Hope Bay Mining Ltd.

Doris North Infrastructure Project Sewage Management Plan

Hope Bay, Nunavut, Canada

Prepared for:

Hope Bay Mining Ltd.

Prepared by:

SRK Consulting
Engineers and Scientists

Project Reference Number
SRK 1CH008.008.200

July 2008

Doris North Infrastructure Project
Sewage Management Plan

Hope Bay, Nunavut, Canada

Hope Bay Mining Ltd.

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SRK Project Number 1CH008.008.200

July 2008

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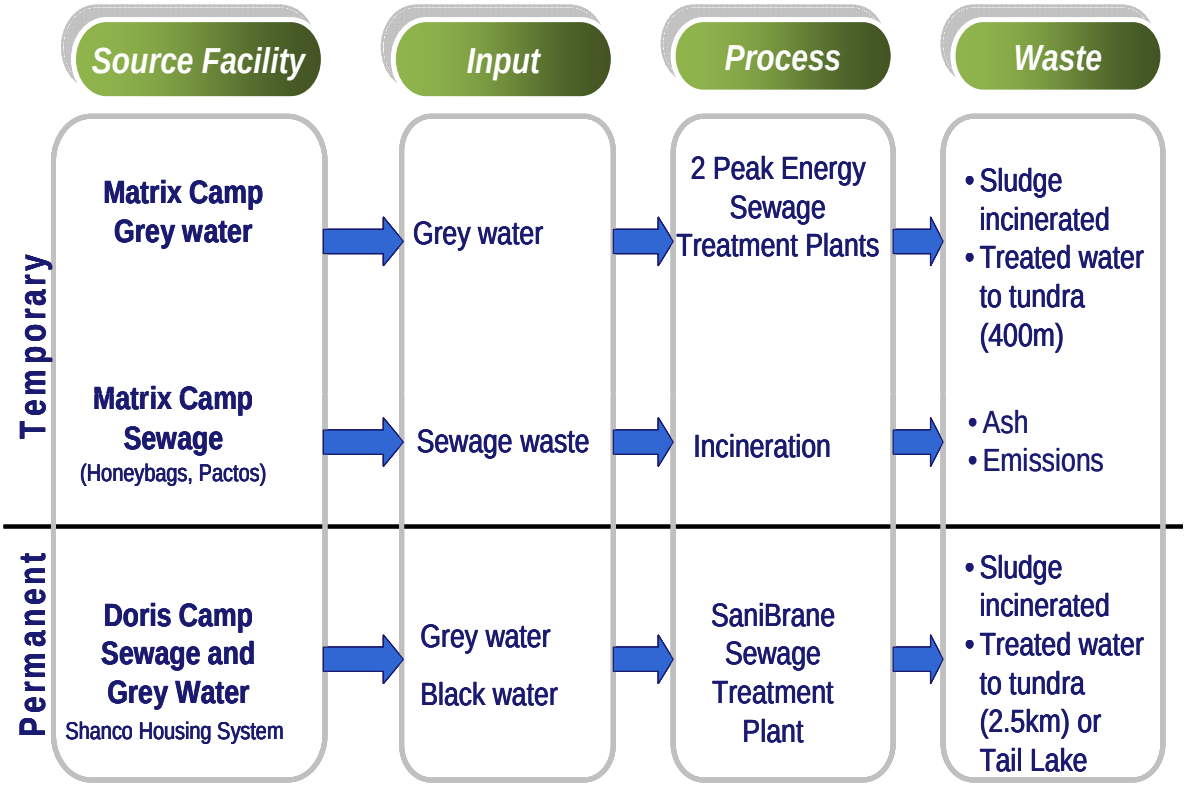
Reviewed by
Maritz Rykaart, Ph.D., P.Eng.

Executive Summary

Hope Bay Mining Limited (HBML) has successfully completed the environmental impact assessment and Water Licence Applications for its proposed operations at Doris North. These assessments and applications have led to the issue of a Water Licence to operate a mine at the Doris North Site. HBML has now started construction activities to build the infrastructure that will be required for the future mining operation. Some of the key components of this infrastructure are the temporary Matrix construction accommodation Camp, the Doris North accommodation Camp and the associated water intake and sewage treatment works for these camps. Compliant with the requirements of the Water Licence and with HBML corporate requirements, this Sewage Management Plan has been prepared for the Nunavut Water Board (NWB) to demonstrate how sewage and grey water will be managed at the site during the construction and operational phases of the mine.

To be able to construct the Doris North Camp and infrastructure, a temporary construction camp, the Matrix Camp has been developed with approval from the NWB. The two camps are in close proximity and fall into the Licenced footprint area. The water supply to the Matrix Camp is from the Licenced intake point in Doris Lake. This point is the same location as will be used for the Doris North Camp, though for the interim it is fitted with different equipment. In compliance with the Water Licence, specific water monitoring and reporting requirements are being followed for the intake point.



Schematic Representation of the Various Sewage Flows at the Matrix and Doris North Camps.

The Matrix Camp is provided with Pacto type toilets. The waste from these toilets is collected and incinerated at the camp in a double chamber incinerator. No sewage effluent is discharged from the Matrix Camp. Grey water from the Matrix Camp is treated in a modular treatment plant and the effluent is discharged to the tundra at the Licenced Doris Camp discharge point. This grey water effluent discharge is subject to routine monitoring and reporting. Use of the Matrix Camp will be phased out as the Doris North Camp becomes operational.

The Doris North Camp is currently being constructed and licenced to accommodate 160 people. The Camp is supplied with a state of the art SaniBrane packaged modular sewage treatment plant with a capacity of 180 people. The plant has been designed to deal with black water and grey water from the Camp and produces a high quality effluent that will meet or better the requirements of the Water Licence. In the future, the effluent from the sewage treatment plant will be discharged with the tailings from the mine into Tail Lake. Until the mine is operational and consistent with the Water Licence requirements, the treated water in the construction phase will be discharged to the tundra some distance from the Camp. The water will be discharged at a point that has erosion control measures in place and which will be subject to routine monitoring and reporting. The Water from the discharge point flows across the tundra towards Glen Lake. Before any surface seepage from the discharge point enters Glen Lake it will be subject to routine monitoring and reporting.

HBML will retain the Pacto toilets onsite in the event there is any upset with the sewage treatment plant and has also built two 8000 gallon sewage holding tanks in the event of an emergency shut down. The plant has also been designed to prevent any discharge in the event of a shut down.

Table of Contents

List of Tables

List of Figures

List of Appendices

1 Introduction

Hope Bay Mining Limited (HBML) is currently further developing the infrastructure for the Hope Mining Project in Hope Bay, Nunavut, Canada. Part of this infrastructure development is for the processing of sewage and waste water in accordance with the two Type B and 1 Type A Water Licences issued to HBML by the Nunavut Water Board (NWB). Under the current water licences three distinct sewage treatment facilities are permitted for operation on the site:

- The Boston Advanced Exploration Project (Boston Camp) – not addressed in this document
- Hope Bay Regional Exploration Project (Windy Camp) – not addressed in this document
- The Doris North Project – the subject of this document.

HBML are required under the Type A Water Licence (Parts D, G and J as noted in Section 2) to submit to the NWB a Sewage Treatment Management Plan. This plan is required for review by the NWB 60 days prior to the commissioning of the sewage treatment plant. This Sewage Management Plan covers both the temporary construction camp and more specifically the permanent Doris Camp. The sewage management plan is required by the water licence to cover operation, maintenance and sludge management associated with the sewage treatment works.

1.1 Objectives

The objectives of managing sewage are numerous. Consistent with HBML's intent to be a responsible operator these objectives are described as follows:

- Compliance with regulatory and permit requirements
- Prevention of public health risk
- Protection of surface water
- Protection of groundwater
- Protection of land
- Protection of local species
- Conservation of resources
- Protection of community amenity.

This Sewage Treatment Management Plan has been developed to ensure these factors are built into the HBML operational approach to working at Hope Bay.

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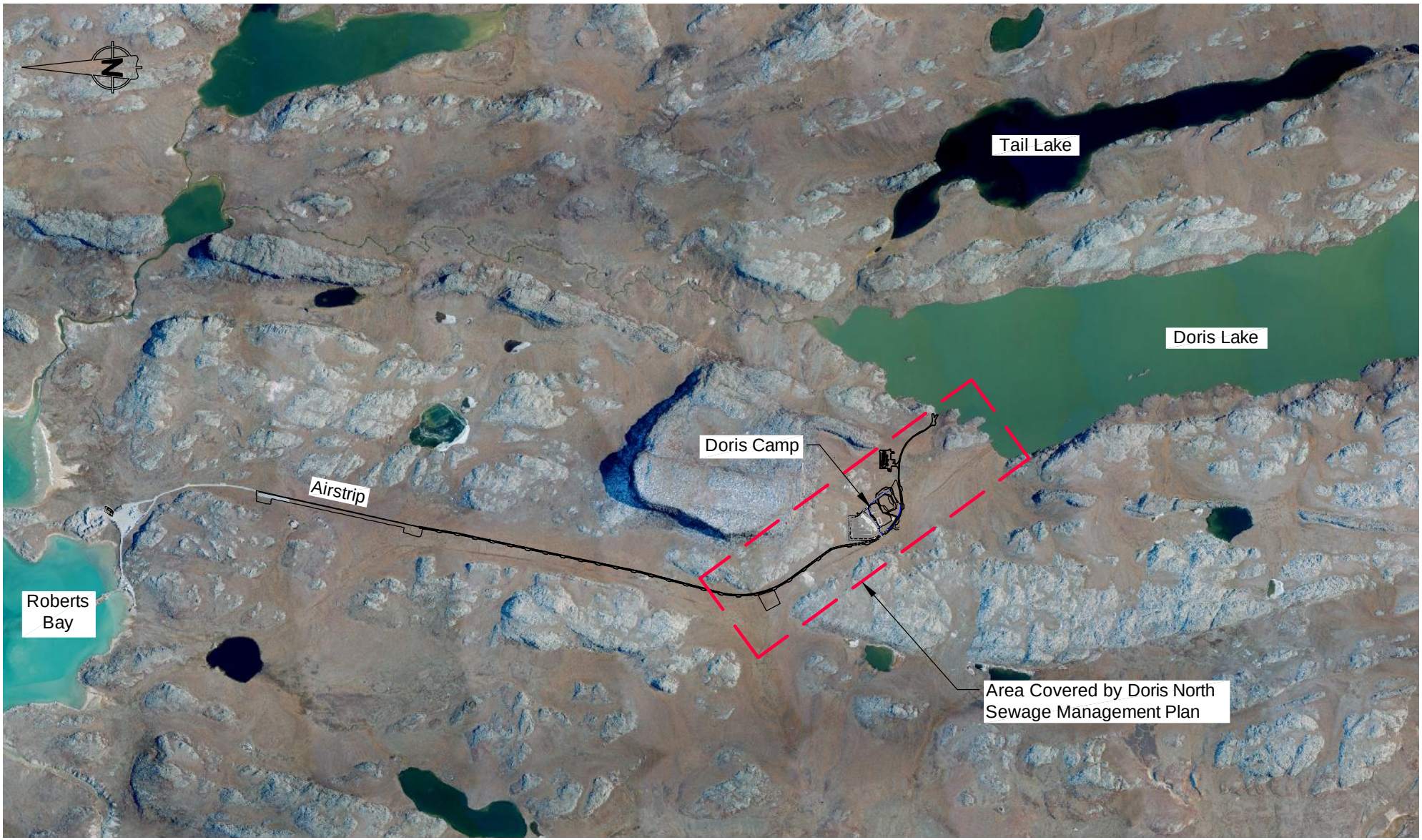

0 300 600 900 1200 1500
Scale in Metres

SRK Consulting
Engineers and Scientists
Vancouver B.C.

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FILE NAME: 1CH008_008-Key Plan.dwg

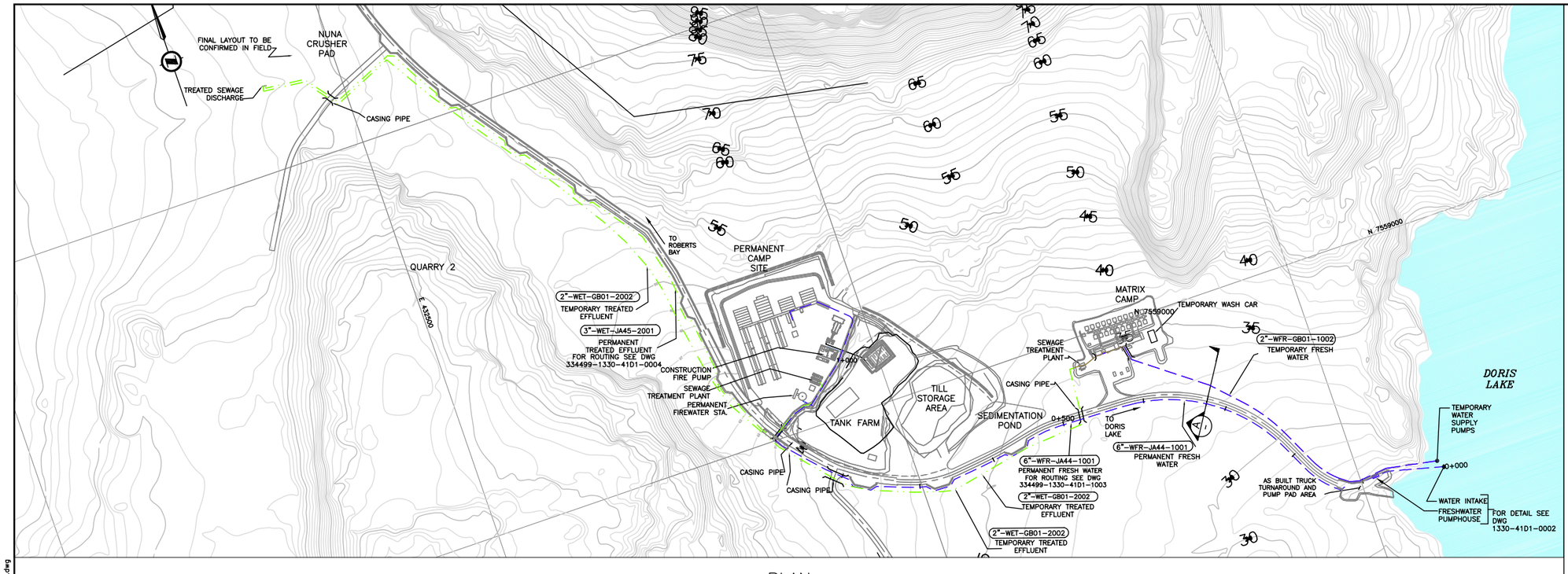
HOPE BAY MINING LTD

Doris North Project

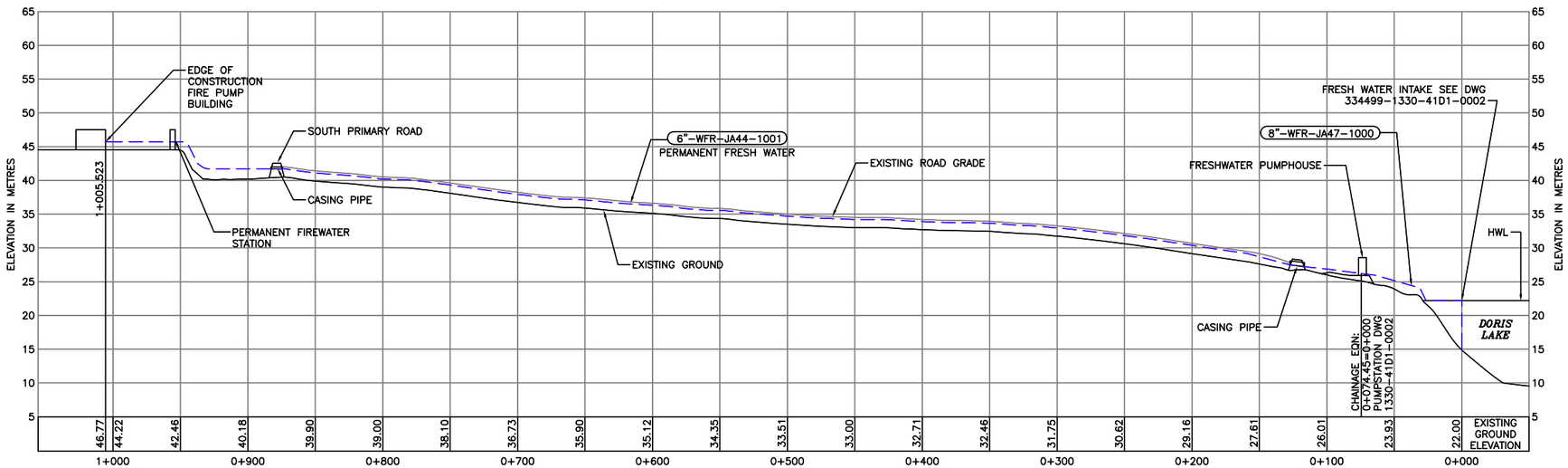
Sewage Management Plan

Doris North Project
General Site Orientation Map

DATE:	APPROVED:	FIGURE:
July 2008	MV	1



PLAN
SCALE 1:2000



PROFILE OF PERMANENT FRESH WATER SUPPLY PIPELINE
SCALE 1:2000 HOR & 1:400 VER

Colours and labels modified by SRK Consulting for clarity

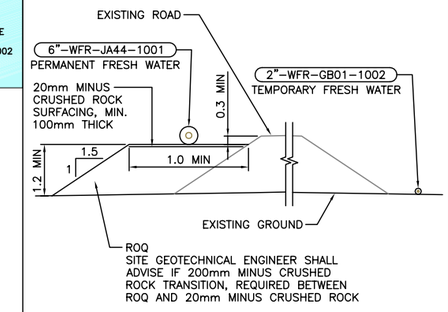
NOTES:

1. HORIZONTAL CONTROL IS UTM NAD 83 AND VERTICAL IS GEODETIC.
2. ALL DIMENSIONS AND ELEVATIONS ARE IN METRES UNLESS NOTED OTHERWISE.
3. ALL PIPES SHALL BE INSULATED WITH FOAM INSULATED AND HEAT TRACED.
4. PIPE BENCH FOR (6"-WFR-JA44-1001) TO FOLLOW ROAD ALIGNMENT.
5. FOR EARTHWORKS SEE SPECIFICATION:
   334499-0000-60EF-2220 EXCAVATION & FILL – GENERAL
   334499-0000-60EF-2320 CORRUGATED STEEL PIPE
   334499-0000-60EF-2701 AGGREGATES & GRANULAR MATERIALS
6. FOR PIPE INSTALLATION AND TESTING SEE:
   334499-0000-60EF-15050 PIPING INSTALLATION
   334499-0000-60EF-15990 PIPING INSPECTION AND TESTING
   334499-0000-46E6-0001 PIPING MATERIALS

LEGEND:

- FRESHWATER (WFR)
- TREATED EFFLUENT WATER (WET)
- UNTREATED WATER

3"-WET-JA45-2001
- LINE NUMBER
- PIPE MATERIAL CLASS
- SERVICE COMMODITY
- LINE SIZE



SECTION A
N.T.S.

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0 Vert. 1:400 20

ENGINEER'S STAMP
PROFESSIONAL ENGINEER — ORIGINAL SIGNED BY — 2/27/2008 — NWT — #L1158

NEWMONT — The Gold Company

CLIENT: HOPE BAY MINING LTD.
CLIENT DWG. NO.

SNC·LAVALIN

PROFESSIONAL ENGINEER | NAME | NO.

TITLE
HOPE BAY MINING LIMITED
DORIS NORTH INFRASTRUCTURE PROJECT
FIGURE 2 DORIS NORTH SEWAGE MANAGEMENT INFRASTRUCTURE FOR THE TEMPORARY MATRIX CAMP AND AND PERMANENT DORIS NORTH CAMP PLAN, PROFILE & SECTION

SNC-LAVALIN INC.			
DESIGNED	GARY MORRIS	GM	08/06/23
DRAWN	ELISA S. LAY	ESL	08/06/23
CHECKED	ROY UMENO	RU	08/06/23
APPROVED LEAD ENG.	ROY UMENO	RU	08/06/23
APPROVED ENG MAN.	ROY UMENO	RU	08/06/23
APPROVED AREA MAN.	G. AKEHURST	GA	08/06/03
CLIENT APPROVED ENG. COORD.			
CLIENT APPROVED AREA MAN.			

NO.	DATE	REVISIONS	BY	CHK	LEAD DISCPL.	ENG. MAN.	AREA MAN.	CLIENT ENG.	CLIENT AREA
0	08/07/25	ISSUED FOR CONSTRUCTION	ESL	RU	RU	RU	GA		
PB	08/07/15	REVISED ISSUED FOR PERMITTING	ESL	RU	RU	RU	GA		
PA	08/07/03	ISSUED FOR PERMITTING	ESL	ARW					

PROJECT NO.	AREA	DISCPL.	DOC.	DRAWING NUMBER	LOC.	REVISION NUMBER
334499	1330	41	D1	0003		0

SCALE: AS SHOWN | NAME (PRINT) | INIT. | DATE

Format: Metric D (TRUE SCALE)

DWG. NO. | REFERENCES

DATE: 2008/09/05 – 3:53pm
PATH: J:\01_SITES\Hope Bay\sewage management Plans and general contingency\[Project_NumberSewage management]\020_Project_Data\SNC\sewage \composite003004.dwg

2 Applicable Legislation and Licences

2.1 Water Licence

The operation and maintenance of the waste water treatment facilities at the Doris North Project is regulated under the Type A Water Licence for the Doris North Project 2AM-DOH0713 issued by the Nunavut Water Board in accordance with Section 56 of the Nunavut Waters and Nunavut Surface Rights Tribunal Act.

The plan presented in this document relates specifically to the Type A - Water Licence from the NWB (Licence number 2AM-DOH0713) regulating the water and wastes on the Doris North project area. Under the licence the following are defined:

Part A Scope

> The management and disposal of wastes associated with the Sewage Treatment Plant, sedimentation and pollution control ponds, Land fill and Landfarm and other wastes as described in the application [submitted to the NWB by Miramar Mining].

