Pangnirtung Waste Water Treatment Plant: Comprehensive Performance Evaluation

Draft Final Report
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1.0 INTRODUCTION

1.1. Scope of Work

The Government of Nunavut (GN), Department of Community and Government Services (CGS) retained Dillon Consulting Limited (Dillon) to conduct a Comprehensive Performance Evaluation (CPE) of the Pangnirtung Waste Water Treatment Plant (WWTP). The scope of work for the CPE is described in Dillon's proposal to CGS, dated December 21, 2006. The Scope includes a review of plant operation in the following areas:

- Operation,
- Design,
- Maintenance, and
- Administration.

The intent of the CPE is to provide the following:

- Identify performance limiting factors,
- Prioritize performance limiting factors,
- Assess the approach to improve performance, and
- Produce a detailed CPE Report for discussion.

This report summarizes the CPE results and recommendations. An optimization strategy will be developed for the plant once the contents of the CPE report are reviewed and accepted by the GN. The optimization report will be provided under a separate cover.

2.0 PROCESS OVERVIEW

2.1. Process Overview

The Pangnirtung WWTP was constructed in 2003 and operates according to the following philosophy, as depicted in Figure 6:

- Raw sewage is received into a 7.5 m^3 receiving tank.
- Raw sewage is pumped through an IPEC Model IFU 3036 rotary screen into a 7.5 m^3 screened sewage receiving tank. Potable water is used to rinse the screen.
- Screened sewage is pumped into a 189 m^3 aerated equalization tank. Aeration is provided by 71/2 hp Sutorbilt Model 4HVP positive displacement blowers.
- Wastewater from the equalization tank is transferred into the treatment train consisting of an aerated reactor basin followed by a secondary clarifier. There are two treatment trains in parallel. Aeration is provided by a 5 hp Sutorbilt Model 3MVP positive displacement blower.
- Overflow from the clarifier exits the plant.
- Scum collected by the scum pumps in the clarifiers is directed to the equalization tank.
- Sludge from the clarifiers is directed to the 75 m^3 aerobic digester. Aeration is provided by a 5 hp Sutorbilt Model 3MVP positive displacement blower.
- Sludge from the digester is directed into an Envirodyne 12 bag sludge bagger.
- Decant from the digester is returned to the screened sewage tank.
- Filtrate from the sludge bagger is returned to the screened sewage tank.
- Bagged sludge is manually transferred to a loader bucket and disposed at the landfill.

The plant was operated by setting the pumping rate to allow the equalization tank to fill to nearly full throughout the day, and then pump to almost empty by the start of the following day.

The WWTP was originally conceived as a rotating biological contactor (RBC) and three rotating cages filled with Geoform media balls were located in each of the reactors. Mechanical and operational difficulties were experienced with the rotating cages, and the plant operating philosophy was modified.

The plant treatment philosophy was modified towards an activated sludge system. The rotating cages were removed, but a quantity of geoform media balls were left floating on the reactor basin in an effort to provide a surface that would promote biological growth.

Almost all sludge from clarifiers was wasting to the digester and very little sludge was recycled from the clarifier to the head of the treatment train. Note that an activated sludge system relies upon recycling a portion of the sludge, which contains a mixture of new and old bacterial cells, to treat the wastewater.

2.2. Sequence of Operation

The sewage trucks discharge into the sewage-receiving tank where level activated pumps transfer the raw sewage too the sewage screen. The screen removes the large, non-organic items such as plastics, etc and allows the screened sewage to flow into the screened sewage side of the tank.

Screened sewage is pumped into the flow equalization tank where it is aerated. Float switches control both the raw sewage and screened sewage pumps. High-level alarms, also controlled by float switches, are present in both the raw sewage and screened sewage tanks.

The aerated sewage is slowly pumped from the equalization tank to the activated sludge bioreactors at an adjustable, constant rate. The two progressing cavity feed pumps are controlled by VFDs in the main control panel and an ultra-sonic sensor prevents these pumps from running dry.

After passing through the bioreactors, sewage mixed with activated sludge flows into the final clarifiers where microorganisms and bacteria will settle to the bottom as sludge. Any lighter material such as fats, greases and dead microorganisms will float on the surface of the clarifiers as scum. Timer controlled sludge pumps and scum pumps transfer the sludge and scum away to the sludge digester and the equalization tank, respectively. The overflow from the final clarifiers flows through the outlet flow meter and then to the ocean.

The sludge is pumped to the sludge digester tank where it is continuously aerated and the sludge is further digested. The operator can thicken the sludge by decanting water back to the screened sewage tank. The sludge pumped to the sludge bagger where the sludge is dewatered by adding polymer and then letting the sludge sit in de-watering bags. Filtrate from the de-watering bags is returned to the screened sewage tank. The sludge bags are then land filled.

All of the process equipment for the plant (except for the IPEC screen) is controlled at the main control panel. The main logic PLC is located in this panel as is the alarm modem.

3.0 PANGNIRTUNG WASTE WATER TREATMENT PLANT PERFORMANCE EVALUATION (JANUARY 2007)

The current Wastewater Treatment Plant process flow schematic is provided on Figures 6 and 8.

3.1. Influent Wastewater Characteristics

A summary of the composite influent wastewater characteristics is presented in Table 1.

Table 1: Pangnirtung WWTP, Influent Wastewater Characteristics

Parameters	Unit	Range [min – max]	Average
Flow Rate Jan-Dec 2006	m^3/d	24 - 316	130
Flow Rate January 2007	m^3/d	85 - 192	140
BOD5 Year 2004-06	mg/L	150 - 1280	515
Suspended Solid Year 2004-06	mg/L	136 - 630	412
Ammonia Nitrogen January 2007	mg/L	24 - 154	40
Total Phosphorus January 2007	mg/L	12 -54	25

Complete operational data tables are provided in Appendix A.

3.2. Effluent Quality Criteria

Effluent quality is regulated in the Hamlet of Pangnirtung's Water Licence, number NWB3PAN0207. Part D of the licenced specifies that all effluent discharged from the Sewage Treatment Facility at "Monitoring Program" Station Number PAN-3 shall meet the effluent quality standards shown in table 2.

Table 2: Effluent Quality Limits for the Pangnirtung WWTP

Parameter	Maximum Average Concentration
Fecal Coliforms	1000 CFU/100 mL
BOD5	120 mg/L
Total Suspended Solids	180 mg/L
Oil and grease	No visible sheen
pH	Between 6 and 9

3.3. Effluent Wastewater and Process Characteristics

The characteristics of the wastewater at various points during the treatment cycle were monitored during the period of January 15 to January 23, 2007. The monitoring data are summarized in Table 3.

Table 3: Analytical Data – Pangnirtung WWTP Process Characteristics, Validation Period January 15/2007 – 23/2007

Parameters	Influent **Avg.** (Min.-Max)	EQ Tank **Avg.** (Min.-Max)	Biotrain#1 **Avg.** (Min.-Max)	Biotrain#2 **Avg.** (Min.-Max)	Effluent **Avg.** (Min.-Max)	Digester **Avg.** (Min.-Max)
TSS [mg/L]	**400** (136-530)	**1620** (930-2060)	**1670** (1540-2190)	**1650** (1600-2280)	**125** (30-500)	**10000** 8800-13000
Sludge Settling 30min [ml/L]	N/A	**740** (400-980)	**950** (800-990)	**960** (860-990)	**25** (10-170)	**990** (970-1000)
Ammonia Nitrogen [mg/L]	**40** (24-62)	N/A	N/A	N/A	**21** (12-28)	N/A
Nitrate Nitrogen [mg/L]	**0.1** (0.0-0.3)	N/A	N/A	N/A	**15** (6-34)	N/A
Phosphorus [mg/L]	**25** (12-54)	N/A	N/A	N/A	**9.5** (5-17)	N/A
Dissolved Oxygen [mg/L]	N/A	**2.4** (1.7-3.8)	**0.6** (01-1.0)	**0.4** (0.1-0.8)	**0.1** (0.0-0.2)	**0.3** (0.0-0.5)
Temperature [C deg.]	**8** (6-11)	**14.5** (12-17)	**16** (14-18)	**16** (14-18)	**17** (16-18)	**20** (19-21)
Sludge Volume Index [ml/g]	N/A	**340** (280-500)	**450** (360-800)	**460** (370-800)	N/A	N/A
BOD5 [mg/L]	978				45	
Faecal Coliforms (cts/100 ml)					8,400	

Note, BOD_5 and faecal coliform data were not collected over the course of the week since field laboratory equipment for these parameters was not available. The BOD_5 and faecal coliform information in Table 3 was determined from an effluent grab sample collected on January 20, 2007.

The water licence requires monthly sampling from monitoring station PAN 3. Monthly monitoring per the licence requirements was not available, so historical effluent monitoring data available for the plant are summarized in Table 4. Complete analytical information for the influent and effluent grab samples collected on January 20, 2007 is included in Appendix B. The influent sample was collected from PAN-1 and the effluent sample was collected from PAN-3. Note the samples collected on January 20, 2007 were not analyzed for all the parameters specified in Part-H of Water Licence NWB3PAN0207. Rather the January 20, 2007 samples were analyzed for parameters critical to assessing plant operation.

Table 4. Pangnirtung WWTP, Effluent Analytical Data

Sample	Date	BOD_5	TSS
Effluent	26-Aug-04	28	54
Effluent	27-Aug-04	31	191
Effluent	28-Aug-04	12	30
Effluent	29-Aug-04	4	40
Effluent	30-Aug-04	5	40
Effluent	31-Aug-04	63	76
Effluent	3-Sep-04	5	54
Effluent	4-Sep-04	7	94
Effluent	5-Sep-04	8	58
Effluent	6-Sep-04	7	62
Effluent	7-Sep-04	6	94
Effluent	11-Sep-04	11	44
Effluent	12-Sep-04	11	63
Effluent	13-Sep-04	13	110
Effluent	14-Sep-04	8	42
Effluent	15-Sep-04	15	27
Effluent	16-Sep-04	13	91
Effluent	18-May-05	102	60
Effluent	23-May-05	70	62
Effluent	3-Nov-05	47	110
Effluent	7-Dec-05	60	48
Effluent	7-Feb-06	69	48
Effluent	28-Jun-06	65	65
Effluent	27-Sep-06	181	41
Effluent	28-Nov-06	39	50
Effluent	20-Jan-07	45	35
	Mean	36	65
	Max	181	191
	Min	4	27

4.0 CURRENT PROCESS UNITS PARAMETERS

4.1. Contaminant Concentrations

BOD5	515 mg/L BOD_5
TSS	412 mg/L TSS
NH_3-N	40 mg/L
Total Phoshpate (TP)	25 mg/L

4.2. Hydraulic Load

Average day flow	130 m^3
Maximum day flow	316 m^3
Maximum hour flow	30 m^3

4.3. Contaminant Load

Average day organic load (BOD_5)	67 kg BOD_5/d
Maximum day organic load (BOD_5)	163 kg BOD_5/d
Average day solids load (TSS)	53 kg/d TSS
Maximum day solids load (TSS)	130 kg/d TSS

4.4. Influent Receiving Tank

Total Volume	7.5 m^3
Operating volume	6.5 m^3
Number of pumps	2
Pump Capacity	200 UGM @ 7-ft TDH
Power	1½ hp

4.5. Screened Sewage Tank

Total Volume	7.5 m^3
Operating volume	6.5 m^3
Number of pumps	2
Pump capacity	200 UGM @ 21-ft TDH

4.6. Influent Equalization Tank

Dimensions	7.6 m dia. x 4.1 m H
Maximum operation volume	183 m^3
Minimum operation volume	45 m^3
Number of EDI model 84P coarse bubble diffusers	6
Number of blowers	2 (1 duty, 1 stand by)
Capacity of Air	150 CFM @ 7-psi

4.7. Bioreactor Feed Pumps

Number of pumps (progressing cavity)	2
Pump capacity	7.2 m^3/h @ 1200 RPM
Power	2 hp

4.8. Bioreactor – Activated Sludge Process

Number of tank	2
Total volume tanks	27.6 m^3
Volume of one tank	13.8 m^3
Dimensions L x W x H	5.48 x 2.74 x 0.92 m
HRT @ avg. day flow	5 hours
HRT @ max. day flow	2 hours
MLSS	1200 mg/L
SVI	800 ml/g
SRT	1-2 days
F/M avg. day organic load	2 g BOD_5/g MLSS
Number of blowers	1 per 2 tanks
Capacity of Air	70 CFM @ 7 psi
Number of EDI model 84P coarse bubble diffusers	9/tank
Power	5 hp

4.9. Clarifier

Number of tank	2
Total volume tanks	53 m^3
Total clarifier area	18.2 m^2
Volume of one tank	26.5 m^3
Tank depth	3.5 m
HRT @ avg. day flow	9.8 hours
HRT @ max. day flow	4.0 hours

4.10. Scum Pumps

Number of pumps (submersible)	4 (2 per clarifier)
Maximum Pumping Capacity	16 m^3/h
Power	½ hp

4.11. Wast Activated Sludge/Return Activated SludgePumps

Number of pumps (progressing cavity)	4 (2 per clarifier)
Pump capacity	2.0 m^3/h
Power	½ hp

4.12. Aerobic Digester

Dimensions	5 m dia x 4.1 m H
Tank maximum operation volume	75 m^3
Number of blowers	1
Capacity of Air	70 CFM @ 7 psi
Number of EDI model 84P coarse bubble diffusers	5
Concentration sludge	1 – 1.3% solid

4.13. Sludge Dewatering System

"Envirodyne" sludge bagger	12-bag station
Sludge pump	6 m^3/h
Polymer make-up unit and control panel	150 L mix. tank
Filtrate return sump pump	3.5 m^3/h
Volume dewatered sludge (12 x 80 L)	960 L
Concentration dewatered sludge	10% solid
Number of cycles per week	1 – 2

5.0 WASTEWATER FACILITY PROCESS MODIFICATION - ACTIVATED SLUDGE TREATMENT

The treatment process at the Pangnirtung WWTP has been modified from an RBC to activated sludge. However, the modified plant did not include all the elements required for the activated sludge process. An overview of the activated sludge process is provided in the following section to provide background for the discussion of operational issues in Section 6 and process modification recommendations in Section 7.

5.1. Process Description

The activated sludge process involves blending wastewater with a culture of microorganisms into a fluid called "mixed liquor". This mixed liquor is passed through an aeration tank which must provide an adequate oxygen source for the type of activated sludge process selected and to mix the "mixed liquor". The microbes eat (stabilize) the organic waste in the water, and the number of microbes increases. The solids and microbes are separated from the wastewater being treated in a clarifier.

The conversion of biochemical oxygen demand (BOD) into a microbial culture means that excess microbes must be removed (wasted) from the process, in what is termed waste activated sludge (WAS). In addition, a large portion of the microbes is returned to the aeration basin as return activated sludge (RAS), to keep the cycle going. The process mode design is selected to meet the process goals:

a) BOD removal, and
b) Conversion of ammonia into nitrate (nitrification).

5.2. Design Criteria

The primary design criteria for the activated sludge process include:

- The organic loading rate;
- The selected food (CBOD) to microorganism (F/M) ratio and the corresponding solids retention time (SRT) or mean cell resident time (MCRT);
- The hydraulic detention time of the wastewater being treated in the aeration basins;
- Aeration blower capacity, oxygen uptake rate of the mixed liquor, and type of diffuser;
- Aeration tank depth – to facilitate oxygen transfer;
- The secondary clarifier design criteria: hydraulic, and solids surface loading rates and minimum depth;
- Waste activated sludge (WAS) and return activated sludge (RAS) design parameters; and
- Wastewater treatment stream characteristics.

5.3. Return Activate Sludge Operational Controls

Return activated sludge modes of operation include:

- Constant flow rate: the return activated sludge (RAS) is pumped from the secondary clarifier(s) back to the aeration basin(s) at a constant flow rate disregarding all other process variables.
- Raw wastewater flow paced: the RAS is returned to the aeration basins according to a rate that is proportional to the incoming wastewater to be treated. Usually this means that as the wastewater flow increases, the flow rate of the return activated sludge is increased at a preset proportional rate.

It is very important to maintain the selected quantity of microorganisms in the aeration basin and clarifier (SRT or MCRT). This is accomplished by removing (wasting), on a daily basis, a volume of sludge from the system equivalent to each day's growth of microorganisms, as what is called waste activated sludge. The wasting of the excess microbes from the process is the most important process variable, as it affects all of the other variables.

5.4. Wasting of Activate Sludge

Generally speaking, approximately 0.5 to 0.85 kg of microorganisms is created for every kg of BOD entering the process. The excess microbes must therefore be wasted from the system to prevent excess solids accumulation in the clarifiers.

Wasting of activated sludge is achieved using one of two methods:

- Constant flow rate: the wasting rate of the activated sludge is constant over the entire day, based upon the number of dry pounds of activated sludge that need to be wasted to hold a specific MCRT or SRT, or
- Batch wasting rate: treatment processes that have a high MCRT or SRT, may waste solids from their system in small batches daily, or once per day. This is usually recommended, and has provided satisfactory results for many small facilities.

The most effective method for determining the wasting rate for the Pangnirtung WWTP is as follows:

- Calculate the SRT or MCRT at least daily,
- Set the wasting rate of activated sludge on a five-day or seven-day running average. This helps to stabilize swings in the number of kg of microbes in the system.

5.5. Dissolved Oxygen Concentration

The microorganisms require dissolved oxygen in the water in order to carry out their metabolic processes, and to stabilize the organics (CBOD) in the wastewater. There must be sufficient dissolved oxygen not only for the free swimming and small colonies of microbes, but also for those microbes that are in the center of larger flock particles. Most processes, without selectors, hold 2 to 3 mg/L dissolved oxygen concentration. DO concentrations above 3 mg/L do not

provide significant additional advantages to the system relative to the energy required to maintain this DO concentration.

Filamentous microorganisms are usually able to out compete more desirable microbes when the DO concentration is below 1 mg/L. (Filamentous microorganisms, in higher proportions to other microbes, can cause poor sludge settling problems in the clarifiers.) Additional oxygen, above that required for biochemical oxygen demand (BOD) removal, is required if the treatment process is to convert ammonia into nitrates (nitrification).

5.6. Optimizing the Activated Sludge Process

Treatment plant optimization treatment includes optimizing two elements: design parameters "Technological decision" and operational control "Operational decision". The requirements for each are discussed in the following sections.

5.6.1. Technological Decision - Design Parameters

Design parameters for wastewater treatment plants treating municipal waste flows less than 1000 m^3/d are dependant on the type of biological treatment. The main design parameter for an activated sludge system is the sludge loading, represented by the daily organic load per aerated sludge mass (F/M ratio in kg BOD/kg MLSS).

The typical range of applied design F/M ratios is between 0.05 and 0.25 kg BOD/kg MLSS. Aerated activated sludge plants are designed to provide a 24-hour aeration period. When operating properly, activated sludge plants can achieve treatment efficiencies ranging between 80 and 95% BOD reduction.

Table 5 shows the differences between the existing Pangnirtung WWTP parameters and typical design criteria for an activated sludge plant.

Table 5: Pangnirtung WWTP Biological System Parameters vs. Typical Design Criteria for an Activated Sludge Process Treating Municipal Waste

Parameters	Pangnirtung Existing Biological System	Typical Design Criteria
Average day flow [m^3/d]	130	< 1000
Tank Volume [m^3]	28	130
Liquid depth [m]	0.92	3.5 –5.0
HRT [h]	5	24
SRT [d]	1 - 2	15 - 30
F/M [kg BOD/kg MLSS]	2.0	0.05 – 0.25
Organic Load [kg BOD/m^3 reactor]	2.2	0.15 – 0.4
MLSS [mg/L]	1600	3000 - 5000
BOD5 Removal %	< 70	80 - 95
Sludge Volume Index[mL/g]	450	150
Capacity of Air [m^3/kg BOD]	50	120
DO [mg/L O_2]	<1.0	2 - 3
RAS [% avg. flow]	No control	50 - 100
WAS [% Total solid/d]	No control	3.5 - 7

5.6.2. Operational Decision – Operational Control

Controlling the mass of active organisms in the plant is crucial to successful operation of an activated sludge plant. Critical control of the system is based on solids wasting, independent of operating decisions made for the up-stream processes.

There are two commonly used methods to decide how much sludge to waste: Food to Microorganism (F/M), and Sludge Residence Time (SRT). Both parameters must be calculated at least weekly and related to the treatment plants operating efficiency.

Therefore, to calculate the wasting rate the operator needs to know, as a minimum, the volume of the aeration basin, the suspended solids concentration of the mixed liquor (MLSS) and the solids concentration of the return sludge.

Laboratory analysis must be used to measure the internal and effluent parameters which can be related back to the calculated F/M and SRT. Tracking the various residue concentrations against operational conditions is necessary to establish and maintain satisfactory operating control of the plant. Proper control of the plant is extremely difficult without daily lab support.

The optimum operating conditions for a specific WWTP may be determined using a graphical method described below.

Using the X-axis (horizontal) for the time value of days, graph (trend) the treatment plant's influent and effluent BOD and suspended solids on the Y- axis (vertical). Using the same scale of the X-axis, graph the corresponding activated sludge process values of F/M ratio, MLSS, SRT, SVI and DO concentrations. The goal of this task is to correlate process parameters to the best quality of plant effluent. Once the best quality of effluent is found, the process parameters that achieved this water quality are selected for operational use.

Smaller communities generally have greater variations in flow rates, suspended solids, and BOD loadings on the plant. The challenge therefore, is to hold proportional process variables as stable as possible, to select the best SRT value as indicated by the graphs and to apply sufficient dissolved oxygen to meet the corresponding oxygen demand. Generally speaking, even small changes in the operating parameters such as the SRT, F/M ratio and mixed liquor suspended solids concentration require as much as two or three times the SRT value to stabilize to the new parameters.

Figures A and B show example plots that may be generated and how the plots should be interpreted.

Figure A: Influent and Effluent Parameters, Example Plot

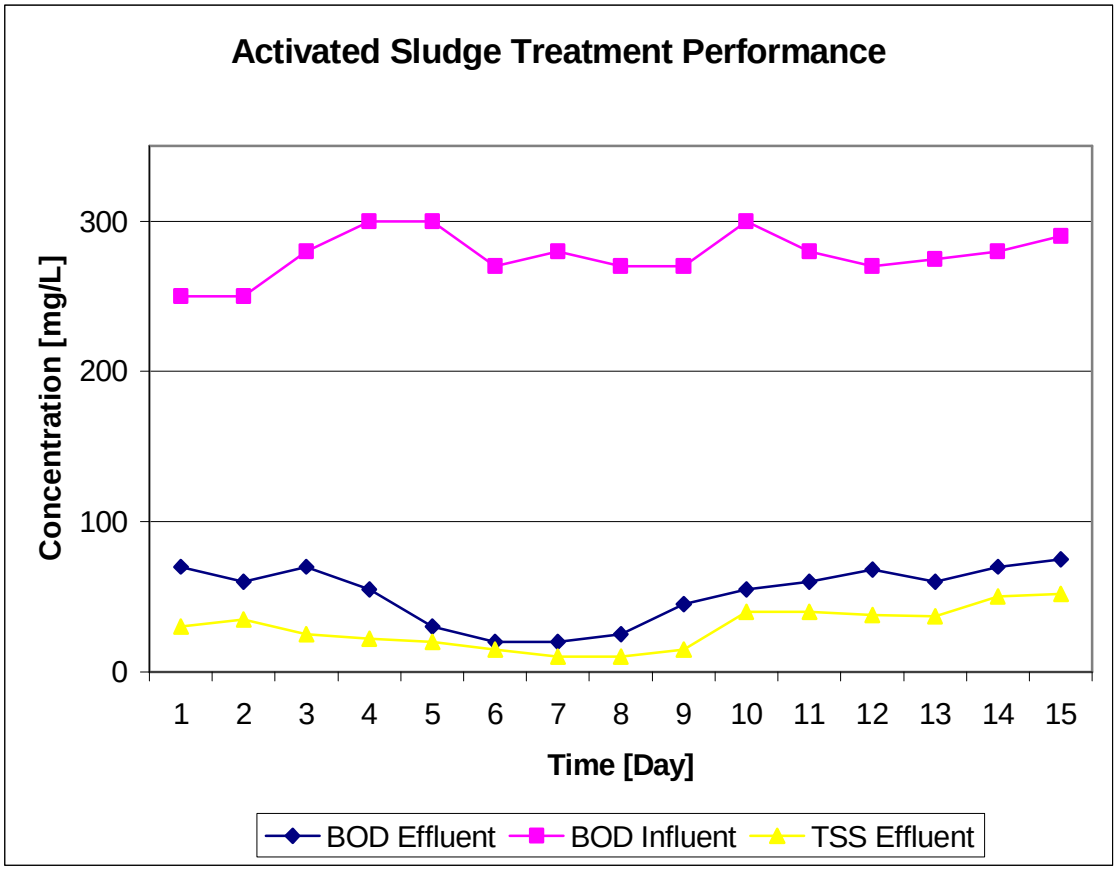
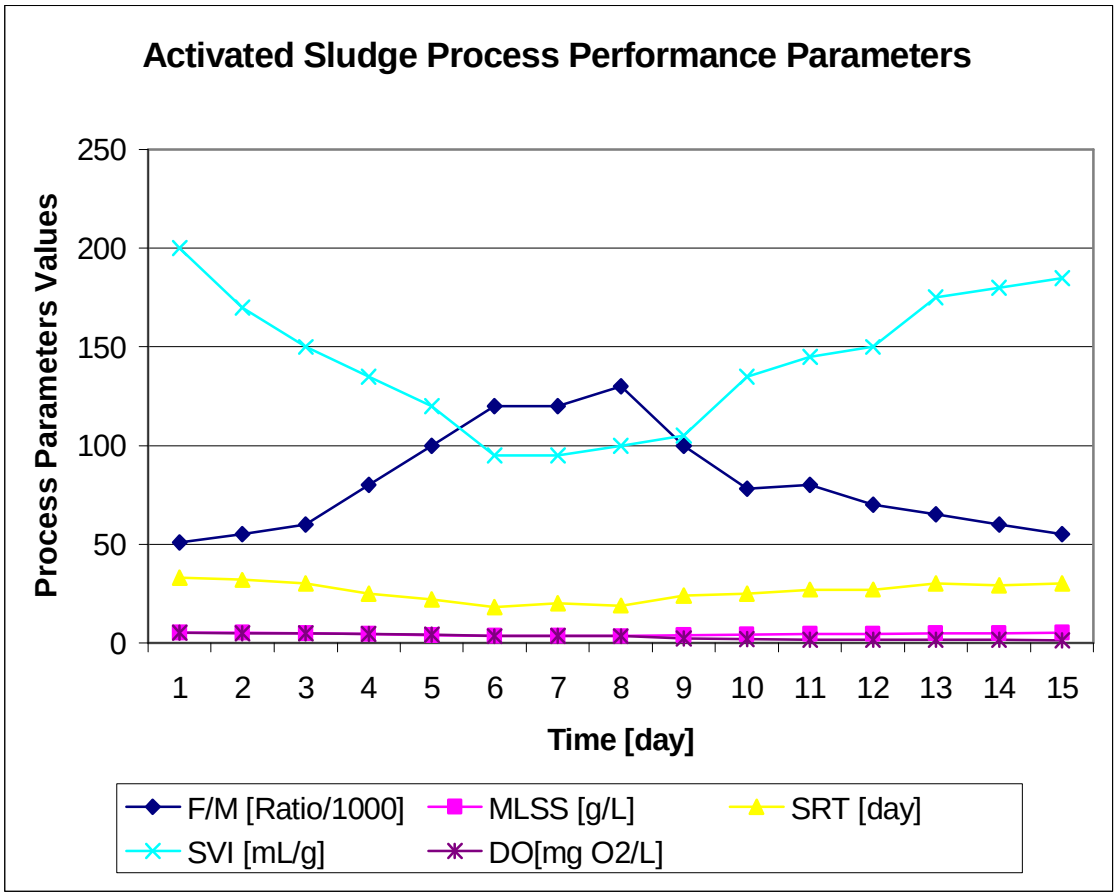


Figure B: Internal Process Parameters, Example Plot



5.7. Sampling and Lab Analysis

The following monitoring should be considered for control of the activated sludge process:

- Aeration basin:
  - Dissolved oxygen concentration,
  - Mixed liquor suspended solids, and
  - Sludge volume index (SVI).

