HOPE BAY PROJECT DOMESTIC WASTEWATER TREATMENT MANAGEMENT PLAN

HOPE BAY, NUNAVUT

March 2022

Hope Bay Project Domestic Wastewater Treatment Management Plan

Plain Language Overview:

This Domestic Wastewater Treatment Management Plan describes the management and monitoring obligations for wastewater treatment plants at Hope Bay during all project phases. The plants are designed to remove contaminants from the sewage and greywater produced at Agnico Hope Bay Project sites. The wastewater treatment plants are an integral part of the site facilities required for continued exploration, mining, and infrastructure development of the Hope Bay Project.

Hope Bay, Nunavut

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Revisions

Revision #	Date	Section	Changes Summary	Author	Approver
0	July 2008		Initial version of Doris North Sewage Management Plan submitted in accordance with Type A Water Licence 2AM-DOH0713 and Type B Water Licence 2BE-HOP0712	Newmont, Hope Bay Mining Company Ltd. (SRK)	HBML
1	March 2009	Throughout	Doris North Infrastructure Project Sewage Management Plan submitted in accordance with Type A Water Licence 2AM-DOH0713 and Type B Water Licence 2BE-HOP0712	Newmont, Hope Bay Mining Company Ltd. (SRK)	HBML
2	March 2012	Throughout	Updated Waste Water Treatment Management Plan for Doris North, added Sanitherm® system, removed Matrix Camp and submitted in accordance with Type A Water Licence 2AM-DOH0713	Newmont, Hope Bay Mining Company Ltd.	HBML
3	October 2012	Throughout	Included use of old discharge point, discharge to overburden pile as per approvals from AANDC and submitted in accordance with Type A Water Licence 2AM-DOH0713. Approved Waste Water Treatment Management Plan under 2AM-DOH1323	Newmont, Hope Bay Mining Company Ltd.	HBML, NWB
4	March 2014	Throughout	Transfer of ownership and re-activation of construction activities. Revised Doris North Wastewater Treatment Management Plan in accordance with Type A Water Licence 2AM-DOH1323	TMAC	TMAC
5	March 2016	Throughout	Changes to document structure for operational suitability and efficiency, including addition of licence specific module.	TMAC	TMAC
6	February 2017	Throughout	Revised to include information requests from reviewer comments.	TMAC	TMAC
7	November 2017	Throughout	Revised to reflect operational status of Doris North project. Addition of Module B: Windy as per license 2BE-HOP1222. Addition of Module C: Madrid and Module D: Boston	TMAC	TMAC
8	March 2022	Throughout	Update to Agnico	AEM	AEM

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Glossary

Term	Definition
NWB	Nunavut Water Board
INAC	Indigenous and Northern Affairs Canada
BOD	biochemical oxygen demand
CIP	clean in-place
DOE	Department of Environment
ERT	emergency response team
GN	Government of Nunavut
GNWT	Government of the Northwest Territories
KIA	Kitikmeot Inuit Association
MBR	membrane biological reactor
MLSS	mixed liquor suspended solids
MSDS	material safety data sheets
NWB	Nunavut Water Board
QA/QC	quality assurance / quality control
TIA	Tailings Impoundment Area
UV	ultra violet
WTP	wastewater treatment plant

1 Introduction

This Domestic Wastewater Treatment Management Plan (the Plan) has been prepared by Agnico Eagle Mines (Agnico) in accordance with the Nunavut Water Board (NWB) water licence forthe Doris Project.

The Plan is intended primarily for use by AGNICO and its contractors to ensure that best practices for the operation of wastewater treatment plants (WTP) are followed, and that the conditions of water licence and project permits are met in all project phases.

This Plan is structured in a manner such that the main document outlines Agnico's approach to wastewater management as it pertains to all Agnico Hope Bay developments and the subsequent modules provide details specific to each project's Water Licence. In the event of a new water licence, or an existing licence amendment, only the module pertaining to that licence will need to be revised. Thisis intended for consistency and efficiency across operations and for compliance management. This Plan has been constructed to be suitable for the construction, operations and care and maintenance phases of all Agnico Hope Bay developments, and is appropriate for the currently proposed Project amendments.

1.1 Objectives

The main objective of this Plan is to ensure wastewater treatment plants are operated in a safe, efficient and environmentally compliant manner. Consistent with Agnico's intent to be a responsible operator, these objectives are described as follows:

- Compliance with Project Certificate and Water Licence requirements and applicable regulations;
- Prevention of public health risk;
- Protection of the operator;
- Protection of surface and ground water;
- Protection of land, local flora and fauna; and
- Conservation of water.

The Domestic Wastewater Treatment Management Plan has been developed to ensure that these factors are built into the Agnico operational approach at Hope Bay.

1.2 Relevant Legislation and Guidance

Table 1.1. List of regulations and guidelines pertinent to the domestic wastewater treatment management plan

Regulation	Year	Governing Body	Relevance
Environmental Protection Act	2011	Government of Nunavut (GN), Department of Environment (DOE), Environmental Protection division	Legislation to authorize discharge of wastewater
Environmental Rights Act	2011	GN, DOE, Environmental Protection division	Grants all residents the ability to launch an investigation
Camp Sanitation Regulations, *Public Health Act*	2006	GN, Department of Health and Social Services	Regulation sets minimum sanitation standards
Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories	1996	Government of the Northwest Territories (GNWT), Department of Municipal and Community Affairs	Guidance on developing an operation and maintenance manual
Environmental Guideline for Industrial Waste Discharges	2002	GN, Department of Environment	Guidance on effluent wastewater quality
Guidelines for the Disposal of Domestic Wastewater in Nunavut	2000	Nunavut Water Board (NWB)	Generic guidelines for wastewater effluent quality

1.3 Related Documents

Table 1.2. List of documents related to the hope bay domestic wastewater treatment management plan

Document Title	Relevance
Hope Bay Project Spill Contingency Plan	Spill response procedure
Hope Bay Project Incinerator Management Plan	Sludge disposal
Hope Bay Project Quality Assurance and Quality Control Plan	Discharge monitoring
Hope Bay Project Hazardous Waste Management Plan	Proper handling and disposal of hazardous chemicals to divert these materials from entering the wastewater treatment system
Sewage Treatment Plan Operation, Testing, Sampling and Monitoring Standard Operating Procedure	Safe operating procedures that outline operation, service, sampling and inspection of the Sewage Treatment Plan

1.4 Plan Management

The Chief Operating Officer (COO) has overall responsibility for implementing this management plan and will provide the on-site resources to operate and maintain all wastewater treatment plants located in the Hope Bay Belt in accordance with the operation manuals and regulatory requirements.

The Mine General Manager (MGM) is responsible for implementing this management plan and providing on-site resources to operate, manage and maintain the WTPs in accordance with this management plan and the WTP operational manual.

The Site Services Supervisor is responsible for revising this management plan in consultation with the environmental coordinator and will conduct regular inspections of the WTP, audits of the maintenance records, and will provide input on modifications to design and operational procedures to improve operational performance of the facility.

The Environmental Coordinator will conduct sampling of the treated wastewater, report on the performance of the wastewater treatment facilities, and assess whether the treated wastewater has met applicable regulatory standards. The Environmental Coordinator will provide direction to operational personnel as to storage and disposal of the WTP sludge.

WTP Operator is responsible for providing input on modifications to design and operational procedures to improve operational performance of the WTP facilities. The Operator will provide technical expertise for the operation and maintenance of the facilities and maintain all WTP records.

2 Management Issues

2.1 Appropriate Domestic Wastewater Treatment

Appropriate wastewater management can lower environmental risks and minimize wildlife attractants. There are several methods of wastewater treatment used in Nunavut.

2.1.1 Management Response

All sewage and greywater generated at Hope Bay is collected and treated in Wastewater Treatment Plants as required in the associated Water Licences for the Hope Bay Project. Agnico has chosen to operate mechanical treatment plants and the models used are based on the anticipated volume of wastewater to be produced. The WTP treats and removes contaminants (organic, inorganic, and bacteria) from wastewater generated from toilets, showers, sinks and kitchen facilities. The treatment process produces two separate waste streams: a clean waste stream (or treated effluent) suitable for discharge back into the environment; and a solid waste (or sludge) suitable for proper disposal.

2.2 Compliant Facility Operations

Thorough knowledge of the operation and maintenance of the WTP is required to properly operate the plant and achieve compliant effluent discharge limits.

2.2.1 Management Response

Agnico has designated operators familiar with the function of the WTPs who manage all aspects of the plant and perform the routine maintenance as specified by the manufacturer in the Operation and Maintenance Manual for each WTP unit. New operators are provided with mentoring and on-the-job training by an experienced operator.

2.3 Compliant Effluent Discharge and System Upset

Effluent discharged to tundra must meet water quality discharge criteria as outlined in the water licence and be discharged in a manner as to not cause erosion. Hazardous chemicals entering the wastewater stream can cause environmental damage when not treated properly and can damage the WTP biological membrane systems. A failure of the WTP system or overwhelming the capacity of the system can lead to the production of non-compliant effluent.

2.3.1 Management Response

Effluent quality and quantity is monitored during daily operations, and WTP operators adjust WTP settings as effluent quality fluctuates. Monitoring equipment, such as pH meters, are calibrated regularly to ensure accurate readings are obtained during monitoring activities, and microorganism activity and abundance is assessed to evaluate the efficiency of the biological treatment system.

Effluent samples are collected by the Environmental Coordinator as prescribed under the applicable licence or if there are suspected issues with the effluent quality based on daily monitoring conducted by

the WTP operator. These samples are submitted for analysis at an accredited laboratory and compared to discharge criteria outlined in the water licence.

If water quality samples indicate the effluent is not compliant with these discharge criteria or if monitoring activities conducted by the operators indicate there is an issue with the WTP system, discharge to the tundra is stopped until the cause of the issue is identified. Adjustments are made to the operational settings of the WTP and additional sampling is conducted. Storage tanks on site are available to store non-compliant effluent or this effluent may be directed to the TIA until issues with the WTP operation are identified and repaired.

Discharge locations on rock outcrops are preferentially selected to minimize impacts of effluent discharge to the receiving environment. Diffusers are installed on the end of discharge lines and are designed to reduce the discharge energy, disperse the effluent and minimize erosion or vegetation damage from ice build-up downstream of the discharge location. Discharge locations are approved by the Inspector.

Hazardous chemicals are diverted from the wastewater stream and are handled as per the Hazardous Waste Management Plan and standard operating procedures that address proper storage, handling and disposal of hazardous materials. Personnel working at the Hope Bay site are provided on-site training in the handling of these materials and are given instructions for proper disposal of hazardous materials related to their tasks. All personnel are also educated on what cleaning agents are not suitable for use in sinks, toilets, showers and laundry machines.

2.4 Wildlife Interaction

Sludge generated as part of the WTP processing is an attractant to wildlife and must be disposed of in a manner that is not accessible to wildlife.

2.4.1 Management Response

Sludge is removed from the WTP and is transported directly to the TIA for disposal. Agnico will continue to explore alternative methods of sludge disposal which may include incineration of dried cake or disposal into the landfill once constructed.

2.5 Exposure to Pathogens

Sewage and greywater have the potential to contain pathogens that can be transmitted to operators working with WTP units.

2.5.1 Management Response

Employees working in the WTP facility are trained prior to the commencement of work to be aware of the health and safety risks associated with the wastewater treatment. The following two absolute points of compliance are part of the training program:

- No person is to drink the water in the WTP or the water that is discharged from the plant.

- Working with wastewater requires adequate protection for operators that includes wearing steel toed boots, protective goggles, and protective gloves. Face shields should be used if there is a risk of wastewater or sludge being splashed near the operator's face.

Operators and workers assisting with operation or maintenance of the WTP must have current Hepatitis A and B vaccinations.

2.6 Exposure to Chemicals

Operation of the WTPs involved the handling and use of a number of oxidizing chemicals that could pose hazards to operators working with these units.

2.6.1 Management Response

Before handling and using any chemicals, the appropriate material safety data sheets (MSDS) must be reviewed (MSDSs are available in each WTP building). When handling chemicals operators should wear protective goggles, protective gloves and any other personal protective equipment as described in the MSDS. First aid and emergency response procedures described in the MSDS are to be followed. Chemicals required for the operation of each WTP will be used according to manufactures specifications.

2.7 Monitoring and Evaluation

Monitoring requirements associated with the applicable water licences are described in the appended modules. The objective of discharge monitoring is to:

- Measure the performance of the WTP;
- Ensure treated water from the WTP meets the appropriate discharge limits; and
- Assess water quality in the receiving water environment.

2.8 Documentation and Reporting

Records of operation and maintenance are required to evaluate the effectiveness of the WTP operation. Daily logs completed include the following information:

- Volume and flow rate of discharge, and discharge location of effluent discharged to environment;
- Sludge volume removed from the plant;
- Sludge disposal location/method; and
- Details of any maintenance undertaken at site.

Agnico is required to report the volumes of WTP effluent discharged, volume of sewage sludge removed from the WTP and the results of effluent quality sampling outlined in the applicable licences in monthly and annual reports submitted to the Nunavut Water Board.

3 Contingencies

3.1 Treatment Option Contingency

During Hope Bay Project operations, if a WTP becomes inoperable or requires maintenance, a second unit is available. In the event that both units become inoperable Agnico will utilize multiple holding tanks available onsite to hold untreated wastewater. Overflow tanks located at the WTP have a total capacity of 27 m^3. Agnico would also place restrictions on water usage to minimize the amount of wastewater produced. Based on the maximum average use when the Doris Camp is at full capacity, these tanks would provide approximately 4 days of operational capacity based on a 75% reduction in domestic water use (i.e., showers, laundry, etc.). In addition, a 14 m^3 vacuum truck is available for storage or transportation of the untreated sewage to another holding tank or the TIA if required.

If required, they may also reduce the number of people at camp by providing off-site housing. Untreated wastewater stored temporarily would later be fed into the plant once repaired at a rate appropriate for effective plant treatment.

3.2 Spill Response

Only small quantities of chemicals are maintained on hand for the WTP. In the event of a minor chemical spill, the MSDS instructions for containment and cleanup are followed and the incident must be reported to the environmental and health and safety departments. In the event of a large chemical spill, the emergency response team (ERT) are called and cleanup crew members follow the direction of the ERT. Spills of raw or partially treated wastewater are managed following the same procedure.
The details for the spill response procedures are included in the Hope Bay Spill Contingency Plan (Agnico 2022b).

All spills are internally reported, and any meeting Nunavut and Northwest Territories' spill reporting requirements will be reported to the spill line as required and will be included in the monthly and annual reports for the water licence.

4 Responses to Comments Received on Previous Plan Versions

This Plan replaces the 2014 Wastewater Treatment Management Plan for the Hope Bay Project. Table 4.1 below outlines the comments received on the previous version of this Plan and Agnico's responses.

Table 4.1. Comments received on the previous version of this Plan and Agnico's responses

Reviewer	#	Section	Comment	Recommendation	Response
INAC	1	Section 2.4.1 & A2.2.2	Three options are presented in the plan for the disposal of sewage cake/sludge: "*Sewage sludge is incinerated in accordance with the Incinerator Management Plan, or buried in the overburden pile or beneath tailings in the Tailings Impoundment Are when it is constructed. Sewage sludge that will be stored for disposal in the overburden stockpile or in the Tailings Impoundment Area will be placed in biodegradable bags and stored securely at the waste management facility in a manner that will prevent wildlife from accessing the sludge until such a time that it can be disposed of in these locations."* The plan provides no details as to timelines for the use of different options. Nor does the plan mention what measures will be taken to contain nutrients or pathogens that might leach from the cake if it is to be buried in the overburden stockpile. It is also not clear what water containment measures are present around the overburden stockpile.	INAC recommends that the licensee be required to notify the NWB which disposal method be used or timelines for the use of different methods if they will be changed. The chosen disposal method would subsequently be included in an updated wastewater treatment management plan that would be submitted to the NWB for approval, including the location of the sludge burial is that was the option chosen, and a description of the measures taken to contain leachate will be necessary if sewage cake is being buried in overburden.	This topic is addressed in sections 2.4.1 and A2.2.2.
INAC	2	A2.1.4, Figure A1	There appears to be an inconsistency in the text with regards to the discharge out of the membrane biological reactor (MBR). The permeate pump is the last component of the MBR and the text states: "*The effluent removed by the permeate pump is discharged (to the tundra), while overflow from the MBR tank is recycled back to the anoxic tank."* However, the following sentence adds *"After the MBR, the treated effluent is pumped through the UV disinfection modules",* which also appears to be the case in figure A1.	INAC recommends that the text be modified so that it is clear if the MBR discharge is routed through a UV disinfection module before being discharged to the tundra.	Section A2.1.4 has been modified to provide clarity on effluent flow sequence.

Reviewer	#	Section	Comment	Recommendation	Response
INAC	3	A2.2.1	The management plan states: *"Prior to entering operations the effluent discharge from the WTP occurs from the effluent discharge trailer through a pipeline to a discharge point located on a rock outcrop (UTM 432125E 7559324N) approximately 1 km northwest of the Doris Camp (Figure A2)."* Figure A2 showing disposal location of treated is not available in the plan.	INAC recommends that the licensee include Figure A2 in the plan to identify the disposal location of the treated wastewater.	Figure A2 has been added to section A2.2.1 of the plan.
INAC	4	A2.2.1	The closest water body to the wastewater treatment plant primary and secondary discharge locations is described as Glenn Lake, located over 1 km away. According to the site map there is a body located at UTM 432187E 7559000N, which is much closer than Glenn Lake. If Glen Lake is the nearest body in the downstream direction of the discharge location, this should be clarified, if not the closer water body should be referenced.	INAC recommends that the licensee clarify the statements about the water body closest to the wastewater treatment plant discharge locations. Including a figure, such as suggested in comment#3, could help illustrate the position of the water bodies relative to the discharge locations.	Glenn Lake is in fact the closest downstream water body in proximity to the effluent discharge location. Wording in section A2.2.1 has been modified to provide clarity.
INAC	5	Section 1.2, Table 1, Section A2.2.1	Domestic is repeated in the last entry of the table. A digit is missing in the northing of the UTM coordinates in the third paragraph of this section.		Both typos have been corrected.
ECCC	1	Section 2.4.1, Section 4, Table 3, EC29, A2.2.2	Several methods for the disposal of sewage cake from the water treatment plant are proposed in the plan. Contrary to TMAC's response to EC 29 (Table 3) the proposed sewage sludge management options outlined in section A2.2.2 of the revised plan still includes incineration. ECCC is of the opinion that incineration should not be included as a sewage cake disposal option unless the incinerator is specifically rated for incinerating sewage sludge.	ECCC reiterates comment EC 29 (Table 3 pg 9) by recommending that the proponent dispose of sewage cake by means other than incineration. In the event that incineration is to be used the proponent should demonstrate that the incinerator is capable of consistently meeting the design emissions ratings when processing sewage cake before sewage cake is added to the incineration waste stream	Sections 2.4.1 A2.2.2
ECCC	2	Section 4 EC 31 (previous revision)	In EC 31 the Department recommended that the proponent adopt the best practices of confirming that the waste water treatment plant effluent meets the discharge criteria prior to release to the receiving environment. The proponent responded that it would not be feasible to store effluent in monthly quantities.	ECCC recommends that wastewater be directed to the TIA, once able to do so, in order to have further control over the effluent quality that is released to the receiving environment	Noted. TMAC are exploring the means to direct wastewater to the TIA.