Sewage Treatment Plant (STP)" means the Sani-Membrane Bio-Reactor system designed for the treatment of sewage described in the Water Licence Pre-Hearing Technical Meeting Information Supplement Part A - Item 10.

HBML are required under this Licence to comply with the following:

Part D Conditions to Construction Clause 20:

> The Licensee shall ensure that the Sewage Treatment Plant is operated in accordance with conditions provided in Part G, Item 3 with compliance at monitoring station ST-8 during construction.

Part G Conditions Applying to Waste Management and Waste Management Plans

3. The Licensee shall operate the Sewage Treatment Plant in accordance with the following:
   a. All Sewage and Greywater shall be collected and treated in the Sewage Treatment Plant;
   b. During the construction phase, all effluent from the Sewage Treatment Plant at monitoring station ST-8 shall not exceed the following effluent quality limits: (See Section 2.1);
   c. During site construction, treated effluent from the Sewage Treatment Plant shall be discharged approximately 400 metres north of the camp pad;
   d. Once the Tailings Impoundment Area is operational, all treated effluent from the Sewage Treatment Plant shall be discharged to the Tailings Impoundment Area; and
   e. The Licensee shall notify an Inspector at least ten (10) days prior to start-up of the Sewage Treatment Plant and subsequent discharge from the facility.

4. The Licensee shall submit a Sewage Treatment Management Plan, to the Board for review sixty (60) days prior to commissioning the Sewage Treatment Plant that takes into consideration operation, maintenance and sludge management.

Part J. – Conditions Applying to General Aquatic Effects Monitoring

12 f. The volume of sewage sludge removed from the Sewage Treatment Plant and the locations or method of sewage sludge disposal during construction, operation and closure;

20. The Licensee shall visually monitor and record observations on a daily basis during periods of discharge, all discharge onto the tundra from the:

f. Sewage Treatment Plant (during the construction phase).

All effluent discharged from the Sewage Disposal Facility at the Doris North Project Monitoring Station ST-8 during the construction and operation phase shall meet and not exceed the following quality standards:

Table 1: Discharge Water Quality Requirements for Doris North Camp at Discharge Monitoring Point ST-8

Parameter	Maximum Average	Maximum Allowable in a Grab Sample
pH	6-9	9
Total Suspended Solids	100 mg/L	100 mg/L
BOD_5	80 mg/L	80 mg/L
Faecal Coliform	10,000 CFU/100 mL	10×10^4 CFU/100 mL (10,000 CFU/100 mL)
Total Oil and Grease	5 and no visible sheen	10 and no visible sheen

Monitoring Station ST-8 is defined as the Sewage Disposal Facility final effluent discharge.

Monitoring will also be required at ST-9. This monitoring point is for the monitoring of runoff water from the discharge point just prior to Lake entry. The runoff effluent at ST-9 shall during the construction and operation phase meet and not exceed the following quality standards:

Table 2: Discharge Water Quality Requirements for Doris North Camp at Discharge Runoff Monitoring Point ST-9, Just Prior to Entry into Glen Lake

Parameter	Maximum Average	Maximum Allowable in a Grab Sample
pH	6-9	9
Total Suspended Solids	100 mg/L	100 mg/L
BOD_5	80 mg/L	80 mg/L
Faecal Coliform	10,000 CFU/100 mL	10×10^4 CFU/100 mL (10,000 CFU/100 mL)
Total Oil and Grease	5 and no visible sheen	10 and no visible sheen

Copies of relevant legal documents will be kept on file at the Doris North Site. Management and safety personnel will provide an overview of the applicable regulations to all employees as part of their orientation training and through ongoing training.

Specific Sewage Management Clauses or clauses which have a bearing on sludge management are presented in Appendix A.

2.2 Other General Guidance

Other documentation pertinent to the Waste Water Treatment Facilities are as follows:

- Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories, NWT Municipal and Community Affairs - Community Development, dated October 1996 by Diep Duong and Ron Kent
- Consolidation of Environmental Protection Act (RSNWT 1988c E.7)
- Consolidation of the Environmental Rights Act RSNWT 1988 c83 2nd Supp)
- Consolidation of Camp Sanitation Regulations
- Environmental Guideline for General Management of Hazardous Waste.

3 Sewage Management at Hope Bay

3.1 Introduction

Waste water treatment in Northern climates requires careful consideration to ensure that the local environment is not disturbed by the input of excessive waste or the creation of chemical imbalance. HBML is extending its operation in the Hope Bay area and starting infrastructure development associated with the mining and exploration activities which have been permitted and continue respectively.

In the past, sewage from mining sites was often not treated, and either released separately to the receiving environment or co-disposed in an untreated condition with the mill tailings. More recently, sewage from human activities is typically treated at northern mine sites through the use of sewage lagoons or through packaged sewage treatment plants that use biological activity to digest the sewage. This reduces its biological oxygen demand (i.e., its ability to consume oxygen). Sewage sludge typically consumes oxygen from the water column if they are placed into areas where they ultimately will end up on the bottom of a lake. In northern lakes, this can have adverse effects in lakes that are shallow and are covered by a relatively thick ice cover over an extended winter period. In these lakes, dissolved oxygen within the water column will decrease naturally over the winter months, as oxygen is used up by biological activity within the remaining unfrozen portion of the water column; however, generally sufficient oxygen remains to sustain aquatic life. Any additional oxygen consumer (such as untreated sewage sludge) can result in there being insufficient oxygen in the water column under the ice cover to sustain life within the lake, which would lead to the death of the over-wintering fish populations within these lakes (extract from Miramar Revised Water Licence Application, April 2007).

The release of sewage water and sludge into water bodies also adds nutrients to the receiving lakes which, under certain conditions, can lead to increase rates of algal growth. When the algal matter decays, oxygen is consumed within the water column, again reducing the available oxygen in the water column to sustain aquatic life. Consequently, the release of untreated sewage wastewater and sludge into receiving water bodies can affect the ability of these water bodies to sustain aquatic life (extract from Miramar Revised Water Licence Application, April 2007).

In this section the various plans being considered in this document are presented and compared. The three plans presented in the sections below are:

- The Original approved Sewage Management Plan
- The Temporary Sewage Management Plan
- The Permanent Sewage Management Plan.

4 Original Sewage Management Plan

The Doris North Project Type A Water Licence requirements for sewage management cover two phases: treatment of the Matrix temporary camp at Doris North and the permanent sewage treatment system for the Doris North Camp.

4.1 Matrix Temporary Camp at Doris North

The temporary Matrix Camp is being built in close proximity to the Doris North Camp and meets the requirements of the NWB Licence Number 2AM-DOH0713 Part G Section 3. Furthermore letters of approval for the 68 person Matrix Camp have been obtained from the NWB (Appendix B). Pacto type toilets are used which produce contained waste packages. The waste from the toilets is incinerated. Grey water from the camp is treated and then discharged to the tundra within 400m of the camp as per the licence. Sludge from the grey water treatment is incinerated. Once the construction of the Doris North Camp is complete and the sewage treatment plant has been commissioned, the Matrix Camp will be phased out and the permanent sewage management solution described in the following section will be followed.

4.2 Doris North

The Doris North Project and 160 person camp has been subjected to Environmental Impact Assessment, which has been approved and a Water Licence from the NWB (Licence Number 2AM-DOH0713) has been issued for the site. Part of this licence required the co-disposal of sewage sludge and mine tailings waste into Tail Lake. As the mine is not yet in production this co-disposal cannot be affected so a temporary sewage management plan is needed which is compliant with Part G Section 3 of the Licence. Sludge from the SaniBrane sewage treatment plant will be incinerated in an incinerator that meets the requirements of Environment Canada. The temporary and permanent sewage treatment systems will be different and are the subject of the remainder of this document. The key difference between the temporary solution and the final solution is that treated sewage water will be released onto the tundra temporarily, some 2.5km from Doris Camp and under the permanent solution mixed in with tailings once the mine is operational.

5 Temporary Construction Sewage Management Plan for Doris North (Matrix Camp)

In order for HBML to build the infrastructure associated with the Doris North Project it is necessary for staff to be accommodated on site in a construction camp. A temporary, NWB approved 68 person camp, the Matrix Camp, located in the Doris North Camp disturbance reviewed by the Nunavut Impact Review Board (NIRB) and compliant with the NIRB Project Certificate is being used (Figure 2). The Matrix Camp will accommodate less than 161 people as noted in the existing licence. The Matrix Camp is a temporary construction camp and will be replaced by the permanent Doris North Camp with sewage management following the conceptual model in Figure 3.

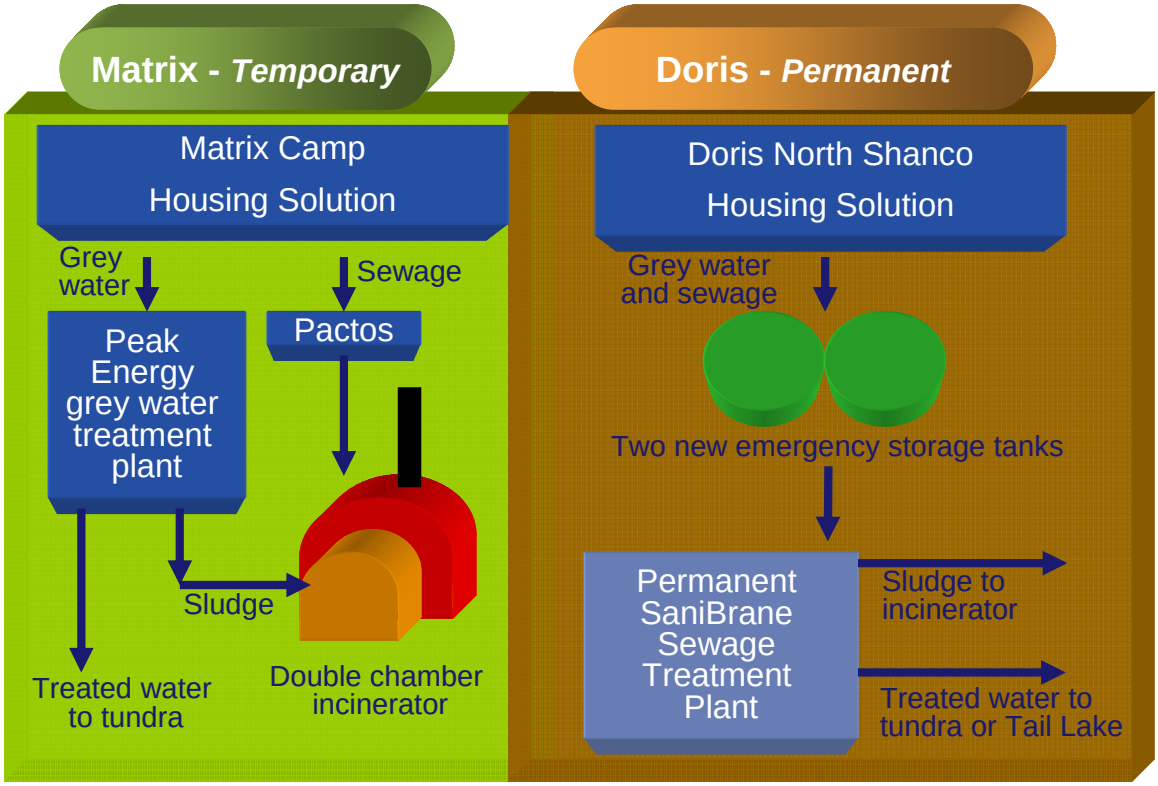


Figure 3: Conceptual Sewage Model for Construction and Operation of the Temporary Matrix Camp and Permanent Doris North Camp

The Matrix Camp is currently serviced with the following dry ablution and sewage management infrastructure:

- Honey bags (not used regularly)
- Incinerator type toilets (not being used)
- Pacto type toilets.

The Matrix Camp grey water is treated using:

- Two Peak Energy sewage treatment plants.

These systems will be used until the permanent system for the Doris North Camp is commissioned and accepted for use by the Regulator. The permanent system will be a:

- SaniBrane MBR system
- Two 8000 gallon storage tanks.

Each of these systems is described in greater detail below.

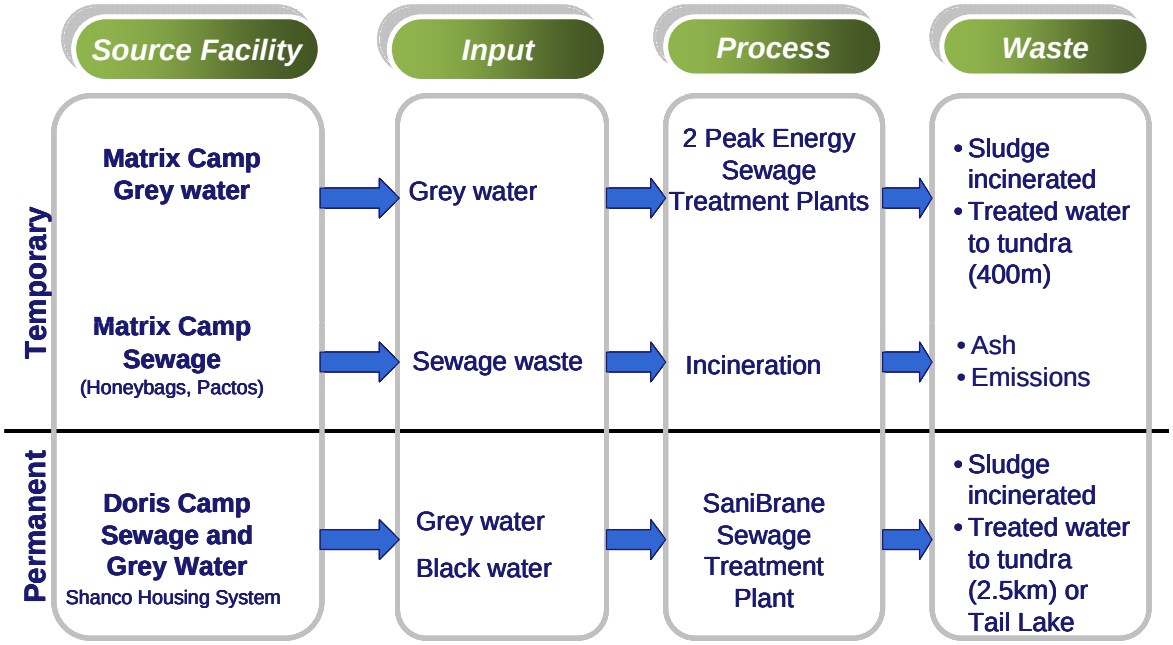


Figure 4: Schematic Representation of the Various Sewage Flows at the Matrix and Doris North Camps

5.1.1 Matrix Camp Dry Toilet and Sewage Management System Description

The temporary construction Matrix Camp is currently using a waterless toilet solution:

- Honey Bags: This is highly unpopular with staff and needs to be replaced.
- Pacto Toilets: Ten new units are being installed as construction site toilets, but are unpopular with staff. The Pacto type toilets are deemed suitable by INAC.
- Incinerating Type Toilets are available on site but are not being used as Environment Canada has noted they are unlikely to comply with emission standards:
  - Propane fired units that were supplied with the Matrix camp
  - 10 electric units supplied through Rocky Mountain Environmental.

Both the incinerator type toilets used to combust black water wastes are deemed unsuitable by Environment Canada. Environment Canada has noted that the incinerator toilets do not comply with the requirements of the Water Licence which specifies limits for dioxins and furans. The single chamber combustion units of the toilets may not burn at high enough temperatures to combust the dioxins and furans that may be emitted.

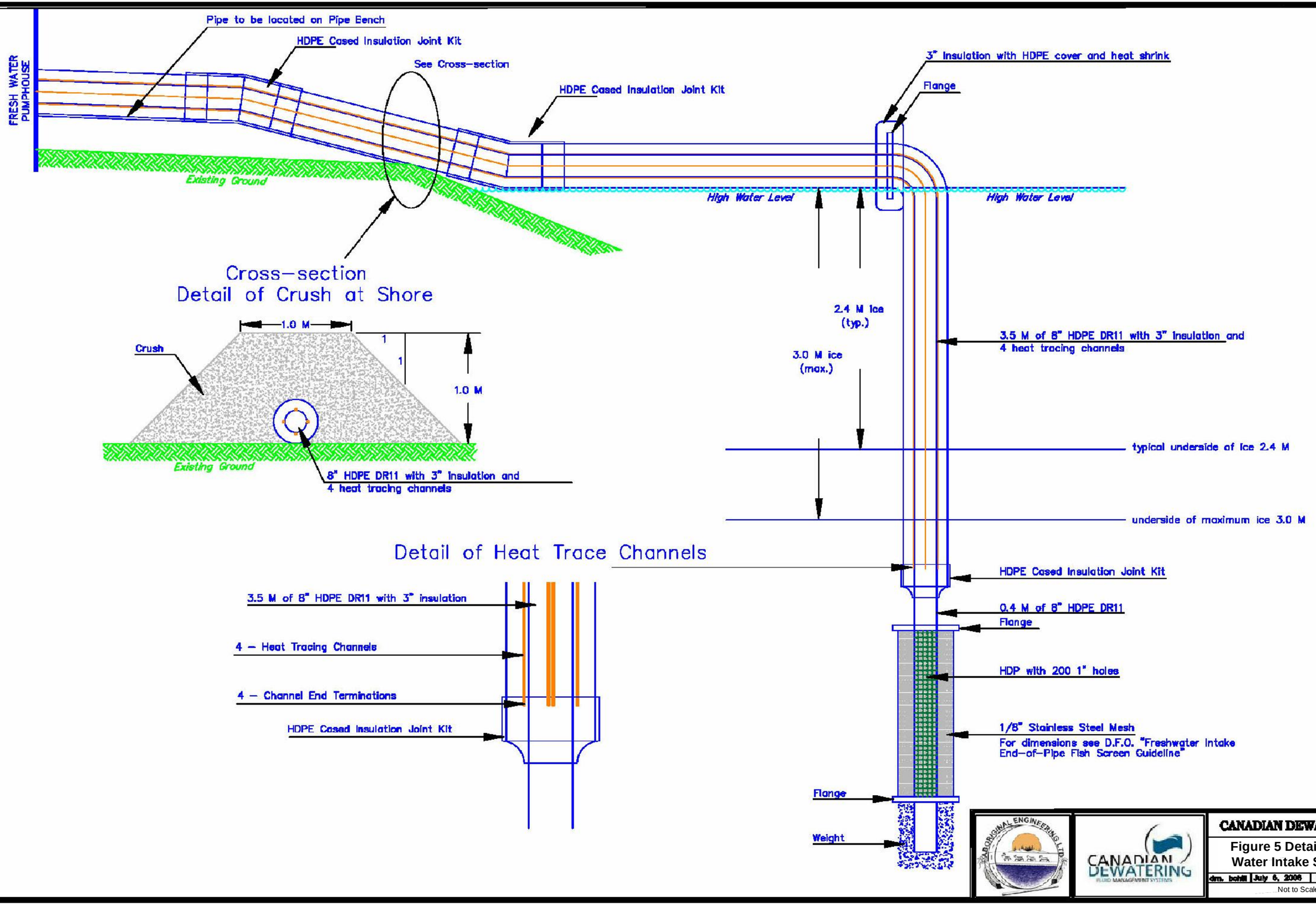
The waste arising from the Pacto toilets is removed and incinerated on site in the large double chamber incinerator.

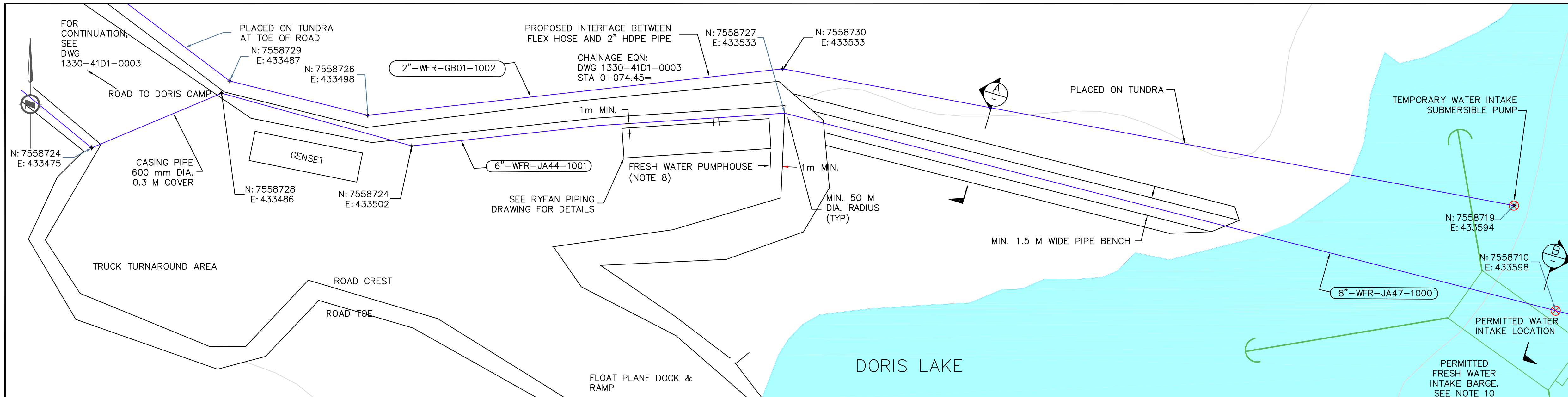
5.1.2 Matrix Camp Grey Water Management

Grey water from the Matrix Camp is processed at the camp via two existing Peak Energy MBR membrane plants and then discharged to the tundra at the permitted discharge point ST-8 some 400m from the Camp Site. Effluent volume and quality will need to be monitored and sampled respectively at both monitoring points ST-8 at the discharge point and ST-9 seepage. Specific water discharge criteria are set for these points in Section 7.1 and in Appendix A.