- Secondary clarifier:
  - Sludge blanket depths and suspended solids concentration in the clarifier.

6.0 FINDINGS

Dillon personnel monitored the plant's operation, with the operators, during the period of January 15 to 23, 2007. Observations and on-site analytical monitoring identified a number of issues with the plant. Issues with both process operation and general plant operation are summarized in the following sections.

Recommendations for improving the process related issues are contained in Section 7 and 8 of this report. Recommendations for dealing with general plant issues are provided in Section 9.

6.1. Effluent and Sludge Quality

6.1.1. Effluent Quality

WWTP effluent quality is stipulated in Part D of Pangnirtung's water licence NWB3PAN0207 as follows:

- Faecal Coliforms: 1×10^3 cfu/dl
- BOD_5 120 mg/L
- Total Suspended Solids 180 mg/L
- Oil and Grease no visible sheen
- pH between 6 and 9

The present treatment process is inadequate, and the effluent will periodically exceed the regulated parameters.

6.1.2. Sludge Quality

The existing solids train can treat the sludge to an acceptable quality, however the solids content of the bagged sludge is low (6.5%) and the volatile suspended solids (VSS) concentration is high (80%). Improving the sludge treatment process could increase the solids concentration to 10% and reduce the VSS by 40 to 50%. Increasing the solids concentration will reduce sludge volume, and reducing the VSS will reduce the potential for odours.

6.2. Process Problems

The following process operational issues were identified at the plant:

- Problems with the management and operation of the biological stage - activated sludge process:
  - Inadequately sized bioreactors for the organic load.
  - Insufficient dissolved oxygen levels in the biological process, train #1 and #2.
  - Incorrect sludge recycle operating philosophy - no recycle, clarifiers to digester only.
  - Incorrect scum sludge wasting philosophy - removal and return to EQ tank.
  - Insufficient bioreactor tank depth.

- Problems with the operation of the sludge – solid process:
  - Insufficient mass WAS removal from the biological system.
  - Insufficient oxygen concentration in the digester tank.
  - Insufficient sludge stabilization.
  - Insufficient volume of sludge removal from digester tank to the dewatering process.
  - Odor generation during sludge bagging.
  - The sludge bagging process is physically labour intensive.

- Problem with the operation, maintenance and flow control of the EQ feed and sludge pumps:
  - Plagued by debris clogging and requiring frequent maintenance.

6.3. Plant Problems

In addition, a number of non-process issues were identified at the plant:

- Ventilation - odour problem,
- Insufficient air changes per hour inside the treatment plant (Maximum of 4 changes per hour compared to the recommended 6),
- The portion of the plant where sewage receiving and sludge bagging occurs is not isolated from the remainder of the plant or provided with dedicated air exchangers.

- Electrical installation – not protected from high humidity which leads to corrosion problems, unexpected difficulty with instrumentation and controls.

- The electrical system is 600 V, and the operators are not qualified to work on them. A qualified technician must be brought in at least twice per year to maintain the electrical system.

- Limited space for office and lab work.

- Insufficient support equipment for plant operation, treatment quality control and information management. Some records are maintained at the plant, but the system is not well organized. Operators do not have access to a computer with internet and e-mail

access for corresponding with equipment suppliers, etc. Available lab ware and monitoring equipment is not sufficient for the monitoring that is required.

- Insufficient content in the Operation manual – needs to be updated to reflect the process modifications completed at the plant.

- No maintenance schedule for equipment. A list recording timing of maintenance and sign off should be developed, and used to record maintenance activities.

- More advanced technical training required for operators – most likely to benefit from on-site training.

- Insufficient operators for the additional work required too maintain the activated sludge process - Three full time and one part time operator are required.

- Insufficient spare pumps and equipment – inventory what is available and order spares of critical process equipment such as sludge pumps.

7.0 PANGNIRTUNG WASTEWATER TREATMENT PLANT TREATMENT PROCESS - PROPOSED MODIFICATIONS

The current Pangnirtung WWTP process schematic is shown on Figures 6 and 8 and the existing process is described previously in Sections 3 and 4 of this report.

The plant is currently experiencing reduced treatment effectiveness and operational difficulties due to a combination of factors:

- Inadequately sized bio-reactors relative to the organic load,
- Low oxygen levels in the bioreactors (shallow aeration tank), and
- A misunderstanding of the activated sludge treatment process.

Modifications to the WWTP process are required in order to improve treatment efficiency. The recommended modifications have been divided into three categories: low cost short-term recommendations, medium cost recommendations and higher cost long-term recommendations. Each set of recommendations is described separately in the following sections.

In addition, several structural modifications are recommended to extend the life of the electrical equipment and to improve working conditions for the operator. These modifications should be completed in the short term, and are included with the Low Capital Cost Modifications.

7.1. Low Capital Cost Modifications

A number of changes can be made relatively easily to the existing process equipment and instrumentation to quickly improve effluent quality. The proposed changes are graphically represented on attached Figure 9 and Figure A below, and are summarized as follows:

Proposed process flow schematic changes include:

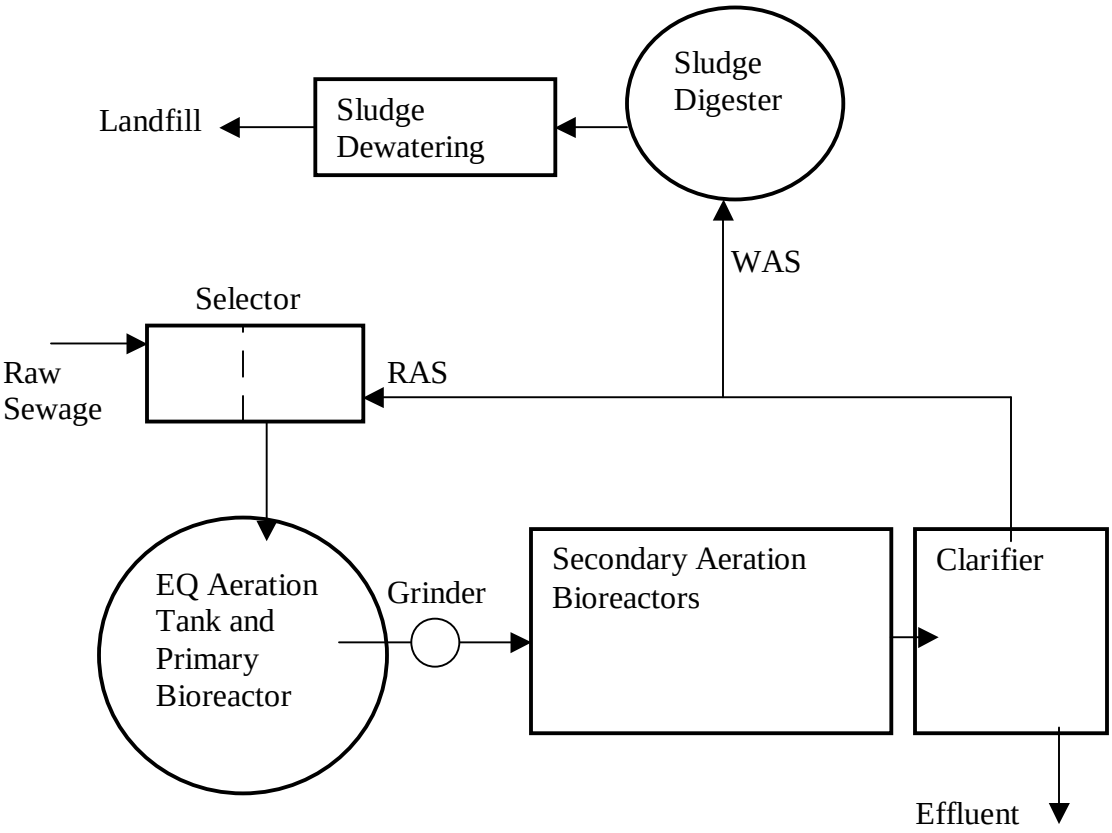
- Continuously transfer RAS (Return Activated Sludge) from the Clarifiers to the Sewage Receiving Tank or the Screened Sewage Tank;
- Remove WAS (Waste Activated Sludge) from the Clarifiers to the Aerated Sludge Digester in daily batches;
- Eliminate the return of sludge from the Aerated Sludge Digester to the Screened Sewage Tank;
- Re-route the Clarifier scum sludge waste piping to the Aerated Sludge Digester instead of to the Equalization Tank;
- Increase the size of the Bioreactors' aeration system blower, from 5 hp to 7½ hp, could use existing "Sutorbilt" model 4HVP;
- Install a new in-line grinder on the feed line to the Bioreactors, following the Equalization Tank;
- Establish the timing of the operation of the RAS and WAS cycles;
- Increase the aeration in the digester;
- Intermittently aerate and decant digester supernatant to increase sludge solids; and
- Increase the removal frequency of sludge from the Aerated Sludge Digester to the Dewatering Bagger System.

The proposed new flow schematic and operating changes will create a new philosophy for the activated sludge process. The new philosophy should alter the following process parameters:

- Increase HRT, SRT and lower the F/M in system;
- Create a new Anoxic Selector, small basin (Receiving Sewage Tanks) in which the Return Activated Sludge and primary effluent are treated prior to the activated sludge process. The basins provide about 30 to 45 minutes of hydraulic detention time and reduce the potential for filamentous bacteria growth;
- Create a new biological reactor in the Equalization Tank (i.e. EQ and Primary Biological Aeration Tank);
- Change existing Bioreactors to secondary biological units;
- Improve DO, SVI and sludge settling in clarifiers;
- Improve control and balance of sludge in the system; and
- Increase process nitrification, thereby lowering the effluent Total Nitrogen concentration.

Implementing the Low Cost Modifications would extend the effectiveness of the plant (i.e. the plant will satisfy regulatory requirements) by approximately 3 to 5 years.

Figure A. New Process Flow Schematic - Low Cost Modification



Expected changes to process parameters as a results of short term changes to the process flow schematic are summarized in Table 6.

Table 6. Treatment Parameter Changes after Biological System Modification at Average Organic Load 67 kg BOD/d and Average Hydraulic Load 130 m^3/d

Parameters	Existing Biological System	New Biological System (Low Cost Modification)
HRT [h]	5	26
SRT [d]	1 - 2	10 - 15
F/M [kg BOD/kg MLSS]	2.0	0.2
Total Vol. Bio-system [m3]	80	140
MLSS [mg/L]	1200	2500
BOD5 [mg/L]	>100	<50
TSS in Effluent [mg/L]	>150	<50
Sludge Removal -Dewatering cycles/week	1- 2 (No control)	4
Capacity of Air [CFM]	220	300
DO [mg/L O2]	<1.0	2 - 3
RAS [% avg. flow]	No control	50
WAS [kg solid/d]	No control	30 - 40

Some simple process modifications were made during the week of January 15 to 23, 2007. Analytical data from samples collected on January 20, 2007 are included in Appendix B (Lab report No. B07- 02970) and provide information on plant parameters after five days of operation under the modified conditions.

7.1.1. Structural Modifications

The following structural modifications are recommended for the plant. Cost estimates have been provided, but note that the work is specialized and low-volume, and the working conditions are difficult. Due to the current shortage of skilled workers, competitive bids may not be available for these modifications.

7.1.1.1.New Office and Laboratory

The plant washroom currently doubles as the plant office/laboratory. The Hamlet Council has identified this situation as unacceptable, and has requested that ventilated office/laboratory space be provided for the plant operators.

Several options are available for providing the new office space, including:

- Constructing an addition on the south side of the plant, or
- Re-configuring the storage space above the sludge bagging equipment on the northeast corner of the plant,

The most cost effective option is to reconfigure a portion of the storage space located above the sludge bagging equipment.

The partitions and new floor would not need to be constructed as fire separations, but a vapour barrier and separate ventilation and heating would be beneficial. Electrical outlets would need to be provided, and structural modifications to the mezzanine would likely be required before the floors and partitions could be constructed. Fixed windows would allow the operator to survey the plant.

The current ladder access to the mezzanine is not acceptable for a space that will be used routinely. An acceptable staircase cannot be located inside the plant due to interference with process piping and equipment. An enclosed exterior stair and door could be added. The exterior stair could likely be supported from the existing building structure.

Note that odours may be difficult to control in this space due to the location directly above the sludge bagging equipment. In addition, the reason for using open grated floor for the mezzanine is not known, and air movement throughout the plant would be affected by the addition. Ceiling mounted light fixtures and a fan may need to be relocated as part of this work.

Construction costs are estimated to range from $50,000 to $100,000 depending on how the work is contracted, the extent of structure modifications required and the scheduling of the work. An on-site review of partition locations should be conducted to confirm dimensions, identify piping and duct work locations and to note any other potential conflicts or access problems that should be resolved before a contractor could begin work.

7.1.1.2.Electrical Equipment Isolation

The electrical equipment in the plant is located on a mezzanine level, above the plant floor at the southeast corner of the building. The equipment is not isolated from the gases and elevated humidity present in the main plant area, and showing signs of corrosion as documented in two reports completed in May 2007, by Sifec North. The electrical equipment must be protected from the plant environment, or the operating life of the electrical equipment will be reduced.

Several options have been identified to protect the electrical equipment, including:

- Construct a separate addition to house the electrical equipment,
- Construct walls to separate the electrical equipment on the mezzanine from the plant atmosphere. Provide separate ventilation into the electrical enclosure,
- Install a vent hood over the open reactors and clarifiers, or
- Construct walls to isolate the reactors and clarifiers from remainder of the plant.

The most cost effective method for protecting the electrical equipment is to isolate the mezzanine from the remainder of the plant. Constructing a separate addition and moving the exposed electrical equipment would be very costly, while constructing an isolation wall around the reactors would require complicated partitions and doors around the reactor access catwalk, and would limit access to the processing equipment. Installing a vent hood over the bioreactors and clarifiers would provide some benefit, but likely would not provide the degree of isolation required.

Separate air supply, exhaust and heating are required for the enclosed area. The enclosure would need to be a rated fire separation (assume equal to that provided on the main floor), with all joints and penetrations sealed to prevent smoke passage. A vapour barrier and/or air barrier should be incorporated into the partitions and all joints and penetrations sealed to reduce air and vapour migration or leakage. The enclosed are will need to be tightly sealed in order to be effective. A door at the top of the stairway may be acceptable to the Office of the Fire Marshal given this room is intended for occasional servicing of equipment only.

Construction of the partition will be difficult because access to existing walls, floors and ceilings is limited by ductwork, piping and equipment. An on-site review of the partition location should be conducted to confirm dimensions, identify piping and ductwork locations, and to note any other potential conflicts or access problems (including space for working ladders, scaffolding or staging) that should be resolved before a contractor could begin work. Some of the ductwork may need to be temporarily disassembled in order to construct the partition.

Construction costs are estimated to range between $100,000 and $200,000 depending on how work is contracted, the strategies available to work around the ducts and pipes and the scheduling of the work.

7.1.2. Odour and Ventilation

Most of the odour issues in the plant are associated with the sewage receiving and sludge bagging operation at the northeast corner of the building.

Several potential modifications are possible to improve the odour issues at the northeast side of the plant including:

- Isolate this area from the remainder of the plant and provide a dedicated ventilation sytem, or
- Install a fume hood over the sludge bagging system.

Installing a fume hood over the sludge bagging system is considered the most feasible solution for reducing odour. Enclosing the bagging area would interfere with access to the exit door and so is rejected.

The fume hood would be constructed of stainless steel with explosion proof components. Fabrication would occur off-site due to the specialized nature of the materials, and then shipped to Pangnirtung for installation. The cost of installing the vent hoods is estimated at $50,000. This estimate assumes that installing the vent hood will not cause make-up air issues with the plant's overall HVAC system.

Keeping the hatches on the raw sewage receiving tanks closed would further reduce odours. The hatches are kept open so that truck drivers can visually assess the level of sewage in the receiving tanks and can then judge whether they can proceed to empty their trucks. A high-level alarm light has been installed outside the building to serve this purpose, but the light is largely ignored by the drivers and the raw sewage receiving tanks have overflowed in the past.

An additional auditory alarm or level gauge should be considered to permit the receiving tank hatches to remain closed during plant operation.

Additionally, the National Fire Protection Code stipulates a minimum of 6 exchanges per hour in buildings where municipal sewage sludge is handled. Critical portions of the WWTP require 12 air changes/per hour. Calculations completed using available information for the Pangnirtung WWTP suggests that the maximum exchanges per hour available for this plant is 4. The HVAC system for the plant should be reviewed to confirm whether it meets the requirements of the National Fire Protection Code. Recommendations and cost estimates for any required modifications would be developed from this review.

7.2. Medium Capital Cost Modifications (<2 M)

The low cost option described above represents necessary upgrades to the plant. Some medium cost modifications may be made, in addition to the low cost modification, to further improve treatment plant operation and effluent quality. The proposed medium term modifications are consistent with the treatment philosophy described in Section 5, and recommended changes for low capital cost modification described in Section 7.1. The proposed medium term process flow modifications are shown below on Figures B, and are summarized as follows:

Major recommended changes include the following:

- Install new Bioreactors,
- Install new blower and aeration system for Bioreactors,
- Install new feed and sludge pumps,
- Install an in-line grinder on the feedline to the Bioreactors, following the Equalizatio Tank, and
- Install a new UV disinfection system.

The Equalization Tank, Digester Tank and Dewatering System will not be modified as part of the medium capital cost recommendations.

The proposed medium cost upgrade will improve the WWTP's effectiveness up to average daily flows of 260 m^3/d and organic loads of 140 kg/d.

Either UV or chlorine could be used to disinfect the effluent leaving the plant. However, UV is recommended for the Pangnirtung plant since chlorine disinfectants are more difficult to ship, store and use than a UV system, and there may also be a requirement to dechlorinate the effluent before it enters Pangnirtung Fiord. The dechlorination step would require additional process equipment and chemicals. Therefore, UV disinfection would provide a simpler process and is expected to be economically competitive with chlorine (when dechlorination costs are factored in).

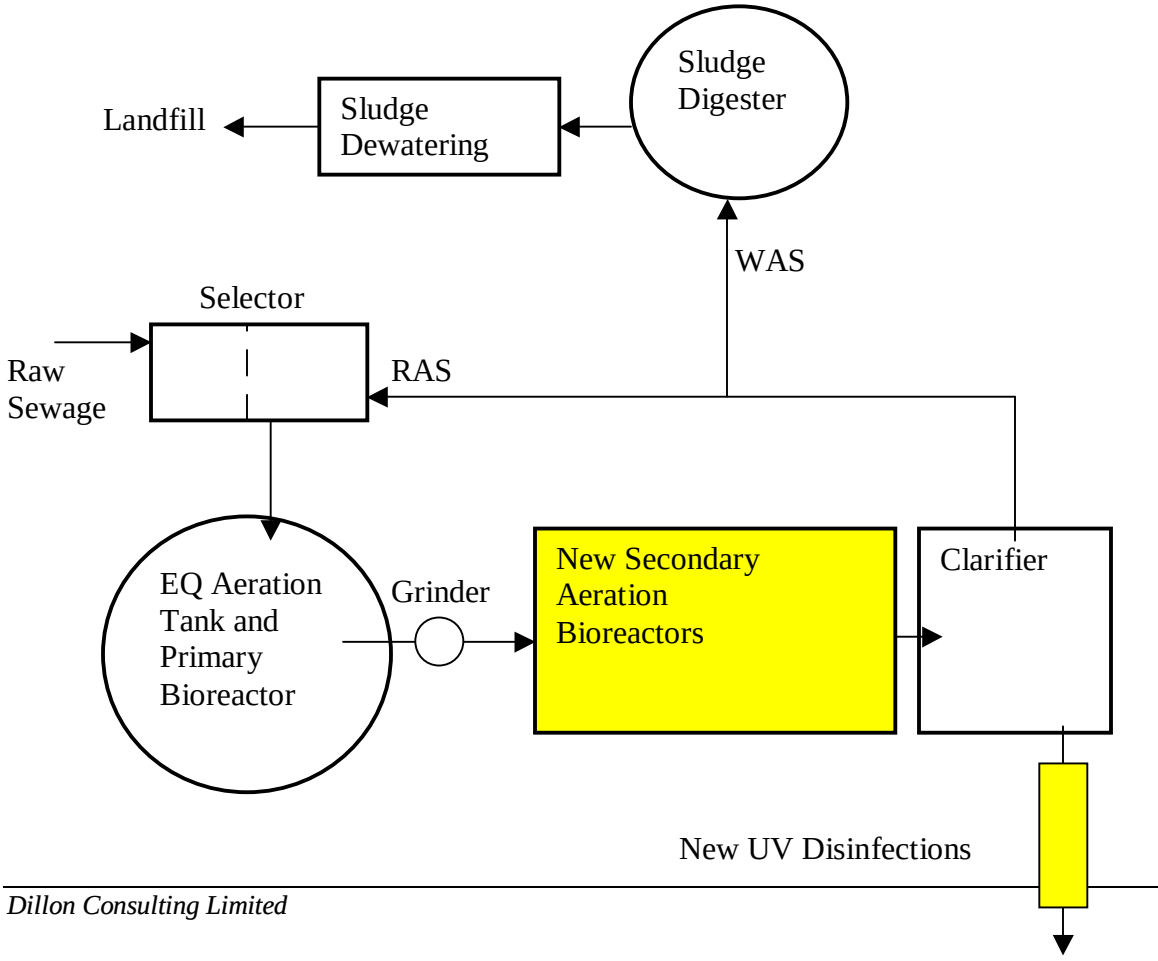
Table 7 below summarizes the estimated operating parameters that would be possible with the expanded biological system.

Table 7. Treatment Parameters after medium cost expanding Biological System

Parameter	New Expanded Biological System (Medium Cost Modification)
HRT [h]	16 - 24
SRT [d]	10 - 15
F/M [kg BOD/kg MLSS]	0.1
Total Vol. Bio-system [m^3]	200
MLSS [mg/L]	3500
BOD5 [mg/L]	<50
TSS in Effluent [mg/L]	<50
Fecal Coliforms [CFU/100 mL]	<200
Dewatering sludge [m^3/d]	1 – 1.2
Capacity of Air [UGM]	800
DO [mg/L O_2]	2 - 3
RAS [% avg. flow]	50 - 75
WAS [kg solid/d]	50 - 70
Digester HRT [d]	8 - 10
Clarifiers HRT [h]	4

The proposed medium cost changes are graphically represented on Figure B

Figure B: New Process Flow Schematic – Medium Cost Modification



Effluent

7.3. High Capital Cost Modification (> 2 M)

Pangnirtung's population is increasing (expected to double in the next 20 years) and consequently the organic and hydraulic loads to the treatment plant will also increase. These changes must be considered when planning for the long term future of the plant.

The following estimated organic and hydraulic loads should be used when planning upgrades to the WWTP's capacity:

- Organic load to avg. 134 kg/d, and
- Hydraulic load to avg. 260 m3/d.