Reviewer	#	Section	Comment	Recommendation	Response
ECCC	3	Section 3.1	In section 3.1 the Plan indicates that "During Hope Bay Project operations, if a WTP becomes inoperable TMAC will use multiple bladders and holding tanks available onsite to hold untreated wastewater". While ECCC is encouraged that contingencies will be in place to manage wastewater in the event of a plant failure the Plan currently contains insufficient detail to determine if the proposed mitigation is adequate.	ECCC recommends that TMAC provide more detail regarding the available storage volume and the storage format to be used in the event of a WWT plant failure. ECCC also recommends that TMAC provide an estimate of how long the alternative management option (storage) could be maintained if the proposed water use reduction strategies are implemented.	Additional details have been provided in section 3.1 of the plan.
ECCC	4	Section 4, Table 3	ECCC is of the opinion that clarification of the response to EC #31 regarding "Wastewater Treatment Plant monitoring and reporting" is required. The reponse to EC 31 states that "if effluent quality is suspect, tundra discharge is stopped until the cause can be identified, corrected and compliant laboratory results recived"; and Section 2.3.1 of the Plan states that suspected issues with the WTP effluent quality are to be identified and addressed based on the daily monitoring conducted by the WTP operator. However, it is unclear what indicators or critical parametrs would be used to detect suspect effluent or if procedures will be in place for the WTP operator to use to address issues.	ECCC recommends that TMAC clarify: what criteria/indicators will be used to identify suspect effluent; what procedures will be available to the operator to rectify the problems; how long it will take for confirmatory laboratory results to be obtained and how the suspect effluent will be managed while waiting for those test results.	Additional details and clarification have been provided in section A3.2.1.
ECCC	5	Section A2.2.1	When reviewing the Plan ECCC noted that Figure A2 is referred to in the text but it is not included in the report.	Figure A2 should be added to the Plan.	Figure A2 has been added to section A2.2.1.

5 References

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AGNICO EAGLE
HOPE BAY

HOPE BAY PROJECT DOMESTIC WASTEWATER TREATMENT MANAGEMENT PLAN

HOPE BAY, NUNAVUT

Module A: Doris

Conformity Table

Licence	Part	Item	Topic	Report Section
2AM-DOH1323	D	19	The Licensee shall operate the Wastewater Treatment Plant in accordance with conditions provided in Part G, Item 4 with compliance at monitoring station ST-8 during discharge to the tundra.	Section A3.2
	G	4	The Licensee shall operate the Wastewater Treatment Plant in accordance with the following:	See below
		4. a	All sewage and greywater shall be collected and treated in the Wastewater Treatment Plant;	Section 2.1.1 and A1.2
		4. b	All Effluent discharged from the Domestic Wastewater Treatment Plant to tundra at monitoring station ST-8 shall not exceed the following Effluent quality limits;	Section A3.2
		4. c	All Effluent discharged from the Domestic Wastewater Treatment Plant to the tundra shall be discharged to the west of the facility laydown areas or as otherwise approved by the Board in writing;	Section A2.2.1
		4. d	Once the Tailings Impoundment Area is operational, all treated Effluent from the Domestic Wastewater Treatment Plant shall be discharged to the Tailings Impoundment Area, or as required, as per Item 3(c) to the tundra provided the criteria set out in 3(b) are met; and	Section A2.2.1
		4. e	The Licensee shall provide at least ten (10) days written notice to the Inspector prior to any planned discharge from the Domestic Wastewater Treatment Plant to the tundra. The notice shall include the volume proposed for discharge and the discharge location.	Section A2.2.1
	J	11	The Licensee shall measure and record all flow and volume measurements on a monthly basis, during the operations, and any use of water (unless otherwise stated):	Section 2.8 and A3.1
		11. g	The volume of sewage sludge removed from the Wastewater Treatment Plant and the locations or method of sewage sludge disposal during construction, operation and closure.	Section 2.8 and A3.1
		18.	The Licensee shall visually monitor and record observations, to be made available to an Inspector upon request, during periods of discharge onto the tundra from:	see below
		18. e	Domestic Wastewater Treatment Plant (on a weekly basis).	Section A3.2
		19.	The Licensee shall, within thirty (30) days following the month being reported, submit to the Board a monthly monitoring report in an electronic format. The Report shall include the following:	see below
		19. a	All data and information required by this Part and generated by the Monitoring Program in the Tables of Schedule J.	Section 2.8 and A3

Contents: Module A

A1 Introduction

A1.1 Background

The Type A Water Licence No. 2AM-DOH1323 issued to Agnico by the Nunavut Water Board (NWB) allows for the management and disposal of wastes associated with Wastewater Treatment Plants (WTP).

Agnico is required to operate the WTP in accordance with Part G (Item 4) of the Licence. The Domestic Wastewater Treatment Management Plan has been prepared and is being submitted by Agnico to address the requirement specified in Part G, Item 3 of the 2AM-DOH1323 Water Licence, and also includes the plan for wastewater management throughout the Hope Bay belt. This Plan has been developed such that it will remain applicable to all Project phases, with revisions being submitted as necessitated by changes that may occur or to reflect improvements in operational practices.

A1.2 Overview of Doris Wastewater Compliance

All wastewater produced at Doris North is collected and managed through the Wastewater Treatment Plants located at the main Doris Camp facility. Domestic wastewater treatment under Agnico has improved significantly since activity resumed at the site in 2013. Water quality sampling has shown that careful plant operations are capable of producing effluent quality that is in compliance with discharge criteria outlined in Water Licence 2AM-DOH1323.

A2 Domestic Wastewater Treatment Plant Management at Doris

A2.1 Membrane Biological Reactor Wastewater Treatment Plant Process

The Doris Camp has two modular Sanitherm® membrane biological reactor (MBR) WTPs housed in multiple 40-foot long containers. Each plant has the capacity to manage the average waste volume generated by 150 people as well as the capacity to accept raw wastewater and sludge from other WTPs into its surge and conditioning tanks. A third MBR WTP is available onsite as a contingency plant in the event that one WTP malfunctions. These plants are maintained and replaced as necessary to ensure continued discharge compliance.

The MBR WTP consists of the following major processes:

- Pre-treatment—primary settling and equalization;
- Biological treatment and effluent separation—anoxic treatment, aeration, and membrane reactor;
- Treated effluent discharge;
- Sludge de-watering (membrane press); and
- Clean in-place (CIP) system.

The full operation and maintenance manual for the systems is included in Appendix A of this document. The operation and maintenance manual also describes the critical operating limits as well as potential operational failures and alternatives.

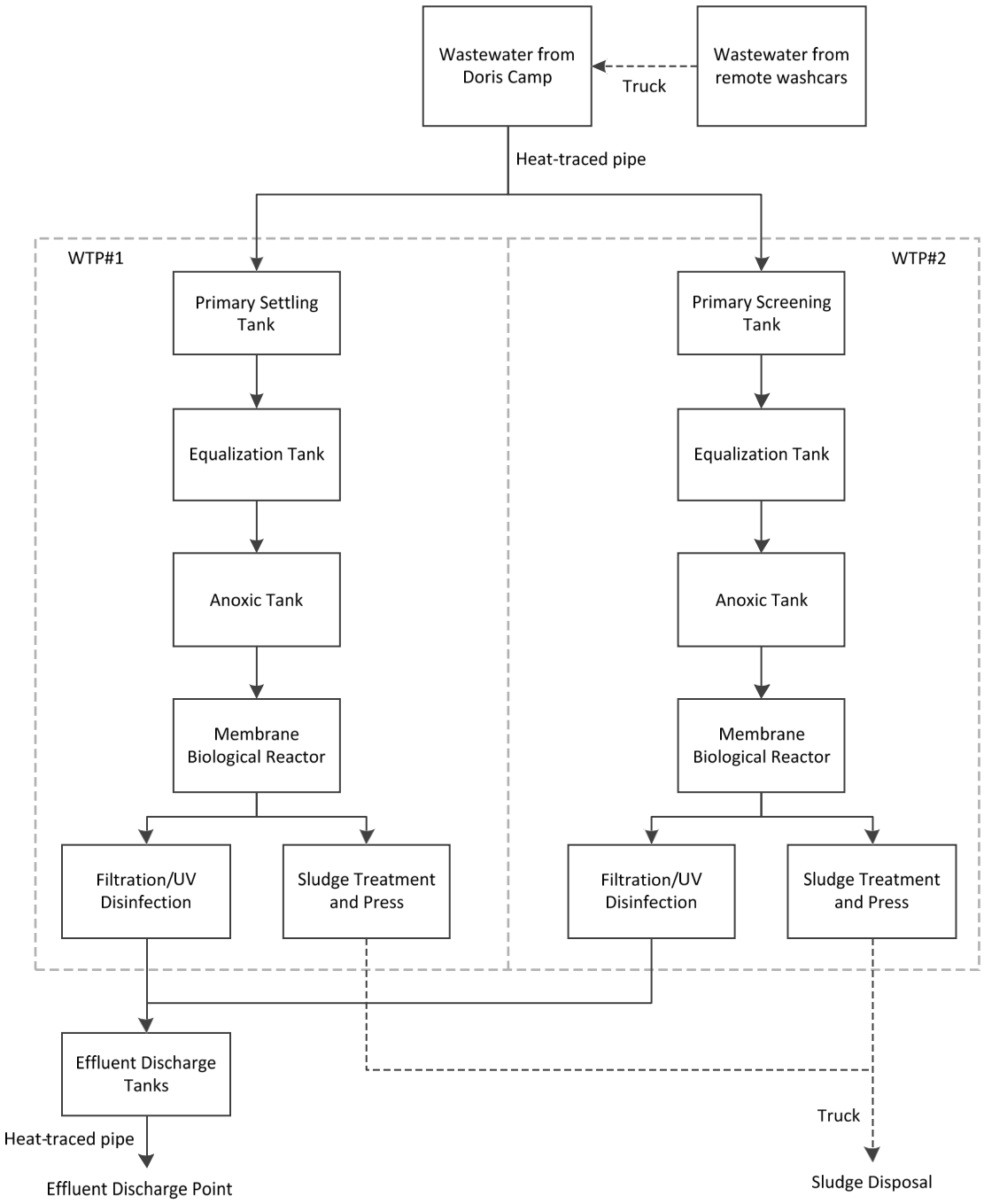

Figure A1. Wastewater treatment process flow diagram Illustrating dual system configuration

A2.1.1 Pre-treatment Primary Settling/Screening

There are two pre-treatment methods utilized by the WTP systems. In system #1, wastewater enters the WTP flowing into the primary settling tank, which is divided by a bulkhead into two sections. Settling occurs in the first section while aeration for odour control and mixing by coarse bubble diffusers occurs in the second section. Wastewater then flows from the primary settling tank into the equalization tank through a basket screen. In system #2, wastewater enters the WTP flowing through a travelling screen inside of a primary screened tank. Wastewater then flows from the primary screening tank into the equalization tank through a basket screen. Materials removed by the basket screens are dewatered and are disposed of with the sludge.

Wastewater enters the WTP in two ways:

- Piped directly from Doris Camp through a heat traced line; and
- Transferred with a wastewater truck from washcars placed around the project site into the Doris wastewater stream through one of the lift stations.

A2.1.2 Pre-treatment Equalization

The equalization tanks provide a reservoir for the fluctuating wastewater feed, allowing the downstream biological process to be fed at a constant rate. The equalization tank is divided into two sections by a bulkhead. The tank has coarse bubble aeration for mixing to reduce odours.

Two submersible equalization pumps are located in the tank and provide the forward flow at a controlled rate. The pumps operate with one primary duty pump running at design flow and one in standby. The standby pump automatically responds if the primary duty pump fails, because the system is controlled by a programmable logic controller. The tanks are equipped with level switches and alarms. The flow to the anoxic tank is set by throttling ball valves. By the end of equalization, actual removal of any organic compounds is minimal and incidental. Aeration in the equalization tank may remove 5% of the BOD_5 and some organics may be collected by screening.

A2.1.3 Biological Treatment and Effluent Separation Anoxic Tank

The anoxic tank is divided by a bulkhead to form anoxic and supplemental aeration tanks. The flow into the anoxic tank is received from the equalization tank and a recycle flow from the membrane reactor tank. The mixing of streams forms a mixed liquor with a suspended solids concentration ranging from 10,000 to 20,000 mg/L. The recycle flow contains high levels of nitrates (NO_3-N), which are the end products of nitrification (ammonia removal). Under anoxic conditions (zero dissolved oxygen), the nitrates are removed and in the conversion a portion of the BOD_5 is also removed. To achieve anoxic conditions, the tank is not aerated, but mixing is provided by bubble diffusers using a manual ball valve on the air line.

The process switches, pumps, and alarms are controlled by a programmable logic controller. In the event of high flows, the equalization tank pumps are stopped. In the event only low levels of effluent liquid are available for processing, timers are activated and the process enters into a sleep mode. Sleep mode involves periodically turning on blowers for scouring in the membrane modules and provides

minimal mixing to the equalization tank. The entire system stays in sleep mode until the equalization tank is reactivated and levels in the anoxic tank are raised. Transfer pumps forward the partially treated liquid to the membrane reactor.

A2.1.4 Membrane Biological Reactor

The MBR step in the process provides the same aeration as in the previous step, with the added purpose of separating the biological solids from the flow stream, thereby creating a highly treated, acceptable effluent for disposal. Also, like the previous tank, the mixed liquor suspended solids will range from 10,000 to 20,000 mg/L.

The aluminum MBR tank houses one membrane module that acts as the aeration and the separation device. Air is provided to the unit from the membrane blower and serves primarily as a cleaning or scouring mechanism, while simultaneously providing air for mixing and process oxygenation. Two blowers are used: a primary duty blower and a standby blower. Two effluent pumps are associated with the membrane reactor tank. One operates as a primary duty pump and the other as a standby unit. The pumps are responsible for removing treated effluent from themodule.

This module is protected by level switches, alarms, and the programmable logic controller. The float switches in the membrane tank prevent the water level above the membrane module from falling to a level where the unit can be affected. On low level alarms, the permeate pumps are deactivated. In addition, the permeate pumps cannot be operated if scouring air is cut off; therefore, the blower pressure supply is monitored. Failure to supply air because of motor failure or failure to pressurize the line (possibly due to blockage or V-belt failure) prevents the effluent pumps from operating. This prevents poor quality effluent from leaving the unit. Failure of the main membrane blower triggers an alarm and results in start-up of the standby unit. Recycle liquid flow continues regardless of equalization pump or effluent pump operation.

After the MBR, the treated effluent is pumped through the UV disinfection modules (separate modules are in each WTP) and then into the effluent discharge trailer, while overflow from the MBR tank is recycled back to the anoxic tank. Effluent is then pumped from the effluent discharge tanks to the effluent discharge point.

A2.2 Waste Disposal

A2.2.1 Effluent Discharge

Ten days prior to the start-up or recommissioning of the WTP following a shutdown, Agnico will notify the inspector and provide the location of effluent discharge.

Prior to entering operations the effluent discharge from the WTP occurs from the effluent discharge trailer through a pipeline to a discharge point located on a rock outcrop (UTM 432125E 7559324N) approximately 1 km northwest of the Doris Camp (Figure A2). The discharge line is a three-inch diameter HDPE pipeline and effluent is fed into the discharge pipeline by pumps in the WTP effluent trailer. A diffuser is located at the end of the discharge line and is designed to reduce the discharge energy,

disperse the effluent and minimize erosion or vegetation damage from ice build-up. The discharge is directed from the rock outcrop to the tundra through the diffuser and drains west. Monitoring is routinely conducted at the discharge point and the area down slope to ensure erosion management is effective. The closest downstream water body (Glenn Lake; UTM 430285E 7560303N) is located over 1 km from this discharge point.

Occasionally, Agnico may be required to discharge to a secondary tundra location west of the Batch Plant pad (UTM 432412E 7559600N), as approved by the Inspector, as a contingency in the event that the main discharge line becomes frozen or requires repair. This discharge line is also equipped with a diffuser to minimize erosion or vegetation damage from ice-build up. The closest water body (Glenn Lake; UTM 430285E 7560303N) is located over 1km from this discharge point.

As permitted in the water licence per Part G Item 4d, during mining and milling phase of operations Agnico will discharge effluent into the TIA or, as required, to the tundra upon providing notification to the Inspector. Agnico will transfer treated effluent to the TIA prior to operations provided the proper infrastructure is in place. Tailings effluent discharged to the environment is monitored at the intake of the discharge line and at a location downstream of the discharge point to the receiving environment.

A2.2.2 Sludge Disposal

Sludge is regularly transferred to the sludge disposal tank based on the results of the MLSS testing. An MLSS result of 8,000 to 12,000mg/L is the ideal operating range for this parameter. MLSS is an important part of the activated sludge process to ensure there is a sufficient active biomass for consumption of active pollutants in the waste stream. The WTP operator collects weekly samples for analytical testing in order to determine if the sludge is suitable to facilitate this process. MLSS that does not meet the criteria is then transferred to the sludge disposal tank.

Both treatment units are each equipped with 500 gallon waste disposal tanks. This allows the WTP operator to store up to 1,000 gallons of wasted sludge before disposal in required. Approximately every 4 to 5 days, the WTP operator utilizes the vac-truck to sufficiently drawdown the level in the sludge disposal tank. The sludge is then transferred to the TIA for disposal.

A2.2.3 Sludge Dewatering

Sludge dewatering is a manual process. The WTP operator directs some of the flow from the anoxic and supplemental aeration tank via pumps to the sludge holding tank. Polymers for thickening sludge may be added to the mixing tank. The solution is then pumped to a plate and frame press and filtrate is pumped back to the anoxic and supplemental aeration tank by a submersible pump.

The resulting sludge/pressed cake is then placed into bags and disposed of in the TIA. Agnico will continue to explore alternative disposal methods for sludge/pressed cake generated from the sludge dewatering process which may include incineration or disposal into the landfill once constructed. Sludge/pressed cake that will be disposed of in the in the TIA will be placed in bags and stored securely at the waste management facility in a manner that will prevent wildlife from accessing the sludge until such time that it can be disposed of in this location.

