WWTP Bypass Contingency Plan
Hamlet of Pangnirtung, Pangnirtung, Nunavut

Type of Document
Final Rev 2

Client:
Government of Nunavut
Community and Government Services
Pond Inlet
Nunavut X0A 0S0

Project Number
FRE-00234334-A0

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Date Submitted

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1. Introduction

Exp Services Inc. (**exp**) was retained by the Department of Community & Government Services (CGS), Government of Nunavut (GN) to prepare a Wastewater Treatment Plant (WWTP) Bypass Contingency Plan (WWTP-BCP) as part of the operation and maintenance of the wastewater treatment facility servicing the Hamlet of Pangnirtung (Hamlet). The WWTP is a secondary wastewater treatment facility that utilizes Membrane Bioreactor (MBR) technology for the treatment of the Hamlet's domestic sewage.

The purpose of the WWTP-BCP is to address potential environmental spill incidents that may occur as a result of any unusual events that could arise during the routine operation and maintenance activities that take place within the facility. The WWTP-BCP is designed to have the operations personnel be proactive in the day-to-day operations of the facility to recognize and address potential problems so to minimize the need for a partial or full-plant bypass.

The WWTP-BCP should be used in conjunction with the Spill Contingency Plan (SCP) that was developed for the Hamlet. The SCP does not replace any Health & Safety protocols, procedures, etc., already established by the Hamlet but rather is intended to be complimentary to existing protocols.

It is recommended that all persons involved with the WWTP operations read the WWTP-BCP. If there are any questions regarding any aspect of this document, individuals are encouraged to contact **exp** for additional information or clarification.

Rev 1 (August 10, 2017): Contact information added for the NWT/NU Spill Line.

Rev 2 (May 28, 2018): Revised INAC agency name to CIRNA (Table 4-2).

2. Site Description

The Hamlet Pangnirtung is located on Baffin Island, in the Qikiqtaaluk Region of Nunavut. The approximate coordinates of the Hamlet are 66.14778°N, 65.69944°W. It has population of 1,510 according to 2012 Nunavut Bureau of Statistics data. Its areal coverage is approximately 7.54 km^2. The community utilizes trucked water and sewage services with the wastewater being treated by a Municipal Treatment Plant. The location of the WWTP is shown in Figure 2-1.

Figure 2-1: Location Wastewater Treatment Plant, Pangnirtung, NU

3. Treatment Process

The Pangnirtung WWTP utilizes the GE MBR system to treat domestic sewage, as well as fish processing wastewater generated at the Pangnirtung Fisheries site. The quality of the WWTP effluent is well suited for discharge to the Pangnirtung Fiord.

The various treatment processes used at the plant include:

1. Coarse screening;
2. Fine screening;
3. Equalization;
4. Bioreactor tanks;
5. Membranes;
6. UV Disinfection;
7. Pumping at various points in the process;
8. Waste sludge dewatering;
9. Final effluent re-use; and
10. Various chemical feed systems to aid in the operation.

Refer to the attached flow diagram (Appendix A).

4. Contacts & Regulatory Authorities

The following table includes the contact information for the persons responsible for the facility. The persons listed below should be contacted in the event of a bypass event.

Table 4-1 : Contacts

Job Title	24-Hour Telephone #
Municipal Foreman	(867) 473-8986
Chief WWTP Operator	(867) 473-8951
SAO	(867) 473-8953
Municipal Engineer, Baffin Region	(867) 899-7314

In addition to the local contacts described above, the following table summarizes the additional regulatory authorities that have a vested interest in the event of a bypass event.

Table 4-2: Additional Agencies

Agency Name	Regulation	24-Hour Telephone #
Nunavut Water Board	Nunavut Waters and Surface Right Tribunal Act	(867) 360-6338
Nunavut Impact Review Board	Nunavut Land Claims Agreement Act	(866) 233-3033
NT/NU Spill Line	Spill Contingency Planning and Reporting Regulations	(867) 920-8130
Crown-Indigenous Relations and Northern Affairs Canada (CIRNA)	Arctic Waters Pollution Prevention Act	(867) 975-4295
Transport Canada (Coast Guard)	Transportation of Dangerous Goods Act	(867) 979-5269
Department of Fisheries and Oceans	Fisheries Act	(867) 645-2871

5. Potential Bypass Scenarios

5.1 Introduction

Wastewater from the treatment plant is discharged to the Pangnirtung Fjord which serves as a source of revenue for the local fishery as well as fishing and recreational use by residents of the Hamlet. The Fjord is a pristine water source in Canada's arctic and maintaining the water quality is critical for the Hamlet and indeed the entire Territory of Nunavut. Bypassing any or all of the unit processes in the treatment facility allows the potential for untreated or partially treated sewage to be discharged that could compromise the water quality in the Fjord. For this reason, it is a priority for the operators to minimize the frequency and duration of the any bypass events that may occur.

Bypass events at any wastewater treatment facility typically occur as a result of equipment that is out of service. This could be part of a planned bypass for routine maintenance/replacement or an unplanned event such as a sudden equipment failure. Unplanned bypass events require quick action on the part of the operator to restore plant operation as soon as possible. In this respect, normal preventative maintenance in accordance with the plant's operation manuals coupled with a sufficient stock of spare parts is the best way to minimize the frequency and duration of potential bypass events.

Within the Hamlet, all wastewater is collected in holding tanks at individual residences and buildings and trucked to the wastewater treatment facility. As a result of this collection method, the plant essentially has two main modes of bypass as follows:

1. External bypass: this refers to the ability of trucks to discharge wastewater directly to the outfall, thereby completely bypassing the treatment plant. Under this mode of bypass, there is no treatment performed on the wastewater prior to discharge. It is preferred to avoid this mode of bypass except under specific conditions identified below.
2. Internal Bypass(es): this refers to the bypass of specific unit processes within the plant by isolating equipment. Under this mode of bypass, some partial treatment is still performed on the wastewater prior to discharge. If a bypass is required, this mode is preferred, if possible, over a complete external bypass of the plant. Most of the equipment in the plant has been installed in a duty/standby arrangement to allow uninterrupted service in the event of an equipment failure or regularly scheduled maintenance routine.

5.2 Bypass Summary

The following section provides further details on the type of bypass events that can occur at the Pangnirtung WWTP including potential causes and action items. Refer also to the plant flow diagram for additional details and unit processes. Section 5.3 provides a summary of each unit process and how the operations may impact on potential bypass events.

5.2.1 External Bypass

Description: Complete bypass of wastewater treatment facility. Trucks do not discharge to the plant.

Potential Causes:

1. Raw Sewage Pump Station (PS) out of service.
2. Complete plant power failure (back-up generator failure).

(Note that these are the only scenarios where an external bypass situation should be allowed under normal operation.)

Bypass Initiation: An external bypass must be initiated by communication with the truck drivers. The drivers must be directed not to discharge their trucks to the Raw Sewage Sump as they normally would.

Action and Follow-up:

1. Raw Sewage Pump Station Failure:
   a. Steps should be taken to restore service to the Raw Sewage PS. This will allow for the wastewater to at least pass through the manual bar screen before being discharged to the environment.
   b. Follow notification protocols.
   c. Record bypass details (see Section 6 for more details).
2. Complete Plant Power Failure:
   a. Steps should be taken to restore power (either by getting the back-up generator up and running, or re-establishing line power if the main Hamlet generating system is operational).
   b. Follow notification protocols.
   c. Record bypass details (see Section 6 for more details).

5.2.2 Internal Bypass – Inlet to Fine Screen (10-FDS-01)

Description: Bypass of fine screen and all downstream treatment processes. Bypassed wastewater is coarse screened before being directed to the final outfall using the Raw Sewage PS.

Potential Causes: This mode of bypass would only be required if either the Fine Screen (10-FDS-01) or the Screened Sewage Pump Station (PS) is out of service.

Bypass Initiation: Bypass is initiated using valves to redirect flow. Closing valve 10-V-08 and opening 10-V-07 will direct the coarse screened wastewater directly from the Raw Sewage Sump to the final outfall.

Action and Follow-up:

1. Steps should be taken to restore service to either the Fine Screen or the Screened Sewage PS as soon as possible. This will allow for the wastewater to return to full treatment before being discharged to the environment.
2. Follow notification protocols
3. Record bypass details (see Section 6 for more details)

Additional Information: If the fine screen is out of service for any reason, the wastewater cannot be directed to the treatment process. All wastewater must be 100% fine screened in order to protect the membranes.

5.2.3 Internal Bypass – Inlet to EQ Tank (20-TK-01)

Description: Bypass of EQ tank and all downstream treatment processes. Bypassed wastewater is coarse and fine screened before being directed to the final outfall using the Screened Sewage PS.

Potential Causes: There are number of unit processes that could be out of service that may require this mode of plant bypass. Some examples are as follows:

1. Equalization tank out of service for repairs, cleaning, etc.
2. Anoxic or aeration tanks out of service for repairs, cleaning, etc.
3. Both membrane trains out of service simultaneously.

Note that the majority of mechanical equipment as part of the treatment process has been installed in a duplex arrangement which would generally not require a bypass if one of the units is out of service. Further details are provided in Section 5.3 for each unit process.

Bypass Initiation: Bypass is initiated using valves to redirect flow. Closing valve 10-V-15 and opening 10-V-16 will direct fine screened wastewater directly from the Screened Sewage Sump to the final outfall.

Action and Follow-up:

1. Steps should be taken to restore service to the affected process as soon as possible.
2. Follow notification protocols
3. Record bypass details (see Section 6 for more details)

Additional Information: If the EQ tank is in service and the issue is with a downstream process it would be preferred to direct wastewater to the EQ tank and use the tank overflow for bypass as indicated in item 5.2.4 below. This will allow some of the wastewater to be captured in the tank which can then be treated when the affected downstream process is restored.

