Iqaluit

ᐃᖃᓗᐃᑦ

Completion Study for the Iqaluit Wastewater Treatment Plant

Prepared by

CH2MHILL

Responsible Solutions for a Sustainable Future™

October 2003

CH2M HILL

CH2M HILL Canada Limited
475 W. Georgia Street, Suite 920
Vancouver, BC V6B 4M9
Tel 604.684.3282
Fax 604.684.3292

October 14, 2003

Mr. Brad Sokach, P.Eng.
Director of Engineering
City of Iqaluit
P.O. Box 460
Iqaluit, Nunavut
X0A 0H0

Subject: Wastewater Treatment Plant Completion Study Final Report

Dear Mr. Sokach:

We are please to submit 3 copies of our final report on the above project. We have incorporated the City's comments on our draft report received in a letter dated September 30, 2003, and those received from Kriss Sarson, P.Eng. (Department of Community Government and Transportation, Government of Nunavut) in an email on September 26, 2003. We have also clarified the issue of local concrete costs and the need for a geotechnical investigation in a recent telephone conversation with Mr. Sarson.

The report confirms that the existing wastewater treatment plant can best be completed by conversion to a conventional activated sludge process.

We have divided the facility completion into two phases. The Phase 1 project involves upgrading the existing facility to meet all applicable design guidelines and codes and the construction of two new secondary clarifiers and the associated superstructure, HVAC and electrical systems. The Phase 1 plant will serve a population of approximately 8,000. A detailed cost estimate has been prepared for the Phase 1 completion including engineering, contingency and applicable taxes. The Phase 2 project involves the doubling of the existing aeration tanks to increase the plant capacity to a population of approximately 12,000.

Thank you for the opportunity to work on this interesting assignment. We look forward to presenting the results of the study to Council during the fall.

Sincerely,

Barry Rabinowitz, Ph.D., P.Eng.
Senior Environmental Engineer

Iqaluit

ᐃᖃᓗᐃᑦ

Completion Study for the Iqaluit Wastewater Treatment Plant

Prepared by

CH2MHILL

Responsible Solutions for a Sustainable Future™

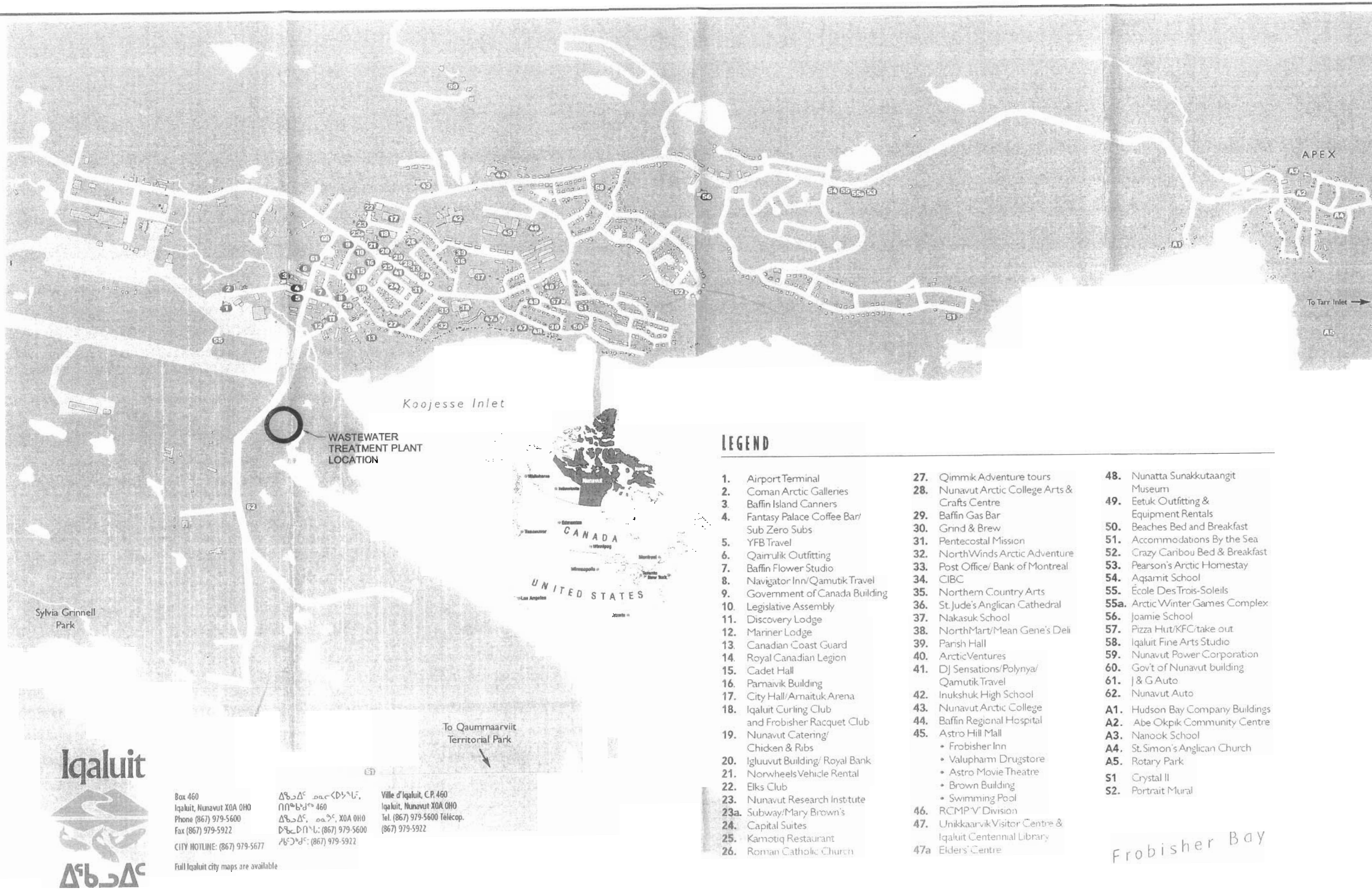
October 2003

Table of Contents

List of Figures

List of Tables

Appendices



IQALUIT WASTEWATER TREATMENT PLANT LOCATION

FIGURE 1-1

CH2MHILL

1.0 Introduction

1.1 Project Location

The City of Iqaluit is located in Koojesse Inlet on Baffin Island in Nunavut, Canada (Figure 1-1). The existing wastewater treatment plant (WWTP) is located on the southeastern corner of airport property.

1.2 Project History and Background

In 1998, the City of Iqaluit entered into a design/build contract with Hill, Murray & Associates (HMA) for the design and construction of a new wastewater treatment plant using membrane technology. Construction work on the new facility was started in 1998 but stopped after the City noted serious deficiencies related to the "Octoform" concrete tank construction, and HMA subsequently abandoned the project. CH2M HILL were retained under a separate contract for the design and construction supervision of the concrete tank refurbishment.

In 2002, the City of Iqaluit retained Earth Tech Canada (ETC) to provide an assessment of the existing operational status and physical condition of the facility, and the steps required to bring the plant into operation and address all of the design and regulatory deficiencies. The ETC report concluded that it would cost the City approximately $820,000 to complete the facility in accordance with its original design. However, it recommended that the City not pursue this strategy because of the high ongoing operations and maintenance (O&M) cost of the facility (estimated to be approximately $900,000 per annum) and the inadequate hydraulic capacity of the membrane system to handle the anticipated peak flows. The ETC report included a preliminary economic and non-economic evaluation of converting the plant to either primary treatment or one of three alternative secondary treatment processes (conventional activated sludge, hybrid suspended growth, and sequencing batch reactors). Although primary treatment had the lowest life-cycle cost, it was not deemed to be viable because the effluent would not meet the standard established for the plant by the City of Iqaluit and the Nunavut Environmental Authority, i.e. BOD/TSS of 30/35 mg/L. The three secondary treatment options evaluated had comparable life-cycle costs. However, conventional activated sludge was recommended on the basis of its simplicity of operation and its proven ability to maintain acceptable levels of effluent quality. The converted plant must eventually serve a projected population of 12,000. The major new additional unit processes required for this conversion is a pair of 12 m diameter secondary clarifiers to replace the membranes as the final liquid/solid separation stage of the activated sludge process, and a doubling of the existing aeration tank volume.

In 2003, the City Iqaluit retained CH2M HILL Canada to undertake a completion study for the wastewater treatment plant. The principal objectives of the study were to:

- Confirm the ETC recommendation regarding the selection of the conventional activated sludge process as the basis for completing the facility;

- Refine the capital and operations and maintenance cost estimates presented in the ETC report for completing the facility;
- Prepare preliminary process flow diagrams, and conceptual equipment and site layout drawings for the completed facility.

This study details the results of the City of Iqaluit Wastewater Treatment Plant Completion Study.

1.3 Report Organization

Section 2 presents a summary of the existing facilities.

Section 3 provides the basis for the process design for conversion of the existing plant into a conventional activated sludge process in two phases.

Sections 4 and 5 define the scope of the proposed work required to complete the Phase 1 facilities.

Section 6 provides the Phase 1 construction cost estimate.

Section 7 discusses operator training and O&M costs.

Section 8 provides the conclusions and recommendations.

- Refine the capital and operations and maintenance cost estimates presented in the ETC report for completing the facility;
- Prepare preliminary process flow diagrams, and conceptual equipment and site layout drawings for the completed facility.

This study details the results of the City of Iqaluit Wastewater Treatment Plant Completion Study.

1.3 Report Organization

Section 2 presents a summary of the existing facilities.

Section 3 provides the basis for the process design for conversion of the existing plant into a conventional activated sludge process in two phases.

Sections 4 and 5 define the scope of the proposed work required to complete the Phase 1 facilities.

Section 6 provides the Phase 1 construction cost estimate.

Section 7 discusses operator training and O&M costs.

Section 8 provides the conclusions and recommendations.

New pipe spools will have to be installed in the repaired concrete tanks and through the existing metal building. New doors and HVAC penetrations will have to be installed in the metal building. All penetrations should be selected based on the information that is gathered on the structure prior to detailed design.

2.3 Architectural

The existing metal building does not meet the current building codes based on building size, classification, and proposed occupancy. Two points of access and egress must be available from any point in the building. The maximum allowable travel distance to an outside exit is 30 meters and the minimum distance between two viable exists is 9 meters. Additional doors will have to be added in a variety of locations to bring the building up to code.

Other code violations should be investigated prior to detailed design. For example, proper panic hardware must be present on all doors, fire ratings must be met, and all other pertinent codes have to be addressed in the upgrade.

2.4 Mechanical

There are a number of components in the building that can be retained such as the aeration blowers and trash augers. All these components must be investigated prior to detailed design to ensure that they are still functional and meet the requirements of the completed facility. Other components in the plant, such as the Fournier press and membranes are no longer required and will have to be removed during construction.

Some of the process piping in the plant will have to be rerouted to accommodate the conversion to a conventional treatment process.

2.5 Electrical

An electrical inspection will have to be done prior to detailed design to ensure that there are no code violations. Where possible, existing electrical components will be used. There are also a number of electrical issues identified in the Earth Tech report that have to be addressed during preliminary design.

2.6 HVAC

Based on the Earth Tech report and discussions with the system operators, the HVAC system is grossly undersized. If possible, some of the heating and ventilation components will be used in the upgrade. The cost breakdown included in Appendix B carries a price to install a new HVAC system for the existing building. If further investigations reveal that some of the existing components can be reused, this HVAC cost will be reduced.

2.7 Instrumentation and Controls

The treatment facility is being converted to a conventional secondary treatment system. New instrumentation and controls will be required.

2.8 Anoxic and Aerobic Tanks

There are four existing concrete tanks in total that have been refurbished. These concrete tanks have been leak tested and are now capable of holding wastewater. The anoxic tanks will form part of the new process and will require only minor changes to piping entering and leaving the tanks. These tanks treat the wastewater by retaining the activated sludge biomass in an oxygen deficient environment to allow denitrification. The biomass in the anoxic tanks is kept in suspension by submersible mixers. The biomass in the aerobic tanks is mixed and aerated by an aeration system consisting of blowers and diffusers. The aerobic tanks will also be used and will require some minor changes to the inlet and outlet piping. In addition, they will also have to be covered and vented to the outside to prevent condensation from forming in the WWTP. A condensate trap and air dryer will also have to be included on the ventilation discharge line to prevent large amounts of ice from forming outside the building.

