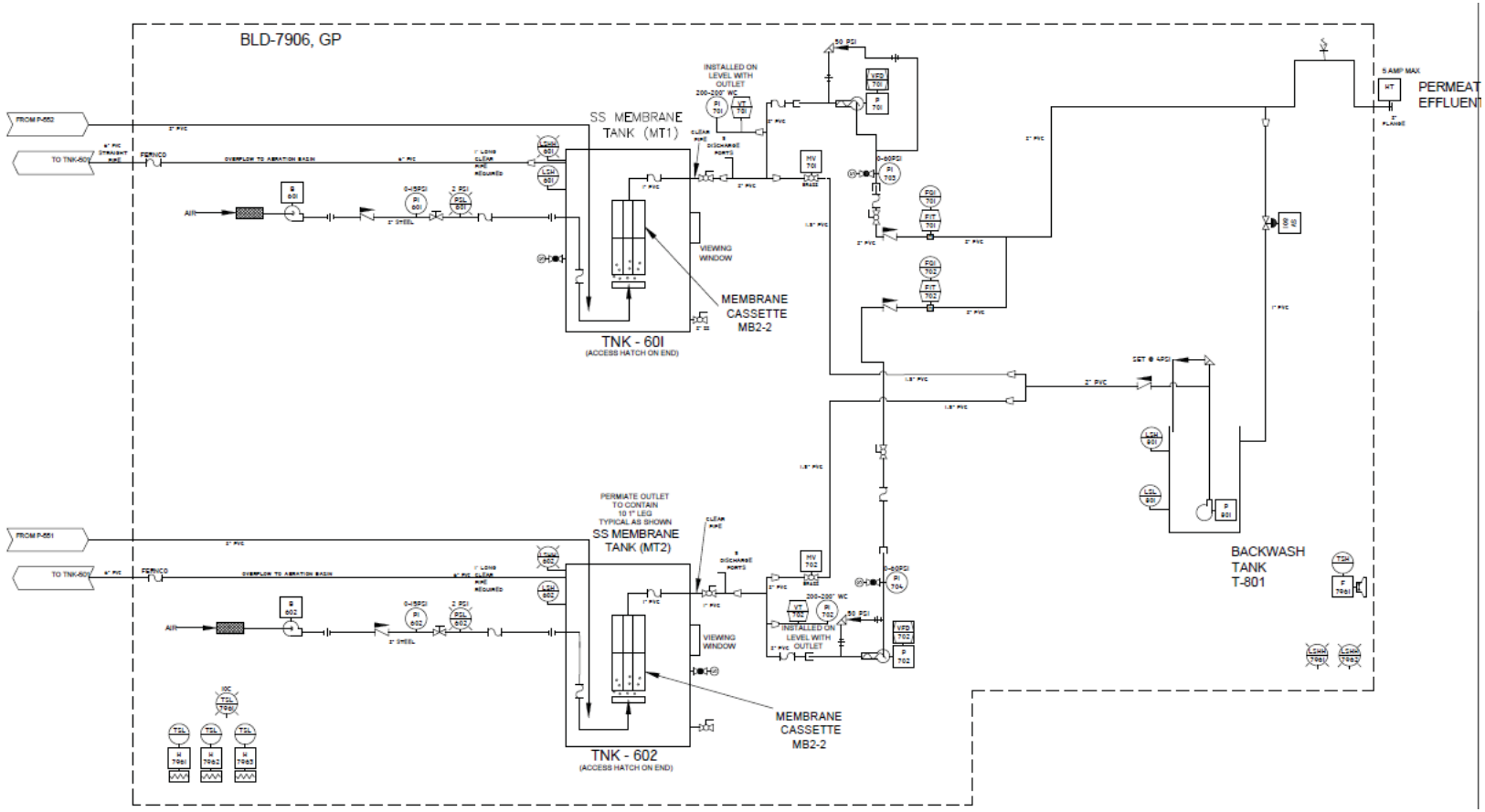

Figure 8 – Membrane filtration step

2.1.2 Process description

Oil and Grease (O/G) removal
Raw sewage from the kitchens entering the system can contain high levels of fats, oils and grease that can damage equipment and membranes downstream. To remove the oil and grease from the system a double trap grease interceptor is installed prior to the kitchen sewage entering the fine screen. Floating grease is removed via a vacuum truck hookup that will be used when the sludge tank is emptied. A pipe and vacuum truck hookup are also used to remove any debris that sunk to the bottom of the tanks. Vacuumed debris, oil and grease are to be disposed at the Meadowbank's tailings storage facility (TSF).