5.1.3 Water Intake

Intake of water and discharge of waste will be from and to the same locations considered during assessment and specified in the Water Licence. Initially a temporary water intake supplying the Matrix Camp will be used. This temporary intake is fitted with a submersible pump. The temporary arrangement will be removed once the permanent water supply pipeline to Doris North Camp is installed and the Matrix Camp is closed or can be connected to the permanent supply pipeline. The permanent supply pipeline intake point will be fitted with a screen to prevent the collection of fish and is in compliance with Part E of the Water Licence. The water quality at the intake point in Doris Lake will be routinely checked at ST7. This monitoring point is defined as the water taken from a valve on the discharge end of the fresh water pump. Figure 5 and Figure 6 provide information on the intake system and water delivery system to the Matrix and Doris North Camp respectively. Water quality monitoring requirements for this point are defined in Section 7.2 and in Appendix A.


FRESH WATER PUMPHOUSE
Pipe to be located on Pipe Bench
HDPE Cased Insulation Joint Kit
See Cross-section
HDPE Cased Insulation Joint Kit
3" Insulation with HDPE cover and heat shrink
Flange
Existing Ground
High Water Level
High Water Level
Cross-section
Detail of Crush at Shore
1.0 M
1
1
1.0 M
Crush
Existing Ground
8" HDPE DR11 with 3" insulation and
4 heat tracing channels
2.4 M ice
(typ.)
3.0 M ice
(max.)
3.5 M of 8" HDPE DR11 with 3" insulation and
4 heat tracing channels
typical underside of ice 2.4 M
underside of maximum ice 3.0 M
Detail of Heat Trace Channels
3.5 M of 8" HDPE DR11 with 3" insulation
4 – Heat Tracing Channels
4 – Channel End Terminations
HDPE Cased Insulation Joint Kit
HDPE Cased Insulation Joint Kit
0.4 M of 8" HDPE DR11
Flange
HDP with 200 1" holes
1/8" Stainless Steel Mesh
For dimensions see D.F.O. "Freshwater Intake
End-of-Pipe Fish Screen Guideline"
Flange
Weight
ABORIGINAL ENGINEERING LTD.
CANADIAN DEWATERING
FLUID MANAGEMENT SYSTEMS
CANADIAN DEWATERING
Figure 5 Detail of the
Water Intake System
drn. bchill | July 6, 2006 | ref. no. 44-077
Not to Scale



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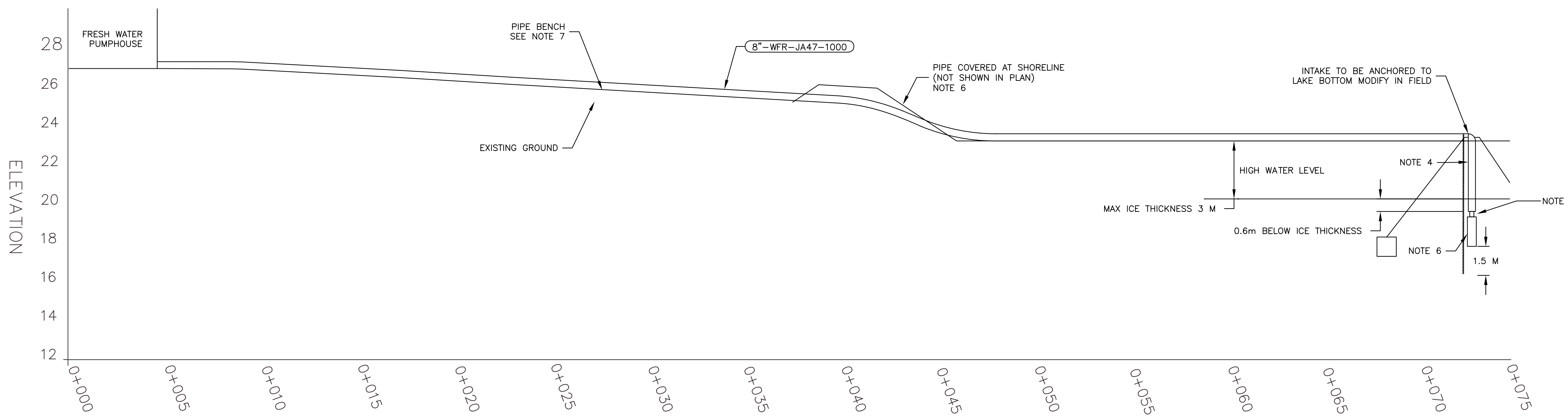

PERMANENT WATER SUCTION LINE PROFILE
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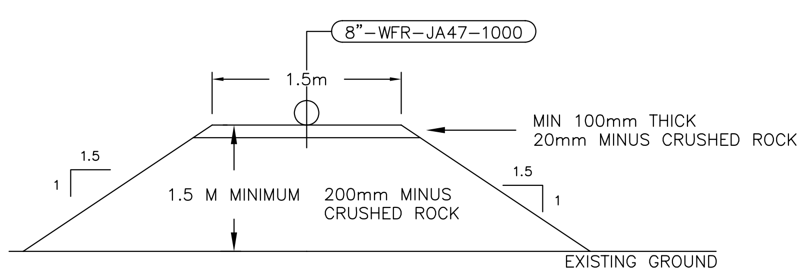


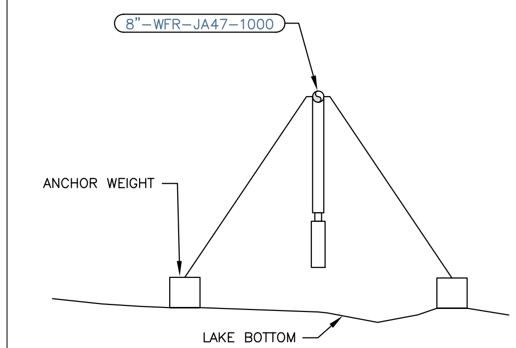
SECTION A
1:30

NOTES:

1. ALL PIPES SHALL BE INSULATED WITH INSULATION AND HEAT TRACED
2. ALL PUMPS TO BE EQUIPPED WITH FISH INTAKE SCREEN
3. PUMPS TO BE INSTALLED IN AN ABS SUBMERSIBLE DEWATERING ACCESSORY FLOATING RING P/N 00831602
4. 3.5m OF 8" HDPE DR11 WITH 3" INSULATION AND 4 HEAT TRACING CHANNELS
5. 0.4m OF 8" HDPE DR11
6. REFER TO CANADIAN DEWATERING DRAWING: 44-077; FRESH WATER INTAKE END-OF-PIPE; JULY 6, 2008
7. PERMANENT PIPELINE TO BE PLACED DIRECTLY ON PIPE BENCH
8. REFER TO RYFAN DRAWING "SEACAN PUMPHOUSE REV 1 CONVERSION DORIS NORTH"
9. DESIGN OF FRESHWATER PUMPHOUSE AND INTAKE BY CANADIAN DEWATERING.
10. PERMITTED LOCATION OF FRESHWATER INTAKE BARGE AS PER WATER LICENSE.

LEGEND

- FRESHWATER (WFR)
- FRESHWATER PUMPHOUSE



SECTION B
1:125

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ENGINEER'S STAMP

PROFESSIONAL ENGINEER · ORIGINAL SIGNED BY · LICENSEE 27/11/2008 · NWT · #L1158

CLIENT

SNC·LAVALIN

CLIENT DWG. NO.

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DWG. NO.	REFERENCES
1330-41D1-003	FRESH WATER SUPPLY PIPELINE (PERMANENT AND TEMPORARY) PLAN, PROFILE AND SECTION

NO.	DATE	REVISIONS	BY	CHK	LEAD DISCPL.	ENG. MAN.	AREA MAN.	CLIENT ENG.	CLIENT AREA
0	08/07/28	ISSUED FOR CONSTRUCTION	ESL	RU	RU	RU	GA		
PB	08/07/07	ISSUED FOR COMMENTS	LJG	ARW					
PA	08/06/19	ISSUED FOR PERMIT	LJG	RU					

SNC-LAVALIN INC.	NAME (PRINT)	INIT.	DATE
DESIGNED	TONY WACHMANN	ARW	08/06/15
DRAWN	LEE GOUDZWAARD	LJG	08/06/17
CHECKED	ROY UMENO	RU	08/06/19
APPROVED LEAD ENG.	ROY UMENO	RU	08/06/19
APPROVED ENG MAN.	ROY UMENO	RU	08/06/19
APPROVED AREA MAN.	GEOFF AKEHURST	GA	08/06/19
CLIENT APPROVED ENG. COORD.			
CLIENT APPROVED AREA MAN.			
SCALE AS SHOWN			

TITLE

HOPE BAY MINING LIMITED
DORIS NORTH INFRASTRUCTURE PROJECT
FIGURE 6 DETAIL DRAWING OF THE WATER SUPPLY SYSTEM TO THE DORIS NORTH AND MATRIX CAMPS
PLAN & PROFILE

PROJECT NO.	AREA	DISCPL.	DOC.	DRAWING NUMBER	LOC.	REVISION NUMBER
334499	1330	41	D1	0002		0

Format: Metric D (TRUE SCALE)

DATE: 2008/07/31 - 5:53pm
PATH: J:\01_SITES\Hope.Bay\Sewage management Plans and general contingency\[Project_NumberSewage management]\020_Project_Data\SNC\sewage \second334499-1330-41D1-0002.dwg

5.1.4 Effluent Discharge

Grey water effluent discharge will occur via pipeline from the temporary Matrix Camp grey water treatment plant to the discharge point located over a rise, initially 400m from Camp and then 2.5 kilometres to the Northwest of the Doris Camp once the permanent pipeline is complete. A three-inch diameter permanent HDPE pipeline has been laid from the STP to the tundra discharge point northwest of the Nuna Crusher Pad as shown in Figure 2. The effluent will be fed into the discharge pipeline by pumps in the treatment plant. The discharge will be direct to the tundra which will drain to the west towards a large lake at UTM E430285 N7560303N (Glen Lake). In the Water Licence, a monitoring point ST-8 is required to ensure the quality of the discharge water is maintained and reported. Monitoring point ST-9 will also require sampling. ST-9 is for runoff water from the discharge point just prior to entry into Glen Lake.

As with the other camps at Hope Bay, HBML intends to manage the discharge point to ensure that soil erosion does not occur. Erosion protection in the form of a bed of armour rock placed at the discharge point or a diffuser system used to reduce the discharge energy will be provided. Erosion protection needs will be monitored routinely at the discharge point and the down slope area to ensure that erosion management is effective. The discharge dispersal area may also be fitted with silt curtains should it be observed that these are required.

In winter, if the discharge point will continue to be used. The discharge water will be distributed over a wide area of minimum 1ha to form ice to a depth of 1m. During the spring thaw, this ice will slowly melt and flow away and is not anticipated to cause erosion as it is wide spread and slow melting.

5.1.5 Matrix Camp Sewage Sludge Management

This MBR unit for grey water treatment is equipped with a sludge filter press feature, which dewaters the sludge and packs it into bags for disposal. The bags are hung for a time in the filter press container to partially dry after which they are incinerated in the new double chamber incinerator. The temporary incinerator able to meet criteria G – 5 and 6 of the Water Licence will be brought in and utilized until the permanent (main site) incinerator for the Doris Camp is installed during the summer of 2008. This unit will be used to dispose of sewage sludge and food waste from the camp.

5.1.6 Transition from the Temporary to Permanent Sewage Management Facility

The effluent stream from the Doris North Camp will be fed to the SaniBrane system which has greater capacity than the number of people currently on site. In the event there are any operational difficulties during the SaniBrane start up, the Pacto toilets will be kept operational and two 8000 gallon emergency storage tanks will be in place. In this way any temporary problems can be accommodated and an alternative option is available. Once the SaniBrane system and Doris Camp are fully functional, the Matrix Camp will be phased out over time.

6 Permanent Sewage Management Plan for Doris North

The permanent SaniBrane Sewage Treatment Plant will be set up in its ultimate location near the Shanco Housing Solution at Doris Camp Figure 2. The SaniBrane plant has a capacity for waste water from 180 people and capacity to accept raw sewage and sludge from other STPs into its surge/conditioning tanks. It is anticipated the Doris North camp will at maximum accommodate around 160 people, which is below the maximum design capacity (180 people) of the SaniBrane plant. Specific details on the SaniBrane Membrane Bio-reactor (MBR) are presented in this section of the sewage management plan.

The Doris Camp will have a state of the art packaged MBR plant. Processes such as these were originally introduced in Japan where they are used in conjunction with membrane waste water treatment to treat and recycle water in high rise buildings. The treatment process operates both aerobically and anoxically and will treat the carbon fraction of the wastewater (the BOD) and address ammonia and other nitrogen containing compounds to some extent. Ammonia reductions exceeding 95% are possible with this type of plant. Although reducing ammonia is not a component of the water licence for this facility, it is consistent with HBML's intent to minimise its environmental footprint.

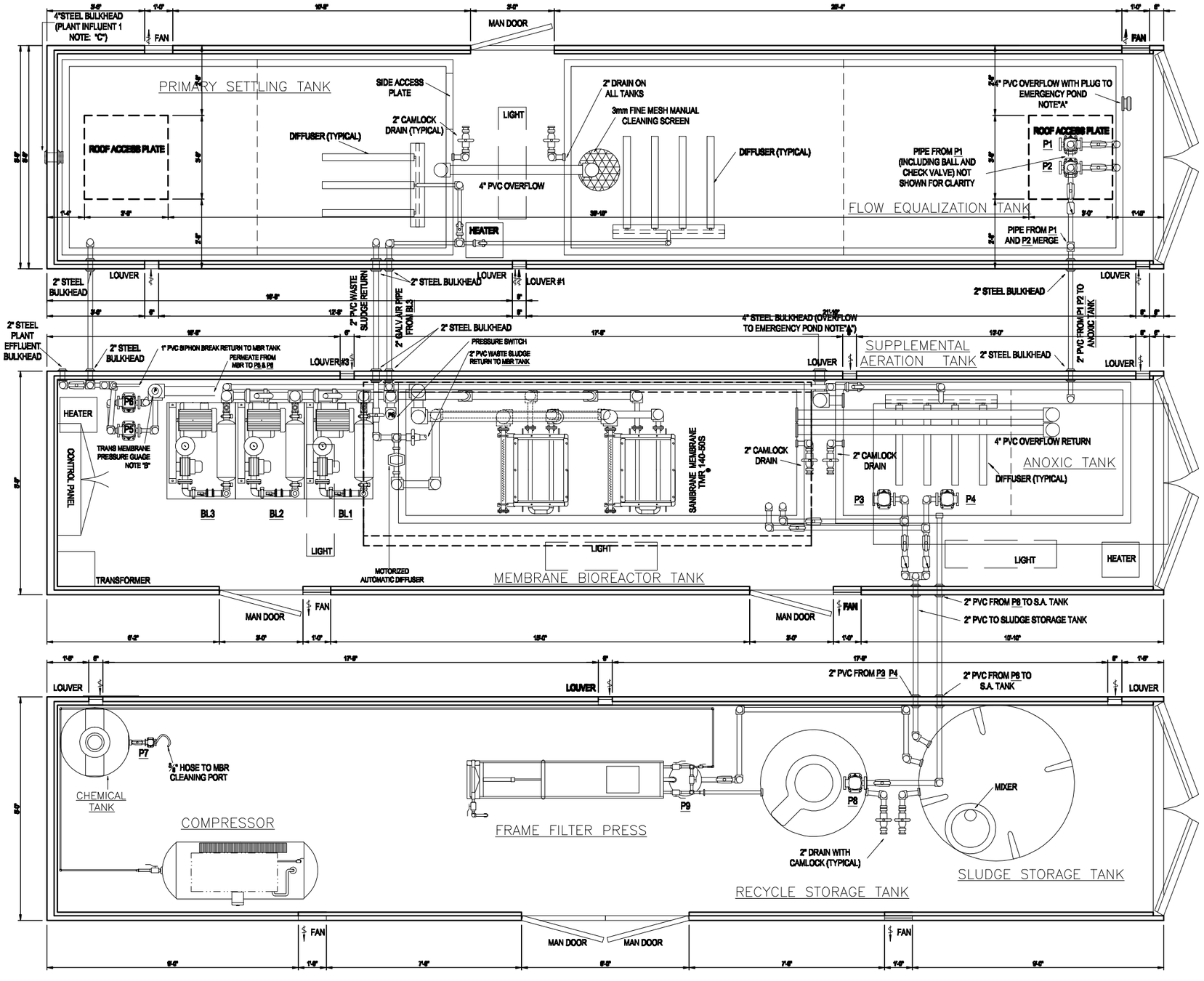
A regular cleaning process is necessary to maintain the membrane filter. Under continual operation (24/7) the SaniBrane filter has a life of between 3 to 5 years before requiring replacement. With cleaning and extremely good sewage preparation and screening, 7 years of life may be possible.

Importantly for operators with the exception of the final sludge handling, the sludge management process is entirely enclosed within the process vessels. This reduces operator exposure to noxious gases and liquids resulting in a more pleasant work environment for operators and living environment for nearby residents of the Doris North Camp.

6.1 Description of the SaniBrane Sewage Treatment Plant

The STP for HBML's Doris North Camp was designed to treat municipal strength sewage and is housed in three - 40 foot-long containers (Figure 7). The effluent discharge is expected to have the following characteristics:

- 10 mg/l BOD_5
- 10 mg/l TSS
- 10 mg/l NH_3-N
- 200 fecals/100ml.



SRK Consulting Figure 7

REVISION	DATE	DESCRIPTION
6	09-AUG-07	REVISED AS BUILT
5	17-JUL-07	BLOWER LAYOUT MODIFIED
4	13-JUL-07	MIXER ADDED TO SLUDGE STORAGE TANK

SANITHERM ENGINEERING LTD.
SUITE 100 - 340 BROOKSBANK AVENUE, NORTH VANCOUVER, BC, V7J 2C1, CANADA
TEL: (604) 986 - 9168
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E-MAIL: saneng@sanitherm.com
WEBSITE: www.sanitherm.com

PROJECT	180 MAN CAMP			PROJ. NO.	
CLIENT	MIRAMAR DORIS NORTH			REV. NO.	6
TITLE	SANIBRANE® MBR-GENERAL LAYOUT KEY PLAN				
DRAWN BY	T.Y.	CHECKED BY	DATE 09-AUG-07	SCALE N.T.S.	DRAWING NO. 070072-A3622-P01

The anticipated effluent quality is expected to be equal to or better than the quality requirements laid out in the Nunavut Water Board Water Licence 2AM-DOH0713, which indicates the Maximum Average Concentrations of the parameters listed below.

- 100 mg/L TSS
- 80 mg/L BOD5
- 10,000 CFU/100 ml Fecal Coliforms.

6.2 Description of the SaniBrane MBR STP Process

The system consists of the following major processes:

- Pre-treatment
  - Primary settling
  - Equalization
- Biological treatment and effluent separation
  - Anoxic treatment
  - Aeration
  - Membrane reactor
- Treated effluent discharge
- Sludge de-watering
- Clean In-Place (CIP) system.

6.2.1 Pre-treatment – Primary Settling

Wastewater enters the STP flowing into the primary settling tank, divided by a bulkhead into two sections. Settling occurs in the first section while aeration for odour control and some mixing is provided by coarse bubble diffusers in the second section. Wastewater then flows from the primary settling tank into the equalization tank through a basket screen.

6.2.2 Pre-treatment - Equalization

The purpose of equalization tank is to provide a reservoir to smooth 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 equalization tank is designed to hold a varying volume between approximately 0 and 3880 L at an average flow of approximately 0.946 L/s (15 USGPM).

The tank is provided with coarse bubble aeration for mixing and freshening to reduce potential odours. The system is vented to the outside through air blowers. Two submersible equalization pumps are located in the tank and provide the forward flow at the controlled rate of 0.946 L/s (15 USGPM). The pumps will 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 as the system

is controlled by a Programmable Logic Controller (PLC). 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 contaminants (BOD, Ammonia-N, etc.) has been minimal and incidental. Aeration in the equalization tank may remove 5% of the BOD and some organics may have been collected by screening.

6.2.3 Biological Treatment and Effluent Separation – Anoxic Tank

The anoxic tank is divided into two by a bulkhead to form an anoxic and supplemental aeration tank. The flow into this tank is influent from the equalization tank and a recycle flow from the membrane reactor tank of two to four times the influent flow. The mixing of streams forms a mixed-liquor-suspended-solids (MLSS) concentration of ~10,000 to 20,000 mg/L. The recycle flow contains high levels of nitrates (NO_3-N), the end products of nitrification (ammonia removal). Under anoxic conditions (zero dissolved oxygen), the nitrates will be removed and in the conversion will remove a portion of the BOD. To achieve anoxic conditions, the tank is generally not aerated, but mixing is provided by coarse bubble diffusers, using a manual ball valve on the air line.

The process is PLC controlled with level switches, pumps and alarms being controlled. In the event of high flows the equalization tank pumps are stopped. In the event that 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 EQ basin. Until the EQ basin has been reactivated and raised levels in the Anoxic Tank, the entire system stays in sleep mode. Transfer pumps forward the partially treated liquid to the membrane reactor.

6.2.4 Membrane Reactor

This step in the process provides the same aeration purpose as the previous step with the added purpose of separating the biological solids from the flow stream and thereby creating a highly treated, acceptable effluent for disposal (Figure 8). Also like the previous tank the MLSS will be ~10,000 to 20,000 mg/L.