3.0 Process Re-design

3.1 Regulatory Framework

The Effluent Quality Guidelines for the Discharge of Treated Municipal Wastewater in the Northwest Territories issued by the Norwest Territories Water Board in 1992 for a community that discharges more than 600 L/c/d to the marine environment require that the effluent BOD/TSS concentrations be below 80/70 mg/L. A less stringent effluent quality standard is specified for communities discharging less than 600 L/c/d. However, the maximum average effluent concentrations stipulated by the Nunavut Water Board in Appendix I of the contract between the City of Iqaluit and Hill Murray & Associates for the Water Reclamation Facility signed in July 1999 was for an average effluent BOD/TSS of below 30/35 mg/L. In the absence of any firm effluent quality requirements for the completed facility, we have used the more stringent 30/35 effluent quality standard.

Given that the requirements of this wastewater treatment facility completion project involves the use of secondary treatment, a relaxation of the effluent quality requirements to 80/70 mg/L would not result in any significant capital or operating and maintenance cost savings. Further, it is recognized that a primary treatment plant would not be capable of meeting an 80/70 effluent quality standard.

3.2 Design Criteria

The following table lists the key design criteria used for the proposed plant conversion.

TABLE 3-1
Design Criteria

Item	Design Value
Discharge Criteria BOD/TSS	30/35 mg/L
Population (Ultimate)	12,000
Piped Flow	60% @ 330 L/c/d
Trucked Flow*	40% @ 145 L/c/d
Average Annual Flow (AAF)	3,100 m^3/d
BOD Load @ 80 g/c/d	960 kg BOD/d
COD Load @ 160 g/c/d	1,920 kg COD/d
COD Concentration	620 mg COD/L

* We understand that the City is moving towards piped flow. This move will not alter the organic and solids loading of the proposed process and therefore will not significantly change the size of the facility.

3.3 Treatment of Liquid Stream

The existing aeration tanks (2 anoxic plus 2 aerobic cells) have a total volume of 1,040 m^3, arranged in 2 parallel trains. To serve a population of 12,000, the aeration tank volume must be doubled to a total of 2,080 m^3 to provide a hydraulic retention time (HRT) of 16 hours. This will allow the activated sludge process to maintain a solids retention time (SRT) of up to 12 days so that the system can be operated in a stable nitrifying mode in which the wastewater ammonia is biologically oxidized to nitrate/nitrite. Mixed liquor from the aeration tanks will flow by gravity to two new 12 m diameter secondary clarifiers. Settled sludge from the clarifiers will be recycled to the anoxic zones at the head end of the aeration tanks by two new return activated sludge (RAS) pumps. Clarified effluent will be discharged into the bay through the existing outfall. The existing recycle pumps will be used to recycle nitrified mixed liquor from the aerobic cell to the anoxic cell, where it will be denitrified to nitrogen gas. This will both improve the final effluent quality and stabilize the plant operation. The process SRT will be maintained by continuously wasting a fraction of the sludge mass (waste activated sludge, or WAS) to the solids handling system, where it will be thickened and dewatered, prior to being trucked off site for disposal at the local landfill.

3.4 Solids Handling

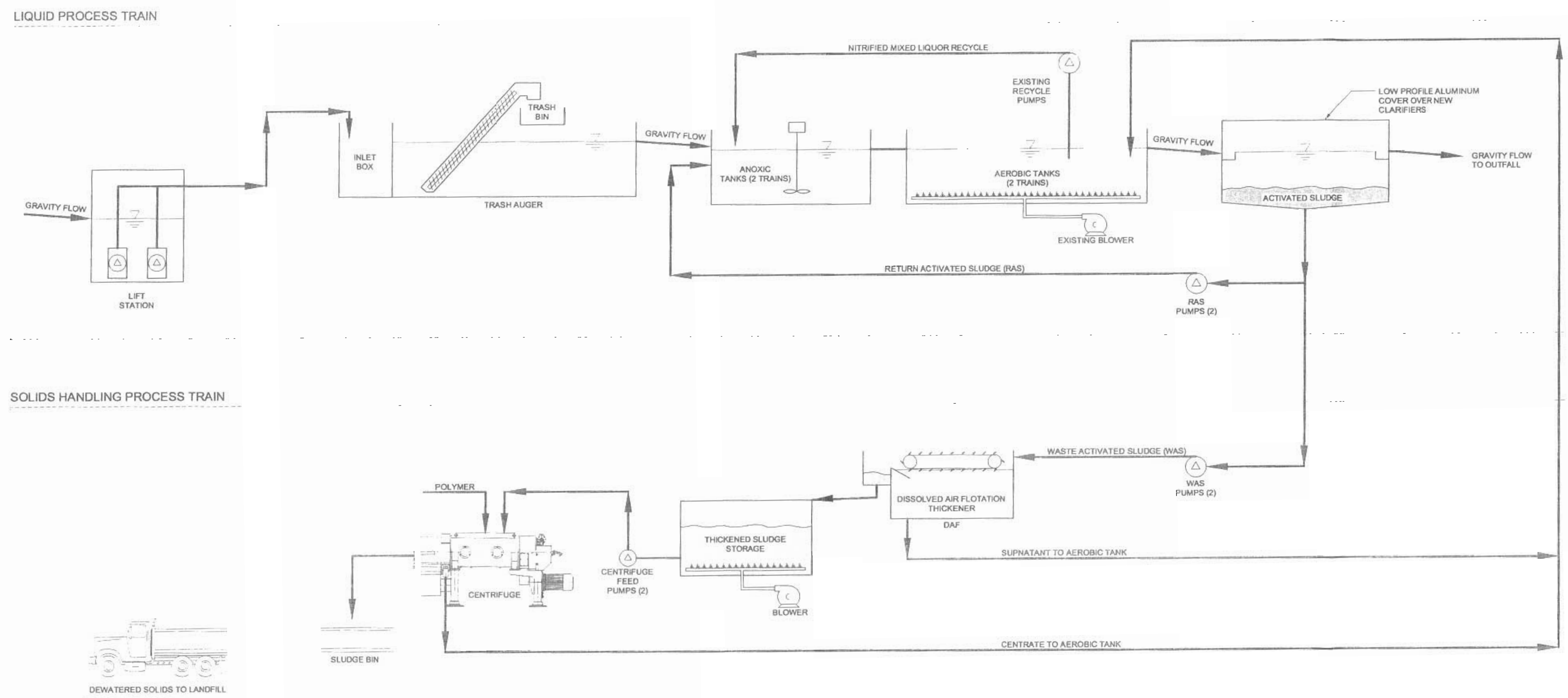
The existing plant has a Fournier press for sludge dewatering. This unit is considered to be an inappropriate technology in a remote location like Iqaluit, primarily because of the large quantity of wood pellets that are continuously required to assist in the dewatering operation. As a result, the sludge handling system will consist of a dissolved air flotation (DAF) thickener, followed by a dewatering centrifuge. The DAF thickener increases the concentration of the waste activated sludge from approximately 0.6 percent (as dry solids) to between 3.5 and 4 percent without the use of polymer. The unit requires a minimum amount of operator attention and is operated on a more-or-less continuous basis. The dewatering centrifuge increases the concentration of the thickened WAS from approximately 4 percent to between 20 and 25 percent. This unit requires polymer and the presence of an operator, and will be operated on a batch basis for 2 or 3 shifts per week. Thickened WAS from the DAF thickener is allowed to accumulate in an aerated sludge storage tank for periods of up 5 days during periods when the dewatering centrifuge is not in operation.

Approximately 120 cubic meters of biosolids will be produced per 1,000 people per year, which will have to be landfilled. The biosolids will have a solids content of 20-25% (as dry solids).

The following process flow diagram illustrates the liquid treatment process train and the solids handling process train (Figure 3-1).

3.5 Project Phasing

The project will be split into two phases. In Phase 1, a new covered and insulated structure will be built adjacent to the existing plant. This structure will include the two 12 m diameter



CONVENTIONAL SECONDARY TREATMENT PROCESS TRAIN

N.T.S.

PRELIMINARY

NOT FOR CONSTRUCTION

DSGN	DN				
DR	JAD				
CHK	TR				
APVD	BR	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
BAR IS 25mm ON ORIGINAL DRAWING.
0 25mm
IF NOT 25mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CH2MHILL

CITY OF IQALUIT
WASTEWATER TREATMENT PLAN

PFD
CONVENTIONAL SECONDARY TREATMENT PROCESS TRAIN DIAGRAM

SHEET	SHEET-NO
DWG	FIGURE 3-1
DATE	SEPT. 3/03
PROJ	122399

FILENAME: P1.DWG PLOT DATE: SEPT. 3/03 PLOT TIME: 15:53:50

secondary clarifiers and the associated RAS and WAS pumping systems, the DAF thickener and the thickened WAS storage tank. In addition, the Fournier press will be replaced with a dewatering centrifuge. All existing deficiencies with the plant related to the heating, air conditioning and ventilation (HVAC) systems will be rectified so that the plant fully complies with all applicable codes. In Phase 1, the plant will be capable of serving a population of approximately 8,000.

In Phase 2, two new aeration tanks with a total volume of 1,040 m^3 will be built adjacent to both the existing plant and the secondary clarifiers. The plant will continue to operate as two parallel trains. The interconnecting piping will be modified so that mixed liquor from the existing aeration tanks will flow into the Phase 2 aeration tanks, and mixed liquor from the Phase 2 aeration tanks will flow into the secondary clarifiers.

It is important to note that the secondary clarifiers are sized for a population of 12,000 people. This allows some redundancy in the system and operational flexibility. It also means that the future Phase 2 expansion will only require the doubling of the aeration tank volume to meet the projected Phase 2 population of 12,000 people.

4.0 Proposed Site Layout

4.1 Proposed Phase 1 and Phase 2

Design objectives for the site plan were to minimize the impact on the marsh area and to found the construction works on bedrock. The site plan as shown in Figure 4-1 is based on the assumption that the bedrock is just below the surface within the footprint of the works and dips slowly away as it enters the marsh area. This would have to be confirmed with test pit information at a later date.

The proposed arrangement has the new secondary clarifiers sited on the western side of the building, which is the area that has the largest amount of space available. Future aerobic tanks (Phase 2) would be constructed along the northern edge of the building and would adjoin the secondary clarifier building. This phase of construction would involve some work in the area of marsh that has been filled in with gravel. Arranging the proposed and future works in this fashion minimizes the surface area of the building and the impact on the marsh, while allowing the enter structure to be founded on bedrock.

4.2 Survey

The survey presented to CH2M HILL is difficult to correlate with previous borehole information as elevations were not provided for the boreholes. Therefore, there is some uncertainty about the location of the bedrock and the depth of structural fill used beneath the existing building. Test pits will need to be dug to determine the depth of bedrock and structural fill prior to detailed design.

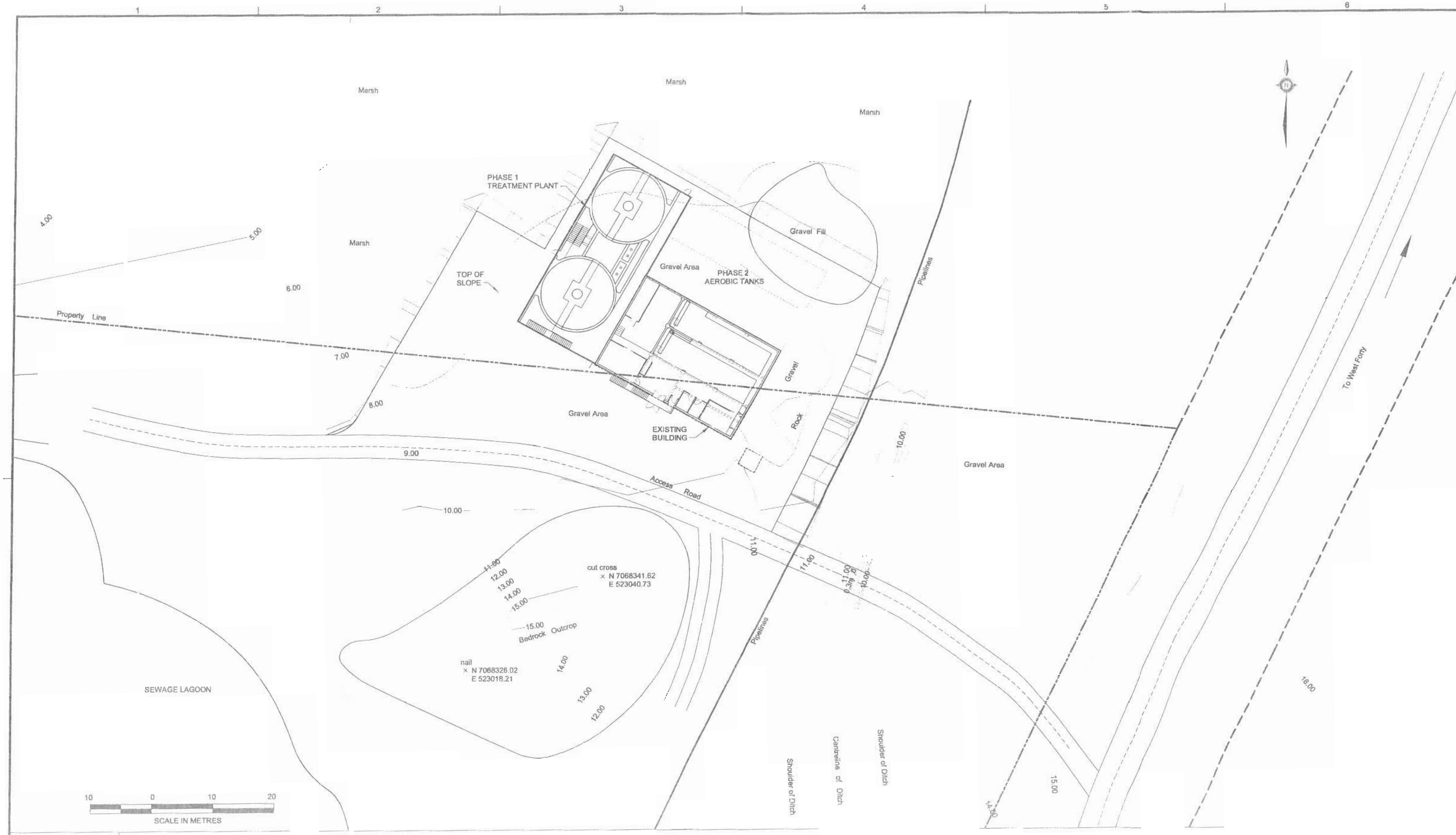
Current survey information also shows a property line running east to west through the southern portion of the building. Conversations with North Tech Land Surveying and Engineering indicate that the majority of the existing facility is sited on airport property.

