SUMMARY REPORT

Project Title: Pangnirtung WWTF

Aftercare Service – Site Visit #16 (SUMMARY REPORT)

Project No.: FRE-00232735-A5

Site Visit: Sept 19-28, 2023

Report Date: February 6, 2024

GENERAL

This report is to provide a summary of the Pangnirtung WWTF Aftercare Service visit by EXP and Veolia from Sept 19-28, 2023 including general works that were completed.

Full details on the Service visit are provided in Appendix A (EXP Field Report – September 2023).

Additional photos for the membrane replacement are provided in Appendix B

MBR MEMBRANE REPLACEMENT

- All membrane materials arrived on site – Membrane crates (32 of 32) and Boxes (4 of 4) arrived at the plant.
- One crate had been damaged during transportation resulting in one module breaking, and another had its foil packaging punctured potentially exposing the fibers to heat and/or dryness
- A blank was installed on cassette 2 of train 2, in place of the broken module. The module with the potential exposure was installed on cassette 1 of train 2. While it did not behave abnormally during the bubble test, it's longevity may be affected by the exposure.
    - A damage claim has been submitted by Veoila to the courier service

- Sept 18 to Sept 25 – Train #1 Membrane Replacement
    - Tank 1 taken offline and drained. Recovery clean completed and tank drained and washed down.
    - old membranes and cassettes were pulled out and were transported to the landfill for disposal.
    - Overflow weir (Tank #1) backing plate and gasket appears to be in good shape – no visible signs of damage
        - Bolts were tightened on outflow weir
    - Installed new air diffusers, cassettes and modules for Train #1
    - glycerin flush + bubble test completed – no noted issues
    - Filled train 1 and back into production near end of day
    - Tank #1 water level appears to remain stable overnight (after tightening bolts on overflow weir backing plate)
    - Observed Train #1 production to monitor membrane performance

- Sept 25- 29 – Train #2 Membrane Replacement
    - Tank 2 taken offline and drained. Recovery clean completed and tank drained and washed down.
    - old membranes and cassettes were pulled out and were transported to the landfill for disposal.

- Overflow weir (Tank #2) backing plate and gasket appears to be in good shape – no visible signs of damage
  - Bolts were tightened on outflow weir
- Installed new air diffusers, cassettes and modules for Train #2
- Tank #2 water level appears to remain stable overnight (after tightening bolts on overflow weir backing plate).
- Bubble test for Train #2 completed – no noted issues and Train #2 was put back in production

- Operational issues resolved during Membrane Replacement:
  - Issues during backpulse cycle – flowmeter was giving erratic readings during the backpulse cycle and the permeate pump was ramping up above the allowable setpoint triggering a shutdown. Pump PID settings adjusted to provide some additional dampening on the signal to help reduce sudden peaks
    - Gain = 0.25 (from 0.7)
    - Reset = 0.04 (from 0.15)
  - Also during the backpulse cycle, the suction line (from the backpulse tank) was airlocked. We manipulated and closed the permeate OF valve to flow permeate back into the tank removing the trapped air
  - Following these steps, when we started production the turbidity alarm was exceeded triggering a shutdown (>10NTU). We noticed air coming in through the permeate header (causing the turbidity meter to give erratic readings). Upon further investigation and leak testing we witnessed air leaks at the permeate outlet fittings (inside the tank) that were not observed during the bubble testing
    - Permeate outlet couplings were realigned and retighted. Line was repressurized and afterwards showed no sign of leakage
    - Train #1 put back into production
      - 20-PIT-301-1 = -7.53 kPa
      - 20-PDI-301-1 = -2.63 kPa
  - For Train #1, air was again observed coming into the train 1 turbidimeter. The permeate hose of cassette 2 of the train was letting air in. The hose clamp was tightened, solving the leak. However, during backwashes the pump sucks in air from the line for (55-PS-03/20-PI-311-1) which shares a source line with the turbidimeters, sporadically introducing air to the turbidimeter.
    - No other abnormalities noticed during the bubble tests.
    - Both permeate turbidimeters were cleaned, and calibrated. Operators were also taught how to perform calibrations. However all the calibration solution had expired.

Sodium Hypochlorite pump and Maintenance Cleans

- During the site visit it was observed that the sodium hypochlorite pump was not operational. The operators noted that the system has not been run in over 8 months.

- Troubleshooting steps undertaken by EXP included:
    - Calibration chamber was filled with water to provide sufficient head above the pump and to monitor flow
    - Lines were disassembled and investigated – no apparent blockages in the suction or discharge lines
    - Pump was cleaned (suction and pressure valves of pump)
    - Issue appears to be foot/check valve in the chemical tank which may not be closing properly (might be slightly cracked). This is causing additional friction losses in the suction line and not allowing the pump to prime properly
        - A new suction line was installed – however, no replacement foot valves or spare parts are available onsite – a sodium hypochlorite repair kit was ordered for the 2023 sealift and should be arriving later in October 2023

- Maintenance cleans were tested on both trains. Maintenance cleans are now operational, however the dosing pump is old and has an intermittent leak behind the pump diaphragm (leakage hole)

Permeate Pumps

- Both permeate pumps requires an oil change and there appears that some water has entered the pump (apparent through the viewfinder)

Screened Sewage Sump/Pump

- Inspected screened sewage pumps
    - Noted that Pump #2 was not turning on and observed fault with Allen-Bradley drive
- Inspected screened sewage discharge piping
    - Observed blockage in discharge pumping and crack in 4” PVC tee
    - Repairs could not be done as there are no replacement tees/piping on site

Spray Wash System Solenoid Valve Issue

- Inspected spray wash solenoid system
    - The fine drum screen is functioning properly, but the spray wash bar is not operational, due to a cracked ball valve.
    - Fittings for the 81-V-09 Ball Valve are cracked and there are no replacement valves onsite.
    - The existing actuator (VALBIA - VB015-HT) does not appear to be actuating (open or close).
    - No replacement parts on site
- Inspected raw sewage pumps
    - Plant only operating one raw sewage pump (connected with 4” flex hose)

Defoamer System

- During the site visit, the defoamer pump, piping, and valves (pressure and suction) were taken apart, inspected and cleared of any blockages. BPV and PRV pressure setpoints were checked and confirmed.

- It was observed that there is a crack on the discharge size of the pump which does not allow the defoamer to be delivered to the RAS line.
- There are no spare parts available at the plant (limited supply for all 1/2" sizing)
- As we could not repair the system onsite, the defoamer pump has been turned off

Compressor / Air Dryer / Actuated Valves

- Multiple pneumatically actuated valves were reported to have trouble opening and closing on command. The source seems to be inadequate moisture drainage or air drying. Upon further investigation, it was observed that the air dryer (ProDry HTD18) requires servicing as it constantly displays a high humidity alarm which is likely the reason for the air quality issues. Numerous valves that rely on compressed air appear to affected are as follows:

Tag ID	Component
55-V-03	Permeate/Backpulse valve
55-V-04	
65-V-01	RAS/WAS discharge valve
65-V-02	
50-V-06	Membrane Flow Control Inlet
50-V-07	
60-V-20	Membrane Train #1 - air inlet valve
60-V-21	Membrane Train #2 - air inlet valve

- Train #1 – The position sensor for the train 1 cyclic air valve (60-V-20) was not reading open. The roller for the switch had fallen out. It was reinstalled with a temporary fix.
- Train #2 – the solenoid valve/sensor was sticking as well. The valve was opened and it appeared that the o-ring was leaking and rusting the spring. The spring was lubed with Molykote.
- There are no spares onsite.
- The automatic drain valve on the compressor that was previously installed does not appear to be expelling moisture due the 1/8" ID tubing being clogged with rust particles. The blockage was cleared, and new manual drain valves were installed on the drain line and on the filter air dryer inlet. The operators were instructed to manually drain the tank daily to confirm the auto drain is working.

Anoxic and Aerobic Tanks ('Bioreactor') / WAS & RAS Processes

- The plant operators did not note any issues with the Aerzen aeration blowers (60-AB-01 and 60-AB-02).
- At the moment, the plant are recycling 100% the sludge back to the anoxic tank
- During the site visit, we manually tested WAS cycle. The WAS inlet (65-V-15) and RAS inlet (70-V-01), both valves open and close as intended.
- TSS/MLSS

- Based on grab samples, the mixed liquor was low in total suspended solids (TSS) which are crucial in providing an appropriate growth environment for the aerobic and anaerobic bacteria in the tanks.
- TSS measurements

	Sept 21, 2023	*Sept 24, 2023*	*Sept 27, 2023*
Aerobic	*779 mg/L*	*793 mg/L*	*1,049 mg/L*
Anoxic	*12,545 mg/L*	*16,646 mg/L*	*15,405 mg/L*

- Dissolved oxygen
  - Online DO sensors were checked with the handheld (HACH LDO) probe
    - The anoxic tank sensor is calibrated
    - The aerobic tank is reading low but still providing a measurement within range

	Anoxic Tank (16-AIT-406)	*Anoxic Tank (handheld)*	Aerobic Tank (16-AIT-405)	*Aerobic Tank (handheld)*
Sept 20, 2023	0.7 mg/L		1.8 mg/L	
Sept 21, 2023	0.6 mg/L	*0.4 mg/L*	3.58 mg/L	*8.24 mg/L*

Soda ash System

- Plant has been manually dumping soda ash directly into bioreactor. Currently, they use the forklift to lift a couple buckets of soda ash up to the top of the bioreactor tank and then climb up the ladder and dump the soda ash directly through the anoxic hatch
- Operators noted that manual mixing tank that was provided over by the sludge storage tank is no longer in use
  - Outlet valve to connect the hose would constantly get plugged and/or not mix properly (especially in the winter)
  - The outlet valve is located at the bottom of the tank (lifted on pallets) and would accumulate solids
  - Proposal to upgrade the soda ash system is in progress

UV Disinfection System

- Upon arrival, the UV transmittance reading on the UV display was reading 0.0 mW/cm2 and displaying a UV fault on the SCADA.. The UV modules were removed from the UV bank and the sensor and quartz sleeves were wiped clean using a rag and Lime-A-Way. The resulting UV transmittance was increased from 0.0 mW/cm2 to 2.5 mW/cm2.