Fine Screening
Raw sewage entering the MBR system contains particulates and solids that could damage the equipment and membranes downstream. 0.5mm wedge wire fine screening protects the downstream equipment by removing large solids and fibrous material. Two screens are used for redundancy so that no unscreened influent enters the EQ tank. Redundant pumps are used to move the screened influent to the equalization tank.

Flow-Equalization
Throughout the day the flow and strength of the sewage will vary. To accommodate this, an equalization tank will buffer the flow and homogenize the loading. The equalization tank is aerated to maintain an aerobic environment to reduce odors and to maintain suspension of solids and pumps transfer sewage to biological treatment. This tank is provided with tank heaters. All wetted materials in this tank are either stainless steel or polypropylene to eliminate the possibility of corrosion. In addition, the tank has two liners, one primary, one secondary, with interstitial monitoring, providing the protection of a double wall tank.

Biological Treatment
In the anoxic zone, the pre-treated sewage is combined with return activated sludge from the aerobic tank and is kept mixed while maintaining a low level of dissolved oxygen (DO). Denitrification occurs as specific microorganisms convert nitrates to nitrogen gas – reducing the total nitrogen (TN) in the mixed liquor. Additionally, the anoxic stage optimizes the biological treatment process, which recovers alkalinity, aids in stabilizing pH, and improves energy efficiency by reducing overall aeration demand. In the aerobic zone, fine bubble diffusers create an aerobic environment where the organics contributing to biological oxygen demand (BOD) and ammonia are oxidized by the biology. Dissolved oxygen is continuously measured and aeration blowers controlled to maintain it in the range of 2 to 3 mg/L for process optimization and energy savings. In the post-anoxic zone, return activated sludge from the aerobic tank is kept mixed while maintaining a low level of dissolved oxygen (DO). The denitrification process continues in the post anoxic zone to reduce the TN even further.

Phosphorous Reduction
Chemical precipitation is used to remove inorganic phosphate. An aluminum sulphate or "Alum" solution is dosed into the mixed liquor causing dissolved phosphate to precipitate and coagulate. The suspended phosphate cannot pass through the Newterra MicroClearUltra Filtration membrane (UF), and the phosphate is eventually removed from the system as a solid with the waste activated sludge (WAS).

Membrane Filtration
After being treated biologically, the treated effluent is separated from the mixed liquor and solids by the Newterra MicroClear membrane modules and the permeate extraction system. The membrane

modules are continually air scoured to induce flow of mixed liquor over the flat sheet membrane surface and prevent fouling and buildup of solids on the membrane surface without the use of chemicals. The mixed liquor is then transferred to the inlet of the biological treatment to maintain even distribution of solids throughout the system and to introduce activated biology to the raw sewage. Newterra MicroClear membranes are produced with true ultrafiltration membrane material with 0.04 µm pore size, which blocks all bacteria and most viruses. Secondary disinfection is not required to exceed effluent requirements. Figure 9 presents a schematic view of the UF process.