A portion of the marsh has been filled in with gravel. The proposed future expansion will encroach on this gravel filled area. Although the marsh is an environmentally sensitive area, it is assumed that building in the gravel filled area is acceptable provided that the remainder of the marsh is not subject to degradation.

4.3 Utilities

4.3.1 Electrical

Electrical utilities currently enter the building in the northwest corner and obstruct the construction of the future aerobic tanks and therefore would be relocated as part of the proposed works. A description of the relocation is described under Section 5.5.



SITE PLAN

SCALE 1:300

PRELIMINARY NOT FOR CONSTRUCTION	DSGN D.N. DR J.A.D. CHK T.R. APVD B.R.	NO.	DATE	REVISION	BY	APVD	VERIFY SCALE BAR IS 25mm ON ORIGINAL DRAWING. 0 25mm IF NOT 25mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY.	CH2MHILL	IQALUIT WASTEWATER TREATMENT PLANT	CIVIL WASTEWATER TREATMENT PLANT SITE PLAN	SHEET SHEET-NO DWG FIGURE 4-1 DATE SEPT. 1/03 PROJ 122399

FILENAME: SW-1.DWG PLOT DATE: SEPT. 1/03 PLOT TIME: 15:53:50

4.3.2 Fuel Tank

An exterior fuel tank is located on the western side of the building within the footprint of the proposed works and therefore has to be relocated. This tank will be moved to the south side of the building and the fuel line to the generator will be rerouted. The exhaust stack for the emergency generator will be rerouted to the north side of the building. Care should be taken to ensure that this does not interfere with the aerobic tank additions planned for Phase 2.

4.3.3 Sewage Outfall

We have been informed that the sewage outfall was constructed and currently leaves the building on the west side and therefore runs beneath the proposed works. A new connection to the sewage outfall will be made on the west side of the secondary clarifiers and the old connection will be terminated. Detailed information will have to be gathered on the location and elevations of this outfall during geotechnical investigations.

4.3.4 Domestic Water Line

It is our understanding that domestic water for the plant is trucked in and, therefore, there is no underground service line that has to be considered in the upgrade and future construction. Domestic water service to the plant has not been included in the cost estimate.

4.3.5 Airport Fuel Line

Construction work will have minimal impact on the existing airport fuel line. The works are approximately 42 meters (Phase 1) and 15 meters (Phase 2) from the pipeline. Any blasting operations will require monitoring of particle velocities at the pipeline, emergency procedures, and coordination with the airport, but are considered manageable given that all new works are no closer to the pipeline than the existing facilities.

Costs for preparing the foundation for the Phase 2 works have been included in the cost estimate as this area will likely be needed for construction staging for Phase 1.

4.3.6 Lift Station

This may have to be moved for Phase 2 to allow access to the construction area. Costs to move this item have not been included in our estimate as there appears to be sufficient room between the lift station and the pipeline to access the rear of the facility with heavy equipment.

5.0 Project Scope of Work

5.1 Site Works

Prior to commencing site works, a geotechnical investigation must be completed to establish the depth to the bedrock in the proposed construction area. In order to minimize the overall cost of the project, it is recommended that the foundation preparation for Phase 1 and Phase 2 works be completed during Phase 1. This will also allow the Phase 2 area to be used for staging of the Phase 1 portion of the work.

Relocation of the lift station was not included in the cost for Phase 1 as a 7 meter access road will be available for trucks on the northeast side of the existing building and should be sufficient access for future construction. It is recommended that this item be noted as a potential issue for Phase 2 construction.

Site preparation for Phases 1 and 2 would involve excavating to bedrock and removing all rock that is above grade by blasting. Site leveling would be accomplished by using structural fill or a low strength concrete fill. If structural fill is used to level the site, proper drainage from the fill is essential to ensure that frost heave does not damage the structure. Concrete fill must be used beneath the structure to a minimum elevation that corresponds with the 200 year high water level in the marsh.

If the bedrock is found to be sloping steeply into the marsh area, some rock doweling or anchoring of the concrete fill may be required. Geotechnical investigations and structural calculations will determine the risk associated with this item. Some doweling has been assumed in the cost table (Appendix B).

A marsh protection strategy will be implemented during construction to minimize the impact on the marsh.

Cost estimates for the earthwork are based on the borehole information provided and assumed elevations for these boreholes. The approximate dip for the bedrock was established and earth volumes and rock volumes were calculated. Future geotechnical investigations will further refine these quantities.

Other site works include: building perimeter drains wrapped in drain rock and geotextile, road base and surfacing around the sides of the building, a walking path on the north side of the building, concrete bollards, a new connection to the sewage outfall and termination of the old connection, and other utility work as described in Section 4.3 and Section 5.5.

5.2 Structural

As described above, the new facilities will be founded on bedrock leveled with a combination of low strength concrete (that may be doweled or anchored into the bedrock) and structural fill. The new secondary clarifiers and their enclosure will be constructed of structural concrete and reinforced masonry block. Phase 2 of the proposed works would be constructed of similar materials. Figure 5-1 A and 5-1 B show the proposed plan and section for Phase 1 of the work.

Each clarifier will be capped with a removable low profile aluminum or fiber reinforced plastic (FRP) cover to localize condensation formation to the area directly above the clarifier. Each cover will have access hatches so the operator can observe the effluent weirs. Covers will also be added over each of the aerobic tanks. The addition of these low profile covers will considerably reduce the HVAC requirements in the rest of the building and therefore the ongoing operational and maintenance requirements and costs.

Some structural steel may be required over new doorways that will be added to the existing building. Additional steel plate reinforcing may also be required for the new pipe spool penetrations in the existing concrete tanks.

Minor demolition will be required and will include the soaking pits, new openings for the HVAC system, piping, and doors.

5.3 Architectural

One of the primary concerns with the existing building is access and egress. In order to meet the building code, two man doors will be added. The first will leave the upper floor of the building near the entrance to the trash auger room with metal stairs down to grade. The second will be added in the basement exiting from the soaking pit room to the outside under the metal stair platform from the second story.

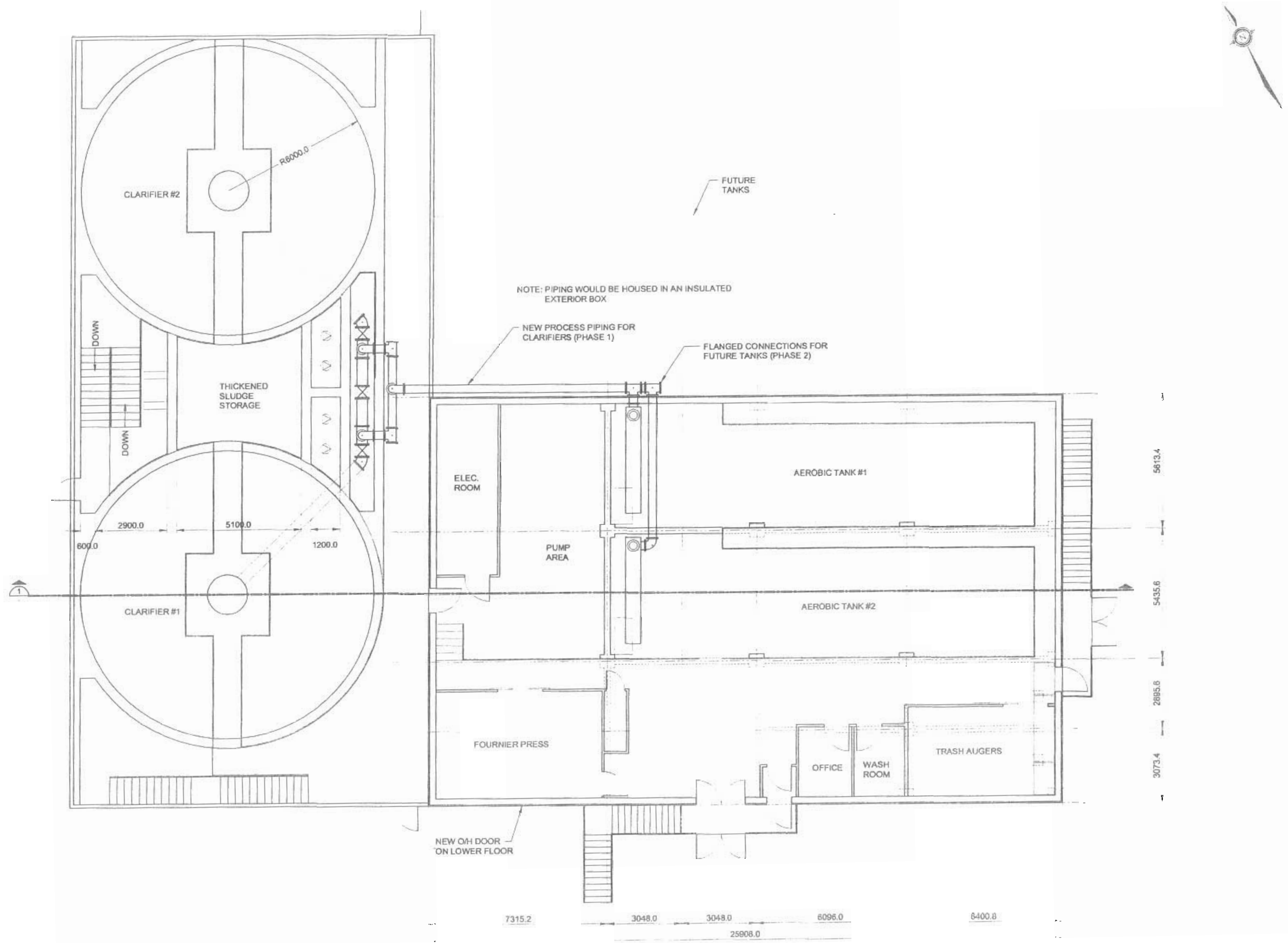
A single overhead door will also be added in the room adjoining the soaking pit room and will allow the removal of the biosolids bin. This door will be located on the same side of the building as the existing external metal stairs (south side) and therefore, this metal stairway will have to be rerouted.

The entrance to the blower room may also have to be altered by either adding a man door adjacent to the overhead door or replacing the overhead door with a new blower room door that has panic hardware incorporated. Architectural review will determine if this is required under the local and national building codes based on the building classification and the occupancy of this room.

All other doors have to be checked to ensure that proper panic hardware is installed and that they have proper fire ratings. Fire ratings need to be investigated further for other items such as floor penetrations and stairwells.

Aesthetics have been considered for the future building. The new secondary clarifier building will have a base slab that is lower than the existing building and the new roofline will tie into the existing roofline. The portion of the new building that extends north beyond the existing building will tie into the proposed future works, which will run along the northern edge of the existing building.

The cover over the Phase 2 expansion will likely be flat and possibly buried for insulation purposes. The area above these tanks would be accessible from the new building. Hatch access would be available to the inside of the Phase 2 aeration tanks for maintenance.



CLARIFIER FLOOR PLAN

SCALE 1:100

2 0 2 4
SCALE IN METRES

PRELIMINARY

NOT FOR CONSTRUCTION

DSGN	X ENGINEER
DR	DRAWN-BY
CHK	X CHECKED-BY
APVD	APPROVED-BY

NO. DATE REVISION BY APVD

VERIFY SCALE

BAR IS 25mm ON ORIGINAL DRAWING.