The influent composition is not expected to change, and is represented as follows:

- BOD5 500 mg/L
- TSS 400 mg/L
- TKN 60 mg/L
- TP 30 mg/L

Dillon's experience at other facilities in Nunavut suggests that effluent quality limits will likely become more stringent. The following estimates should be used as probable effluent quality limits for the plant:

- BOD5 45 mg/L
- TSS 45 mg/L
- Ammonia 10 mg/L
- TP 5 mg/L

7.4. Proposed Long Term Modifications

The proposed long term modifications are consistent with the treatment philosophy described in Section 5, and recommend changes and additions to existing equipment. The proposed long term process flow modifications are shown on Figures 1, 10, 11, 12 and are summarized as follows:

Major recommended changes include the following:

- New bigger Bioreactors,
- New blower and aeration system for Bioreactors,
- New feed and sludge pumps,
- New sludge dewatering centrifuge system and building expansion,
- New UV disinfections system, and
- New monitoring SCADA system.

The proposed long-term modifications will improve the WWTP's effectiveness up to average daily flows of 260 m^3/d and organic loads of 140 kg/d, which Dillon estimates will permit effective operation of the plant for approximately 20 years. The modified WWTP's ability to

treat flows or organic loadings above these levels will be limited. The existing building footprint limits the degree of possible modification in the following areas:

- Space for increasing volume new Bioreactors,
- The capacity of the existing clarifiers,
- Space for storage and digestion WAS sludge,
- Room for mechanical and electrical equipment.

Table 8 summarizes the estimated operating parameters that would be possible with the expanded biological system.

Table 8: Treatment Parameters after Expanding Biological System At Max. Organic Load 134 kg BOD/d and Max. Hydraulic Load 260 m^3/d

Parameter	New Expanded Biological System (High Cost Modification)
HRT [h]	24
SRT [d]	10 - 15
F/M [kg BOD/kg MLSS]	0.1
Total Vol. Bio-system [m^3]	200
MLSS [mg/L]	3500
BOD5 [mg/L]	<50
TSS in Effluent [mg/L]	<50
Waste sludge to digester [m^3/d]	10 - 12
Capacity of Air [UGM]	800
DO [mg/L O_2]	2 - 3
RAS [% avg. flow]	50
WAS [kg solid/d]	50 - 70
Digester HRT [d]	15
Clarifiers HRT [h]	4.0
Dewatered sludge volume (@ 15% solids) [m^3/d]	0.8 - 1

8.0 EXISTING AERATED SLUDGE DIGESTER AND DEWATERING SYSTEM LIMITATIONS

8.1. Current Equipment and Processing Parameters

Digester:

Tank maximum operation volume	75 m^3
Number of blower	1
Capacity of Air	70 CFM @ 7 psi
Number of EDI model 84P coarse bubble diffusers	5
Concentration sludge	1 – 1.3 % solid
DO	< 0.5 mg/L 0_2
Sludge loading	5 – 8 m^3/d
HRT	8 – 12 days
VSS	78 %
% VSS destroyed	< 10 %
TSS	0.9 – 1.4 %
Total Solid Load	210 – 245 kg/week

Analytical information for the digester sludge is included in Appendix B as Lab report No. B07-02973.

Sludge Dewatering System:

"Envirodyne" sludge bagger	12-bag station
Volume dewatered sludge (12 x 80 L)	960 L
Concentration dewatered sludge	6.5 - 10 % solid
Volatile Solids	80 %
Max. number of cycles per week	4
Average solid mass dewatered per cycle	60 kg
Number bags sent to landfill per month	200

Analytical information for the bagged sludge is included in Appendix B as Lab report Nos. B07-02972, 2610624 and 2610633. Note the increase in VSS in the bagged sludge compared to the digester sludge is likely due to the addition of polymer during the bagging/dewatering process.

The existing digester system is working under anaerobic conditions and below the typical minimum aerobic digester HRT of 15 days. The process destroys a very low portion of the volatile solids and creates an unpleasant odor during the dewatering process.

The Sludge Dewatering System is presently nearing capacity. If the solids quality does not improve as a result of the recommended changes to the digester operation, future increases in organic load will create problems with the treatment system as a whole. The functioning of the existing solids circuit should be monitored, and changes should be made if required.

If Digester operation is improved, the existing sludge dewatering system could handle sludge produced by the plant for approximately an additional 10 years. After this time, or if additional

significant organic loads are added to the plant, an upgraded sludge dewatering system such as described in Section 8.3 will be required.

8.2. Improve Biosolids Quality

The Biosolids quality can be improved by increasing the oxygen concentration in the digester to the levels required for VSS destruction. Increasing either the capacity or number of blowers would increase oxygen levels. In addition, the HRT in the digester should also be increased.

Achieving aerobic digestion in the digester should reduce VSS by at least 35% and significantly reduce the odour problem.

The present sludge dewatering system is limited by the length of the cycle. Each bagging cycle takes 24 hours, so a maximum of seven cycles are possible in a week. In addition, the current system is labour intensive. Changing the Dewatering process to a more effective mechanical system will improve Biosolids quality and quantity by lowering volume, reducing costs and reducing potential leachate generation at the sludge disposal site.

Additional process instrumentation and routine laboratory analysis is also required to improve process control and Biosolids quality.

8.3. New Sludge Dewatering Centrifuge

Sludge dewatering systems remove water from the digested sludge to simplify handling of the stabilized sludge before transport from plant site for ultimate disposal/utilization. The present dewatering system is nearing capacity, as described in Section 8.1, and will need to be upgraded.

The proposed new dewatering system consists of the following components:

- Sludge Transfer Pump,
- Static Mixer (Polymer solution will be blended with the sludge fed to the dewatering system in this mixer),
- Centrifuge (dewatering unit), and
- Screw Conveyor.

The aerobically digested sludge is pumped to the sludge dewatering system using a sludge transfer pump. Polymer is mixed with digested sludge in the static mixer located upstream of the Dewatering Centrifuge, and then enters the centrifuge. Dewatered solid is conveyed via closed screw conveyor from the centrifuge unit directly into a trailer and then transported to the landfill as required.

Figure 12 provides a graphical overview of the proposed system and Figure 9 lists the major components in the proposed system.

Table 9: Sludge Dewatering System Equipment

Item	Description
Sludge Transfer Pump	Progressive Cavity Pump, (PFE Inc.), Nominal Conveying Capacity: 6 m3/hr, Nominal Power: 6 hp
Centrifuge	Alfa Laval Decanter Centrifuge, Nominal Capacity: 4.0 m3/hr, Nominal Power: 20 hp, Operating Speed: 3250 rpm, Dewatered sludge conc.: 20 % solid
Screw Conveyor	SPIRAC AB, U-shaped conveyor, Motor Power: 3hp
Polymer Mixing System	Polymer Feed Pump, Polymer and Dilution Water Mixing Unit, Static Mixer, Polymer requirement: 10 kg/1000 kg solid

The dewatering process can be operated in Remote MANUAL (on–off and VFD setting), or AUTO mode through the SCADA system. The operating status of the Centrifuge could also be reported to the SCADA sludge control system.

9.0 RECOMMENDED GENERAL PLANT AND OPERATIONAL IMPROVEMENTS

9.1. Electrical

As described previously, the electrical equipment is showing signs of corrosion due to the humid atmosphere present in the plant. In addition, the electrical system is 600V, and the operators are not qualified to complete any electrical work at this voltage. A certified technician should be brought in at a frequency of twice per year to provide maintenance for the system.

9.2. Process Monitoring

The equipment available for monitoring the process consists of a DO metre and two 1000 ml graduated cylinders. Additional analytical equipment is required in order to properly track the operation of the treatment process. This equipment should include sufficient labware to perform accurate measurements and dilutions and a portable pH metre and bench top colourimeter for monitoring process parameters.

A separate laboratory/office area is not provided at the plant. Process monitoring and administrative work must be completed in the washroom. A dedicated laboratory/office area should be provided.

9.3. Operations and Maintenance

The Operations and Maintenance (O&M) manual reflects the original operating philosophy for the plant (RBC). The O&M manual should be updated to reflect the modified operating philosophy and should include more detailed information on plant operation, monitoring and maintenance.

A maintenance schedule should be developed for equipment in the plant. The schedule should include all major process equipment, recommended timing for maintenance and an area for signing off (who and when) on the maintenance work when completed.

The availability of equipment and parts is poor in remote locations such as Pangnirtung, and the quantity of spares available in the plant appeared low. The available spare equipment should be inventoried and any additional equipment potentially required should be ordered and kept at the plant.

9.4. Outfall

The effluent outfall is located on a slope above the Pangnirtung Fiord high water mark. The ground surface below the outfall is reportedly eroding as a result of the discharge from the WWTP.

The outfall area should be upgraded to reduce the erosion caused by the WWTP discharge. The Federal Department of Fisheries and Oceans should be consulted prior to initiating any upgrades since the work will be occurring adjacent to fish bearing waters.

9.5. Staffing, Operator Knowledge and Training

There are currently two full time and one part time operator for the plant. One additional full time operator should be added to the plant staff in order to accommodate the increased workload created by increasing the frequency of sludge removal and conducting the additional process monitoring required to keep the plant operating efficiently.

The operators need additional technical training to properly operate the WWTP. On-site training coursers, of approximately one week's duration, should be conducted at a frequency of twice per year until the operators are fully able to operate the plant efficiently. Additional training should be provided when any additional equipment is added or if the process is modified.

9.6. Administration

Minimal administrative support is available for the plant operators. There is no computer available at the plant for internet/e-mail access with suppliers or for maintaining electronic records of process operating condition, performing spreadsheet calculations, etc.

A daily operating checklist is completed and stored in a binder in the mechanical room. Historical records are stored loose in a filing cabinet, also in the mechanical room. Analytical information is kept in a stack of papers in the washroom/office.

A computer with e-mail accessibility should be provided to permit the operators more efficient contact with suppliers, and to permit the operators to maintain electronic records and perform electronic data analysis. Off-site backup and storage of information should also be provided.

Additional hard copy filing equipment (i.e. a better filing cabinet) should also be provided for the plant, and a suitable filing system should be set up such that historical plant operating information is readily accessible.

10.0 SUMMARY

Dillon was retained by the Government of Nunavut, Department of Community and Government Service to conduct CPE of the Pangnirtung Wastewater Treatment Plant (WWTP). This assessment included evaluating the existing infrastructure of the WWTP and its ability to accommodate future demands loads from Pangnirtung 20- years projected growth.

CPE findings include the following:

- The existing Wastewater Treatment Plant does not treat the sewage to meet current Water License standards (NWB3PAN0207);
- The WWTP is at capacity now and additional loading from any source will require a plant expansion;
- The existing WWTP Bioreactors are at organic load and hydraulic capacity under the current flow rate, and require upgrading; and
- The two Bio-trains operate with an average Sludge volume Index of 450 mL/g (well above the typical design value of 150 mL/g, which create poor solids settling performance) and do not meet requirements for Total Suspended Solids, Faecal coliforms and BOD_5 in the effluent.
- The WWTP requires a disinfection process.

In summary, the existing plant is at its organic and hydraulic capacity and in it's current operating state, with septic inhibition, cannot provide treatment to the degree required to meet effluent quality requirements.

10.1. Recommended Plant Upgrades and Support

The WWTP requires modification in order to provide sufficient treatment for current and future sewage flows and loading. The recommended WWTP upgrades consider three scenarios: low, medium and high capital cost modifications to upgrade the process and additional structural modification to protect the electrical equipment, reduce odours and improve operator working conditions.

In the low cost scenario, (short term solution) the upgraded WWTP effluent will more consistently meet the existing BOD_5, Suspended Solids and Oil/grease effluent criteria. The Faecal coliforms criterion will not be met. This short-term solution will not change the issue that the plant is undersized with respect to biological process and a major change is required to the plant.

Structural modifications are also required under the low cost scenario to protect the electrical equipment from corrosion and reduce odours within the plant. The Hamlet has also requested that the operator be provided with a ventilated office/laboratory space. The most feasible upgrades are to achieve these objectives are to isolate the electrical equipment on the mezzanine by constructing a partition wall, provide a vent hood over the sludge bagging equipment and to reconfigure a portion of the storage mezzanine at the northeast corner of the plant as an office/laboratory. The cost estimates for these modifications are **$100 K to $200 K** for the

electrical equipment isolation, $**50 K** for the vent hood over the sludge bagger and **$50 K to $100 K** for the office/laboratory space. A review of the plant's HVAC system could be completed for **$15 K**.

In the medium cost scenario the upgraded WWTP, with new Bioreactors and a new effluent disinfection system, will meet all the physical-chemical and bacteriological criteria and create a much more environmentally safe effluent than the low cost scenario.

The high capital cost plant modifications include the medium cost upgrades plus a new dewatering digested sludge system for upgrading sludge quality. The high cost effluent scenario includes all of the equipment upgrades identified for remote control of the treatment process.

The total upgrade cost for low cost scenario is less then $ **600 K** and will provide an estimated additional maximum of 3 - 5 years of effective operation at the current average flow rate.

The total plant upgrade cost for the medium cost scenario, is **$ 1.7** M. Completing these upgrades will provide an estimated additional 20 years of effective operation for the biological system, and 10 years for the digestion and dewatering process.

The upgrade cost estimate for the high cost scenario is **$ 2.9 M**. This upgrade will provide an estimated additional 20 years of effective plant operation.

Tables 10, 11 and 12 provide a summary of recommended modifications and associated costs for each of the three scenarios.

Table 10: Pangnirtung Sewage Plant LowCost Upgrade, Capital Cost Estimate

No.	Item description	Estimated cost
1.	Re-route scum sludge waste piping to the Digester; Extend existing WAS/RAS pipe to the Screened Sewage Tank; Change aeration piping to the Bioreactors to connect to the existing 7.5 hp "Sutorbit" model 4HVP blower, to increase the blower size from 5 to 7.5 hp; and Install a new grinder on the feed line to the Bioreactors.	
	Equipment,	$75,000
	Miscellaneous, Mechanical, Electrical	$65,000
2.	Electrical equipment enclosure	$150,000
3.	Sludge Bagger ventilation	$50,000
4.	Office/laboratory space	$75,000
5.	HVAC Review	$15,000
	Subtotal	**$430,000**
	Contingency 20%	$86,000
	Engineering 15%	$64,500
	Total Cost	**$ 580,500**

Table 11: Pangnirtung Sewage Plant Medium Cost Upgrade, Capital Cost Estimate

No.	Item description	Estimated cost
1.	**New Bioreactors**	
	Equipment	$400,000
	Miscellaneous, Mechanical, Electrical	$200,000
2.	**UV Disinfections**	
	Equipment	$100,000
	Miscellaneous, Mechanical, Electrical	$70,000
	Subtotal	**$770,000**
	Contingency 20%	$154,000
	Engineering 15%	$115,500
	Other 5%	$38,500
	+ Low Cost Modifications	$580,500
	Total Cost	**$1,659,000**

Table 12: Pangnirtung Sewage Plant High Cost Upgrade, Capital Cost Estimate

No.	Item description	Estimated cost
1.	**New Bioreactors**	
	Equipment	$400,000
	Miscellaneous, Mechanical, Electrical	$200,000
2.	**UV Disinfections**	
	Equipment	$100,000
	Miscellaneous, Mechanical, Electrical	$70,000
3.	**New Sludge Dewatering Centrifuge System**	
	Construction (Mechanical, Structural, Electrical, Miscellaneous)	$350,000
	Equipment	$550,000
	Subtotal	**$1,670,000**
	Contingency 20%	$334,000
	Engineering 15%	$250,500
	Other 5%	$83,500
	+ Low Cost Modifications	$580,500
	Total Cost	**$2,919,000**

Dillon also recommends that additional operator technical support should be provided in addition to the capital upgrades. The most efficient program would initially provide operator training at

the Pangnirtung facility. Training at an off-site facility or classroom could be considered once the operators reach a pre-determined level of competency.

A well developed Operator On-site Technical Assistance Program can help with some of the following common problems encountered at WWTPs:

- Understanding process control procedures such as sludge wasting and return rates, mixed liquor concentrations, and aeration tank dissolved oxygen levels;
- Improving sludge handling and disposal procedures (one of the most complex areas of operation);
- Practicing proper process control and data reporting. In most cases, adequate laboratory equipment was needed to test and interpret data to appropriately control the process and monitor the facility;
- Improving operating budget;
- Insufficient staffing or frequent turnover;
- Plant design problems with aerators, clarifiers, digester, or disinfection systems;
- Concerns over industrial dischargers to the system;
- Implementing preventive maintenance; and
- Problems with inoperable equipment and process units.

Participating in a Technical Assistance Program will improve regulatory compliance at the plant and will likely provide long term cost savings to the Hamlet. The cost to maintain regulatory compliance is generally more economical than paying a penalty for noncompliance, and implementing preventive maintenance and identifying energy savings provide other methods of reducing costs.

10.2. Recommended Upgrade Schedule

The following upgrade schedule is recommended for the plant:

2007 – 2009 (3 year)

- Adopt low capital cost plant modifications;
- Optimize plant performance;
- Start "Operator On-site Technical Assistance Program" to provide technical assistance to WWTP staff to improve wastewater treatment;
- Provide isolation for the electrical equipment, additional ventilation at the sludge bagging station and office/laboratory space;
- Complete a review of the HVAC system, and
- Design medium capital cost plant modifications.

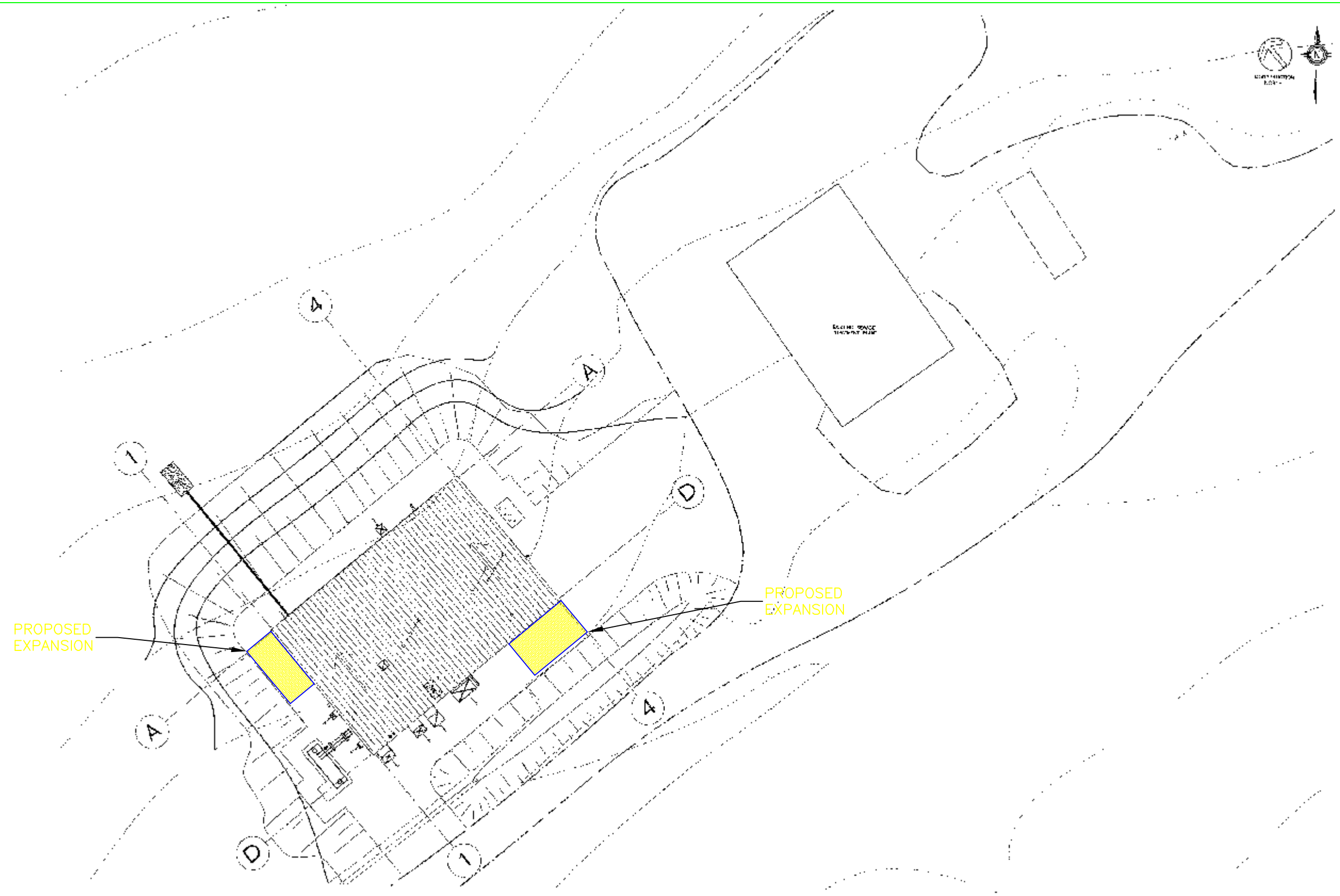
2010 – 2012 (3 year)

- Adopt medium capital cost plant modifications,
- Provide as-required engineering assistance,
- Continuation Technical Assistance Program,
- Optimize plant performance,
- Design high capital cost plant modifications.

2013 – 2016 (4 year)

- Complete installation of high capital cost plant modifications,
- Provide as-required engineering assistance,
- Continue On-site Operator Technical Assistance, and
- Optimize all process treatment elements for improved regulatory compliance.