Polymer Dosing System and Sludge Transfer Pumps

- The polymer dosing system and sludge transfer pump is only used when sludge from the sludge tank is being wasted to the geotube trailer. The dosing system and pump were tested by EXP and appear to be in working order.

Air Louver system

- The air louver (near the roof by the membranes and EQ tank) does not open – the motor belt is loose and needs to be replaced.

Other Lab Equipment

- The HACH DR3900 spectrometer machine is not turning on at all. Charger appears to be getting power but machine won't power on. It appears that the screen is broken.
- Small compressor to filter TSS samples is broken

Appendix A –

EXP – Pangnirtung WWTF Aftercare Service Field Report (Sept 2023)

Field Report

Project Title: Pangnirtung WWTF

Aftercare Service – Site Visit #16

Project No.: FRE-00232735-A5

Date: Sept 19-28, 2023

Weather: Variable

General

Chris Keung (EXP) left Vancouver, British Colombia on September 17th, 2023 and arrived in Pangnirtung on September 18th, 2023. The first visit to the wastewater treatment facility occurred around 8:30 am on September 19th. Kane Shillingford and Ravi Krishnasamy (Veolia) arrived in Pangnirtung on September 19th and travelled to the plant the following morning. The site visits extended over consecutive days with EXP leaving the plant on September 29th and Veoila on October 1st. Please find Veolia's site visit report attached for more detailed information on the membrane replacement works.

The purpose of the site visit was as follows:

- Assist/supervise new membrane installation and air diffuser upgrade for the MBR
- Inspect membrane tanks once emptied
- Troubleshoot/fix issue on the existing overflow weir of Tank #2
- Investigate TSS levels in Bioreactor
- Monitor performance of new membranes
- Investigate spray wash drum screen solenoid valve issue
- Confirmation of 2023 sea lift order
- Speak with the plant operators to gain an understanding of all operational issues since previous EXP site visit and to aid in resolving these issues.
- Perform an inventory check on supplies such as chemicals, spare parts, spare equipment, and tools such that a sea lift order containing all required items could be produced by EXP

Sealift Items

- The second sealift (2 of 3) arrived prior to the EXP site visit. For this sealift shipment, only the membrane replacement materials and sodium hypochlorite drums for the plant have been delivered. The remaining WWTP order is on the third sealift and set to arrive in mid-Oct 2023.
    - 12 Sodium Hypochlorite drums (210L) are currently onsite

Screened Sewage Sump/Pump

- The operators have noted significant issues at the headworks of the plant. During the site visit, EXP witnessed numerous occasions where the raw sewage and screened sewage sumps were overfilled. Typically, these events would occur during peak hours (first thing morning, after coffee break, after lunch break) when sewage trucks were at the WWTP emptying their loads. On one occasion, overflow sewage entered the annular space around the sumps causing the steel plate to heave 3-4".

- Plant operators noted that they typically bypass a majority of the flows from the raw sewage sumps directly to the EQ tanks (>80%) and stated that only one raw sewage pump and one screened pump have been operational over the past year.
- During the site visit, it is apparent that the screened sewage pumps are not discharging flows at their expected rates. This is causing the sumps to back up and overflow

Figure 1: Headworks Overflowing
Figure 2: Screened Sump Overflowing
Figure 3: Screen Plate Heaving

- Screened Sewage Pumps
    - The screened sewage pumps were removed, inspected and cleaned of any blockages. This did not improve the discharge flows.
    - The 2 screened sewage pumps are intended to operate in a lead/lag configuration where Pump #2 turns on when a float switch in the screened sump is activated. However, it was observed that Pump #2 (lag) does not turn on at any time.

- A fault was observed with the Allen-Bradley drive (Pump #2)

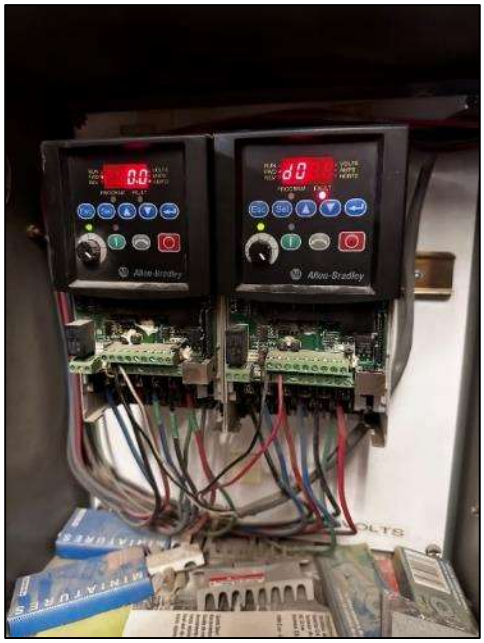


Figure 4: Screen Pump Allen Bradley Drive Fault
Figure 5: Screen Pump Electrical Box

- Screened Sewage Discharge Piping
  - Based on our observations, it is expected that there is a blockage in the screened pump discharge piping. The rate that the liquid level drops in the screened sump when Pump #1 (lead) is running is slower than expected.
  - The screened pump discharge piping (4” PVC tee) is cracked and taped together.
    - During the site visit, with help from the operators, we attempted to open up the valving below the tee to inspect and clean the check valves. However, the connections were tight. Attempts to open the connections applied significant stresses to the existing PVC piping and would potentially lead to a bigger failure. EXP directed the plant staff to stop as this discharge piping is a critical connection that cannot fail.
  - There were no replacement fittings onsite to try to repair the piping
    - Based on the 2023 sealift order list, there are no replacement fittings (4” PVC tees, unions, valves, elbows, etc.) due to arrive this year.

Figure 6: Cracked 4" PVC Screened Pump Discharge Tee
Figure 7: Screened Pump Discharge Piping

EXP Recommendation:

- ***Immediately hire a contractor to replace the length of the PVC pipe and fittings from the discharge end of the isolation valves to the 90° bend toward the EQ tank including clearing all connections of potential blockages – this is a critical connection for the plant and in its current condition, it is vulnerable to further damage***
    - ***There are no spare parts onsite and the contractor would be required to bring up the PVC pipe fittings and spare parts to complete this work***
- ***Contractor to fix the drive fault (Allen Bradley) and confirm programming for the screened sewage Pump #2 (lag pump)***

SPRAY WASH SYSTEM SOLENOID VALVE ISSUE

- The plant has temporarily connected the fine drum screen system to the non-potable water (1" PVC) line with a 2" flexible hose secured with some pipe clamps.
- The fine drum screen is functioning properly, but the spray wash bar is not operational, due to a cracked ball valve. The operators are required to routinely clean the drum screen manually with a pressure washer.
    - Fittings for the 81-V-09 Ball Valve are cracked and there are no replacement valves onsite.
        - The existing actuator (VALBIA - VB015-HT) does not appear to be actuating (open or close). However, it was not confirmed if this was due to a minor electrical issue or if the component requires replacement
    - During the site visit, EXP found some spare/used fittings– these were passed off to the plant staff to try to repair.
        - However, it was noted that there are minimal 1 ½" PVC fittings (tees, unions, adapters, elbows, etc.) onsite and there are no replacements on the 2023 sealift order

EXP Recommendation:

- ***hire a contractor to repair the spray wash system. Contractor to provide and bring replacement parts:***
  - ***new ball valve 1”***
  - ***new actuator (VALBIA – VB015-HT)***
  - ***PVC fittings (1”, 1 ½” and 2”) to repair connection to non-potable water system***

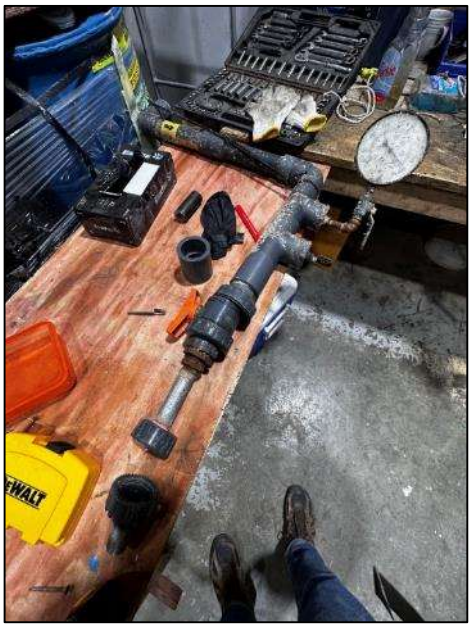


Figure 8: Cracked Solenoid Valve for Drum Screen Wash
Figure 9: Cracked Solenoid Valve for Drum Screen Wash
Figure 10: Temporary Screen Wash Configuration
Figure 11: Miscellaneous 1 ½” PVC Fittings for Screen Wash