0 25mm

IF NOT 25mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

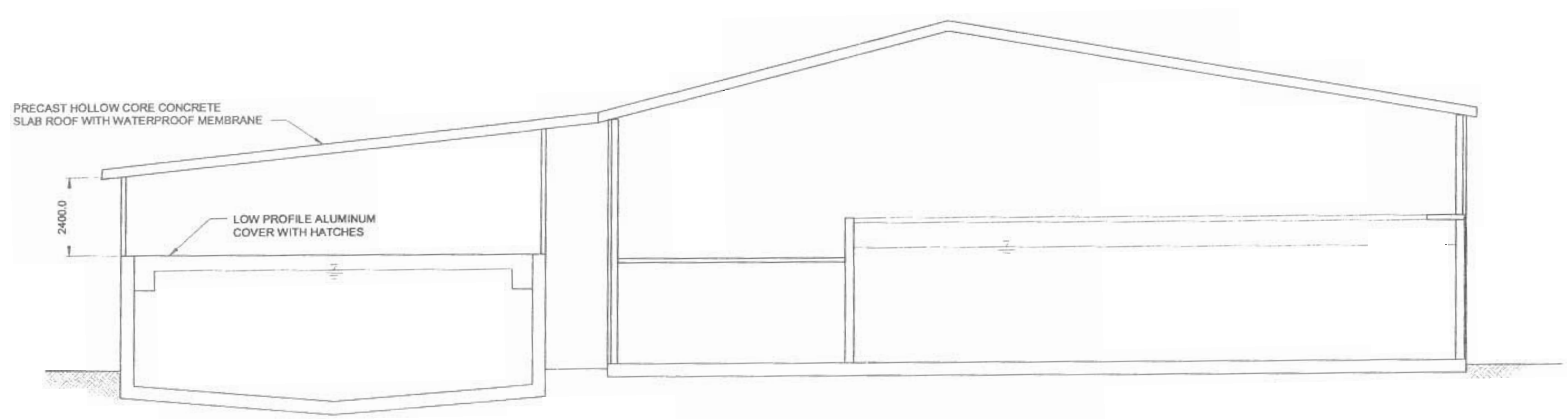
CH2MHILL

IQALUIT
WASTE WATER TREATMENT PLANT

CIVIL
WASTEWATER TREATMENT FLOOR PLAN

SHEET	SHEET-NO
DWG	FIGURE 5-1A
DATE	SEPT. 18/03
PROJ	122399

FILENAME: CLARIFIERS-2.DWG PLOT DATE: SEPT.18/03 PLOT TIME: 15:53:50



CLARIFIER SECTION 1
SCALE 1:100

PRELIMINARY
NOT FOR CONSTRUCTION

SCALE IN METRES

DSGN	X ENGINEER				
DR	DRAWN-BY				
CHK	X CHECKED-BY				
APVD	APPROVED-BY	NO.	DATE	REVISION	BY APVD

VERIFY SCALE
BAR IS 25mm ON ORIGINAL DRAWING.
0 25mm
IF NOT 25mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

CH2MHILL

IQALUIT
WASTE WATER TREATMENT PLANT

TITLE-1
WASTEWATER TREATMENT PLANT SECTION

SHEET	SHEET-NO
DWG	FIGURE 5-1B
DATE	SEPT. 18/03
PROJ	122399

FILENAME: CLARIFIERS-2.DWG PLOT DATE: SEPT.18/03 PLOT TIME: 15:53:50

5.4 Mechanical

The following is a list of the mechanical items that are no longer required and/or cannot be incorporated into the re-design and must be removed from the existing facility:

- Soaking pits
- Chemical clean equipment adjacent to the soaking pits
- Clean in place tank in the room adjoining the soaking pit room
- All membrane cassettes and process piping in the aerobic tanks
- Two backpulse tanks and the associated piping
- Three backpulse pumps
- Fournier press and associated equipment

The following is a list of the mechanical items that can be reused:

- The blowers for the aerobic tanks and the associated piping
- Trash augers and trash bin
- Lift station equipment
- The sump pumps in the existing aerobic tankage may have to be moved and the piping rerouted, but they should be kept for future works.

The following is a partial list of the new mechanical equipment that is required:

- HVAC equipment for the existing and new building
- Mixers
- Blowers
- Clarifier equipment
- Pumps
- DAF
- Centrifuge

An on site assessment of the existing mechanical equipment is required to confirm the condition of the equipment listed as reusable.

5.5 Electrical

Very little information is available about the electrical equipment in the existing building. We have made the following assumptions.

- Service size is adequate for the existing building and proposed expansion (for a conventional treatment system)
- Lighting in the existing building is adequate and meets the building code requirements
- Wiring in the existing building meets the building code requirements and there is minimal room in the service panel for expansion (a new panel will be required)
- Heating for the existing building may be undersized and possibly require some upgrading

- Existing pump motors and their motor control centers are operational
- Pump and equipment breaker systems are operational and meet code

An electrical assessment is required to confirm the above assumptions. The information gathered during the assessment can be incorporated into the detailed design.

It is also important to note that the dip pole and service entrance to the existing facilities is in a location that conflicts with the proposed future aerobic tanks. It is recommended that this dip pole and service entrance be moved during Phase 1 construction. The new service entrance can be rerouted to enter the building on the east side and electrical conduit can be run to the existing electrical room above the aerobic tank. The dip pole may require further offset from the east side of the building and the exact location should be determined during detailed design.

If further space is required to house the new electrical equipment, it can be mounted in the existing backpulse tank and pump area as this equipment will no longer be required. NEMA 4 rated panels (suitable for hose directed water) would be necessary in the process area or an additional room could be constructed in this area to house NEMA 12 panels (suitable for dripping water). The final decision will depend on the number of additional pieces of electrical equipment and the cost of the panels verses the room.

5.6 HVAC

Large open tanks containing warm water is a concern in this northern environment. The large airflow required to prevent condensation from forming would not be cost effective. To reduce operation costs and to prevent condensation from forming throughout the new structure, a low profile aluminum or FRP cover has been recommended for each clarifier and the existing aerobic tanks.

The remainder of the new building will have a HVAC system that is properly sized to handle the volume of the building and maintain the building temperature at 10° C, except the office and washroom where the temperature will be maintained at 20° C.

To reduce heating costs, a geothermal horizontal loop system could be installed in each clarifier and used to extract heat from the wastewater to heat the building. This has not been included in the cost breakdown but can be investigated further in the detailed design phase to determine if there are significant cost savings with this system.

There have been a number of indications that the existing HVAC system is grossly undersized. Therefore, it has been assumed that very little of the existing equipment can be reused to bring the facility up to the local and national building codes.

Fuel oil heating has been used as the basis for costing and no backup heaters have been provided in the cost estimate. If required, direct vent propane heaters, or other secondary source, could be provided as a backup with only a small increase in cost.

5.7 Instrumentation and Controls

Very little information is available about the instrumentation and controls equipment in the existing building. We have made the following assumptions:

- The plant does not currently have a suitable computer or SCADA (supervisory control and data acquisition) system for a conventional activated sludge process
- New instrumentation for the conventional process is required and none of the existing instrumentation can be reused
- A Program Logic Controller (PLC) is required for the new process
- Some controls may have to be added to equipment pieces that are to be reused, such as the pumps

Essentially, a new SCADA system, complete with instrumentation and controls for the usable existing equipment and new equipment, will be required for the plant conversion.

5.7 Instrumentation and Controls

Very little information is available about the instrumentation and controls equipment in the existing building. We have made the following assumptions:

- The plant does not currently have a suitable computer or SCADA (supervisory control and data acquisition) system for a conventional activated sludge process
- New instrumentation for the conventional process is required and none of the existing instrumentation can be reused
- A Program Logic Controller (PLC) is required for the new process
- Some controls may have to be added to equipment pieces that are to be reused, such as the pumps

Essentially, a new SCADA system, complete with instrumentation and controls for the usable existing equipment and new equipment, will be required for the plant conversion.

8.0 Conclusions and Recommendations

8.1 Conclusions

The following conclusions can be drawn from the information presented in this Completion Study report:

1. The 2-phase plan for bringing the existing Iqaluit WWTP to completion as a conventional activated sludge process will provide the community with a relatively simple, operator friendly, economical process that reliably meets the requirements for secondary treatment agreed to between the City of Iqaluit and the Nunavut Environmental Authority, i.e. an effluent BOD/TSS of 30/35 mg/L.
2. The capital cost for bringing the Phase 1 plant to completion as a conventional activated sludge process with a treatment capacity of 8,000 people is approximately $5.5 M. This value is in line with the capital cost estimate presented in the 2003 Earth Tech Canada report, and includes the construction costs, engineering (20%), contingency (30%), and applicable taxes. The relatively high contingency allowance of 30% is believed to be necessary at this stage given the limited information about the suitability and condition of the existing superstructure and mechanical systems, and to allow for the high degree of variability in construction costs typically experienced in a remote northern community.
3. The annual operating and maintenance cost for the Phase 1 plant serving 6,000 people is approximately $400,000/year. Additional O&M costs are approximately $10,000 per 1,000 people per year.
4. Every attempt should be made to use the existing tankage, superstructures, HVAC and mechanical equipment whenever practical and cost effective in the completion of the facility.
5. A clear division should be created between the operation of the liquid treatment stream and the solids handling system so that these two processes can be operated independently of each other, allowing the liquid treatment process to be operated in a stable manner even at times when the sludge dewatering/disposal system is shut down for periods of up to 7 day during periods of bad weather or mechanical problems.

8.2 Recommendations

It is recommended that the City of Iqaluit adopt this report as the basis for moving forward with the WWTP completion. The next phase required is to retain a suitably qualified consulting engineering firm to undertake the preliminary design of the facility completion. The principal objectives of the preliminary design phase are to minimize construction costs and ensure that the existing and future facilities are upgraded to the current design and regulatory standards prior to entering the predesign/detailed design phases. The preliminary design phase should include the following elements:

- Legal Land Survey
- Property Assessment
- Geotechnical Investigation
- Environment Screening Report (if required)
- Electrical Assessment
- HVAC Assessment
- Mechanical Assessment
- Architectural Review

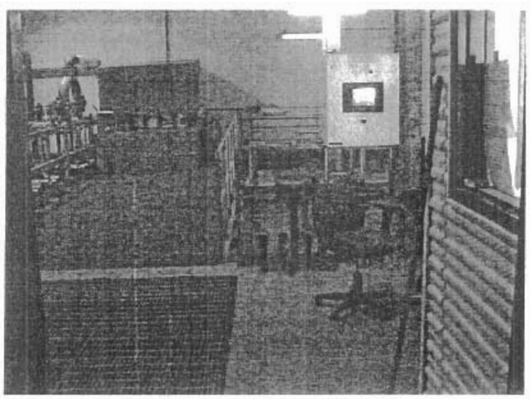
Following preliminary design, the City of Iqaluit should appoint a suitably qualified engineering company for the detailed design and construction supervision for the facility completion.

APPENDIX A

PLANT PHOTOGRAPHS

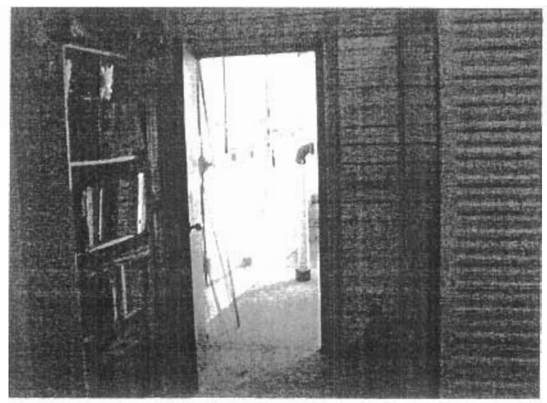
The following pictures were used as the basis for evaluating the existing facilities. Assumptions were made based on what can be seen in each picture. Some items were difficult to interpret and other items were not clear. Drawings provided to CH2M HILL were also used in conjunction with the pictures to fill in missing information on the facilities.

A site visit will be required to confirm the assumptions made and the operation of equipment prior to proceeding with future design work.