Figures



DILLON CONSULTING

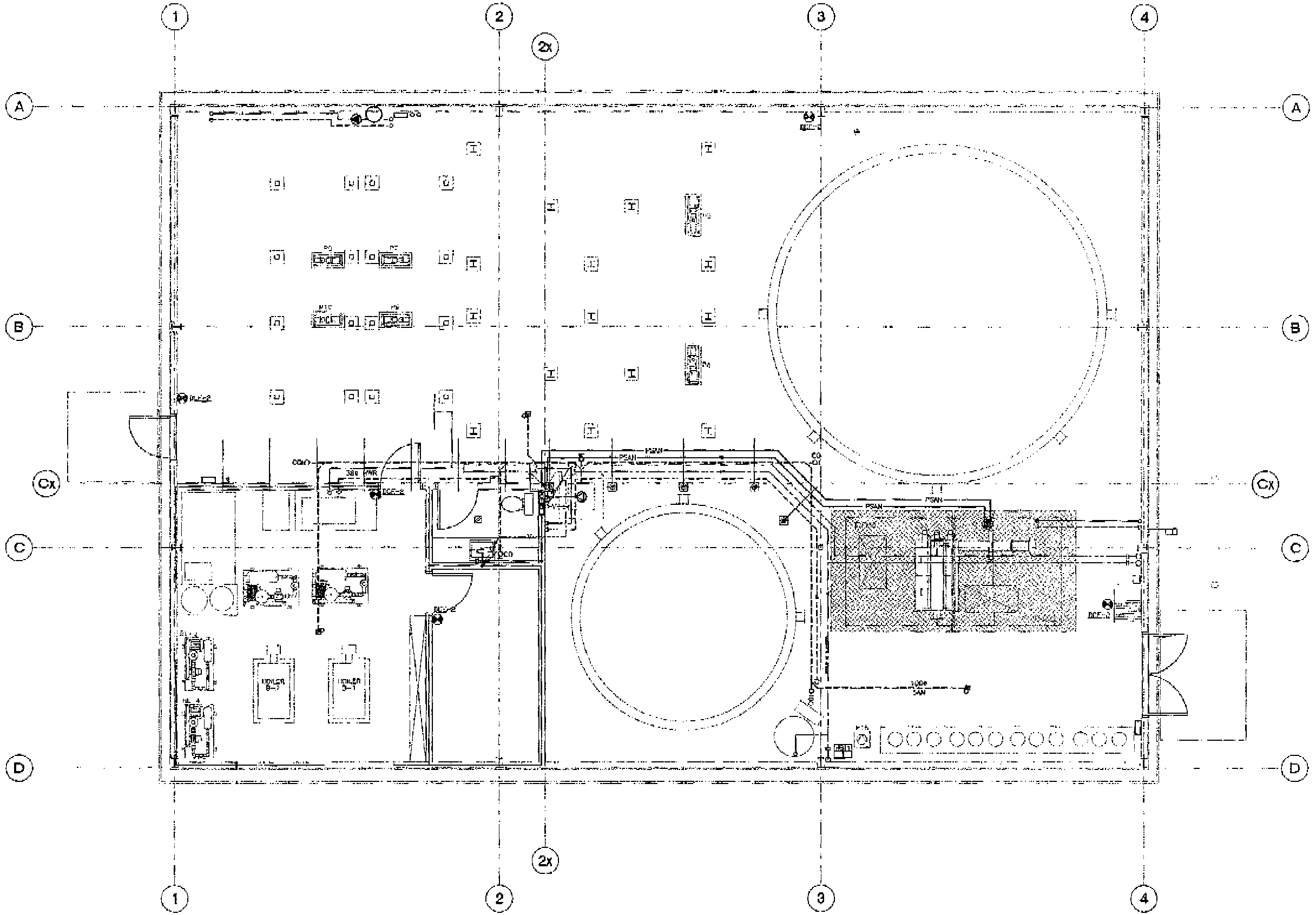
FEBRUARY 2007

PANGNIRTUNG
SEWAGE TREATMENT PLANT

SITE PLAN

PROJ. NO.
06-6119-4000

FIG. NO.
1



DILLON CONSULTING

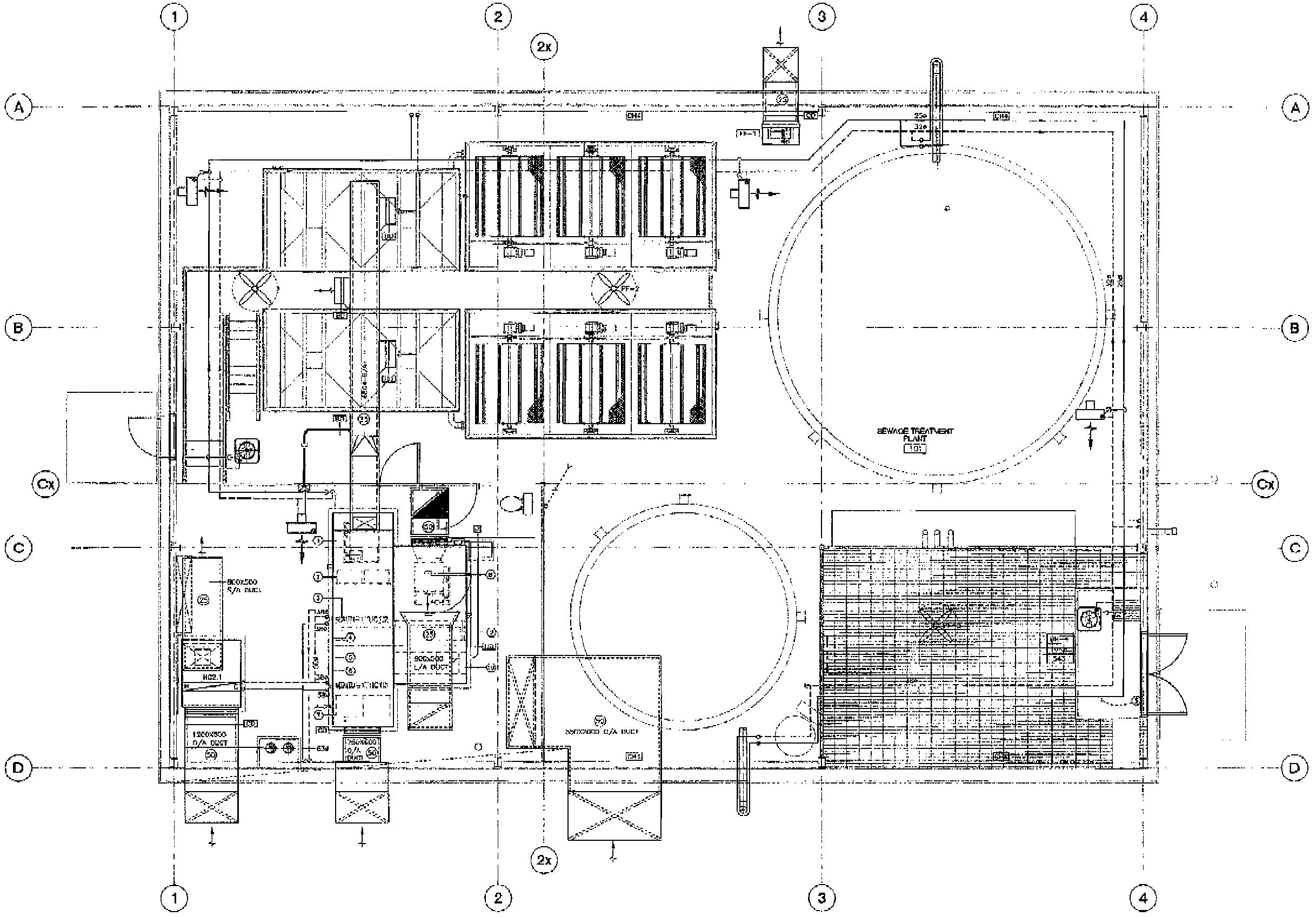
FEBRUARY 2007

PANGNIRTUNG
SEWAGE TREATMENT PLANT

EXISTING LOWER LEVEL MECHANICAL PLAN

PROJ. NO.
06-6119-4000

FIG. NO.
2



DILLON CONSULTING

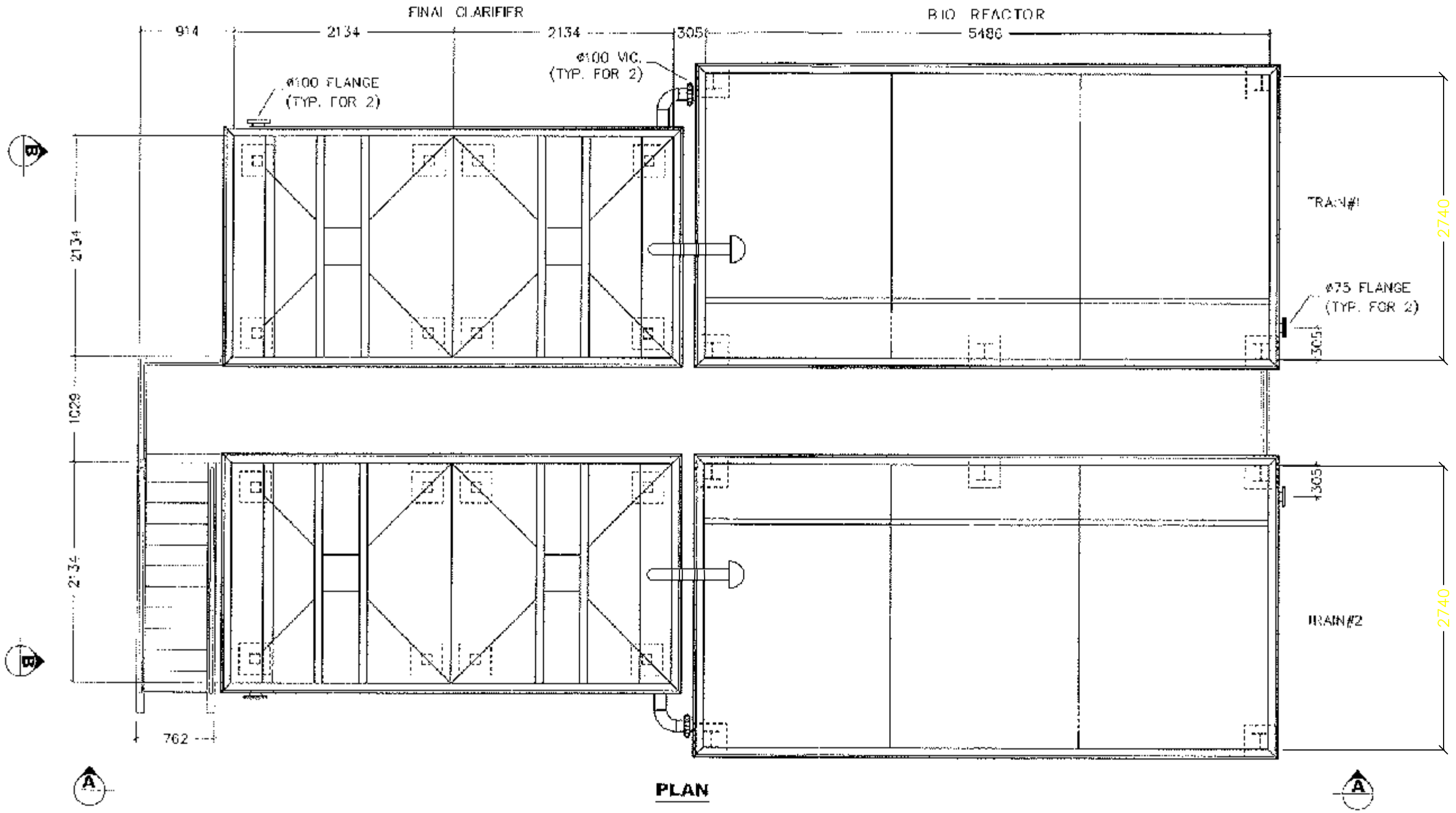
FEBRUARY 2007

PANGNIRTUNG
SEWAGE TREATMENT PLANT

EXISTING UPPER LEVEL MECHANICAL PLAN

PROJ. NO.
06-6119-4000

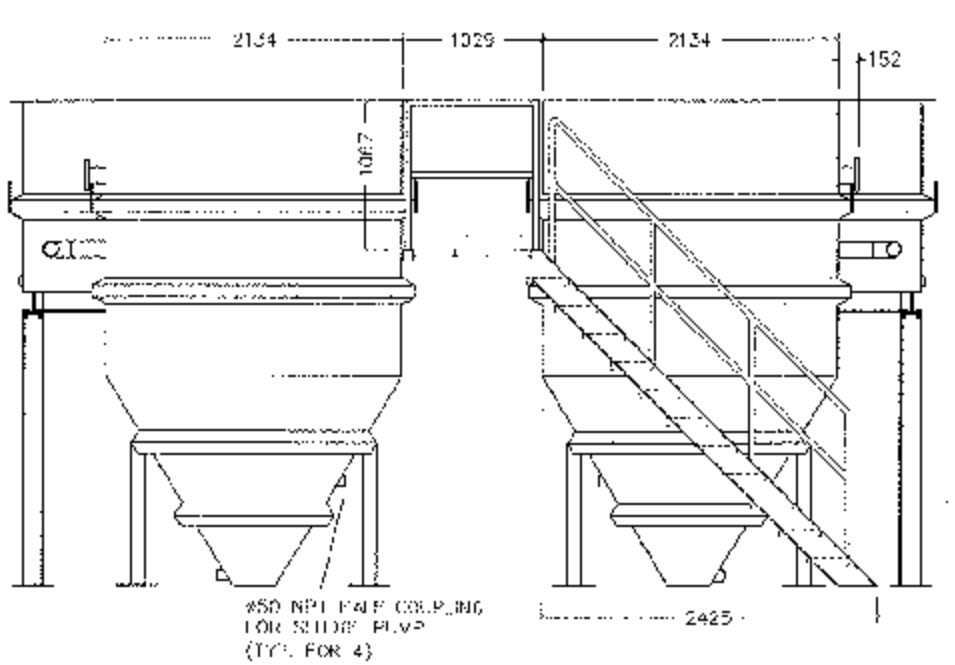
FIG. NO.
3



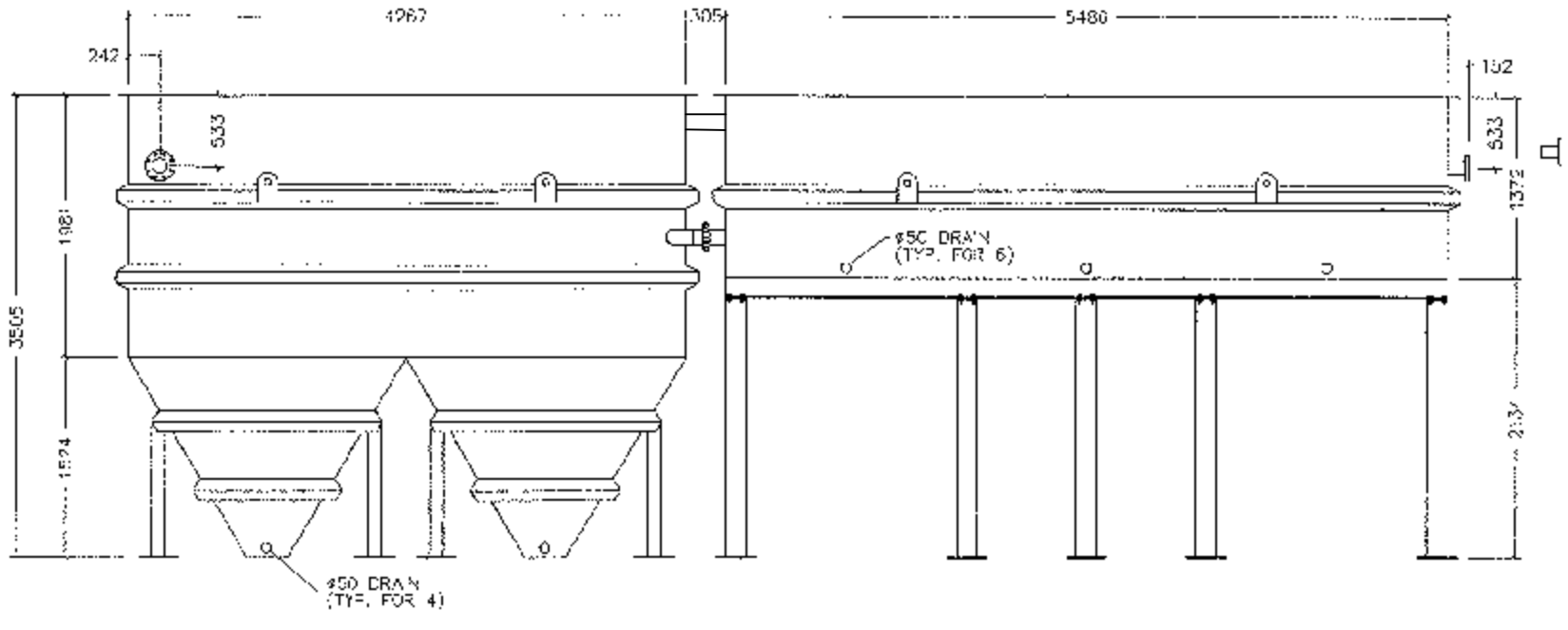
NOTES:

1. TANKS ARE CONSTRUCTED OF MARINE GRADE ALUMINUM ALLOY 5086 H116.

DILLON CONSULTING FEBRUARY 2007	PANGNIRTUNG SEWAGE TREATMENT PLANT	PROJ. NO. 06–6119–4000
	EXISTING FINAL CLARIFIER AND BIO-REACTOR GENERAL PLAN	FIG. NO. 4

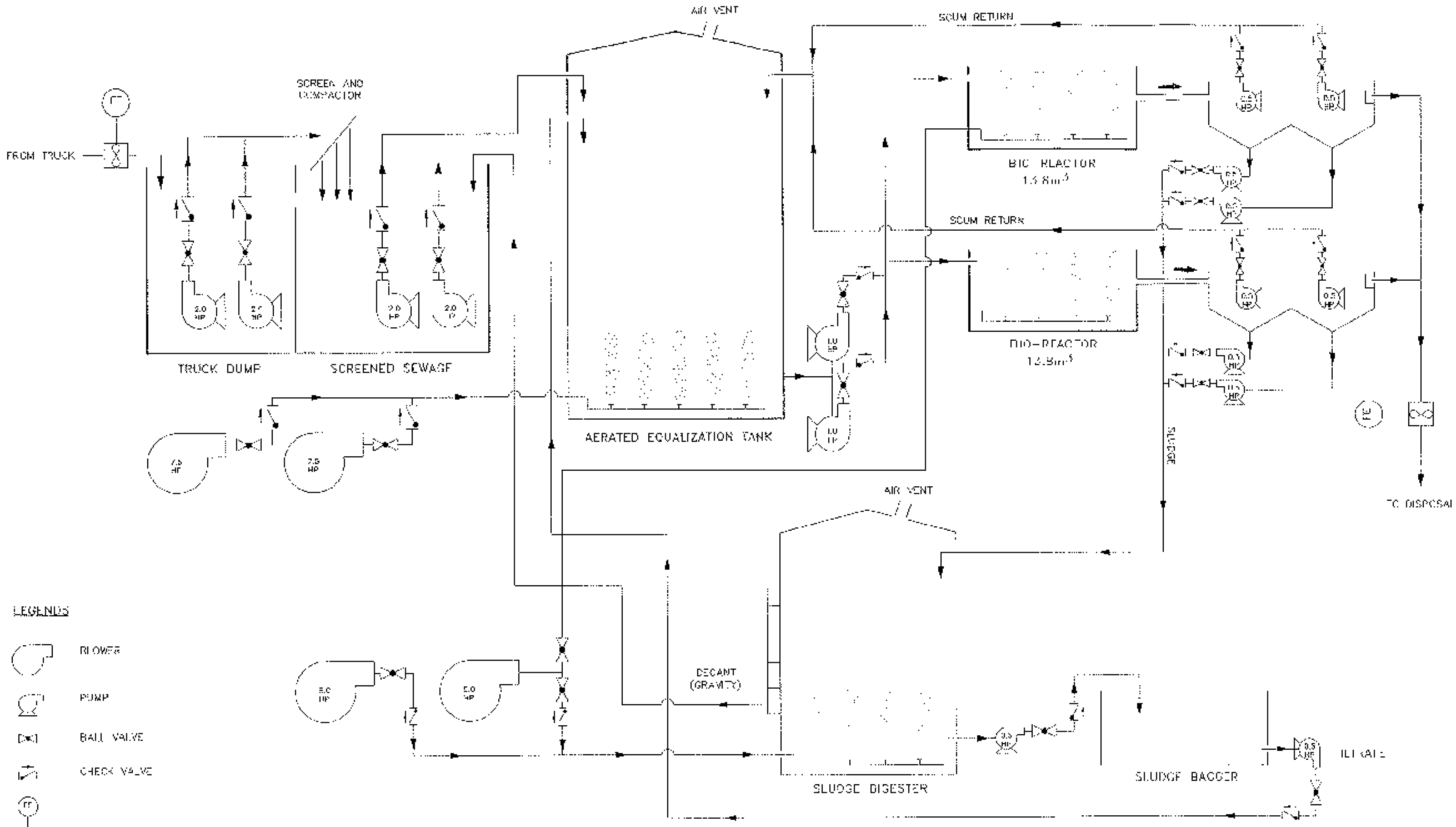


VIEW B-B



VIEW A-A

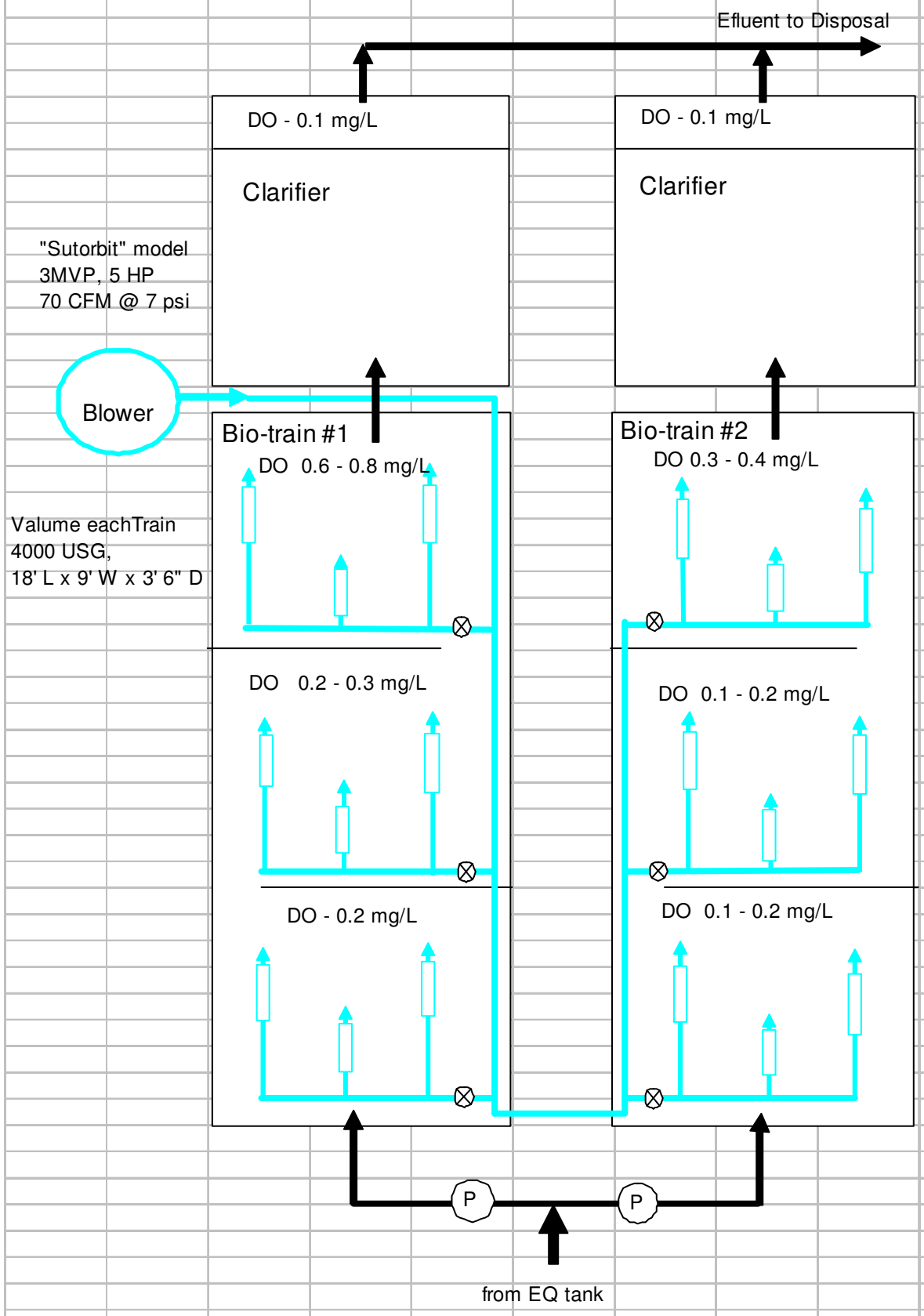
DILLON CONSULTING FEBRUARY 2007	PANGNIRTUNG SEWAGE TREATMENT PLANT	PROJ. NO. 06-6119-4000
	EXISTING FINAL CLARIFIER AND BIO-REACTOR ELEVATIONS	FIG. NO. 5



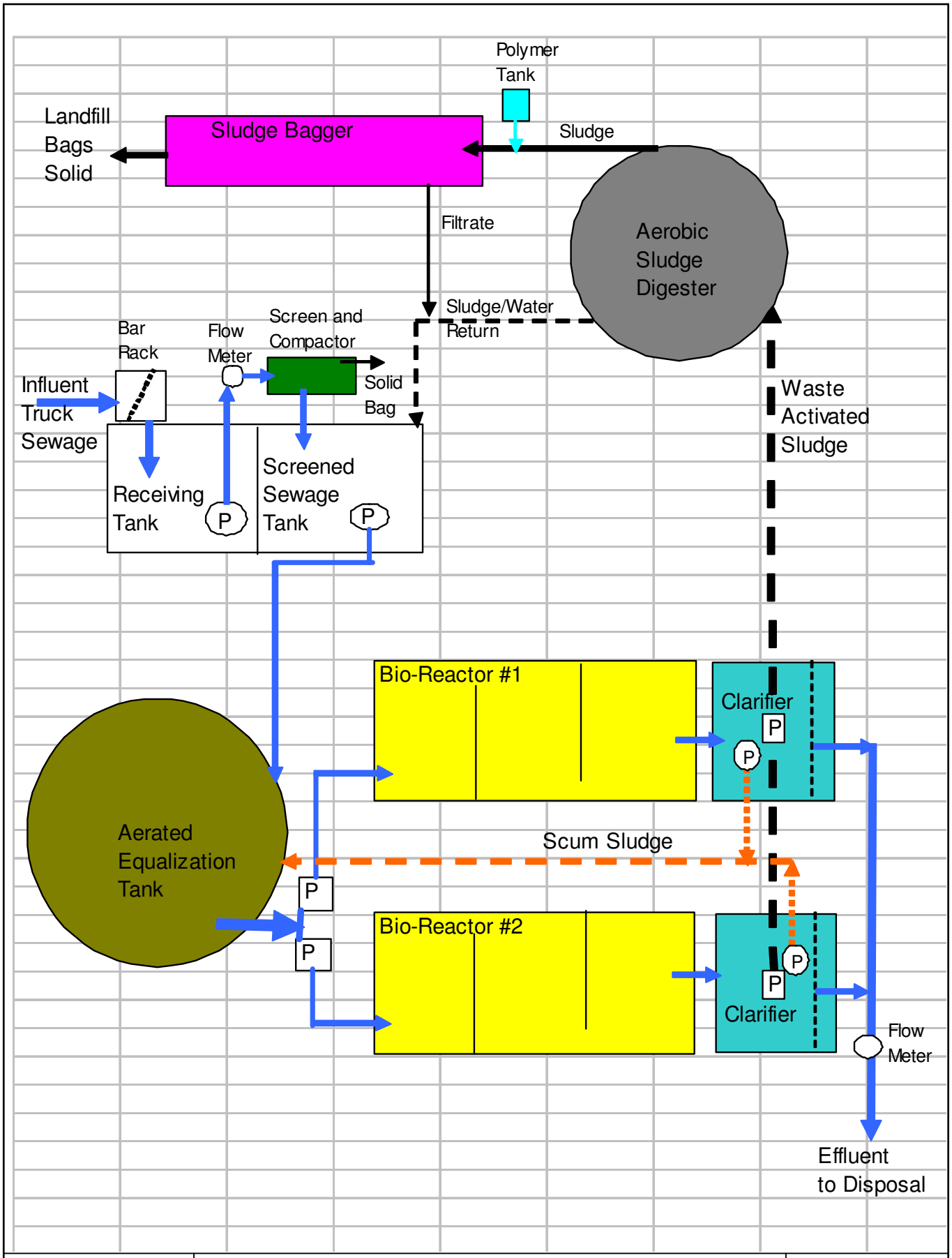
LEGENDS

- BLOWER
- PUMP
- BALL VALVE
- CHECK VALVE
- FLOWMETER

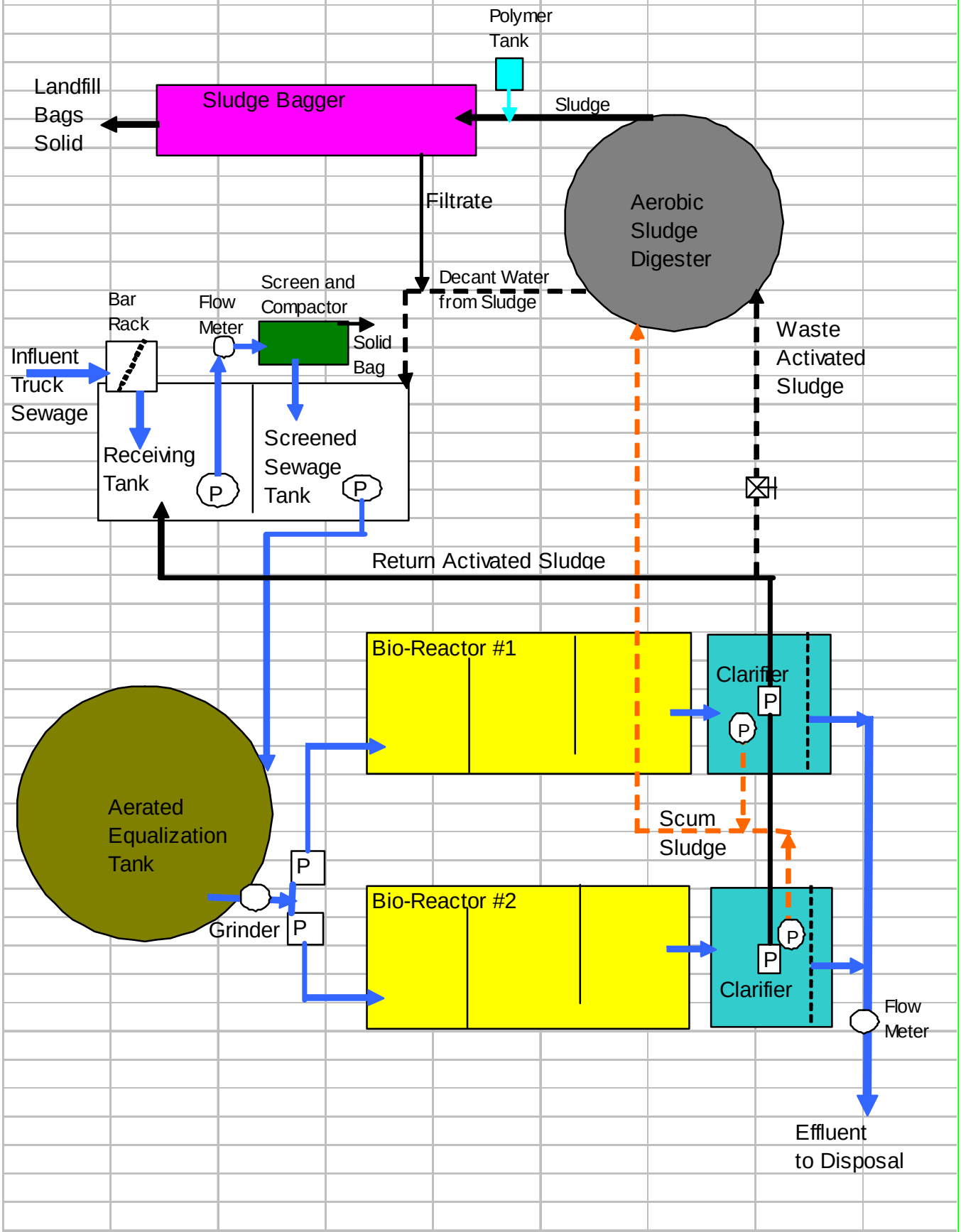
DILLON CONSULTING	PANGNIRTUNG SEWAGE TREATMENT PLANT	PROJ. NO. 06–6119–4000
FEBRUARY 2007	EXISTING WASTE WATER TREATMENT PLANT PROCESS FLOW DIAGRAM	FIG. NO. 6