5.2.4 Internal Bypass – Overflow from EQ Tank (20-TK-01)

Description: Fine screened wastewater can be directed to the EQ tank and allowed to bypass the downstream treatment processes via the tank overflow to the final outfall.

Potential Causes: There are multiple unit processes that could be out of service that may require this mode of plant bypass. Some examples are as follows:

1. Anoxic or aeration tanks out of service for repairs, cleaning, etc.

2. Both membrane trains out of service simultaneously.

Note that the majority of mechanical equipment as part of the treatment process has been installed in a duplex arrangement which would generally not require a bypass if one of the units is out of service. Further details are provided in Section 5.3 for each unit process.

Bypass Initiation: Bypass is initiated by stopping operation of the anoxic tank feed pumps (20-AFP-01 and 20-AFP-02) that draw wastewater out of the EQ tank. This will cause the tank to naturally fill up and eventually bypass via the overflow.

Action and Follow-up:

1. Steps should be taken to restore service to the affected process as soon as possible.
2. Follow notification protocols
3. Record bypass details (see Section 6 for more details)

5.2.5 Internal Bypass – Overflow from Membrane Tanks (55-TK-1, 55-TK-2)

Description: An emergency overflow from the membrane tanks allows the tank contents to flow to final outfall without passing through the membranes or the disinfection system.

Potential Causes: This type of scenario would generally be caused by a failure to remove permeate from the membrane system fast enough. This could be a result of an issue with the pump, a partially closed valve, or an equipment failure.

Bypass Initiation: Operators should not be actively selecting this as a mode of bypass. There is no initiation sequence to select this mode of bypass.

Action and Follow-up:

1. Steps should be taken to determine the cause of the overflow from the membrane tanks.
2. An alternate mode of bypass should be implemented as soon as possible to stop the overflow situation (scenario 5.2.3 or 5.2.4 above are preferred).
3. Steps should be taken to correct the initial cause of the overflow bypass situation as soon as possible.
4. Follow notification protocols
5. Record bypass details (see Section 6 for more details)

Additional Information: This type of bypass should never be actively selected by the operator as it allows the flow of mixed liquor which is high in TSS and BOD to be discharged from the system directly to the final outfall. If there is a problem with the system that requires a bypass, the operators should choose to bypass fine screened wastewater instead in accordance with bypass scenarios 5.2.3 or 5.2.4 above. This type of bypass is an

emergency overflow only in the event of a sudden issue with the permeate system that operators cannot immediately react to. It is a fail safe to avoid overflowing the membrane tanks within the treatment building.

5.2.6 Internal Bypass – UV Disinfection System (80-UV-01)

Description: A local bypass pipe allows treated permeate from the membrane tanks to bypass the UV channel and be directed to the final outfall.

Potential Causes: If the UV system requires significant maintenance, this mode of bypass may be required.

Bypass Initiation: Bypass is initiating using valves to redirect flow. Closing 80-V-01 and opening 80-V-03 will direct treated permeate to the final outfall downstream of the UV system.

Action and Follow-up:

1. Steps should be taken to restore service to the UV disinfection system as soon as possible.
2. Follow notification protocols
3. Record bypass details (see Section 6 for more details)

Additional Information: Normal maintenance activities such as lamp replacement or cleaning can be completed external to the UV channel (i.e., lamp racks are physically removed from the channel) and treated permeate can still flow through the channel. This would be preferred if possible as it may still provide some level of disinfection from the lamps that remain in service.

5.2.7 Internal Bypass – Overflow from Sludge Storage Tank (70-TK-01)

Description: An emergency overflow from the sludge storage tank allows the tank contents to flow to final outfall without passing through the treatment system.

Potential Causes: Continued sludge wasting from the membrane treatment process can lead to a high level in the storage tank if the dewatering system is out of service. This may include issues with the waste sludge pump (70-WSP-01), the polymer dosing system, or the Geotube® system.

Bypass Initiation: Operators should not be actively selecting this as a mode of bypass. There is no initiation sequence to select this mode of bypass.

Action and Follow-up:

1. Steps should be taken to identify the issues with dewatering system and restore service as soon as possible so waste sludge can be removed from the storage tank and properly dewatered.

2. Depending on the operating conditions in the membrane tanks, it may be possible to temporarily suspend wasting of mixed liquor from the membrane tanks to the storage tank.
3. If excess material needs to be removed from the storage tank, it is preferred to decant from the tank as per 5.2.8 below which does not result in any untreated material being discharged to the environment.
4. If there are still some tank contents that escape the tank via the overflow piping to the final outfall, the following steps should be taken:
    a. Follow notification protocols
    b. Record bypass details (see Section 6 for more details)

5.2.8 Internal Bypass – Decant from Sludge Storage Tank (70-TK-01)

Description: The sludge storage tank is equipped with decant piping that can be used to return some of the tank volume to the plant headworks. Turning off the aeration system to the storage tank will allow the sludge to settle such that relatively clean supernatant can be decanted. It is recommended to minimize the duration that the aeration system is off in this tank to avoid odours and septic conditions.

Potential Causes: Continued sludge wasting from the membrane treatment process can lead to high level in the storage tank if the dewatering system is out of service. This may include issues with the waste sludge pump (70-WSP-01), the polymer dosing system, or the Geotube® system.

Bypass Initiation: Operators must first stop the flow of the air to the sludge storage tank by shutting off the blowers (75-AB-01 and 75-AB-02). After the sludge has been allowed to settle, decant flow can be initiated by opening valve 70-V-03.

Action and Follow-up:
1. Steps should be taken to identify the issues with dewatering system and restore service as soon as possible so waste sludge can be removed from the storage tank and properly dewatered.
2. Depending on the operating conditions in the membrane tanks, it may be possible to temporarily suspend wasting of mixed liquor from the membrane tanks to the storage tank.

5.3 Unit Process Break-down for Bypass Contingency and Mitigation Measures

The following section provides further details for each individual unit process and how maintenance activities and/or equipment failures may impact on plant bypass events. Contingency measures are included to help operators minimize the duration and frequency of bypass events related to specific unit processes. The unit processes in this section are generally listed in the order they appear in the plant process flow diagram.

The following definitions apply to the content in this section:

1. Install Configuration: Refers to the number of units installed in parallel and how they operate. Potential configurations are as follows:
   - Simplex – a single unit is installed.
   - Duplex – two units are installed and both may be required to operate simultaneously under normal operation.
   - Duty/Standby – two units are installed but only one unit will operate under normal conditions. The second unit operates as an installed spare. Operation is normally cycled between the two installed units to promote even run-times.
2. Bypass Mode: Refers to the bypass mode that should be used if there is a service interruption for maintenance or equipment failure. Bypass modes have been listed in Section 5.2.
3. Bypass Mitigation: Refers to specific measures the operator should take to minimize the duration and frequency of service interruptions that may result in a plant bypass event. Mitigation measures also include steps that may reduce the severity of a bypass event once it has occurred.

5.3.1 Coarse Bar Screen (Manually Cleaned)

Description:	Raw wastewater discharged from the trucks passes through a manual bar screen for removal of large debris before passing into the Raw Sewage PS.
Install Configuration:	Simplex
Potential Service Interruptions:	Under normal operation, there should be virtually no situations where the coarse screen is out of service. It is a manually cleaned unit with no mechanical or electrical components that may fail.
Bypass Mode:	5.2.1 External Bypass
Bypass Mitigation:	Regular cleaning of bar screen to avoid blockages

5.3.2 Raw Sewage Pump Station (10-RSP-01, 10-RSP-02)

Description:	Coarse screened wastewater is pumped, using submersible grinder pumps, through the fine drum screen to the Screened Sewage PS
Install Configuration:	Duplex (pumps)
Potential Service Interruptions:	Power failure, pump failure or blockage. Maintenance activities including bearing replacement.
Bypass Mode:	5.2.1 External Bypass
Bypass Mitigation:	1. Maintain full inventory of spare parts or complete shelf spare pump to minimize the time required for repairs. 2. If service interruption is a sudden failure of a single pump during normal truck delivery hours, it may be possible to remove the affected unit to complete the repairs and continue operation of the pump station using a single pump. Truck drivers will need to be made aware to keep close watch on the level in the sump when discharging to the plant to avoid spills. 3. If service interruption is a planned maintenance activity, schedule repairs to coincide with periods when trucks would not normally deliver wastewater to the plant such as evenings. Plant operation can continue under normal operating conditions with no bypass required.

5.3.3 Fine Drum Screen (10-FDS-01)

Description:	Coarse screened wastewater is passed through a fine drum screen into the Screened Sewage PS. All wastewater entering the downstream EQ tank and MBR process must be fine screened to avoid potential damage to the membranes.
Install Configuration:	Simplex
Potential Service Interruptions:	Power failure or any failure or blockage related to the fine screen would result in wastewater having to be bypassed around the biological treatment process. Parts of the screen, including the dewatering auger, can require several hours of labour in order to complete parts replacement or repairs.
Bypass Mode:	5.2.2 Internal Bypass – Inlet to Fine Screen (10-FDS-01)
Bypass Mitigation:	1. Maintain full inventory of spare parts in accordance with the manufacturer's recommendations.

2. If service interruption is a sudden failure or issue, all wastewater should still be directed to the plant for coarse screening to remove larger debris before being discharged to the outfall.
3. Regular maintenance in accordance with the operations manual will help to reduce equipment down-time.
4. Regular inspection of the screen should be performed to ensure the spray water system is working properly. Regular inspection will help avoid excessive plugging in the screen which could lead to longer service interruptions.
5. If service interruption is a planned maintenance activity, schedule repairs to coincide with periods when trucks would not normally deliver wastewater to the plant such as evenings. Plant operation can continue under normal operating conditions with no bypass required.