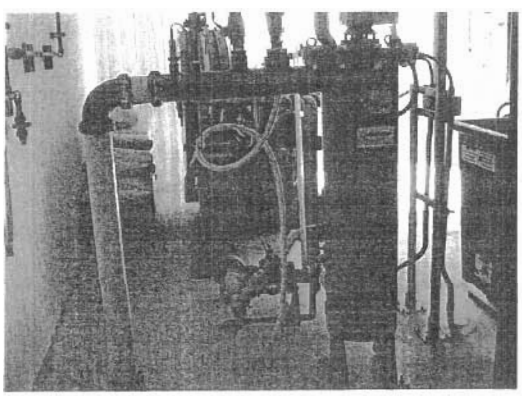


Single Door Entrance From South Stairs

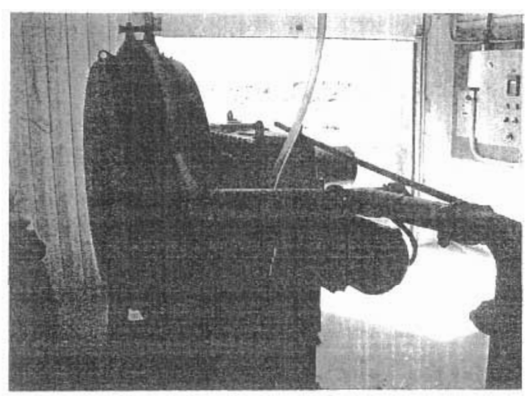
(Office Window Right Soaking Pits Left)



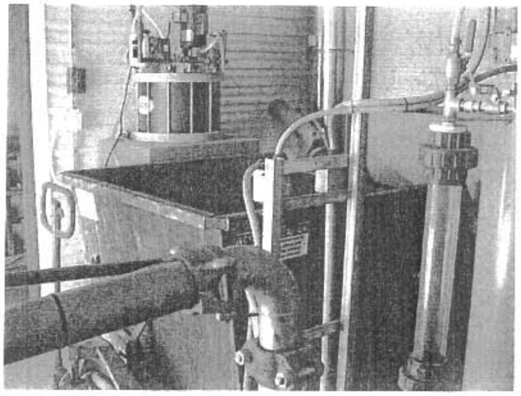
Single Door To Fournier Press Room



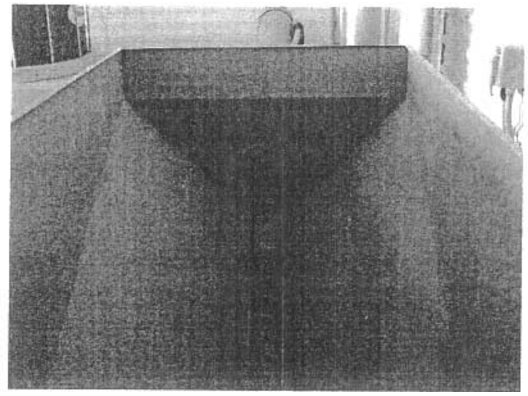
Fournier Press Room and Equipment



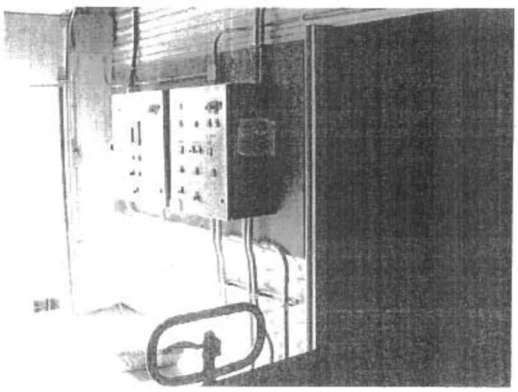
Fournier Press Room and Equipment



Fournier Press Room and Equipment



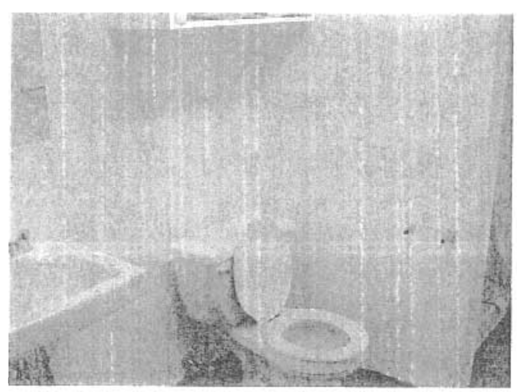
Fournier Press Room and Equipment



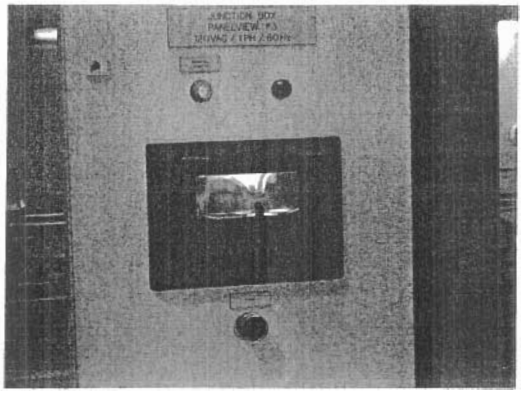
Fournier Press Control Panels

Fournier Press Control Panels

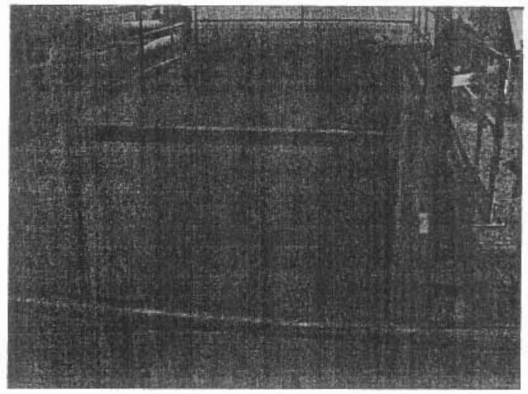
Office



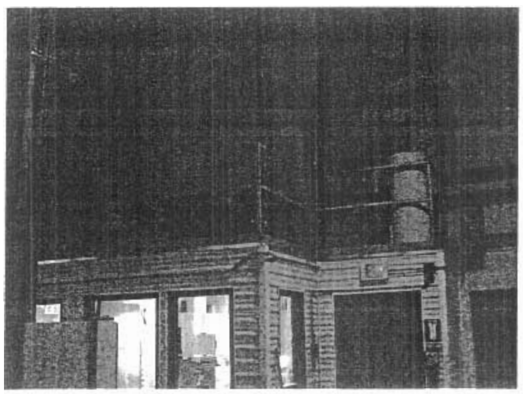
Washroom



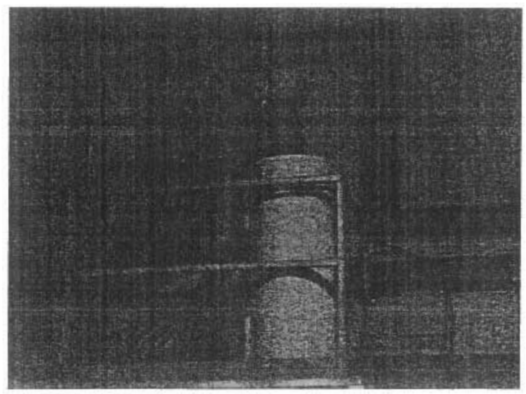
Trash Auger Control Panel



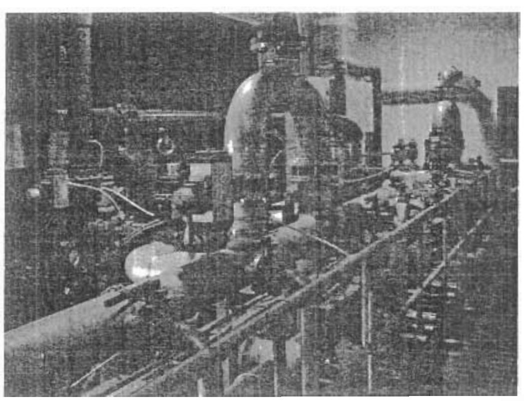
Concrete Tank



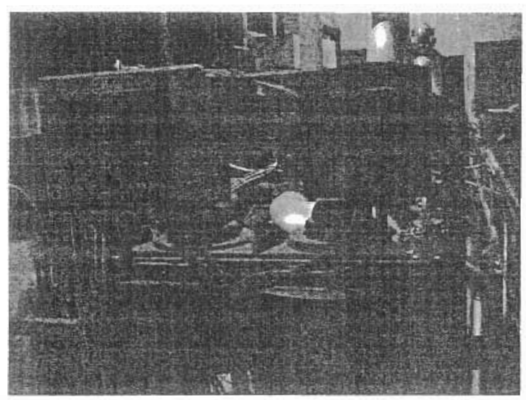
Office Door and Windows (HWT Above)