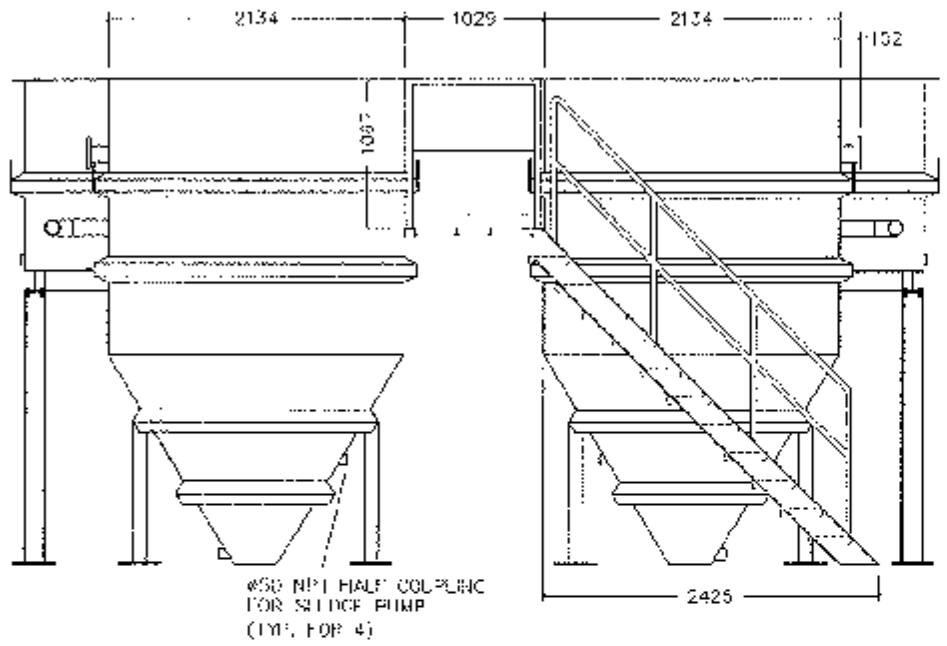
DILLON CONSULTING	PANGNIRTUNG SEWAGE TREATMENT PLANT	PROJ. NO. 06-6119-4000
FEBRUARY 2007	EXISTING PROCESS BIO-REACTOR AERATION SCHEMATIC	FIG. NO. 7



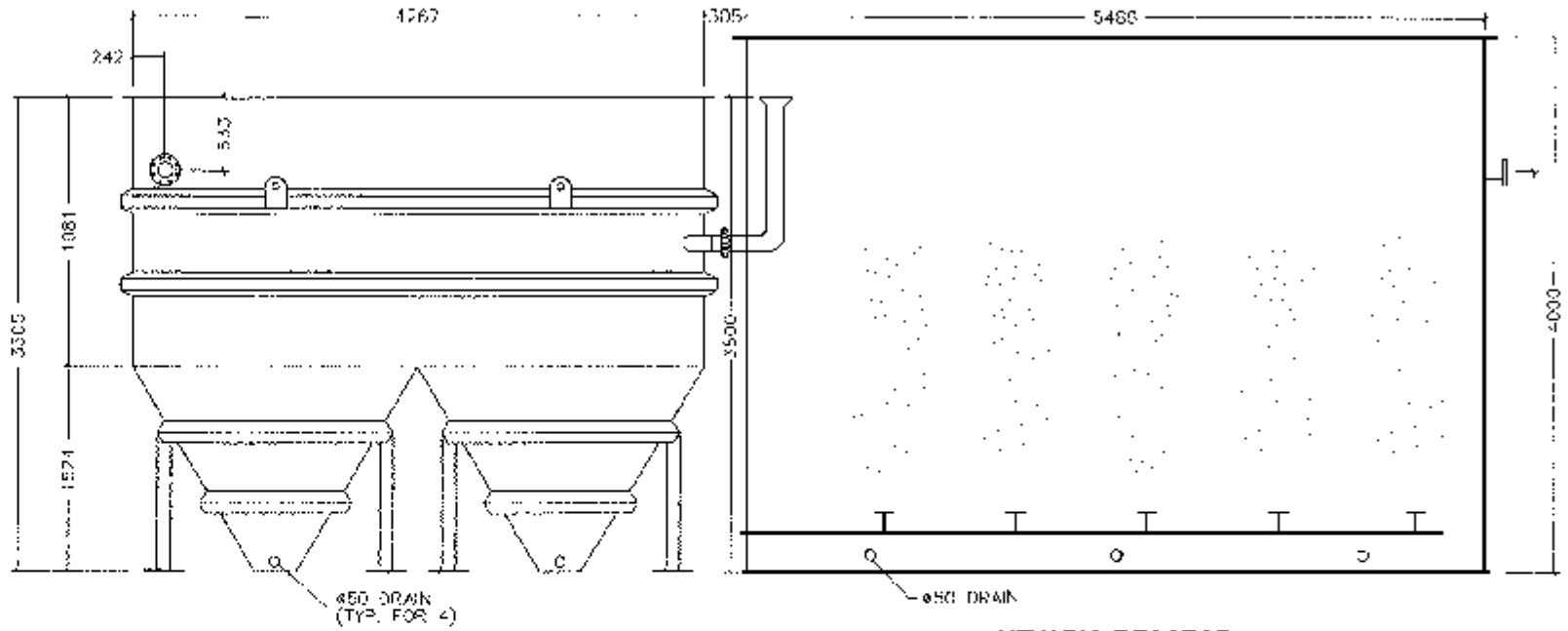
DILLON CONSULTING	PANGNIRTUNG SEWAGE TREATMENT PLANT	PROJ. NO. 06-6119-4000
FEBRUARY 2007	EXISTING PROCESS FLOW SCHEMATIC	FIG. NO. 8



DILLON CONSULTING FEBRUARY 2007	PANGNIRTUNG SEWAGE TREATMENT PLANT	PROJ. NO. 06-6119-4000
	FLOW SCHEMATIC NEW PROCESS PROPOSED LOW COST MODIFICATIONS	FIG. NO. 9



VIEW B-B



VIEW A-A

NEW BIO-REACTOR

DILLON CONSULTING

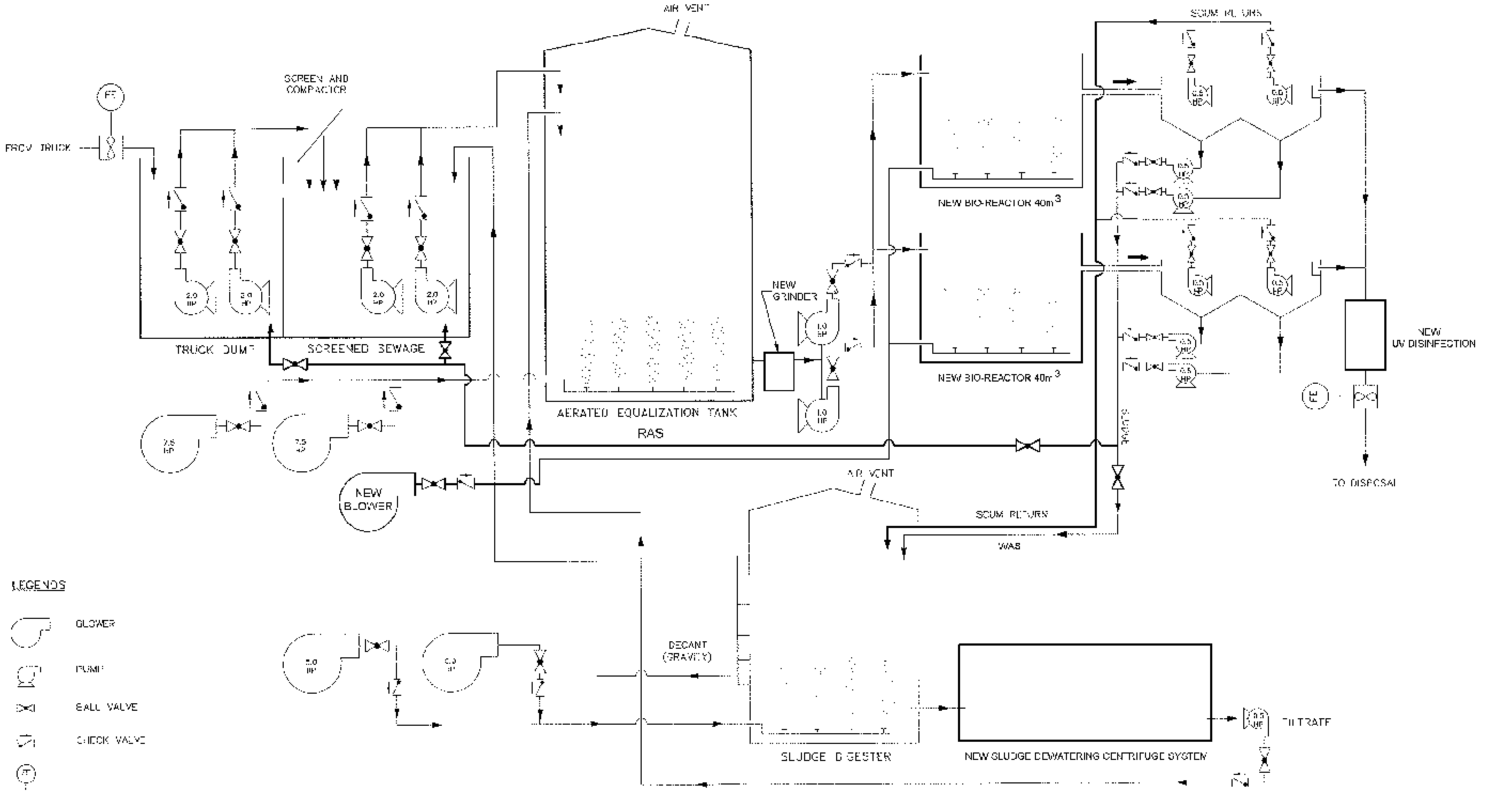
FEBRUARY 2007

PANGNIRTUNG
SEWAGE TREATMENT PLANT

CLARIFIER AND BIO-REACTOR - ELEVATIONS
PROPOSED MODIFICATIONS

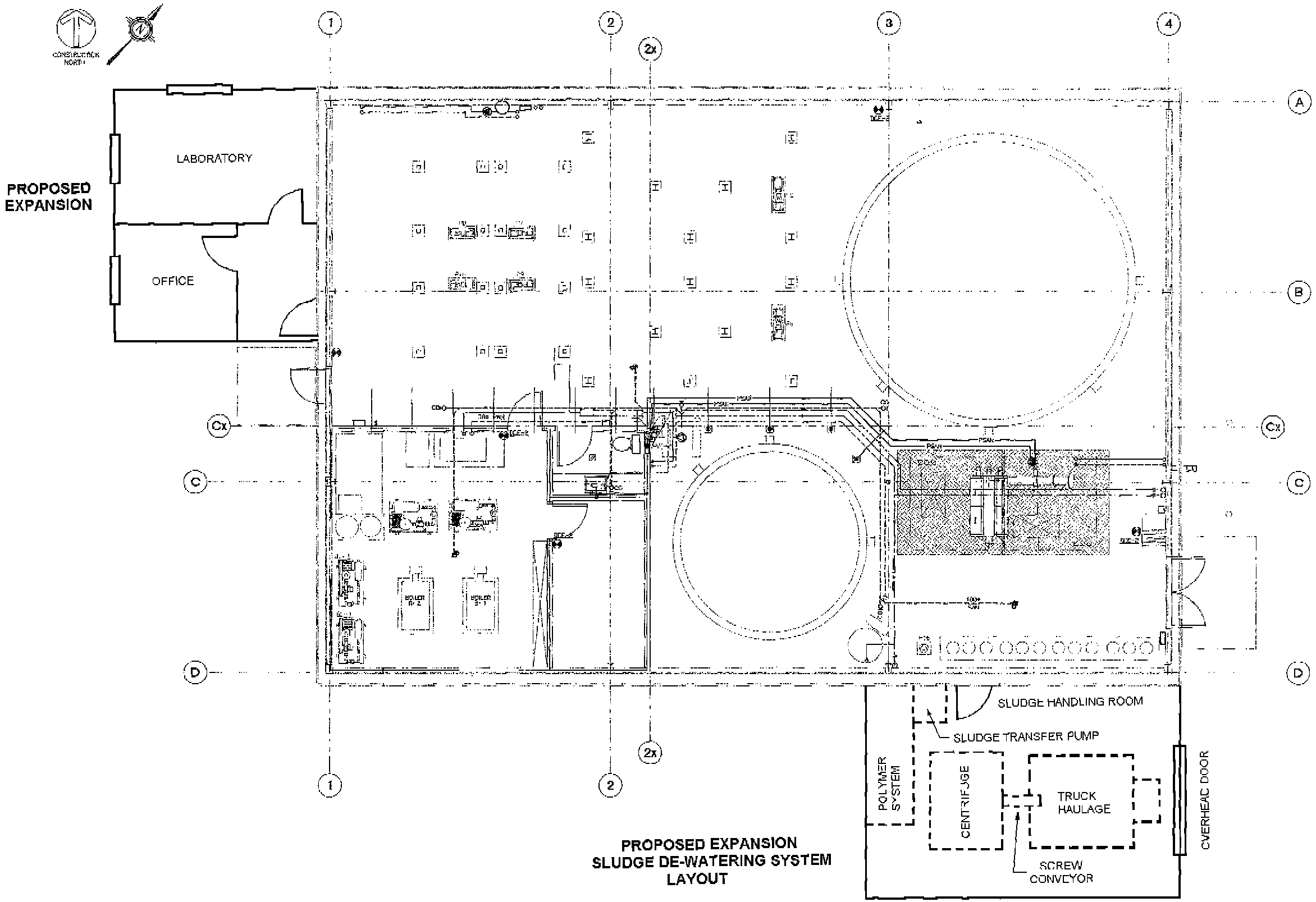
PROJ. NO. 06–6119–4000

FIG. NO. 10



DILLON CONSULTING FEBRUARY 2007	PANGNIRTUNG SEWAGE TREATMENT PLANT	PROJ. NO. 06–6119–4000
	WASTE WATER TREATMENT PLAN FLOW DIAGRAM - NEW PROCESS MODIFICATION	FIG. NO. 11

40DILLON ACAD FILE: G:\CAD\066119\DRAWINGS\066119-1.DWG 02/16/07



PROPOSED EXPANSION SLUDGE DE-WATERING SYSTEM LAYOUT

DILLON CONSULTING

FEBRUARY 2007

PANGNIRTUNG
SEWAGE TREATMENT PLANT

NEW LOWER LEVEL MECHANICAL PLAN
PROPOSED BUILDING MODIFICATION

PROJ. NO. 06–6119–4000

FIG. NO. 12

Photo Set 1:
Plant Sewage Receiving System

Photo Set 1: Pangnirtung WWTP Sewage Receiving System

Photo 1. The sewage trucks discharge into sewage receiving tank.

Photo 2. The 150 mm Cam-lock reducing to 100 mm inlet receives the raw sewage from the trucks.

Photo 3. Billy is removing solid waste from bar rack influent chamber.

Photo 4. Receiving tank and influent flow meter.

Photo 5. Rotary screen, compactor/conveyor and screenings bagger.

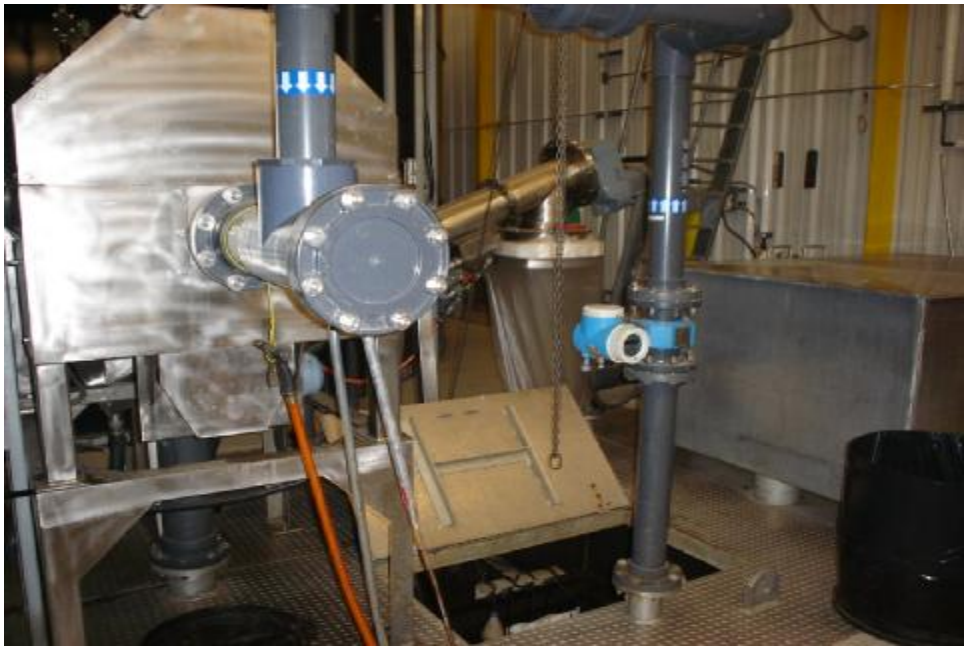


Photo 6. IPEC 30” x 36” with 3 mm rotary screen and ½ hp motor.

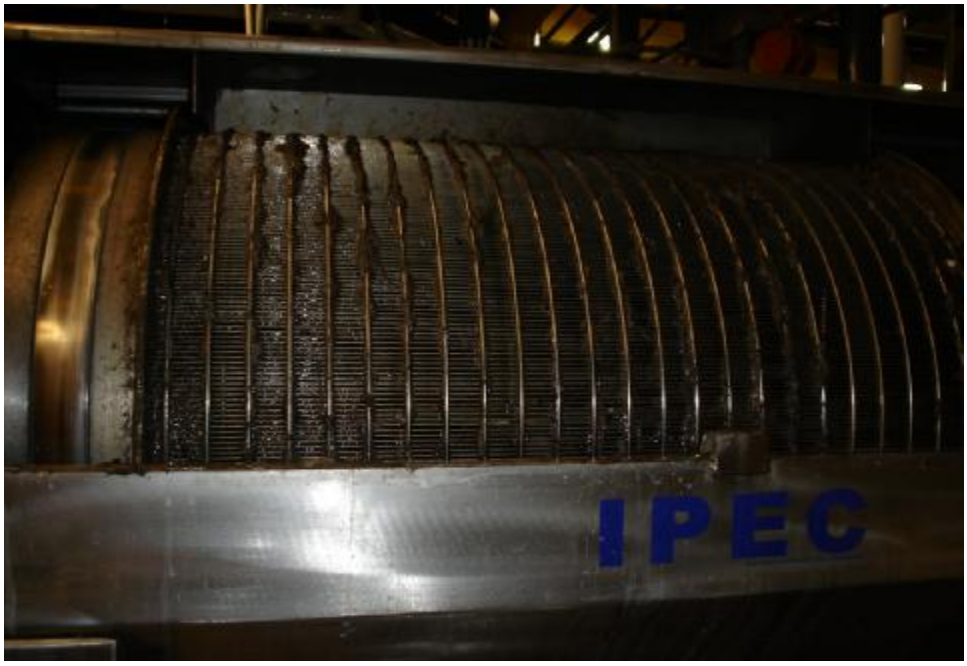


Photo 7. Screened Sewage Tank

Photo 8. Equalization Tank

Photo Set 2:
Biological Process Components

Photo Set 2: Pangnirtung WWTP Biological Process Components

Photo 1. Biological Process Feed Pumps, (Taking sample from EQ Tank)

Photo 2. Activated Sludge Reactors. (Jan. 2007)

Photo 3. Bioreactor Train #1

Photo 4. Bioreactor Train #1

Photo 5. Clarifier – Scum sludge

Photo 6. Clarifier – Scum sludge

Photo 7. Clarifier – overflow suspended solid to effluent.

Photo Set 3:
Sludge System

Photo Set 3: Pangnirtung WWTP Sludge System

Photo 1. Sludge Pumps

Photo 2. Sludge Digester with decant piping

Photo 3. Sludge Bagger

Polymer System

Photo 4. Pumping sludge with polymer to dewatering system

Photo 5. Checking sludge flow and distributing to bags

Photo 6. Filtrate return pump

Photo 7. Storage - dewatering solid bags outside building.

Photo 8. Disposal – sludge solids bags in the Landfill

Photo Set 4:
Operational Problems

Photo Set 4: Pangnirtung Operational Problems

Feed and sludge pumps require frequent maintenance.

Sludge bagging is physically labour intensive and difficult to operate.

