Water Supply for Gjoa Haven Design Concept Brief

Draft Design Concept Brief

October, 2002

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Gjoa Haven, NU

Submitted by

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DILLON CONSULTING

October 18, 2002

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Attention: Mr. Guntis Rozitis,
Project Officer

Water Works/Water Supply for Gjoa Haven
PW&S Project # 02-4100

Dear Mr. Rozitis:

Dillon Consulting Limited is pleased to provide you with the draft Design Concept Brief for the water supply system Gjoa Haven. This report is developed to allow your department and community to review the conceptual development of the proposed facilities and pipelines.

We trust that this report provides you with sufficient detail to provide direction on the design development.

Yours sincerely,

Dillon Consulting Limited

Gary Strong, P.Eng.,

Managing Partner

Dillon Consulting Limited

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1.0 INTRODUCTION

1.1 General

The community of Gjoa Haven is supplied water from a truck fill station that draws its water from a lake near the community, namely Water Lake. Over several years, it has been noted that the quality of the water supply system has deteriorated. In the past 2 years, the Government of Nunavut has undertaken studies to determine the best long-term water supply system for the community. The selected raw water source is Swan Lake located approximately 3.0 kilometres from the current water supply lake. To meet the requirements of the Fire Marshal with respect to Fire Flow and to meet the future community water demand, the GN plans to construct the following facilities;

- ✓ A water supply pipeline from Swan Lake to a new in-community water treatment and storage facility.
- ✓ An intake and pump station at Swan Lake
- ✓ An in town water treatment and pumphouse
- ✓ Upgrades to the access road to Swan Lake.

Figure 1 in Appendix A illustrates the location of the proposed facilities.

To complete the implementation of the project, the Government of Nunavut, Department of Public Works and Services (PW&S) retained the services of Dillon Consulting limited in July of 2002. Dillon's contract with the GN is #02-4200.

1.2 Scope of Work

The specific terms of reference for the project are included in Appendix A. Briefly, the scope of work included in this assignment is:

- To provide water to the community, which is free of health hazards, meet or exceed the Nunavut Public Health Act for Canadian Drinking water Quality, and meet all specific requirements of the community's Nunavut Water Board Licence to operate. The water must be aesthetically acceptable and of sufficient quality and quantity for domestic, commercial and industrial use. And for fire protection.
- At the 20-year design horizon the community population is 1,435 residents. The design must meet community water supply needs for 20 years but water supply planning should consider a 40-year planning period.

1.3 Scope of this Report

Report Layout

The purpose of this Design Concept Brief is to document the preliminary design process and is a decision-making document. The sections of the report describe;

- The design requirements as laid out in the terms of reference and the background documentation
- The design criteria, assumptions, and calculations
- System descriptions

- Component descriptions
- Option development and selection
- Cost estimates
- Implementation schedules and strategies

Where options exist for the design concept, these options are presented in a tabular form. The tables describe the options, list the criteria for design process, and rate the options against the criteria. The report recommends the best option. Cost estimates for all options are developed using a life cycle cost assessment model.

All figures are located in Appendix A.

Acknowledgements

Throughout the development of this report, Dillon has gratefully received the assistance of the Client Department, Community Government and Transportation, the Community of Gjoa Haven, and the representatives of the Department of Public Works and Services.

2.0 SYSTEM DESIGN STANDARDS

Design Criteria

The design criteria for this project will be completed in accordance with the parameters set out by the GN, "Water and Sewage Facilities Capital Programs". These are as follows:

Table 2.1
Design Horizons

Facility	Design Horizon (Years)	Design Economic Life (Years)	Design Expected Life (Years)
Building	20	20	40
Pumps	10	20	20
Pipelines	20	20	30

Where the:

- Design horizon is the period used to establish capacity requirements for a facility.
- Design economic life is the period used in the economic analysis to establish the present value (or equivalent capital cost) of a facility.
- Design expected life is the practical maximum expected life of a facility assuming no premature failure, destruction or obsolescence.

Design Standards

The following is a list of the design standards to be used in the development of the water supply system. These are derived from the GNWT "General Terms of Reference for Water and Sanitation" (GTR), and the "National Building Code" (NBC), and "Capital Standards Criteria, September 1993," MACA.

Table 2.2
Water Consumption Rates

Water Consumption Rates		**Reference**
Domestic	90 litres per capita per day	MACA
Commercial	0.00023 x population	MACA
Total Consumption per Capita	90 x (1.0 + 0.00023 x pop.)	MACA
Fire Demand	910 litres per minute. 170,000 L storage	MACA & Fire Marshal
Discount Rates	4%, 8% and 12%	MACA

Table 2.3
Environmental Conditions

Environmental Conditions	
Design Minimum Temp.	-41°C [1]
Degree Days (18 C)	10751 [2]
Snow Load SS SR	3.5 kPa [1] 0.2 kPa [1]
Wind Pressures	1.20 kPa [1]

1. Supplement to the National Building Code of Canada 1996 Third Revisions and Errata.
2. Canadian Climate Normals (1961-1990). Yukon and Northwest Territories.

Design Parameters

The following are items that have been identified as design parameters for the facility:

- The facility must be simple to operate and maintain by local forces with limited equipment, and parts and materials that are available locally.
- Reliability of the facility is extremely important.
- The facility must be efficient and cost effective.
- The fire flows at truck fill arms are to have a minimum pumping capacity of 910 L/min.
- All equipment and pipes must be self-draining after each use cycle, where practical. When self-draining of any major component cannot practically be accommodated, some other means of frost protection should be incorporated.
- All major components must be capable of recovering from a frozen condition, in an operable state, if there is any possibility of freezing.
- Provisions of spares for all equipment is required, particularly components that have bulbs, fuses, relays, timers, etc.
- The first year supply of consumable, such as disinfectant, water testing packets, and cleaning supplies are to be a requirement of the construction contract.
- Fuel storage at the pumphouse must provide for spill containment (if applicable).
- Water supplied from the pumphouse must be metered.
- Provision for an alarm system which indicates loss of power and low building temperature, is required.

Cost Analysis

Throughout this document, there are cost analysis of various options. The analysis have been carried out as outlined in the GTR as described below:

Capital Cost

Cost of construction for the facility

Annual Operation and Maintenance Costs

The cost of operation, which may include manpower, energy requirements, fuel, general maintenance (light bulbs, paint), and equipment replacement.

Life Cycle Costs

The calculation of the total facility cost over a 20-Year period. This includes the capital, operations and maintenance costs. The life cycle value is shown as a present value, which is calculated at a discount rate of 4%, 8% and 12%.

3.0 COMMUNITY INFORMATION

3.1 Water Quantity Calculations

The water supply system design horizon is indicated in the previous section. Based on an implementation year of 2004, the 20 year design horizon is set at 2024. Using current population projections from the Bureau of statistics, the following table indicates the water consumption values. Also shown are the peak day demand values.

Table 3.1
Design Water Consumption Values

	2004	2014	2024
Water Demand per capita (litre)	112	116	122
Population (people)	1056	1272	1556
Average Day Demand (litre)	118,075	147,902	190,082
Peak Day demand (litre)	194,824	244,039	313,636

The calculation of these values is shown in Appendix B

3.2 Community Meeting

On March 21, 2002, the Hamlet council of Gjoa Haven passed a motion (Motion #54/02) choosing Swan Lake for the future water supply lake. In August of 2002, representatives from Public Works and Service, Community Government and transportation and Dillon Consulting

Limited met with the hamlet representatives to discuss the location of the proposed new facilities. These discussions were held with the community SOA, council members, the Mayor, and hamlet staff. At the conclusion of the discussions, it was felt that the parties agreed to a set of facility locations, and pipeline alignments.

4.0 SYSTEM COMPONENTS

There are 4 (four) major components in the water supply and treatment design for the community. Each system has several sub-systems. The development of the design of the individual components requires knowledge of the operation of each system and subsystem. In the sections that follow, the design development of all systems is described. In some cases, there is reference to forwarding sections, which unfortunately is unavoidable due to the interrelationship of the systems.

The four (4) major components are;

- The Intake Pump House (IPH) and back-up truck fill station located at Swan Lake
- The water supply pipeline between Swan Lake and the In-town Water Treatment Plant (WTP)
- The WTP
- The Storage tanks located adjacent to the WTP

4.1 Intake Pump House at Swan Lake

The pumphouse will have the following major components:

- Building Foundation
- Truckfill controls and metering
- Conveyance Pipes
- Power Supply
- Intake Pipe Freeze Protection
- Monitoring and Alarms
- Building Construction
- Building Layout
- Spares and Ancillary Components

The following sections will describe these components for each facility.

IPH Controls and Metering

The truckfill control has been established according to the Government of Nunavut standard for similar facilities in other small communities. The truckfill control system will have the following components:

- Truckfill control with one customer key lock. This will have a flow accumulator to record cumulative flows. The control will be on the truckfill arm, with a start and stop switch, and a timer.
- Flow rate indicator.

- Flow sensor installed in the truckfill pipe to control the flow accumulator.
- Flow switch to interlock with the pump and chlorine pump to avoid damage to the equipment or excessive chlorine injection into an empty line.
- All measurements for the metering are to be in SI units (litres).
- The accumulators, flow indicator, and miscellaneous control devices will be located in a main control panel inside the IPH.