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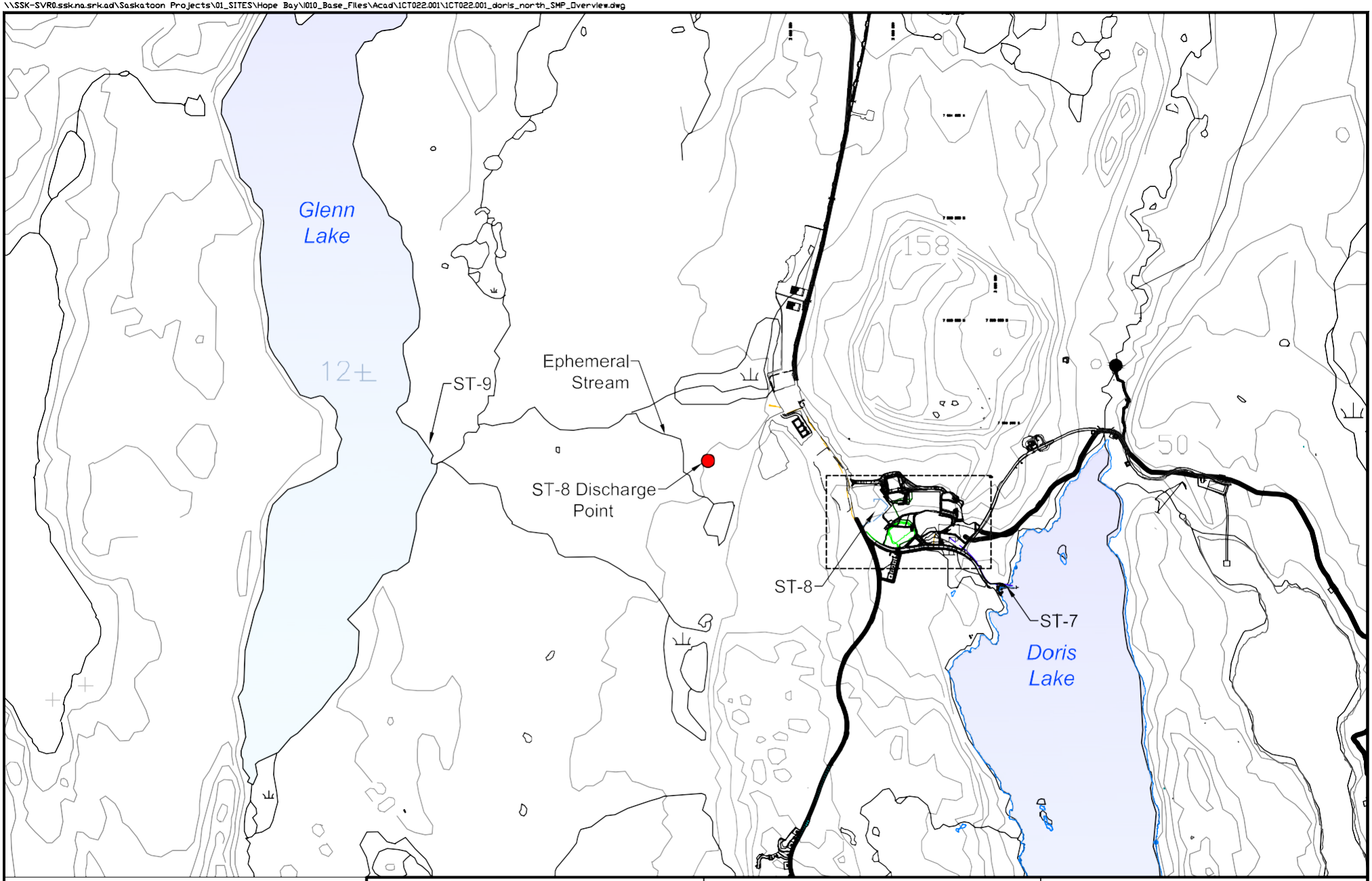

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TMAC RESOURCES

Hope Bay Project

Domestic Waste water Management Plan - Doris

Station Locations

DATE:	APPROVED:	FIGURE:
February 2014	MP/ML	A2

A2.3 Membrane Cleaning and Critical Operating Limits

A2.3.1 Clean-in-place System Organic Cleaning

A mild solution of sodium hypochlorite (0.5%) is added to the membrane modules for cleaning as required. The system requires cleaning if there is an increase of more than 3 psi (20 kPa) in the initial daily readings between the discharge headers in the MBR tank and the discharge pressure on the effluent pump. A chemical feed pump introduces 500 L of sodium hypochlorite solution into the module and the system is allowed to soak for several hours. If an inorganic cleaning is required, a solution of oxalic acid or citric acid is used instead of sodium hypochlorite.

The majority of the cleaning agents are consumed and their oxidizing potential reduced during the cleaning process. During operations this water is discharged as part of the effluent stream. However, when the effluent stream is discharged to the tundra the water from the cleaning process is collected and returned to the front end of the WTP. This ensures any oxidizing potential is completely consumed and the water is subjected to further dilution and treatment with new raw wastewater.

A2.3.2 Critical Operating Limits

For a complete list of installation, operation and maintenance requirements, refer to the manufacturer's manual provided in Appendix A of this document. The following points are noted by the manufacturer as critical operating limits that must be met to ensure proper system operation, maximum lifespan and good effluent quality:

- The WTP is designed to treat normal human domestic waste from toilets, showers, laundry, and kitchens.
- The system is not designed to treat industrial wastes, chemical cleaning agents, bactericides, or any product that is toxic to the bacteria.
- Only biodegradable detergents and products should be used in effluent feeds.
- Kitchen grease traps must be well serviced to prevent overloading the system with oils and grease.
- Plastic, rubber, and other non-biodegradable items must be kept out of the wastewater flow.
- The unit must be protected from freezing. Maintain a temperature range from 5 to 40°C (41 to 104°F).
- The effluent discharge from the unit must not be used for drinking water.
- Effluent water should be tested for suitability before it is used again.
- To protect the membranes and prevent clogging, design the peripheral equipment in such a way that the raw water is supplied to the membrane submerged basin via a screen with openings 3 mm or less.
- Avoid applying pressure to the permeate side.
- Large amounts of iron, manganese, calcium, and/or silica may cause clogging in the membrane.

A3 Monitoring and Reporting

A3.1 Record Keeping

Record sheets and daily operations logs are completed by the WTP operator for each unit as outlined in Section 3.2 of this plan and are kept in the WTP. Records of sewage sludge disposal are completed by WTP operator and Waste Management personnel and are maintained at the Waste Management Facility.

Monthly and annual reports are submitted to the Nunavut Water Board as per Part J, Item 19 of the 2AM-DOH1323 Water Licence and as outlined in Section 3.2 of this document.

A3.2 Discharge Monitoring

Agnico has implemented a monitoring program for the WTP as required by the Type A Water Licence (2AM DOH1323).

The objective of discharge monitoring is to:

- Measure the performance of the WTP;
- Ensure treated water from the WTP meets the appropriate discharge limits; and
- Assess water quality in the receiving water environment.

All treated effluent discharged to tundra from the WTP at the ST-8 monitoring station must meet the effluent limits as outlined in Part G, Item 4b of Water Licence (2AM-DOH1323) and summarized in Table A1.

Table A1. Domestic Wastewater Treatment Plant Effluent Quality Limits for Monitoring Station ST-8

Parameter	Maximum Allowable Concentration (mg/L)
pH	6-9
Total Suspended Solids	100
BOD5	80
Fecal Coliforms	10,000 CFU/100mL
Total Oil and Grease	5 and no visible sheen

Treated effluent samples are collected by the Environmental Coordinator from a sampling port on the effluent discharge line located inside the WTP (Monitoring Station ST-8). Effluent samples are collected monthly or more frequently if daily operational measurements (e.g. pH) indicate an issue with effluent quality. While discharging to the tundra, monthly samples are also collected during the open water season at a location downstream of the effluent discharge line (Monitoring Station ST-9; UTM 13W 434914E 7558239N) located near the shore of Glenn Lake.

All samples are collected and handled following the sampling procedures and QA/QC methods outlined in the Hope Bay Quality Assurance and Quality Control Plan (HBML 2012) and in any applicable water sampling standard operating procedures developed by Agnico's Environment Department.

During mining and milling operations phases, treated effluent from the WTP will be discharged to the TIA as permitted in Part G Item 4(d) of the 2AM-DOH1323 Water Licence. Tailings effluent discharged to the environment is monitored at the intake of the discharge line and must meet the discharge criteria as outlined in Part G, Item 29 of the 2AM-DOH1323 Water Licence; these criteria are summarized in Table A2.

Table A2. Tailings Impoundment Area Effluent Quality Limits

Parameter	Maximum Average Concentration (mg/L)	Maximum Allowable Grab Sample Concentration (mg/L)
pH	Between 6–9.5	Between 6-9.5
Total Suspended Solids	15.00	30.00
Chloride	120	640
BOD5	80	160
Fecal Coliforms	10,000 CFU/100mL	10,000 CFU/100mL
Total Arsenic - T-As	0.50	1.00
Total Copper - T- Cu	0.30	0.60
Total Cyanide - T-CN	1.00	2.00
Total Lead – T-Pb	0.20	0.40
Total Nickel – T-Ni	0.50	1.00
Total Zinc – T- Zn	0.50	1.00
Radium 226	0.37 Bq/L	1.11 Bq/L
Total Ammonia-N	6	-
Total Oil and Grease	5	10
Benzene	0.37	-
Toluene	0.002	-
Ethyl Benzene	0.090	-

Sample results are reported to the WTP operator upon receipt from the laboratory. The results are reported in the monthly and annual reports required under the Water Licence (No: 2AM-DOH1323).

A3.2.1 Off-specification Effluent Quality

The potential does exist for isolated, short-term discharges of treated wastewater effluent that does not meet the discharge limits due to equipment malfunction or operator error. However, the system design limits the potential for partially treated wastewater to be discharged from the plant. In addition, operators conduct daily checks throughout the treatment system to confirm that the unit is operating within an acceptable range. Parameters such as pH, dissolved oxygen, temperature, flow, settleability of solids, etc. are measured to evaluate the systems performance. Adjustments within the system are

made by the operator based on these results to ensure optimal treatment performance and compliance are achieved.

In the event that analysis indicates a sample exceeded the specified discharge limit, Agnico will, as soon as possible upon receiving the analytical results:

- Re-sample the effluent and submit the sample for appropriate analysis. A “same day” priority will be placed on the analysis to provide expedient turnaround time on results;
- Stop the discharge of effluent to the tundra and conduct a detailed inspection of the entire WTP and all associated facilities to identify the cause of the off-specification discharge, correct any issues identified and ensure the facility is operating within the prescribed parameters and operation limits before resuming discharge; and
- if necessary, implement additional monitoring of the downstream environment to assess the level of any potential impact of the off specification discharge.

Effluent discharge will be directed to the TIA until compliant results have been received by the accredited laboratory.

During these upset conditions the wastewater effluent may have slightly elevated pH and fecal coliforms. However, due to the limited frequency and relatively short duration of such events and the distance to the lake receiving environment (~1 km), residual environmental effects are negligible.

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HOPE BAY PROJECT DOMESTIC WASTEWATER TREATMENT MANAGEMENT PLAN

HOPE BAY, NUNAVUT

Module B: Windy

Conformity Table

Licence	Part	Item	Topic	Report Section
2BE-HOP1222	D	8	The Licensee shall direct all sewage and greywater to the Waste Water Treatment Facilities, ("WWTF") as described in the application, unless otherwise approved by the Board.	This Plan
		9	The Licensee shall direct all effluent from the WWTF to a surge tank, prior to pumping and discharging the effluent approximately 300 meters over the ridge to the east of the camp facilities.	Section 2
		10	The Licensee shall discharge the effluent in Part D, Item 9 in such a manner to prevent surface erosion.	Section 2
		11	All effluent being discharged from the WWTF, monitoring station HOP-2 shall meet the following effluent quality standards:	Section B3.1
		12	The Licensee shall collect as required, all sludge generated by the Waste Water Treatment Facilities in 45 gallon drums and transport to the Boston Camp for proper disposal un less otherwise approved by the Board in writing.	Module D
		13	The Licensee shall provide to the Board for approval in writing, at least four (4) months prior to any alternative means of sludge disposal, a proposal which shall address, but not be limited to: a. Location of Disposal area; b. Quantities and composition of sludge; c. Mitigation measure to control run-off and restrict access; d. A program for water quality monitoring; e. An implementation schedule; f. An executive summary of the proposal in English and Inuktitut.	B3 – no WTP at this time
		14	The Licensee shall implement the proposal specified in Item 13 above, as and when approved by the Board.	B3 – no WTP at this time
		15	If the Board does not approve the proposal referred to in this Part, the Licensee shall withdraw or revise this proposal and resubmit it to the Board for approval within two (2) months of receiving notification of the Board's decision.	B3 – No WTP at this time
		23	The Licensee shall operate and maintain the WWTF and Bulk Fuel Storage Facilities to the satisfaction of the Inspector.	B3- no WTP at this time
	E	6	The Licensee shall submit to the Board for approval in writing, at least sixty (60) days prior to occupying the Windy Camp and resuming exploration activity at the Hope Bay Regional Exploration Project, a revised Operation and Maintenance Manual for the Waste Water Treatment Facility that is specific to the facilities in use, 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 sewage treatment facility.	This Plan
	J	2	The Licensee shall sample at Monitoring Program Stations HOP-2 and HOP-3 monthly during discharge. Samples shall be analyzed for the following parameters:	B3

Licence	Part	Item	Topic	Report Section
2BE-HOP1222	J	3	The Licensee shall conduct toxicity testing to demonstrate Non-Acute Toxicity of the effluent discharged from the WWTF, at Monitoring Station Hop-3, to be conducted in accordance with the following test procedures and carried out once annually during open water season: the following test procedures and carried out once annually during open water season: a) Acute lethality to Rainbow Trout, Oncorhynchus mykiss (as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/13);and b) Acute lethality to the crustacean, Daphnia magna (as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/14).	B2- no WTP at this time.
		10	The Licensee shall measure and record, in cubic metres, the daily quantities of effluent discharged at Monitoring Program Station HOP-3 as well as volumes pumped Stations HOP-5, HOP-6, HOP-7A, B and D and HOP-8.	B3 and 2.7
		11	The Licensee shall measure and record, in cubic metres, the annual quantity of Sludge removed from the WWTF.	Section 2.8
		20	A monitoring Program summary report shall be submitted to the Board for review within thirty (30) days following the month being reported. The summary shall include, at a minimum, the monitoring results of Part J, Items 2 through 8 inclusive.	Section 2.8
		21	The Licensee shall include in the Annual Report required under Part B, Item 2, all data, monitoring results and information required by this Part.	Section 2.8

Contents: Module B

B1 Introduction

B1.1 Background

The Type B Water Licence No. 2BE-HOP1222 issued to Agnico by the Nunavut Water Board (NWB) allows for the management and disposal of wastes associated with Wastewater Treatment Plants (WTP).

Old Windy Camp was closed for operations in 2008 and is undergoing closure and reclamation. A New Windy Camp is permitted under the current water licence, but has not yet been constructed. No domestic wastes are produced at Windy Camp and there is no WTP operating under this Licence.

Agnico is required to operate the WTP in accordance with Part G (Item 4) of the Licence. The Domestic Wastewater Treatment Management Plan has been prepared and is being submitted by Agnico to address the requirement specified in Part G, Item 3 of the 2AM-DOH1323 Water Licence, and also includes the plan for wastewater management throughout the Hope Bay belt. This Plan has been developed such that it will remain applicable to all Project phases, with revisions being submitted as necessitated by changes that may occur or to reflect improvements in operational practices.

B2 Domestic Wastewater Treatment Plant Management at Windy

There is no WTP operated at the Windy Camp at this time.

B3 Monitoring and Reporting

B3.1 Discharge Monitoring

All treated effluent discharged to tundra from the WTP at the HOP-2 monitoring station must meet the effluent limits as outlined in Part D, Item 11 of Water Licence (2BE-HOP1222) and summarized in Table B1.

Table B1. Domestic Wastewater Treatment Plant Effluent Quality Limits for Monitoring Station HOP-2

Parameter	Maximum Allowable Concentration (mg/L)
pH	6-9
Total Suspended Solids	100
BOD5	80
Fecal Coliforms	10,000 CFU/100 mL
Oil and Grease	No visible sheen

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HOPE BAY PROJECT DOMESTIC WASTEWATER TREATMENT MANAGEMENT PLAN

HOPE BAY, NUNAVUT

Module C: Madrid

Conformity Table

Licence	Part	Item	Topic	Report Section
2BB-MAE1727	E	22	The Licensee shall direct all Sewage to the Sewage Disposal Facility at Doris North unless otherwise approved by the Board.	C1

Contents: Module C

C1 Introduction

C1.1 Background

The Type B Water Licence No. 2BB-MAE1727 issued to Agnico by the Nunavut Water Board (NWB) does not allow for the management and disposal of wastes associated with Wastewater Treatment Plants (WTP). As per Part E, Item 22 for the Water License, all sewage produced at Madrid North or Madrid South is transported to Doris Camp for treatment and disposal. This approach is in line with wastewater management proposed at the Madrid North and Madrid South locations under the Madrid-Boston Final Environmental Impact Statement.

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HOPE BAY PROJECT DOMESTIC WASTEWATER TREATMENT MANAGEMENT PLAN

HOPE BAY, NUNAVUT

Module D: Boston (Operations)

Contents: Module D

D1 Introduction

D1.1 Background

All domestic wastewater generated at the Boston camp under the Madrid-Boston (Phase 2) proposal will be handled in accordance with the existing Type A Water Licence 2AM-DOH1323 conditions. The wastewater treatment plant at Boston will be the same system that is current permitted at the Doris camp and details are provided in Appendix A of this document.

D1.2 Overview of Boston Wastewater Compliance

All wastewater produced at the Boston Camp will be collected and managed through Wastewater Treatment Plants located at the main Boston Camp facility.

D2 Domestic Wastewater Treatment Plant Management at Boston

D2.1 Membrane Biological Reactor Wastewater Treatment Plant Process

The Boston Camp will have two modular Sanitherm® membrane biological reactor (MBR) WTPs housed in multiple 40-foot long containers. Each plant has the capacity to manage the average waste volume generated by 150 people as well as the capacity to accept raw wastewater and sludge from other WTPs into its surge and conditioning tanks. These plants will be maintained and replaced as necessary to ensure continued discharge compliance.

The MBR WTP consists of the following major processes:

- Pre-treatment—primary settling and equalization;
- Biological treatment and effluent separation—anoxic treatment, aeration, and membrane reactor;
- Treated effluent discharge;
- Sludge de-watering (membrane press); and
- Clean in-place (CIP) system.

The full operation and maintenance manual for the systems is included in Appendix A of this document. The operation and maintenance manual also describes the critical operating limits as well as potential operational failures and alternatives.

D2.1.1 Pre-treatment Primary Settling/Screening

There are two pre-treatment methods utilized by the WTP systems. In system #1, wastewater enters the WTP flowing into the primary settling tank, which is divided by a bulkhead into two sections. Settling

occurs in the first section while aeration for odour control and mixing by coarse bubble diffusers occurs in the second section. Wastewater then flows from the primary settling tank into the equalization tank through a basket screen. In system #2, wastewater enters the WTP flowing through a travelling screen inside of a primary screened tank. Wastewater then flows from the primary screening tank into the equalization tank through a basket screen. Materials removed by the basket screens are dewatered and are disposed of with the sludge.

Wastewater enters the WTP in two ways:

- Piped directly from Boston Camp through a heat traced line; and
- Transferred with a wastewater truck from washcars placed around the project site into the Boston wastewater stream through one of the lift stations.

D2.1.2 Pre-treatment Equalization

The equalization tanks provide a reservoir for the fluctuating wastewater feed, allowing the downstream biological process to be fed at a constant rate. The equalization tank is divided into two sections by a bulkhead. The tank has coarse bubble aeration for mixing to reduce odours.

Two submersible equalization pumps are located in the tank and provide the forward flow at a controlled rate. The pumps operate with one primary duty pump running at design flow and one in standby. The standby pump automatically responds if the primary duty pump fails, because the system is controlled by a programmable logic controller. The tanks are equipped with level switches and alarms. The flow to the anoxic tank is set by throttling ball valves. By the end of equalization, actual removal of any organic compounds is minimal and incidental. Aeration in the equalization tank may remove 5% of the BOD_5 and some organics may be collected by screening.

D2.1.3 Biological Treatment and Effluent Separation Anoxic Tank

The anoxic tank is divided by a bulkhead to form anoxic and supplemental aeration tanks. The flow into the anoxic tank is received from the equalization tank and a recycle flow from the membrane reactor tank. The mixing of streams forms a mixed liquor with a suspended solids concentration ranging from 10,000 to 20,000 mg/L. The recycle flow contains high levels of nitrates (NO_3-N), which are the end products of nitrification (ammonia removal). Under anoxic conditions (zero dissolved oxygen), the nitrates are removed and in the conversion a portion of the BOD_5 is also removed. To achieve anoxic conditions, the tank is not aerated, but mixing is provided by bubble diffusers using a manual ball valve on the air line.