5.3.4 Screened Sewage Pump Station (10-SSP-01, 10-SSP-02)

Description:	Fine screened wastewater is pumped to the equalization tank before entering the biological treatment process. If there is a service interruption to the pump station, wastewater cannot be directed to the fine screen.
Install Configuration:	Duplex (pumps)
Potential Service Interruptions:	Power failure, pump failure or blockage. Maintenance activities including bearing replacement.
Bypass Mode:	5.2.2 Internal Bypass – Inlet to Fine Screen (10-FDS-01)
Bypass Mitigation:	1. Maintain full inventory of spare parts or complete shelf spare pump to minimize the time required for repairs. 2. If service interruption is a sudden failure of a single pump during normal truck delivery hours, it may be possible to remove the affected unit to complete the repairs and continue operation of the pump station using a single pump. Truck drivers will need to be made aware to keep close watch on the level in the Raw Sewage PS when discharging to the plant to avoid spills. 3. All wastewater should still be directed to the plant for coarse screening as a minimum treatment to remove larger debris before being discharged to the outfall. 4. If service interruption is a planned maintenance activity, schedule repairs to coincide with periods when trucks would not normally deliver wastewater to the plant such as evenings. Plant operation can continue under normal operating conditions with no bypass required.

5.3.5 Equalization Tank (20-TK-01)

Description: Fine screened wastewater is pumped to the equalization (EQ) tank for flow attenuation prior to entering the biological treatment system. There are limited means of failure with this unit process that would require the operators to actively bypass wastewater as a result. It is far more likely for wastewater to bypass this process via the tank overflow as a result of associated equipment failures or too much flow being directed to the plant in a short period of time.

Install Configuration: Simplex (tank)

Potential Service Interruptions: Maintenance/replacement/inspection of the aeration diffuser grid (infrequent).

Bypass Mode(s):

5.2.3 Internal Bypass – Inlet to EQ Tank (20-TK-01)

- This bypass mode should only be used in the event that the entire tank is out of service to repair the aeration diffuser system.

5.2.4 Internal Bypass – Overflow from EQ Tank (20-TK-01)

- If the tank itself is in service but there are issues with any downstream processes that prevent the biological treatment of wastewater, this is the preferred bypass mode. The tank can provide a significant volume for fine screened wastewater to be captured before the bypass event (overflow) begins.
- This mode of bypass may also occur unintentionally (i.e. not actively selected by the operators) as a result of excessive flows to the plant.

Bypass Mitigation:

1. Maintain full inventory of spare parts for aeration diffuser system.
2. The operators should actively strive to maintain the EQ tank at it's lowest possible level at the end of each day when in normal operation. This strategy provides the greatest volume for capturing wastewater in the event of a failure before the tank begins to bypass. This does not effect the quality of the wastewater being bypassed but can reduce the ultimate volume discharged during the bypass event.
3. If service interruption is a planned maintenance activity, schedule repairs or inspections to coincide with periods when trucks would not normally deliver wastewater to the plant such as evenings. Plant operation can continue under normal operating conditions with no bypass required.

5.3.6 Equalization Tank Aeration Blowers (20-AB-01, 20-AB-02)

Description:	Aeration blowers are used to aerate the EQ tank to help prevent septic conditions and to mix the tank contents.
Install Configuration:	Duty/Standby
Potential Service Interruptions:	Power failure, parts failure (e.g. belts, bearings, etc.). Regular service and maintenance activities.
Bypass Mode(s):	There are no bypass modes associated with this equipment. If one unit is out of service, the other unit can be used to aerate and mix the tank contents. In the unlikely event that both units are out of service, the EQ tank can still be used for short durations of up to a few days without mixing and aeration.
Bypass Mitigation:	Bypass is not required, however, regular service and maintenance of this equipment in accordance with the operation and maintenance manual will help minimize unexpected failures and reduce equipment downtime.

5.3.7 Anoxic Tank Feed Pumps (20-AFP-01, 20-AFP-02)

Description:	Fine screened wastewater is transferred from the equalization tank to the bioreactor tanks.
Install Configuration:	Duty/Standby
Potential Service Interruptions:	Power failure, parts failure (e.g., bearings, mechanical seals, etc.). Pump clogging. Regular service and maintenance activities.
Bypass Mode(s):	5.2.4 Internal Bypass – Overflow from EQ Tank (20-TK-01) • A bypass event is only required in the event that both pumps are out of service simultaneously.
Bypass Mitigation:	1. The installation of these pumps as a duty/standby configuration mitigates the potential for bypass. If one pump is out of service, operation can continue normally without any bypass. Valves are provided for each pump so it can be isolated from the process for repairs, maintenance or full replacement. 2. Maintaining a full inventory of spare parts as recommended by the manufacturer will reduce the duration of service interruptions.

3. Proper maintenance and operation of the fine screen will minimize the potential for debris to enter the EQ tank which may clog these pumps.

5.3.8 Anoxic Tank (50-TK-01)

Description:	The anoxic tank is the first step in the biological treatment process where pre-anoxic denitrification occurs; this tank is located within the aeration tank. Fine screened wastewater is pumped from the EQ tank to this tank before entering the aeration tank.
Install Configuration:	Simplex
Potential Service Interruptions:	Maintenance/replacement/inspection of the aeration diffuser grid (infrequent). Significant foaming event.
Bypass Mode(s):	5.2.4 Internal Bypass – Overflow from EQ Tank (20-TK-01) • Note that bypass is only required if the entire tank or diffused aeration system is out of service. • If a significant foaming event is experienced, it may require reducing the flow to the system. In this case, the tank may not be completely out of service but may result in some excess wastewater being diverted to bypass via the EQ tank overflow as a result of the reduced plant flows.
Bypass Mitigation:	1. Maintain full inventory of spare parts for aeration diffuser system. 2. A significant foaming event can be mitigated by maintaining sufficient quantities of anti-foam chemical and ensuring the anti-foam dosing system is inspected and maintained on a regular basis. 3. If service interruption is a planned maintenance activity, schedule repairs or inspections to coincide with periods when trucks would not normally deliver wastewater to the plant such as evenings.
Additional Information:	If the anoxic tank is completely out of service, the RAS flow from the membrane tanks must be suspended. Any time there is no RAS flow, there also cannot be any permeate flow from the membrane tanks.

5.3.9 Aeration Tank (50-TK-02)

Description:	The aeration tank is constructed exterior to the anoxic tank. Flow is by gravity from the anoxic tank to the aeration tank where biological removal of BOD and ammonia occurs.

Install Configuration:	Simplex
Potential Service Interruptions:	Maintenance/replacement/inspection of the aeration diffuser grid (infrequent). Significant foaming event.
Bypass Mode(s):	5.2.4 Internal Bypass – Overflow from EQ Tank (20-TK-01) • Note that bypass is only required if the entire tank or diffused aeration system is out of service. • If a significant foaming event is experienced, it may require reducing the flow to the system. In this case, the tank may not be completely out of service but may result in some excess wastewater being diverted to bypass via the EQ tank overflow as a result of the reduced plant flows.
Bypass Mitigation:	1. Maintain full inventory of spare parts for aeration diffuser system. 2. A significant foaming event can be mitigated by maintaining sufficient quantities of anti-foam chemical and ensuring the anti-foam dosing system is inspected and maintained on a regular basis. 3. If service interruption is a planned maintenance activity, schedule repairs or inspections to coincide with periods when trucks would not normally deliver wastewater to the plant such as evenings.
Additional Information:	If the aeration tank is completely out of service, the RAS flow from the membrane tanks must be suspended. Any time there is no RAS flow, there also cannot be any permeate flow from the membrane tanks.

5.3.10 Aeration Blowers (60-AB-01, 60-AB-02)

Description:	The aeration blowers are used to aerate and mix both the anoxic tank and the aeration tank. An automatic valve in the common air header controls the flow split to each tank.
Install Configuration:	Duty/Standby
Potential Service Interruptions:	Power failure, parts failure (e.g. belts, bearings, etc.). Regular service and maintenance activities.
Bypass Mode(s):	5.2.4 Internal Bypass – Overflow from EQ Tank (20-TK-01) • Note that bypass is only required if both blowers are out of service simultaneously. If one unit is out of service, the other unit can be used to aerate and mix the tank contents.

Bypass Mitigation:

1. Maintain full inventory of spare parts.
2. If service interruption is a planned maintenance activity, schedule repairs or inspections to coincide with periods when trucks would not normally deliver wastewater to the plant such as evenings.
3. Regular service and maintenance according to the manufacturer's recommendations will help to minimize service interruptions.

5.3.11 Membrane Tanks (55-TK-01)

Description: Biologically treated mixed liquor from the aeration tank flows by gravity to the membrane tanks. Virtually all suspended solids material is removed by the membranes.

Install Configuration: Duplex

Note: Under normal conditions, both tanks may be required to operate. However, for short-term operation (1-2 days), a single tank can handle the entire average day flow.

Potential Service Interruptions: RAS pump failure (RAS pumps must be in operation at all times while producing permeate).

Failure of both membrane scour blowers simultaneously.

Membrane cleaning required (usually a scheduled event).

Membrane scour aeration diffuser blockage.

Membrane failure.

Membrane replacement or inspection.

Significant foaming event.

Power failure.

Bypass Mode(s): 5.2.4 Internal Bypass – Overflow from EQ Tank (20-TK-01)

- If both membrane tanks are out of service simultaneously, which is an unlikely scenario, fine screened wastewater should be bypassed via the EQ tank overflow.
- If a significant foaming event is experienced, it may require reducing the flow to the system. In this case, the tank may not be completely out of service but may result in some excess wastewater being diverted to bypass via the EQ tank overflow as a result of the reduced plant flows.

5.2.5 Internal Bypass – Overflow from Membrane Tanks (55-TK-1, 55-TK-2)

- The membrane tanks are equipped with an overflow that should only be used in emergency situations. This results in a discharge of high solids mixed liquor to the environment.