Conveyance Piping

The process piping will consist of the following:

- An intake screen, submersible pump on 100 mm HDPE DR17 piping, contained within a 300 mm HDPE DR17 casing. The casing will be insulated with 50 mm of polyurethane foam and will be heat traced. The intake piping will enter the pumphouse and terminate with a flange connection just inside the pumphouse wall.
- Galvanized 100 mm Schedule 40 steel piping with Victaulic system connections.
- Chlorine injection diffuser, located on the galvanized steel piping within the building for back-up purposes.
- Flow switch to activate the chlorine pump.
- Flow sensor for the truckfill control system.

Prime Power

Prime power can be obtained from either Nunavut Power Corporation's power plant, or an on-site diesel electric generator.

Typically, the use of grid power generated by the Power Corporation is the source of prime power. However, the new facility is not directly next to the community, and a new power line is required to service the pumphouse. Based on estimates received from the Power Corporation, the cost to install the new lines will be approximately $120, 000 for 1200 m of overhead line. The installation of on-site power generation will require:

- A building or space within the truckfill building to house the generator.
- A generator sized to meet the power requirements of the IPH.
- Controls, monitoring and alarms for the power supply system.

The estimated steady-state power requirements of the IPH are:

	Power (kW)
Intake Pump	15.0
Building Heat	0.5
Heat Trace	1.0
Lighting	1.0
Chemical Feed Pumps	0.1
TOTAL	18 kW

This results in a minimal generation requirement of 18 kW. Start-up power for the truckfill pump is not included, but will be approximately 2 kW more for total of 20 kW. The on-site generator is assumed to run continuously for the 20-Year design horizon. Estimated daily power requirements are 72 kW/h in winter. The capital and life cycle costs of these options are as follow:

Table 4.1
Prime Power Cost Assessment

Prime Power System	Capital Cost	Operation Cost	Annual Maintenance Cost	Life Cycle Cost		
				4%	8%	12%
Power Line	360,000	5,400	0	433,000	412,000	400,000
On-site Generator	250,000	50,000	12,000	1,093,000	858,000	709,000

Power supplied by overhead line would cost significantly less than if a generator were to be used.

Standby Power

The in-town water storage provides for 8hours of emergency storage. The water tempering system provides for freeze protection of the pipeline (see section 4.2.3). Therefore standby electrical power is not required. Should prime power be interrupted for greater than 8 hours in severer weather, there is a risk that the IPH will freeze. The system is designed to recover from freezing with minimal damage. Further, the Water Lake will provide emergency water supply for several weeks if required.

Freeze Protection

To protect the water supply system from failure due to freezing, two freeze protection systems are required:

1. IPH building heating.

2. Intake casing freeze protection.

IPH Building

Heating load calculations for the truckfill building are based upon a pre manufactured building with vapour barrier, air barrier, and sheathing. The climatic factors of 10751 degree days below 18C and -41C design temperature. Based on these factors, a 4m x 4m x 3m high truckfill building will require 3.2 kW of heat for peak load and an annual requirement of 9,400 kWh. The costs of electricity and diesel fuel for the GN in the communities are approximately $0.70/kWh. The table below shows the estimated costs of heating systems using electric heat or a diesel furnace. For comparison, a heating value of 10 kWh/l was used for diesel.

Table 4.2
IPH Building Heat Assessment

Freeze Protection System	Capital Cost	Annual Power/Fuel Cost	Annual Maintenance Cost	Life Cycle Cost		
				4%	8%	12%
Diesel Furnace or Unit Heater	3,000	300	5,000	75,000	55,000	43,000
Electric Unit Heater	1,500	3,100	0	43,600	31,900	24,700

The life cycle cost for electric heat is lower than for a diesel furnace. Also, electric heating is much more convenient and the maintenance is minimal. Additionally, electric heating will not require fuel to be stored at the IPH building, greatly reducing the risk of fire, and environmental contamination. We recommend the use of an electric unit heater.

Note: In the event that there becomes a requirement for a boiler to be placed at the IPH for tempering the water supply, then this assessment needs to be re-examined

Intake Casing and Intake Pipe

The intake casing and intake pipe must be protected from freezing. This will be accomplished by electric heat trace cable installed adjacent to the outside of the intake pipe. The cable will be 15 W/m self-limiting, such that it will not damage the HDPE pipe. Two lengths of cable will be installed. The second cable will provide backup in case of failure of the first cable. Automatic controls will be used. The cable will be removable.

Truckfill Arm

A method must be used to protect the truckfill pipe from freezing and to recover the pipe if it freezes. Various methods have been used in past designs, including insulation and heat trace cable. A key to successfully avoiding freezing of the truckfill pipe is to ensure that it drains quickly and completely after use. The truckfill pipe will be installed with a 4% or greater slope back into the IPH. The pipe will be bare steel and not insulated or heat traced. Freezing of the pipe is unlikely, due to the draining system. In the unlikely event that the pipe freezes, a propane tiger torch can be used to thaw the pipe.

Monitoring and Alarms

The IPH building will have the following monitoring and control system. The system will have two (2) levels of alarms: major and minor. Minor alarms will cause a green alarm light to activate, and a horn to sound at the WTP. Major alarms will activate a red alarm light and sound a horn. The alarms for this system are set as follows:

Major High building temperature alarm
Power Off

Minor Truckfill pump failure
Building temperature low

Building Construction

Two types of buildings are available for this facility, namely:

- Wood frame, on-site construction.
- Pre engineered, pre fabricated construction.

The wood frame building would be constructed to the standard for pump houses used by the Government of the Nunuavut Standard as follows:

- Wall construction consisting of 38 mm x 150 mm with 150 mm of fibreglass batt insulation.
- Walls with vapour barrier on the inside and air barrier on the outside of the wall studs.
- Walls with plywood sheathing on the outside face and 50 m of rigid foam insulation.
- The interior of the walls sheathed with dry wall, plywood, and clad with metal siding. (The interior plywood is for convenient equipment installation.)
- Roofing provided by a pre-manufactured truss, or rafter system.

The pre-manufactured building would be constructed to provide the equivalent insulation value as the wood frame building. Several companies produce these structures (Bally, Cold Stream, Brytex, Butler), and each have a slightly different building design. Typically these buildings have an insulation value of RSI 5.6.

The use of on-site construction will typically add $40,000 to $50,000 to the total facility cost. The increase in cost is a result of the required accommodations, flights and additional man hours on-site for down time. Local involvement created by on-site construction will be approximately 10 man days, or the equivalent of $2,000 in wages the economic benefit to the community is not justified and off-site construction is recommended.

On previous projects, the GN has had success with pre manufactured buildings (Cold Stream). This building type will be used in the final design. The type of building is well suited for the use of a skid-mounted foundation. This foundation has proven to be very economical for truckfill stations in Nuvavut.

Building Layout

A summary of the requirements for the special allowance for the building is shown below:

Intake piping
Off take piping to the water supply pipeline
Truckfill discharge piping, including allowance for intake pump removal.
Chlorination system with chlorine pump and injection point.
Control panels, electrical panels.
Truckfill control (from truckfill arm).
Storage of chemicals and spare parts.

Figure 2 shows the building schematic for the IPH. **Figure 3** shows the floor plan concept for the IPH.

4.2.1 Transmission Main

4.2.1 General Configuration

The transmission pipeline starts at the wall of the IPH and terminates at the wall of the WTP. The in will have the following components;

Access Vaults

These will provide access to the main and allow for the use of a steamer to thaw the main in the event of a freeze up. Figure 7 shows the schematics of the access vaults and the midpoint heater station (to be described in a later section)

Drains

Low points on the line will require drains. There will be a total of three (3) gravity drains and two (2) pumps.
Pumps will be used in areas where the land is wet and will not allow for natural drainage.

Air Vents

High points along the transmission line require vents to allow air to escape. There will be a total of five (5) vents along the line.

4.2.2 Site Investigation and Alignment

Dillon Consulting mobilized to Gjoa Haven, NU from August 13 to August 20 of 2002, to undertake the site investigation and site survey components of the work. While on site, the tasks addressed were:

- Set control points for alignment of water transmission main for the survey work on the project.
- Determine an alignment for the water transmission line and do preliminary elevation/distance profile surveys.
- Perform bathymetric survey of Swan Lake for new water intake line.
- Perform bathymetric survey of existing water reservoir for a new intake location.

- Site topographic surveys for water treatment plant location.
- Site topographic surveys for truckfill location.

There were a number of survey control pins, established by GN, around the Hamlet and also in the area of the new transmission line. GN (GNWT) markers #5039343, #5039330 and #5039320 were used for primary control. The co-ordinates of the pins were obtained from Natural Resources Canada. Using these markers, the survey can be tied into existing surveys and mappings of the surrounding areas. Other GN/GNWT markers were also used for a system of checks. The checks confirmed the accuracy of the survey was suitable for the location, topographic and bathymetric work. All surveys were done with a total station with a labourer as the rodman.

Alignment

The transmission line alignment was determined by surface profile and avoided any possible obstacles (i.e. hills, wet spots). Refer to **Appendix A, Figures 4 to 6** view the plan view of the pipeline alignment. The line follows a path that is generally flat running northwest and avoids any sharp changes in elevations. The control points are marked with 150-mm spikes hammered into the earth and marked with a tag to identify the point. Wooden survey stakes were also placed near the control points and along various vantagepoints along the alignment. The total length of the transmission line is approximately 3.3 km long running northwest from the hamlet.