The process switches, pumps, and alarms are controlled by a programmable logic controller. In the event of high flows, the equalization tank pumps are stopped. In the event only low levels of effluent liquid are available for processing, timers are activated and the process enters into a sleep mode. Sleep mode involves periodically turning on blowers for scouring in the membrane modules and provides minimal mixing to the equalization tank. The entire system stays in sleep mode until the equalization tank is reactivated and levels in the anoxic tank are raised. Transfer pumps forward the partially treated liquid to the membrane reactor.

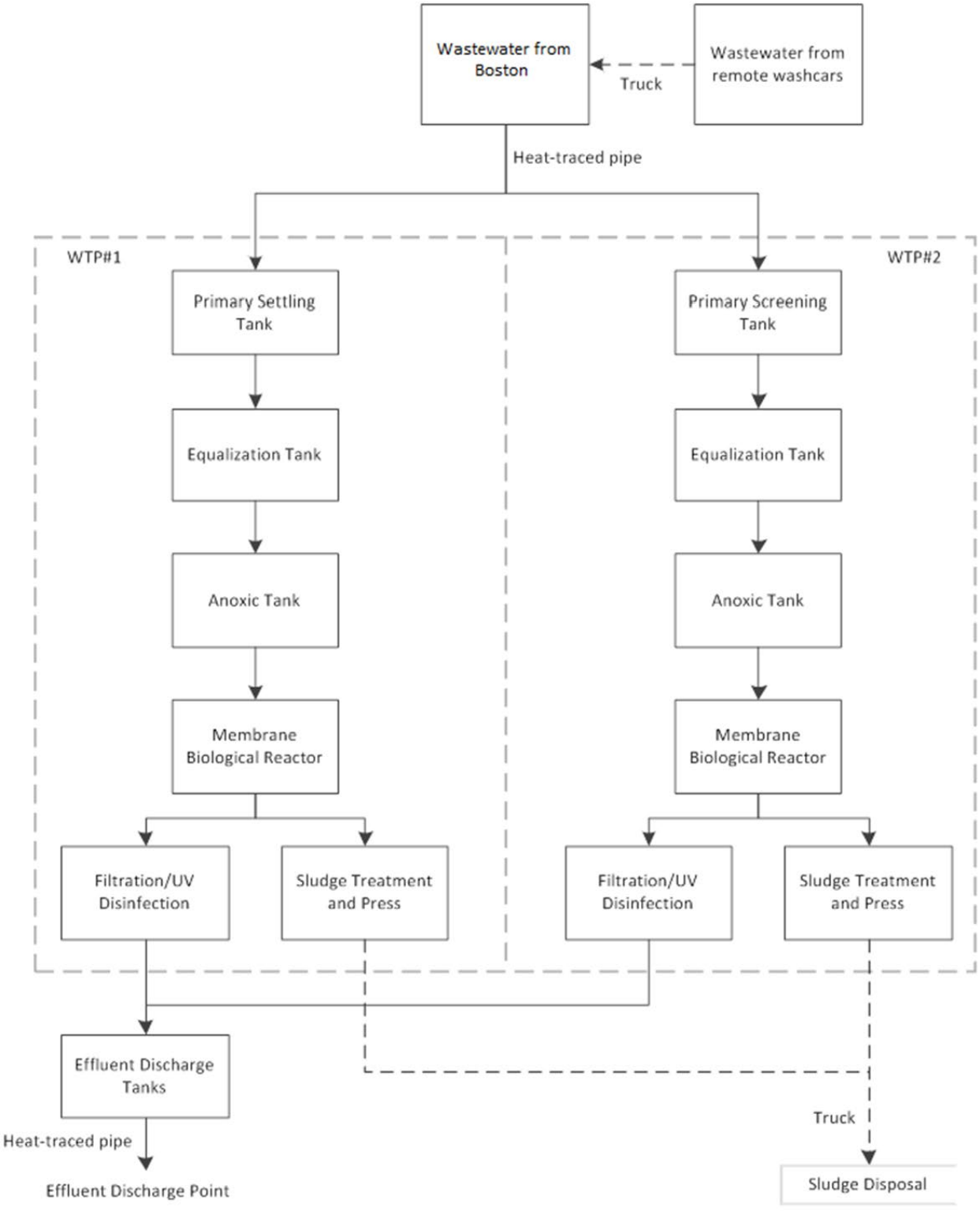

Figure D1. Wastewater treatment process flow diagram Illustrating dual system configuration

D2.1.4 Membrane Biological Reactor

The MBR step in the process provides the same aeration as in the previous step, with the added purpose of separating the biological solids from the flow stream, thereby creating a highly treated, acceptable effluent for disposal. Also, like the previous tank, the mixed liquor suspended solids will range from 10,000 to 20,000 mg/L.

The aluminum MBR tank houses one membrane module that acts as the aeration and the separation device. Air is provided to the unit from the membrane blower and serves primarily as a cleaning or scouring mechanism, while simultaneously providing air for mixing and process oxygenation. Two blowers are used: a primary duty blower and a standby blower. Two effluent pumps are associated with the membrane reactor tank. One operates as a primary duty pump and the other as a standby unit. The pumps are responsible for removing treated effluent from themodule.

This module is protected by level switches, alarms, and the programmable logic controller. The float switches in the membrane tank prevent the water level above the membrane module from falling to a level where the unit can be affected. On low level alarms, the permeate pumps are deactivated. In addition, the permeate pumps cannot be operated if scouring air is cut off; therefore, the blower pressure supply is monitored. Failure to supply air because of motor failure or failure to pressurize the line (possibly due to blockage or V-belt failure) prevents the effluent pumps from operating. This prevents poor quality effluent from leaving the unit. Failure of the main membrane blower triggers an alarm and results in start-up of the standby unit. Recycle liquid flow continues regardless of equalization pump or effluent pump operation.

After the MBR, the treated effluent is pumped through the UV disinfection modules (separate modules are in each WTP) and then into the effluent discharge trailer, while overflow from the MBR tank is recycled back to the anoxic tank. Effluent is then pumped from the effluent discharge tanks to the effluent discharge point.

D2.2 Waste Disposal

D2.2.1 Effluent Discharge

Ten days prior to the start-up or recommissioning of the WTP following a shutdown, Agnico will notify the inspector and provide the location of effluent discharge.

During construction and closure of the proposed phase 2 Boston site, the effluent discharge meeting discharge criteria from the WTP occurs from the effluent discharge trailer through a pipeline to a suitable discharge point approved by the Inspector. The discharge line is a three-inch diameter HDPE pipeline and effluent is fed into the discharge pipeline by pumps in the WTP effluent trailer. A diffuser is located at the end of the discharge line and is designed to reduce the discharge energy, disperse the effluent and minimize erosion or vegetation damage from ice build-up. The discharge is directed from the rock outcrop to the tundra through the diffuser and drains west. Monitoring is routinely conducted at the discharge point and the area down slope to ensure erosion management is effective. The closest downstream water body is Aimaokatalok Lake.

D2.2.2 Sludge Dewatering

Sludge dewatering is a manual process. The WTP operator directs some of the flow from the anoxic and supplemental aeration tank via pumps to the sludge holding tank. Polymers for thickening sludge may be added to the mixing tank. The solution is then pumped to a plate and frame press and filtrate is pumped back to the anoxic and supplemental aeration tank by a submersible pump.

The resulting sludge/pressed cake will be incinerated or placed into bags and disposed of underground. Agnico will continue to explore alternative disposal methods for sludge/pressed cake generated from the sludge dewatering process which may include disposal into the Boston Tailings Management Area (TMA) (dry stack tailings) or into the landfill once constructed. Sludge/pressed cake that will be disposed of in the in the TMA or landfill and will be placed in bags and stored securely at the waste management facility in a manner that will prevent wildlife from accessing the sludge until such time that it can be disposed of in this location.

D2.3 Membrane Cleaning and Critical Operating Limits

D2.3.1 Clean-in-place System Organic Cleaning

A mild solution of sodium hypochlorite (0.5%) is added to the membrane modules for cleaning as required. The system requires cleaning if there is an increase of more than 3 psi (20 kPa) in the initial daily readings between the discharge headers in the MBR tank and the discharge pressure on the effluent pump. A chemical feed pump introduces 500 L of sodium hypochlorite solution into the module and the system is allowed to soak for several hours. If an inorganic cleaning is required, a solution of oxalic acid or citric acid is used instead of sodium hypochlorite.

The majority of the cleaning agents are consumed and their oxidizing potential reduced during the cleaning process. During operations this water is discharged as part of the effluent stream. However, when the effluent stream is discharged to the tundra the water from the cleaning process is collected and returned to the front end of the WTP. This ensures any oxidizing potential is completely consumed and the water is subjected to further dilution and treatment with new raw wastewater.

D2.3.2 Critical Operating Limits

For a complete list of installation, operation and maintenance requirements, refer to the manufacturer's manual provided in Appendix A of this document. The following points are noted by the manufacturer as critical operating limits that must be met to ensure proper system operation, maximum lifespan and good effluent quality:

- The WTP is designed to treat normal human domestic waste from toilets, showers, laundry, and kitchens.
- The system is not designed to treat industrial wastes, chemical cleaning agents, bactericides, or any product that is toxic to the bacteria.
- Only biodegradable detergents and products should be used in effluent feeds.

- Kitchen grease traps must be well serviced to prevent overloading the system with oils and grease.
- Plastic, rubber, and other non-biodegradable items must be kept out of the wastewater flow.
- The unit must be protected from freezing. Maintain a temperature range from 5 to 40°C (41 to 104°F).
- The effluent discharge from the unit must not be used for drinking water.
- Effluent water should be tested for suitability before it is used again.
- To protect the membranes and prevent clogging, design the peripheral equipment in such a way that the raw water is supplied to the membrane submerged basin via a screen with openings 3 mm or less.
- Avoid applying pressure to the permeate side.
- Large amounts of iron, manganese, calcium, and/or silica may cause clogging in the membrane.

D3 Monitoring and Reporting

D3.1 Record Keeping

Record sheets and daily operations logs will be completed by the WTP operator for each unit. P. Records of sewage sludge disposal will be completed by WTP operator and Waste Management personnel and are maintained at the Waste Management Facility.

Monthly and annual reports are submitted to the Nunavut Water Board.

D3.2 Discharge Monitoring

Agnico will develop a monitoring program for the WTP similar to the established program at the Doris Camp.

The objective of discharge monitoring is to:

- Measure the performance of the WTP;
- Ensure treated water from the WTP meets the appropriate discharge limits; and
- Assess water quality in the receiving water environment.

All treated effluent discharged to tundra from the WTP at the designated effluent discharge point will meet the current effluent limits as outlined in the existing Type A Water Part G, Item 4b (2AM-DOH1323) and summarized in Table D1.

All samples will be collected and handled following the sampling procedures and QA/QC methods outlined in the Hope Bay Quality Assurance and Quality Control Plan (Agnico 2022) and in any applicable water sampling standard operating procedures developed by Agnico's Environment Department.

Table D1. Domestic Wastewater Treatment Plant Effluent Quality Limits for Monitoring

Parameter	Maximum Allowable Concentration (mg/L)
pH	6-9
Total Suspended Solids	100
BOD_5	80
Fecal Coliforms	10,000 CFU/100 mL
Total Oil and Grease	5 and no visible sheen

Sample results will be reported to the WTP operator upon receipt from the laboratory. The results will also be reported in the monthly and annual reports.

D3.2.1 Off-specification Effluent Quality

The potential does exist for isolated, short-term discharges of treated wastewater effluent that does not meet the discharge limits due to equipment malfunction or operator error. However, the system design limits the potential for partially treated wastewater to be discharged from the plant. In addition, operators conduct daily checks throughout the treatment system to confirm that the unit is operating within an acceptable range. Parameters such as pH, dissolved oxygen, temperature, flow, settleability of solids, etc. are measured to evaluate the systems performance. Adjustments within the system are made by the operator based on these results to ensure optimal treatment performance and compliance are achieved.

In the event that analysis indicates a sample exceeded the specified discharge limit, Agnico will, as soon as possible upon receiving the analytical results:

- Re-sample the effluent and submit the sample for appropriate analysis. A “same day” priority will be placed on the analysis to provide expedient turnaround time on results;
- Stop the discharge of effluent to the tundra and conduct a detailed inspection of the entire WTP and all associated facilities to identify the cause of the off-specification discharge, correct any issues identified and ensure the facility is operating within the prescribed parameters and operation limits before resuming discharge; and
- If necessary, implement additional monitoring of the downstream environment to assess the level of any potential impact of the off specification discharge.

HOPE BAY PROJECT DOMESTIC WASTEWATER TREATMENT MANAGEMENT PLAN

HOPE BAY, NUNAVUT

Appendix A: Sanitherm® Membrane Biological Reactor (MBR) Operating Manual

SaniBrane®
Operations Manual

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SANITHERM A DIVISION OF wellco

Over Sixty Years of Excellence

SANIBRANE® OPERATIONS MANUAL

TABLE OF CONTENTS

FORWARD:

This operations manual has been created to provide the user:

- An overview of Sanitherm's SaniBrane® Membrane
- Requirements for safe operations
- Installation information
- Operation information
- Maintenance procedures
- Peripheral equipment requirements

Important NOTE:

- All metric conversions (") were done using an electronic converter, however are not deemed exact.

- Operators must read through this manual to ensure efficient and effective operation.

OVERVIEW OF SANITHERM'S SANIBRANE® MEMBRANE:

1.1 Introduction:

The following is a brief overview of the operation and maintenance of SANITHERM SANIBRANE® MBR, a revolutionary system that utilizes cutting edge FLAT PLATE membrane technology. There are many benefits of our FLAT PLATE membranes. The design ensures effective, reliable air scouring and consistent, long-term flux rates. The design has been proven in installations around the world in both industrial and municipal applications.

1.2 Module:

The module, shown in Diagram 1.3i, consists of a membrane case and a diffuser case. The membrane case incorporates multiple membrane elements shown in Diagram 1.3ii, which are connected to a manifold with transparent tubes. The diffuser case contains the air header and diffusers. Each membrane element can be removed individually.

Diagram 1.3i - Module

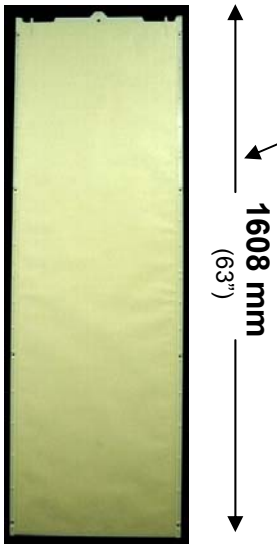
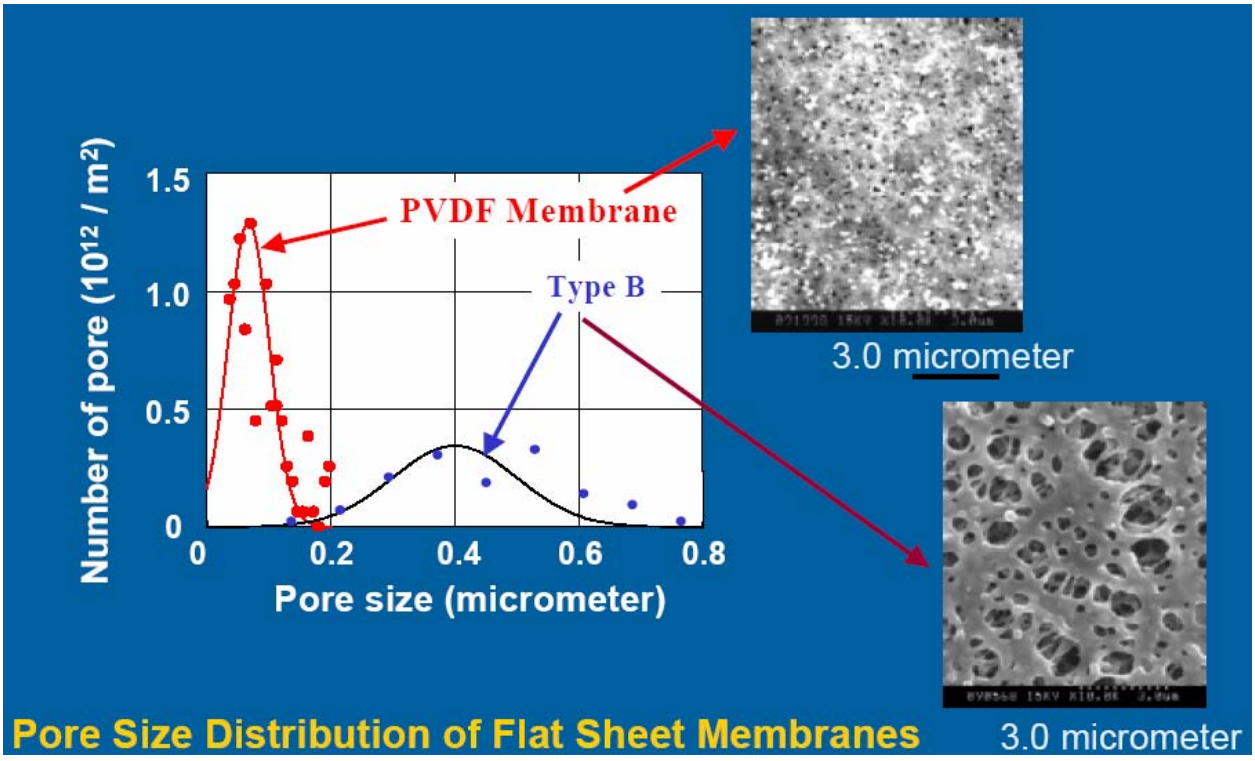


Diagram 1.3ii - Membrane element

1.3 Membrane Materials and Structure:

The membrane sheets are made from polyvinylidene fluoride (PVDF) that is bonded to the Polyethylene Terephthalete (PET) support fabric, chemically welding them to the surface. The PET is a non-woven fiber for the base and makes this membrane superior in strength and chemical stability.

The structure has a small pore size (.08 micron) with narrow pore size distribution. This structure gives an outstandingly high treated water quality.



2 SAFETY PRECAUTIONS:

All installation, operations and maintenance procedures must adhere to each jurisdictions occupational health and safety standards, including providing individuals with appropriate protective attire and safe working conditions.

Throughout this manual, special attention is given to areas that outline Danger, Caution and Warnings. Although they are outlined in each individual section, they are reiterated in Table 2.1, 2.2 and 2.3 for added awareness.

2.1 Danger:

The symbol within Table 2.1 shows anything that will pose a hazard to one's self or equipment.

Table 2.1 DANGER SYMBOLS

SYMBOL:	
MESSAGE(s):	• DO NOT leave the SaniBrane® in temperatures higher than 40^{O} C (104^{O} F). • Avoid direct sunlight • Protect SaniBrane® from freezing • Sparks from welding, fusion cutting or grinding can cause irreversible damage. Use fireproof sheets or other protective measures. • The chains or slings being used to raise the SaniBrane® must be sufficient for the weight of the SaniBrane® System. Lifting should be done in a straight upward motion not allowing any shaking of the product. • No one should ever be under the SaniBrane®! • To install SaniBrane® set a foothold. • Never climb on the module. • Use protective equipment to ensure the safety of the worker. • DO NOT place heavy objects on the module.

2.2 Warning:

The symbol within Table 2.2 indicates a possible or impending hazard to self or equipment.