Figure 12: 1 1/2" PVC Valve for Wash Bar
Figure 13: 1 1/2" PVC Fittings for Wash Bar

Raw Sewage sumps/pumps

- At the moment, the plant currently operates one raw sewage pump (connected with 4” flexible hose)

EXP Recommendation:

- ***Hire a contractor to install a connection to the second raw sewage pump (add 4” tee and flexible hose connection) including confirming the pump programming to run in a lead/lag configuration.***

Figure 14: Existing Raw Sewage Pump/Sump

DEFOAMER SYSTEM

- Operators had noted that the defoamer system was not operational for over 6 months. They noted only one occasion where they needed to dose defoamer agent directly into bioreactor
- During the site visit, the defoamer pump, piping, and valves (pressure and suction) were taken apart, inspected and cleared of any blockages. BPV and PRV pressure setpoints were checked and confirmed at 45 and 60 psi, respectively
- It was observed that there is a crack on the discharge size of the pump on the union/tee fitting (injection quill) which does not allow the defoamer to be delivered to the RAS line.
- There are no spare parts available at the plant. In general, there is limited supply for all the 1/2" sizing.
- As we could not repair the system onsite, the defoamer pump has been turned off

EXP Recommendation:

- ***Hire a contractor to replace the ½" piping from tee to pump discharge including the required Prominent injection quill component.***

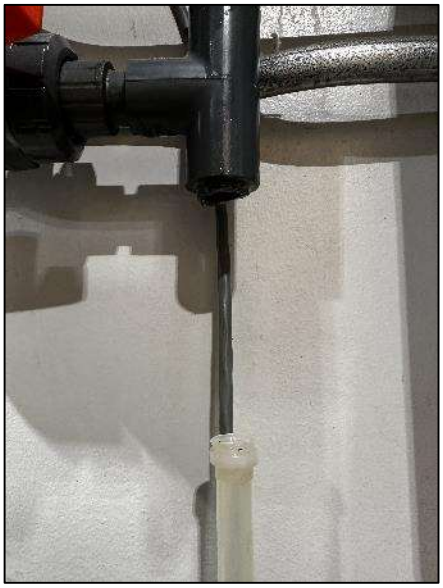


Figure 15: Defoamer Injection Quill and Cracked Piping
Figure 16: Defoamer Cracked PVC Piping

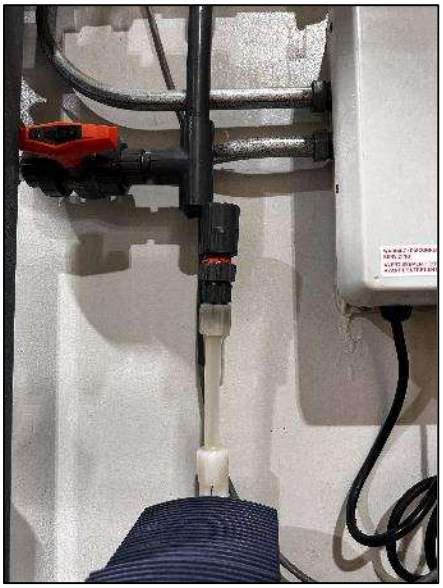


Figure 17: Defoamer ½" PVC Replacement from Pump Discharge to Tee

Compressor / Air Dryer

- Multiple pneumatically actuated valves were reported to have trouble opening and closing on command. The source seems to be inadequate moisture drainage or air drying. Upon further investigation, it was observed that the air dryer (ProDry HTD18) requires servicing as it constantly displays a high humidity alarm which is likely the reason for the air quality issues. Numerous valves that rely on compressed air appear to affected – this is discussed in the following section.
- According to plant staff, no maintenance has ever been done on the compressor and compressed air system
- The automatic drain valve that was previously installed does not appear to be expelling moisture due the 1/8" ID tubing being clogged with rust particles. The blockage was cleared, and new manual drain valves were installed on the drain line and on the filter air dryer inlet. The operators were instructed to manually drain the tank daily to confirm the auto drain is working.

EXP Recommendation:

- ***Hire a contractor to service the air dryer, compressor and compressed air system (drain air lines). It is also recommended to replace the existing auto drain with one controlled by an electronic timer.***

Figure 18: Water Drained from Compressor
Figure 19: 1/4" Valve installed on compressor
Figure 20: 1/4" valve installed on air dryer

MEMBRANE OPERATION – MALFUNCTIONING VALVES

- As noted above, multiple pneumatically actuated valves were reported to have trouble opening and closing on command. This indicated that there could be an issue with the compressed air system. Valves that are malfunctioning include:

Tag ID	Component
55-V-03	Permeate/Backpulse valve
55-V-04	
65-V-01	RAS/WAS discharge valve

65-V-02	
50-V-06	Membrane Flow Control Inlet
50-V-07	
60-V-20	Membrane Train #1 - air inlet valve
60-V-21	Membrane Train #2 - air inlet valve

- Permeate Backpulse Valves (55-V-03 and 55-V-04)
    - The permeate/Backpulse outlet valves (55-V-03) and (55-V-04) appear to be always open. This is typicaly not an issue as there is typically flow either forward (permeate) or backward (backpulse) through this section. However, for maintenance purposes, these valves should have the ability to close to isolate the sections

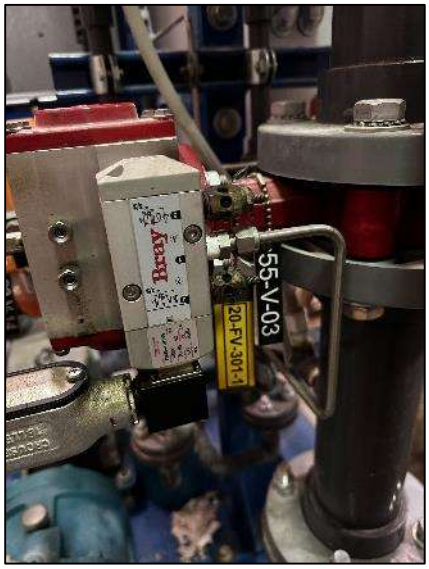


Figure 21: 55-V-03 Valve
Figure 22:55-V-03 Valve

- WAS/RAS Solenoid Outlet Valve (65-V-01 and 65-V-02)
    - The WAS/RAS solenoid outlet valve (Bray 630250) on Train #1 (65-V-01) dooes not close (in both auto/manual modes) and is always open
    - Valve on Train #2 (65-V-02) was noted by plant staff to be non-functioning but appears to be working when observed during the site visit

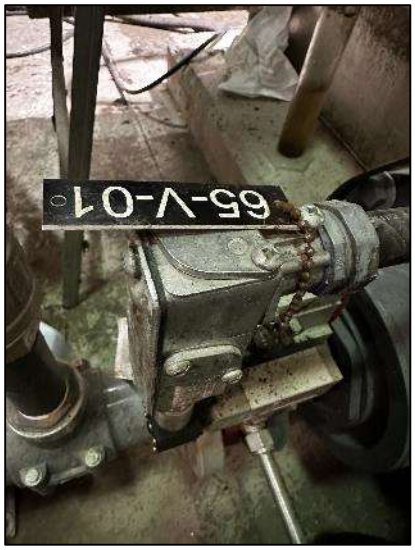
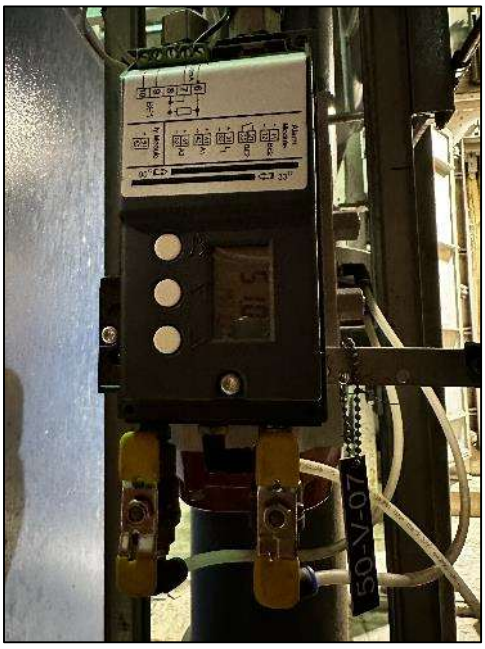
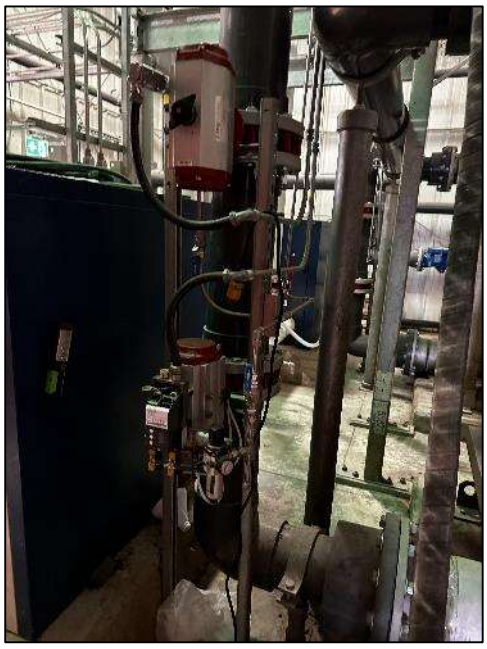


Figure 23: Valve 65-V-01
Figure 24: Valve 65-V-01

- Membrane Flow Control Inlet (50-V-06 and 50-V-07)
    - 50-V-06 and 50-V-07 (Train 1 and 2 membrane flow control inlet valves) do not open/close automatically.
    - Both these valves are run in manual. At the beginning of the day, at the start of production, operators will bleed line and set valve at ~25-50% open to manually control the flow through the MBR
    - This issue was noted in previous inspections. The plant changed one of the actuators on 50-V-07 themselves but the valves are still malfunctioning.