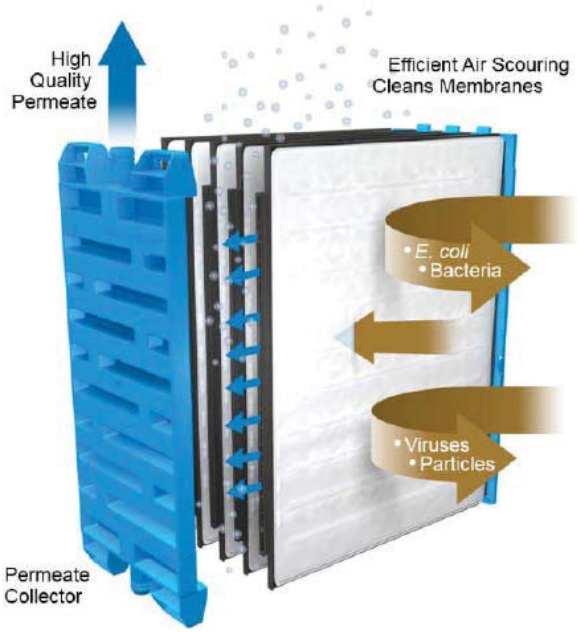

Figure 9 – Membrane filtration concept

2.1.3 Sludge Management Strategy

As solid-laden sewage enters the system and solid-free effluent is discharged, the suspended solids concentration in the mixed liquor suspended solids (MLSS) will increase. To maintain the proper level of MLSS, solids must be removed from the system as Waste Activated Sludge (WAS) which is mixed liquor discharged from the aerobic tank at approximately 0.8% dry. WAS is discharged to a tank for holding and decanting. The holding tank is aerated to maintain an aerobic environment to reduce odors. In the decanting process the WAS is allowed to settle and supernatant is pumped off, and returned to the MBR, thickening the sludge in the holding tank. By thickening the sludge to approximately 2% dry solids by weight, the total volume that must be disposed of is decreased, extending holding time and reducing operational costs. Level control in the tank indicates when the tank should be decanted or a vacuum truck should be scheduled to dispose of the WAS.

3 OPERATION AND MAINTENANCE

3.1 PUMPING

The system includes several pumps for the operation of the STP. All pumps are regularly inspected by the Operator who will ensure the pumps continue to operate efficiently and will address any deficiencies. If the pumps require maintenance, the Operator will report the situation and take appropriate action. Some of the pumps are installed with a standby unit that allows the Operator to switch from one pump to the other if necessary. In some specific situations, it may be necessary to temporarily shutdown the STP for servicing of the equipment.

A preventative maintenance program, as recommended by the pump supplier, will be followed to ensure the pumps are always kept in good working order.

3.2 SEWAGE COLLECTION

The sewage from the kitchen must pass through a grease trap (or similar facility for grease/fat removal). The large amount of oil and fat can harm treatment facility (e.g., clogging pumps and piping and cause foaming in the aeration tank). To avoid premature membrane fouling, maximum O/G concentrations should not exceed 30 mg/L.

The raw wastewater should not contain any of the following substances:

- Hydrocarbons – lubricants, gasoline, diesel, etc.;
- Paints, solvents, silica, silicon and polymers;
- Antibacterial solutions and products with quaternary ammonia;
- Large quantities of chemicals such as water softener, disinfectants, strong acids & alkalis, pesticides or photographic chemicals;
- Silicone based defoamers;
- Non-biodegradable solid waste (plastic, rubber products, disposable diapers, etc.);
- High amount of metals, such as iron, magnesium, calcium, barium and strontium.

3.3 SLUDGE DISPOSAL

Sludge will be disposed at Amaruq or Meadowbank site in the Waste Rock Storage Facility or the Tailings Storage Facility (Meadowbank only) or in a landfarm as a nutrient amendment as per the Water License Part F Item 3.

3.4 CONTROL

MBR (Membrane Bioreactor) treatment technology is an effective combination of an activated sludge biological treatment process with MBR membrane filtration technology. The STP can be operated in either manual or automatic mode. The system is designed to always run in auto mode. The manual option is provided mainly for maintenance purposes.

STP's control and automation system is based on several instruments measuring key parameter of the process, combined with a PLC. The STP don't require continuous operator intervention except for daily inspection and maintenance. The user interface can be accessed on-site from the control panel mounted touch-screen HMIs or remotely from a computer. Alarm messages can be set up to alert operators to issues.

The STP PLC is programmed to:

- Receive analogue and digital input signals from the switches and transmitters being controlled;
- Process the information using the structure and rules entered into the program;
- Generate outputs that control the equipment - turn equipment OFF or ON.
- Generate alarms if critical conditions are present
- Provide a HMI (Human Machine Interface) touch-screen for use of operator process monitoring and control.

More information are provided in the Operation and Maintenance Manual in Appendix.

3.5 REAGENTS

Some chemicals are required for treatment operation and also for Membrane cleaning. Chemicals will be used according to the MSDS recommendation. MSDS are provided in Appendix. Table 3 presents the estimated chemical consumption per year.