Table 2.2 WARNING SYMBOLS

SYMBOL:	
MESSAGE(s):	• DO NOT use permeated water for drinking. To use permeated water, analyze its quality and ensure that the water quality meets the intended purpose. • Many chemical agents are extremely hazardous to one's health. When handling chemicals, one should wear protective goggles, gloves and any other available protective gear. Be sure to carefully read the details of the material safety data sheet (MSDS) BEFORE handling any chemicals. • If chemicals come in contact with your skin or clothes, immediately rinse with large amounts of water and see a physician. • Store chemicals in a dark, cold place away from direct sunlight. • If chemicals come in contact with your eyes, immediately flush with running water and see a physician. • Be sure to use the proper storage and mixing tanks for all chemicals • Do not mix sodium hypochlorite with heavy metals or acids. Its mixture with an acid generates toxic chlorine gas. • If an abnormality is found in the equipment during chemical cleaning, immediately stop the operation. • If chemicals are injected forcibly with the chemical feed pump or by any other means, the internal pressure of the element may increase, causing damage to the element. Be sure to inject chemicals by gravity at 10 pKa or less. • Before feeding chemicals for chemical cleaning, check that the water surface is 500 mm (20") or more above the top of the module. Feed chemicals after SaniBrane® are completely submerged.

2.3 Caution:

The symbol shown in Table 2.3 indicates care should be taken to avoid hazards or mistakes to one's self or equipment.

Table 2.3 CAUTION SYMBOLS

SYMBOL:	**CAUTION**
MESSAGE(s):	• DO NOT leave the SaniBrane® in temperatures higher than 40^{O} C (104^{O} F). • Avoid direct sunlight • Protect SaniBrane® from freezing • Sparks from welding, fusion cutting or grinding can cause irreversible damage. Use fireproof sheets or other protective measures. • DO NOT place heavy objects on the module. • To protect the membranes and prevent clogging, design the peripheral equipment in such a way that the raw water is supplied to the membrane submerged basin via a screen with openings 3 mm or less. • Avoid applying pressure to the permeate side. • Before feeding clean water to the membrane submerged basin, open the air discharge valve to release air form the element. After feeding water, close the air discharge valve. • DO NOT use raw ground water for start up testing. If it contains a large amount of iron, manganese, calcium and/or silica it may cause clogging the membrane. • Clean water operations tend to cause clogging, and should only be done cautiously. • After clean water operation, keep the membranes wet. Dried membranes will reduce permeable amounts of water. • To restart filtration after maintenance, keep the membranes wet during the maintenance. Dried membranes will reduce permeable amounts of water.

3 PRE-INSTALATION PRE-PREPARATION:

3.1 Equipment check:

To ensure that you are ready to start installation, keep in mind the following:

1. All items match the shipping slip*
2. There has not been any damage in transport.
3. The protective cover is in position.
4. There should be full preparation for the transportation of the SaniBrane® including a clear route.
5. You will require a cargo crane or forklift for unloading the SaniBrane® from the truck.

** Please contact the trucking company should any items be missing.*

3.2 Storage of the SaniBrane®:

Store the SaniBrane® indoors, keeping it upright, at 5^{O} to 40^{O} C (41^{O} to 104 ^{O} F). Avoid direct sunlight.

During the entire process take adequate measures to protect the elements and other components. Sparks from welding, fusion cutting or grinding can cause irreversible damage. Use fireproof sheets or other protective measures.
If the SaniBrane® system *must* be stored outdoors during the construction phase, make certain that it is not for a long period of time and note the following requirements:

1. Maintain the temperature from 5 ^{O} to 40^{O} C (41^{O} to 104 ^{O} F).
2. Prevent freezing.
3. Prevent it from getting wet
4. Prevent it from being immersed in water
5. Avoid direct sunlight

CAUTION

- DO NOT leave the SaniBrane® in temperatures higher than 40^{O} C (104 ^{O} F).
- Avoid direct sunlight
- Protect SaniBrane™ from freezing
- Sparks from welding, fusion cutting or grinding can cause irreversible damage. Use fireproof sheets or other protective measures.
- DO NOT place heavy objects on the module.

4 SPECIFICATIONS:

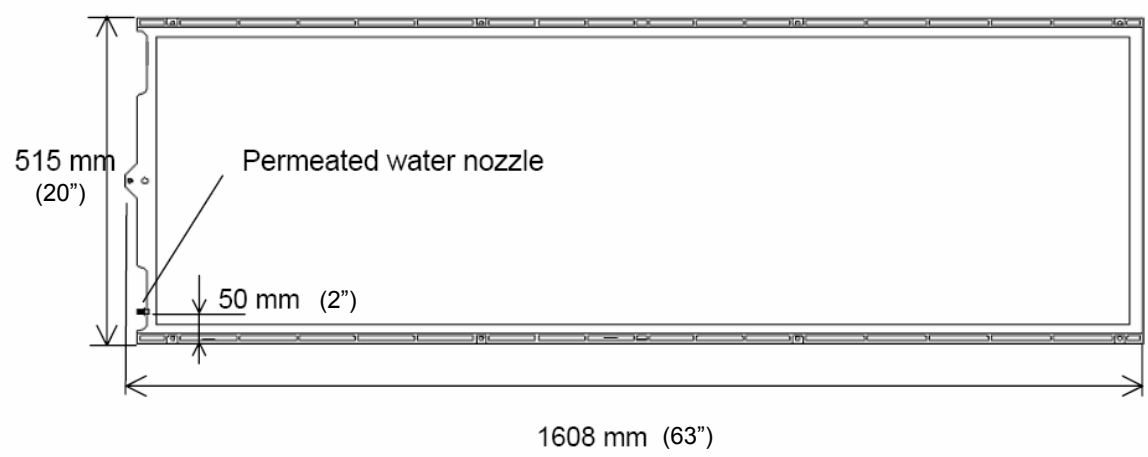
4.1 Specifications of the Element:

Table 4.1 and Diagram 4.1 – show the specifications and the appearance of the element, respectively.

Table 4.1 Element (TSP – 50150)

Model Name		TSP-50150
Membrane configuration		Flat Sheet
Application		Filtration of activated sludge
Filtration method		Suction filtration
Nominal pore diameter (um)		0.08
Effective membrane)area (m^2)		1.4
Dimensions (mm)	Total width	515
	Total Height	1,608
	Thickness	13.5
Weight	Dry	4.8
	Wet (Reference)	8.0
Main Material	Membrane	PVDF and PET non-woven fibre
	Supporting Panel	ABS resin

Diagram 4.1 Appearance of the Element.



4.2 Specifications of the Tube:

Table 4.2 shows the specifications of the tube.

Table 4.2 Specifications of the Tube

Material	TPU-ARET*[1]
Inside diameter/ outside diameter/ total length (mm)	8/12/360

* - Allowable temperature limit: 60° C (140° F)

*1 - The material name as per ISO-18064

4.3 Specifications and Performance of the Module:

Table 4.3i shows the specifications of the Module.

Table 4.3i Specifications of the Module

Model Name		TMR 140-050S	TMR140-100S	TMR140-200W	TMR 140-200D
Number of membrane elements		50	100	200	200
Element block structure		1 deck 1 row	1 deck 1 row	1 deck 2 rows	2 decks 1 row
Dimensions *1	Width (mm)	810	810	840	810
	Length (mm)	950	1,620	3,260	1,620
	Height (mm)	2,100	2,100	2,100	4,130
Weight (kg)	Module (dry)	400	695	1,430	1,365
	Aeration block (dry)	40	65	150	65
	Element block (dry)	360	630	1,280	1,300
	Element block (sludge clogging) *2	690	1,240	2,480	2,500
Material	Diffuser, Frame, Permeated water manifold	304 stainless steel			
Connection flange *3	Manifold	2” (50 mm)	2” (50 mm)	3” (75mm)	2” (50 mm)
	Air Diffuser	2” (50 mm)	2” (50 mm)	2” (50 mm)	2” (50 mm)
Operating Range	Temperature (degree C)	5-40			
	pH*4 of liquid	5-10			
	MLSS (mg/L)	Not higher than 18,000			
	Trans-membrane pressure (kPa)	Not higher than 20 (2.9 psi)			
	Cleaning chemicals feed pressure (kPa)	Not higher than 10 (1.45 psi)			
	Cleaning chemicals and chemicals concentration	Sodium hypochlorite (effective chlorine concentration) : 2,000 – 6,000 mg/L (pH is around 12) Oxalic acid : 0.5 -1.0 wt% Citric Acid : 1.0 - 3.0 wt%			
	Scouring Air Flow Rate (NL/min/Module)	650-1,000	1,300 – 2,000	2,600 – 4,000	1,800 – 2,000
		23-35 cfm	46-71 cfm	92-142 cfm	64-71 cfm

*1 indicates the maximum size (excluding the connection tube)
*2 the maximum weight is assumed for a case of sludge clogging between elements.
*3 for flange dimensions see the drawings at the end of this manual
*4 Excludes chemical cleaning of the elements using a designated chemical
* comply with the above operating range.

Table 4.3ii shows the performance of the Module

Table 4.3ii Module Performance

Model Name		TM 140-050S	TMR 140-100S	TMR 140-200W	TMR 140-200D
Permeate water quality *1	TSS (mg/L)*2	Not higher than 1.0			
	Turbidity (NTU) *3	Not higher than 1.0			
Filtration capacity *4	<Reference> Quantity of water treated m3/d (USGPD)	53 (14,000)	105 (27,700)	210 (55,500)	210 (55,500)

*1 - This value can be attained when operated under the standard operating conditions as specified in this Instruction Manual during a period specified separately by Sanitherm, a division of Wellco Energy Services.
*2 – Measuring method of TSS is complied with Standard Method of Examination of Water and Wastewater 20th Edition (1998), Section 254OD, Total suspended Solids Dried at 103^{O} to 105^{O} or ISO 11923.
*3- Measuring method of NTU is complied with Standard Method of Examination of Water and Wastewater 20th Edition (1998), Section 2130, Turbidity or ISO 7027
*4 - Reference value, not a guaranteed value, for treatment of ordinary sewage in a case where the water temperature is higher than 15^{O} C (59^{O} F). Based on a flex rate of 0.75 M^3/ M^2/ D (18.4 9/ft 2/0)

5 PERIPHERAL EQUIPMENT DESIGN FOR SANIBRANE® SYSTEM:

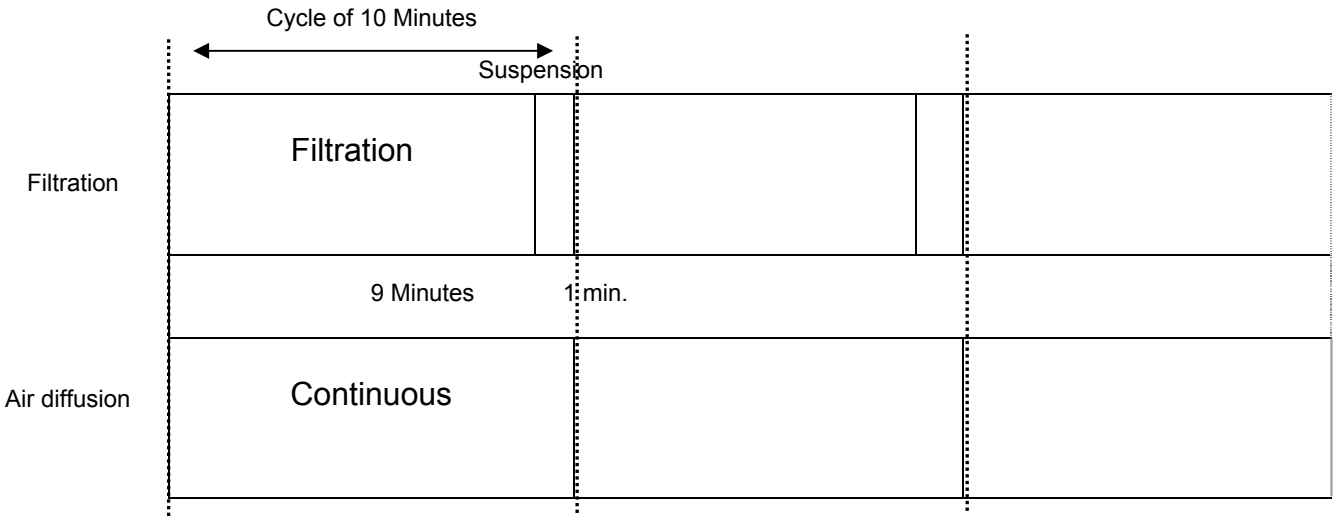
The following explains the standard time chart, membrane filtration flow chart, pipeline procedures and SaniBrane® system layout in the membrane submerged basin. This information will help you design the peripheral equipment necessary to operate your SaniBrane® system.
In order to design the peripheral equipment necessary to operate your SaniBrane® system, you must first understand the process.

5.1 Standard Time Chart:

Two operations are available for filtration, continuous filtration and intermittent filtration. In intermittent filtration, filtering operation is suspended at certain intervals while air diffusion continues, as shown in Diagram 5.1.

While filtration is suspended, air diffusion continues in the absence of suction, enabling effective cleaning of the membrane surfaces. Although a control device is required to start and stop filtration, intermittent filtration is recommended when you need a higher filtration flux.
Recommended intermittent filtration setting: 9 minutes for filtration and 1 minute for suspension:

Diagram 5.1: Standard Time chart:



5.2 Flow Diagram of Membrane Filtration:

Points (5.2.1) and (5.2.2) follow with standard examples of the operation of the SaniBrane® system with a natural water head and with suction pump. Ancillary devices necessary for operations are explained in (5.2.3).

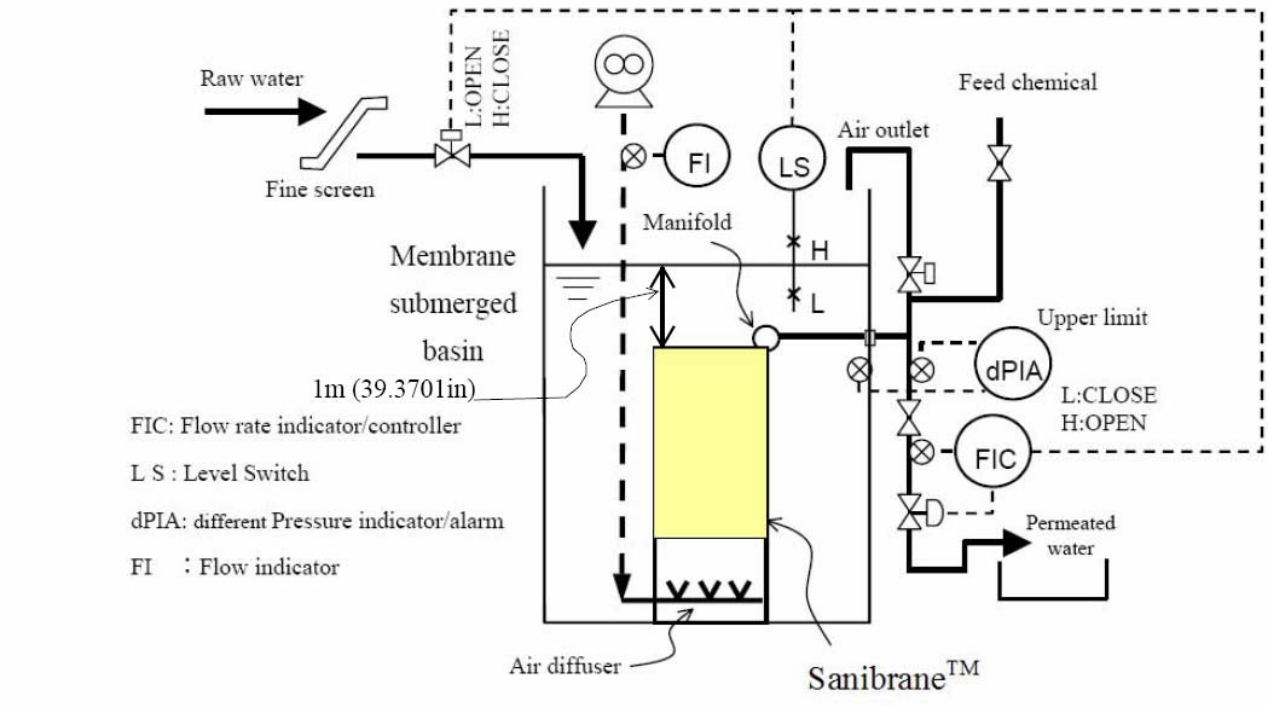
5.2.1 Operation with natural water head:

In natural water head operation, filtration is performed using the natural water head differential pressure, generated from the vertical distance between the membrane submerged basin's water surface and water outlet (see Diagram 5.2.1).

To produce a water head, the water outlet should be located below the surface of the water in the membrane submerged basin, typically 1 meter lower.

It is recommended that the permeated water pipe be connected to the water outlet so that the pipe penetrates the basin wall, as shown in Diagram 5.2.1.

Diagram 5.2.1 Natural Water Head Operation



The opening of the permeated water flow control valve is automatically controlled for flow rate. Moreover, if the water level in the membrane submerged basin gets to the lower limit, filtration will be stopped. If it gets to the higher limit, it will stop raw water inflow. The equalization tank (not shown) is designed to meet the fluctuation of the raw water flow rate.

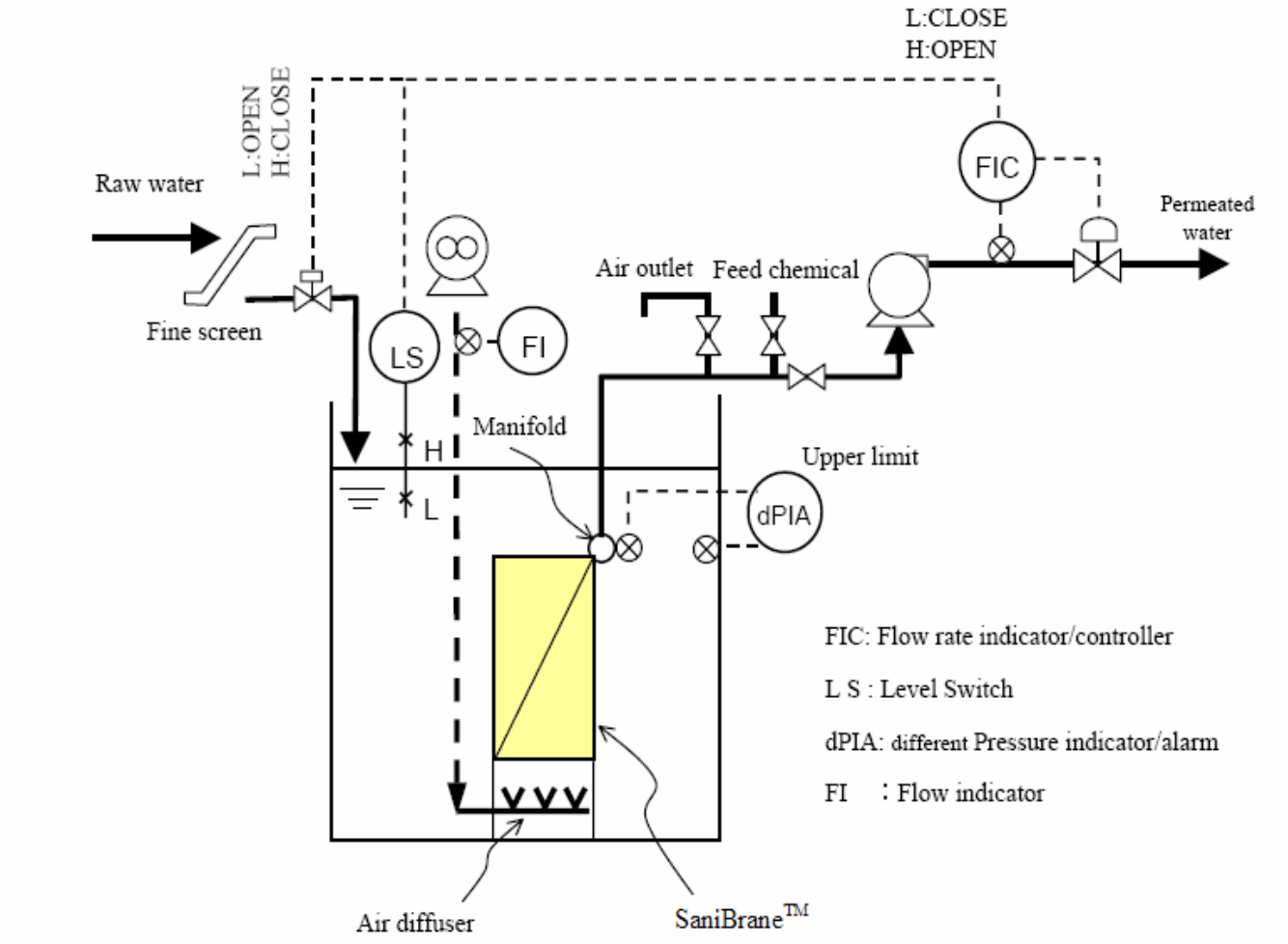
Air must be discharged once a day from the natural water head. If air were allowed to collect inside the pipe it will reduce its effectiveness.