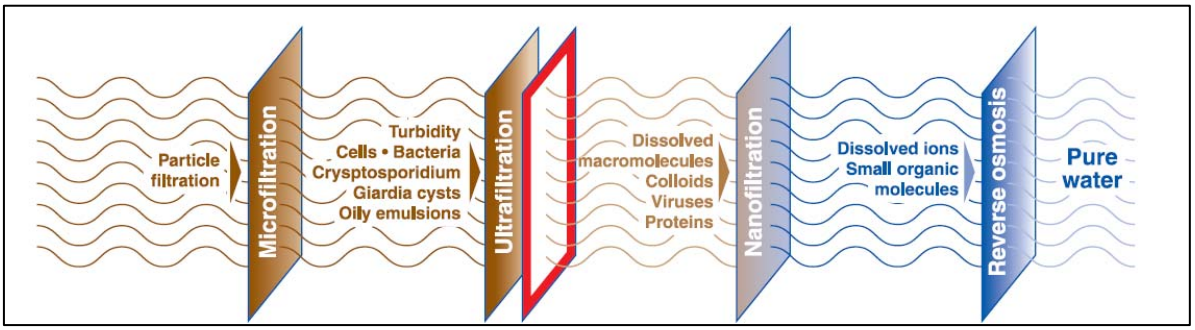

Figure 8: The 0.08 Micron Pore Size of the SaniBrane Membrane Shown in Red and the Quality of the Water that is Produced with Different Types of Filtration

The aluminum MBR tank houses one membrane module that acts as both the aeration and the separation device. Air is provided to the unit from the membrane blower, serving primarily as a cleaning or scouring mechanism, but 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 with the other as a standby unit and is responsible for removing treated effluent from the module at a rate of 0.946 L/s (15 USGPM).

This module is again protected by level switches, alarms and the PLC. The float switches in the membrane tank act to 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, to shut down due to low levels, the permeate pumps cannot be operated if scouring air is cut off. To this end 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 SaniBrane unit. Failure of the main membrane blower will trigger an alarm as well as result in a start-up of the standby unit. Recycle liquid flow continues regardless of equalization pump or effluent pump operation.

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.

6.2.5 Effluent Discharge

Effluent discharge will occur via pipeline from the Doris Camp SaniBrane sewage treatment plant to the discharge point located over a rise, 2.5 kilometres to the Northwest of the Doris Camp. A three-inch diameter permanent HDPE pipeline has been laid from the STP to the tundra discharge point northwest of the Nuna Crusher Pad as shown in Figure 2. This is the same discharge pipe and point that will be used for the Matrix Camp. The effluent will be fed into the discharge pipeline by pumps in the treatment plant. The discharge will be direct to the tundra which will drain to the west

towards a large lake at UTM E430285 N7560303N (Glen Lake). In the Water Licence, a monitoring point ST-8 is required to ensure the quality of the discharge water is maintained and reported. Monitoring point ST-9 will also require sampling. ST-9 is for runoff water from the discharge point just prior to entry into Glen Lake.

As with the other camps at Hope Bay, HBML intends to manage the discharge point to ensure that soil erosion does not occur. Erosion protection in the form of a bed of armour rock placed at the discharge point or a diffuser system used to reduce the discharge energy will be provided. Erosion protection needs will be monitored routinely at the discharge point and the down slope area to ensure that erosion management is effective. The discharge dispersal area may also be fitted with silt curtains should it be observed that these are required.

In winter, if the discharge point will continue to be used. The discharge water will be distributed over a wide area of minimum 1ha to form ice to a depth of 1m. During the spring thaw, this ice will slowly melt and flow away and is not anticipated to cause erosion as it is wide spread and slow melting.

6.2.6 Sludge Dewatering, Destruction and Use

Sludge dewatering is a manual process. The operator directs some of the flow from the anoxic and supplemental aeration tank via pumps to the sludge holding tank. Polymers can be added for thickening in the sludge mixing tank, using the mixer for agitation. The solution is pumped to a plate and frame press with filtrate directed to the sump from where it is periodically pumped back to the anoxic and supplemental aeration tank by submersible pump. Dried sludge is collected in a sludge hopper and is removed for disposal in a suitable facility. Currently the plan is to incinerate the sludge in the main site incinerator which meets the requirements of Environment Canada (Appendix B). Consistent with HBML's intent to conserve natural resources, they will investigate opportunities for using the dried sludge as a fuel or fertilizer for revegetation if the material is found to be chemically suitable.

SaniBrane sludge will have a typical solids content of 25-30 % after the frame press. This will give it the consistency of top soil. This material can be further composted or it can be incinerated. If the material can be further processed and subjected to composting at high enough temperatures to destroy remaining pathogens, the compost could possibly be used as a source of fertilizer for rehabilitation in the future. The sludge would need to be acceptable to local regulators as well as comply with regulations in terms of metal content and pathogen content. Furthermore the sludge is reported to sustain combustion at 50% solids. If the sludge can be adequately dried it could be used as a source of fuel, possibly even to sustain composting temperatures at high enough levels. Burning of the sludge would need to comply with emission requirements contained in the NWB2AM-DOH0713 licence and the ash would need to be safely disposed of in an appropriate facility. HBML is committed to investigating these and other opportunities to ensure their environmental footprint is reduced as far as possible.

6.2.7 CIP System – Organic Cleaning

A mild solution of sodium hypochlorite (0.5%) needs to be added to the membrane modules for cleaning once or twice per year. The need for this cleaning process is determined from monitoring of the trans-membrane pressure. This will involve daily monitoring of the pressure reading between the discharge headers in the MBR Tank and the discharge pressure on the effluent pump. A reading indicating a rise of 3psi (20kPa) from the initial recorded reading requires a planned cleaning.

A chemical feed pump introduces the sodium hypochlorite solution to the module . After adding 500L (130 Gallons) to the module, the system will be allowed to soak for several hours. If an inorganic cleaning is required, a solution of oxalic acid or citric acid would be used instead of sodium hypochlorite.

The cleaning agents will generally be consumed and their oxidizing potential reduced during the cleaning process. Under normal circumstances the water from the plant would be discharged as part of the effluent stream. As the effluent stream is being discharged to the tundra, the water from the cleaning process will be collected and returned to the frontend of the sewage treatment plant. This will ensure that any oxidizing potential is used up and that the water is subjected further normal dilution and treatment with new raw sewage.

6.2.8 SaniBrane Operation and Maintenance

The rounded design parameters for the SaniBrane plant are

- 180 person camp
- 285 L/person/day (75 USG/person/day)
- Two 30 000L (8000 USG) emergency storage tanks.

The specific process includes primary settling, sludge management, and chemical cleaning to ensure minimal manual interface with the STP, effluent and sewage sludges and discharge water.

A comprehensive operations manual is attached in Appendix C. The manual is not repeated in summary form here as the plant has complex start-up, normal operation and maintenance procedures. The full operation manual as supplied by the supplier is regarded as the key document for the SaniBrane plant.

Regular maintenance of the SaniBrane plant is required to maintain high water quality effluent and availability of service. The table below refers to the routine maintenance items on the plant. (Table 3).

Table 3: Routine Maintenance Requirements for the SaniBrane System

Item No.	Tag No.	Equipment	Task	Frequency
1.	B1, B2 & B3	Sutorbilt 3MV - P Blower	Check gear case oil level and top up as required to maintain proper level	Daily
			Drain and replace gear case oil	Every 1500 hours
			Grease drive end bearings	Every 500 hours
			Check blower inlet filters and replace as necessary	Weekly
2.	Air Compressor	Ingersoll - Rand 2545E10V	Lubricate level	Fill as needed
			Drain receiver tank condensate (if automatic draining device is not provided) open manual drain valve and collect and dispose of condensate accordingly	Daily or as required
			Check system oil pressure on lubricated models while compressor is hot	Daily or as required
			Observe operation of safety/relief valves while compressor is running. Replace if not operating freely. Inspect air filters, replace as necessary	Weekly
			1. Inspect for air leaks by squirting soapy water around joints and watch for bubbles 2. Check tightness of screws and bolts 3. Change petroleum lubricant while crankcase is warm, drain compressor oil and clean oil sight glass 4. Replace oil filter and change lubricant (if necessary) on pressure lubricated models 5. Install maintenance pack, change synthetic lubricant while crankcase is warm, replace filter element	Monthly Monthly 3/500 (months/operating hours) whichever occurs first 6/1000 (months/operating hours) whichever occurs first 12/2000 (months/operating hours) whichever occurs first
3.	P1, P2, P3, P4 & P8	Tsurumi Pumps	Bearing Lubrication	As required upon inspection
			Major Overhaul	As required depending on pump performance.
			Motor Inspection with the following tasks: 1) Check that the motor is clean. Check that the interior and exterior of the motor is free of dirt, oil, grease, water etc. Oily vapour, paper, pulp, textile lint etc., can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure. 2) Use an Ohmmeter (“Megger”) periodically to ensure that the integrity of the winding insulation has been maintained. Record the Ohmmeter readings. Immediately investigate any significant drop in insulation resistance. 3) Check all electrical connectors to be sure that they are tight.	Every 500 hours or every three (3) months or whichever occurs first.

Item No.	Tag No.	Equipment	Task	Frequency
4.	Star Poly Press	Star Poly Press 470MM	Check pressure regularly Check for press leaks, look around o-rings for cracks	As required depending on press performance Daily
			Check filter cloths are not detached and that they are torn Caution: Do not over tighten valves in hydraulic system	Regularly During maintenance
5.	P5 & P6	Grundfos CR1-2 Permeate/Effluent Pumps	Motor Inspection with the following tasks: 1) Check that the motor is clean. Check that the interior and exterior of the motor is free of dirt, oil, grease, water etc. Oily vapour, paper, pulp, textile lint etc., can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure. 2) Use an Ohmmeter (“Megger”) periodically to ensure that the integrity of the winding insulation has been maintained. Record the Ohmmeter readings. Immediately investigate any significant drop in insulation resistance. 3) Check all electrical connectors to be sure that they are tight.	Every 500 hours or every three (3) months or whichever occurs first.
6.	P9	Little Giant PE 2.5 Centrifugal Chemical Clean Pump	Inspect impeller and body for excessive build-up or clogging and repair as required.	Upon significant decrease in pump performance.
7.	MBR	SaniBrane™ TMR 140-50S	Observe and record trans-membrane pressure.	Daily
			Perform Chemical Clean of membranes	During start-up perform weekly; During normal operation, perform within seven (7) days of observation of a trans-membrane pressure of 20kPa (3psi)

6.2.9 Critical Operating Limits

The following points are noted amongst others by the manufacturer as critical operational limits that must be met to ensure proper system operation, maximum lifespan and good effluent quality. For a complete list of installation, operation and maintenance requirements refer to the manufacturer's manuals, parts of which are presented in Appendix C.

- The SaniBrane sewage treatment plant is designed to treat normal human domestic waste from toilets, showers, laundry and kitchens
- It is not designed to treat industrial wastes, chemical cleaning agents, bactericides or any product that is toxic to the bacteria that forms to biologically treat the human waste
- Only biodegradable detergents and products can be used in effluent feeds
- Kitchen grease traps must be well serviced to prevent overloading the SaniBrane system with oils and grease
- Plastic, rubber and other non-biodegradable items must be kept out of the sewage flow
- The SaniBrane unit must be protected from freezing. Maintain the temperature from 5º to 40° C (41° to 104° F)
- The effluent discharge from the SaniBrane unit must not be used for drinking water
- SaniBrane effluent water should be water quality 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
- 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.

6.2.10 Potential Operational Failures and Alternatives

Critical components such as discharge pumps, blowers and sewage transfer pumps are supplied in duplicate on the SaniBrane plant. The primary duty equipment can therefore be replaced by a standby duplicate piece of equipment. In essence, no critical component of the plant should be able to fail. In the event that there is a failure in the plant the interlocks in the system have been arranged so that the SaniBrane plant goes into sleep mode and partially treated effluent cannot be pumped from the system. In the event that there is an electrical supply failure the plant will shut down and it will not be possible to treat sewage and therefore it will not be possible for partially treated sewage to be discharged to the tundra. The sewage treatment process includes two 8000 gallon holding tanks in place at the Doris North Camp site to hold sewage. These tanks will be used as an emergency sewage holding system in the event that there is a temporary failure in the plant. Again no untreated sewage can be discharged to the environment. In the event of a prolonged sewage

treatment failure, the current system of honey bags and Pactos can be used as these units will be retained on site.

6.2.11 Electrical Power

SaniBrane plant and Effluent Discharge System

This unit will draw a maximum 200 KW of power. The NUNA twin 250 KW gensets will be used to supply this power as well as construction power for the Doris North Camp and related services construction program. A permanent power supply for the camp is being installed and will replace the Nuna gensets.

7 Performance and Environmental Monitoring

7.1 Doris North Discharge Sampling

HBML will implement a monitoring program around the STP facility as required under the Doris North Project Water Licence from the Nunavut Water Board.

The objective of discharge monitoring is to measure:

- The performance of the waste water treatment facilities
- Ensure that treated water from the Waste Water Treatment Facility meets the appropriate discharge standards
- Assess water quality in the receiving water environment.

All treated effluent discharged from the STP at the Doris North Project Monitoring Station ST-8 and ST-9 during the construction and operation phase must meet and not exceed the following quality standards Table 4:

Table 4: Monitoring points ST8 and ST9 Compliance Requirements

Parameter	Maximum Average	Maximum Allowable in a Grab Sample
pH	6-9	9
Total Suspended Solids	100 mg/L	100 mg/L
BOD_5	80 mg/L	80 mg/L
Faecal Coliform	10,000 CFU/100 mL	10×10^4 CFU/100 mL (10,000 CFU/100 mL)
Total Oil and Grease	5 and no visible sheen	10 and no visible sheen

In addition the following are also required:

- Each sample should also be visually assessed for visible oil and grease sheen
- The daily volume in cubic meters of treated sewage effluent discharged at ST-8 must be measured, recorded and reported to the Nunavut Water Board with the monthly and annual reports
- The annual quantity of sludge in cubic meters removed from the sewage treatment plants must be measured, recorded and reported to the Nunavut Water Board with the monthly and annual reports
- A monitoring program summary report is required to be submitted to the Nunavut Water Board for review within thirty (30) days following the month being reported.

7.2 Doris North Water Intake Sampling

HBML are in terms of the water licence permitted to take fresh water from Doris Lake. This water can be used for domestic camp use, mining and milling and associated uses. The location of the intake point is Station ST-7. The volume taken at this point is not to exceed 480,000 cubic meters per year unless otherwise approved by the Board.

HBML will need to accurately monitor the following as per the Water Licence requirements:

- General
  - pH
  - TSS
- Nutrients (N1)
  - Total Ammonia-N
  - Nitrate-N
  - Nitrite-N
- Nutrients (N2)
  - Orthophosphate-P
  - Total Phosphate-P
- Total Metals - Unfiltered (MT)
  - T-Aluminum
  - T-Arsenic
  - T-Copper
  - T-Iron
  - T-Nickel
  - T-Lead
  - T-Zinc
- Biological
  - BOD5
  - Faecal Coliform
- Other
  - Free CN
  - Total CN
  - TAg
  - T-Cd
  - T-Cr
  - T-Hg
  - TMo
  - T-Se
  - T-Tl
  - Total Oil and Grease
- Discharge (Intake)
  - Flow
  - Volume
  - Duration

These parameters are all to be reported monthly during periods of pumping.

7.3 Sampling Containers

Sample containers vary in size and material of construction, depending on the analysis to be conducted. The method used to analyze for a particular parameter dictates the minimum size of the sample bottle. HBML will use clean, chemically-resistant polyethylene bottles and closures with inert liners supplied by the accredited external laboratory analyzing the samples. Typically these will be 1 litre sample bottles (for pH, BOD and TSS).

Samples to be analyzed for oil and grease must be collected in glass containers as hydrocarbons are attracted to the walls of plastic bottles and may not be released when sample aliquots are transferred from the bottle.

Monthly samples collected for analysis of Faecal Coliform must be shipped in sterilized sample bottles provided by the external lab. Bottles to be used for bacterial testing must be autoclaved (sterilized). These samples must get to the laboratory within 24 hours of sampling so special planning is required as to how and when the samples are shipped to ensure that they arrive at the lab in a timely manner. It is recommended that the lab be contacted ahead of the planned sampling so that they can provide guidance as to shipping procedures, volume of sample required and appropriate sample shipping containers. No preservatives may be used on these samples as this would negate the test validity.

7.4 Data Collection during Sampling

Details of sampling are to be recorded in a field logbook. The individual collecting the samples should record the:

- Date and time that sampling was conducted
- Sampling stations visited
- Samples taken at each station
- Name of the person who performed the sampling or took the measurements
- Results of any field measurements
- Whether the sample was preserved and should initial each entry.

Additional information can be useful when inquiries are made into the meaning of sample data at a later date. The sampler should record any information that may have a bearing on water quality, such as:

- Weather conditions
- Stream/discharge flow rates
- Unusual conditions at the site
- Any necessary deviations from standard procedures or sampling location.

When sampling and sample preservation is completed, the bottles should be clearly marked with all information that the laboratory analyst will need to report the result. As a minimum, the following information should be included:

- Sample location (Station number)
- Date of sampling
- Parameters to be analyzed
- Preservation method used
- Name or initials of sampler
- Temperature and pH where applicable.

As the samples are to be sent to an external laboratory, the company and property name must also be included. In some cases permanent markers can be used to identify sample bottles, however these markings can be erased with wear and may not be clearly legible. Whenever possible, and always when sending samples to external laboratories, mark the bottles with pre-printed gummed labels. Labels should only be applied to dry surfaces.

A major objective of the field sampler is to minimize any chemical changes to the sample between the time of sample collection and delivery to the laboratory, and which may alter the concentration of the parameter of interest. Heat, light, and agitation can all impact the water chemistry and the samples should be protected from these effects. Samples should be delivered to the analytical laboratory as soon as possible after collection. All samples should be stored and transported at a temperature <10 degrees Celsius. Coolers and ice packs are to be used for field transportation and samples should be refrigerated as soon as possible following arrival at the laboratory. A chain of custody form should be completed for each sampling shipment. The original should be sent to the external laboratory while a copy should be filed on-site accordingly. A follow-up call should be made to the external environmental laboratory ensuring that samples were received as scheduled.

7.5 Quality Control during Sampling

The following QA/QC procedures are to be implemented during sampling:

7.5.1 Field Blanks

Field blanks are samples of pure water that are subjected to exactly the same procedures as routine samples, following which they are analyzed for the same parameters as the field samples. Any measurement of the parameter of interest, above method detection limits, will indicate any analytical error, impurities in the laboratory distilled water supply, contaminated sample preservatives, or contamination of the sample during the handling process. Combined with the results of other quality control procedures, analysis of field blanks can help in the identification of sources of contamination. New sample bottles will be used and prepared using distilled water from the normal laboratory water

supply. This set will represent all of the parameters routinely analyzed. They will be preserved in the field and submitted to the laboratory identified as field blanks.

7.5.2 Duplicate Sampling

Replicate sampling (or sometimes referred to as duplicate sampling) is the collection of more than one sample for a given analysis at a given location. The replicate samples are collected, handled, and analyzed using the standard procedures applied to routine samples. Replicate sampling, combined with the results of other quality control procedures, can help indicate sources of error and is particularly useful in identifying problems with accuracy and sampling methods. Once per operating season, for each active water license sampling station, a set of duplicate samples will be taken, representing as many of the routine analyses as possible. Where possible, this should be carried out in conjunction with audit sampling conducted by the designated inspector. Replicate sampling should alternate between the prescribed sampling stations. These results will be included in the reports provided to the NWB.

8 STP Facility Management

The focus of management of the STP facility will be safety and environmental responsibility. Employees working in the STP facility will be trained prior to commencement of work so that they are aware of the health and safety risks associated with the waste water treatment. The following two absolute points of compliance will be part of training

- No person is to drink the water in the SaniBrane plant or the water that is discharged from it to the tundra
- Furthermore working with sewage requires adequate protection for operators. General and specific requirements are presented in the following sections.

8.1 Health and Safety General Requirements

Some chemical agents used for chemical cleaning are harmful when they come in contact with skin. In handling chemicals, operators should wear protective goggles, protective gloves and other protectors. Before using chemicals, the details on Material Safety Data Sheets (MSDS) should be checked. If chemicals come into contact with skin, the MSDS actions for each chemical should be followed. Table 6 indicates which chemicals and volumes will likely be used for the SaniBrane system.

There are four primary exposure pathways to chemicals within the Waste Water Treatment Facility:

- Inhalation
- Ingestion
- Skin contact
- Eye contact.

Skin contact will be prevented by issuing suitable personal protective equipment to employees working in the STP Facility. Personal Protective Equipment is summarized in Table 5.

Eye contact is unlikely under normal circumstances. Where hand work is to be carried out in the STP facility with the risk of eye contact, protective goggles will be required.

Table 5: General Emergency Response Procedures for the Sewage Treatment Plant

Personal Protection	
Ventilation	Use adequate ventilation. Check that the plant's ventilation fans are operating before entering.
Respiratory protection	Use organic cartridge respirator.
Eye protection	For splash protection, use chemical goggles and face shield
Skin protection	Use gloves resistant to the material being used, i.e., neoprene or nitrile rubber. Use protective garments to prevent excessive skin contact.
Health Hazard Data	
Acute effects of overexposure	Eye: May cause mild irritation, with stinging and redness of eyes.
	Skin: May cause infection especially if cuts are present.
	Inhalation: May cause irritation to nose, throat or lungs. Headache, nausea, may occur.
	Ingestion: Swallowing may produce abdominal pail, nausea and vomiting.
First Aid and Emergency Procedures	
Eye	Flush eyes with running water for at least 15 minutes. If irritation or adverse symptoms develop, seek medical attention.
Skin	Immediately wash skin with soap and water for at least fifteen minutes. If irritation or adverse symptoms develop, seek medical attention.
Inhalation	Remove from exposure. If breathing is difficult, give oxygen. If breathing ceases, administer artificial respiration followed by oxygen. Seek immediate medical attention.
Ingestion	Seek medical attention.
Fire	
Fire extinguishing media	Dry chemical, foam, or carbon dioxide.

8.2 Specific Health and Safety Requirements for the SaniBrane Plant

Various oxidizing chemicals will be used on the SaniBrane STP facility as indicted in Table 6.

Table 6: Details of Chemicals and Volumes Needed for Cleaning the SaniBrane Sewage Treatment Plant

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

Specific safety measures associated with the oxidizing chemicals are presented in Table 7.