Table 3: Chemical consumption

Consumable		Usage Rate			
Purpose	Name	Value	Unit	Value	Unit
Supplemental Alkalinity	Dry Soda Ash	6.28	kg/d	2292	Kg/year
Phosphorus Removal	Liquid Alum, 48%	14.6	L/d	5346	L/year
Nitrate Removal	MicroC 2000	16.5	L/d	6025	L/year
Membrane Cleaning	Sodium Hyprochlorite, 12%	-	L/d	150	L/year

Sodium Carbonate (Soda Ash) is used for pH adjustment in case there is a deficiency in alkalinity in influent sewage and pH drops. It is hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation (lung irritant).

Sodium hypochlorite (NaOCl) and **Citric Acid** ($C_6H_8O_7$) are used for cleaning the membranes.

- Sodium hypochlorite is a common disinfectant, which can be an irritant or corrosive, depending on its concentration. It cannot be mixed with organics, ammonia compounds or acids. Contact with acids produces highly toxic chlorine gas. It has to be mixed only with pure water.
- Citric Acid is hazardous in case of skin contact (irritant, sensitizers), or ingestion, eye contact (irritant) and inhalation (lung irritants).

Aluminum Sulfate ($Al_2(SO_4)_3$) is used for Phosphorus Removal. Mild to moderate irritation can occur from unprotected contact. Aluminum is very poorly absorbed through the skin and toxic effects would not be expected following short-term skin contact. Inhalation of mists can be irritating to the respiratory tract and lungs.

MicroC 2000 is used for nitrate removal. Exposure to eyes may cause slight irritation. Exposure to Skin may cause slight irritation. Inhalation of high mist concentrations may cause irritation of respiratory tract.

3.6 BIOLOGICAL OPERATION

The following table presents target parameters required for a good operation of the STP.

Table 4: Biological system targets operational parameters

Parameter	Recommended	Range	Notes
MLSS (mg/L): Mixed Liquor Suspended Solids	10,000	8,000 – 15,000	Never operate the membranes if MLSS < 3,000 mg/l. Sludge wasting should be undertaken as required to maintain target MLSS
Temperature (°C)	15 - 35	10 – 35	Avoid sudden changes in temperature. Minimum operating temperature is 15 °C
pH	6.8 - 8.5	6.0 – 9.0	Membrane module can handle a change in pH. However it is recommended to keep pH between 6.8 - 8.5
Aeration Tank, DO (mg/L)	≥ 2.0	1.0 – 8.0	This can be maintained by adjusting the volume of air supplied to the aeration tank
Viscosity (mPa-s)	Not applicable	0 – 300	
Aeration Tank to Anoxic Tank Recirculation	400%	200 – 500%	
Membrane Tank to Aeration Tank Recirculation	400%	200 – 600%	
F:M (kg BOD/kg MLSS/d)	0.1	0.03 – 0.2	F:M = [Flow (m3/d) x BOD conc (mg/l)] / [Process volume (m3) x MLSS conc (mg/l)]
F:M (kg COD/kg MLSS/d)	0.15	0.05 – 0.3	F:M = [Flow (m3/d) x COD conc (mg/l)] / [Process volume (m3) x MLSS conc (mg/l)]
SRT : sludge retention time (days)	> 15	12 – 50	

3.7 MEMBRANE OPERATION

This section outlines the operating conditions that are required for proper sewage treatment, and longevity of the membranes.

Generally, the following points can be used to operate the MBR system properly:

- The MBR system is designed to treat wastewater with specified influent characteristics.
- Never operate the MBR tank below the minimum membrane submerged level. It is necessary to maintain a minimum of 250 mm liquid level above the membrane modules to ensure they are wet at all times and to allow for proper filtration.
- Always supply the required amount of air for scouring to the membrane module.
- Always filter sewage at or below design flow rate.
- Periodically, relax the membranes by ending filtration while allowing the membrane aeration scour to operate continuously and initiate backwash operation during membrane relaxation (default relaxation mode preset in PLC - permeation continues for 9 min and stops for 1 min).
- Always operate the MBR in accordance with the parameters listed in the supplier O&M Manual.
- Clean the membranes in-place with a dilute chemical in accordance with the supplier O&M Manual.