If the pipe is connected to the water outlet by penetrating the basin wall, then air can be discharged by opening the air discharge valve during suspension of filtration. However, installing an automatic air discharge valve is highly recommended.

5.2.2 Operation with suction pump:

Filtration is performed by using the suction of a pump (see Diagram 5.2.2)

Diagram 5.2.2 Pump Suction Operation



In filtration, the opening of the permeated water flow control valve is automatically controlled for flow rate. If the water level in the membrane submerged basin gets to the lower limit, filtration will be stopped, and if it gets to the higher limit, it will stop raw water inflow. Fluctuation of the raw water flow rate is absorbed by the equalization tank (not shown), as its capacity is designed to meet the amount of fluctuation.

5.2.3 Ancillary Devices:

The following explains devices shown in the examples on the preceding pages. For the operation of the SaniBrane® System, devices other than those specified here may be used after consultation with Sanitherm:

a) Fine Screen
   To protect the membrane from clogging, raw water should be supplied to the membrane submerged basin through a screen with openings 3 mm or smaller.
b) Flow rate control device
   A flow rate controller, such as a flow rate control valve and flow meter, should be installed on the permeated water line to control the flow rate of permeated water. To operate multiple units of the SaniBrane® System, one should install one flow rate controller on each train of the SaniBrane® System.
c) Differential pressure instrument
   The sensors of the differential pressure instrument should be installed on the permeated water line and the membrane submerged basin at the same level to measure the trans-membrane pressure. To operate multiple units of the SaniBrane® System one should install a differential pressure instrument on each train.
d) Air supply unit (blower)
   This unit supplies air to the air diffuser. The flow rate of air supplied to a module should be equal to the specified scouring air flow rate for the module (see Table III-3)
e) Air Flow Meter.
   An air flow meter should be used to measure the amount of air supplied to the air diffuser. To operate multiple units of the SaniBrane® System, you should install an air flow meter on each train of the SaniBrane® System.
f) Permeate pump.
   A suction pump is required in order to operate with a pump suction install a self-priming pump compatible with the desired flow rate.
g) Level Switch
   It is required that a level switch be installed in the membrane submerged basin to control the liquid level.

CAUTION

- To protect the membranes and prevent clogging, design the peripheral equipment in such a way that the raw water is supplied to the membrane submerged basin via a screen with openings 3 mm or less.

5.3 Layout of the SaniBrane® System:

Diagram 5.3i shows how water circulates in the membrane submerged basin. An upward flow is generated as air is supplied from the lower side of the SaniBrane®. The flow then goes along both sides of the element block.

This circulation flow cleans the membrane surfaces and at the same time stirs up the sludge. It is extremely important to arrange units of SaniBrane® with appropriate distances in order to obtain an effective circulation flow.

Diagram 5.3i and Diagram 5.3ii present a top view and a side view of a basin containing three units of SaniBrane®. To install the modules, you are required to pay attention to dimensions W1, W2, W3, a and b.

Diagram 5.3i Example of SaniBrane® Modules layout in submerged basin (side view)

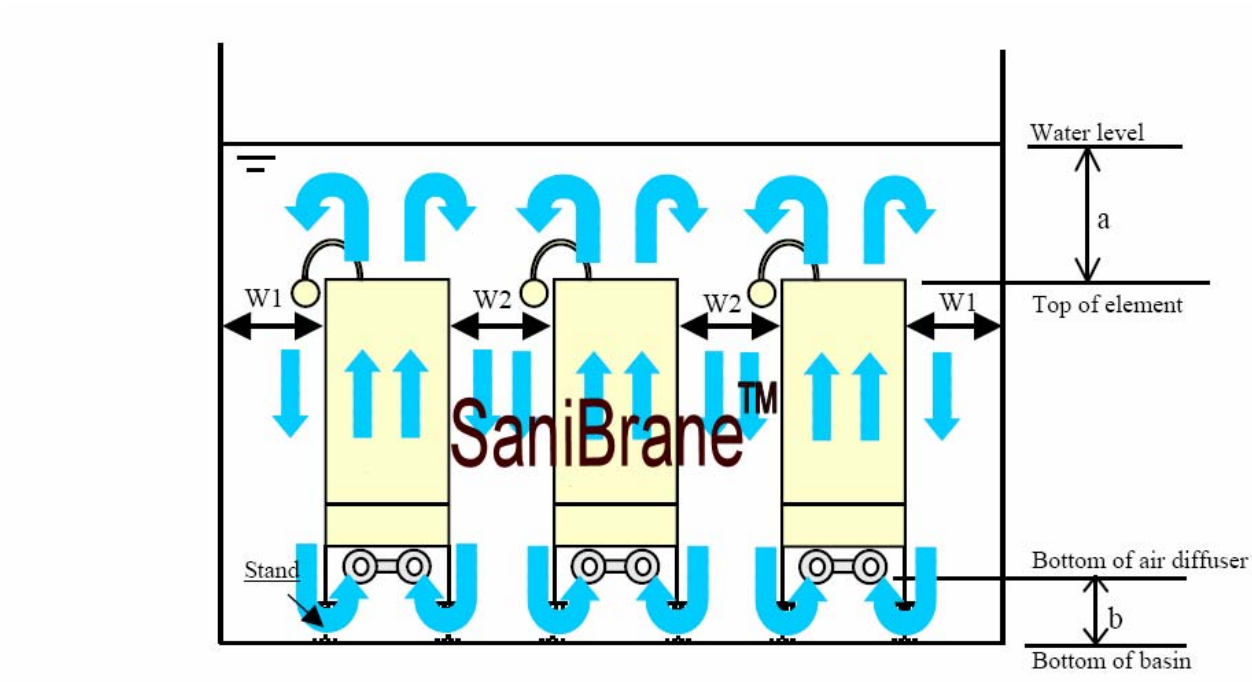
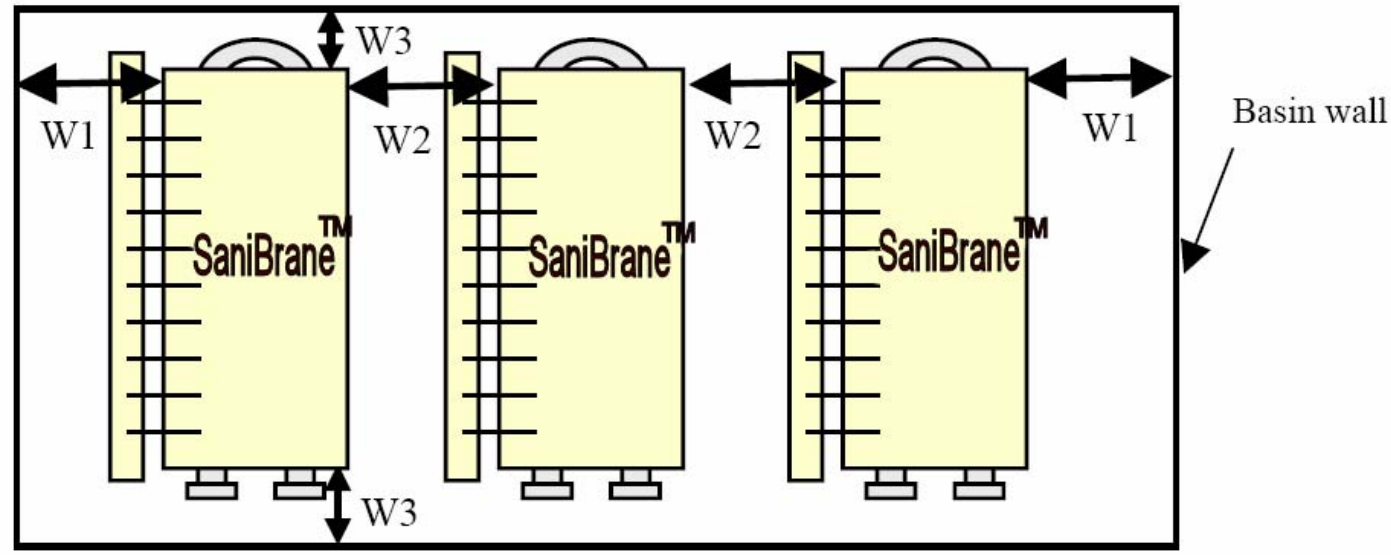


Diagram 5.3ii Example of SaniBrane® Modules layout in submerged basin (top view)



i. W1: 380 to 680 mm (15" to 27")
ii. W2: 430 to 730 mm (17" to 29")
iii. W3: Make W3 as small as possible (normally about 400mm (16") after allowing for piping and maintenance work.
iv. a: Allow at least 500 mm between the top of the element and the water level of the basin (lower limit for operation).
v. b: When a stand is used to support the module, the distance between the water level of the basin and the bottom of the air diffuser should not exceed 400mm (16").

- Please contact Sanitherm if you have any difficulty with the layout design, including installation of the SaniBrane® in an existing activated sludge tank.

5.4 Piping:

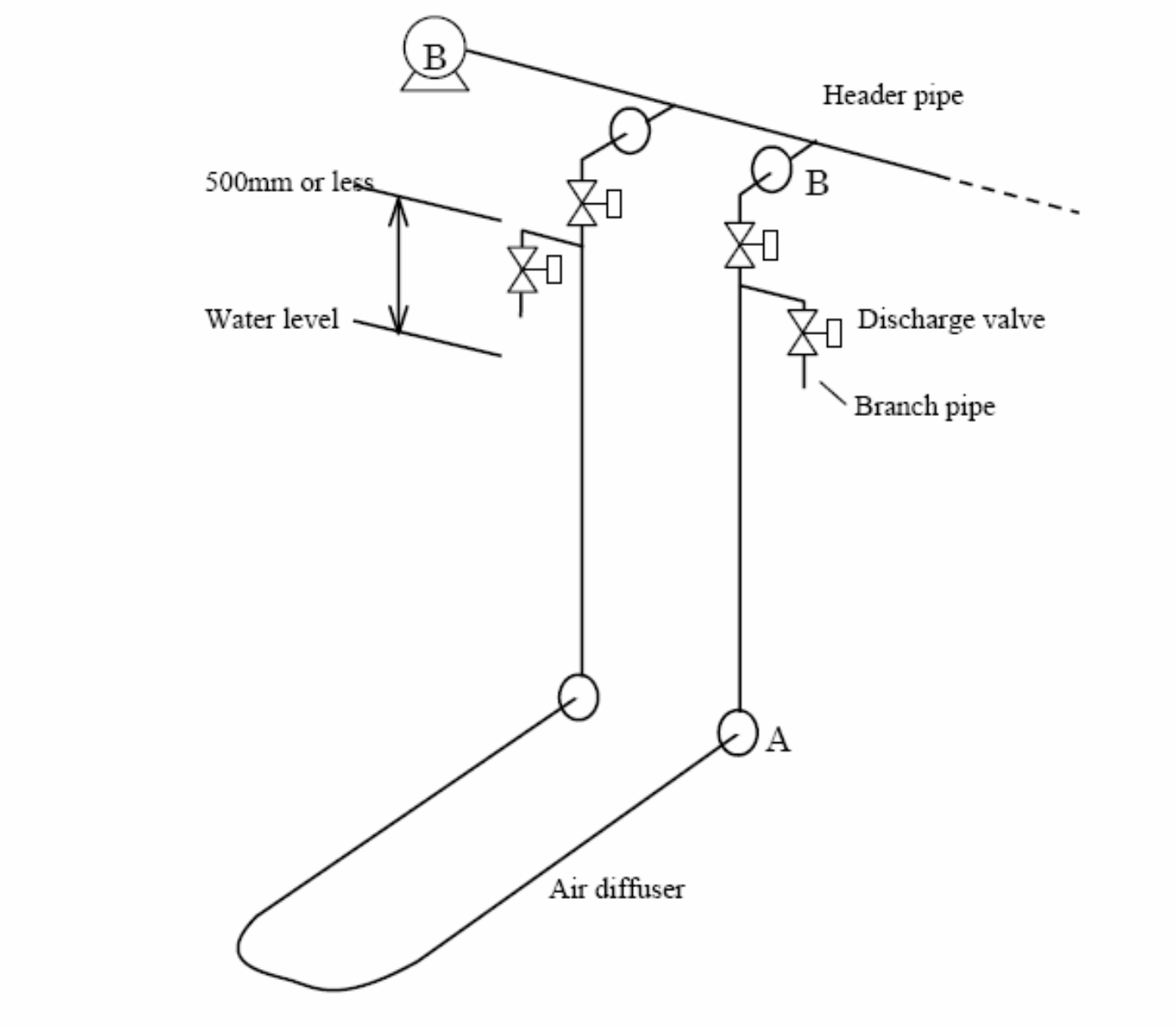
Following is a description of the procedure for piping to the air diffuser and manifold on a SaniBrane® System. For piping arrangements, see the product drawing at the end of this manual.

5.4.1 Piping into the air diffusers:

When piping into the air diffusers, use the flange (A) to connect the pipe from the air supply device to the side of the aeration block (see Diagram 5.4.1). Install another flange connection (B) above the liquid surface on this pipe line to disconnect piping in case it becomes plugged.

Also install branch piping and valves for cleaning the air diffuser into the pipe from the blower. Make sure to place the branch piping within 500mm (20”) above the liquid surface. It is recommended that the cleaning system be automated by installing automatic valves. For the air diffuser cleaning procedure 10.2.

Diagram 5.4.1 Example of piping to Air diffusers:



5.4.2 Piping to the manifold:

For piping into the manifold, Diagram 5.4.2i and Figure 5.4.2ii give two examples of leading permeated water from the membrane submerged basin. One demonstrates downward piping and the other upward piping.

In the operation of a natural water head, downward piping is recommended. In the operation of a suction pump, if the pump is located above the membrane submerged basin, upward piping is preferred, and vice versa.

In both upward and downward piping, a chemical injection valve and an air discharge valve should be installed on a branch pipe between the permeated water valve and the air diffusers. For devices necessary for chemical cleaning, see VIII-3 to VIII-6.

Diagram 5.4.2i Downward Piping from Basin

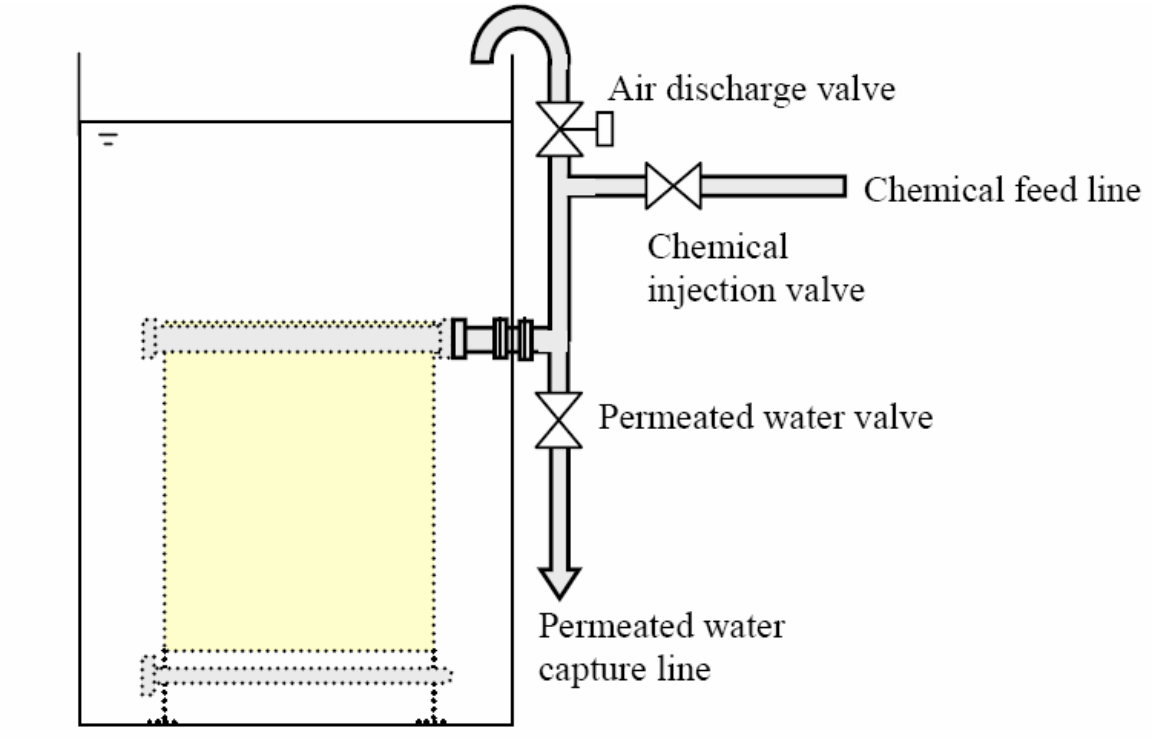
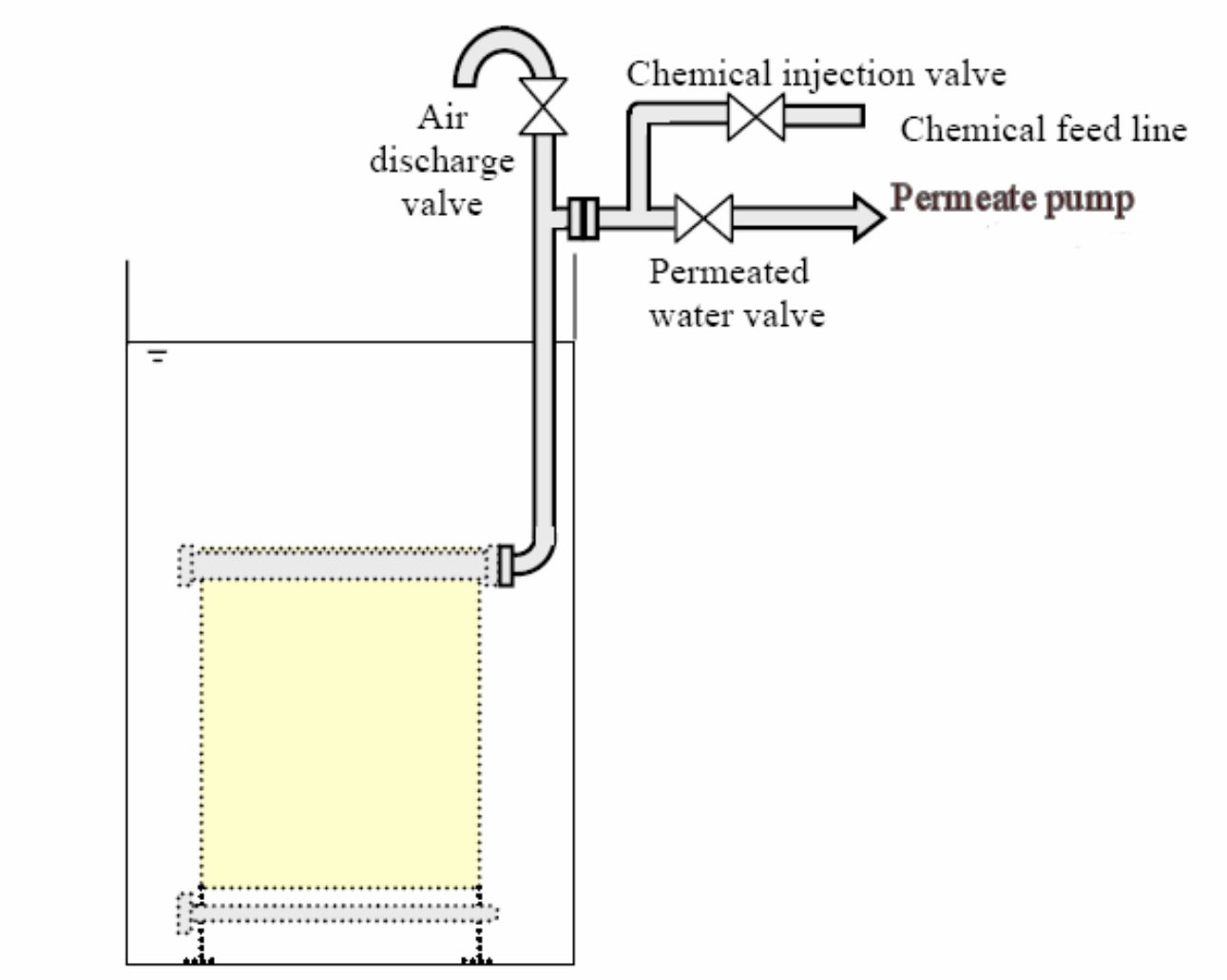


Diagram 5.4.2ii Upward Piping from Basin



6 INSTALLING SANIBRANE®:

6.1 Preparation:

1. There should be full preparation for the transportation of the SaniBrane® including a clear route.
2. You will require a cargo crane or forklift for unloading the SaniBrane® from the truck.
3. Ensure that the membrane submerged basin where the modules will be installed is clean. All waste such as concrete clusters, scrapes and mill ends must be removed.