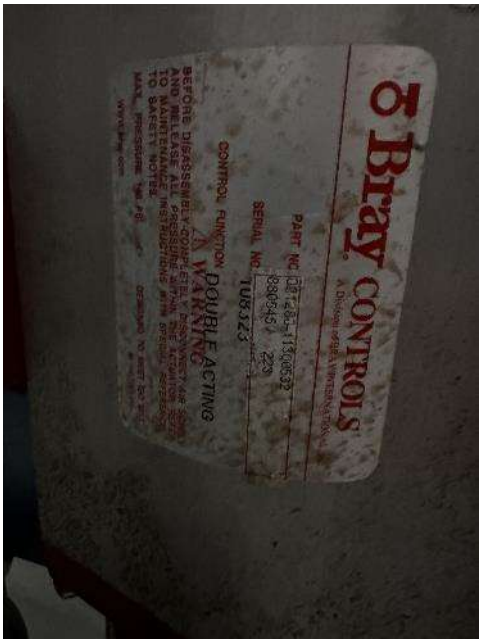


Figure 25: Valves 50-V-06 and 50-V-07
Figure 26: Valves 50-V-06 and 50-V-07
Figure 27: Valves 50-V-06 and 50-V-07
Figure 28: Valves 50-V-06 and 50-V-07

- Membrane Air Inlet Valves (60-V-20 and 60-V-21)
    - The noted issues with the automatic valves (air dryer/compressed air system) are affecting the actuation of the air blower valve and shutting down the trains every time a maintenance clean is initiated (automatic or manual)
    - Train #1 and #2 – aborted Maintenance clean alarm– fault at air blower valve 60-V-20/21
        - Train #1 – The position sensor for the train 1 cyclic air valve (60-V-20) was not reading open. The roller for the switch had fallen out. It was reinstalled with a temporary fix.
        - Train #2 – the solenoid valve/sensor was sticking as well. The valve was opened and it appeared that the o-ring was leaking and rusting the spring. The spring was lubed with Molykote.
        - There are no spares onsite.

Figure 29: Valves 60-V-20 and 60-V-21
Figure 30: Valves 60-V-20 and 60-V-21
Figure 31: Valves 60-V-20 and 60-V-21
Figure 32: Valves 60-V-20 and 60-V-21

EXP Recommendation:

- ***Hire a contractor to service the air dryer, compressor, compressed air system (drain air lines).***
- ***Replace the position sensor on 60-V-20 and 60-V-21***
- ***After the air issues are resolved, replace any valve actuators that are still not functioning properly.***
    - ***The contractor should bring up the valves/actuators/switches to complete this work***
- ***We also recommend that additional spare parts (valves/actuators/switches) be ordered for the next sealift.***

MBR Membrane Replacement

- Refer to Veoila's site report for additoinal details on the membrane replacement work
- Sept 18
    - All membrane materials arrived on site – Membrane crates (32 of 32) and Boxes (4 of 4) arrived at the plant.
    - One crate had been damaged during transportation resulting in one module breaking, and another had its foil packaging punctured potentially exposing the fibers to heat and/or dryness

- Sept 19 – Recovery Clean of Tank 1
    - Tank 1 taken offline and drained. Started recovery clean (filled with clean water and used one full barrel sodium hypo = 210L @ 7%)
    - Overnight the tank level dropped from 2359mm (2pm on Sept 19) to 2198mm (9am on Sept 20)

- Sept 20 - Tank 1 was drained and washed down – tank was left open all night to dry

- Sept 21 – old membranes and cassettes were pulled out and were transported to the landfill for disposal
    - Tank further washed and cleaned to prepare tank for new membrane installation

- Sept 22 – cassettes disassembled
    - Inside washed down further and sludge removed and cleaned from inlet and outlet valves
    - Overflow weir (Tank #1) backing plate and gasket appears to be in good shape – no visible signs of damage
        - Bolts were tightened on outflow weir
    - First module - Metal membrane frame lifted up and positioned to provide clearance underneath to install the diffuser equipment

- Sept 23
    - Lifted frame and installed diffusers under second module
    - Installed cassettes for both Tank #1 modules

- Sept 24
    - new membranes loaded
    - glycerin flush + bubble test completed – no noted issues
    - Filled train 1 and back into production near end of day
    - Started recovery clean of Tank #2

- Sept 25
    - Tank #1 water level appears to remain stable overnight (after tightening bolts on overflow weir backing plate)

Figure 33: Tank 1 - Overflow Weir

- Observed Train #1 production to monitor membrane performance
  - Valve 50-V-06 needs to be opened manually and bled at the valve (due to air compressor issue) – determined that around 27% open is roughly balanced
  - Issues during backpulse cycle – flowmeter was giving erratic readings during the backpulse cycle and the permeate pump was ramping up above the allowable setpoint triggering a shutdown. We adjusted the pump PID settings to provide some additional dampening on the signal to help reduce sudden peaks
    - Gain = 0.25 (from 0.7)
    - Reset = 0.04 (from 0.15)
  - Also observed that during the backpulse cycle, the flow was zero and that the suction line (from the backpulse tank) was airlocked. We manipulated and closed the permeate OF valve to flow permeate back into the tank removing the trapped air
  - Following these steps, when we started production the turbidity alarm was exceeded triggering a shutdown (>10NTU). We noticed air coming in through the permeate header (causing the turbidity meter to give erratic readings). Upon further investigation and leak testing we witnessed air leaks at the permeate outlet fittings (inside the tank) that were not observed during the bubble testing
    - Permeate outlet couplings were realigned and retighted. Line was repressurized and afterwards showed no sign of leakage
    - Train #1 put back into production
      - 20-PIT-301-1 = -7.53 kPa
      - 20-PDI-301-1 = -2.63 kPa

- Tank #2 – recovery clean started
  - Tank #2 put offline, drained, re-filled and chlorinated (one 210L container of 12% Sodium Hypo)
  - Tank level = 2124mm (4:30pm – Sept 25)

- Dropped to = 1852mm (9:00am – Sept 26)

- Sept 26
  - Tank #2 drained and old membranes/cassettes pulled out and disposed

- Sept 27
  - Tank further washed and cleaned to prepare tank for new membrane installation
  - Steel frames lifted
  - diffuser installation completed

- Sept 28
  - Overflow weir (Tank #2) backing plate and gasket appears to be in good shape – no visible signs of damage
    - Bolts were tightened on outflow weir

Figure 34: Tank 2 Overflow Weir

  - Assembly of cassettes
  - Installed new membranes
  - Tank was filled with clean water overnight
  - A blank was installed on cassette 2 of train 2, in place of the broken module. The module with the potential exposure was installed on cassette 1 of train 2. While it did not behave abnormally during the bubble test, it's longevity may be affected by the exposure.
    - A damage claim has been submitted by Veoila to the courier service

Figure 35: Damaged Module
Figure 36: Blank Module Installation in Train #2

- Sept 29
    - Tank #2 water level appears to remain stable overnight (after tightening bolts on overflow weir backing plate).
    - Bubble test for Train #2 completed – no noted issues and Train #2 was put back in production

    - For Train #1, air was again observed coming into the train 1 turbidimeter. The permeate hose of cassette 2 of the train was letting air in. The hose clamp was tightened, solving the leak. However, during backwashes the pump sucks in air from the line for (55-PS-03/20-PI-311-1) which shares a source line with the turbidimeters, sporadically introducing air to the turbidimeter.
        - No other abnormalities noticed during the bubble tests.
        - Both permeate turbidimeters were cleaned, and calibrated. Operators were also taught how to perform calibrations. However all the calibration solution had expired.