3.8 MEMBRANE CLEANING

In order to enhance life duration of the membrane, several cleaning are required as presented below.

In-situ Chemically Enhanced Backflush (CEB)
It is recommended that in-situ CEB be carried out before the trans membrane pressure (TMP) exceeds 0.25 bar (or permeability drops rapidly to 50 LMH/bar) This is typically done once every couple weeks/months depending on biomass characteristics and system operating condition. On certain occasions, membrane module/cassette may need to be physically inspected for membrane integrity if membrane permeability performance is not recovered after the cleaning (i.e., suspect of membrane deterioration). Hypochlorite is used for organic fooling and citric acid for inorganic acid.

Membrane Recovery Cleaning
The membrane recovery cleaning is to be done once a year at a minimum. On certain occasions, membrane cassette may need to be inspected for membrane integrity (suspect of membrane deterioration, membrane permeability performance does not recover after the cleaning, etc.).

- **Cleaning with High pH Solution:** This step is to be done if membrane fouling is a result of high fat, oil and grease. Sodium hydroxide can be used for this cleaning (400 mg/L, pH 12, 1 to 2 hours).
- **Cleaning with Sodium Hypochlorite** (500 mg/L free Cl_2, 12 hours)
- **Cleaning with Citric Acid** only in case of inorganic fouling (2 to 20 g/L during 2 h).
- **Checking Permeability.**

3.9 SERVICE WATER

For better cleaning performance, it is recommended to use:

- Potable water (permeate is acceptable if potable water is unavailable for the CEB cleaning),
- Water temperature is above 20^0C.

3.10 OPERATIONNAL PERFORMANCE TARGETS

The plant is designed to meet the following criteria presented in Table 5. Note that the treated water from STP is not directly discharged to the environment. The target concentrations presented in the following table for the treated water from STP, are set to limit effect on the receiving Environment after mixing with surface water into the Whale Tail attenuation pond and treatment in the AsWTP. There are no Water Licence criteria for the STP treated water. Reaching these values assure Agnico Eagle to operate the STP at a highest level of efficiency.

Table 5: STP treated water quality operational target

Parameters	Unit	Effluent
pH	s.u.	6.5 – 9.5
Oil, Grease	mg/L	<5
Biological Oxygen Demand (BOD)	mg/L	<25
Total Suspended Solids (TSS)	mg/L	<25
Total Kjeldahl Nitrogen (TKN)	mgN/L	-
Unionized Ammonia Nitrogen (NH3-N)	mgN/L	<1.25
Nitrate Nitrogen (NO3-N)	mgN/L	<5
Total Phosphorus (TP)	mgP/L	<0.5
Fecal Coliform	CFU/100 ml	<200
Total Residual Chlorine	mg/L	<0.02

3.11 GENERAL OPERATION & MAINTENANCE, SAMPLING PROCEDURES AND FREQUENCY

To ensure efficiency of STP, samples of water must be collected periodically. Table 6 presents sampling schedule to assess that STP performance comply with operational target values.

More samples can be taken at different locations in the plant to assess any default on STP operation.

Visual inspection is also important to verify STP operation. The following sign must be reported as soon as possible:

- **Plant Visual Checks Noise**
  During normal operation, there is a uniform humming sound at the plant. In case of an unusual noise, it could be an indication that the blower needs maintenance or repairs
- **Smell**
  The MBR is an aerobic system. During normal operation, the system has an earthy smell similar to that of a well-maintained compost pile. If other odors are noticed, the aeration process may not be operating or the system has been overloaded. Check the DO manually and the blower to verify the proper operation.
- **Effluent Aspect**
  Normally, the effluent is reasonably clear, colorless, and odorless. If the effluent becomes turbid, there is a pin hole in the membrane or a leakage in the piping. Take the unit out of operation and investigate. Check uniformity of membrane air distribution periodically to ensure air scouring is effective across all membrane plates.

Table 6: Monitoring program for operational efficiency assessment.