Facility Locations

A grid profile was performed to determine elevations and locations for the water treatment plant. The bathymetric survey consisted of drifting over certain areas of the water and recording depths. A boat and motor was used for this along with a computer, GPS and depth sounding equipment. The 'deep spots' on the existing reservoir were located and marked using this equipment. An area around where the water intake line will be placed at Swan Lake was also measured. Five transects at 50m intervals were taken. These ran from shore straight out and past the drop off point. At Swan Lake, there is a gradual slope running from the shoreline out to about 50-60m, then there is a drop off that is sloped at about a 1H to 1V slope. Points after this drop off were recorded up to about 5.5m – 6.0m deep.

Other notable landmarks in the area are small cabins located around Swan Lake, summer pipeline, road, airport, radar station, reservoir, pumphouse and truckfill station.

General Terrain

The granular make up of the area is generally a mixture of sand and gravel covered with moss and lichen. No apparent bedrock outcroppings were present along the path. Rocks and boulders were avoided in the alignment. A noteworthy elevation change, that was avoided, was the hill where the Short-Range Radar Station is located. The line around this hill was determined by doubling the height of the hill and aligning it that far out from the base of the slope. Refer to Appendix C for pictures and Appendix D for air photos showing the terrain and general landscape of the area.

Site Survey and Land Profiles

Refer to **Figures 4 to 6** to see plan view of survey location as well as land profiles along the transmission line. The profile is preliminary only. There are a number of design issues to be resolved related to the development of on-line heat exchange, intermediate heating station, vault design, and other components listed in the previous sections. The alignment and profile will be adjusted slightly during the detailed design process. The plans and profile should be considered within a 60-m corridor for the final pipeline alignment.

4.2.3 Pipe Size and Heat Loss

Storage Requirements

Using the water demands calculated in **Section 2.0**, the required flow rates to meet the demand can calculated. The flow rate is related to the size of the storage capacity. The storage is comprised of several components, which are described in the following sections.

Balancing Storage

The system operation will require the raw water supply to meet the peak day demand. To optimize the pumping system, the pumps would operate for 24 hours a day, and meet the water demands over that period. In practice, using a 20-hour pumping cycle is more the norm because this allows for some redundant capacity in the system. It is assumed that in the future years, the truckfill operation will occur 6 days a week, and will operate for 10 hours per day. The difference between the supply to the WTP and the delivery of the water over the 10-hour delivery period on a peak day, is the required balancing storage.

Fire Storage

In addition to the balancing storage, there is a requirement of the Nunavut Fire Marshal to provide water storage of 170,000 litres in Gjoa Haven (ref. FSC & TOR).

Dead Storage

In any tankage system, there is a portion of the tank that is not available for use. This is normally the bottom of the tank, located below the obvert of the tank outlet pipe. A value of 10% is used for this storage volume.

Emergency Storage

In the TOR, a value of 8 hours of discontinued service from the supply line was used as an estimate of the emergency storage. This value is carried forward in this assessment.The following table shows a summary of the above values.

Table 4.2
Summary of Required Storage volumes

Case	Equilization Storage	Fire Storage	Emergency Storage	Dead Storage	Total Storage
Existing	102,400	170,000	43,300	15,800	331,000
2024	163,000	170,000	54,200	18,800	406,000

Pipe Size

The required pumping rate is then developed to meet the peak day demand in a 20 hour pumping cycle for the year 2024. This rate is 203 l/min. Using this value, and maintaining the velocity in the pipe at an acceptable rate, the required pipe size is a 100mm pipe. Full calculations are included in Appendix B.

Heat Loss

The heat loss from the transmission main is calculated for several scenarios. These include the operation during start-up (year 2004) , for operation in the design year (2024), and under the no flow condition. In addition to the heat loss calculations is the expected time for the line to freeze in a no flow situation. For comparison purposes, the heat loss value is calculated for a pipe with 50 mm insulation, and for 75 m of insulation. Full calculations are shown in the Appendix B, and summaries are included below.

Table 4.3
Static Heat Loss
(In Watts)

	1.0m bury with 50 mm of insulation	**1.0m bury with 75 mm of insulation**	**0.0m bury with 50 mm of insulation**
Rate of Heat loss for pipeline (Watts)	8,500	6,400	32,400

Table 4.4
Temperature Loss
(In degree Celsius)

	1.0m bury with 50 mm of insulation	**1.0m bury with 75 mm of insulation**	**0.0m bury with 50 mm of insulation**
Temperature loss in the transmission main in Year 2014	0.67	0.55	2.17
Temperature loss in the transmission main in Year 2014	0.34	0.26	1.28

Table 4.5
Time to Main Freeze Up
(in Hours)

	1.0m bury with 50 mm of insulation	1.0m bury with 75 mm of insulation	0.0m bury with 50 mm of insulation
Time to complete transmission main freeze up Year 2014	224	285	55
Time to complete transmission main freeze up Year 2014	224	285	55

As can be seen from the tables above, there is little additional benefit to increasing the insulation from 50mm to 75 mm. The heat loss and the time to main freeze up do not change in any appreciable amount. It is therefore recommended to use the 50 mm insulation value indicated in the project description.

The use of an above grade pipeline was discussed while in the community. The above tables show two critical issues in the selection of an above grade pipe. Firstly, the heating requirements for the pipeline increase by nearly four fold; and secondly, the time for the main to freeze completely is decreased by nearly four fold. In the first instance, it results in operational costs that are significantly higher. Approximately an additional 12,000 kW of energy would be required on an annual basis to heat an above grade line over that of a buried line. In the second instance, the buried line would require a significant increase in response time in the event of power loss, or other failures. For these reasons it is recommended that a buried line be implemented.

4.2.4 Freeze Protection

The TOR indicates that hot water injection is to be used to provide freeze protection to the transmission main. An alternative to the use of hot water injection is to use electrical heat trace along the length of the pipe line. The use of electrical heat trace for freeze protection of transmission mains has not been found to be acceptable in other locations (Rankin Inlet, Resolute Bay, Iqaluit, Yellowknife), for the following reasons:

- High cost of electricity. Only 10% of the heat value of diesel fuel is transferred to the water using electrical heat trace, as opposed to nearly 50% when boilers and heat exchangers are used.
- High failure rates of heat trace cables. This is further complicated by the difficulty in monitoring the cables for failure.
- Lack of proportional control. An electrical heat trace is either "on" or "off".
- Difficulty in replacement in freezing month. Heat trace cables can not be readily replaced at temperatures less than -10°C.

It is recommended that hot water injection be used as the primary freeze protection method.

There are several methods used to provide water temporing with hot water injection. These are described below.

- Discrete injection points. This method uses one (1) pipeline, that being the main transmission line. Water is drawn from the main, heated through a heat exchanger, and injected back into the main. This is used in Resolute Bay.
- External water tempering line. This system used 2 pipelines; namely the main supply line and a smaller one that carries tempered water. The tempered water is injected into the main supply line at access vaults. This is used in Rankin Inlet.
- Internal water temping line. This system is similar to the above, however the smaller line is within the main supply line. Heat transfer is continual through the pipe length. The heated water is returned to the main line at the end of the pipe. This method was used in Cambridge Bay.

In either of the latter 2 options, the tempered water can run co-current or counter current to the supply line flow. The following table illustrates the advantages and disadvantages of each approach.

	Discrete Injection	**External Water Line**	**Internal Water Line**
Boilers and heat exchangers can be part of other heating systems (tankage, building, etc.)	No	Yes	Yes
Provides for second line in event of primary line freezes up.	No	Yes	No
Maximizes heat transfer	Yes	No	Yes
Meets TOR	Yes	Yes	Yes
Successfully operated in Nunavut	Yes	Yes	Yes
Capital Cost	300, 000	450, 000	300, 000
Annual Cost	80, 000	40, 000	40, 000
Life Cycle Cost at 20 years at 8% discount rate	$1, 085, 000	$842, 000	$695, 000

4.3 Water Treatment Plant

4.3.1 System Components

The water treatment plant will have the following systems;

- Building Foundation
- Raw water treatment – filtration and chlorinating
- Water tempering
- Domestic water supply
- Truckfill controls and metering
- Conveyance Pipes
- Power Supply
- Building heating and ventilating
- Intake to water Lake and intake pipe freeze protection

- Monitoring and Alarms
- Building Construction
- Building Layout
- Spares and Ancillary Components

4.3.2 Building Foundation

A desktop review of the foundation conditions in Gjoa Haven indicate that there aren't typically concerns with frost susceptible materials. The surficial geology in the Gjoa Haven area is that of well-graded granular materials. For this type of ground conditions an insulated slab on grade with a spread footing at wall and post supports is applicable. This type of foundation is the most favored for the construction of a WTP. Typically the plant components require structural support. House keeping pads, with increased re-bar will be placed under all major equipment.

Once the facility siting and size has been finalized, a site specific geo-technical study will be completed at the site. The use of a concrete slab on grade foundation is carried forth in this report.