Insufficient ventilation – odour problem

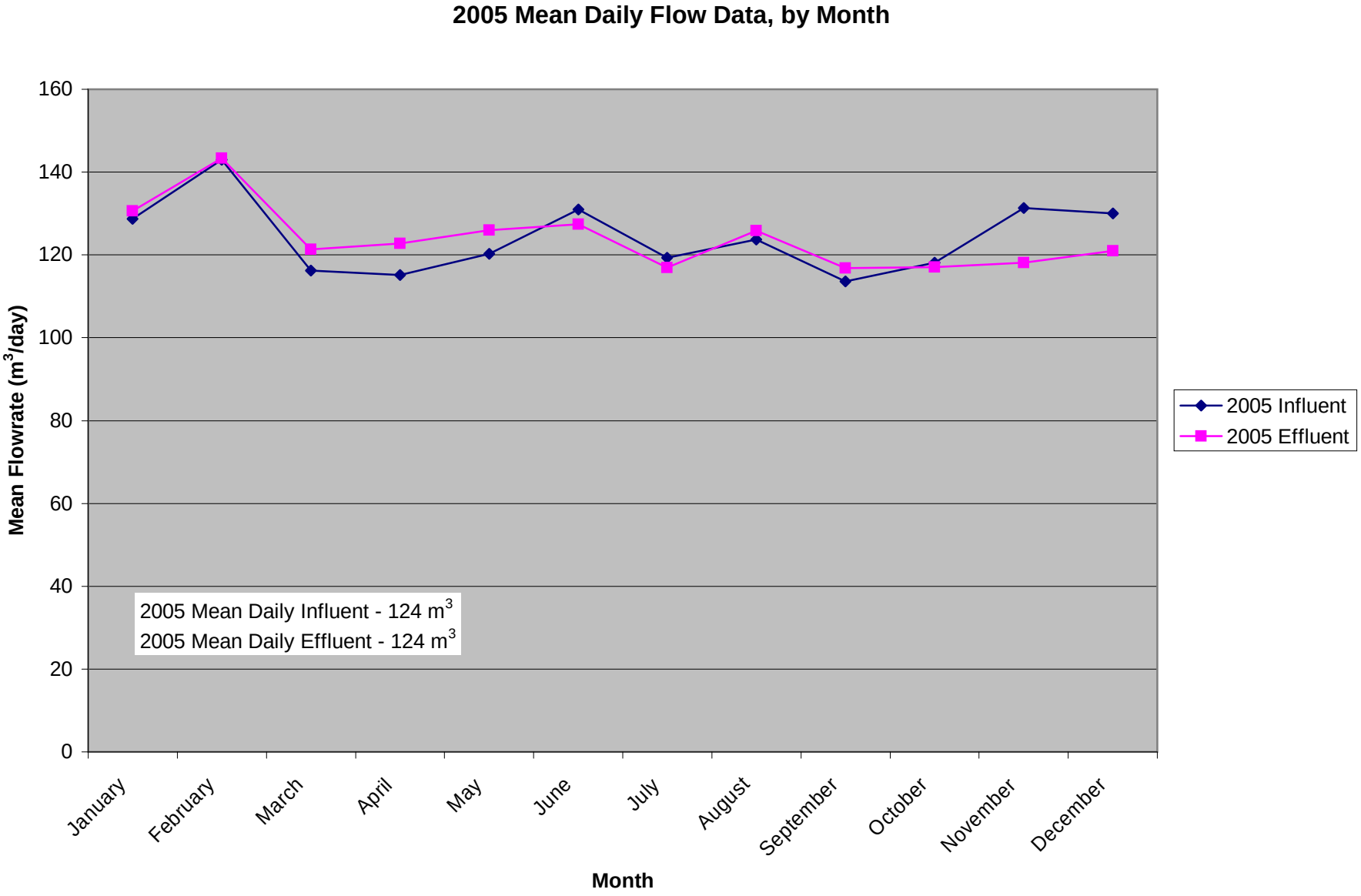
Insufficient ventilation – odour problem

Insufficient blower capacity, oxygen level and aeration

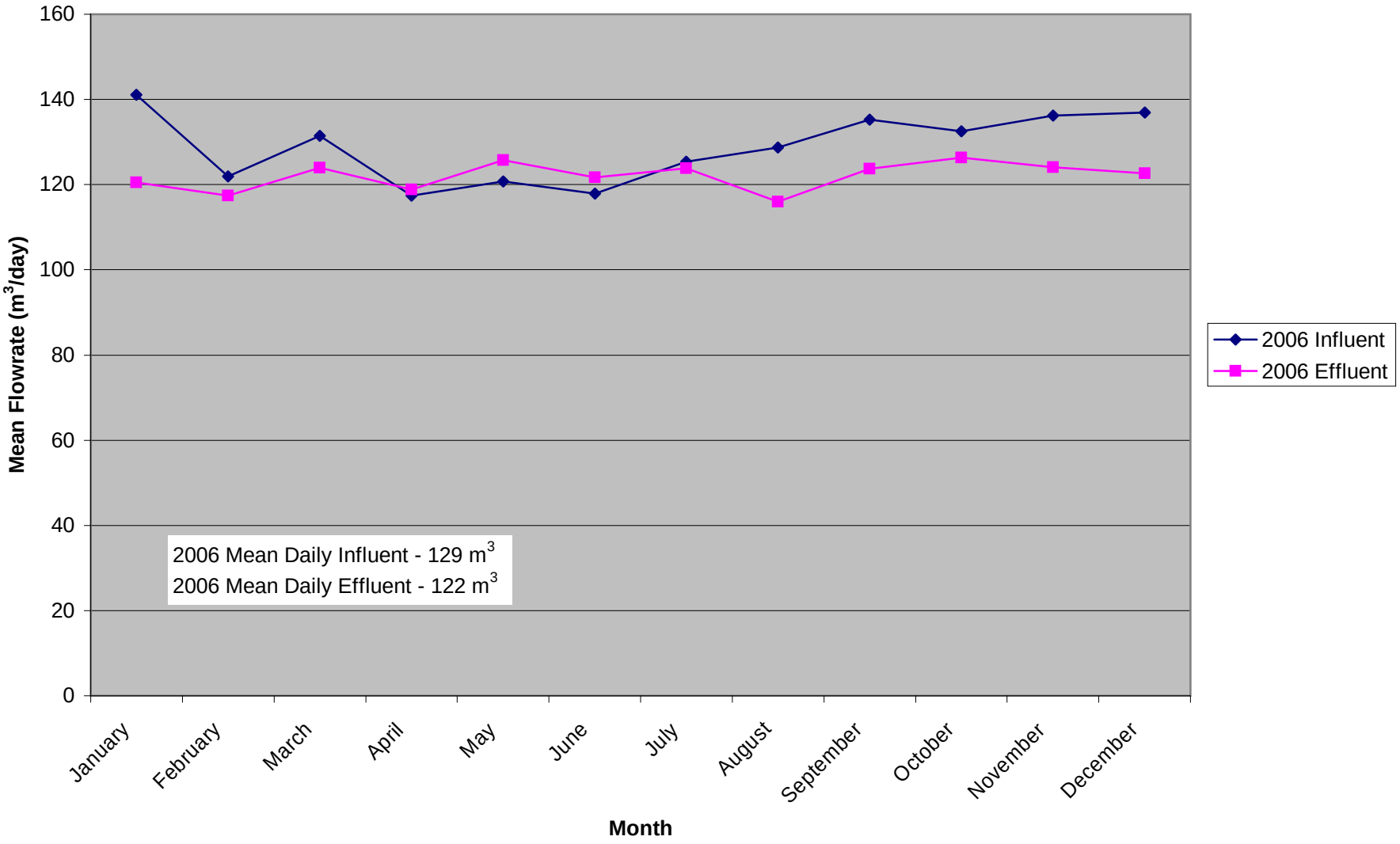
Corrosion electrical connections and instrumentation - problems

Problem room and equipment for lab control treatment system

Appendix A:
Operational Data Tables


2005 Mean Daily Flow Data, by Month
Mean Flowrate (m3/day)
160
140
120
100
80
60
40
20
0
January
February
March
April
May
June
July
August
September
October
November
December
Month
2005 Influent
2005 Effluent
2005 Mean Daily Influent - 124 m3
2005 Mean Daily Effluent - 124 m3

2006 Mean Daily Flow Data, by Month



Flow Data Summary								
Day	Date	Influent (m^3)	Effluent (m^3)		Day	Date	Influent (m^3)	Effluent (m^3)
Saturday	1-Jan-05	161.6	107.4		Friday	18-Feb-05	129.5	149.5
Sunday	2-Jan-05				Saturday	19-Feb-05	100.8	129.6
Monday	3-Jan-05	112.6	94.9		Sunday	20-Feb-05		
Tuesday	4-Jan-05	125.8	121.9		Monday	21-Feb-05		
Wednesday	5-Jan-05	158.3	175.4		Tuesday	22-Feb-05		
Thursday	6-Jan-05	106.4	127.4		Wednesday	23-Feb-05		
Friday	7-Jan-05	146.9	163.1		Thursday	24-Feb-05		
Saturday	8-Jan-05	128.5	121.3		Friday	25-Feb-05		
Sunday	9-Jan-05	131.1	138.1		Saturday	26-Feb-05	117.9	115.6
Monday	10-Jan-05	73.4	98.3		Sunday	27-Feb-05		
Tuesday	11-Jan-05	151.1	135.8		Monday	28-Feb-05		
Wednesday	12-Jan-05	160.4	166.9		Tuesday	1-Mar-05	154.3	ns
Thursday	13-Jan-05	99.9	117		Wednesday	2-Mar-05	121.8	175.3
Friday	14-Jan-05	129.2	126.7		Thursday	3-Mar-05	130.6	125.6
Saturday	15-Jan-05	156.6	164.5		Friday	4-Mar-05	110.8	124.3
Sunday	16-Jan-05	131.4	128.2		Saturday	5-Mar-05	23.5	29.9
Monday	17-Jan-05	60.7	75.1		Sunday	6-Mar-05	155.9	110.8
Tuesday	18-Jan-05	177.8	162.6		Monday	7-Mar-05	60.1	75.8
Wednesday	19-Jan-05	150.9	169.8		Tuesday	8-Mar-05	143.7	164.8
Thursday	20-Jan-05	125.4	126.4		Wednesday	9-Mar-05	133.1	153.5
Friday	21-Jan-05	139.2	161.6		Thursday	10-Mar-05	104.7	106.4
Saturday	22-Jan-05	123.6	116.2		Friday	11-Mar-05	147.4	149.5
Sunday	23-Jan-05	161.2	159		Saturday	12-Mar-05	117.7	136.3
Monday	24-Jan-05	91	105.4		Sunday	13-Mar-05	126.9	143.8
Tuesday	25-Jan-05	151.4	150.1		Monday	14-Mar-05	78	57.7
Wednesday	26-Jan-05	160	160.1		Tuesday	15-Mar-05	151.8	160.8
Thursday	27-Jan-05	122.2	125.7		Wednesday	16-Mar-05	131.8	136.7
Friday	28-Jan-05	139.5	152.3		Thursday	17-Mar-05	108.7	115.5
Saturday	29-Jan-05	129.6	130.8		Friday	18-Mar-05	119.8	131.3
Sunday	30-Jan-05	66.8	45.9		Saturday	19-Mar-05	113.3	120.4
Monday	31-Jan-05	88	90.6		Sunday	20-Mar-05	145.8	136.8
Tuesday	1-Feb-05	284.4	264.4		Monday	21-Mar-05	65.8	62.7
Wednesday	2-Feb-05	158.6	165.4		Tuesday	22-Mar-05	146.4	152.1
Thursday	3-Feb-05	145.2	165.5		Wednesday	23-Mar-05	128.4	133.3
Friday	4-Feb-05	140.1	133.7		Thursday	24-Mar-05	105.5	120.9
Saturday	5-Feb-05	86.3	79.5		Friday	25-Mar-05	124.7	138.9
Sunday	6-Feb-05	177.5	176.5		Saturday	26-Mar-05	107.8	62
Monday	7-Feb-05	133.7	93.8		Sunday	27-Mar-05	92.1	96.5
Tuesday	8-Feb-05	191.2	180.3		Monday	28-Mar-05	98.8	101.4
Wednesday	9-Feb-05	153.5	152.9		Tuesday	29-Mar-05	111.5	114.9
Thursday	10-Feb-05	150	158.5		Wednesday	30-Mar-05	161.7	186.5
Friday	11-Feb-05	140.1	115.2		Thursday	31-Mar-05	119.3	116
Saturday	12-Feb-05	127.8	145.2		Friday	1-Apr-05	120.7	137
Sunday	13-Feb-05	92	95.9		Saturday	2-Apr-05	82.1	95.3
Monday	14-Feb-05	55.9	62.7		Sunday	3-Apr-05	129.9	134.4
Tuesday	15-Feb-05	186.6	162.8		Monday	4-Apr-05	103	106.6
Wednesday	16-Feb-05	157.8	176.4		Tuesday	5-Apr-05	131.9	124.9
Thursday	17-Feb-05	131.4	144.4		Wednesday	6-Apr-05	131.6	148.3

Day	Date	Influent (m^3)	Effluent (m^3)		Day	Date	Influent (m^3)	Effluent (m^3)
Thursday	7-Apr-05	112.3	129.9		Friday	27-May-05	150.8	151.9
Friday	8-Apr-05	105.5	109.5		Saturday	28-May-05	113.5	111.2
Saturday	9-Apr-05	119.1	134.5		Sunday	29-May-05	78.3	58
Sunday	10-Apr-05	131.4	135.1		Monday	30-May-05	105.7	113.1
Monday	11-Apr-05	92.3	104.7		Tuesday	31-May-05	143.5	142.1
Tuesday	12-Apr-05	164.5	155		Wednesday	1-Jun-05	145.6	129.5
Wednesday	13-Apr-05	121.6	144.9		Thursday	2-Jun-05	140.9	157.7
Thursday	14-Apr-05	73.7	77		Friday	3-Jun-05	146.6	143.5
Friday	15-Apr-05	146.7	138.5		Saturday	4-Jun-05	136.5	128.6
Saturday	16-Apr-05	141.1	162.6		Sunday	5-Jun-05	58.6	54.7
Sunday	17-Apr-05	80.2	93.1		Monday	6-Jun-05	58.6	40.9
Monday	18-Apr-05	93.2	93.3		Tuesday	7-Jun-05	164.5	140.4
Tuesday	19-Apr-05	150.9	162.3		Wednesday	8-Jun-05	167.1	175.4
Wednesday	20-Apr-05	141.3	153.3		Thursday	9-Jun-05	117.9	135.5
Thursday	21-Apr-05	105.3	114.9		Friday	10-Jun-05	139.4	147.8
Friday	22-Apr-05	117.7	125		Saturday	11-Jun-05	111.6	109.7
Saturday	23-Apr-05	109.4	108.4		Sunday	12-Jun-05	128.7	110.4
Sunday	24-Apr-05	76	89.5		Monday	13-Jun-05	147.1	152.2
Monday	25-Apr-05	94.3	94.8		Tuesday	14-Jun-05	138.2	132
Tuesday	26-Apr-05	134.6	176.7		Wednesday	15-Jun-05	124.6	118.4
Wednesday	27-Apr-05	84.6	112.8		Thursday	16-Jun-05	115.3	106.8
Thursday	28-Apr-05	116.7	125.5		Friday	17-Jun-05	133.9	136.3
Friday	29-Apr-05	110.1	103.3		Saturday	18-Jun-05	152.4	157.4
Saturday	30-Apr-05	131.8	90.6		Sunday	19-Jun-05	111.8	107.5
Sunday	1-May-05	98.7	138.6		Monday	20-Jun-05	91.9	83.8
Monday	2-May-05	80.7	105.7		Tuesday	21-Jun-05	175.2	154
Tuesday	3-May-05	142.4	140.4		Wednesday	22-Jun-05	139.8	146.5
Wednesday	4-May-05	142.3	141		Thursday	23-Jun-05	134.8	144.6
Thursday	5-May-05	100.9	130.2		Friday	24-Jun-05	136.3	127.2
Friday	6-May-05	104.9	115.2		Saturday	25-Jun-05	149.4	160.1
Saturday	7-May-05	105.5	120.9		Sunday	26-Jun-05	114.6	93.1
Sunday	8-May-05	84.8	88.3		Monday	27-Jun-05	107.4	104.6
Monday	9-May-05	97.9	96.4		Tuesday	28-Jun-05	177.9	168.9
Tuesday	10-May-05	180.4	167.6		Wednesday	29-Jun-05		
Wednesday	11-May-05	136	146.4		Thursday	30-Jun-05		
Thursday	12-May-05	112.2	136.6		Friday	1-Jul-05	133.5	224.4
Friday	13-May-05	102.5	113.4		Saturday	2-Jul-05	22.8	19.5
Saturday	14-May-05	106.2	104		Sunday	3-Jul-05	34.2	0.4
Sunday	15-May-05	72.3	81.6		Monday	4-Jul-05	67.1	103.1
Monday	16-May-05	81	80		Tuesday	5-Jul-05	243.8	215.2
Tuesday	17-May-05	104.7	91.1		Wednesday	6-Jul-05	167.8	173.3
Wednesday	18-May-05	170.8	175.4		Thursday	7-Jul-05	100.4	110.3
Thursday	19-May-05	155	147.1		Friday	8-Jul-05	134.3	112.1
Friday	20-May-05	164	176.8		Saturday	9-Jul-05	143.2	155.8
Saturday	21-May-05	144.4	190.3		Sunday	10-Jul-05		
Sunday	22-May-05	86.5	68.1		Monday	11-Jul-05		
Monday	23-May-05	120.3	111.9		Tuesday	12-Jul-05	126.9	131
Tuesday	24-May-05	125.8	136.5		Wednesday	13-Jul-05	198.7	143.1
Wednesday	25-May-05	180.5	167.5		Thursday	14-Jul-05	119.9	112.5
Thursday	26-May-05	137.5	157		Friday	15-Jul-05	138.8	149.5

Day	Date	Influent (m^3)	Effluent (m^3)		Day	Date	Influent (m^3)	Effluent (m^3)
Saturday	16-Jul-05	129	151.7		Sunday	4-Sep-05	96.1	79
Sunday	17-Jul-05	123	76		Monday	5-Sep-05	82.6	84.4
Monday	18-Jul-05	76	44.3		Tuesday	6-Sep-05	81.5	68.3
Tuesday	19-Jul-05	194.7	ns		Wednesday	7-Sep-05	143	128.9
Wednesday	20-Jul-05				Thursday	8-Sep-05	108.9	116.7
Thursday	21-Jul-05				Friday	9-Sep-05	115.8	124.3
Friday	22-Jul-05				Saturday	10-Sep-05	76.3	77.4
Saturday	23-Jul-05	128	129.5		Sunday	11-Sep-05	64.4	43.1
Sunday	24-Jul-05	103.1	104.4		Monday	12-Sep-05	64.5	64.8
Monday	25-Jul-05	82.8	89.7		Tuesday	13-Sep-05	212.2	203.9
Tuesday	26-Jul-05	125.4	114.6		Wednesday	14-Sep-05	130.7	135.2
Wednesday	27-Jul-05	160.8	164.3		Thursday	15-Sep-05	119.5	112.5
Thursday	28-Jul-05	133.8	145.2		Friday	16-Sep-05	112.8	131.9
Friday	29-Jul-05	130.5	132.8		Saturday	17-Sep-05	106.6	140.1
Saturday	30-Jul-05	89.5	86.8		Sunday	18-Sep-05	121.9	89.8
Sunday	31-Jul-05	68.7	34.3		Monday	19-Sep-05	61.9	81.1
Monday	1-Aug-05	101.8	129.1		Tuesday	20-Sep-05	178.5	149.6
Tuesday	2-Aug-05	116.9	111.4		Wednesday	21-Sep-05	124.8	141.9
Wednesday	3-Aug-05	171.6	148.8		Thursday	22-Sep-05	118.7	127.8
Thursday	4-Aug-05	131.7	165.2		Friday	23-Sep-05	111.9	123
Friday	5-Aug-05	130.6	148.5		Saturday	24-Sep-05	128.1	123.7
Saturday	6-Aug-05	168.8	145		Sunday	25-Sep-05	65.1	60.2
Sunday	7-Aug-05	128.3	121.3		Monday	26-Sep-05	75.7	75.4
Monday	8-Aug-05	86.8	106.5		Tuesday	27-Sep-05	170.2	198.4
Tuesday	9-Aug-05	138.7	129.3		Wednesday	28-Sep-05	140.9	161.1
Wednesday	10-Aug-05	126.2	123.4		Thursday	29-Sep-05	131.9	144.9
Thursday	11-Aug-05	115.3	112.6		Friday	30-Sep-05	102.6	123
Friday	12-Aug-05	116.2	234.2		Saturday	1-Oct-05	128	122.3
Saturday	13-Aug-05	142.3	127.4		Sunday	2-Oct-05	108.1	119
Sunday	14-Aug-05	134.3	124.9		Monday	3-Oct-05	74.8	78
Monday	15-Aug-05	53	53.2		Tuesday	4-Oct-05	109.7	109.9
Tuesday	16-Aug-05	199.4	206		Wednesday	5-Oct-05	158.7	165.7
Wednesday	17-Aug-05	113.4	119.9		Thursday	6-Oct-05	134.8	132
Thursday	18-Aug-05	114.2	112.8		Friday	7-Oct-05	114.3	140.3
Friday	19-Aug-05	119.4	94.8		Saturday	8-Oct-05	97.2	115.4
Saturday	20-Aug-05	118.6	128.7		Sunday	9-Oct-05	78.4	80.3
Sunday	21-Aug-05	82.6	59.8		Monday	10-Oct-05	103.9	42
Monday	22-Aug-05	71.9	62.8		Tuesday	11-Oct-05	130.5	103.8
Tuesday	23-Aug-05	186.2	171.3		Wednesday	12-Oct-05	101.5	127.2
Wednesday	24-Aug-05	93.7	89.9		Thursday	13-Oct-05	16.9	15.3
Thursday	25-Aug-05	140.3	149.4		Friday	14-Oct-05	140.5	152.8
Friday	26-Aug-05	60.3	86.4		Saturday	15-Oct-05	180.9	222.2
Saturday	27-Aug-05	99.9	81.3		Sunday	16-Oct-05	100.5	135.9
Sunday	28-Aug-05	88.1	78.3		Monday	17-Oct-05	89.5	64.3
Monday	29-Aug-05	126.4	144.2		Tuesday	18-Oct-05	193	175.5
Tuesday	30-Aug-05	184.5	160.4		Wednesday	19-Oct-05	132.2	142.6
Wednesday	31-Aug-05	173.1	175.1		Thursday	20-Oct-05	110.5	105.6
Thursday	1-Sep-05	110.2	123.5		Friday	21-Oct-05	130.2	149.2
Friday	2-Sep-05	103.8	97.3		Saturday	22-Oct-05	121.4	135.7
Saturday	3-Sep-05	147.5	172.4		Sunday	23-Oct-05	48.9	56.9

Day	Date	Influent (m^3)	Effluent (m^3)		Day	Date	Influent (m^3)	Effluent (m^3)
Monday	24-Oct-05	36.9	41.6		Tuesday	13-Dec-05	132.8	135.9
Tuesday	25-Oct-05	175.8	40		Wednesday	14-Dec-05	131.7	138.5
Wednesday	26-Oct-05	186.5	197.2		Thursday	15-Dec-05	124.2	110.3
Thursday	27-Oct-05	104.1	0		Friday	16-Dec-05	125.9	135.7
Friday	28-Oct-05	165.3	169.8		Saturday	17-Dec-05	111.6	109
Saturday	29-Oct-05	153	169		Sunday	18-Dec-05	45.3	27.8
Sunday	30-Oct-05	127.3	108.4		Monday	19-Dec-05	57.2	55.4
Monday	31-Oct-05	107.8	92.4		Tuesday	20-Dec-05	232.7	192
Tuesday	1-Nov-05	188.7	154.8		Wednesday	21-Dec-05	135.2	155.5
Wednesday	2-Nov-05	131.6	120.7		Thursday	22-Dec-05	114.9	123.9
Thursday	3-Nov-05	142.4	137.3		Friday	23-Dec-05	131.4	135.4
Friday	4-Nov-05	122.1	123.1		Saturday	24-Dec-05	122	237.1
Saturday	5-Nov-05	103.5	14.7		Sunday	25-Dec-05	0	122.4
Sunday	6-Nov-05				Monday	26-Dec-05	0	62.4
Monday	7-Nov-05	116.5	76.7		Tuesday	27-Dec-05	196	185.2
Tuesday	8-Nov-05	237	174.2		Wednesday	28-Dec-05	500.4	102.7
Wednesday	9-Nov-05	150.4	149.2		Thursday	29-Dec-05	150.3	122.5
Thursday	10-Nov-05	134.1	132.9		Friday	30-Dec-05	108.5	105.6
Friday	11-Nov-05	120.4	109.1		Saturday	31-Dec-05	85.7	95.8
Saturday	12-Nov-05	97.3	82.8		Sunday	1-Jan-06	200.7	101.4
Sunday	13-Nov-05	146.2	118.8		Monday	2-Jan-06	ns	54.6
Monday	14-Nov-05	80.4	91.4		Tuesday	3-Jan-06	303.7	104.1
Tuesday	15-Nov-05	208	177.7		Wednesday	4-Jan-06	131.5	105.3
Wednesday	16-Nov-05	108.8	136.3		Thursday	5-Jan-06	187.4	170.5
Thursday	17-Nov-05	107.9	96.5		Friday	6-Jan-06	153.5	152.9
Friday	18-Nov-05	128	119.4		Saturday	7-Jan-06	130.7	142.9
Saturday	19-Nov-05	122.5	127.4		Sunday	8-Jan-06	131.7	106.8
Sunday	20-Nov-05	110.8	100.2		Monday	9-Jan-06	57.9	71.4
Monday	21-Nov-05	51.6	47.4		Tuesday	10-Jan-06	269.2	139.9
Tuesday	22-Nov-05	201.1	177.5		Wednesday	11-Jan-06	141.9	143.3
Wednesday	23-Nov-05	122.4	120.7		Thursday	12-Jan-06	151.4	154.1
Thursday	24-Nov-05	140.7	125.9		Friday	13-Jan-06	118.4	110.1
Friday	25-Nov-05	105	100.9		Saturday	14-Jan-06	146.2	132.9
Saturday	26-Nov-05	177.5	149.9		Sunday	15-Jan-06	104.2	94.5
Sunday	27-Nov-05	5.3	10.4		Monday	16-Jan-06	23.9	23.2
Monday	28-Nov-05	144.8	123.3		Tuesday	17-Jan-06	162.6	139.9
Tuesday	29-Nov-05	144.3	154.9		Wednesday	18-Jan-06	138.2	142.2
Wednesday	30-Nov-05	158	170.6		Thursday	19-Jan-06	146	147.8
Thursday	1-Dec-05	106.5	114.5		Friday	20-Jan-06	103.5	104.3
Friday	2-Dec-05	138.4	134.7		Saturday	21-Jan-06	153.9	150.5
Saturday	3-Dec-05	95.2	69		Sunday	22-Jan-06	111.8	76.2
Sunday	4-Dec-05	131.6	97.5		Monday	23-Jan-06	104.3	96.1
Monday	5-Dec-05	55.5	73.3		Tuesday	24-Jan-06	140.1	132.3
Tuesday	6-Dec-05	201.5	173.9		Wednesday	25-Jan-06	162.7	165.3
Wednesday	7-Dec-05	144.7	126.6		Thursday	26-Jan-06	121	118.8
Thursday	8-Dec-05	145	151.3		Friday	27-Jan-06	137.1	140.4
Friday	9-Dec-05	122	128.1		Saturday	28-Jan-06	119.8	107.1
Saturday	10-Dec-05	141.3	115.3		Sunday	29-Jan-06	96.4	74.2
Sunday	11-Dec-05	91.7	92.3		Monday	30-Jan-06	120.3	112.7
Monday	12-Dec-05	152.3	120		Tuesday	31-Jan-06	160.9	154.4