Parameters	Sewage	Aeration tank	Membrane tank	Effluent
Flow	daily			daily
Oil and Grease	As required			As required
Alkalinity	As required			
Biological Oxygen Demand	Weekly			Weekly
Total Suspended Solids	Weekly			Weekly
Total Kjeldahl Nitrogen / Total Nitrogen	Monthly			As required
Ammonia Nitrogen				As required
Nitrate				As required
Total Phosphorus	Weekly			Weekly
Mixed Liquor Suspended Solids (MLSS)			Weekly	
Mixed Liquor Volatile Suspended Solids (MLVSS)			As required	
Temperature		daily		
pH	As required	daily		Weekly
Dissolved Oxygen		daily		
Filterability			3 times weekly	
Turbidity				As required
Fecal Coliform / E-Coli				Weekly

Table 7 summarizes also Routine Operation and Maintenance Checkups. More details are provided in the supplier O&M Manual.

According to the water licence, Group 1 Parameters shall be analyzed four times per calendar year during operation and closure. The parameters are presented herein:

- pH, turbidity, hardness, alkalinity, chloride, fluoride, sulphate, total dissolved solids (TDS), total suspended solids (TSS), ammonia nitrogen, nitrite, nitrate, orthophosphate, total phosphorus, Total Metals (aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium and zinc).

Table 7: Routine Operation and Maintenance Checkups

Location	Item	Action	Comments
Grease trap	Periodic cleaning	As needed	Waste sent to Meadowbank TSF
Process	Visual check	Daily	Performance evaluation
	Flow rate in and out	Daily	
	Sampling	Daily / as requested	For water quality and performance evaluation
	Vacuum pressure on membrane	Daily	Evaluate Membrane fouling
Mechanical & process	Inspect Membrane	Weekly	
	Sensor cleaning and calibration	Weekly / yearly	
	Valves, fittings	Weekly	Prevent spill
	Membrane Cleaning	Quarterly/Yearly	Permeability recovery
	Aeration diffuser	Yearly	Process efficiency
	Pumps	Quarterly	Prevent spill
	Blower	Monthly	Process efficiency
	Screening device	Daily/ Weekly/ Quarterly	Prevent clogging, remove solid waste and dispose it
	Dosing pumps	Quarterly	Prevent spill
	Fan and heaters	Yearly	Health and safety of operator
Electrical	Leads	Quarterly	Health and safety of operator and Process efficiency
	Panel fan filter, inspection breaker, fuses, motor bold, clean dust	Monthly	Health and safety of operator Process efficiency
	PLC functionality	Weekly	Process efficiency

3.12 TROUBLESHOOTING AND MAINTENANCE PROCEDURES

MBR operation relies critically on the ability of the membrane unit to pass all flow incoming to the plant. If membrane permeability is impaired, the MBR plant cannot process all flow with potentially negative results even though effluent quality remains consistently high. Membrane fouling (and associated reduction of flux or increase of TMP) remains as an operational challenge.

Membrane fouling in MBR is a result of the interaction between the incoming water quality, mixed liquor filterability, system operation condition, and membrane material. There are four categories of membrane fouling.

Microbial/Biological Fouling
Microbial fouling is a result of the formation of biofilms on membrane surfaces. This structure protects bacterial cells from hydraulic shearing and from chemical attacks of biocides such as chlorine. Chemical cleaning would be required to restore permeability.

Particulate/Colloid Fouling
This type of fouling may be associated with high concentrations of colloidal solids present in mixed liquor. In most cases, particles and colloids do not really foul the membrane because the flux decline caused by their accumulation on the membrane surface is largely reversible by hydraulic cleaning measures such as backwash and air scouring. However, the accumulation of solids between the membranes can create increased membrane resistance to permeation and permanent physical membrane damage.

Inorganic Fouling
Inorganic fouling or precipitative fouling is caused by the accumulation of inorganic precipitates such as metal hydroxides, and “scales” on membrane surface or within pore structure. Chemical cleaning will be required in that case.

Organic Fouling
Organic fouling is the attachment of materials such as oil or grease to the membrane surface. Oil and grease trap will prevent this type of fouling and chemical cleaning is also achievable to restore permeability.

Excessive foaming (white foam accumulating over the liquid surface) in aeration and/or membrane tanks could also reduce performance of the STP. Remediation should be taken to eliminate foaming agent or restore design parameters of the plant.