4.3.3 Raw Water Treatment

Disinfection

The GCDWQ requires that the disinfection process for raw water also have a residual disinfection component. This is achieved through the use of chlorination. A typical residual chlorination level is 1 part per million (ppm). Many communities in the north people find the taste of chlorine unpleasant, and residual levels are often set at 0.5 ppm. Several chemicals are available for disinfection of domestic water supplies. These include:

- Gaseous Chlorine
- Sodium hypochlorite (liquid)
- Calcium hypochlorite (solid)

Gaseous chlorine requires storage in a separate room that is monitored for chlorine gas emissions. Safety equipment and training is necessary to comply with the Occupational Health and Safety Regulations when chlorine gas is used. The transport of gaseous chlorine is regulated by the Transportation of Dangerous Goods (TDG) and it cannot be transported by passenger airplane. For these reasons, the use of gaseous chlorine is not recommended.
Sodium hypochlorite is shipped and stored as a liquid. The liquid is subject to freezing, and is to be stored in a heated room (above -10 C). Sodium hypochlorite used in water treatment is similar to house hold bleach. It is available at 12% available chlorine, whereas bleach is 6% available chlorine. Sodium hypochlorite loses its concentration with time. After 90 days the level of available chlorine drops slowly and may reach a level similar to bleach after 6 months. If the 12% available sodium hypochlorite is diluted to 2% available, the shelf life is significantly extended. The operation of the disinfection system using sodium hypochlorite is relatively simple. The liquid is used directly without mixing. An injection pump is used to inject the liquid into the water as it flows through the truckfill arm.

Calcium hypochlorite is shipped and stored as a powder. There is no concern with freeze protection, and heated storage is not required. Calcium hypochlorite has 65% available chlorine by weight. The powder is mixed with water to make a solution that can be used in the disinfection process. Typically the solution is mixed at a concentration similar to that of sodium hypochlorite (12% available chlorine is typical). The disinfection system for calcium hypochlorite requires a mixing tank, a solution tank, an agitator, and an injection pump.

Both calcium and sodium hypochlorite are commonly used for disinfection in small facilities. The use of calcium hypochlorite is more common in the NWT. The issues to be addressed in the selection of a disinfectant are; the cost of the optional system; the relative ease of use; and the risk of failure.

Cost of System

Sodium hypochlorite, as a liquid, requires a greater volume of disinfectant to be shipped to site than calcium hypochlorite. Based on 12% available chlorine for sodium hypochlorite and 65% available for calcium hypochlorite the required shipping weight of disinfectant and volume to be shipped to site are as follow:

Disinfectant	Year 0 (2004)	Year 20 (2024)
Calcium Hypochlorite	29 kg	53 kg
Sodium Hypochlorite	160 L (160 kg)	290 L (391 kg)

The supply and transportation costs associated with each chemical are as follow:

Disinfectant	Supply (Year 0)	Transportation (Year 0)	Total (Year 20)
Calcium Hypochlorite	$250	$200	$400
Sodium Hypochlorite	$170	$800	$900

Filtration

Water quality data is limited to qualitative data which characterizes the water as being of high turbidity with 'blood worms' in the source. It is reported that the bloodworms in the source water can affect the raw water quality in open water and under ice conditions. This is primarily a result of non-viable organism debris becoming suspended in the water column and entering the intake. Additional water quality data, which may affect the final treatment process configuration, will be acquired for Swan Lake in November. This will include the following water quality data:

colour, turbidity,conductivity,pH
major ions including, Ca, Mg, Na, K, Fe, Mn, and HCO3, SO4, chloride, F, N, NO3
TSS, SS, (and dissolved solids)
Hardness
VSS
TOC

The water treatment processes required include:

turbidity reduction
possibly colour and odour removal

The treatment processes which can effectively remove turbidity and suspended solids, including organic debris, include filtration , or, coagulation and sedimentation followed by filtration. The coagulation and sedimentation processes are typically used if the solids loads, or concentrations, are relatively high. High solids loads, whether organic or a combination of organic and inorganic can result in higher filter backwash frequency and possible filter clogging. This can create higher maintenance costs and manpower requirements to maintain. For that reason if filters are used, a granular media filter would be selected, based on the organic debris that will be present in the raw water. The granular media may be a uniform sized silica sand only, or a multimedia filter, comprised of gradations of silica sand and other filter media such as garnet sand and granular activated carbon.

Cartridge filters with a fibre or paper media, or a wire mesh type screen are not recommended. The paper media type filters are typically disposable and are susceptible to slime build up and frequent clogging requiring manual replacement. Wire mesh filters are not effective in the removal of small sized particulates and decaying organic matter. Pressure sand filters can be open gravity type or pressure type. Either type could be used in this application. The advantage of the pressure type filter is that they are enclosed, can be set up with automatic and manual backwash controls, and can be more readily packaged in a pre-manufactured unit. Pressure sand filters are recommended based on the water quality characterization data currently available, related to the water turbidity.

Pressure filters can also be operated with a feed of a coagulant just up stream of the filters to aid in the efficiency of the filter performance. This filter aid process does however shorten filter runs, that is the time elapsed between filter backwash cycles.
A process of coagulation, flocculation, sedimentation and final filtration (CFSF) would be considered if further testing of the water demonstrates a high level of suspended solids requiring removal. This can be accomplished through the use of packaged pre-manufactured water plants such as the WaterBoy by US Filter, and others.

If the raw water changes over time, or the community deems it to have unacceptable odour or treated water colour, a granular activated carbon process step can be provided. This process will reduce colour and odour producing organic matter in the water. If a CFSF process is used, a powdered activated carbon would be used and added in the coagulation step, to aid in dissolved organic matter adsorption. This would then be removed in the sedimentation and final filtration process.

The treated water would finally be treated with chlorine, as discussed earlier, and optionally fluoride may be added prior to delivery to the treated water storage tank. The chlorine is required for bacteria inhibition, to maintain a safe water supply. The fluoride is typically added where the natural concentrations in the water are below levels required to aid in good dental health.

The filter backwash wastewater and the wastewater streams from sedimentation or GAC column backwash will contain a very low concentration of solids. However because it will be a concentrated waste stream containing water treatment residues, it will be discharges to a holding facility. A summer decant pond may be used to allow the water treatment residues to settle, prior to discharging the decant water to surface ditches. A holding tank will be provided to collect the treatment wastewater streams, which will then be truck hauled to the existing sewage lagoon facility.

The sanitary waste water, if any, will be collected in a separate holding tank, to be truck hauled to the sewage lagoon.

The treatment process will be sized to permit production of the peak day water demand in a daily 20 hour production period. An allowance of 10% for plant use is provided. The plant design capacity will be able to supply finished water at a rate of 62.4 Usgpm .

4.3.4 Building Heat and Water Tempering

As indicated in Section 4.2.4., the primary freeze protection system for the transmission main will be by hot water injection. There is also a requirement to maintain the water temperature in the storage tanks above freezing. One set of boilers within the WTP can accomplish these two requirements and meet the heating requirements of the WTP.

Appendix E shows the heating requirement for the system. Based on these requirements a boiler with an output of 360, 000 BTU is selected. This is at the lower end of available units. The appendix indicates the heat transfer sizing and costing estimates received from suppliers.

4.3.5 Truckfill Control

The truckfill system must address the fact that there will be a positive head from the storage tanks. The system will operate as follows:

- Cycle is activated by the truck fill operator using a key lock and pressing the "start" button on the truck fill arm.
- Motor control valve #1 will open.
- Truckfill pump #1 or #2 will start.
- A flow switch activated by the water flow will energize the chlorine pump.
- Chlorine injection will occur on the truck fill arm.
- A flow sensor will record the flow volume through the plant totalyzer.
- The cycle will be stopped by the expiration of the timer or the truck fill operator by pressing the "stop" button.
- The truck fill pump will be de-energized.
- The motor control valve #1 will close.
- The motor control valve #2 will open and the truck fill arm will drain into a small tank activating level switch 2.
- Pump # 3 or # 4 will pump the water back to the main storage tank.
- Level switch 2 will de-energize the pump #3 or #4.

Note: All pumps are duplexed. Only one of each set will operate in any one cycle.

4.3.6 Conveyance Piping

The process piping will consist of the following:

- An intake screen, submersible pump on 100 mm HDPE DR17 piping, contained within a 300 mm HDPE DR17 casing. The casing will be insulated with 50 mm of polyurethane foam and will be heat traced. The intake piping will enter the pumphouse and terminate with a flange connection just inside the pumphouse wall.
- Galvanized 100 mm Schedule 40 steel piping with Victaulic system connections.
- Chlorine injection diffuser, located on the galvanized steel piping within the building for back-up purposes.
- Flow switch to activate the chlorine pump.
- Flow sensor for the truckfill control system.

4.3.7 Power Supply

Prime power can be obtained from either Nunavut Power Corporation's power plant.

Stand-by Power will be provided through the use of a diesel electric power plant located within the building, but is a separate room, in compliance with the NBC requirements.

4.3.8 Intake Casing and Intake Pipe

The intake casing and intake pipe must be protected from freezing. This will be accomplished by electric heat trace cable installed adjacent to the outside of the intake pipe. The cable will be 15 W/m self-limiting, such that it will not damage the HDPE pipe. Two lengths of cable will be installed. The second cable will provide backup in case of failure of the first cable. Automatic controls will be used. The cable will be removable.

4.3.9 Truckfill Arm

A method must be used to protect the truckfill pipe from freezing and to recover the pipe if it freezes. Various methods have been used in past designs, including insulation and heat trace cable. A key to successfully avoiding freezing of the truckfill pipe is to ensure that it drains quickly and completely after use. The truckfill pipe will be installed with a 4% or greater slope back into the IPH. The pipe will be bare steel and not insulated or heat traced. Freezing of the pipe is unlikely, due to the draining system. In the unlikely event that the pipe freezes, a propane tiger torch can be used to thaw the pipe.