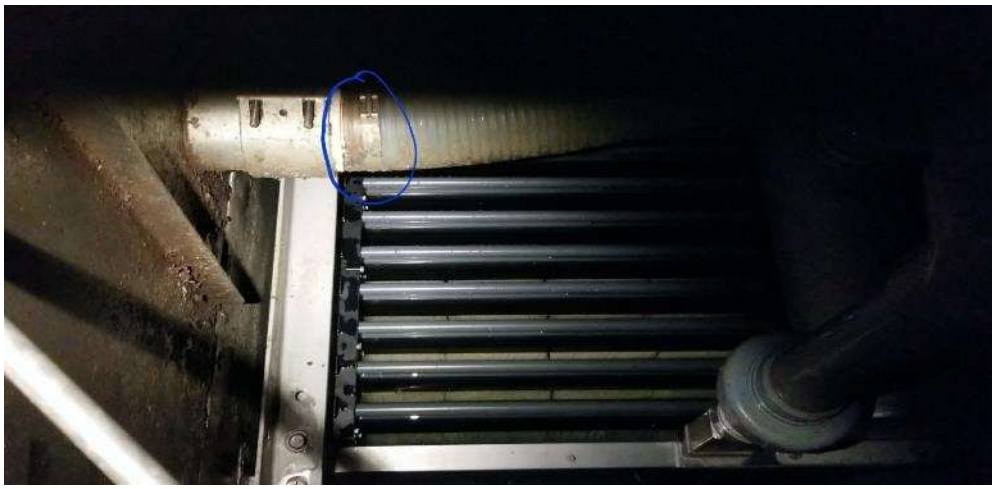


Figure 37: Train #1 Leak in Air Hose Connection

EXP Recommendation:

- ***Replacing the blank with a new module at the earliest convenience. The potentially exposed module can be replaced at that time, or can be replaced once it starts to show reduced performance.***
- ***Re-calibrating on the next visit when fresh calibration solution is available.***

PERMEATE PUMPS

- Both permeate pumps requires an oil change and there appears that some water has entered the pump (apparent through the viewfinder)

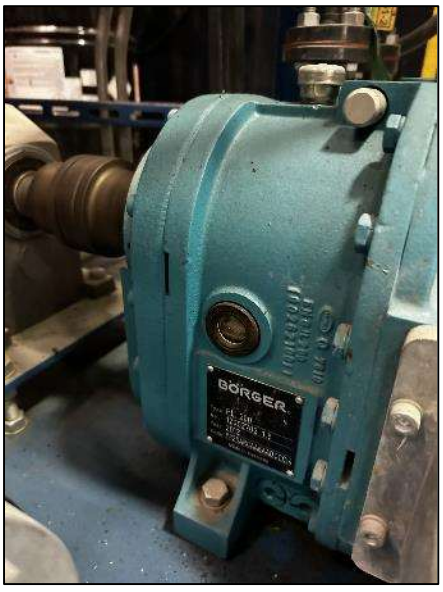


Figure 38: Permeate Pump Oil Change

EXP recommends that a contractor be hired to service the permeate pumps. It is noted that the plant has a set of new spare pumps (delivered Feb 2021)

Sodium Hypochlorite pump and Maintenance Cleans

- During the site visit it was observed that the sodium hypochlorite pump was not operational. The operators noted that the system has not been run in over 8 months.
- Troubleshooting steps undertaken by EXP included:
    - Calibration chamber was filled with water to provide sufficient head above the pump and to monitor flow
    - Lines were disassembled and investigated – no apparent blockages in the suction or discharge lines
    - Pump was cleaned (suction and pressure valves of pump)
    - Issue appears to be foot/check valve in the chemical tank which may not be closing properly (might be slightly cracked). This is causing additional friction losses in the suction line and not allowing the pump to prime properly
        - A new suction line was installed – however, no replacement foot valves or spare parts are available onsite – a sodium hypochlorite repair kit was ordered for the 2023 sealift and should be arriving later in October 2023

- Maintenance cleans were tested on both trains. Maintenance cleans are now operational, however the dosing pump is old and has an intermittent leak behind the pump diaphragm (leakage hole)

Figure 39: Sodium Hypo Pump Leak behind Pump Diaphragm

EXP Recommendation:

- ***Hire a contractor to replace the hypochlorite dosing pump and install a new foot valve to ensure that the performance of the maintenance clean system is reliable.***
    - ***Confirmation of sodium hypo dosing rate once pump is fixed and operational***
        - ***Target = 200 mg/L***

- ***Repair of sodium hypo pump (existing pump to be repaired and kept as shelf spare)***
- ***Until the air compressor and sodium hypo pump issues are resolved, maintenance cleans should not be relied on. In discussion with Veoila, as an interim measure, it is suggested that the plant operators do a recovery clean on the new membranes every 3-4 months. The plant has sufficient sodium hypochlorite inventory to do this.***

Anoxic and Aerobic Tanks ('Bioreactor') / WAS & RAS Processes

- The plant operators did not note any issues with the Aerzen aeration blowers (60-AB-01 and 60-AB-02).
- At the moment, the plant are recycling 100% the sludge back to the anoxic tank
- During the site visit, we manually tested WAS cycle. The WAS inlet (65-V-15) and RAS inlet (70-V-01), both valves open and close as intended.
- TSS/MLSS
    - Grab samples were extracted from the aeration and anoxic tanks to observe the consistency of the mixed liquor. Based on visual inspection, it was evident that the mixed liquor was low in total suspended solids (TSS) which are crucial in providing an appropriate growth environment for the aerobic and anaerobic bacteria in the tanks.
    - In the lab, the compressor is broken for filtering the water
        - Note that the current testing methods are for 'total solids' as the sample is not filtered (only wet weight and dry weight)
    - TSS measurements

	Sept 21, 2023	*Sept 24, 2023*	*Sept 27, 2023*
Aerobic	*779 mg/L*	*793 mg/L*	*1,049 mg/L*
Anoxic	*12,545 mg/L*	*16,646 mg/L*	*15,405 mg/L*

Figure 40: TSS Samples from Anoxic and Aerobic Tanks

- Dissolved oxygen
    - Online DO sensors were checked with the handheld (HACH LDO) probe
        - The anoxic tank sensor is calibrated
        - The aerobic tank is reading low but still providing a measurement within range

	Anoxic Tank (16-AIT-406)	*Anoxic Tank (handheld)*	Aerobic Tank (16-AIT-405)	*Aerobic Tank (handheld)*
Sept 20, 2023	0.7 mg/L		1.8 mg/L	
Sept 21, 2023	0.6 mg/L	*0.4 mg/L*	3.58 mg/L	*8.24 mg/L*

EXP Recommendation:

- ***reseeding the bioreactor to increase the MLSS.***
- ***replacing the aerobic tank DO sensor at the next site visit***

Soda ash System

- Plant has been manually dumping soda ash directly into bioreactor. Currently, they use the forklift to lift a couple buckets of soda ash up to the top of the bioreactor tank and then climb up the ladder and dump the soda ash directly through the anoxic hatch
- Operators noted that manual mixing tank that was provided over by the sludge storage tank is no longer in use
    - Outlet valve to connect the hose would constantly get plugged and/or not mix properly (especially in the winter)
    - The outlet valve is located at the bottom of the tank (lifted on pallets) and would accumulate solids
    - The new soda ash pumping system should ensure that the suction pipe is elevated from the bottom of the tank

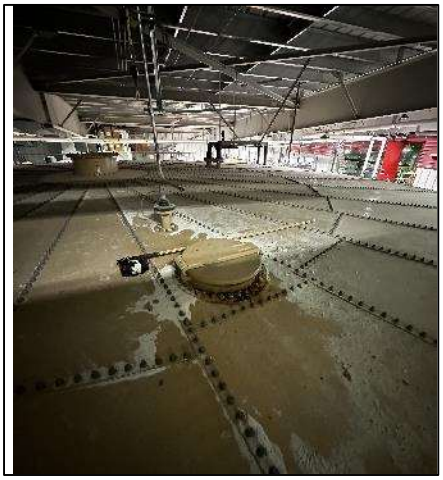


Figure 41: Soda Ash on top of Bioreactor Tank

UV Disinfection System

- Upon arrival, the UV transmittance reading on the UV display was reading 0.0 mW/cm2 and displaying a UV fault on the SCADA. It was determined that the UV lamps and sensor needed to be cleaned. The UV modules were removed from the UV bank and the sensor and quartz sleeves were wiped clean using a rag and Lime-A-Way. The resulting UV transmittance was increased from 0.0 mW/cm2 to 2.5 mW/cm2.

Polymer Dosing System and Sludge Transfer Pumps

- The polymer dosing system and sludge transfer pump is only used when sludge from the sludge tank is being wasted to the geotube trailer. The dosing system and pump were tested by EXP and appear to be in working order.
- Plant staff noted that they have sufficient liners (white rolls) onsite and don't need anymore. When they use a replace a Geotube, they can reuse the white liner roll multiple times.

Air Louver system

- The air louver (near the roof by the membranes and EQ tank) does not open – the motor belt is loose and needs to be replaced.

Figure 42: Air Louver System

EXP Recommendation:

- ***Hire a contractor to repair the motor belt***

Other Lab Equipment

- The HACH DR3900 spectrometer machine is not turning on at all. Charger appears to be getting power but machine won't power on. It appears that the screen is broken.
- Small compressor to filter TSS samples is broken

Figure 43: HACH DR3900 Broken Screen
Figure 44: Broken lab compressor machine

EXP Recommendation:

- ***Order a new HACH DR3900 machine and lab compressor for the 2024 sealift order***

Summary and Recommendations

SCREENED PUMPS AND DISCHARGE PIPING

- Immediately hire a contractor to replace the length of the PVC pipe and fittings from the discharge end of the isolation valves to the 90° bend toward the EQ tank including clearing all connections of potential blockages – this is a critical connection for the plant and in its current condition, it is vulnerable to further damage
    - There are no spare parts onsite and the contractor would be required to bring up the PVC pipe fittings and spare parts to complete this work
- Contractor to fix the drive fault (Allen Bradley) and confirm programming for the screened sewage Pump #2 (lag pump)

SPRAY WASH SYSTEM SOLENOID VALVE ISSUE

- hire a contractor to repair the spray wash system. Contractor to provide and bring replacement parts:
    - new ball valve 1”
    - new actuator (VALBIA – VB015-HT)
    - PVC fittings (1”, 1 ½” and 2”) to repair connection to non-potable water system

RAW SEWAGE SUMPS/PUMPS

- Hire a contractor be hired to install a connection to the second raw sewage pump (add 4” tee and flexible hose connection) including confirming the pump programming to run in a lead/lag configuration.

DEFOAMER SYSTEM

- Hire a contractor to replace the ½" piping from tee to pump discharge including the required Prominent injection quill component.