Bypass Mitigation:

1. Maintain full inventory of spare parts.
2. If possible, avoid bypassing the membrane system by directing as much flow as possible to a single membrane train.
3. Regular maintenance and inspection of equipment such as RAS pumps and scour blowers will help to minimize service interruptions.
4. Regular, scheduled membrane cleanings before issues arise (including high trans-membrane pressure indicating significant fouling) can prolong the life of the membranes and reduce service interruptions.
5. If an emergency overflow situation arises, operators should switch to the preferred mode of bypass as quickly as possible. Bypassed wastewater from the EQ tank has a much lower solids concentration than the mixed liquor in the membrane tank.
6. If service interruption is a planned maintenance activity, schedule repairs or inspections to coincide with periods when trucks would not normally deliver wastewater to the plant such as evenings.

5.3.12 Membrane Scour Blowers (60-AB-03, 60-AB-04)

Description: Scour blowers are used to provide aeration, mixing, and membrane scour for the membrane tanks.

Install Configuration: Duty/Standby (one blower is capable of providing the air required for one or both of the membrane tanks).

Potential Service Interruptions: Power failure, parts failure (e.g. belts, bearings, etc.).

Regular service and maintenance activities.

Bypass Mode(s): 5.2.4 Internal Bypass – Overflow from EQ Tank (20-TK-01)

- Note that bypass is only required if <u>both</u> blowers are out of service simultaneously. If one unit is out of service, the other unit can be used to aerate and mix the tank contents.

Bypass Mitigation:

1. Maintain full inventory of spare parts.
2. If service interruption is a planned maintenance activity, schedule repairs or inspections to coincide with periods when trucks would not normally deliver wastewater to the plant such as evenings.
3. Regular service and maintenance according to the manufacturer's recommendations will help to minimize service interruptions.

5.3.13 Membrane Permeate Pumps (55-PP-01, 55-PP-02)

Description:	The permeate pumps are used to draw treated permeate through the membranes, removing virtually all suspended solids. The pumps convey the treated water to the UV system for disinfection prior to final discharge.
Install Configuration:	Simplex (one pump dedicated to each membrane tank).
Potential Service Interruptions:	Power failure, parts failure (e.g. bearings, seals, etc.). Regular service and maintenance activities.
Bypass Mode(s):	5.2.4 Internal Bypass – Overflow from EQ Tank (20-TK-01) • Note that bypass is only required if both permeate pumps are out of service simultaneously. If one unit is out of service, the other membrane tank is capable of accepting the average day design flow.
Bypass Mitigation:	1. Maintain full inventory of spare parts. 2. If service interruption is a planned maintenance activity, schedule repairs or inspections to coincide with periods when trucks would not normally deliver wastewater to the plant such as evenings. 3. Regular service and maintenance according to the manufacturer's recommendations will help to minimize service interruptions.

5.3.14 Return Activated Sludge (RAS) Pumps (65-RP-01, 65-RP-02)

Description:	The RAS pumps return mixed liquor from the membrane tanks back to the anoxic tank. The purpose is to promote an even distribution of solids throughout the treatment system and avoid over-concentrating the solids in the membrane tanks.
Install Configuration:	Simplex (one pump dedicated to each membrane tank).
Potential Service Interruptions:	Power failure, parts failure (e.g. belts, bearings, etc.). Regular service and maintenance activities.
Bypass Mode(s):	5.2.4 Internal Bypass – Overflow from EQ Tank (20-TK-01) • Note that bypass is only required if both RAS pumps are out of service simultaneously. If one unit is out of service, the other membrane tank is capable of accepting the average day design flow.
Bypass Mitigation:	1. Maintain full inventory of spare parts.

2. If service interruption is a planned maintenance activity, schedule repairs or inspections to coincide with periods when trucks would not normally deliver wastewater to the plant such as evenings.
3. Regular service and maintenance according to the manufacturer's recommendations will help to minimize service interruptions.

5.3.15 UV Disinfection System (80-UV-01)

Description:	The UV system provides final disinfection of the effluent prior to discharge to the environment. It is an open channel system with UV lamps submerged in the channel.
Install Configuration:	Simplex (single channel with multiple lamp racks in parallel).
Potential Service Interruptions:	Bulb fouling that requires cleaning. Biofilm growth on channel that requires cleaning. Lamp failure. Power failure.
Bypass Mode(s):	5.2.6 Internal Bypass – UV Disinfection System (80-UV-01) • If lamps must be removed for cleaning or replacement, this can be accomplished without bypassing the channel. Individual lamp racks can be removed from the channel. The bypass line only needs to be used in the event the channel itself needs to be taken out of service for cleaning.
Bypass Mitigation:	1. Maintain full inventory of spare parts. 2. Regular inspection of the lamps and channel for biofilm growth and cleaning will help minimize service interruptions. 3. If service interruption is a planned maintenance activity, schedule repairs or inspections to coincide with periods when trucks would not normally deliver wastewater to the plant such as evenings. 4. Regular service and maintenance according to the manufacturer's recommendations will help to minimize service interruptions.

5.3.16 Sludge Storage Tank (70-TK-01)

Description:	Waste Activated Sludge (WAS) must be removed from the membrane tanks on a regular basis to control the solids concentration. WAS is directed to the sludge storage tank until it can be dewatered. The tank is aerated for mixing and to avoid septic conditions. Issues would generally arise when wasting from the MBR system is required but there is some problem with the dewatering system.

Install Configuration:	Simplex (tank)
Potential Service Interruptions:	Maintenance/replacement/inspection of the aeration diffuser grid (infrequent).
Bypass Mode(s):	5.2.7 Internal Bypass – Overflow from Sludge Storage Tank (70-TK-01) • This mode of bypass should only be used in emergency situations. The operator should attempt to stop the overflow condition as soon as possible by decanting from the tank or by suspending wasting from the MBR system. 5.2.8 Internal Bypass – Decant from Sludge Storage Tank (70-TK-01) • If the operator needs to waste sludge from the MBR system but the tank is full and the dewatering system is out of service, the operator should attempt to decant clean liquid from the storage tank to reduce the volume.
Bypass Mitigation:	1. Under normal operation, regular operation of the dewatering system will help to maintain a low level in the storage tank. This will maximize the available volume for storage in the event of a failure. 2. Temporarily suspending wasting from the MBR system can stop an emergency overflow situation from the storage tank. 3. Regular inspection, service, and maintenance of the tank and the dewatering system as described in the following sections can minimize dewatering service interruptions that could lead to high levels in the storage tank.

5.3.17 Sludge Storage Aeration Blowers (75-AB-01, 75-AB-02)

Description:	Aeration is provided to the sludge storage tank for mixing and to avoid septic conditions.
Install Configuration:	Duty/Standby
Potential Service Interruptions:	Power failure, parts failure (e.g. belts, bearings, etc.). Regular service and maintenance activities.
Bypass Mode(s):	None required: • If there is a service interruption to a single blower, the other installed unit can be put into service for the duration of the interruption. In the unlikely event that both blowers have failed simultaneously, WAS can still be directed to the storage tank until odours become a concern.

Bypass Mitigation:

1. Although no bypass is required for this process, the following steps will help to minimize the impact of service interruptions:
2. Maintain full inventory of spare parts.
3. Regular inspection, service, and maintenance according to the manufacturer's recommendations will help reduce interruptions.
4. If service interruption is a planned maintenance activity, schedule repairs or inspections to coincide with periods when trucks would not normally deliver wastewater to the plant such as evenings.
5. If both blowers have failed simultaneously, the operators should strive to lower the tank level as much as possible by ramping up dewatering operations. Running at a lower level and with "newer" sludge in the storage tank will reduce odour impacts which could be a concern if there is no aeration.

5.3.18 Waste Sludge Pump (70-WSP-01)

Description: The peristaltic waste sludge pump is used to transfer WAS from the sludge storage tank to the dewatering system.

Install Configuration: Simplex (1 installed unit plus 1 complete shelf spare).

Potential Service Interruptions:

Pump hose failure.

Other mechanical parts failure.

Service interruption to the polymer system (WAS should not be sent to dewatering if polymer cannot be added).

Scheduled service and maintenance.

Power failure.

Bypass Mode(s):

5.2.7 Internal Bypass – Overflow from Sludge Storage Tank (70-TK-01)

- This mode of bypass should only be used in emergency situations. The operator should attempt to stop the overflow condition as soon as possible by decanting from the tank or by suspending wasting from the MBR system.

5.2.8 Internal Bypass – Decant from Sludge Storage Tank (70-TK-01)

- If the operator needs to waste sludge from the MBR system but the tank is full and the dewatering system is out of service, the operator should attempt to decant clean liquid from the storage tank to reduce the volume.

Bypass Mitigation:

1. Under normal operation, regular operation of the dewatering system will help to maintain a low level in the storage tank. This

will maximize the available volume for storage in the event of a failure.

2. Temporarily suspending wasting from the MBR system can stop an emergency overflow situation from the storage tank as a result of an interruption in WAS pump service.
3. Maintain a sufficient inventory of all spare parts. In particular, the operators should have at least one brand new spare pump hose on the shelf at all times.
4. Regular service and maintenance of the shelf spare pump will help to ensure it is in good working condition should the failure of the installed pump require a complete replacement.
5. Regular inspection, service, and maintenance of the installed pump can minimize dewatering service interruptions that could lead to high levels in the storage tank.