Day	Date	Influent (m^3)	Effluent (m^3)		Day	Date	Influent (m^3)	Effluent (m^3)
Wednesday	1-Feb-06	144.9	127.7		Thursday	23-Mar-06	132.1	131.6
Thursday	2-Feb-06	121.7	118.1		Friday	24-Mar-06	109.8	115
Friday	3-Feb-06	136.3	130.3		Saturday	25-Mar-06	130.4	130.2
Saturday	4-Feb-06	114.8	129		Sunday	26-Mar-06	47.9	57.7
Sunday	5-Feb-06	76.5	81.1		Monday	27-Mar-06	79.1	69.8
Monday	6-Feb-06	143.5	111.9		Tuesday	28-Mar-06	230.3	189.4
Tuesday	7-Feb-06	143.4	142.5		Wednesday	29-Mar-06	124.6	146.1
Wednesday	8-Feb-06	152.9	135.7		Thursday	30-Mar-06	98.7	98.4
Thursday	9-Feb-06	123.8	133.3		Friday	31-Mar-06	133.2	134.8
Friday	10-Feb-06	127.9	119.9		Saturday	1-Apr-06	103	117.1
Saturday	11-Feb-06	170.1	137.5		Sunday	2-Apr-06	58.6	55.1
Sunday	12-Feb-06	63.5	53.1		Monday	3-Apr-06	119.2	119.6
Monday	13-Feb-06	41.8	80.1		Tuesday	4-Apr-06	148.8	160.2
Tuesday	14-Feb-06	182.9	176		Wednesday	5-Apr-06	136.9	161.9
Wednesday	15-Feb-06	170.3	162.1		Thursday	6-Apr-06	134.6	124.3
Thursday	16-Feb-06	131.9	138.8		Friday	7-Apr-06	126.9	132.6
Friday	17-Feb-06	121.9	119.8		Saturday	8-Apr-06	120.3	135.3
Saturday	18-Feb-06	142.3	131.1		Sunday	9-Apr-06	82.9	73.7
Sunday	19-Feb-06	131.2	109.1		Monday	10-Apr-06	86.4	92.5
Monday	20-Feb-06	90.9	88.9		Tuesday	11-Apr-06	179.1	183.1
Tuesday	21-Feb-06	164.5	160		Wednesday	12-Apr-06	121.2	132.5
Wednesday	22-Feb-06	132.8	127.6		Thursday	13-Apr-06	124.4	124.7
Thursday	23-Feb-06	142.1	135.1		Friday	14-Apr-06	116.8	124.2
Friday	24-Feb-06	110	109.7		Saturday	15-Apr-06	102.8	112.7
Saturday	25-Feb-06	121.1	123.8		Sunday	16-Apr-06	104.7	77.1
Sunday	26-Feb-06	24.2	30.7		Monday	17-Apr-06	205.9	103.9
Monday	27-Feb-06	85.9	81.4		Tuesday	18-Apr-06	111	117.2
Tuesday	28-Feb-06	100	94.1		Wednesday	19-Apr-06	111	118.6
Wednesday	1-Mar-06	212.9	173.1		Thursday	20-Apr-06	122.1	113.8
Thursday	2-Mar-06	147.3	151.1		Friday	21-Apr-06	135.7	135.5
Friday	3-Mar-06	122.8	133.8		Saturday	22-Apr-06	104.5	119.8
Saturday	4-Mar-06	129.9	127.8		Sunday	23-Apr-06	108.3	88
Sunday	5-Mar-06	113	103.5		Monday	24-Apr-06	86.7	94.8
Monday	6-Mar-06	53.1	71.1		Tuesday	25-Apr-06	109.9	90.8
Tuesday	7-Mar-06	221.3	176.5		Wednesday	26-Apr-06	165.8	253
Wednesday	8-Mar-06	128.1	134.9		Thursday	27-Apr-06	109.5	120.2
Thursday	9-Mar-06	136	139		Friday	28-Apr-06	109.3	111.6
Friday	10-Mar-06	93.9	101.8		Saturday	29-Apr-06	98.4	102.5
Saturday	11-Mar-06	117.9	131.4		Sunday	30-Apr-06	77.9	69.6
Sunday	12-Mar-06	150.7	94.9		Monday	1-May-06	87.5	91.7
Monday	13-Mar-06	54.5	51.2		Tuesday	2-May-06	141.4	151.7
Tuesday	14-Mar-06	177.9	159.9		Wednesday	3-May-06	114	107.2
Wednesday	15-Mar-06	303.2	189.4		Thursday	4-May-06	114.2	119.7
Thursday	16-Mar-06	125.6	141.8		Friday	5-May-06	131.9	124.8
Friday	17-Mar-06	125.3	117.3		Saturday	6-May-06	84.5	85.1
Saturday	18-Mar-06	106.3	111.4		Sunday	7-May-06	92.8	120.2
Sunday	19-Mar-06	74.8	67		Monday	8-May-06	61.5	44.2
Monday	20-Mar-06	43.4	49.4		Tuesday	9-May-06	184.6	160.8
Tuesday	21-Mar-06	219.6	191.9		Wednesday	10-May-06	99.3	124.6
Wednesday	22-Mar-06	132.1	151.2		Thursday	11-May-06	136.1	134.1

Day	Date	Influent (m^3)	Effluent (m^3)		Day	Date	Influent (m^3)	Effluent (m^3)
Friday	12-May-06	130.1	151.7		Saturday	1-Jul-06	124.1	72.2
Saturday	13-May-06	136.4	139.6		Sunday	2-Jul-06	77.6	52.2
Sunday	14-May-06	116.9	114.7		Monday	3-Jul-06	76.6	86
Monday	15-May-06	98.4	103.6		Tuesday	4-Jul-06	180.4	133.9
Tuesday	16-May-06	158.2	158.9		Wednesday	5-Jul-06	151.7	171.2
Wednesday	17-May-06	151.2	171.9		Thursday	6-Jul-06	123.8	125
Thursday	18-May-06	121.9	125.4		Friday	7-Jul-06	115.4	111.6
Friday	19-May-06	134.9	137.7		Saturday	8-Jul-06	137.2	124.6
Saturday	20-May-06	121.3	131.1		Sunday	9-Jul-06	108.1	223.3
Sunday	21-May-06	32.8	34.4		Monday	10-Jul-06	98	90
Monday	22-May-06	168.1	153.6		Tuesday	11-Jul-06	99.1	115.3
Tuesday	23-May-06	120.8	145.2		Wednesday	12-Jul-06	137.5	124.6
Wednesday	24-May-06	164.2	182.2		Thursday	13-Jul-06	125.5	128.9
Thursday	25-May-06	113.3	110.7		Friday	14-Jul-06	136.8	117.2
Friday	26-May-06	143.7	148.6		Saturday	15-Jul-06	140.7	141.2
Saturday	27-May-06	96.3	107.8		Sunday	16-Jul-06	95.5	96.1
Sunday	28-May-06	118.6	102.6		Monday	17-Jul-06	70.6	69.1
Monday	29-May-06	126	131.3		Tuesday	18-Jul-06	168.3	167.6
Tuesday	30-May-06	127.8	157.3		Wednesday	19-Jul-06	174.2	182.5
Wednesday	31-May-06	114.7	125.6		Thursday	20-Jul-06	201.6	123.8
Thursday	1-Jun-06	121.6	97.4		Friday	21-Jul-06	122.6	155.8
Friday	2-Jun-06	99.6	112.9		Saturday	22-Jul-06	159.1	154.7
Saturday	3-Jun-06	141.6	158.6		Sunday	23-Jul-06	87.9	72.6
Sunday	4-Jun-06	104.9	112.9		Monday	24-Jul-06	116	179.2
Monday	5-Jun-06	112.1	117.8		Tuesday	25-Jul-06	143.3	151.3
Tuesday	6-Jun-06	117.9	122.9		Wednesday	26-Jul-06	117.7	89.5
Wednesday	7-Jun-06	122.8	129.5		Thursday	27-Jul-06	118.8	132.2
Thursday	8-Jun-06	112.7	112.3		Friday	28-Jul-06	140.1	154
Friday	9-Jun-06	138.9	133.2		Saturday	29-Jul-06	107.8	81.3
Saturday	10-Jun-06	110	124.7		Sunday	30-Jul-06	139	114.9
Sunday	11-Jun-06	106.7	112.7		Monday	31-Jul-06	91	98.5
Monday	12-Jun-06	114.3	111		Tuesday	1-Aug-06	187	172.5
Tuesday	13-Jun-06	138.3	165.2		Wednesday	2-Aug-06	134.4	138
Wednesday	14-Jun-06	106.8	111.9		Thursday	3-Aug-06	143.7	111
Thursday	15-Jun-06	153.8	136.7		Friday	4-Aug-06	162.6	135.7
Friday	16-Jun-06	118.9	132.3		Saturday	5-Aug-06	143.6	138.5
Saturday	17-Jun-06	122.5	127.4		Sunday	6-Aug-06	103.9	73.1
Sunday	18-Jun-06	121.7	135		Monday	7-Aug-06	89.1	69.9
Monday	19-Jun-06	88.5	80.8		Tuesday	8-Aug-06	198.2	161.2
Tuesday	20-Jun-06	159.8	173.3		Wednesday	9-Aug-06	109.4	170.7
Wednesday	21-Jun-06	112.5	147.3		Thursday	10-Aug-06	148.4	143.2
Thursday	22-Jun-06	128.6	92.6		Friday	11-Aug-06	103.2	96.3
Friday	23-Jun-06	117.1	138.4		Saturday	12-Aug-06	162.4	125.5
Saturday	24-Jun-06	129.6	121.6		Sunday	13-Aug-06	129.4	80.4
Sunday	25-Jun-06	69.8	75.8		Monday	14-Aug-06	75.2	68.2
Monday	26-Jun-06	46.4	51.8		Tuesday	15-Aug-06	155.9	166.3
Tuesday	27-Jun-06	185.4	201.4		Wednesday	16-Aug-06	157.5	144.7
Wednesday	28-Jun-06	100.5	104.7		Thursday	17-Aug-06	92.8	98.9
Thursday	29-Jun-06	130.5	116		Friday	18-Aug-06	92.8	53.2
Friday	30-Jun-06	101.3	93.3		Saturday	19-Aug-06	142.7	104.7

Day	Date	Influent (m^3)	Effluent (m^3)		Day	Date	Influent (m^3)	Effluent (m^3)
Sunday	20-Aug-06	128.7	130.1		Wednesday	11-Oct-06	162.7	182.7
Monday	21-Aug-06	91.3	90.7		Thursday	12-Oct-06	125.7	125.3
Tuesday	22-Aug-06	136.9	124.9		Friday	13-Oct-06	135	145
Wednesday	23-Aug-06	141.1	136.5		Saturday	14-Oct-06	120.6	98.1
Thursday	24-Aug-06	104.9	103.8		Sunday	15-Oct-06	123	135
Friday	25-Aug-06	114.8	126.8		Monday	16-Oct-06	88.6	62
Saturday	26-Aug-06	132.1	114.8		Tuesday	17-Oct-06	26.6	18.5
Sunday	27-Aug-06	132.9	89.1		Wednesday	18-Oct-06	179.5	212.4
Monday	28-Aug-06	83.2	50.8		Thursday	19-Oct-06	169	167
Tuesday	29-Aug-06	96.3	122.5		Friday	20-Oct-06	152.4	150.7
Wednesday	30-Aug-06	147.7	127.4		Saturday	21-Oct-06	143.4	133
Thursday	31-Aug-06	149	125.1		Sunday	22-Oct-06	89.5	96.2
Friday	1-Sep-06	105	115.9		Monday	23-Oct-06	65	44.9
Saturday	2-Sep-06	127.4	215.9		Tuesday	24-Oct-06	221.6	211.6
Sunday	3-Sep-06	134.4	108.7		Wednesday	25-Oct-06	154.2	164
Monday	4-Sep-06	116.2	71.9		Thursday	26-Oct-06	124.8	109.3
Tuesday	5-Sep-06	136.8	54.3		Friday	27-Oct-06	135	122.9
Wednesday	6-Sep-06	172.6	184.4		Saturday	28-Oct-06	125.7	123
Thursday	7-Sep-06	106.1	0		Sunday	29-Oct-06	152.2	143.4
Friday	8-Sep-06	116.5	104.6		Monday	30-Oct-06	115.7	106.2
Saturday	9-Sep-06	94	144.5		Tuesday	31-Oct-06	178.1	166.9
Monday	11-Sep-06	157.8	37.7		Wednesday	1-Nov-06	111.5	107.5
Tuesday	12-Sep-06	168.2	171.1		Thursday	2-Nov-06	136.1	99.5
Wednesday	13-Sep-06	163.5	164.5		Friday	3-Nov-06	113.1	128.3
Thursday	14-Sep-06	97.6	76		Saturday	4-Nov-06	140.3	108.5
Friday	15-Sep-06	112.3	125.7		Sunday	5-Nov-06	118.1	142.7
Saturday	16-Sep-06	120.4	119.7		Monday	6-Nov-06	131.4	111.4
Sunday	17-Sep-06	94.5	81		Tuesday	7-Nov-06	161.4	163.7
Monday	18-Sep-06	119.3	117		Wednesday	8-Nov-06	135.2	134.7
Tuesday	19-Sep-06	153.5	150.8		Thursday	9-Nov-06	121.1	107.6
Wednesday	20-Sep-06	105.2	124.6		Friday	10-Nov-06	112.6	103.1
Thursday	21-Sep-06	116	109.5		Saturday	11-Nov-06	136.4	142.5
Friday	22-Sep-06	316.2	180		Sunday	12-Nov-06	166.3	126
Sunday	24-Sep-06	154.5	186.1		Monday	13-Nov-06	66.8	62.4
Monday	25-Sep-06	86.4	131.8		Tuesday	14-Nov-06	176.8	148.5
Tuesday	26-Sep-06	179.9	189.7		Wednesday	15-Nov-06	160.5	144.8
Wednesday	27-Sep-06	133.9	77.3		Thursday	16-Nov-06	132.4	127.3
Thursday	28-Sep-06	144.5	153.9		Friday	17-Nov-06	125.6	127
Friday	29-Sep-06	109.3	117.7		Saturday	18-Nov-06	128.2	134.7
Saturday	30-Sep-06	145.9	150.1		Sunday	19-Nov-06	171.2	112
Sunday	1-Oct-06	118.8	100.4		Monday	20-Nov-06	134.6	114
Monday	2-Oct-06	125.4	95.9		Tuesday	21-Nov-06	174.6	175.3
Tuesday	3-Oct-06	162.3	151.1		Wednesday	22-Nov-06	145.6	140.8
Wednesday	4-Oct-06	169.1	161.7		Thursday	23-Nov-06	126.6	111.7
Thursday	5-Oct-06	121.9	119.2		Friday	24-Nov-06	132	132.3
Friday	6-Oct-06	147	125.1		Saturday	25-Nov-06	125.7	129.6
Saturday	7-Oct-06	106.2	109.9		Sunday	26-Nov-06	178.8	120.9
Sunday	8-Oct-06	110.7	111		Monday	27-Nov-06	130.4	109.3
Monday	9-Oct-06	97.6	73		Tuesday	28-Nov-06	129.9	106.4
Tuesday	10-Oct-06	161.3	150.5		Wednesday	29-Nov-06	145.8	135.5

Day	Date	Influent (m^3)	Effluent (m^3)		Day	Date	Influent (m^3)	Effluent (m^3)
Thursday	30-Nov-06	118.5	113.9		Friday	19-Jan-07	162.3	138.3
Friday	1-Dec-06	134	125.2		Saturday	20-Jan-07		93.5
Saturday	2-Dec-06	135.7	129.4					
Sunday	3-Dec-06	146.5	114.6					
Monday	4-Dec-06	112.8	91.1					
Tuesday	5-Dec-06	161.3	142.2					
Wednesday	6-Dec-06	128	107.4					
Thursday	7-Dec-06	124.1	123.8					
Friday	8-Dec-06	116.5	112.5					
Saturday	9-Dec-06	137.5	131.7					
Sunday	10-Dec-06	149.1	91.8					
Monday	11-Dec-06	120.6	110.5					
Tuesday	12-Dec-06	173.2	181.1					
Wednesday	13-Dec-06	115	96.6					
Thursday	14-Dec-06	132.2	121.4					
Friday	15-Dec-06	114.2	96.3					
Saturday	16-Dec-06	133.4	95.2					
Sunday	17-Dec-06	115.3	163.5					
Monday	18-Dec-06	100.9	90.1					
Tuesday	19-Dec-06	199.2	199.1					
Wednesday	20-Dec-06	154	156.4					
Thursday	21-Dec-06	126.2	114					
Friday	22-Dec-06	118.8	110.6					
Saturday	23-Dec-06	142.7	133.9					
Sunday	24-Dec-06	163.2	102.6					
Monday	25-Dec-06	200.6	86.6					
Tuesday	26-Dec-06	50.6	99.6					
Wednesday	27-Dec-06	174.6	140.8					
Thursday	28-Dec-06	131.3	151.9					
Friday	29-Dec-06	136.1	130.9					
Saturday	30-Dec-06	118.2	109.1					
Sunday	31-Dec-06	179.6	141					
Monday	1-Jan-07	171.6						
Tuesday	2-Jan-07	0	157.6					
Wednesday	3-Jan-07	175	139.2					
Thursday	4-Jan-07	125.6	155.3					
Friday	5-Jan-07	137.8	134.9					
Saturday	6-Jan-07	108.1	100.7					
Sunday	7-Jan-07	153	112.5					
Monday	8-Jan-07	129.9	104.4					
Tuesday	9-Jan-07	191.5	187.9					
Wednesday	10-Jan-07	84.7	52.9					
Thursday	11-Jan-07	136.2	166.9					
Friday	12-Jan-07	122.2	128.7					
Saturday	13-Jan-07	126	135.4					
Sunday	14-Jan-07	154.7	121.1					
Monday	15-Jan-07	134.6	92.7					
Tuesday	16-Jan-07	154.2	83.3					
Wednesday	17-Jan-07	146.7	183.8					
Thursday	18-Jan-07	135.2	99.8					

Appendix B:
Sludge Analytical Certificates

CADUCEON ENVIRONMENTAL LABORATORIES

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B07-02973

Report To:

Dillon Consulting Limited
200-895 Waverley St.
Winnipeg, Manitoba, R3T 5P4
Attention: T. Waclaw

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa, Ontario, K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 31-Jan-07
DATE REPORTED: 20-Feb-07
SAMPLE MATRIX: Liquid Sludge

JOB/PROJECT NO.: Pang Plant Optimization
P.O. NUMBER:
WATERWORKS NO.

			Client I.D.:		Dig. Sludge			
			Sample I.D.:		B07-02973-1			
			Date Collected:		20-Jan-07			
Parameter	**Units**	**M.D.L.**	**Reference Method**	**Date Analyzed**				
Total Suspended Solids	mg/L	3	SM 2540	01-Feb-07	13700			
Volatile Suspended Solids	mg/L	3	EPA 160.4	05-Feb-07	10700			
Aluminum	mg/L	0.05	SM 3120	05-Feb-07	279			
Arsenic	mg/L	0.005	SM 3114	02-Feb-07	0.020			
Cadmium	mg/L	0.03	SM 3120	05-Feb-07	< 0.03			
Chromium	mg/L	0.01	SM 3120	05-Feb-07	0.21			
Cobalt	mg/L	0.03	SM 3120	05-Feb-07	< 0.03			
Copper	mg/L	0.01	SM 3120	05-Feb-07	7.63			
Lead	mg/L	0.1	SM 3120	05-Feb-07	0.4			
Mercury	mg/L	0.002	EPA 7471A	12-Feb-07	0.020			
Molybdenum	mg/L	0.05	SM 3120	05-Feb-07	0.07			
Nickel	mg/L	0.05	SM 3120	05-Feb-07	0.15			
Selenium	mg/L	0.005	SM 3114	01-Feb-07	0.035			
Zinc	mg/L	0.03	SM 3120	05-Feb-07	9.64			

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

M.D.L. = Method Detection Limit

CADUCEON™ ENVIRONMENTAL LABORATORIES

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B07-02972

Report To:

Dillon Consulting Limited
200-895 Waverley St.
Winnipeg, Manitoba, R3T 5P4
Attention: T. Waclaw

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa, Ontario, K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 31-Jan-07
DATE REPORTED: 20-Feb-07
SAMPLE MATRIX: Solid Sludge

JOB/PROJECT NO.: Pang Plant Optimization
P.O. NUMBER:
WATERWORKS NO.

			Client I.D.:		Bag Sludge			
			Sample I.D.:		B07-02972-1			
			Date Collected:		20-Jan-07			
Parameter	**Units**	**M.D.L.**	**Reference Method**	**Date Analyzed**				
Total Solids	% by wt	0.1	SM 2540	02-Feb-07	6.5			
Volatile Solids	% by wt	0.1	EPA 160.4	02-Feb-07	79.8 [1]			
Aluminum	µg/g	10	EPA 6010	05-Feb-07	14100			
Arsenic	µg/g	1	HYDSWG-E3091	02-Feb-07	< 1			
Cadmium	µg/g	0.5	EPA 6010	05-Feb-07	1.4			
Calcium	µg/g	10	EPA 6010	05-Feb-07	12500			
Chromium	µg/g	1	EPA 6010	05-Feb-07	14			
Cobalt	µg/g	1	EPA 6010	05-Feb-07	1			
Copper	µg/g	1	EPA 6010	05-Feb-07	401			
Lead	µg/g	5	EPA 6010	05-Feb-07	13			
Mercury	µg/g	0.1	EPA 7471A	05-Feb-07	1.5 [2]			
Molybdenum	µg/g	1	EPA 6010	05-Feb-07	3			
Nickel	µg/g	1	EPA 6010	05-Feb-07	9			
Selenium	µg/g	0.1	HYDSWG-E3091	02-Feb-07	10.0			
Zinc	µg/g	1	EPA 6010	05-Feb-07	522			

1. % W/W of "dry" sample (5.2 % of "wet" sample)
2. subcontracted to Paracel Labs

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

M.D.L. = Method Detection Limit

CADUCEON ENVIRONMENTAL LABORATORIES

CERTIFICATE OF ANALYSIS

Final Report

C.O.C.: ---

REPORT No. B07-02970

Report To:

Dillon Consulting Limited
200-895 Waverley St.
Winnipeg, Manitoba, R3T 5P4
Attention: T. Waclaw

Caduceon Environmental Laboratories
2378 Holly Lane
Ottawa, Ontario, K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 31-Jan-07
DATE REPORTED: 20-Feb-07
SAMPLE MATRIX: Waste Water

JOB/PROJECT NO.: Pang Plant Optimization
P.O. NUMBER:
WATERWORKS NO.

			Client I.D.:		Influent	Effluent		
			Sample I.D.:		B07-02970-1	B07-02970-2		
			Date Collected:		20-Jan-07	20-Jan-07		
Parameter	**Units**	**M.D.L.**	**Reference Method**	**Date Analyzed**				
BOD	mg/L	1	SM 5210	01-Feb-07	978	45		
COD	mg/L	5	HACH 8000	02-Feb-07	1790	152		
Oil & Grease-Total	mg/L	1	SM 5520	05-Feb-07	166	7.2		
Total Suspended Solids	mg/L	3	SM 2540	01-Feb-07	430	35		
Nitrate (N)	mg/L	0.1	EPA 300.0	31-Jan-07	0.3	1.2		
Ammonia (N)-Total	mg/L	0.01	EPA 350.2	02-Feb-07	136	8.89		
Total Kjeldahl Nitrogen	mg/L	0.05	EPA 351.2	02-Feb-07	160	48.9		
Phosphorus-Total	mg/L	0.01	EPA 365.4	02-Feb-07	18.4	6.49		
Aluminum	mg/L	0.01	SM 3120	01-Feb-07	4.05	0.32		
Arsenic	mg/L	0.0001	EPA 200.8	05-Feb-07	0.001 [1]	0.001 [1]		
Cadmium	mg/L	0.005	SM 3120	01-Feb-07	< 0.005	< 0.005		
Chromium	mg/L	0.002	SM 3120	01-Feb-07	0.009	< 0.002		
Cobalt	mg/L	0.005	SM 3120	01-Feb-07	< 0.005	< 0.005		
Copper	mg/L	0.002	SM 3120	01-Feb-07	0.144	0.049		
Lead	mg/L	0.02	SM 3120	01-Feb-07	< 0.02	< 0.02		
Mercury	mg/L	0.0001	SM 3112	01-Feb-07	0.0002	< 0.0002		
Molybdenum	mg/L	0.01	SM 3120	01-Feb-07	< 0.01	< 0.01		
Nickel	mg/L	0.01	SM 3120	01-Feb-07	0.01	< 0.01		
Selenium	mg/L	0.0005	EPA 200.8	05-Feb-07	0.007 [1]	< 0.005 [1]		
Zinc	mg/L	0.005	SM 3120	01-Feb-07	0.342	0.049		
Fecal Coliform	cts/100mL	1	MOE E3371	31-Jan-07	--	8400		

1. Diluted due to matrix interference

NOTE: Client requested that we proceed with analysis of BOD and Nitrate despite exceedances in holding times.