4.3.10 Monitoring and Alarms

The WTP building will have the following monitoring and control system. The system will have two (2) levels of alarms: major and minor. Minor alarms will cause a green alarm light to activate, and a horn to sound at the WTP. Major alarms will activate a red alarm light and sound a horn. The alarms for this system are set as follows:

Major
High building temperature
Raw water low temperature
Intake pump failure
Low building temperature
Power Off – Stand-by generator failure
Low Water Level Storage Tank Stage 2
Low Storage tank temperature – Stage 2

Minor
Truckfill pump failure
Power off – Stand-by Power on
Low flow transmission line
Lost contact to IPH
Process plant failure
High Water Storage Tank
Low fuel level

4.3.11 Building Construction

The two types of building construction used in the North are pre-engineered and stick built. Pre-engineered buildings perform poorly for WTP facilities. WTP normally hang process water piping from the roof structures, which can be a concern in pre-engineered building. Secondly, WTP have high internal moisture contents due to the nature of the facility use. For a number of reasons, this results in poor performance in the pre-engineered buildings. It is recommended that a stick built approach be used.

Features of the facility construction will include:

- Minimum R-30 insulated walls.
- Minimum R-40 insulated ceilings.
- Exposed wiring.
- Plywood internal sheeting, covered by drywall, covered by wipable metal cladding.
- Painted concrete flooring.
- Minimum ceiling height of 3.0 meters.

4.3.12 System Schematics

The schematic drawing for the proposed WTP, as described below, is shown in Figure 8. The operation of the WTP and supply line is as follows:

- Level Switch (LS) 1 will indicate the first stage low water and call to energize the intake pump (IP 1/2).
- Energize pump 1 or 2 will pump water through the main supply line.
- FS (located at the IPH) will be used for monitoring the water flow volume and rate.
- Flow switch will activate chlorine pump #1 which will inject chlorine into the supply line up stream of the pressure filter plant.
- Water will be treated in the pressure filters. (See Figure 9 for filter schematics).
- Treated water will flow to the storage tanks. Diffusers will be used in the tanks to maintain circulation.
- LS1 will signal high water stage 1 and de-energize the IP 1and 2.

Temperature control of the tanks will operate as follows:

- Temperature Sensor (TS) 1 will indicate low water storage tank temperature stage 1
- P 5/6 will energize.
- Water will be pumped from the storage tank, heated through the heat exchanger and returned to the diffusers in the tank.
- Temperature Sensor 1 will indicate high water storage tank temperature Stage 1 and de-energize P 5/6.

Transmission Main temperature will be controlled as follows:

- P 7/8 will operate 24 hours per day to maintain constant water circulation in the mains.
- TS2 will monitor the water supply temperature and regulate the heat supply to the P 7/8 heat exchange

4.3.13 Spares and Ancillary Components

The following is a list of spares, replacement parts, and ancillary components that will be included.

Spare Components	Parts
Pumps (intake and process)	pump complete with power cable.
Calcium Hypochlorite Feed System	replacement part kits for chemical pump. 1 chlorine flow switch.1 chemical feed pump. Nylon tubing.
Eyewash	1 spare container of solution.
Lighting – exterior and interior	2 spare lamps each type.
Distribution Panel	2 breakers of each size and type.
Terminal Blocks	1 set of blocks for each size and type installed including end caps, end plates, cross connectors and tear-off markers.
Fuses	Unless noted elsewhere, 12 spares for each type required in facility.
Motor Starters	6 of each type of pilot light and over load heaters. 1 of each type of coil and contact.
Control Devices	1 of each type of push button pilot light and lens. 1 spare rotational water flow paddle wheel. 1 spare flow display/totalizer. 1 spare flow switch.
Alarm Panel	1 alarm annunciator.
6 of each Fuses or Mini-breaker	2 of each relay and timer. 1 of each relay and timer base.
Valves	1 spare of each type of valve.
Thermostats	1 spare of each type of thermostat.
Heat Trace	Spare controller Spare thermostat
Miscellaneous	supply of calcium hypochlorite, and testing chemicals.

Miscellaneous Equipment

1. Fire Extinguisher: Ansul A20E, Class ABC, UL listed, 9 kg capacity, external nitrogen cartridge Foray powder with wall mounting brackets. Mount on wall near exterior door.
2. Dust masks: Fisher 11-875-54 disposable masks supply three (3) packs of 50 masks each.
3. Face Shield: One (1) Fisher 11-409-5, optically clear 1.5 mm polycarbonate shield with adjustable headband.
4. Gloves: Twelve(12) Fisher 11-394-30, large, extra long, heavyweight rubber gloves, 19 mm by 380 mm length.

5. Apron: One (1) Fisher 01-357 double coated abrasion resistant, rubberized cloth apron.
6. Push Broom: One (1) Dustbane 403089, 600 mm wide, horse hair and synthetic bristle broom with handle.
7. Mop: One (1) Dustbane 481127, Syntex Flat size #20 with handle.
8. Mop Bucket and Wringer: One (1) Dustbane No. 2024X, 27 L, round, with Cam Squeezer Wringer.
9. Dust Pan: One (1) Dustbane No. 8 Hooded 300 mm.
10. Garbage Can: One (1) 100 L, galvanized, with cover.
11. Floor Cleaner: Dustbane No. 501379 Liquid cleaner, one (1) 20 L container.
12. Lighting: Two (2) fluorescent tubes and One (1) low temperature ballasts.
13. Storage Cabinet:
    Combination shelving/wardrobe unit.
    Two (2) doors.
    Four (4) half shelves.
    Pre-finished in grey.
    Standard of Acceptance: Par Equipment Ltd. Model No. 4273
17. Hand Winch: 1500 lbs. hand winch, 5,1:1 gear ratio.

4.4 Storage Tanks

The water storage tanks are:

- located at the WTP.
- Tank size is 2 tanks each with a capacity of 203, 000 liters.
- Tanks to have an inlet for incoming treated water and equalization pipe and valve between the tanks.
- Tanks to have an outlet for truckfill with pump & controls.
- Tanks to have an outlet to supply water for backwashing process.
- One tank to have an outlet with pump to supply water to the chlorine mixing area.
- Tanks to have an overflow that spill overflow water.

Of the potential tank construction methods, only steel tanks are suitable for this application. Concrete tanks would require a level of material supply quality control that is not available in Gjoa Haven.

Steel tanks are sized to optimize the height on 6 foot or 8 foot increments which is the supply width of steel plate. The most economical tank to operate is one that the height and diameter are equal. This relationship maximizes the storage capacity and minimum surface area, therefore minimizing the heat loss potential.

A tank size of 5.48m high (18 feet) with a diameter of 6.86m is selected.

A comparison of the Capital Costs to insulate and clad the tanks versus housing the tanks in a building is completed, see Appendix F. A summary is shown below.

Item	External	Internal
Foundation	$120,000	$220, 000
Tanks	$406, 000	$406, 000
Insulation	$150, 000	N/A
Cladding	$5000	N/A
Building	N/A	$150, 000
Total	**$730, 000**	**$775, 000**

An external tank system is recommended. This is used in Rankin Inlet, Resolute Bay, Norman Wells, and Cambridge Bay with success.

5.0 IMPLEMENTATION STRATEGY

Due to funding availability, the Client will construct the WTP in 2003/2004. The installation of the transmission main and of IPH will occur in subsequent years.

A temporary (short-term use) intake will be installed from the WTP to Water Lake for use until the transmission main and the IPH is constructed. This intake will be constructed on the same concept as the Swan Lake Intake.

To facilitate the transmission main construction, and to provide access to the IPH, the existing road to Swan Lake will be re-aligned and upgraded. This is included in the cost estimate.

A project schedule is as follows:

Gjoa Haven Water Works and Water Supply

Project Award .... June 21, 2002

Project Initiation and Project Management .... July 18, 2002

Site Visit .... July 29 to 31, 2002

Site Surveys and geo-technical Investigation .... August 1 to 15, 2002

Siting Report Submission .... September 5, 2002

Comments on Sting Submission .... October 4, 2002

Final Siting Drawing Submission .... October 9, 2002

Predesign Report Submission .... October 18, 2002

Review Meeting....................October 28, 2002

Final Design Brief....................November 1, 2002

Presentation of Final Design Brief to Community....................November 1, 2002