Permeate bad quality can also indicate default in MBR membrane and operation.

Finally, biological system can also indicate default in operation.

- Black color of biomass indicates a lack of aeration,
- Increase of bacteria quantity in the reactor indicates a low sludge wasting,
- Unpleasant odor can indicate overload of the system, blower failure, etc.
- Water quality not achieved: Mixed liquor characteristics are not within proper operating standards.

Further details are available in the manufacturer’ operating manuals in Appendix.

3.13 RECORD KEEPING

Records of the operational, maintenance and sampling procedures will be kept daily in order to assist in the evaluation of the effectiveness of the STP.

The following will be recorded on a daily basis:

- Volume of effluent discharged to the whale tail attenuation pond;
- Sewage volume collected;
- Details of any maintenance undertaken at site;
- Volume of sewage sludge removed from the STP;
- Locations and methods of sewage sludge disposal;
- Water quality parameter results required to follow the STP performance.

The record sheets will be kept in the STP office.

3.14 SAFETY PROCEDURES FOR OPERATORS

Operators working in the STP facility must be trained prior to work so that they are aware of the health and safety risks as well as the operational procedures associated with the STP. The following are important safety considerations:

- The wastewater contains a mixture of viable bacteria and other biological organisms. A wastewater treatment plant poses a number of bacterial hazards and consequently potential health risk. Immunization protects operator against infection. The use of proper hygiene measures, protective equipment, good housekeeping and common sense prevent contact with pathogens. Ensure that hands are washed with an antibacterial soap and warm water and dried by disposable towels on a regular basis, especially prior eating. Do not expose cuts or open sores to wastewater. Any concern about possible infection should be brought to the attention of medical physician immediately.
- Follow local laws and regulations with respect to entering a confined space.
- Working within the plant, especially with chemicals, requires adequate personal protective equipment (PPE) for Operators. This includes wearing steel toed boots, hard hat, rubber aprons, safety glasses with side shields and gloves.
- Operators are required to conduct good housekeeping of the working area to minimize the risk of incidents.
- Lock-out/tag-out procedures must be applied when servicing equipment.
- The MSDS for reagents used in the STP will be readily available for the operator at all times.
- Eyewash stations are located within proximity of reagent systems in the STP.

3.15 CONTROLLING ACCESS TO THE STP

Access to the STP will be restricted to authorized personnel only. Signs will be posted at the STP entrance.

4 EMERGENCY RESPONSE

4.1 FIRE

In case of fire at the STP, the on-site emergency response team (ERT) will be notified as per Agnico Eagle's protocol. Instructions from the on-site emergency response team will be followed by all personnel at the STP. Further details of fire response are provided in the "*Risk Management & Emergency Response Plan*". The STP will include the necessary fire safety protection measures in accordance with the Nunavut and North West Territories Mine Act.

4.2 SPILL

In the event of a spill at the STP, the Environment Department will be notified immediately and provide support, as required. In the event of a large spill, the on-site ERT will be notified as per Agnico Eagle's protocol. Instructions from the ERT will be followed by all personnel at the STP. All spill will be reported and treated according to the "*Spill Contingency Plan".*

4.3 PLANT MALFUNCTION

If there is a major problem or failure in the STP it would be most likely due to changes in the influent (raw sewage) (i.e. high strength sewage (BOD high) killing bacteria in the STP) or membrane failure. In this case, there would be visible effluent problems (part of daily operational checks), poor water quality, and increased odours that the operator would note. If this occurs, a sample will be taken to try to determine the source of the problem.

The following other contingent measures can be applied by Agnico Eagle in the event of a malfunction at the STP:

- Cut back on allowable camp water until the malfunction is corrected and use the equalization tank to retard the peak flow;
- Shut down the malfunctioning unit until the malfunction is repaired and use only one of the two parallel units until repairs are completed (for equipment in parallel);
- Bypassing untreated STP influent around the malfunctioning unit. Sucker truck can collect sewage from the equalization tank and carry it to Meadowbank facilities. Sewage would then be stored into the Tailing storage facility or would be treated into the sewage treatment plant (STP) at Meadowbank depending on the available capacity remaining.
- Shut down temporarily all water use in the camp until the repairs are completed;