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

M.D.L. = Method Detection Limit

ACCUTEST LABORATORIES LTD

REPORT OF ANALYSIS

Client: DILLON Consulting Limited
1-811 Vernon St.
Nelson, BC
V1L 4G3
Attention: Mr. Paul Green

Report Number: 2610533
Date: 2006-05-30
Date Submitted: 2006-05-25

Project:

INVOICE: Dillon

P.O. Number:
Matrix: Sludge - Sol

	LAB ID:	464993					GUIDELINE		
	Sample Date:	2006-05-18							
	Sample ID:	Dillon Sludge							
PARAMETER	**UNITS**	**MDL**					**TYPE**	**LIMIT**	**UNITS**
Moisture	%	0.1	89.4						
Total Solids	%	0.01	10.6						
Total Volatile Solids	%	0.01	7.66						
Arsenic	ug/g	1.0	1.7						
Cadmium	ug/g	0.5	2.0						
Chromium	ug/g	1	20						
Cobalt	ug/g	1	1						
Copper	ug/g	1	661						
Lead	ug/g	1	18						
Mercury	ug/g	0.1	3.0						
Molybdenum	ug/g	1	3						
Nickel	ug/g	1	13						
Selenium	ug/g	1	9						
Zinc	ug/g	1	795						

MDL = Method Detection Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL:

Ewan McTaggart
Inorganic Lab Supervisor

ACCUTEST LABORATORIES LTD

REPORT OF ANALYSIS

Client: DILLON Consulting Limited
1-811 Vernon St.
Nelson, BC
V1L 4G3
Attention: Mr. Paul Green

Report Number: 2610633
Date: 2006-05-30
Date Submitted: 2006-05-25

Project:

P.O. Number:
Matrix: Sludge - Soil

								GUIDELINE		
LAB ID:			464993							
Sample Date:			2006-05-18							
Sample ID:			Dillon Sludge							
PARAMETER	UNITS	MDL						TYPE	LIMIT	UNITS
BTEX										
Benzene	ug/g	0.05	<0.05							
Ethylbenzene	ug/g	0.1	<0.1							
Toluene	ug/g	0.1	<0.1							
m/p-xylene	ug/g	0.2	<0.2							
o-xylene	ug/g	0.1	<0.1							
BTEX SURROGATES										
Toluene-d8	%		100							
CCME Total Petroleum Hydrocarbons										
F1 (C6-C10)	ug/g	20	<20							
F1-BTEX (C6-C10)	ug/g	20	<20							
F2 (C10-C16)	ug/g	20	<20							
F3 (C16-C34)	ug/g	20	194							
F4 (C34-C50)	ug/g	20	<20							

MDL = Method Detection Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL:
Steven Blais
Organic Lab Coordinator

Appendix C:
Plant Existing Equipment List

PANGNIRTUNG WASTE WATER TREATMENT PLANT

List of Equipment

Sewage Receiving Tanks:

- 2 "Goulds" series 3888 pumps, 1½ HP rated for 200 USGPM @ 7-ft TDH (Receiving Tank, Vol. 2000 USG),
- 2 "Goulds" series 3888, 1½ HP rated for 200 USGPM @ 21-ft TDH (Screened Tank, Vol. 2000 USG),
- 8 "Flygt" ENM-10 float switches,
- 1 "Endress & Hauser" model 33, 4-inch magnetic influent flow meter.

Sewage Screen:

- 1 "IPEC" model IFU – 30"x 36" internally fed, Uni-Frame rotary screen, with 3mm wedge wire screen and ½ HP TEFC motor.
- 1 "IPEC" screenings compactor/conveyor for above with 1 HP TEFC motor,
- 1 "IPEC" screenings bagger for above with bag magazine,
- 1 "IPEC" local control panel for screen and bagger.

Equalization Tank

- 1 "Aqua Store" bolted glass fused to steel tank, 25.18 ft dia x 13.75 ft high, Vol. – 50000 USG , c/w glass fused to steel floor, manway and sectional aluminum cover,
- 1 "Milltronics" ultra-sonic level sensor, 24-VDC,
- 1 "Flygt" ENM-10 float switch for high level alarm,
- 6 "EDI" model 84P diffusers,
- 2 "Eagle" model EP-67 CSQM progressing cavity feed pumps, p/w 2 HP, 1200 RPM, 600/3/60 TFC motors,

Biological Process components:

- 2 Fabricated aluminum biozones, Vol. – 4000 USG each,
- 2 Fabricated aluminum final clarifiers, Vol. – 7000 USG each,
- 4 "Goulds" model 3872, ½ HP scum pumps,
- 4 "Eagle" model EP-44 CSQM progressing cavity sludge pumps, p/w ½ HP,
- 1 "Endress & Hauser" model 33, 4-inch magnetic effluent flow meter.

Sludge System:

- 1 “Aqua Store” bolted glass fused to steel sludge digester tank, 16.78 ft dia x 13.75 ft high, Vol. – 20000 USG, c/w glass fused to steel floor, manway, decant piping and sectional aluminum cover,
- 1 “Milltronics” ultra-sonic level sensor, 24-VDC,
- 1 “Flygt” ENM-10 float switch for high level alarm,
- 5 “EDI” model 84P diffusers,
- 1 “Envirodyne”, 12-vag sludge bagger, c/w sludge pump, polymer make-up system and control panel,
- 1 “Goulds” model LSPO3-V filtrate return sump pump,
- Sludge bags and “Zetag” 7557 sludge dewatering polymer.

Aeration System:

- 2 “Sutorbilt” model 4HVP positive displacement blowers, each p/w 7½ HP, 600/3/60 TEFC motors and c/w inlet filter/silencers, check valve, weighted relief valves and pressure gauges. Each rated at 150 CFM @ 7 psi,
- 2 “Sutorbilt” model 3MVP positive displacement blowers, each p/w 5 HP, 600/3/60 TEFC motors and c/w inlet filter/silencers, check valves, weighted relief valves and pressure gauges. Each rated at 70 CFM @ 7 psi.

Control System:

- Custom control panel as manufactured by BCA-Clearwater Controls and Automation, includes VFDs for the feed pumps, PLC logic and phone modem.

Appendix D:
Hamlet of Pangnirtung Water Licence

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

NK5 wmoEp5 vtmpR
NUNAVUT WATER BOARD
NUNAVUT IMALIRIYIN KATIMAYINGI

DECISION

LICENCE NUMBER: NWB3PAN0207

This is the decision of the Nunavut Water Board (NWB) with respect to an application for a Licence dated 4 June 2002, made by:

Hamlet of Pangnirtung

to allow for the use of water and disposal of waste for the Hamlet at Pangnirtung, Nunavut.

With respect to this application, the NWB gave notice to the public that the Hamlet had filed an application for a water licence.

DECISION

After having been satisfied that the application was exempt from the requirement for screening by the Nunavut Impact Review Board in accordance with S. 12.3.2 of the *Nunavut Land Claim Agreement* (NLCA), the NWB decided that the application could go through the regulatory process. After reviewing the submission of the Applicant and written comments expressed by interested parties, the NWB, having given due regard to the facts and circumstances, the merits of the submissions made to it and to the purpose, scope and intent of the *Nunavut Land Claims Agreement* and of the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* (NWNSRTA), decided to waive the requirement to hold a public hearing and furthermore to delegate its authority to approve the application to the Chief Administrative Officer pursuant to S. 49(a) of the NWNSRTA and determined that:

Licence Number NWB3PAN0207 be issued subject to the terms and conditions contained therein. (Motion #:2002-20)

SIGNED this _____ day of December, 2002 at Gjoa Haven, NU.

Original signed by:

_____

Philippe di Pizzo
Chief Administrative Officer

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I. INTRODUCTION{tc \l1 "INTRODUCTION}

Following an application to the Nunavut Water Board filed by the Hamlet of Pangnirtung on June 4, 2002, the Board conducted an initial assessment of the Hamlet's request for a municipal water licence for water use and waste disposal activities within the Hamlet. The assessment was conducted so that the Nunavut Water Board could make a fully informed decision on the application. The application was referred for review and comments to Federal, Territorial and local organizations. Based upon the results of this initial assessment and the technical review, including consideration of any potential accidents, malfunctions, or cumulative environmental effects that the overall project might have in the area, the Board concluded that this application was complete and could go through the regulatory process.

In accordance with the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* S. 55.1 and Article 13 of the *Nunavut Land Claims Agreement*, public notice of the application was posted. No public concerns were expressed, and the NWB waived the requirement to hold a public hearing for the application. Authority to approve the application was delegated to the Chief Administrative Officer pursuant to S. 13.7.5 of the *Agreement*. After considering and reviewing the comments submitted by interested parties, the NWB has issued licence NWB3PAN0207.

II. GENERAL CONSIDERATIONS
{tc \l1 "II. GENERAL CONSIDERATIONS}
Term of the Licence{tc \l2 "Term of the Licence}

In accordance with the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* S. 45, the NWB may issue a licence for a term not exceeding twenty-five years. The NWB believes that a term of five years is appropriate. Because this is the first licence issued to the Hamlet by the Nunavut Water Board, a 5-year licence will allow enough time for the Hamlet to establish a consistent compliance record. The 5-year licence will allow the Licensee to properly carry out the terms and conditions of the licence and to ensure that sufficient time is given to permit the Licensee to develop, submit, and implement the plans required under the licence to the satisfaction of the NWB.

Annual Report{tc \l2 "Annual Report}

The requirements imposed on the Licensee in this licence are for the purpose of ensuring that the NWB has an accurate annual update of municipal activities during a calendar year. This information is maintained on the public registry and is available to any interested parties upon request. Refer to attached standard form for completing Annual Report (see Attachment I).

Regulated Parameters

Effluent quality criteria imposed in this Licence are consistent with the *Guidelines for the Discharge of Treated Municipal Wastewater in the Northwest Territories* (Northwest Territories Water Board; 1992), and follow advice received from both the Department of Indian and Northern Affairs and Environment Canada.

{tc \l2 "}Operation and Maintenance Manual (O&M)

The purpose of an Operation and Maintenance Manual is to assist Hamlet staff in the proper operation and maintenance of their waste disposal facilities. The manual should demonstrate to the Nunavut Water Board that the Hamlet is capable of operating and maintaining all waste disposal sites adequately. The Plan should be completed using the *Guidelines for the Preparation of an Operations and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories* (Duong and Kent, 1996; see Attachment II).

Abandonment and Restoration (A&R)

To ensure that all future abandoned facilities are reclaimed in an appropriate manner, the NWB has imposed the requirement for the submission of Abandonment and Restoration Plans. These plans should be submitted when the Licensee files preliminary design drawings for the construction of new facilities to replace existing ones.

Monitoring Program

The Monitoring Program is a program established to collect data on water quality to assess the effectiveness of treatment for protection of public health and to assess potential impacts to the environment associated with the municipal facilities. As this is the first Municipal Water Licence issued to the Hamlet by the Board, minimum requirements have been imposed, but additional sampling may be required by an Inspector.

Quality Assurance/Quality Control (QA/QC) Plan

The requirements to develop a QA/QC Plan imposed on the Licensee in this licence are for the purpose of ensuring the NWB that samples taken in the field as part of the SNP will maintain a high quality, so as to accurately represent the physical and chemical nature of the samples being taken.

LICENCE {tc \l1 "III. LICENCE }NWB3PAN0207

Pursuant to the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* and the *Agreement Between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in Right of Canada*, the Nunavut Water Board, hereinafter referred to as the Board, hereby grants to

HAMLET OF PANGNIRTUNG
(Licensee)

of **PANGNIRTUNG, NUNAVUT, X0A 0R0**
(Mailing Address)

hereinafter called the Licensee, the right to alter, divert or otherwise use water for a period subject to restrictions and conditions contained within this licence:

Licence Number **NWB3PAN0207**

Water Management Area **NUNAVUT 05**

Location **PANGNIRTUNG, NUNAVUT**

Purpose **WATER USE AND WASTE DISPOSAL**

Description **MUNICIPAL UNDERTAKINGS**

Quantity of Water Not to be Exceeded **100,000 CUBIC METRES ANNUALLY**

Date of Licence **DECEMBER 1, 2002**

Expiry Date of Licence **NOVEMBER 31, 2007**

Dated this ____ day of December 2002 at Gjoa Haven, NU.

Original signed by:

Philippe di Pizzo
Chief Administrative Officer

PART A: SCOPE AND DEFINITIONS

1. Scope

a. This Licence allows for the use of water and the disposal of waste for municipal undertakings at the Hamlet of Pangnirtung, Nunavut (62°10' N, 92°36'"W);

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

c. Compliance with the terms and conditions of this Licence does not absolve the Licensee from responsibility for compliance with the requirements of all applicable Federal, Territorial and Municipal legislation.

2. Definitions

In this Licence: **NWB3PAN0207**

"Act" means the *Nunavut Waters and Nunavut Surface Rights Tribunal Act*

"Amendment" means a change to original terms and conditions of this licence requiring correction, addition or deletion of specific terms and conditions of the licence; modifications inconsistent with the terms of the set terms and conditions of the Licence;

"Analyst" means an Analyst designated by the Minister under Section 85 (1) of the *Act*;

''Appurtenant undertaking'' means an undertaking in relation to which a use of waters or a deposit of waste is permitted by a licence issued by the Board;

"Average Concentration" means the arithmetic mean of the last four consecutive analytical results for analyses carried out on composite or grab samples collected from the Waste Facility's final discharge point;

"**Average Concentration For Faecal Coliforms**" means the geometric mean of the last four consecutive analytical results for faecal coliforms contained in composite or grab samples collected from the Waste Facility's final discharge point;

"**Board**" means the Nunavut Water Board established under the *Nunavut Land Claims Agreement*;

"**Chief Administrative Officer**" means the Executive Director of the Nunavut Water Board;

"**Commercial Waste Water**" means water and associated waste generated by the operation of a commercial enterprise, but does not include toilet wastes or greywater;

"**Effluent**" means treated or untreated liquid waste material that is discharged into the environment from a structure such as a settling pond or a treatment plant;

"**Final Discharge Point**" in respect of an effluent, means an identifiable discharge point of a facility beyond which the operator of the facility no longer exercises control over the quality of the effluent;

"**Freeboard**" means the vertical distance between water line and crest on a dam or dyke's upstream slope;

"**Grab Sample**" means a single water or wastewater sample taken at a time and place representative of the total discharge;

"**Greywater**" means all liquid wastes from showers, baths, sinks, kitchens and domestic washing facilities, but does not include toilet wastes;

"**Inspector**" means an Inspector designated by the Minister under Section 85 (1) of the *Act*;

"**Licensee**" means the holder of this Licence;

"**Modification**" means an alteration to a physical work that introduces new structure or eliminates an existing structure and does not alter the purpose or function of the work, but does not include an expansion, and changes to the operating system that are consistent with the terms of this Licence and do not require amendment;

"**Monitoring Program**" means a monitoring program established to collect data on surface water and groundwater quality to assess impacts to the environment of an appurtenant undertaking.

"Nunavut Land Claims Agreement" (NLCA) means the "Agreement Between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada," including its preamble and schedules, and any amendments to that agreement made pursuant to it;

"Sewage" means all toilet wastes and greywater;

"Sewage Treatment Facilities" comprises the area and engineered mechanical system designed to contain and treat sewage, as described in the Application for Water Licence filed by the Applicant on 4 June 2002;

"Solid Waste Disposal Facilities" comprises the area and associated structures designed to contain solid waste as described in the Application for Water Licence filed by the Applicant on 4 June 2002;

"Toilet Wastes" means all human excreta and associated products, but does not include greywater;

"Waste" means, as defined in S.4 of the *Act*, any substance that, by itself or in combination with other substances found in water, would have the effect of altering the quality of any water to which the substance is added to an extent that is detrimental to its use by people or by any animal, fish or plant, or any water that would have that effect because of the quantity or concentration of the substances contained in it or because it has been treated or changed, by heat or other means;

"Waste Disposal Facilities" means all facilities designated for the disposal of waste, and includes the Sewage Disposal Facilities, Solid Waste Disposal Facilities, and Bagged Toilet Wastes Disposal Facilities, as described in the Application for Water Licence filed by the Applicant on 4 June 2002; and

"Water Supply Facilities" comprises the area and associated intake infrastructure at the Duval River, as described in the Application for Water Licence filed by the Applicant on 4 June 2002.

PART B: GENERAL CONDITIONS

1. The Licensee shall file an Annual Report with the Board not later than March 31st of the year following the calendar year reported which shall contain the following information:

   i. tabular summaries of all data generated under the "Monitoring Program";

   ii. the monthly and annual quantities in cubic metres of fresh water obtained from all sources;

iii. the monthly and annual quantities in cubic metres of each and all waste discharged;

iv. a summary of modifications and/or major maintenance work carried out on the Water Supply and Waste Disposal Facilities, including all associated structures and facilities;

v. a list of unauthorized discharges and summary of follow-up action taken

vi. a summary of any abandonment and restoration work completed during the year and an outline of any work anticipated for the next year;

vii. a summary of any studies, reports and plans (e.g., Operation and Maintenance, Abandonment and Restoration, QA/QC) requested by the Board that relate to waste disposal, water use or reclamation, and a brief description of any future studies planned;

viii. any other details on water use or waste disposal requested by the Board by November 1st of the year being reported; and

ix. a description of any updates or revisions to the approved Operation and Maintenance Plans.

2. The Licensee shall comply with the "Monitoring Program" described in this Licence, and any amendments to the "Monitoring Program" as may be made from time to time, pursuant to the conditions of this Licence.

3. The "Monitoring Program" and compliance dates specified in the Licence may be modified at the discretion of the Board.

4. Meters, devices or other such methods used for measuring the volumes of water used and waste discharged shall be installed, operated and maintained by the Licensee to the satisfaction of an Inspector.

5. The Licensee shall, within ninety (90) days after the first visit of the Inspector, post the necessary signs, where possible, to identify the stations of the "Monitoring Program." All signage postings shall be in the Official Languages of Nunavut, and shall be located and maintained to the satisfaction of an Inspector.

6. The Licensee shall immediately report to the 24-Hour Spill Report Line (867-920-8130) any spills of Waste, which are reported to or observed by the Licensee, within the municipal boundaries or in the areas of the Water Supply or Waste Disposal Facilities.

7. The Licensee shall ensure a copy of this Licence is maintained at the municipal office and at the site of operation at all times. Any communication with respect to this Licence shall be made in writing to the attention of:

(i) Chief Administrative Officer:

Executive Director
Nunavut Water Board
P. O. Box 119
Gjoa Haven, NU X0B 1J0
Telephone: (867) 360-6338
Fax: (867) 360-6369

(ii) Inspector Contact:

Water Resources Officer
Nunavut District, Nunavut Region
P.O. Box 100
Iqaluit, NU X0A 0H0
Telephone: (867) 975-4298
Fax: (867) 979-6445

(iii) Analyst Contact

Taiga Laboratories
Department of Indian and Northern Affairs
4601 - 52 Avenue, P.O. Box 1500
Yellowknife, NT X1A 2R3
Telephone: (867) 669-2781
Fax: (867) 669-2718

8. The Licensee shall submit two paper copies and one electronic copy (in either Microsoft Word or WordPerfect format) of all reports, studies, and plans to the Board. Reports or studies submitted to the Board by the Licensee shall include a detailed executive summary in Inuktitut.

PART C: CONDITIONS APPLYING TO WATER USE

1. The Licensee shall obtain all fresh water from the Duval River using the Water Supply Facilities or as otherwise approved by the Board.

2. The annual quantity of water used for all purposes shall not exceed 100,000 cubic metres.

3. The Licensee shall maintain the Water Supply Facilities to the satisfaction of the Inspector.

4. The water intake hose used on the water pumps shall be equipped with a screen with a mesh size sufficient to ensure no entrainment of fish.

PART D: CONDITIONS APPLYING TO WASTE DISPOSAL

1. The Licensee shall direct all piped and pumpout Sewage to the Sewage Treatment Facilities or as otherwise approved by the Board.

2. All effluent discharged from the Sewage Treatment Facilities at "Monitoring Program" Station Number PAN-3 shall meet the following effluent quality standards:

Parameter	Maximum Average Concentration
Faecal Coliforms	1 x 10^3 CFU/dl
BOD_5	120 mg/L
Total Suspended Solids	180 mg/L
Oil and grease	No visible sheen
pH	between 6 and 9

3. The Licensee shall maintain the Sewage Treatment Facilities to the satisfaction of an Inspector.

4. The Licensee shall, within 30 days of the issuance of this Licence, submit to the Board for approval, a Plan for the disposal of bagged sewage sludge and screenings from the Sewage Treatment Facility.

5. The Licensee shall implement the Plan specified in Part D, Item 4 as and when approved by the Board.

6. The Licensee shall revise the Plan referred to in Part D, Item 4, if not acceptable to the Board. The revised Plan shall be submitted to the Board for approval within thirty (30) days of notification of the Board decision.

7. The Licensee shall dispose of and contain all solid wastes at the Solid Waste Disposal Facilities or as otherwise approved by the Board.

8. The Licensee shall dispose of and contain all fish processing wastes at the Solid Waste Disposal Facility, in a pit excavated below the active layer-permafrost interface. Fish wastes deposited at the Disposal Facility shall be treated with lime, and covered with soil prior to the onset of the annual Spring freshet.

9. The Licensee shall implement measures to ensure wind blown litter, hazardous materials and/or leachate from the Solid Waste Disposal Facility does not enter water.

PART E: CONDITIONS APPLYING TO MODIFICATION AND CONSTRUCTION

1. The Licensee shall submit to the Board for approval design drawings stamped by a qualified engineer registered in the Nunavut prior to the construction of any dams, dykes or structures intended to contain, withhold, divert or retain water or wastes.

2. The Licensee may, without written approval from the Board, carry out modifications to the Water Supply and Waste Disposal Facilities provided that such modifications are consistent with the terms of this Licence and the following requirements are met:

   i. the Licensee has notified the Board in writing of such proposed modifications at least sixty (60) days prior to beginning the modifications;

   ii. said modifications do not place the Licensee in contravention of the Licence or the *Act*;

   iii. the Board has not, during the sixty (60) days following notification of the proposed modifications, informed the Licensee that review of the proposal will require more than sixty (60) days; and

   iv. the Board has not rejected the proposed modifications.

3. Modifications for which all of the conditions referred to in Part E, Item 1, have not been met may be carried out only with written approval from the Board.

4. The Licensee shall provide as built plans/drawings of the modifications referred to in this Licence within ninety (90) days of completion of the modifications.

PART F: CONDITIONS APPLYING TO OPERATION AND MAINTENANCE

1. The Licensee shall, before December 1, 2003 submit to the Board for approval, a plan for the Operation and Maintenance of the Sewage and Solid Waste Disposal Facilities in accordance with *"Guidelines for preparing an Operation and Maintenance Manual for Sewage and solid Waste Disposal Facilities"* (October 1996)

2. The Licensee shall implement the Plan specified in Part F, Item 1 as and when approved by the Board.

3. The Licensee shall revise the Plan referred to in Part F, Item 1, if not acceptable to the Board. The revised Plan shall be submitted to the Board for approval within thirty (30) days of notification of the Board decision.

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

   i. employ the appropriate contingency plan as provided for in the Operation and Maintenance Plan;

   ii. report the incident immediately *via* the 24-Hour Spill Reporting Line at (867) 920-8130 and to an Inspector; and

   iii. submit to an Inspector a detailed report on each occurrence not later than thirty (30) days after initially reporting the event.

PART G: CONDITIONS APPLYING TO ABANDONMENT AND RESTORATION

1. The Licensee shall submit to the Board for approval an Abandonment and Restoration Plan at least six (6) months prior to abandoning any facilities. The Plan shall include, but not be limited to where applicable:

   i. water intake facilities;

   ii. the water treatment and waste disposal sites and facilities;

iii. petroleum and chemical storage areas;

iv. any site affected by waste spills;

v. leachate prevention;

vi. an implementation schedule;

vii. maps delineating all disturbed areas, and site facilities;

viii. consideration of altered drainage patterns;

ix. type and source of cover materials;

x. future area use;

xi. hazardous wastes; and

xii. a proposal identifying measures by which restoration costs will be financed by the Licensee upon abandonment.

2. The Licensee shall implement the plan specified in Part G, Item 1 as and when approved by the Board.

3. The Licensee shall revise the Plan referred to in Part G, Item 1 if not approved. The revised Plan shall be submitted to the Board for approval within thirty (30) days of receiving notification of the Board's decision.

4. The Licensee shall complete the restoration work within the time schedule specified in the Plan, or as subsequently revised and approved by the Board.

PART H: CONDITIONS APPLYING TO THE MONITORING PROGRAM

1. The Licensee shall maintain Surveillance Stations at the following locations:

Station Number	Description
PAN-1	Raw Water supply prior to treatment
PAN-2	Runoff from the Solid Waste Disposal Facilities

PAN-3	Effluent from the Sewage Treatment Facilities
PAN-4	Runoff from the Sludge Disposal Facility

2. The Licensee shall sample monthly at Surveillance Station PAN-2 and PAN-4 during the months of May to August, inclusive.

3. The Licensee shall sample monthly at Surveillance Station PAN-3.

4. The Licensee shall analyze samples collected at Station Numbers PAN-2, PAN-3 and PAN-4 for the following parameters:

BOD	Faecal Coliforms
pH	Conductivity
Total Suspended Solids	Ammonia Nitrogen
Nitrate-Nitrite	Oil and Grease (visual)
Total Phenols	Sulphate
Sodium	Potassium
Magnesium	Calcium
Total Arsenic	Total Cadmium
Total Copper	Total Chromium
Total Iron	Total Lead
Total Mercury	Total Nickel
Total Zinc	

5. Additional sampling and analysis may be requested by an Inspector;

6. The Licensee shall conform to the Quality Assurance/Quality Control (QA/QC) Plan which shall be provided to the Licensee by the NWB within 60 days of the issuance of this licence;

7. All sampling, sample preservation and analyses shall be conducted in accordance with methods prescribed in the current edition of *Standard Methods for the Examination of Water and Wastewater*, or by such other methods approved by the Board;

8. All analyses shall be performed in a Canadian Association of Environmental Analytical Laboratories (CAEAL) Certified Laboratory, or as otherwise approved by an Analyst;

9. The Licensee shall measure and record in cubic metres the monthly and annual quantities of water pumped from Monitoring Program Station Number PAN-1 for all purposes;

10. The Licensee shall measure and record the annual quantities of sewage solids removed from the sewage disposal facility shall be measured and recorded;

11. The Licensee shall include all of the data and information required by the "Monitoring Program" in the Licensee's Annual Report, as required *per* Part B, Item 1; and

12. Modifications to the Monitoring Program may be made only upon written approval of the Chief Administrative Officer.