Class C Cost Estimate....................October 18, 2002

40% Design Submission....................December 15, 2002

Review Meeting....................January 6, 2003

95% Design Drawings and Specifications....................January 23, 2003

Review Meeting....................February 9, 2003

Tender Documents....................February 20, 2003

Construction....................June 2003 to March 2004

6.0 COST ESTIMATE

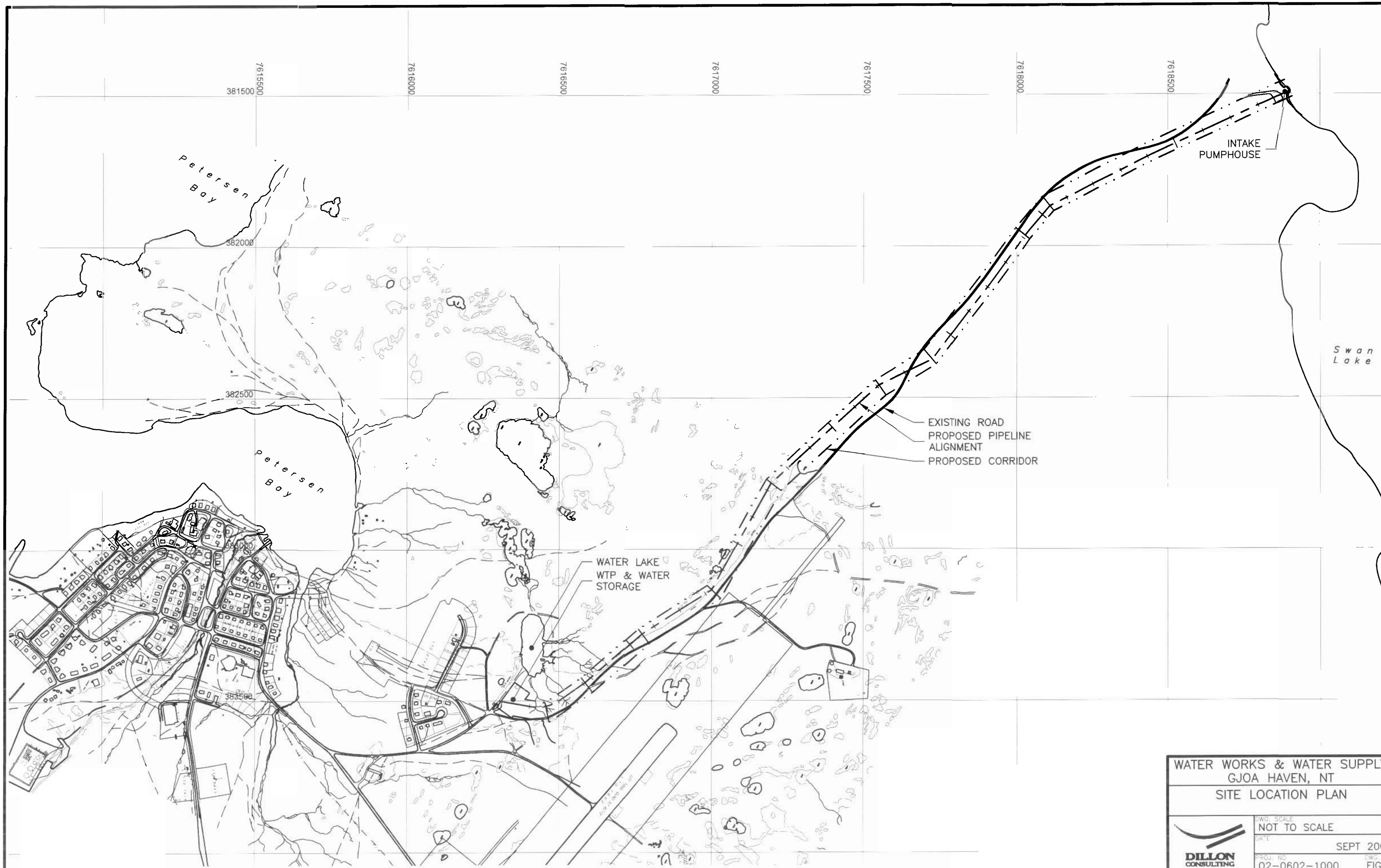
Appendix F includes the detailed estimates. This is summarized below.

Table 6.1

Item Description	Unit Cost	Units	Quantity	Extension
Swan Lake IPH	$ 300, 000	Each	1	$300, 000
100mm Insulated HDPE Pipe	$300	Linear Meter	3300	$990, 000
40mm Uninsulated HDPE Pipe	$100	Linear Meter	3300	$330, 000
Excavate and Backfill	$100	Linear Meter	3300	$330, 000
Access Vaults	$25, 000	Each	16	$400, 000
Drains	$5,000	Each	5	$25, 000
Air Release	$5,000	Each	5	$25, 000
Road Improvements	$150	Linear Meter	3300	$495, 000
WTP Building (150 m2)	2350/m2	Each	1	$353, 000
Process Unit and Controls	$600, 000	Each	1	$600, 000
Foundation	$2000	m3	30	$60, 000
Intake	$50, 000	Each	1	$50, 000
Heating System	$150, 000	Each	1	$150, 000
Water Storage Tanks	$1.80	litre	406, 000	$730, 000
Sub Total 30% Engineering Contigentcy				$4, 838, 000 $1, 450, 000
Total				$6, 288, 000

APPENDIX A

FIGURES



WATER WORKS & WATER SUPPLY
GJOA HAVEN, NT

SITE LOCATION PLAN

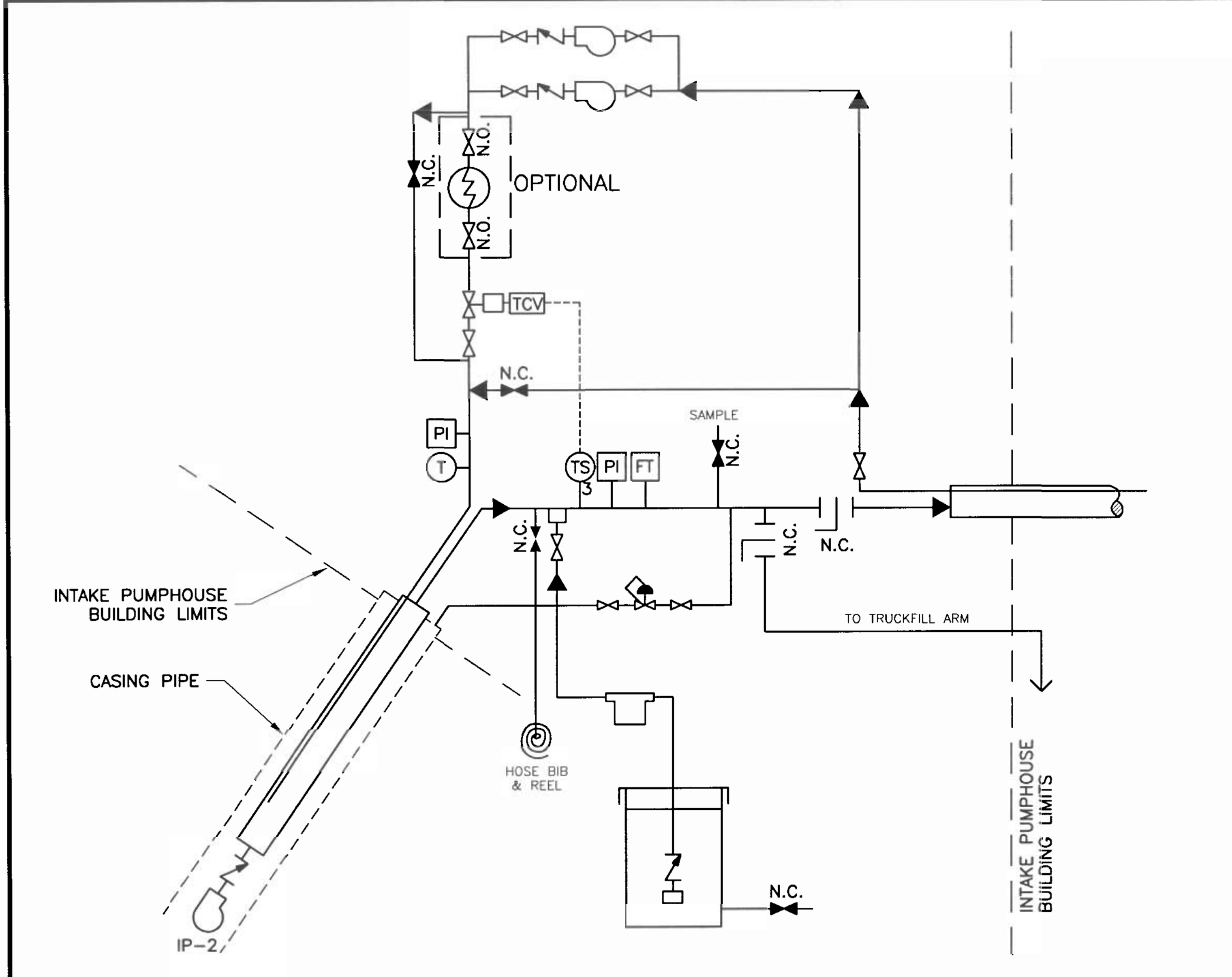
DILLON CONSULTING

DWG. SCALE: NOT TO SCALE

DATE: SEPT 2002

PROJ. NO: 02-0602-1000

DWG. NO: FIG 1



LEGEND:

- VALVE (GLOBE) NORMALLY OPEN
- VALVE (GLOBE) NORMALLY CLOSED
- SOLENOID VALVE
- CHECK VALVE
- VALVE (BUTTERFLY)
- MOTORIZED VALVE (NORMALLY OPEN)
- MOTORIZED VALVE (NORMALLY CLOSED)
- PRESSURE RELEASE VALVE
- N.O. NORMALLY OPEN
- N.C. NORMALLY CLOSED
- HEAT EXCHANGE
- LEVEL SWITCH
- FLOW TRANSMITTER
- TEMPERATURE SENSOR
- TCV TEMPERATURE CONTROL VALVE
- PRESSURE INDICATOR
- PUMP
- 100 PIPE SIZE
- REDUCER
- Y AND BLIND FLANGE
- FLOW DIRECTION