5.3.19 Polymer Dosing System

Description:	Polymer is injected into the WAS line downstream of the WAS pump. Polymer promotes better solids separation in the dewatering system. Under normal operation, it is not recommended to send WAS to dewatering without polymer addition.
Install Configuration:	Simplex (one installed dosing pump plus shelf spare).
Potential Service Interruptions:	Pump hose failure. Other mechanical parts failure. No neat polymer available. Plugged polymer lines. Regular service and maintenance. Power failure.
Bypass Mode(s):	If the polymer system is non-operational, bypass procedures for the sludge storage tank should be followed.
Bypass Mitigation:	1. Maintain a sufficient inventory of all spare parts. In particular, the operators should have at least one brand new spare pump hose on the shelf at all times. 2. Operator's should ensure that sufficient quantities of polymer are on-hand. It is recommended to start with fresh polymer at least every 12 months. 3. Regular service and maintenance of the shelf spare pump will help to ensure it is in good working condition should the failure of the installed pump require a complete replacement.

4. Regular inspection, service, and maintenance of the installed pump can minimize dewatering service interruptions that could lead to high levels in the storage tank.
5. Although not normally recommended, operators may be able to send WAS to the dewatering system without polymer for short durations in emergency situations. This may lead to poor dewatering performance and premature blinding of the dewatering filter bag (Geotube®).

5.3.20 Filtrate Return Pump (70-FRP-01)

Description:	Filtrate from the dewatering system is collected in the filtrate sump. A submersible filtrate return pump directs the filtrate to the start of the treatment system.
Install Configuration:	Simplex (one installed pump plus a complete shelf spare).
Potential Service Interruptions:	Power failure, parts failure (e.g. belts, bearings, etc.). Regular service and maintenance activities.
Bypass Mode(s):	If there is a service interruption to the filtrate pump, the dewatering system cannot operate. Under this scenario, bypass procedures for the sludge storage tank should be followed.
Bypass Mitigation:	1. Maintain a sufficient inventory of all spare parts. 2. Regular service and maintenance of the shelf spare pump will help to ensure it is in good working condition should the failure of the installed pump require a complete replacement. 3. Regular inspection, service, and maintenance of the installed pump per manufacturer's recommendations.

5.3.21 Gen-Set for Backup Power

Description:	A diesel generator has been installed at the plant to provide backup power to all building systems and process equipment.
Install Configuration:	Simplex (generator) Duty/standby (fuel transfer pumps)
Potential Service Interruptions:	Lack of fuel. Mechanical failure of the fuel transfer pumps or diesel engine.
Bypass Mode(s):	5.2.1 External Bypass • Bypass is only required if there is a loss of main power that occurs simultaneously with a issue or failure of the generator

or fuel transfer pumps. If this situation occurs, wastewater cannot be directed to the treatment plant.

Bypass Mitigation:

1. Regular service and maintenance of the system should be completed by a licensed technician. The service program should include the diesel engine and the fuel transfer system.
2. Maintain a sufficient inventory of spare parts and consumables as recommended by the manufacturer for both the diesel engine and fuel transfer pumps.
3. Operators should regularly check the levels of the main fuel storage tank and the day tank. Levels should be maintained as close to full as possible.

6. Bypass Recording and Reporting

If a bypass event occurs at the plant, for whatever reason, this represents either untreated or partially treated wastewater that is being discharged to the environment. Operators should take steps to record the details of the bypass event. It is recommended to record the following details in a log for each individual bypass event:

- Date(s) on which the event occurred.
- Total duration of the event in hours or days.
- Mode(s) of bypass used during the event (refer to Section 5.2 for available modes).
- Estimated volume of wastewater bypassed during the event. This information can usually be taken directly from plant flowmeter data logged in the SCADA system to estimate the total bypassed flow during the event. Some additional suggestions for estimating total bypassed volume are as follows:
    - If the bypass is an external event, operators must estimate the total volume by counting the number of trucks and multiplying by the estimated capacity of each truck. Communication with the drivers may assist with this estimate.
    - If the bypass mode is via a tank overflow, operators can estimate the duration of the bypass event using the level transmitter readings for that tank. The level in the tank must be at the high level in order for bypass to have occurred.
    - If the bypass event does not result in untreated or partially treated wastewater being discharged to the environment, then no volume is recorded. An example would be decant from the sludge storage tank where the bypass results in an internal recycle to the plant headworks and not directly to the final outfall.
- The ultimate cause of the event which may include details of equipment failures, service interruptions, or other issues that lead to the bypass event.
- Follow-up action that was taken to correct the bypass event or reduce the magnitude of the event.
- Any changes in operating procedures as a result of the bypass event. This is a critical step in the process as it encourages operators to review and think about how they may be able to improve the plant operation and maintenance activities to help prevent or reduce future bypass events.

It is recommended that each of the local contacts identified in Table 4-1 be notified immediately at the time of the bypass event. **As well, the incident is to be reported to the NT/NU Spill Line at (867) 920-8130**. In some cases, the operators may also need to have immediate communication with the truck drivers to make them aware of potential issues at the plant. Drivers may need to either slow down their discharge rates to the plant, modify their hauling frequency, or bypass the plant altogether depending on the nature of the issues.

Operators also need to be familiar with any requirements for regulatory reporting as identified in the plant's operating permit and follow these procedures in addition to those listed here.

7. Bypass Follow-up

7.1 Training

To ensure the effectiveness of the Bypass Contingency Plan (BCP), the following actions should be followed:

1. The BCP should be reviewed, as a minimum, on an annual basis and updated as required by changes in operation and/or technology.
2. The BCP should be distributed to the operations personnel.
3. The personnel should be informed as to the importance of first response with respect to the protection of human health and safety, the environment, property, wildlife and the ecosystem by reducing the frequency and duration of bypass events.

7.2 Equipment Service and Maintenance

The number one cause of bypass events is service interruption to key equipment that prevents the complete treatment of wastewater prior to discharge. Operators should review all equipment operation and maintenance manuals regularly and complete all recommended maintenance as recommended by the manufacturer. This should also include any maintenance recommended for shelf spare equipment units. Regular and careful maintenance is the best way to combat premature and/or unexpected equipment failures. Where the operators may not be qualified to complete the maintenance (e.g. the diesel generator and fuel transfer system), a qualified technician should be contracted to complete these duties at the recommended frequency.

8. Closure

The wastewater treatment that has been constructed in the Hamlet of Pangnirtung is capable of a very high level of treatment to protect and maintain the pristine receiving water in the Pangnirtung Fjord. The plant operators have an important role to play by ensuring the treatment plant is well maintained and is performing to the best of its ability. Part of this job is to manage the potential for bypass events that can allow untreated or partially treated wastewater to be discharged. It is impossible to expect that bypass events will be completely eliminated and the job, therefore, is to reduce the frequency and impact of the events that do occur. Through careful operation and diligent maintenance, the operators can be effective in mitigating the impacts of bypass events.

This document has provided a summary of the bypass events that could occur at the treatment plant as well as suggested causes and recommended action and follow-up items. Operators should regularly review this document as well as all operation and maintenance manuals to ensure they are familiar with all procedures. The operators are also encouraged to play an active role in the continued development and refinement of these procedures by recommending changes as they see fit. It is through diligent application of these procedures and continual improvement that the impact of bypass events at the plant will be minimized.

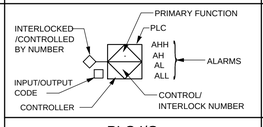
Appendix A – Drawings

- Process Flow Diagram, Symbols, Legend and Abbreviations (Dwg. P401-1)
- Process and Instrumentation Diagram (P&ID) (Dwg. P401-2)
- Process and Instrumentation Diagram (P&ID) (Dwg. P401-3)