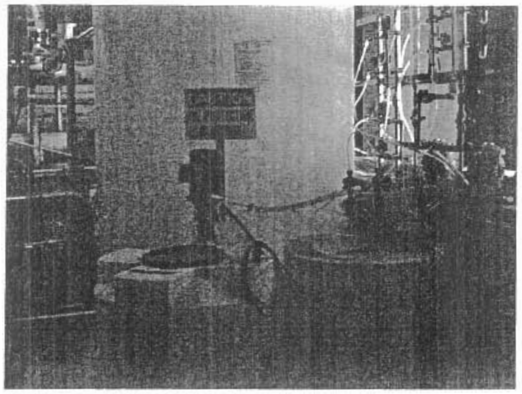
HWT Above Second Floor Entranceway



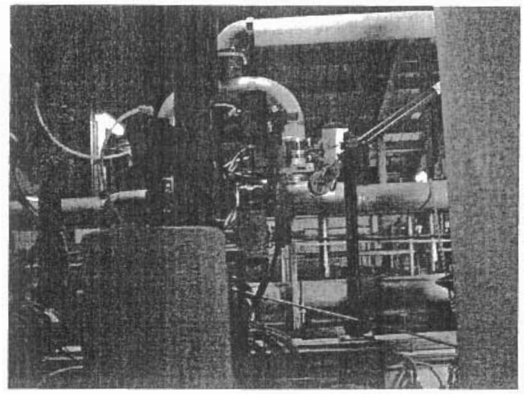
Membrane Cassette Piping



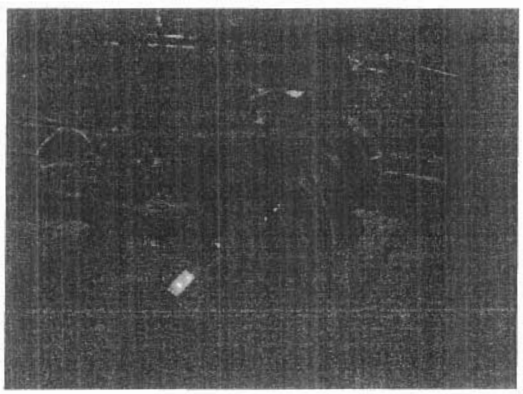
Membrane Particle Counters



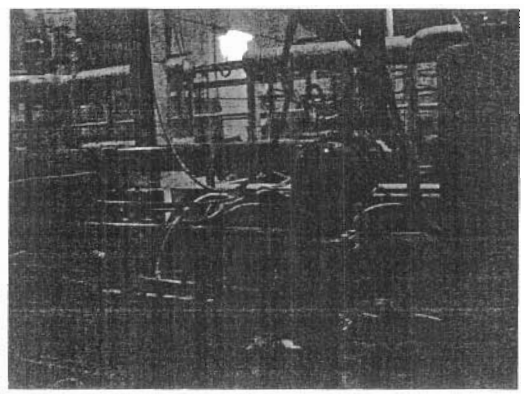
Citric Acid Cleaning System



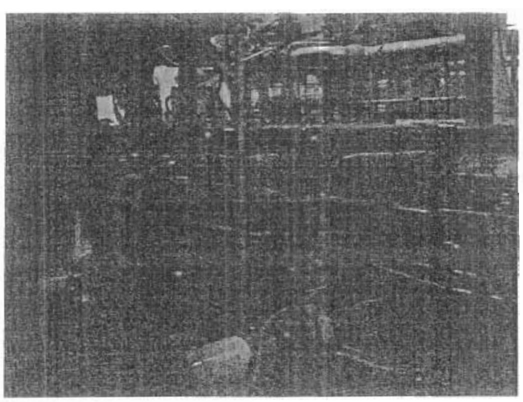
Citric Acid Cleaning System



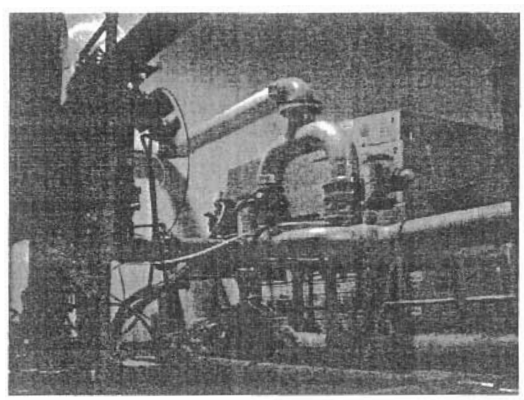
Pump



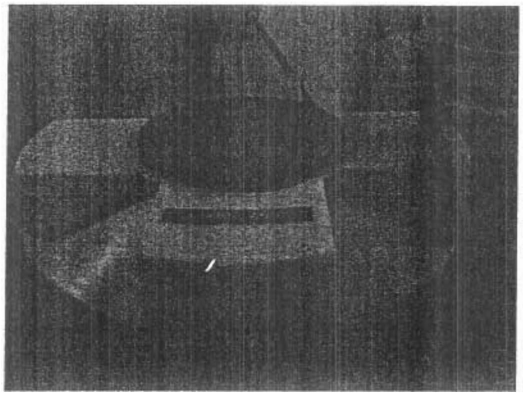
Piping



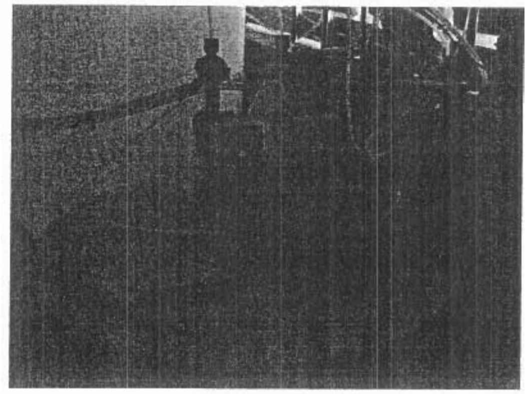
Pumps and Piping



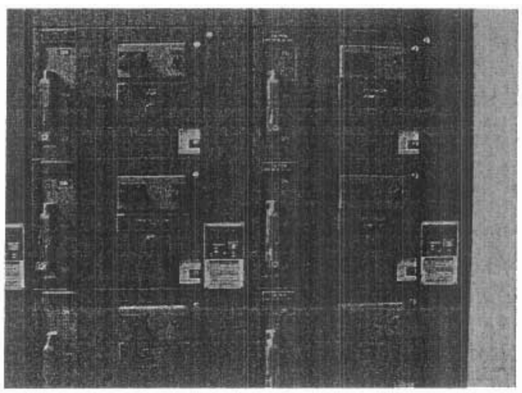
Pipe Headers



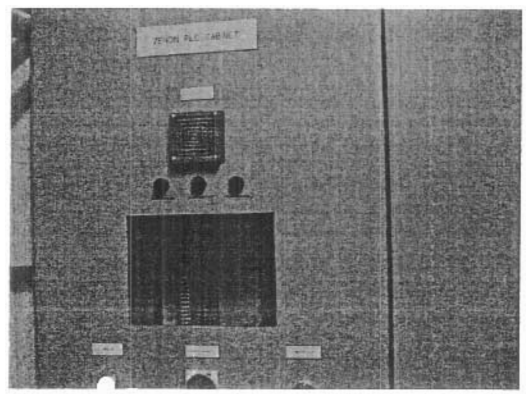
Citric Acid Day Tank



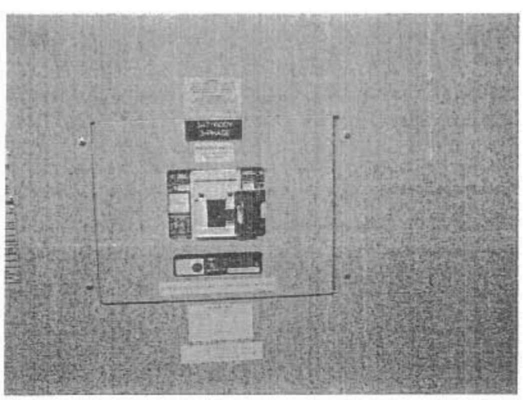
Sodium Hypochlorite Metering Pumps



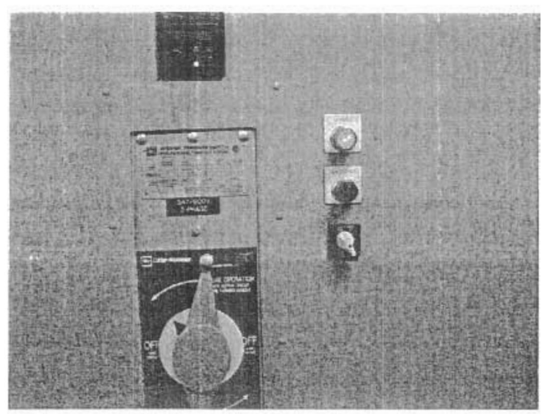
Electrical Room Controls (Breakers)