Table 7: Specific Safety Measures Associated with SaniBrane Cleaning Chemicals

Agent	Sodium Hypochlorite Solution/NaClO	Oxalic Acid $(COOH)^2$	Citric Acid/ HOOCCH2C(OH)(COOH)CH2COOH
CHEMICAL HANDLING PRECAU-TIONS	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, spill over or splattering. Do not cause dust or vapour.		
	Firmly seal the container after use.		
	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.		
	After using chemicals, thoroughly wash your hands and face and rinse out your mouth.		

Specific storage requirements for the oxidizing chemicals can be found in Table 8 and in Figure 9.

Table 8: SaniBrane Cleaning Chemical Storage Requirements

Agent	Sodium Hypochlorite Solution/ NaClO	Oxalic Acid $(COOH)^2$	Citric Acid HOOCCH2C(OH)(COOH)CH2COOH
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.		

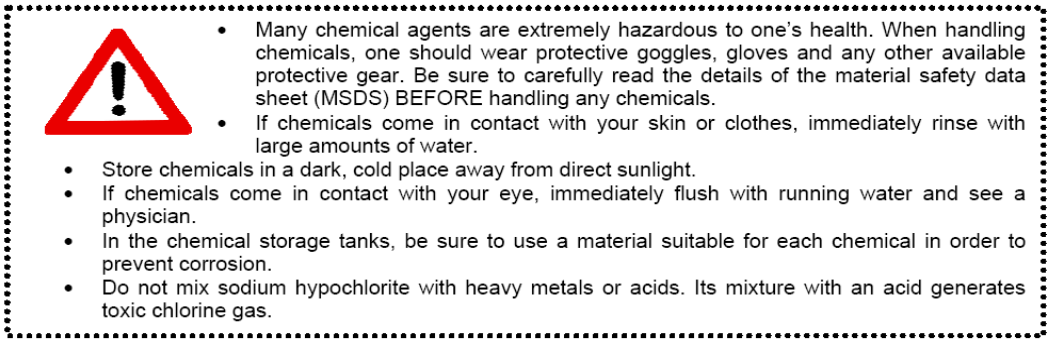

Figure 9: Extract from SaniBrane Operations Manual Relating to Specific Precautions Required with Membrane Cleaning Chemicals

This report, "**Doris North Infrastructure Project - Sewage Management Plan, Hope Bay, Nunavut, Canada**", has been prepared by SRK (Consulting) Canada Inc.

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Appendix A

Specific Sewage and Sludge Management Clauses Contained in the Doris North Water Permit

Sections of Water Licence 2AM-DOH0713 regarding sewage and wastewater treatment

PART A: SCOPE, DEFINITIONS AND ENFORCEMENT

1.

- The construction and operation of a Sewage Treatment Plant (STP);
- The management and disposal of wastes associated with the Sewage Treatment Plant, sedimentation and pollution control ponds, Land fill and Landfarm, and other wastes as described in the application;

2. This Licence is issued subject to conditions contained herein with respect to the taking of water and the depositing of waste of any type in any waters or in any place under any conditions where such waste or any other waste that results from the deposits of such waste may enter any waters. Whenever new Regulations are made or existing Regulations are amended by the Governor in Council under the *Nunavut Waters and Nunavut Surface Rights Tribunal Act*, or other statutes imposing more stringent conditions relating to the quantity, type or manner under which any such waste may be so deposited, this licence shall be deemed to be subject to such requirements.

PART B: GENERAL CONDITIONS

12. The Licensee shall post signs in the appropriate areas to inform the public of the location of the Water Supply Facility and the Waste Disposal Facilities. All signs, must be in English, Inuktitut and Inuinnaqtun and shall be located and maintained to the satisfaction of an Inspector.

PART C: CONDITIONS APPLYING TO SECURITY

PART D: CONDITIONS APPLYING TO CONSTRUCTION

2. The Licensee shall ensure that any chemicals, fuel or wastes associated with the undertaking do not enter any water body.

5. The Licensee shall undertake appropriate corrective measures to mitigate impacts on surface drainage resulting from the Licensee's operations.

6. The Licensee shall limit any in-stream activity to low water period. In-stream activity is prohibited during fish migration.

17. The Licensee shall monitor all activities for signs of erosion and shall implement and maintain sediment and erosion control measures prior to the undertaking to prevent entry of sediment into any water body.

18. The Licensee shall conduct daily visual inspections for all construction activity during spring freshet and during and after remarkable rainfall events with sampling of runoff/seepage where turbidity is evident.

19. All surface runoff during the construction of any facilities, where flow may directly or indirectly enter a water body, shall meet the following effluent quality limits:

Parameter Maximum	Maximum Average Concentration	Maximum Concentration of Any Grab Sample
Total Suspended Solids	50.0 mg/L	100.0mg/L

20. The Licensee shall ensure that the Sewage Treatment Plant is operated in accordance with conditions provided in Part G, Item 3 with compliance at monitoring station ST-8 during construction.

PART E: CONDITIONS APPLYING TO WATER USE

1. The Licensee shall obtain fresh water for domestic camp use, mining and milling and associated uses, from Doris Lake at SNP Station ST-7 using the Fresh Water Intake. The volume shall not exceed 480,000 cubic meters per year unless otherwise approved by the Board.

2. The Licensee shall maximize to the greatest practical extent, the use of reclaim water from the Tailings Impoundment Area for use in the mill.

3. The Licensee shall not use streams as a water source unless authorized and approved by the Board.

4. The Licensee shall maintain the Fresh Water Intake to the satisfaction of the Inspector.

5. The Licensee shall equip all water intake hoses with a screen of an appropriate mesh size to ensure that fish are not entrained and shall withdraw water at a rate such that fish do not become impinged on the screen.

6. The Licensee shall not remove any material from below the ordinary high water mark of any water body unless authorized.

7. The use of water shall not cause erosion to the banks of any body of water and the Licensee shall provide necessary controls to prevent such erosion. Sediment and erosion control measures shall be implemented prior to and maintained during the operation to prevent entry of sediment into water.

PART F: CONDITIONS APPLYING TO WATER MANAGEMENT

PART G: CONDITIONS APPLYING TO WASTE MANAGEMENT AND WASTE MANAGEMENT PLANS

1. The Licensee shall provide at least 10 days notice to the Inspector prior to any planned discharges of any Facilities. The notice shall include the estimated volume proposed for discharge and location.

2. The Licensee shall ensure that all land applied discharges are performed in a manner that prevents erosion at the point of discharge and downstream.

3. The Licensee shall operate the Sewage Treatment Plant in accordance with the following:

a. All Sewage and Greywater shall be collected and treated in the Sewage Treatment Plant;

b. During the construction phase, all effluent from the Sewage Treatment Plant at monitoring station ST-8 shall not exceed the following effluent quality limits:

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

c. During site construction, treated effluent from the Sewage Treatment Plant shall be discharged approximately 400 metres north of the camp pad;

d. Once the Tailings Impoundment Area is operational, all treated effluent from the Sewage Treatment Plant shall be discharged to the Tailings Impoundment Area; and

e. The Licensee shall notify an Inspector at least ten (10) days prior to start-up of

the Sewage Treatment Plant and subsequent discharge from the facility.

4. The Licensee shall submit a Sewage Treatment Management Plan, to the Board for review sixty (60) days prior to commissioning the Sewage Treatment Plant that takes into consideration operation, maintenance and sludge management.

5. The Licensee shall dispose of all food waste in an incinerator designed for this purpose.

6. The Licensee shall ensure that any on-site incinerator meets the requirements of the Canada-Wide Standards for Dioxins and Furans and Canada-Wide Standards for Mercury emissions.

7. The Licensee shall submit to the Board for review by May 1, 2008 an Incineration Management Plan in conjunction with Part G, Item 9.

8. The Licensee is restricted to the open burning of paper products, paperboard packing and untreated wood waste in accordance with the Government of Nunavut policy *Municipal Solid Wastes Suitable for Open Burning.*

9. The Licensee shall submit to the Board for review by May 1, 2008, a revised Landfill Management Plan. The Plan shall consider the following:

a. Recycling/segregation waste program;
b. Incineration technology selected;
c. Waste audit – amount and types of wastes to be incinerated or otherwise disposed;
d. Consolidation of wastes;
e. Operational and maintenance records;
f. Operator Training;
g. Emission measurements;
h. Incinerator Ash disposal;
i. Consideration for disposal of used oil and waste fuel; and
j. Monitoring, characterization, and disposal of incinerator ash.

10. The Licensee is authorized to dispose of and contain all non-hazardous solid wastes at the Landfill or as otherwise approved by the Board.

19. The Licensee shall operate the Sewage Treatment Plant, Landfill, Landfarm, Fuel Storage and Containment Facilities, Sedimentation Pond, and Pollution Control Pond to the satisfaction of the Inspector.

PART H: CONDITIONS APPLYING TO MODIFICATIONS

PART I: CONDITIONS APPLYING TO CONTINGENCY PLANNING

8. If, during the period of this Licence an unauthorized discharge of waste and or effluent occurs, or if such discharge is foreseeable, the Licensee shall:

a. Employ the Emergency Response and Contingency Plan;
b. Report the incident immediately via the 24-Hour Spill Reporting Line (867) 920-8130 and to the Inspector at (867) 975-4295; and
c. For each spill occurrence, submit a detailed report to the Inspector, no later than thirty (30) days after initially reporting the event, which includes the amount and type of spilled product, the GPS location of the spill, and the measures taken to contain and clean up the spill site.

PART J: CONDITIONS APPLYING TO GENERAL AND AQUATIC EFFECTS MONITORING

1. The Licensee shall install and maintain flow meters or other such devices, or implement suitable methods required for the measuring of water use and Effluent discharge volumes, to be operated and maintained to the satisfaction of an Inspector.

9. All analyses shall be conducted as described in the most recent edition of "Standard Methods for the Examination of Water and Wastewater" or by other such methods approved by an Analyst

12. The Licensee shall measure and record all flow and volume measurements on a monthly basis (unless otherwise stated):

a. The volume of freshwater obtained from Doris Lake for potable water;
b. The volume of freshwater obtained from Doris Lake for process water;
c. The volume of reclaim water obtained from Tail Lake for process water at Monitoring Station TL-8;
d. Tonnages of mineralized and un-mineralized waste rock stored on the Temporary Waste Rock Pad on a monthly basis during construction, operations, and closure;
e. Tonnage of waste rock returned underground on a monthly basis during construction, operation and closure;
f. The volume of sewage sludge removed from the Sewage Treatment Plant and the locations or method of sewage sludge disposal during construction, operation and closure; and
g. The ice thickness in Tail Lake measured on a monthly basis during construction, operations and closure.

20. The Licensee shall visually monitor and record observations on a daily basis during periods of discharge, all discharge onto the tundra from the:

a. Landfill Sump;
b. Sedimentation Pond;
c. Landfarm Sump;
d. Plant Site Fuel Storage and Containment Area Sump;
e. Roberts Bay Fuel Storage and Containment Area Sump; and
f. Sewage Treatment Plant (during the construction phase).

The monitoring results shall be made available to an Inspector upon request

PART K: CONDITIONS APPLYING TO GENERAL AND AQUATIC EFFECTS MONITORING PLANS

PART L: CONDITIONS APPLYING TO ABANDONMENT, RECLAMATION AND CLOSURE

Schedule A – Definitions

"**Discharge**" means the release of any water or waste to the receiving environment;
"**Domestic Waste**" means all solid waste generated form the accommodations, kitchen facilities and all other site facilities, excluding those industrial and hazardous wastes associated with the mining and processing of ore; "**Effluent**" means the liquid discharge from all site water management facilities;
"**Greywater**" means the component of effluent produced from domestic use (i.e. washing, bathing, food preparation and laundering), excluding sewage;
"**Sewage**" means all toilet wastes and greywater;
"**Sewage Treatment Plant (STP)**" means the Sani-Membrane Bio-Reactor system designed for the treatment of sewage described in the Water Licence Pre-Hearing Technical Meeting Information Supplement Part A - Item 10;
"**Waste Water**" means the water generated by site activities or originates on-site that requires treatment or any other water management activity;

Schedule B - General Conditions

12. Annual Incineration stack testing results;

14. A summary of modifications and/or major maintenance work carried out on the Water Supply and the Waste Disposal Facilities, including all associated structures, and an outline of any work anticipated for the next year;

19. Any other details on Water use or Waste Disposal requested by the Board by November 1st of the year being reported.

Schedule D - Conditions Applying to Construction

1. The Construction Monitoring Report referred to in Part D, Item 8 shall include the following:
   a. Blast vibration monitoring for quarrying activity carried out in close proximity to fish bearing waters;

b. Monitoring of the performance of erosion protection measures employed by the construction contractor;
c. Monitoring for sediment release from construction areas;
d. Monitoring for wildlife interactions;
e. Monitoring to ensure the protection of all migrating birds and their nesting sites;
f. Follow-up geochemical sampling of quarried rock used in construction of the site roads and pads to verify that the rock used is non-acid generating as predicted;
g. Monitoring of the waste management practices employed by the contractors and their employees (food waste, hazardous wastes such as engine oil and filters etc, non-hazardous wastes);
h. Monitoring of contractor's activity to minimize ground impacts to the tundra (i.e. keeping vehicles off the tundra and on constructed roadways);
i. Monitoring of dust generation and use of water by the contractor to manage dust emissions from crushing and construction activity;
j. Vegetation monitoring;
k. Summary of the Quarry Rock Construction Monitoring Program referred to in Part D, Item 3;
l. Summary of the construction of the North and South Dams;
i. Laboratory results of subsurface investigations of the dam foundations from undisturbed samples;
ii. Details of the geotechnical instrumentation and monitoring plan proposed to monitor the performance of the dams; and
iii. Results of subsurface investigations and laboratory analyses must be reviewed by MHBL and the dam design modified accordingly under the supervision of a Geotechnical Engineer.
m. Summary of the items referred to in Part D, Item 15 with respect to updated construction drawings for the all weather access roads;
n. Summary of the Quarry Rock Seepage Monitoring Program referred to in Part D, Item 22; and
o. Status of the Construction Summary Report referred to in Part D, Items 27. The report shall discuss the monitoring results, analysis and any mitigation measures employed as a result of the monitoring, for each of the items listed above.

Schedule G - Conditions Applying to Waste Management and Waste Management Plans

Temp (ºC)	pH							
	6.0	**6.5**	**7.0**	**7.5**	**8.0**	**8.5**	**9.0**	**9.5**
0	231	73.0	23.1	7.32	2.33	0.749	0.250	0.042
5	153	48.3	15.3	4.84	1.54	0.502	0.172	0.034
10	102	32.4	10.3	3.26	1.04	0.343	0.121	0.029
15	69.7	22.0	6.98	2.22	0.715	0.239	0.089	0.026
20	48.0	15.2	4.82	1.54	0.499	0.171	0.067	0.024
25	33.5	10.6	3.37	1.08	0.354	0.125	0.053	0.022
30	23.7	7.50	2.39	0.767	0.256	0.094	0.043	0.021

CCME - Water Quality guidelines for total ammonia for the protection of aquatic life ($mg \cdot L^{-1} NH_3$)

Temp (°C)	pH							
	6.0	**6.5**	**7.0**	**7.5**	**8.0**	**8.5**	**9.0**	**9.5**
0	231	73.0	23.1	7.32	2.33	0.749	0.250	0.042
5	153	48.3	15.3	4.84	1.54	0.502	0.172	0.034
10	102	32.4	10.3	3.26	1.04	0.343	0.121	0.029
15	69.7	22.0	6.98	2.22	0.715	0.239	0.089	0.026
20	48.0	15.2	4.82	1.54	0.499	0.171	0.067	0.024
25	33.5	10.6	3.37	1.08	0.354	0.125	0.053	0.022
30	23.7	7.50	2.39	0.767	0.256	0.094	0.043	0.021

Schedule J - Conditions Applying to General and Aquatics Effects Monitoring

TABLE 1 - MONITORING GROUPS

Group	Analytical Parameters	Measurement Units	Colour Reference
General (G)	Ph	pH units	Red
	TSS	mg/L	
Nutrients (N1)	Total Ammonia-N	mg-N/L	Blue
	Nitrate-N		
	Nitrite-N		
Nutrients (N2)	Orthophosphate-P	mg/L	Orange
	Total Phosphate-P		
Total Metals - Unfiltered (MT)	T-Aluminum	mg/L	Green
	T-Arsenic		
	T-Copper		
	T-Iron		
	T-Nickel		
	T-Lead		
	T-Zinc		
Dissolved Metals - Filtered (MD)	D-Iron	mg/L	Purple
	D-Copper		
	D-Arsenic		
	D-Zinc		
	D-Cadmium		
	D-Nickel		
Biological (B)	Biological Oxygen Demand	mg/L	Yellow
	Fecal Coliforms	CFU/100 mL (colony forming units)	
Hydrocarbons (HC)	Total Oil and Grease	mg/L	Dk. Green
	T-Lead		
	Benzene		
	Toluene		
	Ethyl-Benzene		
Discharge (D)	Flow	m^3/day	Grey
	Volume	m^3	
	Duration	Day	

GROUP REFERENCE

STATION / PARAMETER	TL-1	TL-2	TL-3	TL-4	TL-5	TL-6	TL-7	TL-8	TL-9	TL-10	TL-11	TL-12	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	ST-7	ST-8	ST-9	ST-10
pH	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Electrical Conductivity											x											
TSS	x	x	x	x	x			x		x		x	x	x	x	x	x	x	x	x	x	x
TDS	x	x	x	x						x												
Cl	x	x	x	x						x				x								
Free CN	x	x	x	x	x			x		x									x			
Total CN	x	x	x	x	x			x	x	x	x		x	x	x				x			
WAD CN					x		x		x		x											
Total Ammonia-N	x	x	x	x	x			x		x	x	x	x	x	x	x			x			
Nitrate-N	x	x	x	x	x			x		x	x	x	x	x					x			
Nitrite-N	x	x	x	x	x			x		x	x	x	x	x					x			
Sulphate					x						x	x	x	x	x							
Orthophosphate-P	x	x	x	x				x		x									x			
Total Phosphate-P	x	x	x	x				x		x									x			
T-Al	x	x	x	x	x	x		x		x			x	x	x				x			
T-Ag	x	x	x	x				x		x									x			
T-As	x	x	x	x	x	x		x		x			x	x	x				x			
T-Ca	x	x	x	x						x									x			
T-Cd	x	x	x	x	x	x		x		x									x			
T-Cr	x	x	x	x	x	x		x		x									x			
T-Cu	x	x	x	x	x	x		x		x			x	x	x				x			
T-Fe	x	x	x	x	x	x		x		x			x	x	x				x			
T-Hg	x	x	x	x	x	x		x		x									x			
T-K	x	x	x	x						x												
T-Mo	x	x	x	x	x	x		x		x									x			
T-Mg	x	x	x	x						x												
T-Na	x	x	x	x						x												
T-Ni	x	x	x	x	x	x		x		x			x	x	x				x			
T-Pb	x	x	x	x	x	x		x		x			x	x	x	x	x	x	x			
T-Se	x	x	x	x	x	x		x		x									x			
T-Zn	x	x	x	x	x	x		x		x			x	x	x				x			

STATION / PARAMETER	TL-1	TL-2	TL-3	TL-4	TL-5	TL-6	TL-7	TL-8	TL-9	TL-10	TL-11	TL-12	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	ST-7	ST-8	ST-9	ST-10
T-Tl	x	x	x	x				x		x									x			
T-Radium 226				x																		
Dissolved Oxygen & Redox Potential	x									x												
Acute Lethality	x			x																		
Flow	x	x	x	x	x			x				x	x	x	x	x	x	x	x	x	x	
Volume	x	x	x	x	x			x				x	x	x	x	x	x	x	x	x	x	
Water Level	x																					
Total Metals by ICP-MS*					x							x		x								
Total Metals ICP-MS including Sulphur						x	x															
Trace Metals by ICP-MS											x											
Alkalinity											x			x								
Acidity											x											
Dissolved Fe									x													
D-Cu									x													
D-As									x													
D-Zn									x													
D-Cd									x													
D-Ni									x													
BOD_5				x															x	x	x	
Fecal Coliforms				x															x	x	x	
Cyanate					x		x															
Thiocyanate					x		x															
Moisture content							x															
Total Oil and Grease			x										x	x	x	x	x	x	x	x	x	
Benzene																x	x	x				
Toluene																x	x	x				
Ethyl-Benzene																x	x	x				
Tonnage						x	x															

STATION / PARAMETER	TL-1	TL-2	TL-3	TL-4	TL-5	TL-6	TL-7	TL-8	TL-9	TL-10	TL-11	TL-12	ST-1	ST-2	ST-3	ST-4	ST-5	ST-6	ST-7	ST-8	ST-9	ST-10
Chemical Oxygen Demand									x													
Total Inorganic Carbon						x	x															

* (definition: metals consistent with baseline data previously collected and any other metals of current interest)

TABLE 2 - MONITORING REQUIREMENTS

ST-7	Freshwater pumped from Doris Lake taken from a valve on the discharge end of the freshwater pump	Construction, Operation, Closure	**G, N1, N2, MT** and Free CN, Total CN, T-Ag, T-Cd, T-Cr, T-Hg, T-Mo, T-Se, T-Tl, and Total Oil and Grease	Monthly
			B	
			D	Monthly during periods of pumping
Station	**Description**	**Phase**	**Monitoring Parameters**	**Frequency**
ST-8	Discharge from Sewage Treatment Plant bio-membrane	Construction, Operation, Closure	**G, B,** and Total Oil and Grease	Monthly
			Location of discharge	Monthly during periods of discharge
			D	Monthly during periods of discharge
ST-9	Runoff from Sewage Treatment Plant discharge - downstream of sewage treatment plant discharge point and just prior to flow entering Doris Lake	Construction	**G, B,** and Total Oil and Grease	Monthly

Sections of Decision 2AM-DOH0713 Final Relating to Sewage and Wastewater Treatment

PART A: SCOPE, DEFINITIONS AND ENFORCEMENT

PART B: GENERAL CONDITIONS

PART C: CONDITIONS APPLYING TO SECURITY

PART D: CONDITIONS APPLYING TO CONSTRUCTION

PART E: CONDITIONS APPLYING TO WATER USE

Section 11 of the NWNSRTA states "… no person shall use, or permit the use of, water in Nunavut except in accordance with the conditions of a licence." KIA requested that the Board consider in its assessment of the Applicant's requested water use volume, the estimate per person based on World Health Organization (WHO) recommendations.94 The Board believes the camp water use in a mine work environment may extend beyond the estimates proposed by the WHO and therefore agrees with the water use volumes requested by the Applicant for camp use. Further, without taking away from the importance of drinking water quality, the Board believes it is outside its jurisdiction to require the applicant to ensure potable treated water comply with the Canadian Drinking Water Quality Guidelines as recommended by the GN-DOE as this is a public health issue. 95 Finally, if MHBL requires water for the construction, operation and maintenance of a winter road from other exploration licensed operations, an amendment shall be filed under a valid water licence for the additional use of water.