ABBREVIATIONS

AA -	ANALYSIS ALARM
AAE -	AUTOMATIC AIR ELIMINATOR
AAIR -	ANALYSIS ALARM INDICATING RECORDER
AAV -	AUTOMATIC AIR VENT
AB -	AERATION BLOWER
AC -	ANALYSIS CONTROL OR AIR COMPRESSION
ACS -	AUTOMATIC COARSE SCREEN
AD -	AIR DRYER
ADE -	ANAEROBIC DIGESTER EFFLUENT
ADG -	ANAEROBIC DIGESTER GAS
ADR -	ANAEROBIC DIGESTER RECYCLE
ADRP -	ANAEROBIC DIGESTER RECYCLE PUMP
AE -	ANALYSIS ELEMENT
AF -	AIR FILTER
AFP -	ALUM FEED PUMP
AHLR -	ALARM HIGH/LOW RECORDING
AH -	ALARM HIGH
AHH -	ALARM HIGH/HIGH
AI -	ANALYSIS INDICATOR
AIR -	AIR
AIT -	ANALYSIS INDICATING TRANSMITTER
AL -	ALARM LOW
ALL -	ALARM LOW/LOW
AM -	AUGER MOTOR
AMS -	ALKALINITY METERING SYSTEM
AnMBR -	ANAEROBIC MEMBRANE BIOREACTOR
AOV -	AIR OPERATED VALVE
AR -	ANALYSIS RECORDER
ARI -	ANALYSIS RECORDER/INDICATOR OR ANAEROBIC REACTOR INFLUENT
ART -	AIR RECEIVER TANK
ARVB -	AIR RELIEF AND VACUUM BREAKER
AS -	AUTOMATIC SAMPLER
BB -	BIOGAS BLOWER
BC -	BELT CONVEYOR
BF -	BACK FLUSH
BFP -	BIOLOGICAL FEED PUMP
BG -	BIOGAS
BP -	BYPASS
BPV -	BACK PRESSURE VALVE
BS -	BAR SCREEN OR BASKET STRAINER
BSP -	BUILDING SUMP PUMP
BSV -	BLOCKING SAFETY VALVE
BVF -	BULK VOLUME FERMENTER
BWP -	BOOSTER WATER PUMP
CA -	COMPRESSED AIR
CAD -	COMPRESSED AIR DRYER
CBP -	CHEMICAL CLEANING WATER BOOSTER PUMP
CC -	CALIBRATION COLUMN
CD -	CONDENSATE DRAIN
CF -	COOLING FAN OR CHEMICAL FEED
CFP -	CHEMICAL FEED PUMP
CPF -	CHEMICAL POT FEEDER
CS -	CONTROL STATION
CV -	CONTROL VALVE
DBC -	DISTRIBUTION BELT CONVEYOR
DCS -	DISTRIBUTED CONTROL SYSTEM
DFB -	DUAL FUEL BOILER
DFO -	DROP FEED OILER
DFP -	DEFOAMER METERING PUMP
DO -	DISSOLVED OXYGEN
DP -	DEWATERING PRESS OR DILUTE POLYMER
DPG -	DIFFERENTIAL PRESSURE GAUGE OR DIGITAL PRESSURE GAUGE
DR -	DRAIN
DS -	DRAIN SUMP
DSP -	DRAIN SUMP PUMP
DT -	DRIP TRAP
ED -	EDUCTOR
EFF -	EFFLUENT
EFP -	EDUCTOR FEED PUMP
EJ -	EXPANSION JOINT
EOF -	EMERGENCY OVERFLOW
EP -	EFFLUENT PUMP
ETK -	EXPANSION TANK
FA -	FLOW ALARM
FAL -	FLOW ALARM LOW
FC -	FLOW CONTROLLER OR FLAME CHECK OR FLUSH CONNECTION
FCP -	FLARE CONTROL PANEL OR FERRIC CHLORIDE PUMP
FCV -	FLOW CONTROL VALVE
FD -	FLOOR DRAIN
FDS -	FINE DRUM SCREEN
FE -	FLOW ELEMENT
FI -	FLOW INDICATOR
FIT -	FLOW INDICATING TRANSMITTER
FL -	FLARE
FLV -	FLOAT VALVE
FM -	FLOWMETER
FQI -	FLOW QUANTITY INDICATOR
FQR -	FLOW QUANTITY RECORDER
FQRI -	FLOW QUANTITY RECORDER/INDICATOR
FS -	FERMENTER SLUDGE OR FINE SCREEN
FTA -	FLAME TRAP ASSEMBLY
FV -	FILL VALVE OR FOOT VALVE
FW -	FLUSH WATER
GEC -	GAS ELIMINATION CHAMBER
GG -	GAUGE GUARD
GR -	GRINDER
GV&B -	GATE VALVE & BOX
H -	HORN
HB -	HOSE BIBB
HOP -	HOPPER
HP -	HEATING PUMP
HS -	HAND SWITCH
HSFA -	HIGH SPEED FLOATING AERATOR
HX -	HEAT EXCHANGER
IC -	CURRENT CONTROLLER
INF -	INFLUENT
INJ -	VENTURI INJECTOR
IP -	INFLUENT PUMP
IT -	CURRENT TRANSMITTER
IV -	INJECTION VALVE
JRC -	JET RECIRCULATION
JRP -	JET RECIRCULATION PUMP
KC -	TIMER CONTROLLER
LA -	LEVEL ALARM
LAH -	LEVEL ALARM HIGH
LAL -	LEVEL ALARM LOW
LAHL -	LEVEL ALARM HIGH/LOW
LARI -	LEVEL ALARM RECORDER INDICATOR
LC -	LEVEL CONTROLLER
LCP -	LOCAL CONTROL PANEL
LE -	LEVEL ELEMENT
LI -	LEVEL INDICATOR
LIT -	LEVEL INDICATING TRANSMITTER
LR -	LEVEL RECORDER
LPS -	LADDER PIPE SUPPORT
LRI -	LEVEL RECORDER/INDICATOR
LS -	LEVEL SWITCH
LSC -	LEVEL SWITCH CLOSED
LSH -	LEVEL SWITCH HIGH
LSL -	LEVEL SWITCH LOW
MBR -	MEMBRANE BIOREACTOR
MCV -	MODULATING CONTROL VALVE
MFP -	MEMBRANE BIOREACTOR FEED PUMP
MFV -	MULTI-PUNCTURE VALVE
MH -	MAGNESIUM HYDROXIDE
MHP -	MAGNESIUM HYDROXIDE PUMP
MIX -	MIXER
MP -	MAGNESIUM HYDROXIDE PUMP
MPP -	MEMBRANE BIOREACTOR PERMEATE PUMP
MRP -	MEMBRANE BIOREACTOR RECYCLE PUMP
MV -	MOTORIZED VALVE
MWP -	MONITORING WELL PUMP
NC -	NORMALLY CLOSED
NMP -	NITROGEN METERING PUMP
NO -	NORMALLY OPEN
NOx -	NITROGEN
NP -	NUTRIENT PUMP OR NEAT POLYMER
NPW -	NON-POTABLE WATER
NWL -	NORMAL WATER LEVEL
NWP -	NON-POTABLE WATER PUMP
O2 -	OXYGEN
OCV -	OPEN/CLOSE VALVE
PAH -	PRESSURE ALARM HIGH
PAC -	POLY ALUMINUM CHLORIDE
PAL -	PRESSURE ALARM LOW
PAP -	PHOSPHORIC ACID PUMP
PAM -	POLYMER SYSTEM
PB -	PLOW BLENDER
PC -	PRESSURE CONTROLLER OR PRIMING CONNECTION
PCRI -	PRESSURE CONTROLLER RECORDER INDICATOR
PE -	PRESSURE ELEMENT
PFP -	POLYMER FEED PUMP
PG -	PRESSURE GAUGE OR PROPANE GAS
PH/T -	PH AND TEMPERATURE
PI -	PROCESS AND INSTRUMENTATION DIAGRAM
P&ID -	PRESSURE INDICATOR/MANOMETER
PIR -	POLYMER INJECTION RING
PIT -	PRESSURE INDICATING TRANSMITTER
PLC -	PROGRAMMABLE LOGIC CONTROLLER
PM -	PADDLE MOTOR
PMP -	PHOSPHORUS METERING PUMP
PP -	PURGE POINT OR POLYMER PUMP
PRI -	PRESSURE RECORDER/INDICATOR
PRV -	PRESSURE RELIEF, REGULATING OR REDUCING VALVE
PS -	PRESSURE SWITCH
PSH -	PRESSURE SWITCH HIGH
PT -	PRESSURE TRANSMITTER
PV -	PINCH VALVE
QC -	QUICK CONNECT
RADS -	RECYCLE ANAEROBIC DIGESTER SLUDGE
RANS -	RETURN ANAEROBIC SLUDGE
RAS -	RECYCLE ACTIVATED SLUDGE
RAW -	RAW WASTEWATER
REC -	RECYCLE
REP -	REACTOR FEED PUMP
RP -	RETURN ACTIVATED SLUDGE PUMP
RSP -	RAW SEWAGE PUMP
RTP -	RAW WASTEWATER TRANSFER PUMP
S -	SOLENOID
SA -	SAMPLE
SARV -	SEWAGE AIR RELIEF VALVE
SBR -	SEQUENCING BATCH REACTOR
SC -	SPEED CONTROLLER/VFD OR SCREEN
SDB -	SLUDGE DUMPING BIN
SFB -	SINGLE FUEL BOILER
SFP -	SLUDGE FEED PUMP
SG -	SUCTION GUIDE OR SIGHT GLASS
SM -	STATIC MIXER
SMP -	SAMPLER PUMP
SMT -	SEDIMENT MOISTURE TRAP
SMU -	SUBMERGED MEMBRANE UNIT
SN -	SPARE NIPPLE
SO -	SULFIDE OXIDATION
SP -	SAMPLE POINT OR SOLUTION PUMP
SSP -	SCREENED SEWAGE PUMP
ST -	SAMPLE TAP
STR -	STRAINER
SV -	SOLENOID VALVE
SW -	SLUDGE WASTE
TA -	TEMPERATURE ALARM
TAH -	TEMPERATURE ALARM HIGH
TC -	TEMPERATURE CONTROLLER
TE -	TEMPERATURE ELEMENT
TG -	TEMPERATURE GAUGE
TI -	TEMPERATURE INDICATOR
TIT -	TEMPERATURE INDICATING TRANSMITTER
TIS -	TEMPERATURE INDICATING SWITCH
TK -	TANK
TR -	TRAILER
TRI -	TEMPERATURE RECORDER/INDICATOR
TS -	TEMPERATURE SWITCH OR TUBE SETTLER
TT -	TEMPERATURE TRANSMITTER
UAP -	UREA ADDITION PUMP
UV -	ULTRAVIOLET DISINFECTION
V -	VALVE
VAFM -	VARIABLE AREA FLOW METER
VFD -	VARIABLE FREQUENCY DRIVE
VE -	VACUUM EJECTOR
VT -	VENT
W -	WATER
WADS -	WASTE ANAEROBIC DIGESTER SLUDGE
WANS -	WASTE ANAEROBIC SLUDGE
WAS -	WASTE ACTIVATED SLUDGE
WC -	WASHER/CONTACTOR
WCP -	WATER CIRCULATING PUMP
WP -	WASTE ANAEROBIC SLUDGE PUMP
WPS -	WALL PIPE SUPPORT
WSP -	WASTE SLUDGE PUMP
WW -	WASTEWATER
WWP -	WASH WATER PUMP
YA -	EVENT ALARM
YC -	EVENT/STATUS CONTROLLER
YS -	EVENT SWITCH
ZS -	LIMIT SWITCH
ZSL -	LIMIT SWITCH LOW
ZSC -	LIMIT SWITCH CLOSED
ZSO -	LIMIT SWITCH OPEN
ZSOC -	LIMIT SWITCH OPEN/CLOSED

PLC AND DEVICE LEGEND



PLC I/O

A	1 DISCRETE OUTPUT	I	1 ANALOG OUTPUT
B	1 DISCRETE OUTPUT 2 DISCRETE INPUTS	J	2 DISCRETE OUTPUT
C	1 DISCRETE INPUT	K	4 DISCRETE INPUTS 2 ANALOG INPUTS
D	1 ANALOG INPUT	L	DEVICENET
E		XX	INTERLOCKS USED: 1-
F	1 DISCRETE OUTPUT 2 DISCRETE INPUTS 1 ANALOG OUTPUT		
G			
H	1 ANALOG OUTPUT 1 DISCRETE INPUT		

CONTROLLER / CONTROL PANELS

1 MBR
2 DEWATERING
3 DELTA V
4 AERATION

FIELD MOUNTED

PRIMARY REMOTE LOCATION

PLC SYMBOLS

FIELD MOUNTED

PRIMARY REMOTE LOCATION

INSTRUMENT SYMBOLS

SINGLE DEVICE FIELD MOUNTED

MULTIPLE DEVICES INTEGRALLY CONNECTED

MULTIPLE DEVICES REMOTELY CONNECTED

EQUIPMENT IDENTIFICATION PROCEDURE

NN DDD #

NN: TWO DIGIT PROCESS AREA NUMBER. THIS IS USED TO IDENTIFY THE AREA OF THE PROCESS IN WHICH THE EQUIPMENT IS USED RATHER THAN THE AREA IN WHICH IT IS LOCATED.