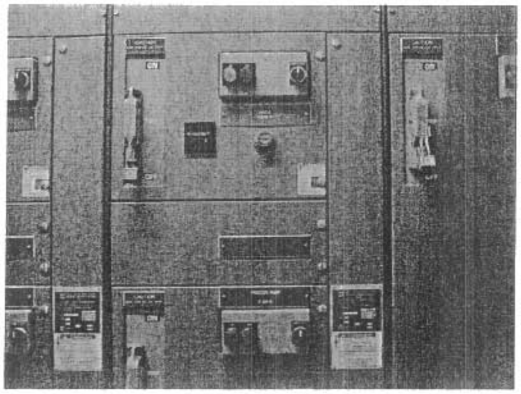
Zenon PLC Cabinet



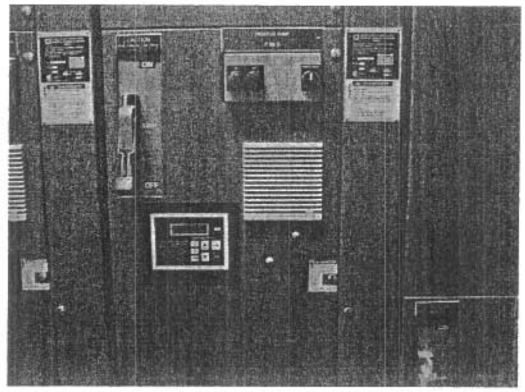
Main Breaker



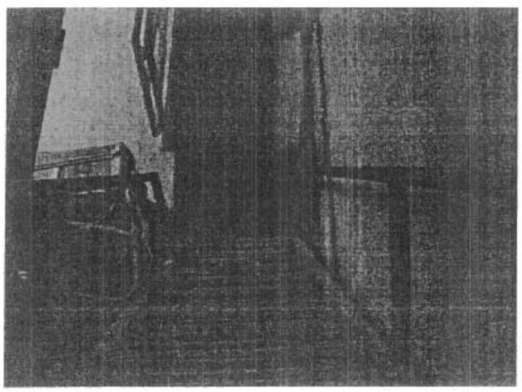
Transfer Switch



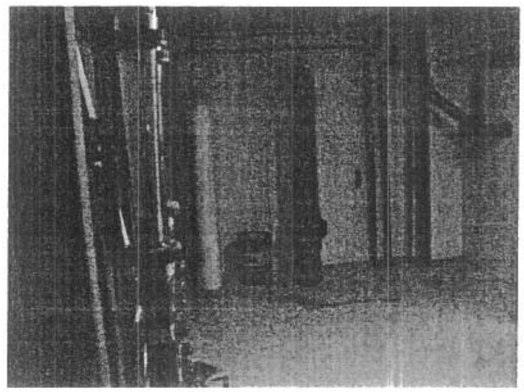
Process Pump Breakers



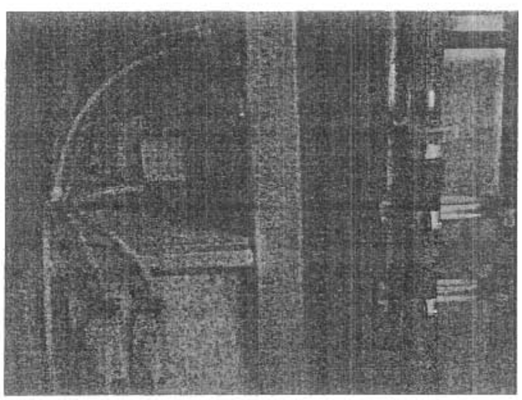
Process Pump Breaker and VFD



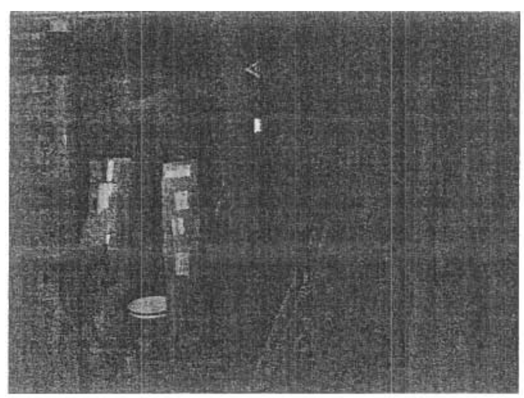
Stairs to Basement



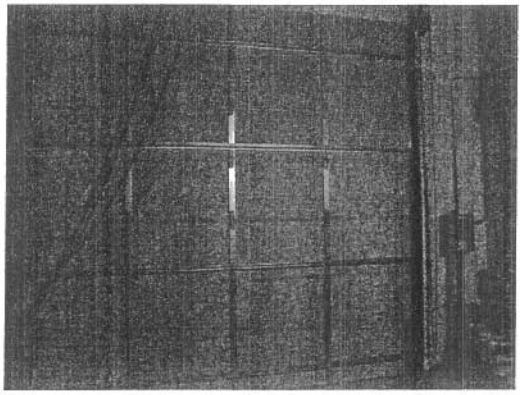
Pipe Gallery



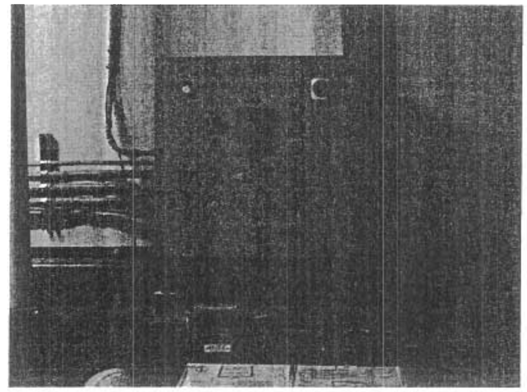
Pipe Gallery



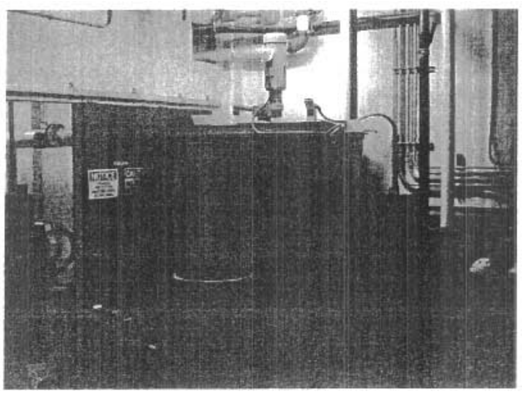
Backpulse Tank Area



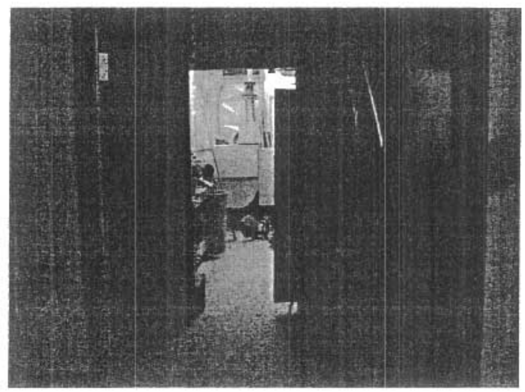
Bay Door



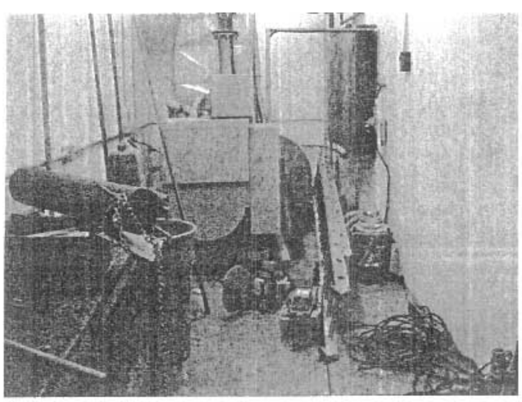
Control Panel



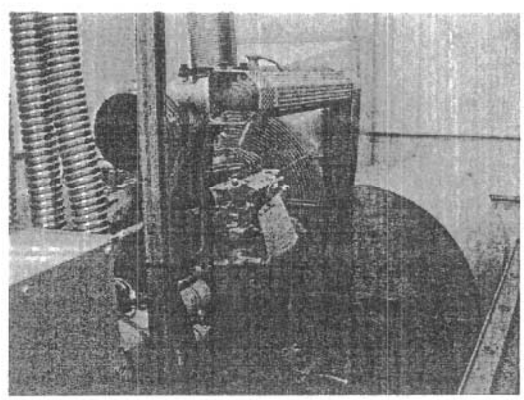
CIP Tank



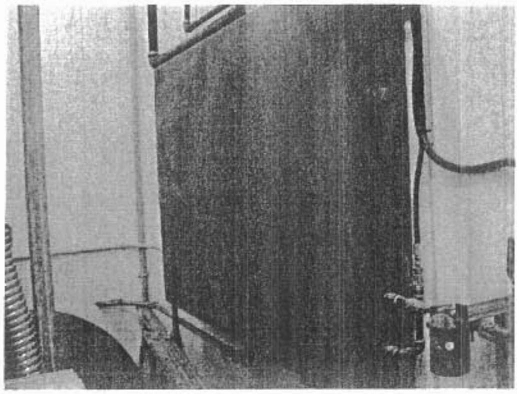
Doors to Genset Room



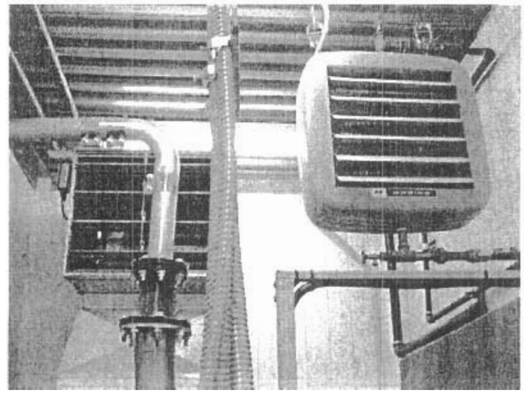
Genset



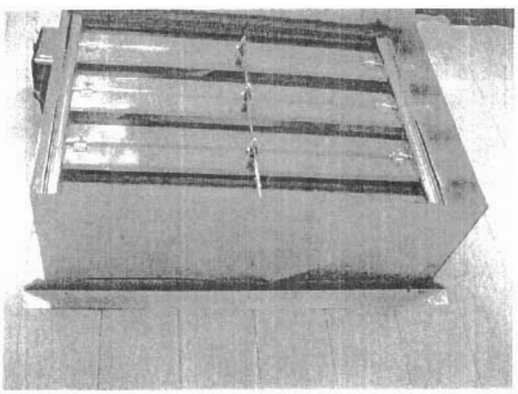
Genset



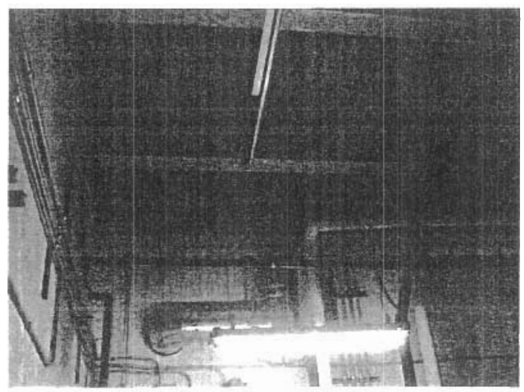
Genset Fuel Feed



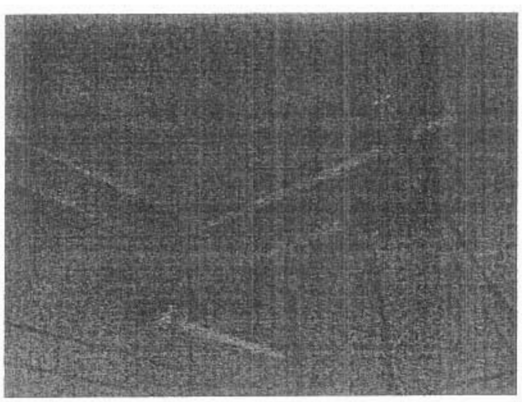
Heating and Ventilation



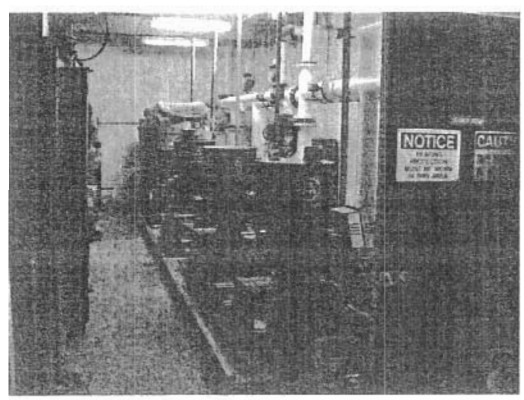
Ventilation



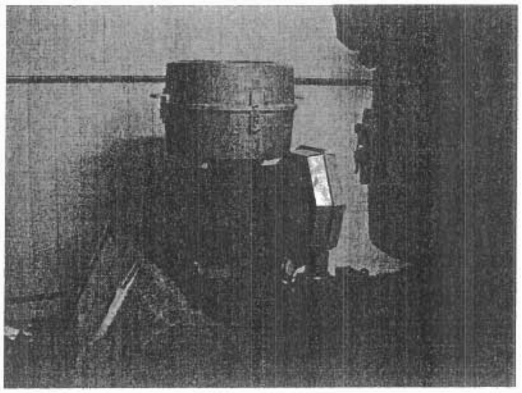
HVAC and Lighting

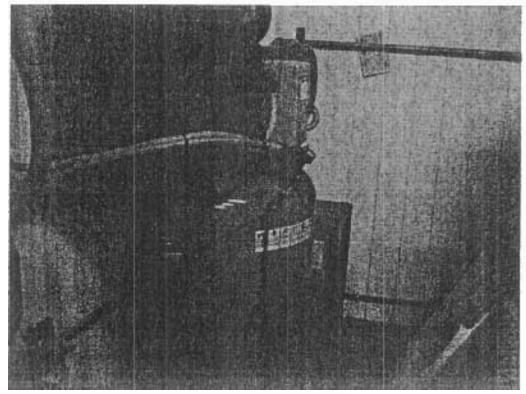


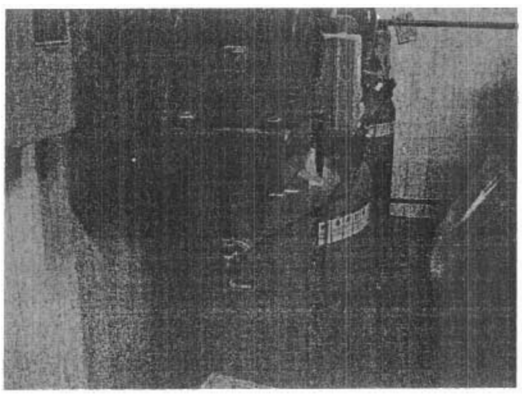
Overhead Crane

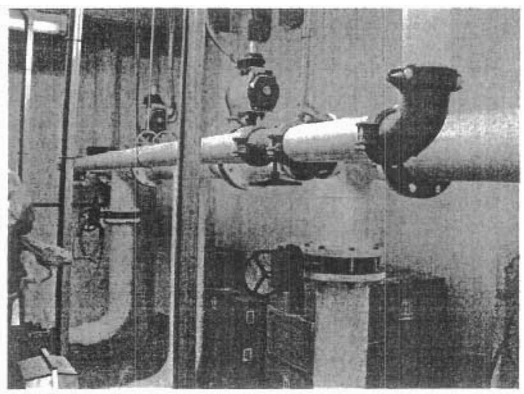


Blower Room

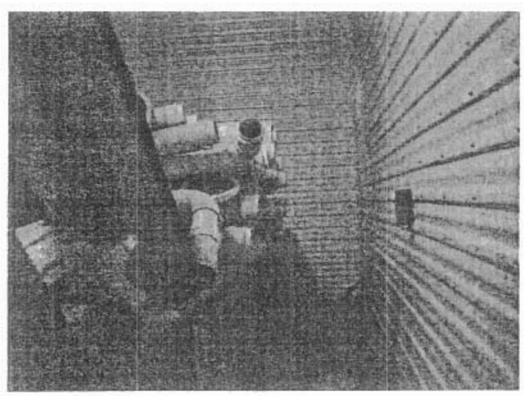

Blower

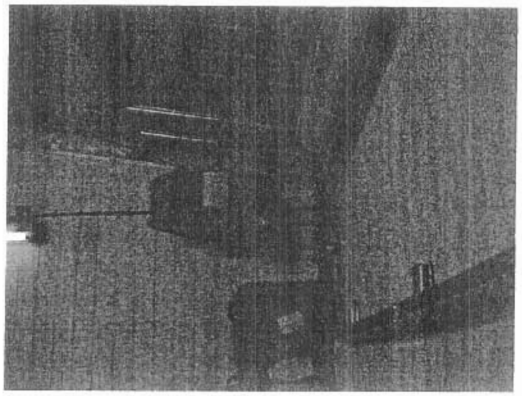

Pressure Tank


Pressure Tanks

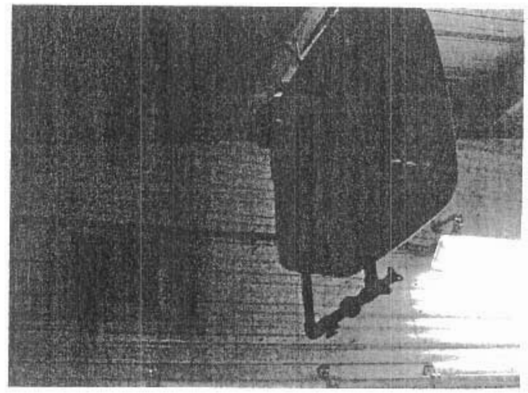

Air Piping


Trash Augers

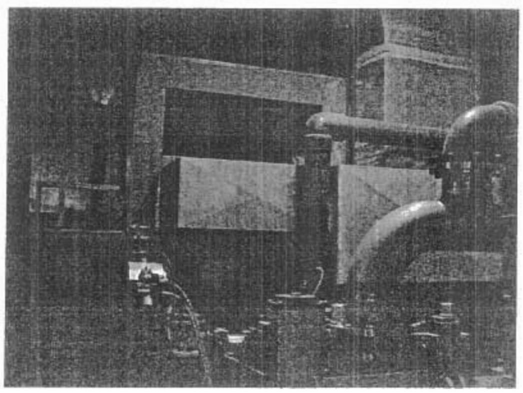

Trash Auger Bin



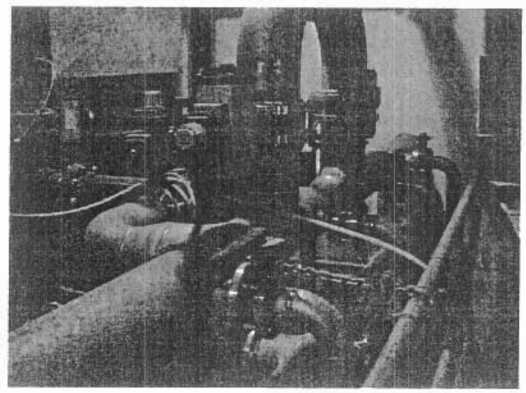
HVAC



HVAC



HVAC Ducting



Membrane Process Piping

APPENDIX B

DETAILED COST OPINION BREAKDOWN

CH2MHILL

CONSTRUCTION COST OPINION

PROJECT: Iqaluit Wastewater Treatment Plant Completion Study
PROJ. NO.: 122399 DATE: 14-Oct-03
AUTHOR: DN & CK REV. NO.: 1
SUBJECT: Probable Completion Cost