PART F: CONDITIONS APPLYING TO WATER MANAGEMENT

PART G: CONDITIONS APPLYING TO WASTE MANAGEMENT AND WASTE MANAGEMENT PLANS

Sewage Treatment: INAC recommended that the construction sewage discharge standards meet the 1992 NWB Wastewater Discharge Guidelines which have been adopted by the Board and the standards should include both maximum grab sample concentrations and monthly average concentrations.[96] The Board agrees with the standards and concentrations proposed MBHL in their monitoring plan.[97]

PART H: CONDITIONS APPLYING TO MODIFICATIONS

PART I: CONDITIONS APPLYING TO CONTINGENCY PLANNING

PART J: CONDITIONS APPLYING TO GENERAL AND AQAUTIC EFFECTS MONITORING

PART K: CONDITIONS APPLYING TO GENERAL AND AQUATIC EFFECTS MONITORING PLANS

PART L: CONDITIONS APPLYING TO ABANDONMENT, RECLAMATION AND CLOSURE

Reference:

57 INAC Supplemental Submission on Security, at p. 2, states: The NLCA defines "water" to mean "waters in any river, stream, lake or other body of inland waters on the surface or under ground in the Nunavut Settlement Area, and includes ice and all inland ground waters, but does not include water or ice in marine areas" The NLCA states that the Nunavut Water Board has "responsibilities and powers over the regulation, use and management of water in the Nunavut Settlement Area" The provision goes on to state that the Nunavut Water Board's responsibilities and powers are at least equivalent to the powers and responsibilities currently held (at the time of the Claim) by the Northwest Territories Water Board under the *Northern Inland Waters Act* Finally, the provision affords the Nunavut Water Board "any other responsibilities acquired under Article 13 of the NLCA The major component of the Nunavut Water Board's jurisdiction flows from section 13 7 1, which states that subject to identified exceptions" no person may use water or deposit waste into water without the approval of the NWB" Article 20 of the NLCA (Section 20 3 1) provides that in consideration whether to approved a use of water or deposition of waste, the Nunavut Water board must consider whether the Designated Inuit Organisation identified for the purposes of article 20 has entered into a compensation agreement with the applicant for the license, which compensation will be for "any loss or damage which may be caused by the change in quality, quantity or flow of water".

58 INAC Supplemental Submission on Security, at p.3, states:
The limited sphere of jurisdiction is carried forward in the NWNSRTA The Act gives a definition of water consistent with that in the NLCA The Act states that " The objects of the Board are to provide for the conservation and utilization of waters in Nunavut in a manner that will provide optimum benefit from those waters for the residents of Nunavut in particular and Canadians in general" The powers of the Board include the issuance of

licences for activities that would otherwise constitute violations of sections 11 or 12 of the NWBSRTA Section 11 prohibits the unauthorized use of waters Section 12 prohibits the unauthorized deposit of waste (i) in waters, or (ii) under conditions in which waste may enter waters, all of the Act's other references to "deposit of waste" must be read in light of these specified conditions

Referenced section 87(4) must be read in conjunction with 87(1):
87. (1) An inspector may direct any person to take such reasonable measures as the inspector may specify, including the cessation of an activity, to prevent the use of waters or the deposit of waste or the failure of a work related to the use of waters or the deposit of waste, or to counteract, mitigate or remedy the resulting adverse effects, where the inspector believes, on reasonable grounds,
(a) that

(i) waters have been or may be used in contravention of subsection 11(1) or of a condition of a licence,
(ii) waste has been or may be deposited in contravention of subsection 12(1) or of a condition of a licence, or
(iii) there has been, or may be, a failure of a work related to the use of waters or the deposit of waste, whether or not there has been compliance with any standards prescribed by the regulations or imposed by a licence; and

(b) that the adverse effects of that use, deposit or failure are causing, or may cause, a danger to persons, property or the environment…
(4) Where a person fails to comply with a direction given under subsection (1), the inspector may take the measures referred to in that subsection and may, for that purpose, enter any place in Nunavut, other than a place that is designed to be used and is being used as a permanent or temporary private dwelling-place.
89. (1) Where the Minister believes, on reasonable grounds, that

(a) a person has closed or abandoned, temporarily or permanently, a work related to the use of waters or the deposit of waste in Nunavut, except in a national park, and

Appendix B
Nunavut Water Board Approval Letters for the Matrix Camp

P.O. Box 119
Gjoa Haven, NU X0B 1J0
Tel: (867) 360-6338
Fax: (867) 360-6369

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NUNAVUT WATER BOARD
NUNAVUT IMALIRIYIN KATIMAYINGI
OFFICE DES EAUX DU NUNAVUT

File: 2AM-DOH0713/TR/H1

June 6, 2008

By Email and Regular Mail

Michael Meyer
Interim Director Environmental and Social Responsibility
Hope Bay Mining Ltd.
Suite 300, 889 Harbourside Drive
North Vancouver, B.C.
V7P 3S1

Email: Michael.Meyer@newmont.com

Subject: Modification request under Part H, Item 1 of Water Licence 2AM-DOH0713; Doris North Project, Nunavut

Dear Mr. Meyer;

The Nunavut Water Board ("NWB") would like to acknowledge the receipt on May 6, 2008 of the above request and supporting documents under Part H, Item 1 of Licence 2AM-DOH0713. The Modification request was distributed upon receipt for a fifteen (15) day review, with comments from interested persons due no later than May 21, 2008 at 5:00p.m.

The request for modification included the following:

- Setup and operation of a 49 person Weatherhaven Camp to be located within the foot print of disturbance previously reviewed by NIRB;
- The intake of water and discharge of waste will be from, and to, the same locations considered during the assessment and specified in the current Licence;
- Grey water generated by laundry, kitchen, and dry facilities will be processed using a Peak Energy Services Membrane Treatment system, discharging to the approved location and complying with discharge criteria as per terms of Part G;
- An Operations Plan for the temporary unit will be prepared and submitted to the Board;
- Installation and operation of a Westland CY2020 FA, or similar model incinerator, meeting the requirements of Part G, Items 5 and 6 of the Licence; and
- An Operations Plan for the incinerator also to be prepared and submitted to the Board.

During the review, the NWB received comments from the Kitikmeot Inuit Association (KIA), Indian and Northern Affairs Canada (INAC) and Environment Canada (EC).

The technical review of the modification request has been completed. Comments were received from the KIA, INAC and EC. Concerns were initially expressed by Env. Can. with respect to the method of handling sewage and the disposal utilizing electric incinerator toilets, which may not meet the Canada Wide Standards (CWS) for dioxins, furans and mercury. A second concern was raised with respect to the main incinerator originally proposed for the Camp and whether it satisfies EC's recommendations for meeting the CWS for dioxins, furans and mercury.

During the review period and following, discussions between the Licensee and EC took place with respect to an alternate incinerator being chosen which would satisfy EC's recommendations for incineration requirements. In addition, with respect to the sewage disposal, the Licensee has proposed to collect the sewage and incinerate the wastes utilizing the main site incinerator, which meets EC's recommendation.

Taking into account the above, and the additional comments provided to the NWB in subsequent email correspondence, the Board has considered the information submitted and hereby accepts and approves the modification request under **Motion 2008-07,** dated **June 6, 2008**.

Should the Licensee decide to provide the information to the NWB as required by EC along with acknowledgment from EC that recommendations have been met for the use of the incinerator toilets, this approval shall include the use of the self contained toilets for the purposes outlined above.

Should you have any further questions, please feel free to contact me at (780) 443-4406, at your earliest convenience.

Yours truly,

Original signed by:

David Hohnstein, C.E.T.
A/Director Technical Services

Cc: Kitikmeot Distribution list

Extract of Letter from Chris Hanks

25-06-08

Phyllis

As per our conversation on the phone today, Newmont Mining Corporation would like to increase the accommodation number in the Temporary Camp at Doris North from 49 approved in David Hohstein's June 6, 2008 letter to 68 people. I understand from our conversation that the increase in the number occupants is acceptable as long as the company complies by the other criteria laid out by Mr. Hohnstein.

Thank you very much for your attention to this request.

Sincerely yours,

Chris Hanks
Director, Environment and Social Responsibility
Hope Bay Mining Ltd.
Newmont Mining Corporation

Appendix C
SaniBrane Operations Manual

SaniBrane®

Membrane Bioreactors for Wastewater Treatment Systems

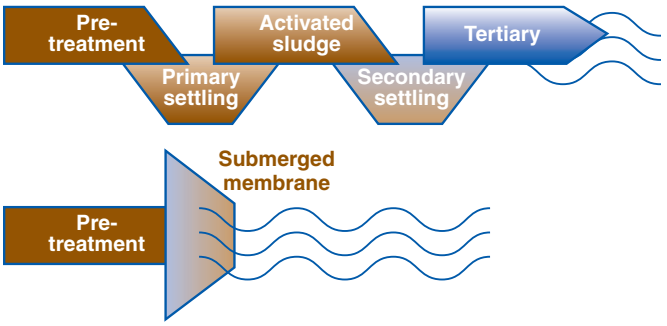
SANITHERM ENGINEERING LIMITED

Since 1946

Membrane Bioreactor Treatment Technology:
Revolutionizing Wastewater Treatment.

A membrane bioreactor (MBR) combines one of the oldest and most mature wastewater treatment technologies with the very newest. It is an activated sludge treatment plant combined with an extremely effective clarifier.

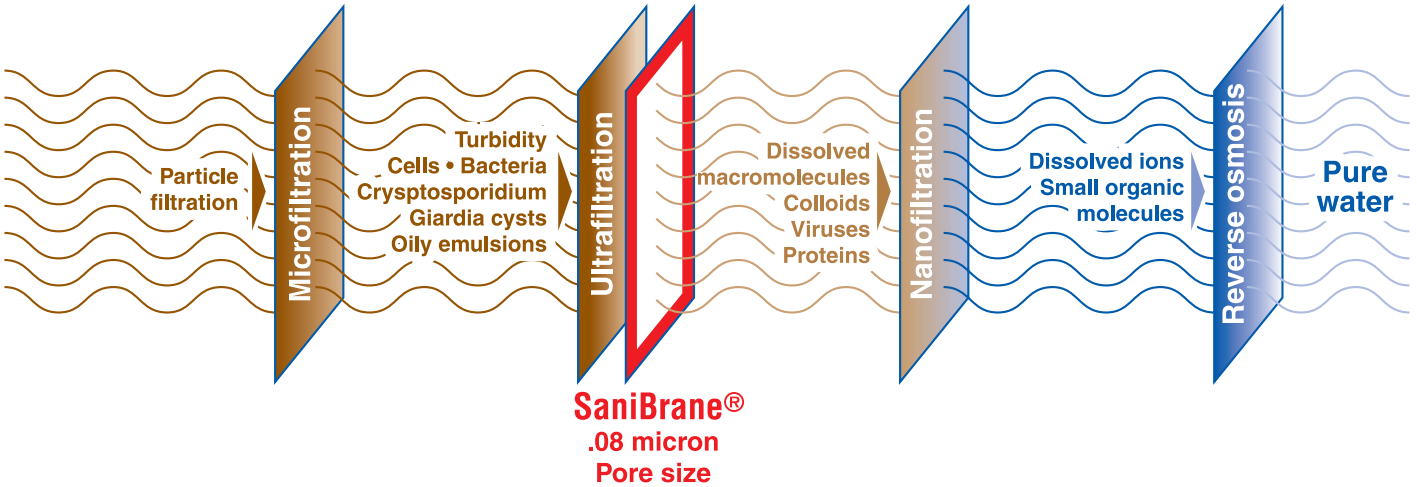
The basic operating theory behind membranes is conventional biological treatment combined with a semi-permeable barrier that precludes mixed liquor suspended solids (MLSS) from being discharged from the biological reactor. This semi-permeable barrier is generally an engineered plastic such as PVDF or PVC, perforated with innumerable tiny holes less than one micron in diameter – smaller than the size of the MLSS. Clear, treated liquid is drawn through the openings, either by gravity or by using a pump. Normally, such a semi-permeable barrier would plug immediately after being placed in the MLSS tank, but proper design prevents solids from accumulating on the membrane surface and "blinding" the holes.



MBRs take fewer steps than conventional activated sludge plants to produce the required effluent. That means there is less room for operator error and equipment malfunctions – saving you money and time.

The SaniBrane® system results in effluent that is often well above the standard required.

Generally speaking, there are two wastewater membrane configurations. Hollow-fibre designs resemble spaghetti strands with hollow centres. Flat-plate designs consist of plates with membrane fabric on each side. SaniBrane® designs are strictly flat-plate, which allows optimum air-scouring to keep the membrane surfaces clean. This results in less maintenance: for example, no back pulsing.

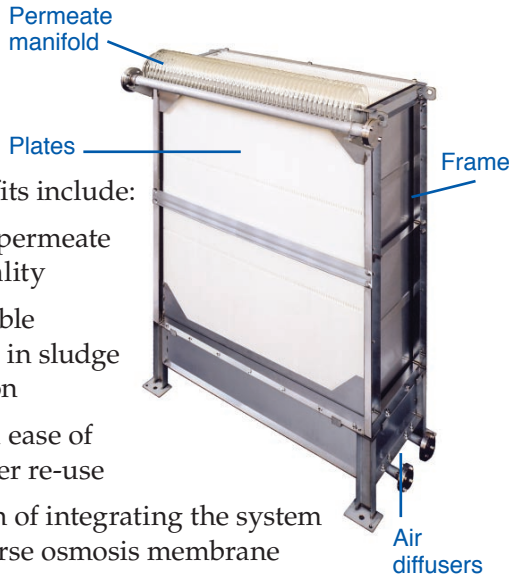


The SaniBrane® MBR: a Flat-Plate Design

The SaniBrane® flat-plate MBR design allows optimum air-scouring to keep the membrane surfaces clean. Use of PVDF for membrane surfaces results in the most consistent pore size and distribution.

The reliable air scouring and consistent, long-term flux rates make these membranes suitable for treating domestic sewage in both industrial and municipal environments.

SaniBrane® flat-plate unit being installed in a concrete tank.



Other benefits include:

- excellent permeate water quality
- considerable reduction in sludge production
- improved ease of wastewater re-use
- the option of integrating the system with reverse osmosis membrane
- two-year warranty on membrane life
- ability to operate with gravity flow (i.e., no pump required)
- significantly less operator intervention than is required with hollow-fibre membranes
- open-top flow-through design ensures effective scouring and MLSS mixing

TYPICAL APPLICATIONS

SaniBrane® Projects	Design Flow	Modules	MLSS	BOD	TSS	Fecal Coliform	Comments
Snap Lake NWT, Canada	5,283 gpd (20 m^3/day)	1	12,000 – 18,000 *(Design Range)*	< 5 mg/L *(detection limit)*	< 2 mg/L	< 15 F.C./100 ml	Industrial Camp
Sooke BC, Canada	63,401 gpd (240 m^3/day)	4	12,000 – 18,000 *(Design Range)*	< 5 mg/L *(detection limit)*	< 1 mg/L		Residential
Attawapiskat ONT, Canada	48,750 gpd (184.5 m^3/day)	3	12,000 – 18,000 *(Design Range)*	10 mg/L	10 mg/L	100 F.C./100 ml	650 Man Industrial Camp
Attawapiskat ONT, Canada	17,250 gpd (65.3 m^3/day)	1	12,000 – 18,000 *(Design Range)*	10 mg/L	10 mg/L	100 F.C./100 ml	230 Man Industrial Camp
Gahcho Kue NWT, Canada	7,000 gpd (26.5 m^3/day)	1	12,000 – 18,000 *(Design Range)*	15 mg/L	15 mg/L	10 F.C./100 ml	Industrial Camp
Pemberton BC, Canada	3,963 gpd (15 m^3/day)	1	12,000 – 18,000 *(Design Range)*	< 5 mg/L *(detection limit)*	< 3 mg/L	< 5 F.C./100 ml	Industrial Camp
Lake O' Hara Lodge BC, Canada	5,019 gpd (19 m^3/day)	1		< 5 mg/L *(detection limit)*	< 1 mg/L		Ultraviolet treatment following SaniBrane®
Gulf Islands, BC, Canada	26,417 gpd (100 m^3/day)	2	36,000	< 5 mg/L *(detection limit)*	< 1 mg/L	< 1 F.C./100 ml	Sludge thickening: activated sludge

Plants Custom-Designed to Meet Your Unique Requirements

SaniBrane® MBR technology is suitable for a wide variety of applications in both industrial and municipal environments. Sanitherm's range of configurations and housing systems will fit your needs perfectly, regardless of the remoteness of your location or the severity of the climate at your site.

Sanitherm's wastewater treatment plants are currently in use worldwide, in municipalities, rural gas stations, remote resorts, golf courses, schools, construction camps and oil and gas exploration camps. They are also suitable for cruise ships and offshore oil drilling facilities – anywhere needing reliable waste treatment with a small footprint.

Sanitherm's design team will work with you to determine the most suitable size and configuration for your project, based on population and environmental considerations. Then Sanitherm will build and install your system. Once in place, you will find it versatile and easy to operate.

SaniBrane® Container Systems

Sanitherm is at the forefront of addressing wastewater challenges in remote areas. The SaniBrane® Container System is suitable if you have limited land mass, a small population and need a complete, compact and self-contained wastewater treatment system.

Clients for this efficient plant include mines, oil fields, industrial camps, remote municipalities, resorts, rural rest stops and . . .

The plant is built in a shipping container, which makes shipping easy to any location in the world. A 15 m^3/d plant weighs approximately 15,000 pounds or 6,800 kg, which means that it's transportable with a heavy-lift helicopter. On-site, it has a small footprint.

A SaniBrane® container system can be set-up and operating in just a few hours – no building required. All you need is the sewage inlet connection, the treated effluent connection and the power connection. The system is very low-maintenance and you will find that in most cases the effluent is of higher quality than required.

Several standard sizes are available, all complete with flow equalization, treatment tankage, heat, lights and controls. A long list of available options will ensure compatibility with your specific requirements. For example:

- Larger heaters (standard is 5kW)
- Effluent discharge pump chamber
- Inlet screens
- Air conditioning
- Effluent disinfection

Let Sanitherm custom-build a compact and cost-effective wastewater treatment solution for your site.

Standard sizes include:

- 4,000 gpd (15m^3/d), built inside a 40-ft "hi-cube" container
- 8,000 gpd (30m^3/d), inside a 48-ft container
- 12,000 gpd (45m^3/d), inside two 40-ft "hi-cube" containers
- 16,000 gpd (60m^3/d), inside two 48-ft containers
- Custom containers

If a helicopter can get there, so can a SaniBrane® Container System.

SaniBrane® Concrete Tank Systems

Installing the MBR units.

Customers with large volumes to treat may prefer the SaniBrane® Concrete Tank option. These permanent tanks are ideal for in-ground installations. They are space-saving, as you can build offices or equipment rooms above them. They can also be built in stages: pour the tanks now, install equipment as it is required.

Sanitherm can help you design an MBR to treat flows of 1 MGD (3800 m^3/d) and greater. Sanitherm's packages can include all of the ancillary equipment required, including aeration blowers, permeate pumps, mixers, supplemental aeration, and level controls. As well, you can incorporate process controls and starters using major manufacturers such as Sutorbilt, Gorman-Rupp, Flygt, Allen-Bradley or any other that you prefer. The plant controls can be simple or as comprehensive as you need.

A concrete tank is ideal for isolated municipalities.

Sanitherm also supplies miscellaneous fabricated components such as access stairways, grating and handrails.

Because of the modular design of the SaniBrane® membrane units, which do not require chemical dip tanks or back-pulse piping, plants are simple to build and expand. In-situ chemical cleaning reduces the long-term maintenance costs. Sanitherm has been designing plants since 1946 and troubleshooting sewage treatment plants in some of the most remote parts of the globe since the early 1990s. Sanitherm can offer your team real-world, practical experience.

SaniBrane® Pre-Fabricated Steel Plants

Municipal application: at a residential resort.

To minimize site labour, time and expense, a Sanitherm pre-engineered steel plant is the recommended solution. They handle large volumes, are portable, self-contained, and pre-piped. Sanitherm has built hundreds of pre-fabricated treatment plants utilizing professionally-engineered tankage, fabricated to ASME, CWB and AWS standards.

Standard plants are built within a 12-ft (3.66-m) width and height envelope. Shipping requirements are also considered during design. Transporting via cargo plane, container ship or helicopter is feasible. To ensure minimum delay when reassembling on site, external piping is factory-installed and then removed for transport.

Industrial application: at a diamond mine. *Right:* prefab plants are easy to ship.

SaniBrane® pre-fabricated steel plants can be installed on-grade, on concrete pads or compacted gravel bases or they can be buried, to suit your specific site conditions. Depending on the local climate, the plants can be totally free-standing or they can be housed within pre-engineered or site-built buildings.

Safe service access is assured with industrial-grade stairways, handrailing and grating over all tanks.