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DILLON CONSULTING

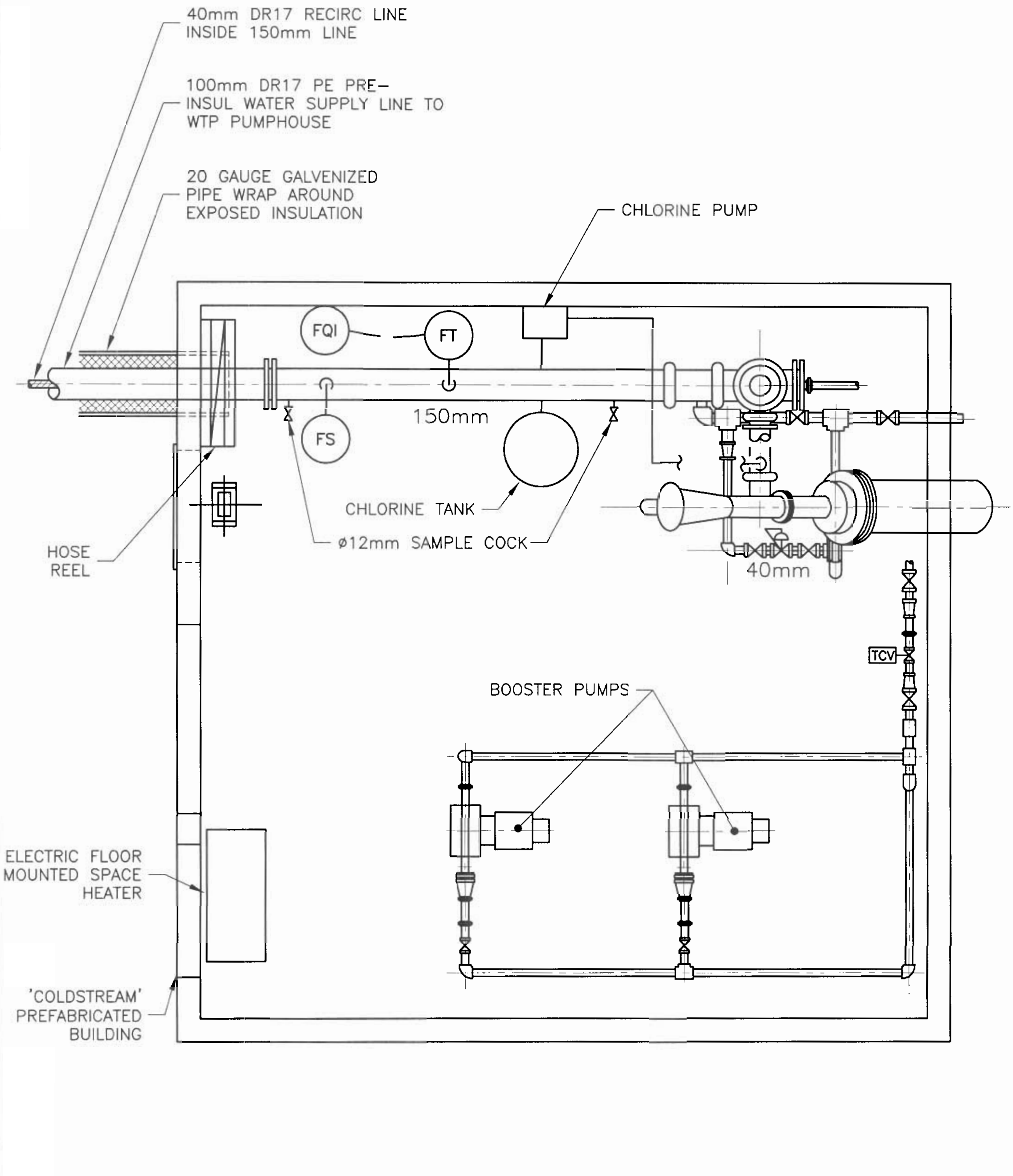
PROJECT: WATER WORKS & WATER SUPPLY GJOA HAVEN, NORTHWEST TERRITORIES

TITLE: PROCESS WATER FLOW SCHEMATIC INTAKE PUMPHOUSE

PROJECT NUMBER: 02-0602-1000

DATE: OCT 02

FIGURE NUMBER: FIG 2



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DILLON CONSULTING

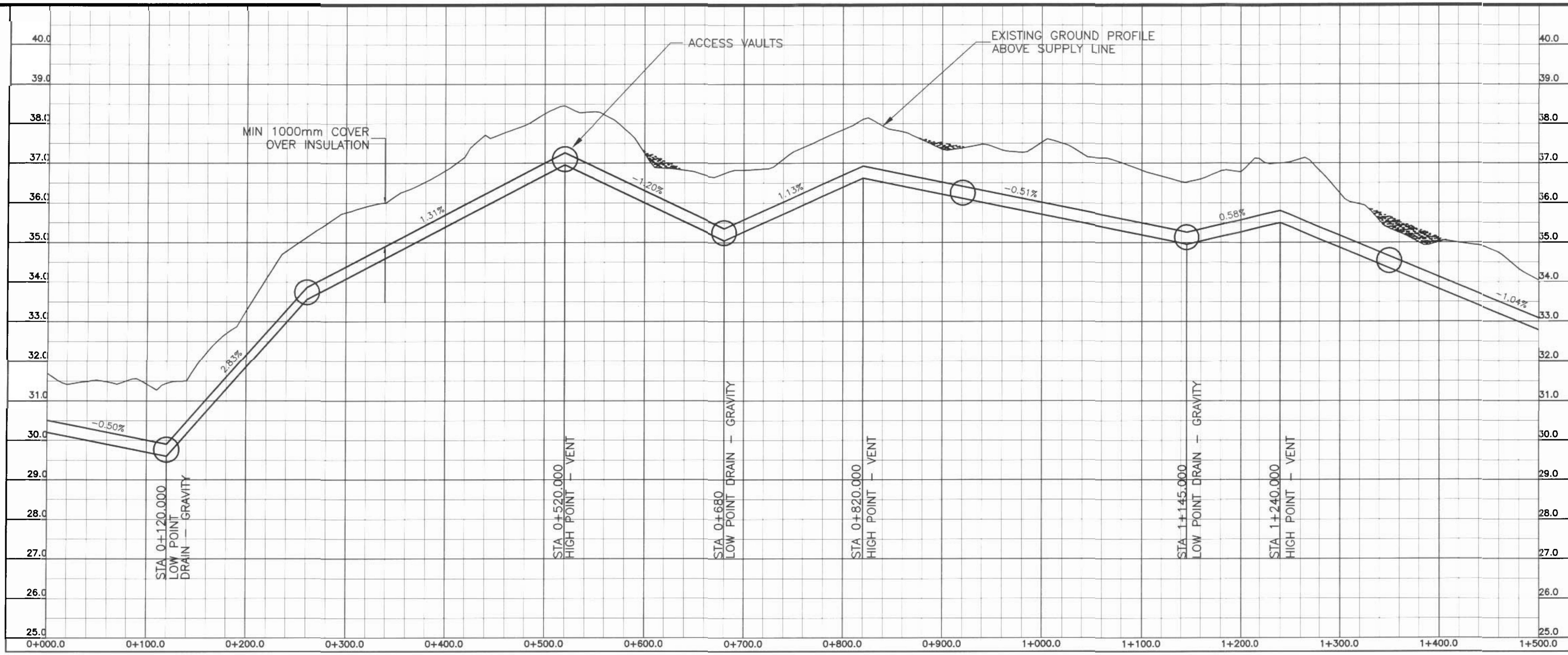
PROJECT
WATER WORKS & WATER SUPPLY
GJOA HAVEN, NORTHWEST TERRITORIES

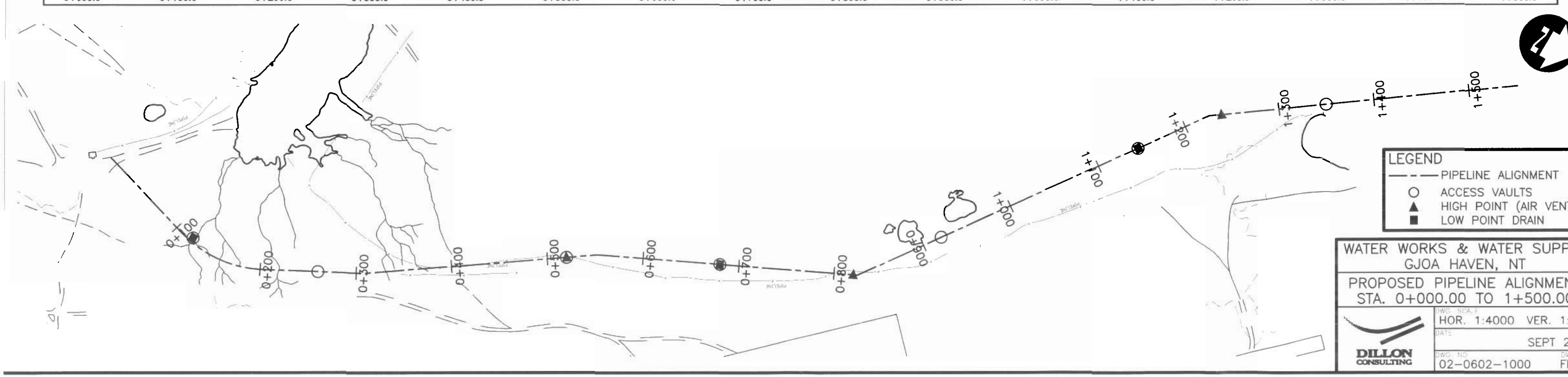
TITLE
EXISTING INTAKE
PUMPHOUSE PLAN

PROJECT NUMBER
02-0602-1000

DATE
OCT 02

FIGURE NUMBER
FIG 3





LEGEND

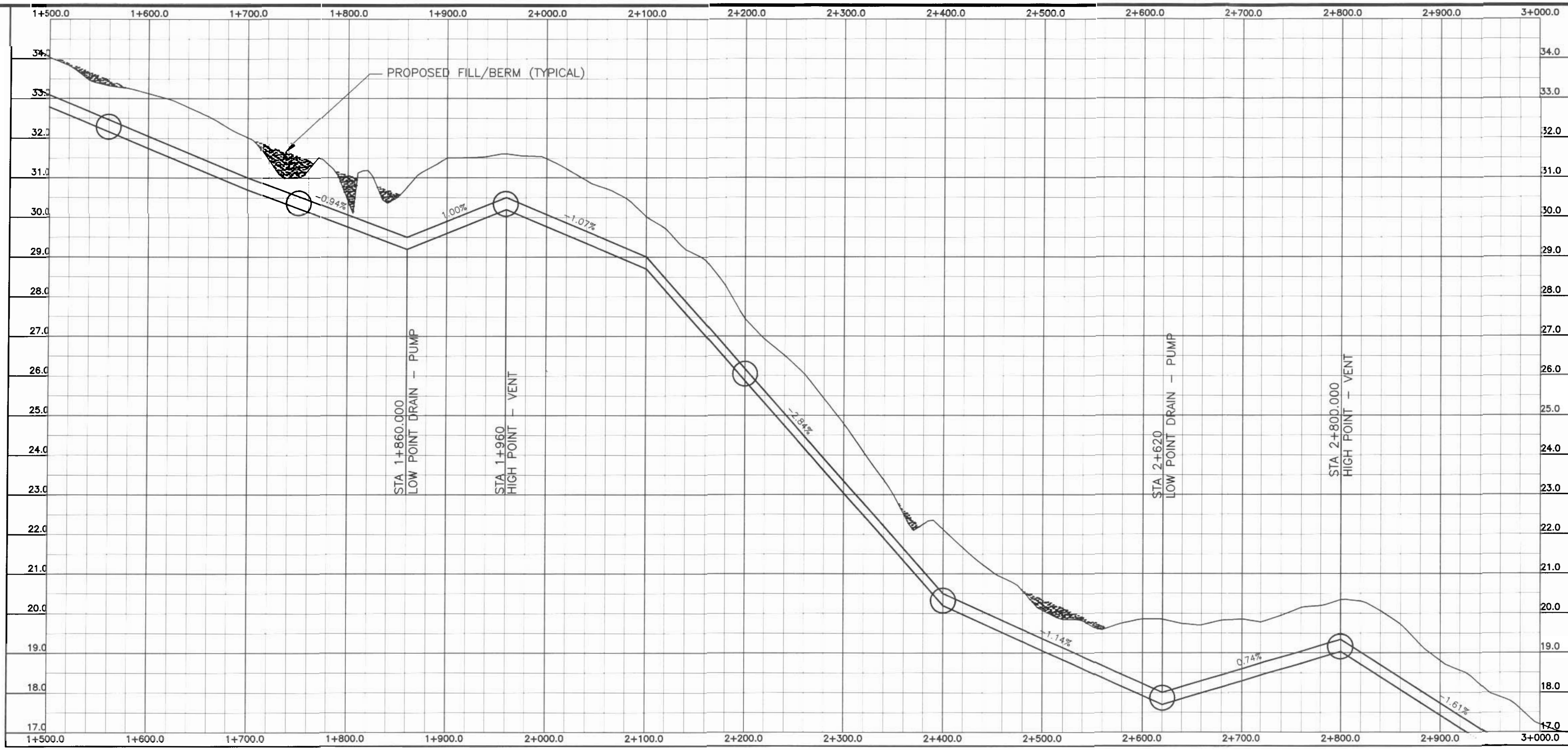