COMPRESSOR / AIR DRYER

- Hire a contractor to service the air dryer, compressor and compressed air system (drain air lines). It is also recommended to replace the existing auto drain with one controlled by an electronic timer.

MEMBRANE OPERATION – MALFUNCTIONING VALVES

- Hire a contractor to service the air dryer, compressor, compressed air system (drain air lines).
- Replace the position sensor on 60-V-20 and 60-V-21
- After the air issues are resolved, replace any valve actuators that are still not functioning properly.
    - The contractor should bring up the valves/actuators/switches to complete this work

Tag ID	Component
55-V-03	Permeate/Backpulse valve
55-V-04	
65-V-01	RAS/WAS discharge valve
65-V-02	
50-V-06	Membrane Flow Control Inlet
50-V-07	
60-V-20	Membrane Train #1 - air inlet valve
60-V-21	Membrane Train #2 - air inlet valve

- We also recommend that additional spare parts (valves/actuators/switches) be ordered for the next sealift.

MBR MEMBRANE REPLACEMENT

- Replacing the blank with a new module at the earliest convenience. The potentially exposed module can be replaced at that time, or can be replaced once it starts to show reduced performance.
- Re-calibrating on the next visit when fresh calibration solution is available.

PERMEATE PUMPS

- EXP recommends that a contractor be hired to service the permeate pumps. It is noted that the plant has a set of new spare pumps (delivered Feb 2021)

SODIUM HYPOCHLORITE PUMP AND MAINTENANCE CLEANS

- Hire a contractor to replace the hypochlorite dosing pump and install a new foot valve to ensure that the performance of the maintenance clean system is reliable.
    - Confirmation of sodium hypo dosing rate once pump is fixed and operational
        - Target = 200 mg/L
- Repair of sodium hypo pump (existing pump to be repaired and kept as shelf spare)
- Until the air compressor and sodium hypo pump issues are resolved, maintenance cleans should not be relied on. In discussion with Veoila, as an interim measure, it is suggested that the plant operators do a recovery clean on the new membranes every 3-4 months. The plant has sufficient sodium hypochlorite inventory to do this.

ANOXIC AND AEROBIC TANKS ('BIOREACTOR') / WAS & RAS PROCESSES

- reseeding the bioreactor to increase the MLSS.
- replacing the aerobic tank DO sensor at the next site visit

AIR LOUVER SYSTEM

- Hire a contractor to repair the motor belt

OTHER LAB EQUIPMENT

- Order a new HACH DR3900 machine and lab compressor for the 2024 sealift order

Appendix B –

EXP – Pangnirtung WWTF Membrane Replacement Photos

Existing Membranes (0)

Existing Membranes (1)

Existing Membranes (2)

Existing Membranes (3)

Existing Membranes (4)

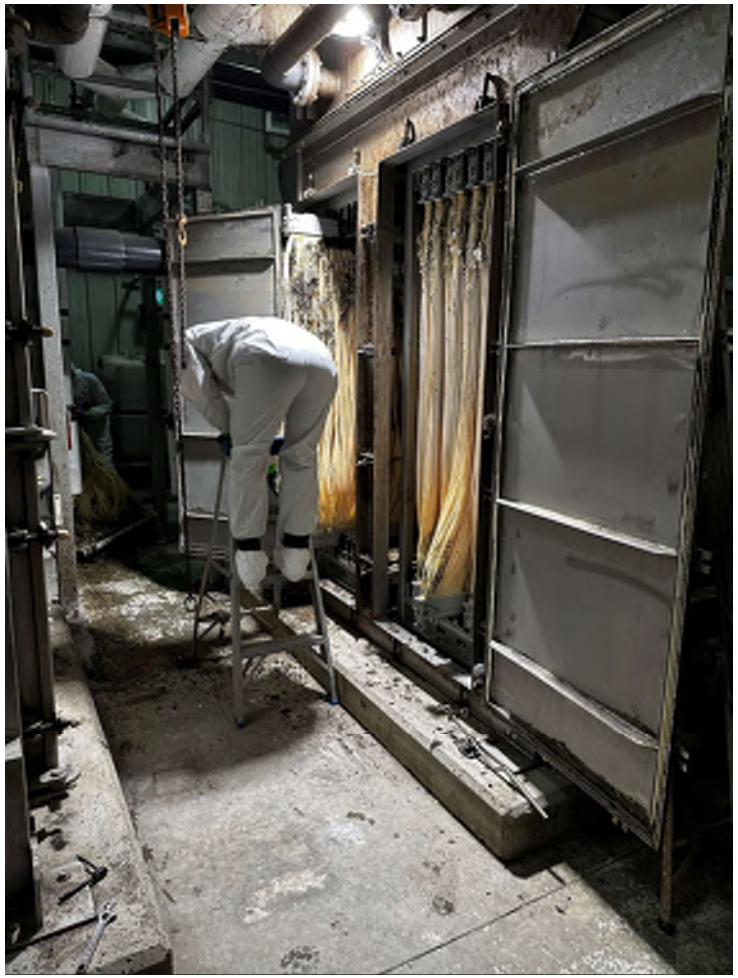
Existing Membranes (5)

Existing Membranes (6)

Existing Membranes (7)

Existing Membranes (8)

Inspecting Existing Membranes (0)



Inspecting Existing Membranes (1)

Removing Existing Membrane Module (0)

Removing Existing Membrane Module (1)

Storing Removed Membrane Modules for Disposal (0)

Storing Removed Membrane Modules for Disposal (1)

Storing Removed Membrane Modules for Disposal (2)

Storing Removed Membrane Modules for Disposal (3)

Storing Removed Membrane Modules for Disposal (4)

Storing Removed Membrane Modules for Disposal (5)

Storing Removed Membrane Modules for Disposal (6)

Transporting Removed Modules (0)

Transporting Removed Modules (1)

Transporting Removed Modules (2)

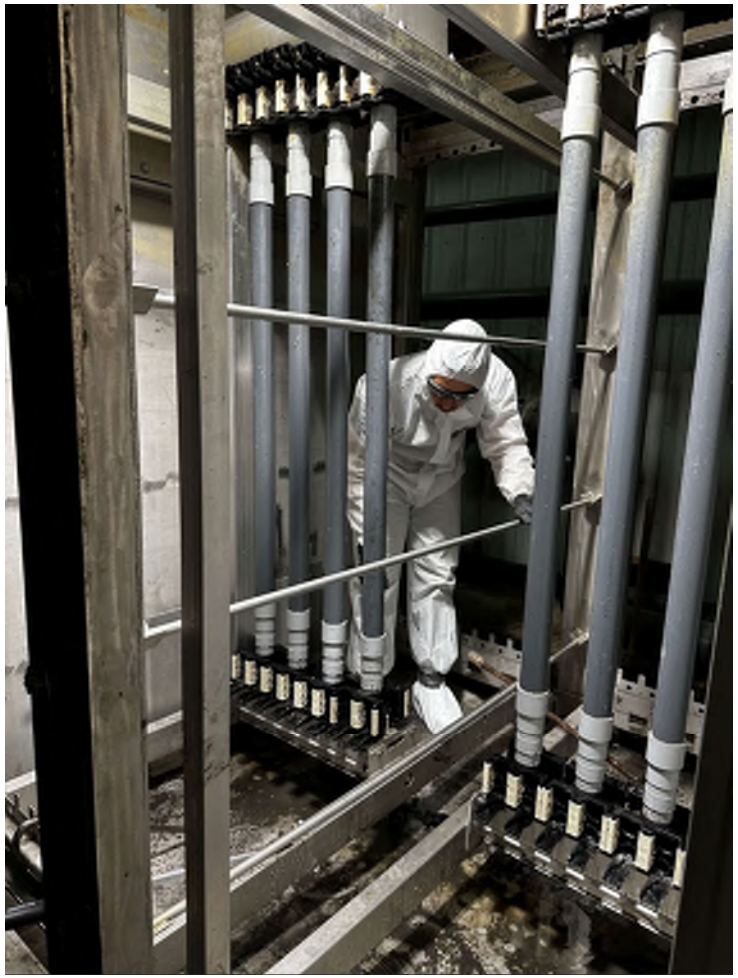
Existing Air Scour Piping (0)

Existing Air Scour Piping (1)

Removing Existing Air Scour Piping and Cassettes (0)

Removing Existing Air Scour Piping and Cassettes (1)

Removing Existing Air Scour Piping and Cassettes (2)



Removing Existing Air Scour Piping and Cassettes (3)