DDDD: DEVICE DESCRIPTION FROM LEGEND IN AREA NN. EG., THE FIRST PI IN THE HEADWORK SYSTEM IS 10-PI-01; ETC.

#: DEVICE/EQUIPMENT NUMBER

INFORMATION BLOCKS

FLOWSTREAM CONTINUATION TO/FROM OTHER DRAWINGS OR TO/FROM PROCESS BY OTHERS.

A — FLOWSTREAM CONTINUATION ON SAME DRAWING.

END DELIVERY (BATTERY LIMITS)

PIPING ACCESSORIES

AIR FILTER
PIPE CAP OR PLUG
COUPLING
BLIND FLANGE (IN-LINE)
BLIND FLANGE
COMPENSATOR
DRAIN
SPRAY NOZZLE
VENT
PULSE ABSORBER
VENTURI INJECTOR
UNION
SIPHON
SIGHT-GLASS WITH FLOW READING
SIGHT-GLASS
FLEXIBLE CONNECTOR
FLEXIBLE CONNECTING REDUCER
CONCENTRIC REDUCER
ECCENTRIC REDUCER
TRUCK CONNECTION
GRAVITY FLOW
JET MIX / JET AERATION
SILENCER
SPRAY NOZZLE
HEADER
FLAME ARRESTOR
CONDENSATE OR DRIP TRAP
STRAINER
STATIC MIXER
BRAIDED HOSE
CO — CLEANOUT
PP — PURGE POINT
DECANTER
BASKET STRAINER
LIQUID SEAL
HEAT EXCHANGER
GG — GUAGE GUARD
SMT — SEDIMENT MOISTURE TRAP
AIR RELIEF VALVE AND BREAKER
HOSE CONNECTION

VALVES

VALVE (BASIC SYMBOL)
BALL VALVE
PLUG VALVE
THREE WAY PLUG VALVE
DIAPHRAGM VALVE
NEEDLE VALVE
KNIFE GATE VALVE
BUTTERFLY VALVE
CHECK VALVE
FOOT VALVE
THREE WAY COCK
PRESSURE REDUCING VALVE
PRESSURE RELIEF VALVE
OVER PRESSURE RELIEF VALVE
UNDER PRESSURE RELIEF VALVE
ADJUSTABLE OVER PRESSURE RELIEF VALVE
BACK PRESSURE VALVE
PINCH VALVE
LUBRICATED PLUG VALVE
MOTOR ACTUATED
DIAPHRAGM ACTUATED
FLOAT CONTROLLED
SPRING ACTUATED
WEIGHT CONTROLLED
S — SOLENOID VALVE
PNEUMATIC CONTROL VALVE
LOCKABLE ACTUATOR ON VALVE
VENT VALVE
PRESSURE REGULATOR
MOTORIZED SAFETY SHUT-OFF VALVE
SHUT-OFF COCK
TWIN FLAPPER CHECK VALVE
MULTI-FUNCTION VALVE
GV&B — GATE VALVE AND BOX
BV&B — BUTTERFLY VALVE AND BOX

DRIVER TYPE

M — ELECTRIC
H — HYDRAULIC
P — PNEUMATIC

PUMPS/ROTARY EQUIPMENT

PUMP
POSITIVE DISPLACEMENT PUMP
FAN/ CENTRIFUGAL PUMP
PD BLOWER
SUBMERSIBLE MIXER
IMPELLER TYPE MIXER
COMPRESSOR
MIXER
CENTRIFUGAL BLOWER
GRINDER
FINE SCREEN AND COMPACTOR

PROCESS AREA IDENTIFIERS

IDENTIFIER	DESCRIPTION
00-09	UNCLASSIFIED. USE THIS FOR ANY EQUIPMENT WHICH CANNOT BE PLACED INTO ANY OTHER AREA.
10-19	INFLUENT SYSTEM / HEADWORKS
20-29	PRIMARY CLARIFICATION/EQUALIZATION
30-39	ANAEROBIC SYSTEM
40-49	BIOGAS HANDLING/UTILIZATION SYSTEM
50-54	ANOXIC/PRE-AERATION SYSTEM
55-59	MBR SYSTEM
60-64	AERATION SYSTEM
65-69	RAS SYSTEM
70-79	SLUDGE MANAGEMENT SYSTEM
80-89	EFFLUENT TREATMENT AND PUMPING SYSTEMS
90-99	CHEMICAL METERING SYSTEMS

NOTE: NOT ALL ABBREVIATIONS, LEGEND, SYMBOLS, VALVE TYPE, PROCESS AREA IDENTIFIERS, ETC. APPLY

PIPING IDENTIFICATION PROCEDURE

XX - XXX / XXX - XX / XX

- PIPE RATING FOLLOWED BY JOINT TYPE (WHEN REQUIRED FOR CLARIFICATION)
- PIPE MATERIAL ABBREVIATION
- FLOW STREAM ABBREVIATION
- FLOW STREAM SOURCE ABBREVIATION (WHEN REQUIRED FOR CLARIFICATION)
- NOMINAL DIAMETER IN mm

FLOWSTREAM SOURCE ABBREVIATION

MT	MEMBRANE TANK

PIPE MATERIAL ABBREVIATION

CPVC	CHLORINATED POLYVINYL CHLORIDE
CS	CARBON STEEL
CU	COPPER
PE/T	POLYETHYLENE TUBING
PVC	POLYVINYL CHLORIDE
PVC/BT	PVC BRAIDED TUBING
SS	STAINLESS STEEL