Typical installations include remote industrial sites as well as residential subdivisions. By reducing the installation time, the sites can be populated sooner and the subdivision lots can be sold more quickly.

SANITHERM ENGINEERING LIMITED

Since 1946

Sanitherm has earned a worldwide reputation for quality equipment and service and continues to acquire new and proven technologies capable of meeting the toughest of regulations.

Sanitherm's experienced team will work with you to create a custom design to suit your requirements. With Sanitherm, you are assured a wastewater treatment system that is operator-friendly, economical, reliable and effective.

Sanitherm has designed, manufactured and installed hundreds of SaniBrane® systems, giving Sanitherm the experience necessary to provide you:

- Standard systems that are pre-plumbed, pre-wired and tested
- Custom designs to suit your requirements
- Designs and systems that are operator-friendly and economical

Please call for details on how Sanitherm can design, build and install a wastewater treatment system that is tailored to your needs and budget.

www.sanitherm.com

Suite 100, 340 Brooksbank Avenue
North Vancouver, British Columbia,
CANADA V7J 2C1
Telephone: (604) 986-9168 Fax: (604) 986-5377
E-mail: saneng@sanitherm.com

Your Area Representative:

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

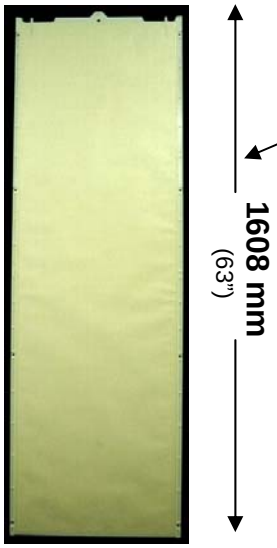
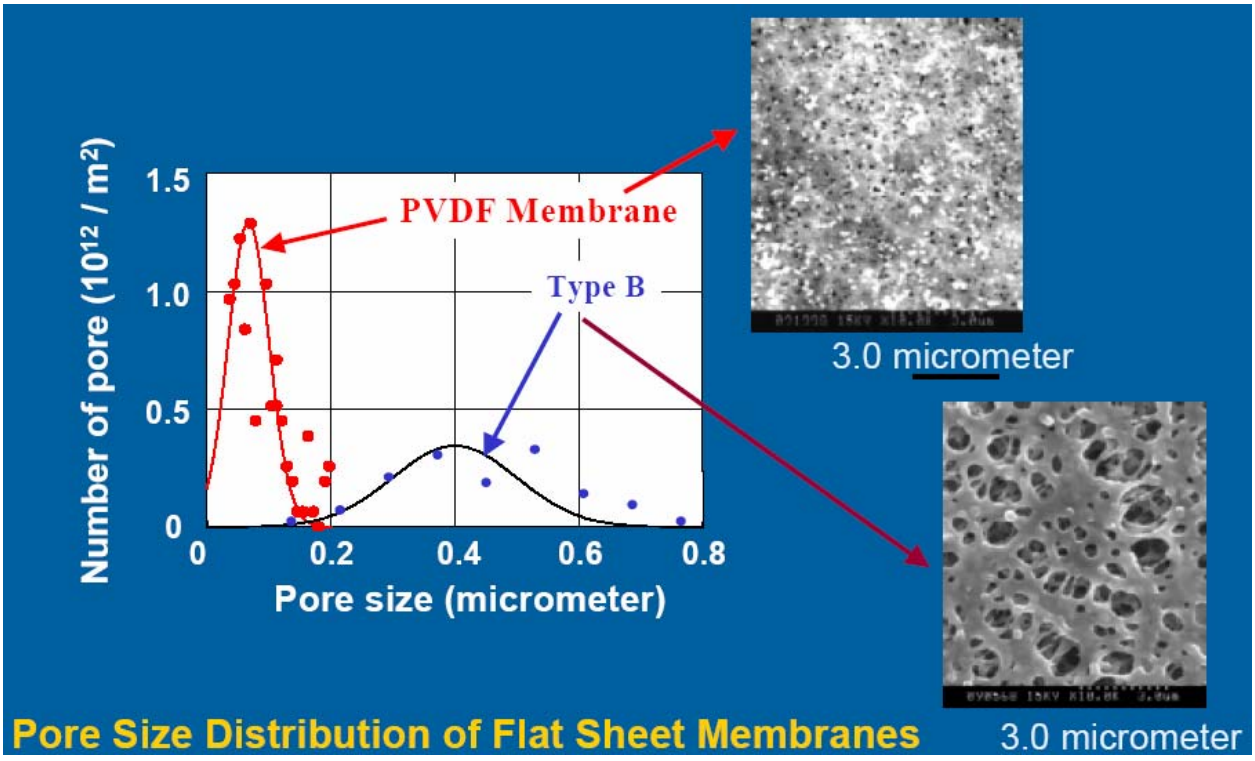


Diagram 1.3ii - Membrane element

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:

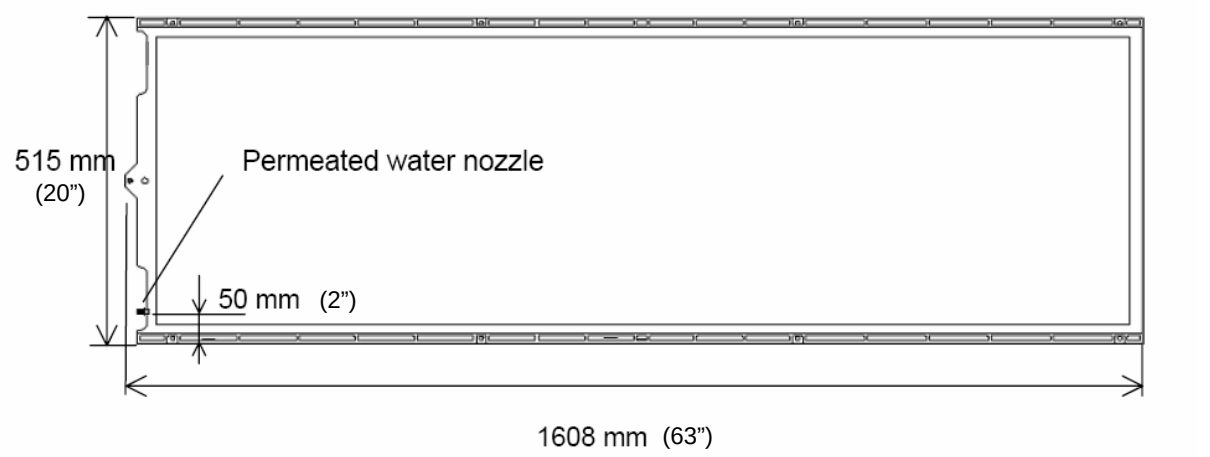
4.1 Specifications of the Element:

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:

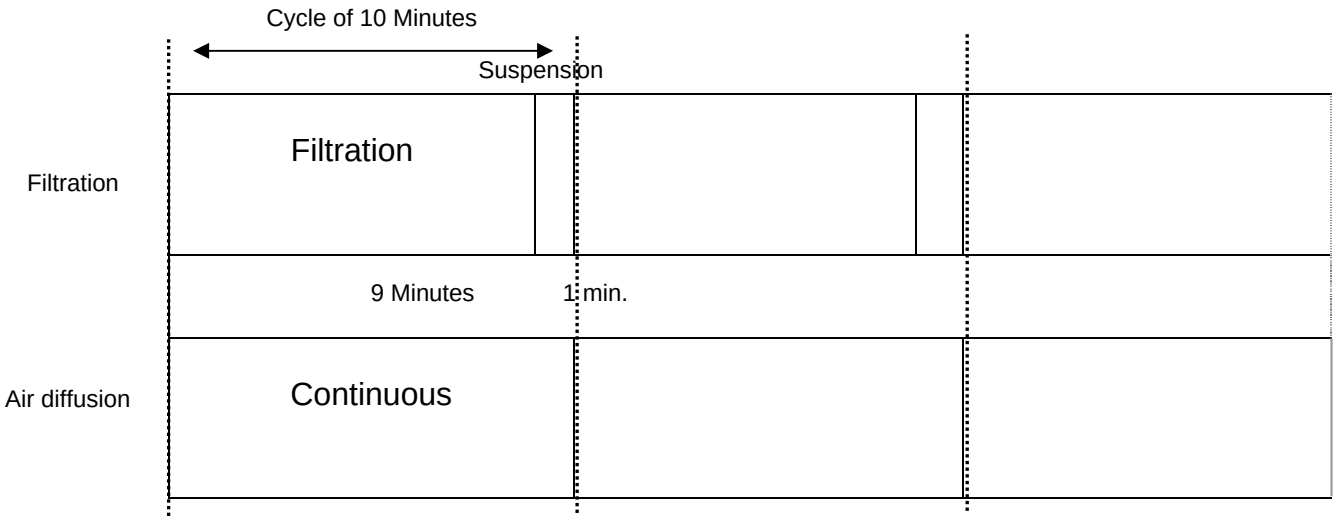
The following explains the standard time chart, membrane filtration flow chart, pipeline procedures and SaniBrane® system layout in the membrane submerged basin. This information will help you design the peripheral equipment necessary to operate your SaniBrane® system.
In order to design the peripheral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

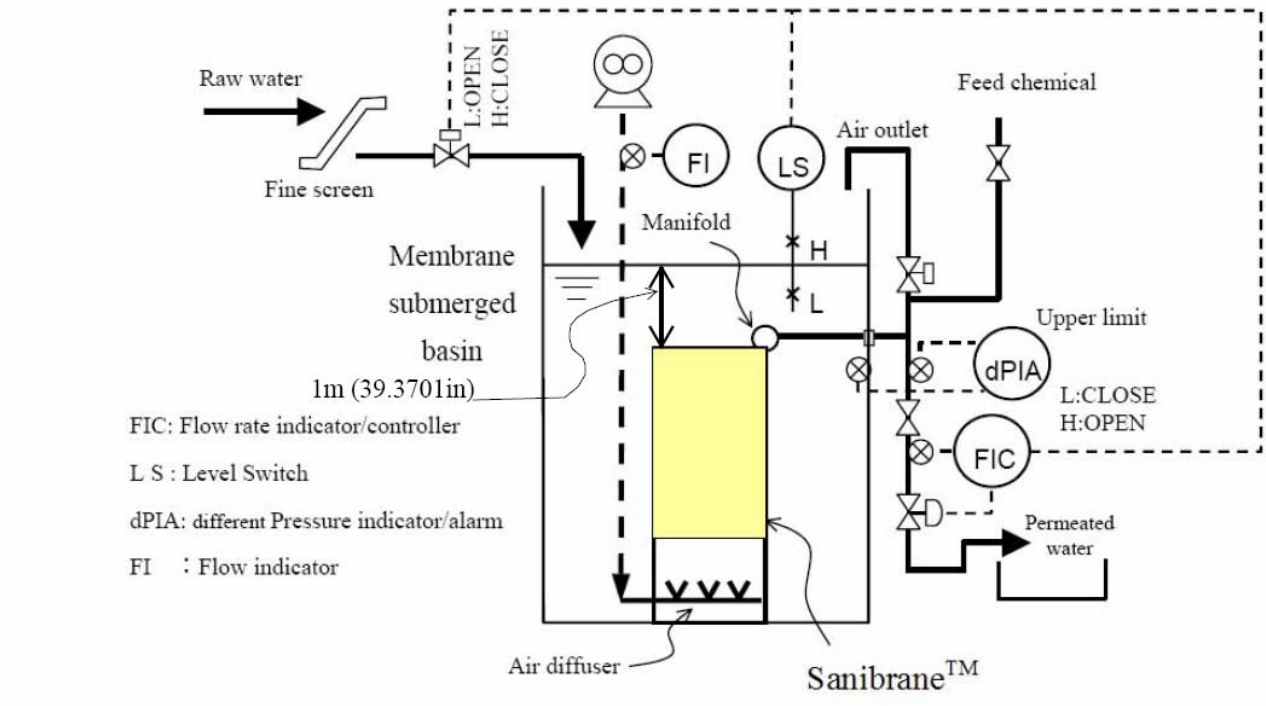
5.2.1 Operation with natural water head:

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.

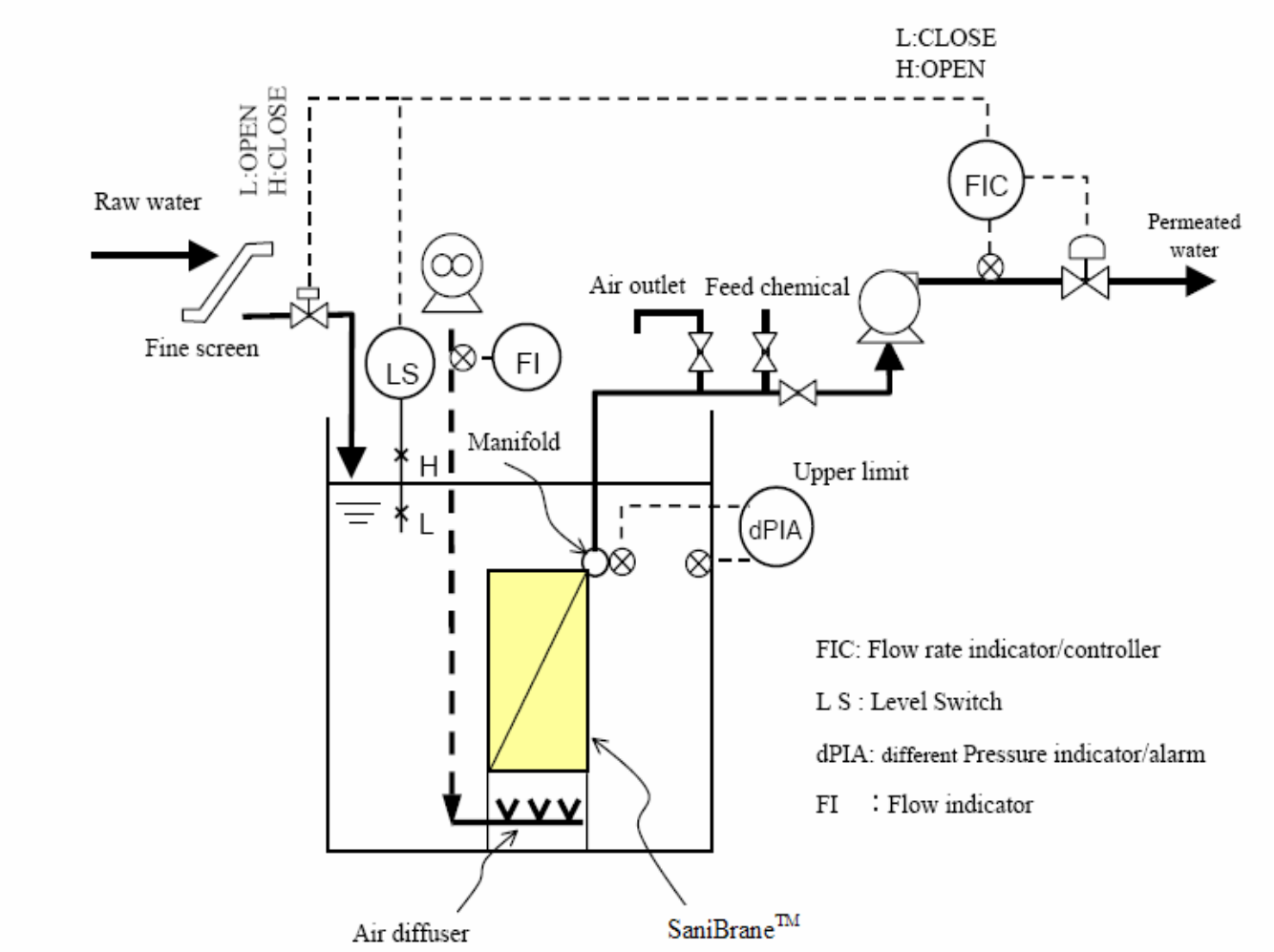
Air must be discharged once a day from the natural water head. If air were allowed to collect inside the pipe it will reduce its effectiveness.

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)

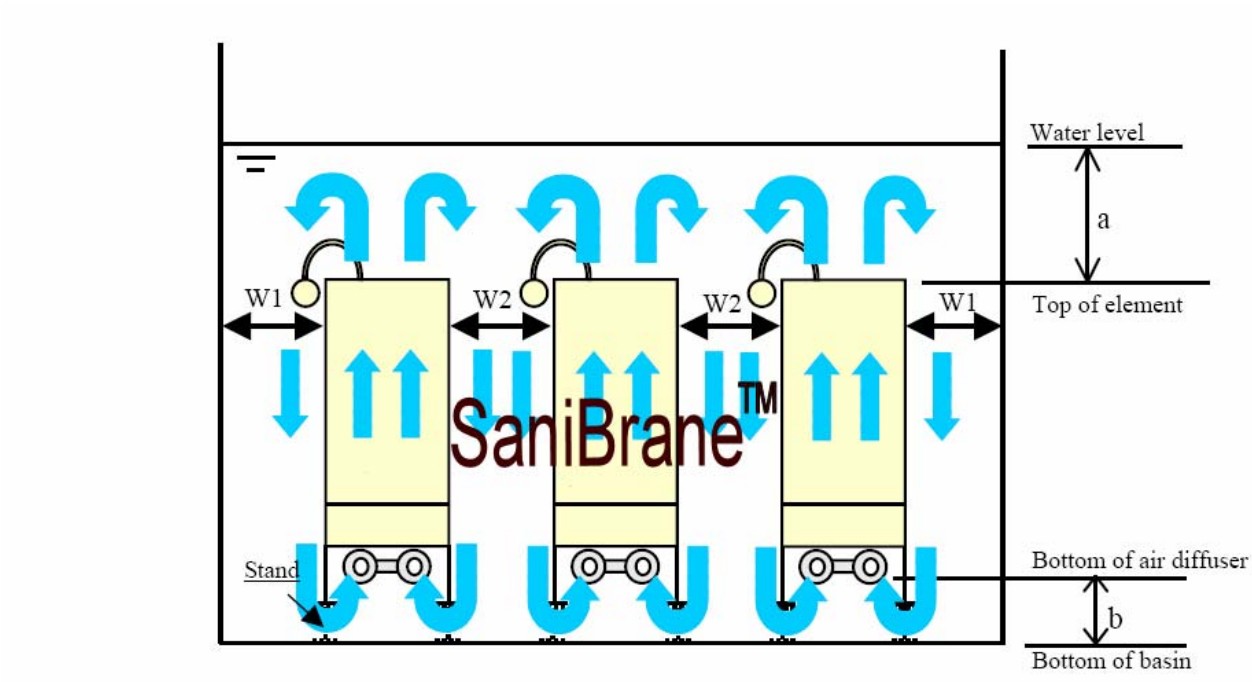
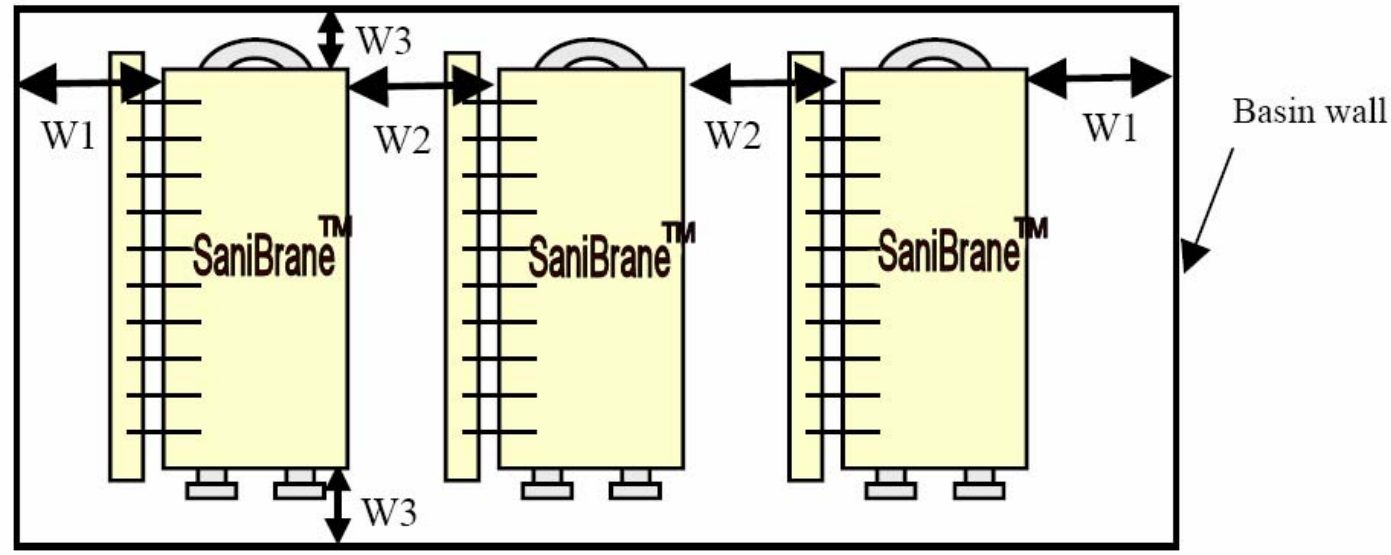


Diagram 5.3ii Example of SaniBrane® Modules layout in submerged basin (top view)



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:

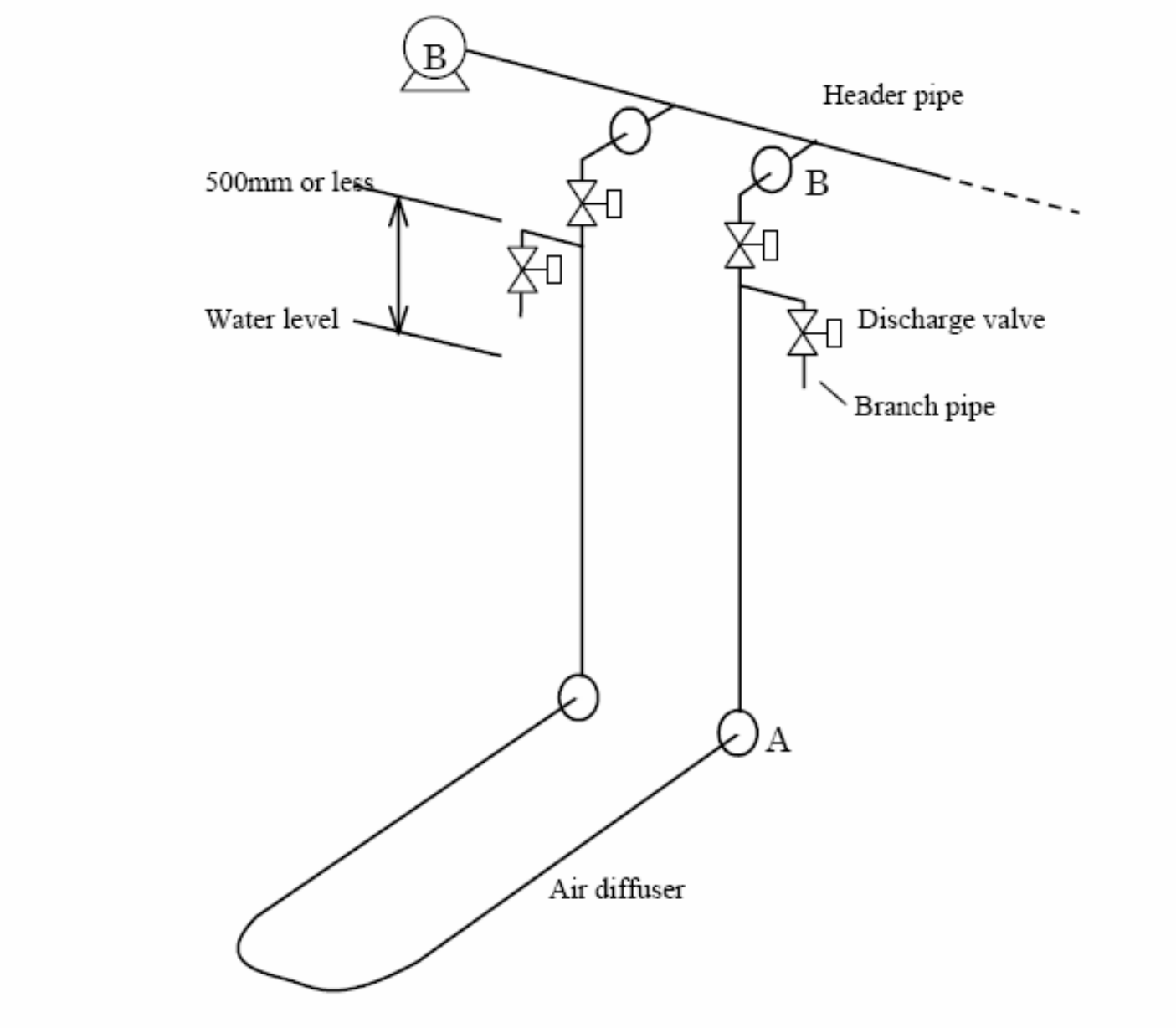
Following is a description of the procedure for piping to the air diffuser and manifold on a SaniBrane® System. For piping arrangements, see the product drawing at the end of this manual.