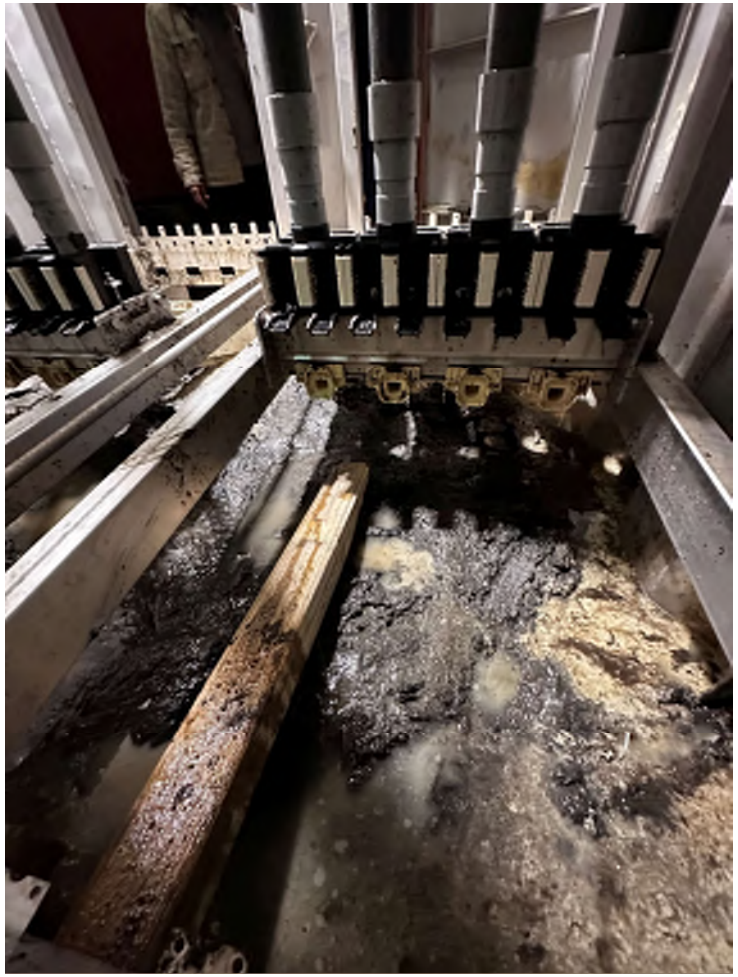
Removing Existing Air Scour Piping and Cassettes (4)

Removing Existing Air Scour Piping and Cassettes (5)

Clearing Membrane Tank of Accumulated Sludge

Membrane Tank Internal Air Piping

Membrane Tank Sludge Accumulation (0)



Membrane Tank Sludge Accumulation (1)

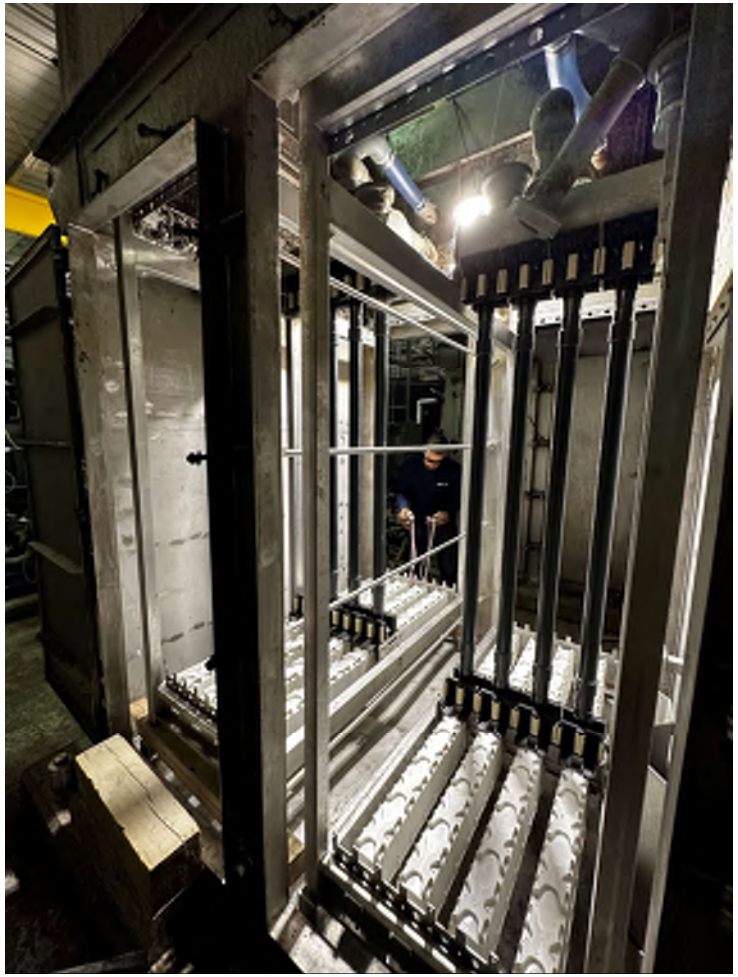
Installing New Cassettes (1)

Installing New Cassettes (2)

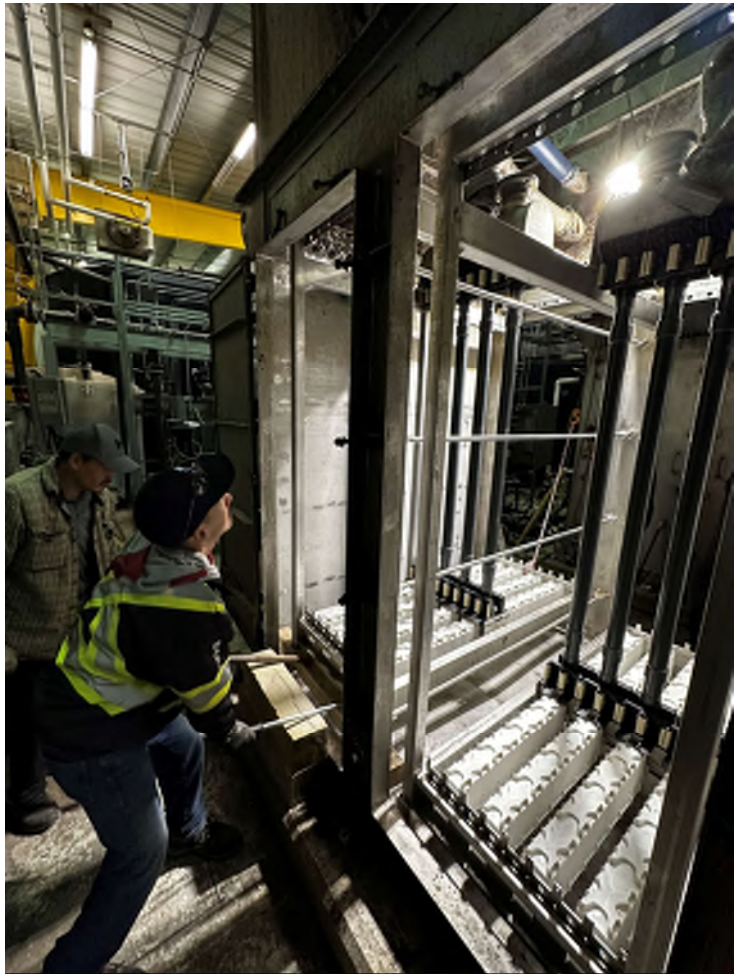
Installing New Air Scour Piping (0)

New Air Scour Piping (0)

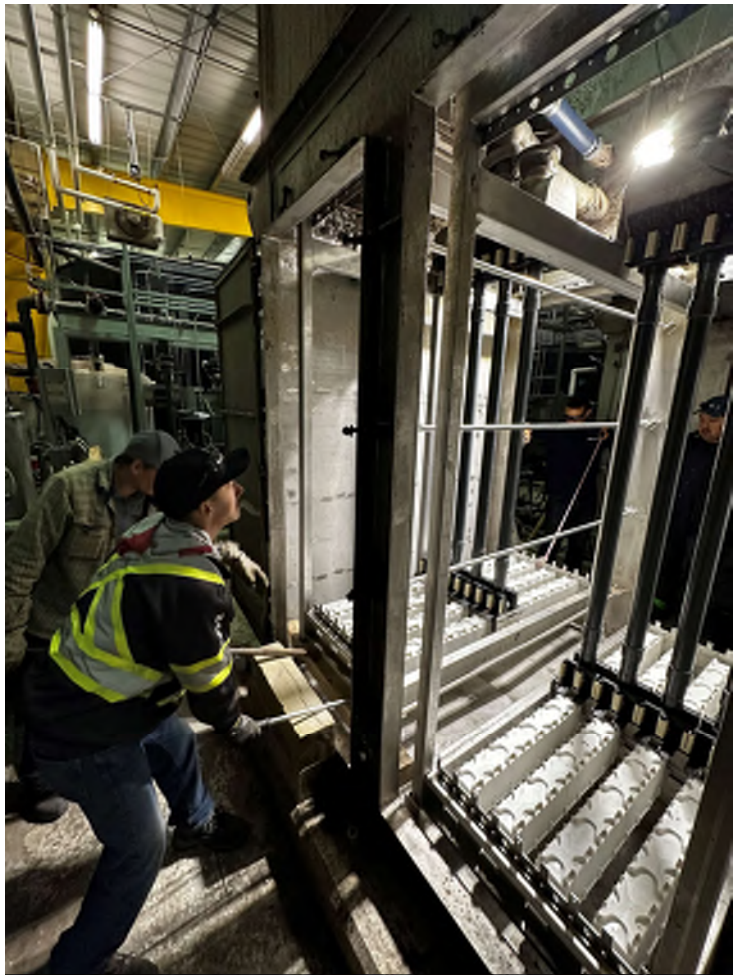
Installing New Air Scour Piping (1)