6.2 Unloading SaniBrane®:

You will require a cargo crane or forklift to unload the SaniBrane®.

When lifting the SaniBrane® please note:

1. The Element block and the Aeration block are delivered in separate packages.
2. When lifting the element block keep it horizontal and lift from all lifting points equally. Be careful not damage the nozzles, air diffusers or other components.

DANGER

- The chains or slings being used to raise the SaniBrane® must be sufficient for the weight of the SaniBrane® System. Lifting should be done in a straight upward motion not allowing any shaking of the product.
- No one should ever be under the SaniBrane®!

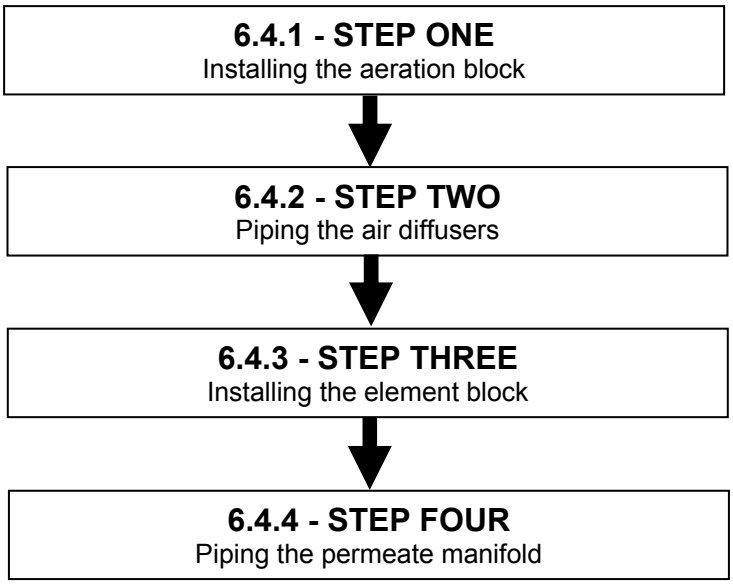
6.3 SaniBrane® check:

After you have the SaniBrane® in place, re-check the following;

1. All items match the shipping manifest.*
2. There has not been any damage in transport.
3. The protective cover is in position.

** Please contact the trucking company should any items be missing.*

6.4 Installation of the SaniBrane®:



6.4.1 STEP ONE - Installing the Aeration block:

Set the aeration block in the membrane submerged basin using anchors. In this installation, it is important to keep the air diffusers horizontal. In order to achieve uniform flows along the membrane surfaces of each element, the air diffuser must be completely level.

To ensure uniform flows, maintain the levelness within 3/1,000 (3mm over 1 meter or 1/8" over 40") on the top surface of the aeration block in both lateral and longitudinal directions.

6.4.2 STEP TWO - Piping the air diffusers:

Each air diffuser is furnished with two blank flanges. Modify the blank flanges or procure suitable flanges, and connect them to the pipe from the air supply unit. Prior to piping, flush the pipes.
After piping the air diffusers, feed clean water until the aeration block is completely submerged and then supplies air for diffusion. Next, check that the air is provided evenly among the aeration blocks and that it is diffused evenly in each aeration block.

6.4.3 STEP THREE – Installing the element block:

To install the element block, take the following steps, depending on the module type:

a) TMR140-050S and 100S
   Set the element block on the aeration block and connect the two with provided bolts.
b) TMR 140-200W

TMR 140-200W consists of two element blocks and one aeration block. Each element block has one manifold and each manifold is furnished with two blank flanges. In installation, these flanges may interfere with each other between the element blocks. In order to prevent this, offset either of the facing blank flanges. Then set two elements on the aeration block to fix them using the provided bolts.

c) TMR140-200D
Place an element block furnished with an intermediate block onto the aeration block, and secure them with the provided bolts. Place another element block on the first element block, and connect the two blocks with the provided bolts.

6.4.4 STEP FOUR – Piping the Permeate Manifold:

The manifold is furnished with blank flanges. Modify the blank flanges or procure suitable flanges. In piping, take the steps shown below in accordance with the module type.

The manifold is designed to allow fine adjustments with the brackets on both ends of it. To prevent air collection inside the manifold, vertically adjust the brackets to raise the permeated water outlet side a little higher than the other.

Prior to connecting the manifold to the pipe, flush the permeated water pipe and check the pipe for leakage.

Avoid applying pressure to the permeate side of the element or the element could suffer damage.

a. TMR140-050S and 100S
Connect one end of the manifold to the permeated water pipe. Leave the other end closed with a blank flange.

b. TMR140-200W
One-side connection
   i. Loosen the U-bolt on the manifolds, connect one manifold to the other on two element blocks. After piping, fasten all U-bolts and check that the manifolds are secured firmly.
   ii. Then connect one end of the joined manifolds to the permeated water pipe. Leave the other end closed with a blank flange.
   iii. Two side connection
   iv. Loosening the U-bolts on the manifolds, connect one manifold to the other on two element blocks. After piping, fasten all U-bolts and check that the manifolds are secured firmly.
   v. Then connect both ends of the joined manifolds to the permeated water pipe.

c. TMR140-200W
Connect one end of the upper and lower manifolds to the permeated water pipe on the relevant line. Leave the other end closed with a blank flange. To connect the manifold to a piping assembly, provide an upper and lower line.

DANGER

- The chains or slings being used to raise the SaniBrane® must be sufficient for the weight of the SaniBrane® System. Lifting should be done in a straight upward motion not allowing any shaking of the product.
- No one should ever be under the SaniBrane®!
- To install SaniBrane® set a foothold.
- Never climb on the module.
- Use protective equipment to ensure the safety of the worker.

CAUTION

- Avoid applying pressure to the permeate side.

7 START OF OPERATIONS:

When starting up the plant for the first time, fill the tank with fresh water, vent the air and test all pumps, blowers and level switches.

7.1 Clean Water Operation

7.1.1 Inspection and arrangements:

Prior to clean water operation; make the following inspection and arrangements:

a) Check that the air diffusion pipe and the permeated water pipes are connected properly.
b) Check that the element block is secured on the aeration block.
c) Check that the membrane submerged basin has been completely cleaned. Then remove the protective cover. The presence of soil, dust, concrete chips, wire ends ty-wrap ends etc. and dust may cause damage to the SaniBrane®.
d) Before feeding clean water to the membrane submerged basin, open the air discharge valve to release air from the element.
e) Feed clean water (tap water or filtered water) to the membrane submerged basin up to the operating level.
f) After feeding water, close the air discharge valve.

CAUTION

- Before feeding clean water to the membrane submerged basin, open the air discharge valve to release air from the element. After feeding water, close the air discharge valve.
- DO NOT use ground water for clean water operation. If it contains a large amount of iron, manganese, calcium or silica it may cause clogging in the membrane.

7.1.2 Clean water operation:

After feeding clean water to the membrane submerged basin, start clean water operation in accordance with the following procedure:

a) Start the blower and check that the required amount of air has been supplied and that the defused air is supplied evenly.
    - Foaming may occur in the membrane submerged basin during clean water operation. This phenomenon is caused by the dissolution of biodegradable hydrophilic components contained in the membrane. Operation can be continued regardless of the foaming.
b) When using only one blower to achieve air diffusion for two or more modules, check that an even amount of air is supplied to them. Otherwise, modify the piping structure (such as the diameter of the header pipe) to attain uniform air supply.

c) While maintaining clean water operation, check the control devices for proper performance.
d) Perform clean water filtration, and measure and record the trans-membrane pressure and water temperature at designed filtration rates (at a normal, maximum and minimum flow rate). These records should be maintained.
e) Upon completion of performance checks in clean water operation, immediately terminate the operation and stop air diffusion.

CAUTION

- Clean water operations tend to cause clogging, and should not be done excessively.
- After clean water operation, keep the membranes wet. Dried membranes may reduce permeable amounts of water.

7.1.3 Injecting seed sludge:

Be sure to inject seed sludge (where possible). Otherwise, if raw water is separated directly by the membranes, membrane clogging may occur at an early stage.

To follow are the steps for injecting seed sludge.

- **STEP ONE:**
  For seed sludge, procure sludge used for the treatment of same kind of waste water. Sludge with MLSS of 20,000 mg/L or higher is recommended.
- **STEP TWO:**
  Right before feeding raw water, inject seed sludge. To remove foreign matter, be sure to use a screen (with an opening of 3 mm or less).
- **STEP THREE:**
  The amount of seeding sludge injected should be adjusted so that MLSS of the membrane submerged basin is 7,000 mg/L or more.

DO NOT use seeding agents (engineered bacteria).

CAUTION

- Be sure to use a screen (with an opening of 3 mm or less) to remove foreign matter.

7.1.4 Actual Operation:

Upon completion of seeding sludge injection, start air diffusion. Then start filtration and the feeding of raw water. Once the permeated water level has been stabilized, measure and record the trans-membrane pressure and water temperature at the actual filtration rate. Details of operation management are given in the next chapter.

8 OPERATION CONTROL:

8.1 Standard Operating conditions:

Table 8.1 shows standard operating conditions for SaniBrane®.

To ensure stable performance, such operation parameters as MLSS, sludge viscosity, DO (dissolved oxygen concentration) and PH must be kept in a range of standard operation conditions given in 8.1.

If raw water contains foreign matter, big chunks of suspended solid or oil, pretreatment is required.

When using an antifoaming agent in the membrane, ensure that it is alcohol-based, such as Kurita Water Industries “Kuriless P.F-663”.

Table 8.1 Standard conditions for SaniBrane®

Parameter	Unit	Operating condition
MLSS	mg/L	7,000 – 18,000
Sludge viscosity*	mPa-s	Not higher than 250
DO	mg/L	1.0 or more
pH	-	6-8
Water temperature	Degree C	15 to 40
Continuous filtration flux	$m^3/m^2/d$	0.75 or less

*Measured by C-type viscometer

- **DO NOT** use permeated water for drinking. To use permeated water, analyze its quality and ensure that the water quality meets the intended purpose.
- **Please contact Sanitherm** if the operating conditions are not standard

CAUTION

- In the activated sludge tank, avoid using chemicals, toxic agents, oils or other substances that can adversely affect activated sludge.
- Avoid abrupt changes in pH, temperature, trans-membrane pressure or any other conditions even if they are within the standard operating conditions.
- Replace renewal parts regularly after inspection.
- Protect SaniBrane® from freezing.

8.2 Operation Control Parameters:

The performance of SaniBrane® varies in accordance with the raw water quality and the preset operating conditions. To ensure stable operation, it is recommended that you record monitored values of control parameters in order to monitor the performance and characteristics of your unit of SaniBrane®.

8.2.1 Control parameters for the operation of SaniBrane®:

1. Scouring Air Flow rate (blower air flow)
2. Diffusion pressure (blower discharge pressure)
3. Permeated water flow rate
4. Trans-membrane pressure (TMP)
5. Permeated water quality (BOD, COD, turbidity, T-N, T-P, TSS etc)
6. Liquid temperature of membrane submerged basin
7. Raw water quality (BOD, COD, turbidity, T-N, T-P, etc.)
8. Excess-sludge discharge rate
9. DO (dissolved oxygen concentration) of membrane submerged basin
10. pH of membrane submerged basin
11. MLSS
12. Sludge viscosity
13. Sludge volume (SV30 or SV60)

8.3 Daily inspection of the Membrane submerged basin:

To ensure consistent operation of SaniBrane® it is essential to stabilize the trans-membrane pressure, diffused air condition, and biological treatment.

8.3.1 Inspection steps:

1. Trans-membrane pressure:

Check that the trans-membrane pressure is stable. A sudden increase in differential pressure suggests membrane clogging, caused by abnormal diffused air conditions or deteriorating sludge properties. In such an event, check the following parameters and take necessary action, such as chemical cleaning of the elements.

2. Diffused air condition:

Check that the standard amount of diffused air is supplied and that the air is diffused evenly. Deviation in the scouring air flow rate from the standard value, or extraordinary uneven diffusion, may cause membrane clogging. In such a case, stop filtration, and check the leakage from the piping, valve situation and the blower condition. If necessary, take

appropriate action, such as fix the leakage, correct the valve situation, adjust the blower condition, clean the air diffusers and adjust the scouring air flow rate.

CAUTION

- If the scouring air flow rate drops or becomes extremely irregular, or if air supply is stopped, then immediately stop filtration to prevent membrane clogging.

3. Colour and smell of activated sludge:

Sludge appropriate for treatment should be brownish-red, coagulable, and free from odour. If the sludge appears to be failing to meet these requirements, then measure its MLSS, viscosity, DO, pH, temperature and BOD load. If necessary, take appropriate action, such as additional injection of seeding sludge or adjust the organic loading, etc.

4. MLSS:

The sludge should have an MLSS of 7,000 to 18,000 mg/L. If MLSS is too low, add seeding sludge or stop sludge transfer. If MLSS is too high, increase the sludge wasting rate.

5. Sludge viscosity:

The sludge viscosity should not be more than 250 mPa-s. If the sludge viscosity is too high, replace the sludge or transfer the sludge to the sludge storage tank until an appropriate viscosity value is attained.

6. DO:

DO values should be 1 mg/L or more at any point in the membrane submerged basin. If this requirement is not met, you may increase the scouring airflow rate to the extent that the rate does not exceed its maximum permissible value. Reduce incoming BOD strength. Add supplemental aeration.

7. pH:

pH range should be 6 to 8. If this requirement is not met and activated sludge property is not good, adjust pH by adding acid or alkali.

8. Liquid temperature:

The liquid temperature should be 15^{O} C to 40^{O} C (59^{O} to 104^{O} F). If this requirement is not met and activated sludge property is not good, it is recommended that you take corrective measures.

9. Liquid level:

Check that the liquid level of the membrane submerged basin is in the appropriate range. If this requirement is not met, check (i) the liquid-level meter, (ii) the suction pump, and (iii) the trans-membrane pressure, and when necessary, take corrective action, such as adjusting the control system.

9 MAINTENANCE OF SANIBRANE®:

9.1 Maintenance Items and Maintenance Frequency:

To maintain SaniBrane® perform the following at specified intervals:

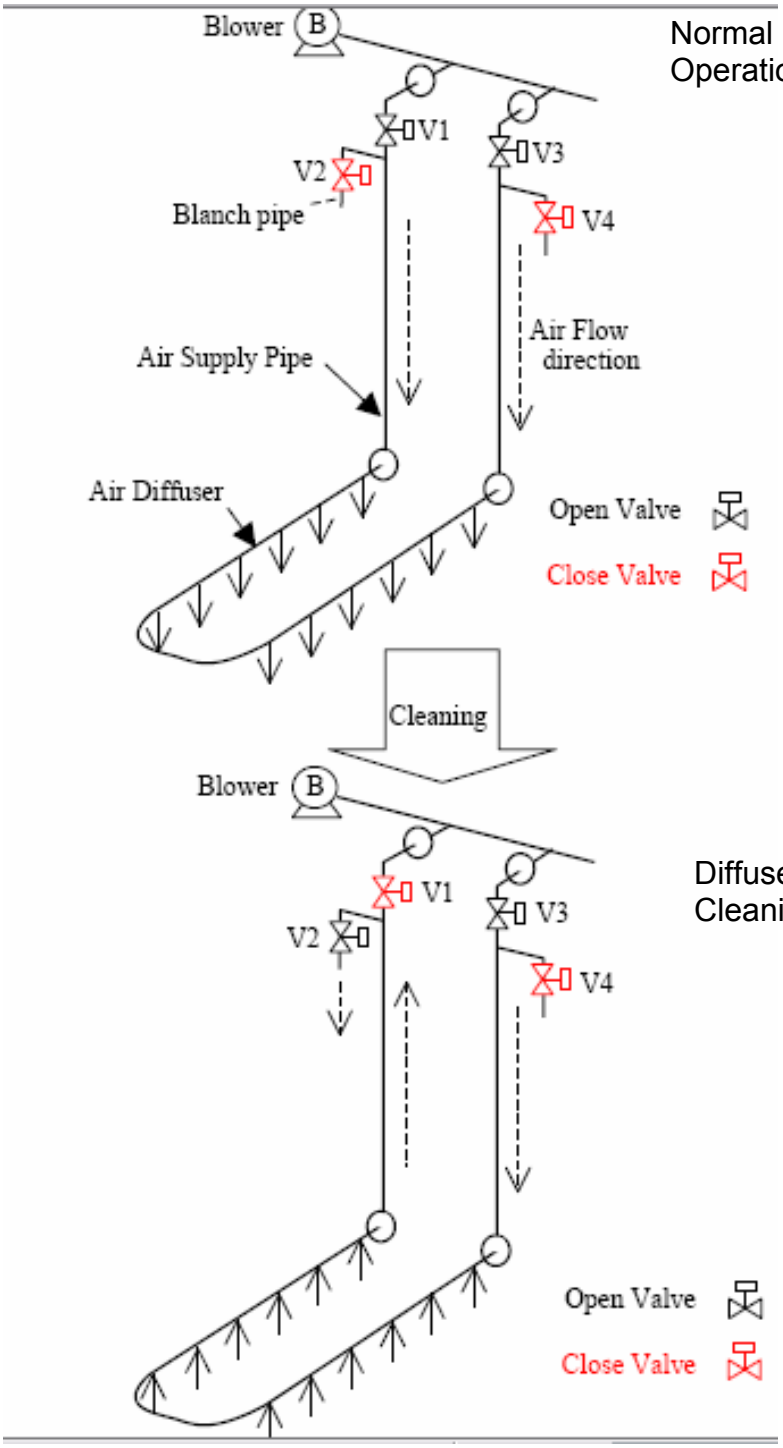
1. Clean the air diffusers (everyday)
2. Chemical cleaning of the element, every six (6) months or when the trans-membrane pressure has risen by 5 kPa or more from its initial operating level at the same permeated water flow rate, whichever occurs earlier.
3. Replace connection tubes (once in three (3) years, or when deteriorated)
    - In replacement of parts, be sure to use specified types.
    - For detailed specifications and procurement routes for replacement parts, please contact us.
    - In replacing tubes, insert the tube securely into the foot of the nozzle.
    - In replacing tubes, avoid applying excess force to the element and manifold nozzles to prevent damage.