REF SPEC SECT No	DESCRIPTION OF ITEM	Q'TY	UNIT	MATERIAL UNIT COST (CDN $)	MATERIAL TOTAL COST (CDN $)	LABOUR % OF MAT'L (CDN $)	LABOUR or UNIT COST (CDN $)	LABOUR TOTAL COST (CDN $)	TOTAL LABOUR & MAT'L (CDN $)	SUB TOTAL COST (CDN $)
DIVISION 1 - GENERAL REQUIREMENTS										
	Bonding and insurance	1	LS					70,000	70,000	
	Mobilization and demobilization	1	LS					70,000	70,000	
	Temporary facilities	1	LS					15,000	15,000	
	Survey	1	LS					10,000	10,000	
	Testing services	1	LS					10,000	10,000	
	Shop drawings	1	LS					10,000	10,000	
	O&M manuals	1	LS					10,000	10,000	
	Record drawings	1	LS					10,000	10,000	
	Sub-contractor's overhead and profit:		%					*O/H & P:*		
								Division 1 Total:	205,000	$205,000
DIVISION 2 - SITEWORK										
02070	**Selective demolition**									
	Demo of walls and walkways in existing bldg	30	m2	50	1,500		150	4,500	6,000	
02140	**Dewatering**									
	Marsh construction area	1	mnth	32,000	32,000				32,000	
02150	**Excavation shoring system**									
	Marsh Area	40	m2	150	6,000		100	4,000	10,000	
02162	**Rock anchors**									
	Anchor concrete pad to bedrock	50	ea	400	20,000				20,000	
02200	**Earthwork**									
	Stripping (topsoil)	370	m3				8	2,960	2,960	
	Excavation	700	m3				20	14,000	14,000	
	Mass concrete fill	250	m3	450	112,500		50	12,500	125,000	
	Structural fill	250	m3	30	7,500		30	7,500	15,000	
	Marsh improvement	1	LS					3,000	3,000	
2212	**Finish grading**									
	Lot drainage and swales	1	LS					5,000	5,000	
2505	**Granular paving**									
	Parking area surfacing	500	m2	30	15,000		30	15,000	30,000	
2630	**Yard piping**									
	New outfall connection	1	LS					5,000	5,000	
2712	**Foundation drainage**									
	Perimeter drain piping	100	m	30	3,000		5	500	3,500	
2831	**Chain link fences and gates**									
	Barbed wire fence and gate around building	200	m	40	8,000		5	1,000	9,000	
2900	**Landscaping**									
	Site clean up	1	LS					2,000	2,000	
02221	**Rock Removal**									
	Bedrock	700	m3				202	141,400	141,400	
	Sub-contractor's overhead and profit:		%					*O/H & P:*		
								Division 2 Total:	423,860	$423,900
DIVISION 3 - CONCRETE										
03100	**Concrete formwork and falsework**									
	Suspended slabs	250	m2	80	20,000				20,000	
	Walls, columns, misc. concrete	2400	m2	70	168,000				168,000	
03200	**Concrete reinforcement (per m3 of concrete)**									
	Footings and base slabs (100 kg/m3)	320	m3	170	54,400				54,400	
	Walls, columns, s.slabs and beams (130kg/m3)	440	m3	240	105,600				105,600	
03250	**Concrete accessories**									
	PVC waterstops									
	150 mm WS	150	m	15	2,250		30	4,500	6,750	
03300	**Cast in place concrete**									
	Concrete (reinforcement excluded)									
	Base slabs	210	m3	240	50,400				50,400	
	Walls	440	m3	240	105,600				105,600	
	Suspended slabs	110	m3	240	26,400				26,400	
03345	**Concrete finishing**									

CH2MHILL

CONSTRUCTION COST OPINION

PROJECT:	Iqaluit Wastewater Treatment Plant Completion Study		
PROJ. NO.:	122399	DATE:	14-Oct-03
AUTHOR:	DN & CK	REV. NO.:	1
SUBJECT:	Probable Completion Cost		

REF SPEC SECT No	DESCRIPTION OF ITEM	Q'TY	UNIT	MATERIAL UNIT COST (CDN $)	MATERIAL TOTAL COST (CDN $)	% OF MAT'L (CDN $)	LABOUR or UNIT COST (CDN $)	LABOUR TOTAL COST (CDN $)	TOTAL LABOUR & MAT'L (CDN $)	SUB TOTAL COST (CDN $)
	Unformed surfaces	800	m2				5	4,000	4,000	
	Formed surfaces	2650	m2				2	5,300	5,300	
03410	**Structural precast**									
	Hollow core slabs	500	m2	130	65,000		30	15,000	80,000	
03610	**Grout and miscellaneous concrete work**									
	Grouted-in dowels	400		3	1,200		10	4,000	5,200	
	Alterations and modifications to existing structures:									
	Pipe penetrations.	4	LS	1,000	4,000		300	1,200	5,200	
03710	**Preparation of existing concrete**									
	Surface preparation	10	m2	8	80		20	200	280	
	Sub-contractor's overhead and profit:		%					*O/H & P:*		
								Division 3 Total:	637,130	$637,200
DIVISION 4 - MASONRY										
04200	**Unit masonry**									
	200mm single width conc block wall	600	m2	45	27,000		65	39,000	66,000	
	Sub-contractor's overhead and profit:		%					*O/H & P:*		
								Division 4 Total:	66,000	$66,000
DIVISION 5 - METALS										
05120	**Structural steel (metal building modifications)**									
	Beams WWF	1	tonne	2,500	2,500				2,500	
	Columns WWF	2	tonne	2,500	5,000				5,000	
	Base plates	1	tonne	3,000	3,000				3,000	
	Ancillary steel (average cost)	1	tonne	4,500	4,500				4,500	
05500	**Metal Fabrication**									
	Alum or galv steel open grating (installed)	15	m2	360	5,400		400	6,000	11,400	
	Alum. or galv steel railing	100	m	320	32,000				32,000	
	Alum or galv steel handrail	30	m	300	9,000				9,000	
	Alum. ladder		EA	600						
	Alum. stairs including grating	6	m	720	4,320				4,320	
	Alum.checkered frame and cover 1 m x 1 m	3	EA	2,000	6,000				6,000	
	SST access hatch 1m x 1m	3	EA	1,900	5,700				5,700	
	SST.access hatch 1.5m x 1m		EA	2,200		30				
	SST ladder	2	EA	3,000	6,000				6,000	
	SST. lifting hook	5	EA	100	500	20		100	600	
	SST. open grating platform	50	m2	360	18,000		400	20,000	38,000	
	Anoxic launder SST	1	LS					13,500	13,500	
	Aeration launder SST	1	LS					13,500	13,500	
	Sub-contractor's overhead and profit:		%					*O/H & P:*		
								Division 5 Total:	155,020	$155,100
DIVISION 6 - WOOD AND PLASTICS										
06100	**Rough carpentry**									
	Interior and exterior	1	LS					5,000	5,000	
06190	**Fabricated roof trusses**									
	(Roof is concrete prefab panels)									
6200	**Finish carpentry**									
	Interior and exterior finishes	1	LS					5,000	5,000	
	Sub-contractor's overhead and profit:		%					*O/H & P:*		
								Division 6 Total:	10,000	$10,000
DIVISION 7 - THERMAL AND MOISTURE PROTECTION										
07121	**Capillary waterproofing**									
	Waterproofing	350	m2	25	8,750				8,750	
07240	**Exterior insulation and fnish system**									
	50 mm rigid insulation	500	m2	22	11,000		23	11,500	22,500	
07525	**Modified bituminous sheet roofing**									
	Hot applied MBSR	500	m2	105	52,500				52,500	
	Sub-contractor's overhead and profit:		%					*O/H & P:*		
								Division 7 Total:	83,750	$83,800
DIVISION 8 - DOORS AND WINDOWS										

CH2MHILL

CONSTRUCTION COST OPINION

PROJECT:	Iqaluit Wastewater Treatment Plant Completion Study
PROJ. NO.:	122399
AUTHOR:	DN & CK
SUBJECT:	Probable Completion Cost
DATE:	14-Oct-03
REV. NO.:	1

REF SPEC SECT No	DESCRIPTION OF ITEM	Q'TY	UNIT	MATERIAL UNIT COST (CDN $)	MATERIAL TOTAL COST (CDN $)	% OF MAT'L (CDN $)	LABOUR or UNIT COST (CDN $)	LABOUR TOTAL COST (CDN $)	TOTAL LABOUR & MAT'L (CDN $)	SUB TOTAL COST (CDN $)
8110	Steel doors and frames	7	ea	1,500	10,500		300	2,100	12,600	
8362	Sectional overhead door	1	ea	1,700	1,700		300	300	2,000	
8710	Door hardware	8	ea	300	2,400		100	800	3,200	
	Sub-contractor's overhead and profit:		%					*O/H & P:*		
								Division 8 Total:	17,800	$17,800
DIVISION 9 - FINISHES										
9900	Painting	1	LS					7,000	7,000	
	Sub-contractor's overhead and profit:		%					*O/H & P:*		
								Division 9 Total:	7,000	$7,000
DIVISION 10 - MANUFACTURED SPECIALTIES										
10200	Mechanical louvers and ducting (ventilation)	1	LS					106,000	106,000	
	Sub-contractor's overhead and profit:		%					*O/H & P:*		
								Division 10 Total:	106,000	$106,000
DIVISION 11 - EQUIPMENT										
11055	Sampling equipment	1	LS					11,000	11,000	
11065	Miscellaneous equipment	1	LS					10,000	10,000	
11160	Loading dock equipment	1	LS					4,000	4,000	
11211	Pumps (WAS and RAS) (4)	1	LS					40,000	40,000	
11241	Polymer feed equipment	1	LS					45,000	45,000	
11285	Gates (3)	1	LS					18,000	18,000	
11632	Centrifuge equipment (plus spare parts)	1	LS					208,000	208,000	
11371	Air blowers (2 TWAS stg)	1	LS					25,000	25,000	
11375	Aeration equipment	1	LS					32,000	32,000	
11381	Mechanical mixers(2)	1	LS					20,000	20,000	
11501	Safety equipment	1	LS					5,000	5,000	
11505	Workshop equipment	1	LS					8,000	8,000	
11600	Laboratory equipment	1	LS					8,000	8,000	
11960	Maintenance equipment and tools	1	LS					8,000	8,000	
	DAF	1	LS					115,000	115,000	
	Clarifier equipment (2)	1	LS					240,000	240,000	
	Obsolete Equipment Removal & Disposal	1	LS					10,000	10,000	
	Sub-contractor's overhead and profit:		%					*O/H & P:*		
								Division 11 Total:	807,000	$807,000
DIVISION 12 - FURNISHINGS										
12345	Casework	1	LS					15,000	15,000	
	Sub-contractor's overhead and profit:		%					*O/H & P:*		
								Division 12 Total:	15,000	$15,000
DIVISION 13 - SPECIAL CONSTRUCTION										
13121	Pre-engineered buildings (low profile covers)	240	m2	890	213,600				213,600	
	Sub-contractor's overhead and profit:		%					*O/H & P:*		
								Division 13 Total:	213,600	$213,600
DIVISION 14 - CONVEYING SYSTEMS										
14600	Hoists and cranes	1	LS					30,000	30,000	
	Sub-contractor's overhead and profit:		%					*O/H & P:*		
								Division 14 Total:	30,000	$30,000
DIVISION 15 - MECHANICAL										
15051	Identification labels for equipment	1	LS					3,000	3,000	
15100	Valves	1	LS					20,000	20,000	
15300	General fire protection systems	1	LS					1,200	1,200	
15375	Standpipe and hose systems	1	LS					5,500	5,500	
15400	Plumbing and dainage systems	1	LS					3,500	3,500	
15481	Fuel oil systems	1	LS					1,200	1,200	
15486	Process piping systems	1	LS					72,000	72,000	
15840	Duct systems	1	LS					65,000	65,000	
15950	HVAC controls	1	LS					125,000	125,000	
15990	HVAC testing and balancing	1	LS					15,000	15,000	
	Sub-contractor's overhead and profit:		%					*O/H & P:*		
								Division 15 Total:	311,400	$311,400
DIVISION 16 - ELECTRICAL										

CH2MHILL

CONSTRUCTION COST OPINION

PROJECT: Iqaluit Wastewater Treatment Plant Completion Study
PROJ. NO.: 122399 DATE: 14-Oct-03
AUTHOR: DN & CK REV. NO.: 1
SUBJECT: Probable Completion Cost

REF SPEC SECT No	DESCRIPTION OF ITEM	Q'TY	UNIT	MATERIAL UNIT COST (CDN $)	MATERIAL TOTAL COST (CDN $)	LABOUR % OF MAT'L (CDN $)	LABOUR or UNIT COST (CDN $)	LABOUR TOTAL COST (CDN $)	TOTAL LABOUR & MAT'L (CDN $)	SUB TOTAL COST (CDN $)
	Electrical lump sum based on division 11 and 14 and electrical heat							255,000	255,000	
	Sub-contractor's overhead and profit:		%					*O/H & P:*		
								Division 16 Total:	255,000	$255,000
									SUB-TOTAL:	$3,343,800
GENERAL ITEMS										
1	Shipping and delivery	5	%						167,190	
								General Items Total:	167,190	$167,200
									SUB-TOTAL:	$3,511,000
ENGINEERING AND CONTINGENCY										
1	Engineering (design & construction services)	20	%						702,200	
2	Contingency allowance	30	%						1,053,300	
								Engineering and Contingency Total:	1,755,500	$1,755,500
									SUB-TOTAL:	$5,266,500
TAXES										
1	Provincial sales tax (included above)		%							
2	Federal goods and services tax (after rebate)	3.5	%						184,328	
3	Other taxes, patent fees, import duties, etc		%							
								Taxes Total:	184,328	$184,400
									TOTAL:	**$5,450,900**

No	REVISION	DATE	NOTES
0			
1			
2			
3			
4			
5			