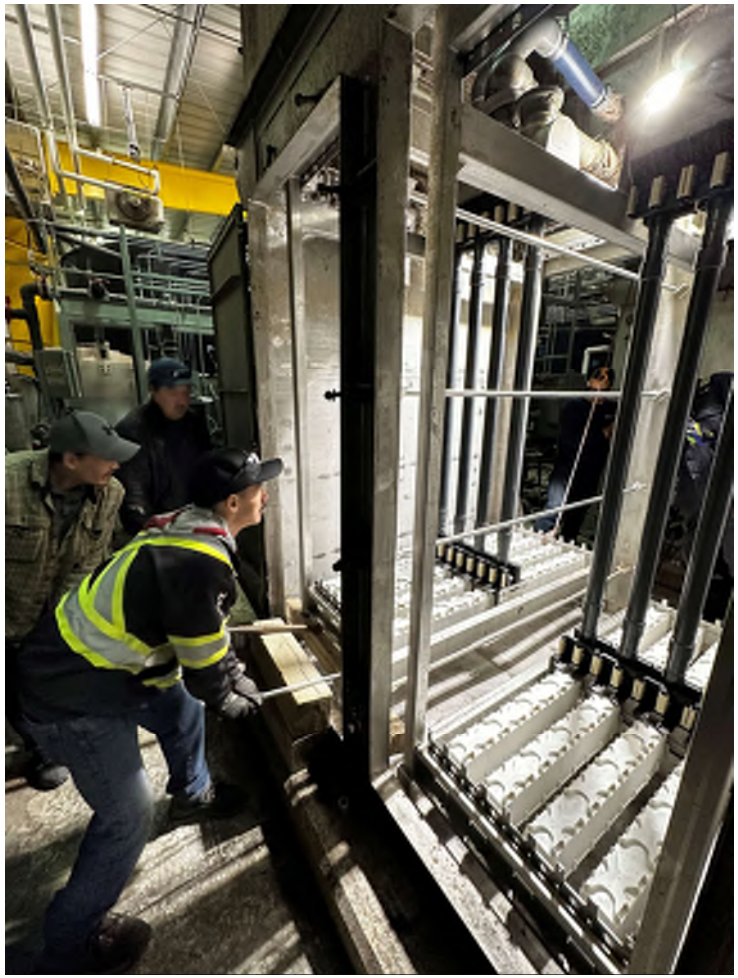
Installing New Air Scour Piping (2)



Installing New Air Scour Piping (3)

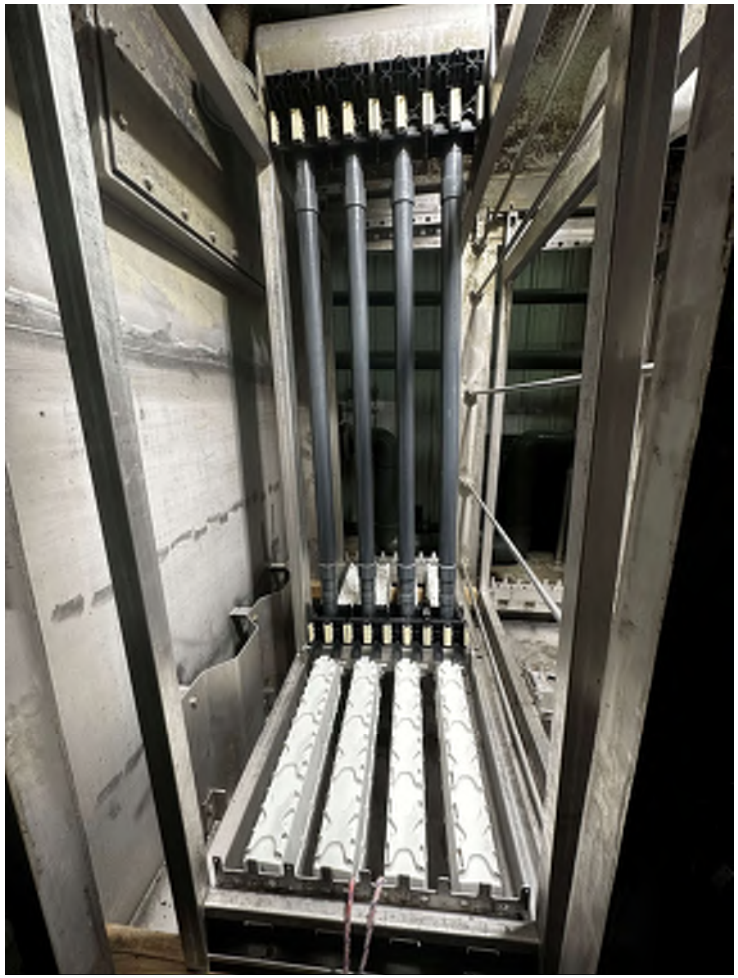


Installing New Air Scour Piping (4)



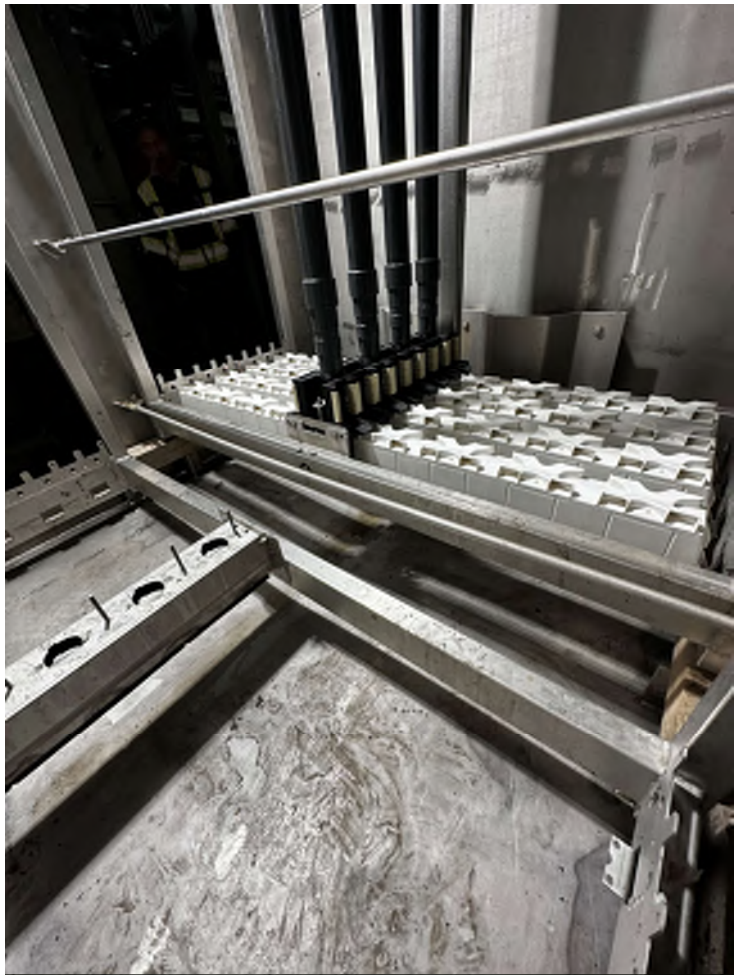
Installing New Air Scour Piping (5)

Installing New Air Scour Piping (6)



New Air Scour Piping (1)

New Air Scour Piping (2)



New Air Scour Piping (3)

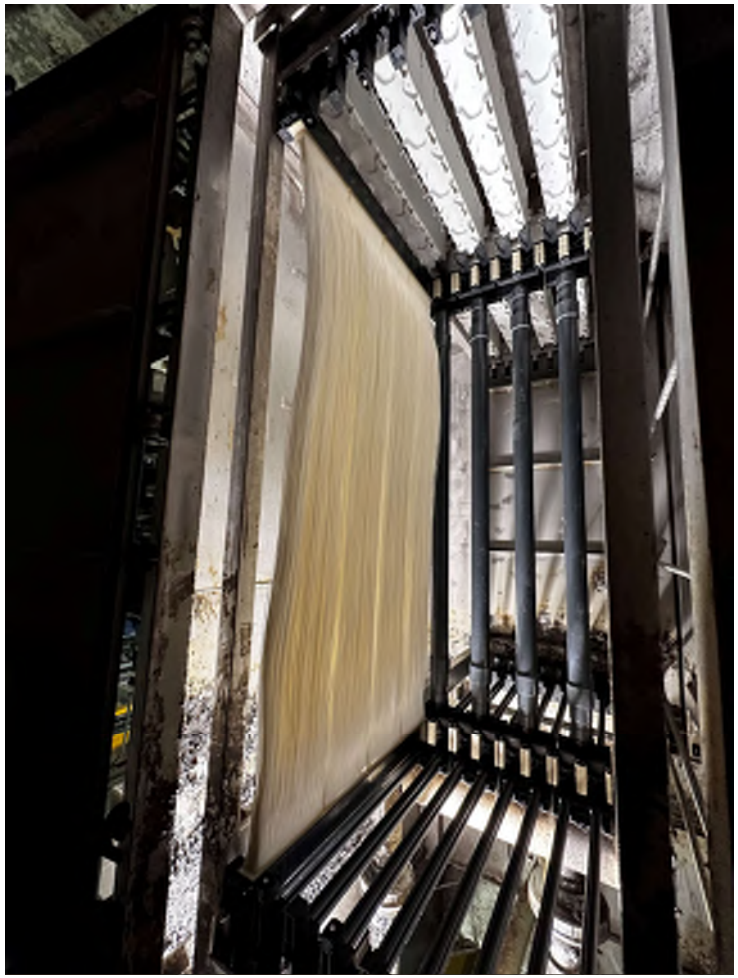
New Air Scour Piping (4)

New Air Scour Piping (5)

New Air Scour Piping (6)

New Air Scour Piping (7)

New Membranes (0)



New Membranes (1)

New Membranes (2)

New Membranes (3)

New Membranes (4)

New Membranes (5)