PIPE RATING

DR	DIMENSION RATIO
DWV	DRAIN, WASTE & VENT
GR	GRAVITY
T	TUBING
SCH	SCHEDULE

JOINT TYPE

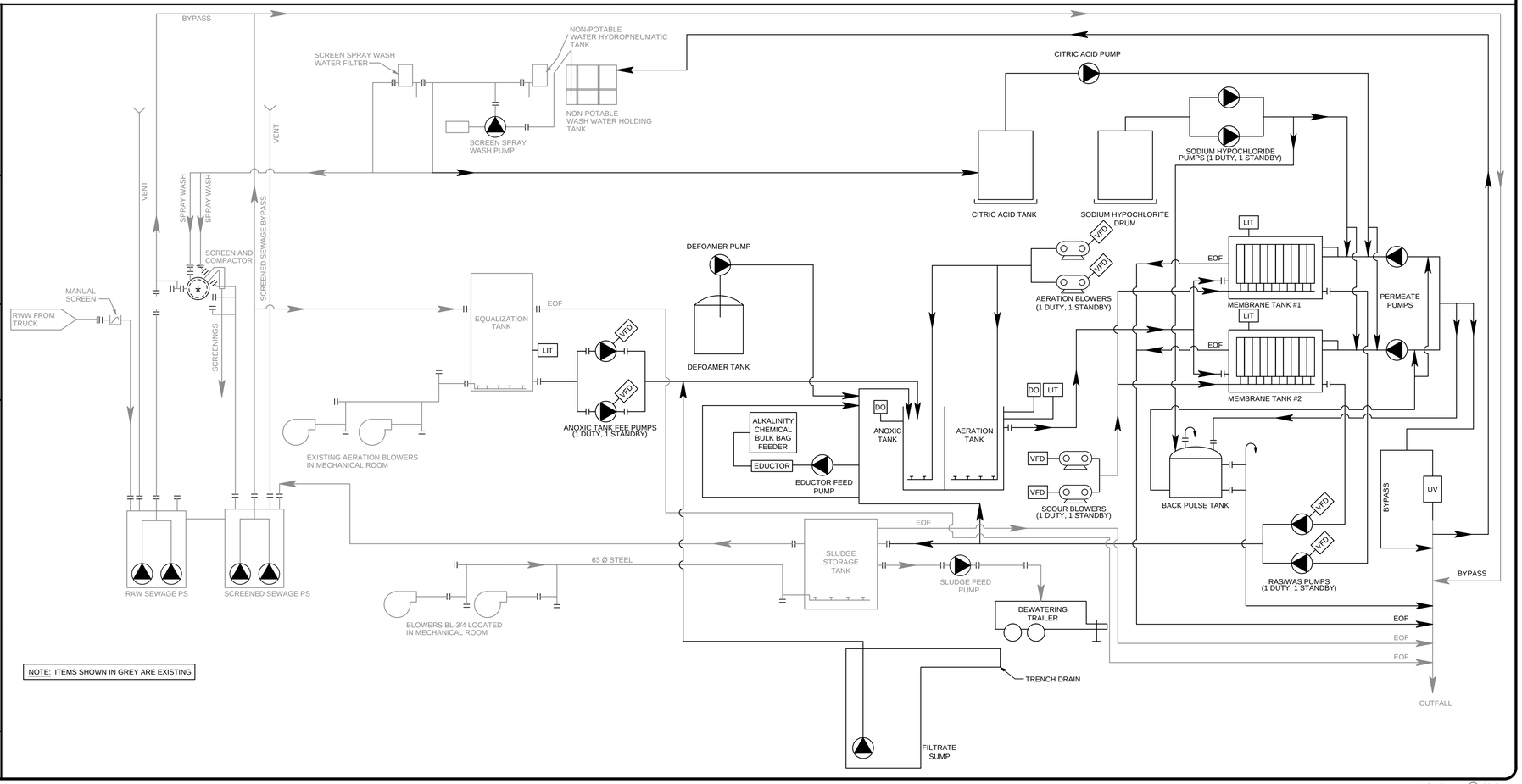
FL	FLANGED
G	GASKETED
NPT	THREADED
SW	SOLVENT WELDED
W	WELDED
SC	THREADED

FLOWSTREAM ABBREVIATION

AA	AERATION AIR	MF	MEMBRANE FEED
AD	ANAEROBIC DIGESTER	NG	NATURAL GAS
ATF	ANOXIC TANK FILL	NP	NEAT POLYMER
ATT	ATTEMPERATION TANK	NPW	NONPOTABLE WATER
BF	BACKFLUSH	OVF	OVERFLOW
BG	BIOGAS	PAC	POLY-ALUMINUM CHLORIDE
BPS	BYPASS	PER	PERMEATE
CA	COMPRESSED AIR	PG	PROPANE GAS
CAF	CITRIC ACID FEED	PF	POLYMER FEED
CC	CLEANING CHEMICAL	PW	POTABLE WATER
CCS	CLEANING CHEMICAL SOLUTION	PX	PEROXIDE
CCW	CLEANING CHEMICAL WASTE	R	RETURN
CEN	CENTRATE	RANS	RETURN ANAEROBIC SLUDGE
CF	CHEMICAL FEED	RAS	RETURN ACTIVATED SLUDGE
CW	COLD WATER	RWW	RAW WASTEWATER
DF	DEFOAMER	RWW FT	RAW WASTEWATER FROM TRUCK
DR	DRAIN	REC	RECYCLE
EFF	EFFLUENT	S	SAMPLE OR SUPPLY
EOF	EMERGENCY OVERFLOW	SA	SANITARY
EQ IN	EQUALIZATION TANK INFLUENT	SCOUR	SCOUR
EQ VT	EQUALIZATION TANK VENT	SCUM	FLOATING SCUM
FE	FERRIC/FERROUS	SF	SOLUTION FEED
FILL	FILL	SHF	SODIUM HYPOCHLORITE FEED
FL	FLAME LINE	SR	SOLUTION RECYCLE
FM	FORCE MAIN	SREC	SUPERNATANT RECYCLE
GLR	GLYCOL RETURN	SW	SERVICE WATER
GLS	GLYCOL SUPPLY	SWW	SCREENED WASTEWATER
GRIT	GRIT	VT	VENT
HP	HYDROGEN PEROXIDE	W	WATER
HPW	HIGH PRESSURE WATER	WANS	WASTE ANAEROBIC SLUDGE
HW	HOT WATER	WAS	WASTE ACTIVATED SLUDGE
INF	INFLUENT	WCC	WASTE CLEANING CHEMICAL
MBP	MEMBRANE BACKPULSE		

SUPPLEMENT

PIPE SIZES ON SOME PIPING SYSTEMS, (NPW), MAY BE INDICATED USING THE NPS STANDARD BASED ON INCHES.



NOTE: ITEMS SHOWN IN GREY ARE EXISTING

No.	Issue	Date
1	60% REVIEW SUBMISSION	2013-MAR-08
2	ISSUED FOR TENDER	2013-APR-10
3	RELEASED FOR CONSTRUCTION	2013-JUN-27
1	RECORD DRAWING	BFB	2015-OCT-16
No.	Revision	Ckd. By	Date

RECORD DRAWING

Const. North

Drawn By: ARL

Dwg. Standards Ckd. By: PD

Designed By: DFB

Date Printed

Dwg. Design Ckd. By: SAO

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Project Title

WASTE WATER TREATMENT PLANT UPGRADE PANGNIRTUNG, NU

Dwg. Title

FLOW DIAGRAM, SYMBOLS, LEGEND & ABBREVIATIONS

Project No. OTT-00204430-A0

Dwg. No. **P401-1**

Rev. No. 1

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1	TAG NUMBER CORRECTIONS	BFB 2014-NOV-27
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Dwg. Title

PROCESS AND INSTRUMENTATION DIAGRAM (P&ID)

Project No. OTT-00204430-A0

Dwg. No. **P401-2** Rev. No. 2

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WASTE SLUDGE FROM RECYCLE PUMPS SEE DWG. P401-2

WASTE SLUDGE PUMP AND POLYMER DOSING SKID

POLYMER FEED PUMP 70-PFP-01

NEAT POLYMER TOTE

70-V-16

NEAT POLMER ACTIVATION DEVICE

MIXER 70-MIX-01

70-V-19

70-V-18

70-V-17

70 PT 01

70 PE 01

70 PG 03

S

OUTDOOR VENT

70 LT 01

70 LE 01

OVERFLOW TO FINAL EFFLUENT SEE DWG. P401-2

EOF

SLUDGE STORAGE TANK 70-TK-01 (REPURPOSED EXISTING SLUDGE DIGESTER)

70 LS 05

DECANT TO SCREENED SEWAGE SUMP SEE DWG. P401-2

70-V-03

75 PG 01

75-V-05

75-V-06

70-V-06

PULSATION DAMPER 70-PD-01

PULSATION DAMPER 70-PD-02

70-V-23

70-V-15

70 SC 01

70 PC 01

70 PC 02

70 FIT 02

70 FE 02

70-V-08

70-V-09

70-V-07

70-V-10

70-V-11

70-WSP-01 SLUDGE PUMP

ST

MIXER 70-MIX-02

70-V-12

70-V-13

ST

70-V-14

70 LS 04

DEWATERING 70-TR-01

DEWATERED SLUDGE TO DISPOSAL

TRENCH DRAIN

FILTRATE RETURN TO SCREENED SEWAGE SUMP SEE DWG. P401-2

70 PG 04

70-V-20

70 LS 03

70 LS 02

70 LS 01

70-V-22

70-V-21

70-FRP-01

FILTRATE SUMP

75-V-04

75-V-02

75-V-01

75-V-03

75-AB-01

75-AB-02

EXISTING AERATION BLOWERS IN MECHANICAL ROOM

DEFOAMER CHEMICAL FEED SEE DWG. P401-2

93-V-05

93-V-04

93-BPV-01

93-V-03

93 SC 01

93-CFP-01

93-PRV-01

93 LS 01

93-V-01

DEFOAMER DRUM 93-TK-01

TO PROCESS PIPING

TO DEWATERING SCREEN SPRAY WASH SEE DWG. P401-2

80 PS 01

81-V-06

81-V-05

81-V-04

VENT

81-V-03

81-V-02

81-NWP-01

81-V-01

FROM UV DISINFECTION SEE DWG. P401-2

NON-POTABLE WATER HOLDING TANK (81-TK-01)

CITRIC ACID TO MEMBRANE TANK # 1 PERMEATE PIPING SEE DWG. P401-2

CITRIC ACID TO MEMBRANE TANK # 2 PERMEATE PIPING SEE DWG. P401-2

CITRIC ACID PANEL

91 PG 01

91-BPV-01

91-V-09

91-V-07

91-PRV-02

91-PRV-01

91-CC-01

91-V-05

91-CFP-01

91-V-06

91-V-04

91-V-07

91 LS 01

91-MIX-01

91-V-03

91-V-02

CITRIC ACID TANK 91-TK-01

SODIUM HYPOCHLORITE TO BACK PULSE TANK SEE DWG. P401-2

SODIUM HYPOCHLORITE TO MEMBRANE TANK #1 PERMEATE PIPING SEE DWG. P401-2

SODIUM HYPOCHLORITE TO MEMBRANE TANK #2 PERMEATE PIPING SEE DWG. P401-2

COMPRESSED AIR

91-V-01

92-PRV-03

SODIUM HYPOCHLORITE PANEL

92 PG 01

92-V-11

92-V-16

92-V-18

92-BPV-01

92-V-15

92-V-09

92-PRV-02

92-V-10

92-V-08

92-PRV-01

92-V-17

92-CC-01

92-V-06

92-V-03

92-CFP-02

92-CFP-01

92-V-07

92-V-04

92-V-05

92-V-08

92-V-02

92 LS 01

92-V-01

SODIUM HYPOCHLORITE DRUM 92-TK-01

61-V-11

MAINTENANCE SHOP

61 PS 01

61-V-02

19 Ø

61-V-08

61-PRV-01

TO MBR SYSTEM

61-V-12

DRAIN

61-V-09

61-V-10

61-AC-01

61-AC-02

61 PG 01

61-TK-03

AIR COMPRESSOR

TO DRAIN

61-V-01

61-V-03

61-AF-01

FILTER

61-V-04

61-V-06

61-AD-01 DRYER

61-V-07

61-AF-02

FILTER

61-V-05

AIR SUPPLY ASSEMPLY # 1

56-V-01

56-F-01

56-V-03

EJECTOR ASSEMBLY #1

56-V-07

56-V-05

56-VE-01

DRAIN

AIR VACUUM FROM PERMEATE HEADER TRAIN 1. SEE DWG P401-2

AIR SUPPLY ASSEMPLY # 2

56-V-02

56-F-02

56-V-04

EJECTOR ASSEMBLY #2

56-V-08

56-V-06

56-VE-02

DRAIN

AIR VACUUM FROM PERMEATE HEADER TRAIN 2. SEE DWG P401-2

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Dwg. Title

PROCESS AND INSTRUMENTATION DIAGRAM (P&ID)

Project No. OTT-00204430-A0

Dwg. No. **P401-3**

Rev. No. 2

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