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

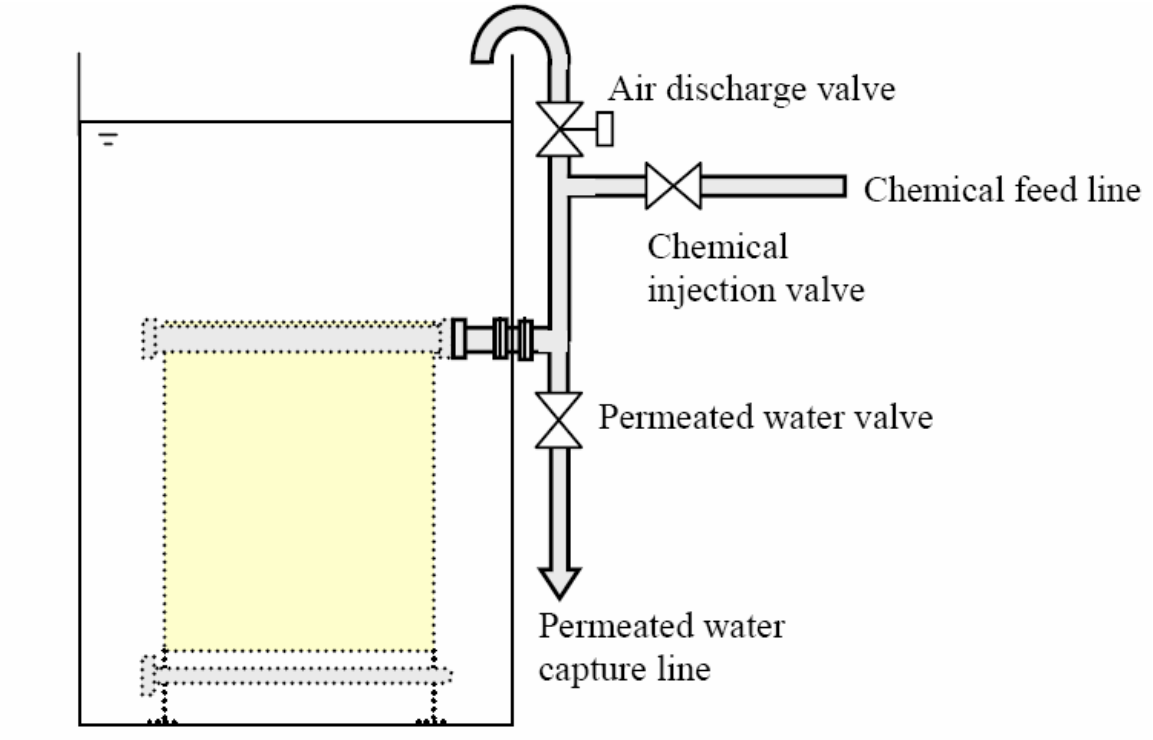
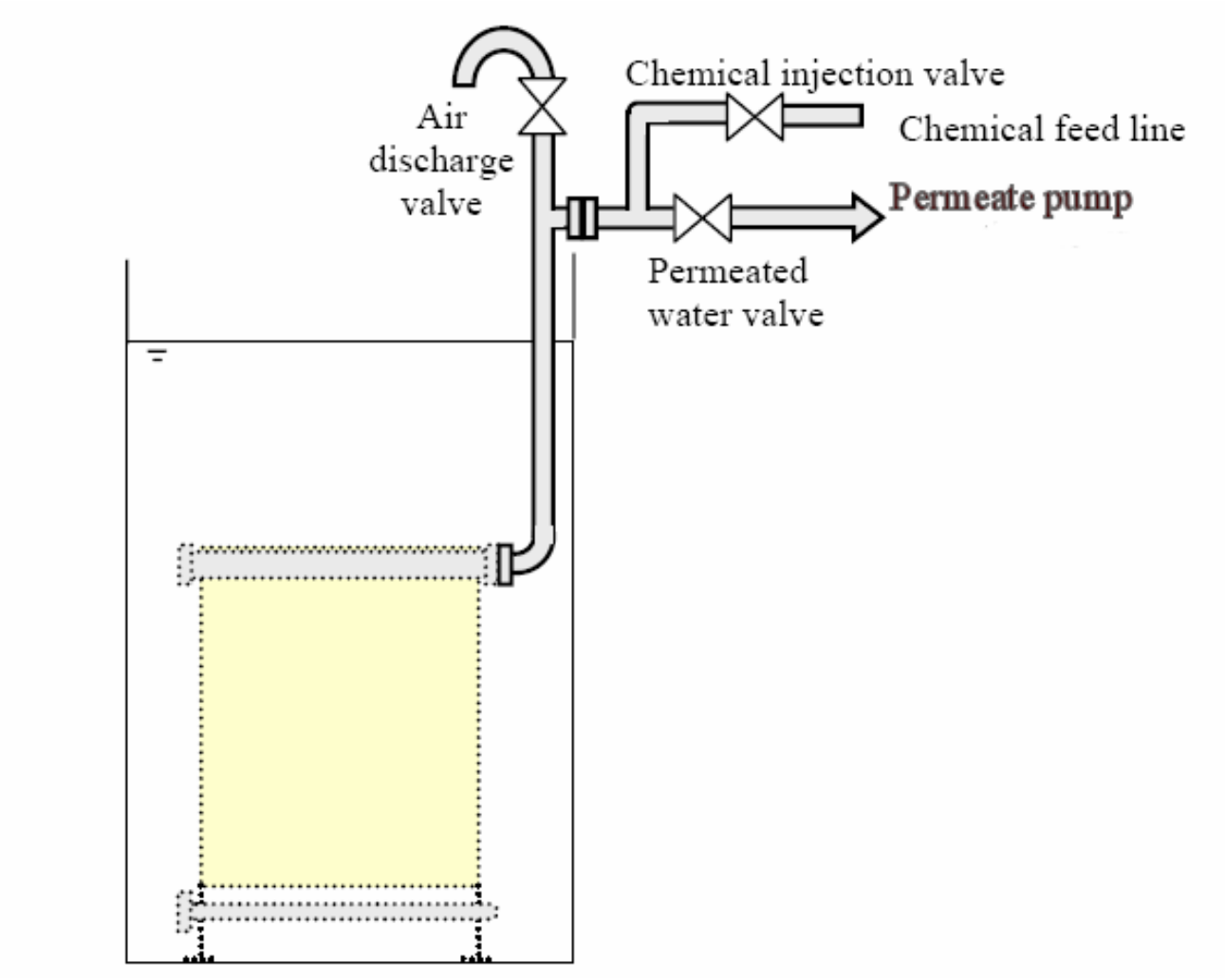


Diagram 5.4.2ii Upward Piping from Basin



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®!

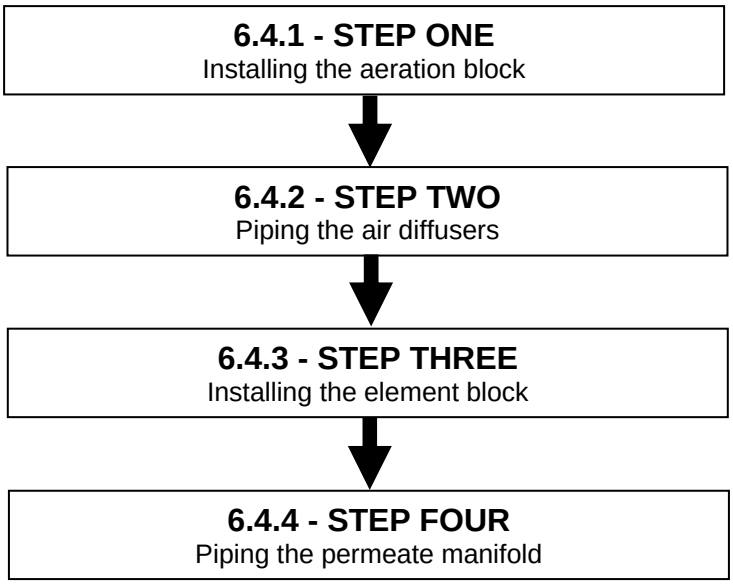
6.3 SaniBrane® check:

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:

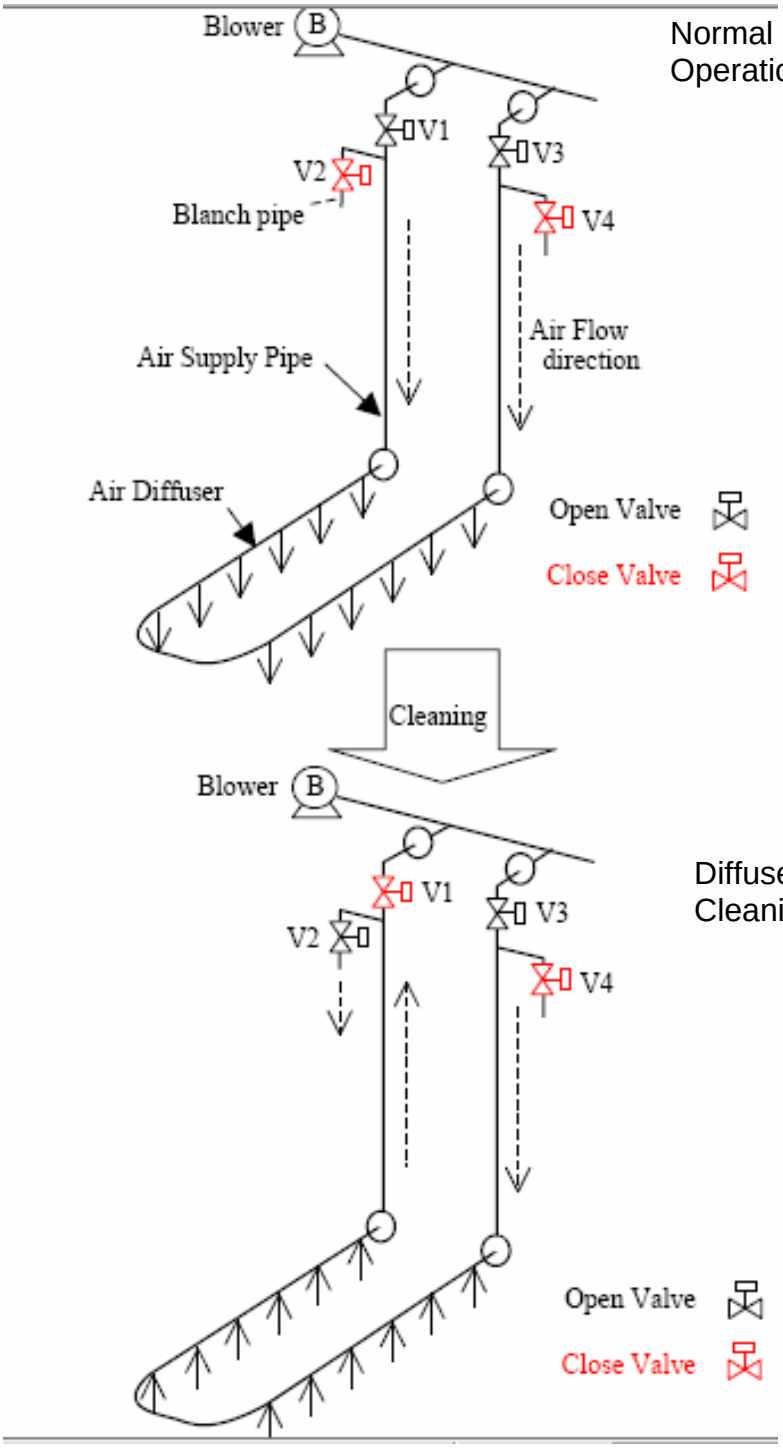
1. Clean the air diffusers (everyday)
2. Chemical cleaning of the element, every six (6) months or when the trans-membrane pressure has risen by 5 kPa or more from its initial operating level at the same permeated water flow rate, whichever occurs earlier.
3. Replace connection tubes (once in three (3) 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:

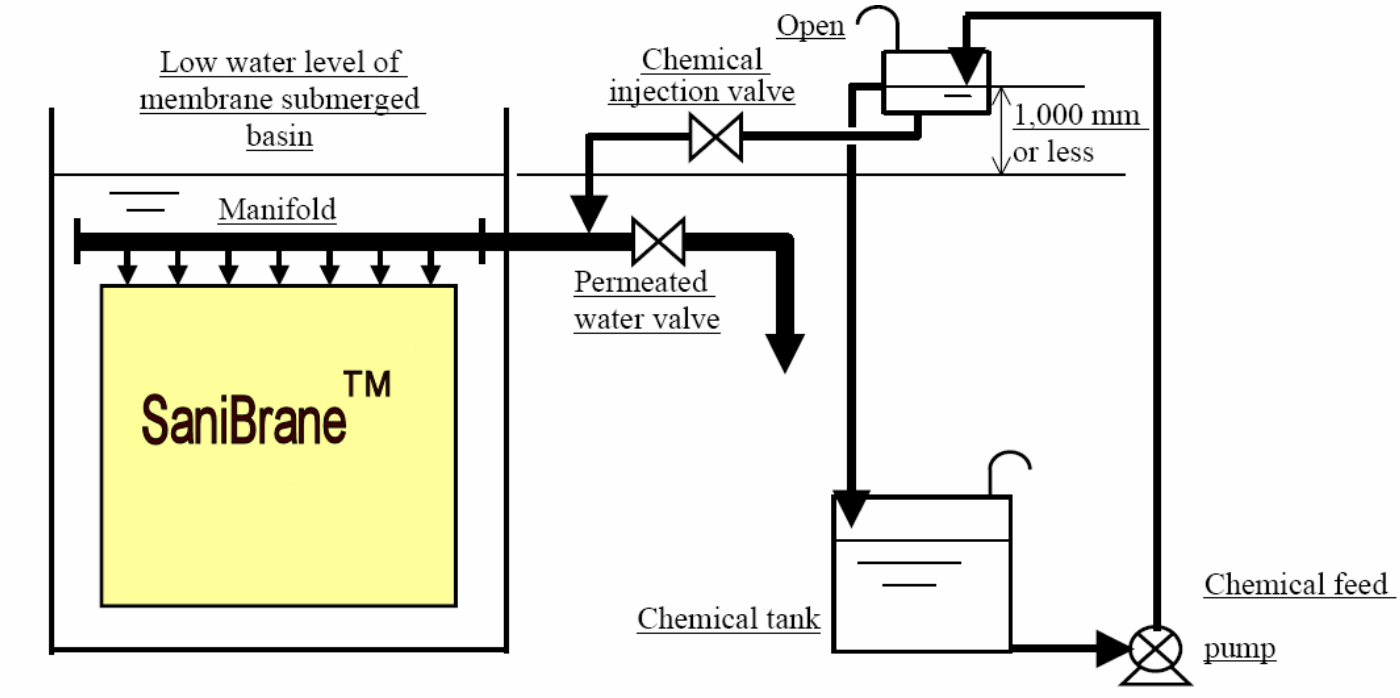
When cleaning, slowly inject chemicals via the permeated water nozzle into the elements until they percolate through the membranes.

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.

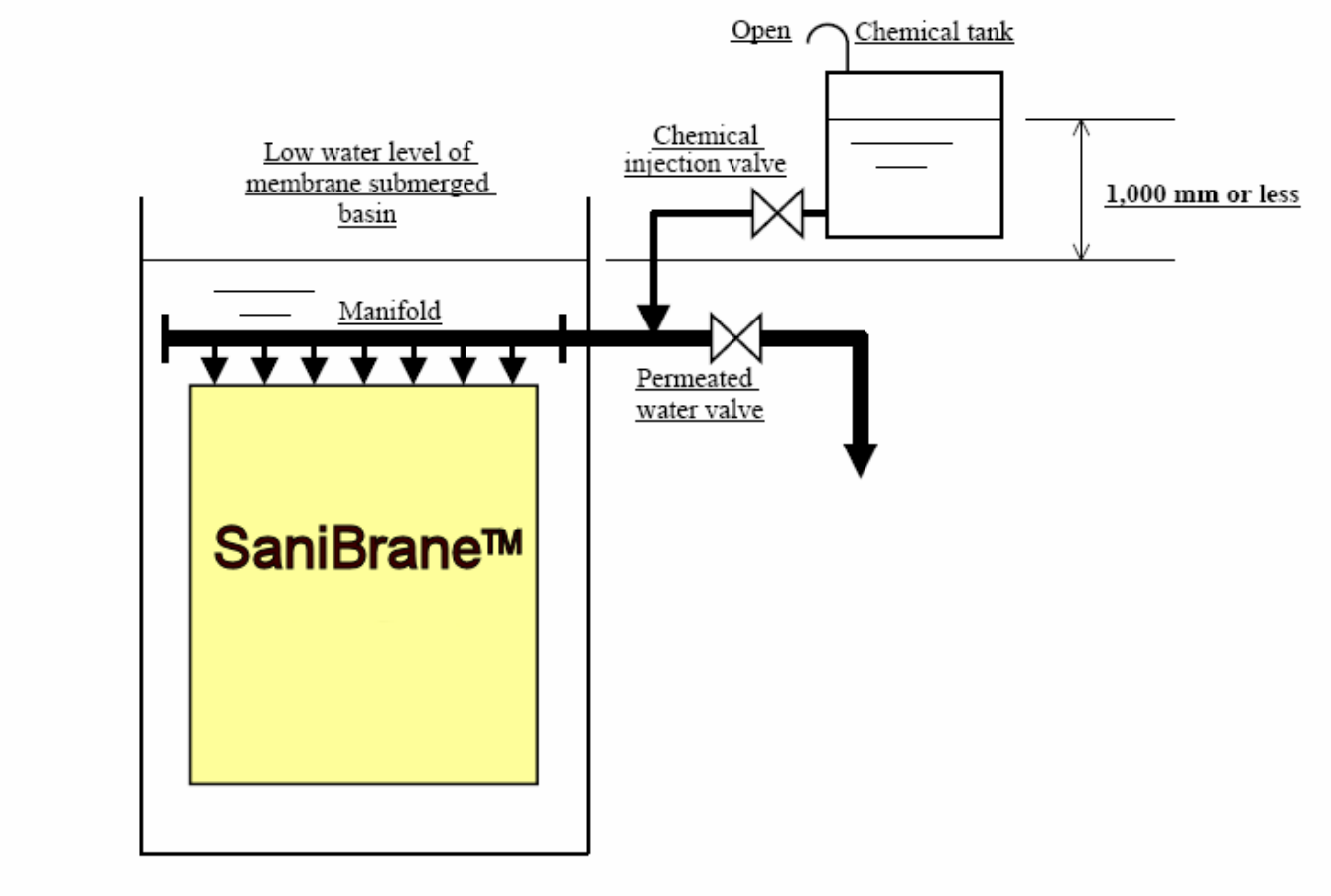
Diagram 9.6.1A - Chemical cleaning with Chemical Tank Located below the MBR liquid level:



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.

- 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.