9.2 Air Diffuser Cleaning:

Clogging of diffuser holes may lead to uneven air diffusion and membrane clogging. To prevent such clogging, clean the air diffusers at least once a day (it is recommended to automate the air diffuser cleaning process by using automatic valves). Ensure that the permeate flow is stopped before starting.

The cleaning is done by the reverse flow of the sludge from the diffuser hole into the diffuser piping. This is accomplished by opening the air diffuser cleaning valve and releasing the pressure inside the air diffuser, discharging such sludge by the diffusing air through the branch valve.

9.2.1 Air diffuser cleaning procedure:



1. Stop Filtration
2. Close V1 Valve
3. Open V2 valve. At this step, the sludge liquid comes through the diffuser holes into diffuser piping, and is discharged together with the air.
4. Keep V2 valve open for about one (1) minute.
5. Close V2 valve, and then open V1 valve.
6. Clean the other line in the same manner as follows.
7. Close V3 valve.
8. Open V4 valve. At this step, the sludge liquid comes through the diffuser holes into the diffuser piping, and is discharged together with the air.
9. Keep V4 valve open for about one (1) minute.
10. Close V4 valve, and then open V3 valve
11. Restart filtration.

9.3 Chemical Cleaning of Element:

Chemical cleaning of the element should be conducted when the trans-membrane pressure rises in excess of operational limits. Such a pressure increase can be caused when contaminants clog the pores of the membrane surface. The timing of chemical cleaning should be determined as follows:

1. Every six (6) months or when the trans-membrane pressure has risen by 5 k Pa from its initial operating level at the same permeated water flow rate, whichever occurs earlier.
2. If the Trans-membrane pressure is rising rapidly, conduct chemical cleaning much earlier. Early chemical cleaning is effective to remove contaminates clogged in the membrane pores.
3. In the case that the trans-membrane pressure rises by 5 k Pa within six (6) months, record how many months it took to rise and conduct chemical cleaning accordingly. This measure is effective in prolonging the life of membranes.

9.4 Chemical Agents Used for Chemical Cleaning:

For chemical cleaning of the element, it is important to select chemicals in accordance with the type of adherent contaminant. Cleaning under inappropriate cleaning conditions or using the wrong chemicals may cause poor filtration performance or damage to the element. Select chemicals suitable for each contaminant. Table 9.4 shows suitable chemicals and standard cleaning conditions.

Table 9.4 Cleaning Chemicals and Standard Cleaning Conditions by Contaminant

Contaminant	Chemical	Solutions concentration	Amount used	Hold time
Organic matter	Sodium hypochlorite	2,000 – 6,000 mg/L (effective chlorine concentration) (pH is about 12)	5L/ element (1.32 USG)	1 to 3 hours
Inorganic matter	Oxalic acid	0.5 - 1.0 wt %	5 L/element (1.32 USG)	1 to 3 hours
Inorganic matter	Citric acid	1.0 – 3.0 wt%	5 L/element (1.32 USG)	1 to 3 hours

9.5 Handling of Chemical Agents:

Some chemical agents used for chemical cleaning are harmful when they come in contact with skin. In handling chemicals, wear protective goggles, protective gloves and other protectors. Before using chemicals, be sure to check the details of its material safety data sheet (MSDS) and the instructions given below. If chemicals come into contact with your skin, follow the MSDS to take suitable action for each chemical.

Table 9.5i Chemical Handling precautions:

Agent:	Sodium hypochlorite Solution/ NaClO	Oxalic Acid / $(COOH)_2$	Citric acid/ $HOOCCH_2C(OH)(COOH)CH_2COOH$
CHEMICAL HANDLING PRECAUTIONS	Ventilate well. Avoid heat sources and sparks. Also avoid contact with acids.	Keep away from acids and bases.	Keep away from strong acids and bases.
	Handle the chemical container with great care. Avoid toppling, bumping or dragging it.		
	Take care to prevent leaks, spillover or splattering. Do not cause dust or vapor.		
	Firmly seal the container after use.		
	After using chemicals, thoroughly wash your hands and face and rinse out your mouth.		
	Do not eat or drink except in a designated place.		
	Keep gloves in a designated area away from any rest area or lunch rooms.		
	Forbid unauthorized entry to the place where chemicals are handled.		
	Wear appropriate protectors to avoid inhalation, eye or skin contact, and direct contact with your clothes.		
	To handle chemicals outdoors, provide local ventilation.		

Table 9.5ii Storage Precautions:

Agent:	Sodium hypochlorite Solution/ NaClO	Oxalic Acid / $(COOH)_2$	Citric acid/ $HOOCCH_2C(OH)(COOH)CH_2COOH$
STORAGE PRECAUTIONS	Store container in a dark, cold place. Avoid direct sunlight. Firmly seal to prevent direct contact with air.		
	For storage, use corrosion-resistant containers.		

- Many chemical agents are extremely hazardous to one's health. When handling chemicals, one should wear protective goggles, gloves and any other available protective gear. Be sure to carefully read the details of the material safety data sheet (MSDS) BEFORE handling any chemicals.
- If chemicals come in contact with your skin or clothes, immediately rinse with large amounts of water.
- Store chemicals in a dark, cold place away from direct sunlight.
- If chemicals come in contact with your eye, immediately flush with running water and see a physician.
- In the chemical storage tanks, be sure to use a material suitable for each chemical in order to prevent corrosion.
- Do not mix sodium hypochlorite with heavy metals or acids. Its mixture with an acid generates toxic chlorine gas.

9.6 Chemical Cleaning Procedure:

9.6.1 For Elements:

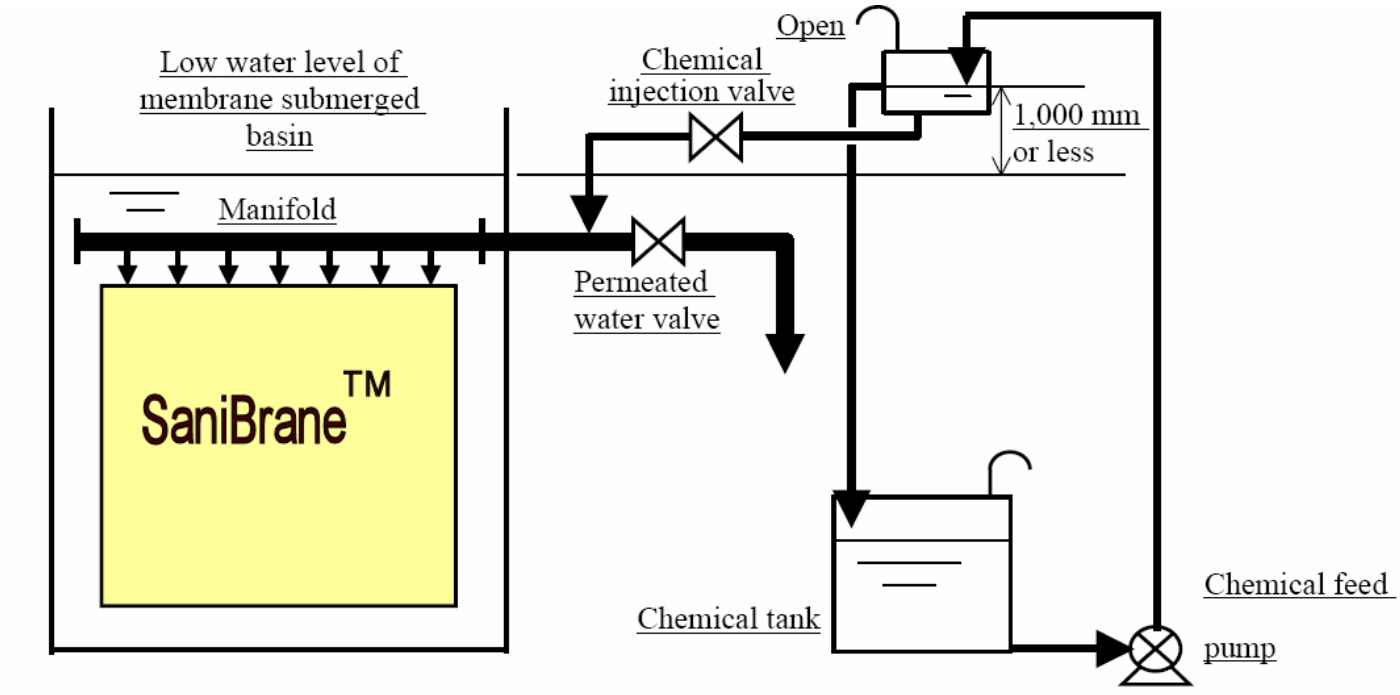
When cleaning, slowly inject chemicals via the permeated water nozzle into the elements until they percolate through the membranes.

Depending on the location of the chemical tank, use a natural water head when injecting chemicals, as shown below.

1. Chemical cleaning with the chemical tank located at the bottom (Diagram 9.6.1A)

a) Check that the chemical injection valve is closed and that the chemical feed pump is at rest.
b) Fill the chemical tank with specified amounts of chemicals.
c) Stop filtration and close the permeated water valve (air diffusion should be continued).
d) Start the chemical feed pump and check that the chemicals circulate.
e) Slowly open the chemical injection valve to inject chemicals.
f) After injecting the specified amount of chemicals, stop the chemical feed pump.
g) Leave the equipment for 1 to 3 hours.
h) Close the chemical valve, open the permeated water valve and restart filtration.
i) Chemicals remain in the permeated water in an early phase of filtration (for a period of 2 or more intermittent cycles). Send back the permeated water to the raw water. Otherwise, dispose of it in accordance with applicable legal standards for waste disposal.

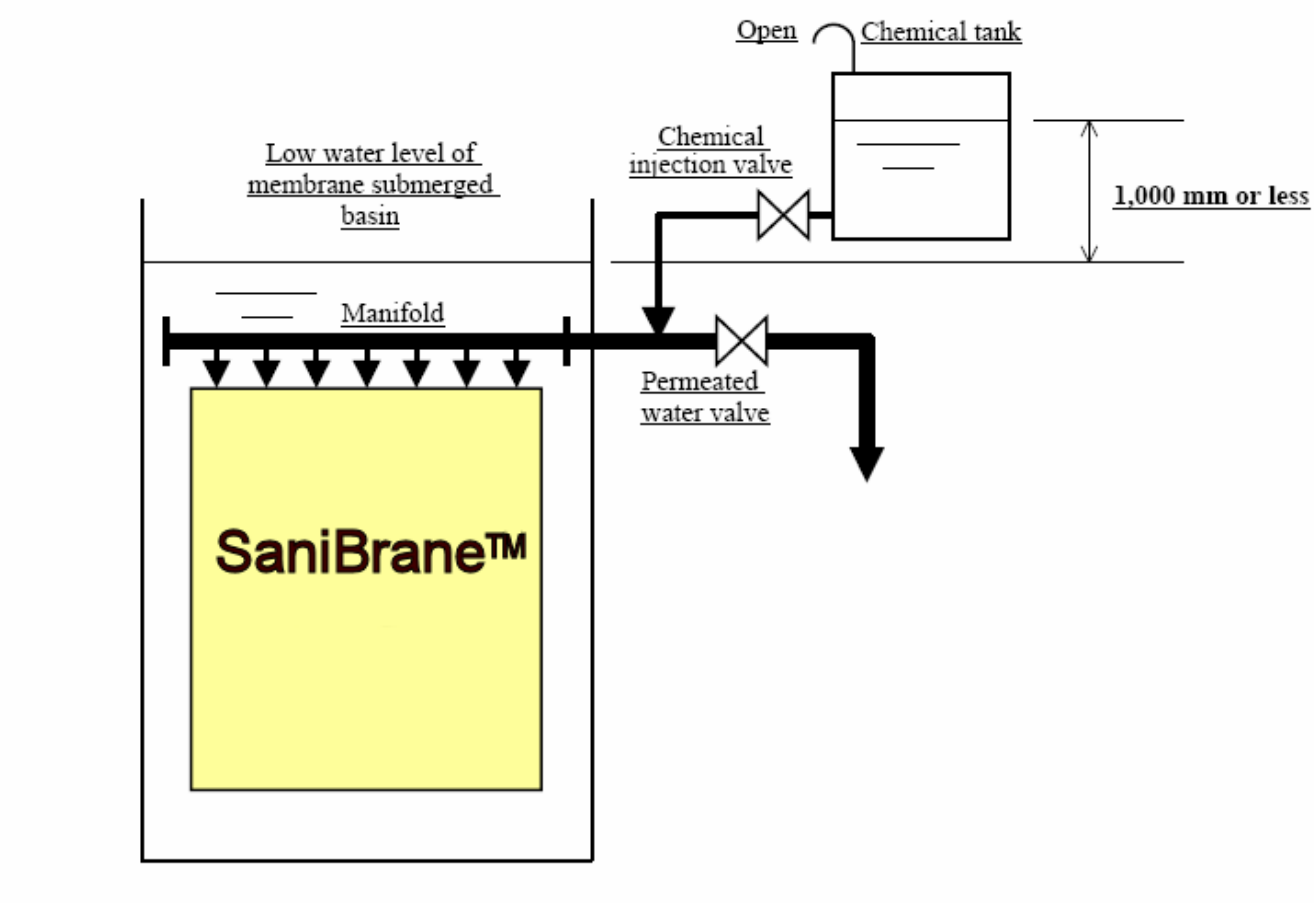
Diagram 9.6.1A - Chemical cleaning with Chemical Tank Located below the MBR liquid level:



2. Chemical cleaning with the chemical tank located above the membrane submerged basin (Diagram 9.6.1B)

a) Check that the chemical injections valve is closed
b) Feed the chemical tank with specified amounts of chemicals.
c) Stop filtration and close the permeated water (air diffusion should be continued)
d) Slowly open the chemical injection valve to inject chemicals
e) After injecting chemicals, leave the equipment for 1 to 3 hours
f) Close the chemical injection valve, open the permeated water valve and restart filtration
    - Chemicals remain in the permeated water in an early phase of filtration (for a period of 2 or more intermittent cycles). Send back the permeated water to the raw water tank. Otherwise, dispose of it in accordance with applicable legal standards for waste disposal.

Diagram 9.6.1 B – Chemical cleaning with Chemical Tank Located above the MBR liquid level



9.6.2 Precautions for chemical cleaning of elements:

a) Inject chemicals using gravity. Maintain the pressure at 10 kPa (1.45 psi or approximately 1 meter) or less. Avoid forcibly applying pressure with the pump directly connected. A higher pressure can damage the elements.
b) Inject chemicals with SaniBrane® submerged in the membrane submerged basin. To ensure the safety of the operator, keep the top of the module at least 500 mm (20”) below the water surface.
c) Continue air diffusion during chemical cleaning. Note, however, that foaming may occur inside the membrane submerged basin depending on the type of chemicals used or other conditions. In such a case, reduce the defused air rate.
d) A higher temperature of chemicals produces greater cleaning effects. However, maintain the temperature at 40^{O}C or below. Conversely, a lower temperature causes poor cleaning effects, hampering the recovery of the membrane function. Maintain as high of a temperature as is possible inside the membrane submerged basin.
e) After chemical cleaning, a small amount of chemicals remain inside the elements and filtration piping right. To restart filtration, send back the permeated water to the

raw water tank until the permeated water is free from the effects of the chemicals (for a period of at least 2 intermittent cycles). Otherwise, dispose of it in accordance with applicable legal standards for waste disposal.

- If an abnormality is found in the equipment during chemical cleaning, immediately stop the operation.
- If chemicals are injected forcibly with the chemical feed pump or by any other means, the internal pressure of the element may increase, leading to damage to the element. Be sure to inject chemicals by gravity at 10 pKa or less.
- Before feeding chemicals for chemical cleaning, check that the water surface is 500 mm or more above the top of the module. Feed chemicals after SaniBrane® are completely submerged.

9.7 Lifting Procedure:

To lift SaniBrane® for maintenance, take the following steps:

1. Completely empty the membrane submerged basin.
2. To lift only the element block, remove the manifold. To lift the aeration block along with the element block, also remove the air diffuser pipe.
3. To remove and lift only the element block, remove the bolts connecting it to the aeration block.
4. For TMR140-200W, if the manifold is connected to two element blocks, remove the bolts and separate the manifold.
5. To lift the aeration block along with the element block, remove the fastened anchors.

DANGER

- The chains or slings being used to raise the SaniBrane® must be sufficient for the weight of the SaniBrane® System. Lifting should be done in a straight upward motion not allowing any shaking of the product.
- The element block will be significantly heavier after operation. Ensure the lifting equipment is suitable.

CAUTION

- To restart filtration right after lifting maintenance, keep the membranes wet during the maintenance. Dried membranes may reduce permeable amounts of water.

10 TROUBLESHOOTING:

Most abnormalities in SaniBrane® concern abnormal air diffusion, increased trans-membrane pressure, decreased permeated water flow rate, and degenerated permeated water quality. The following explains such abnormalities and corrective actions against them:

Table 10 - Troubleshooting

	Problem	Cause	Action
1	The air diffusion rate is below the standard level.	The blower is broken or worn	Check the blower
		The air diffusers are clogged	Clean the air diffusers
2	The air diffusion is uneven inside a module or between modules.	The air diffusers on the module are clogged.	Clean the air diffusers on the module.
3	The permeated water flow rate was decreased. Or, the trans-membrane pressure has increased.	Membrane clogging has worsened.	Perform chemical cleaning.
		Decreased or uneven diffused air is preventing smooth membrane cleaning.	Inspect the blower and clean the air diffusers to improve air diffusion.
		Abnormal properties of sludge have worsened its filterability.	Improve sludge properties: • Adjust the sludge discharge rate. • Prevent entry of abnormal components, such as oils. • Adjust BOD load • Adjust the raw water quality (add nitrogen, phosphorous, etc.)
		Partial clogging of membrane	• Perform an extensive air scour with permeate flow off.
4	The concentration of suspended solids in the permeate water has increased.	An element or tube has fractured.	Seal the element and manifold nozzle.*1
		A leakage has occurred in the permeated water piping.	Inspect the faulty part *2 and correct the fault.
		Germs are generated on the membrane.	To clean the permeated water piping, inject into it a sodium hypochlorite solution with an effective chlorine concentration of 100 to 200 mg/L.

*1: Even if a cause is found in the tube, there still is the possibility of contamination inside the element. Thus, seal the element and manifold nozzle.

*2: To check the piping joints and welds for leakage with pressure being applied, take care not to exert pressure.