- PIPELINE ALIGNMENT
- ○ ACCESS VAULTS
- ▲ HIGH POINT (AIR VENTS)
- ■ LOW POINT DRAIN

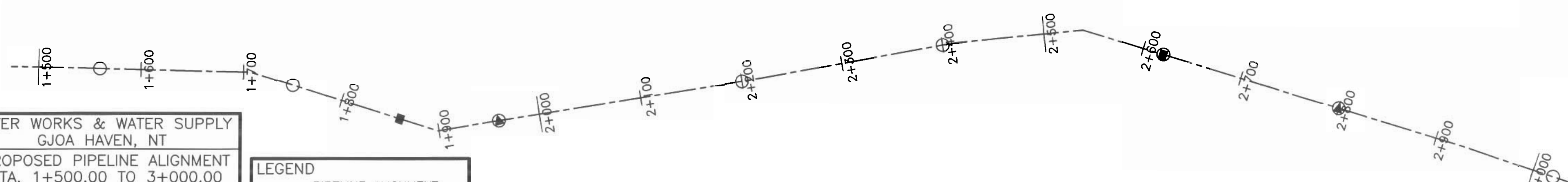
WATER WORKS & WATER SUPPLY
GJOA HAVEN, NT

PROPOSED PIPELINE ALIGNMENT
STA. 0+000.00 TO 1+500.00

DILLON CONSULTING

DWG. SCALE	HOR. 1:4000 VER. 1:100
DATE	SEPT 2002
DWG. NO. 02-0602-1000	DWG. NO. FIG 4





WATER WORKS & WATER SUPPLY
GJOA HAVEN, NT

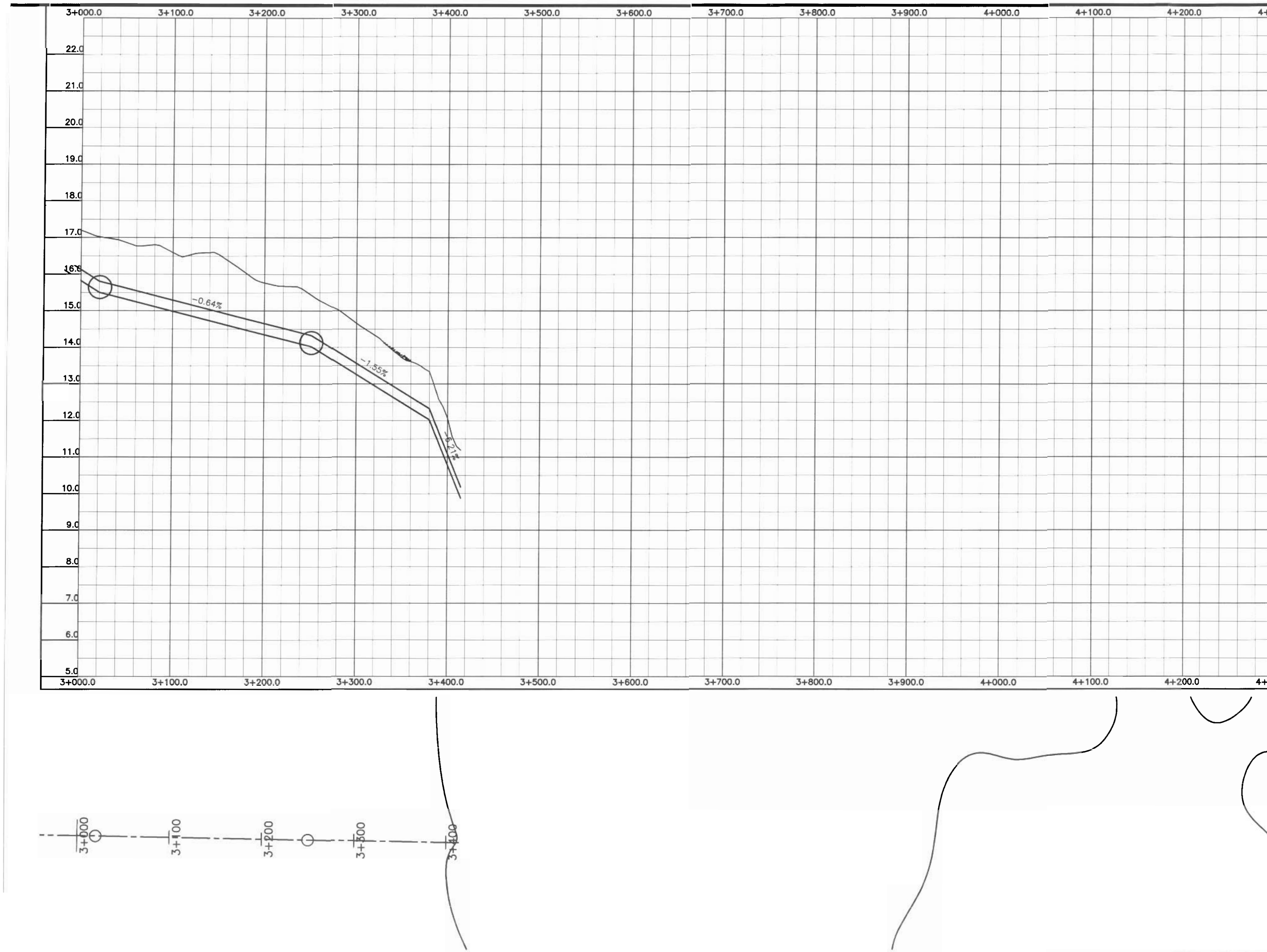
PROPOSED PIPELINE ALIGNMENT
STA. 1+500.00 TO 3+000.00

DILLON CONSULTING

DWG. SCALE HOR. 1:4000 VER. 1:100	
DATE SEPT 2002	
DWG. NO. 02-0602-1000	DWG. NO. FIG 5

LEGEND

- PIPELINE ALIGNMENT
- ○ ACCESS VAULTS
- ▲ HIGH POINT (AIR VENTS)
- ■ LOW POINT DRAIN



LEGEND

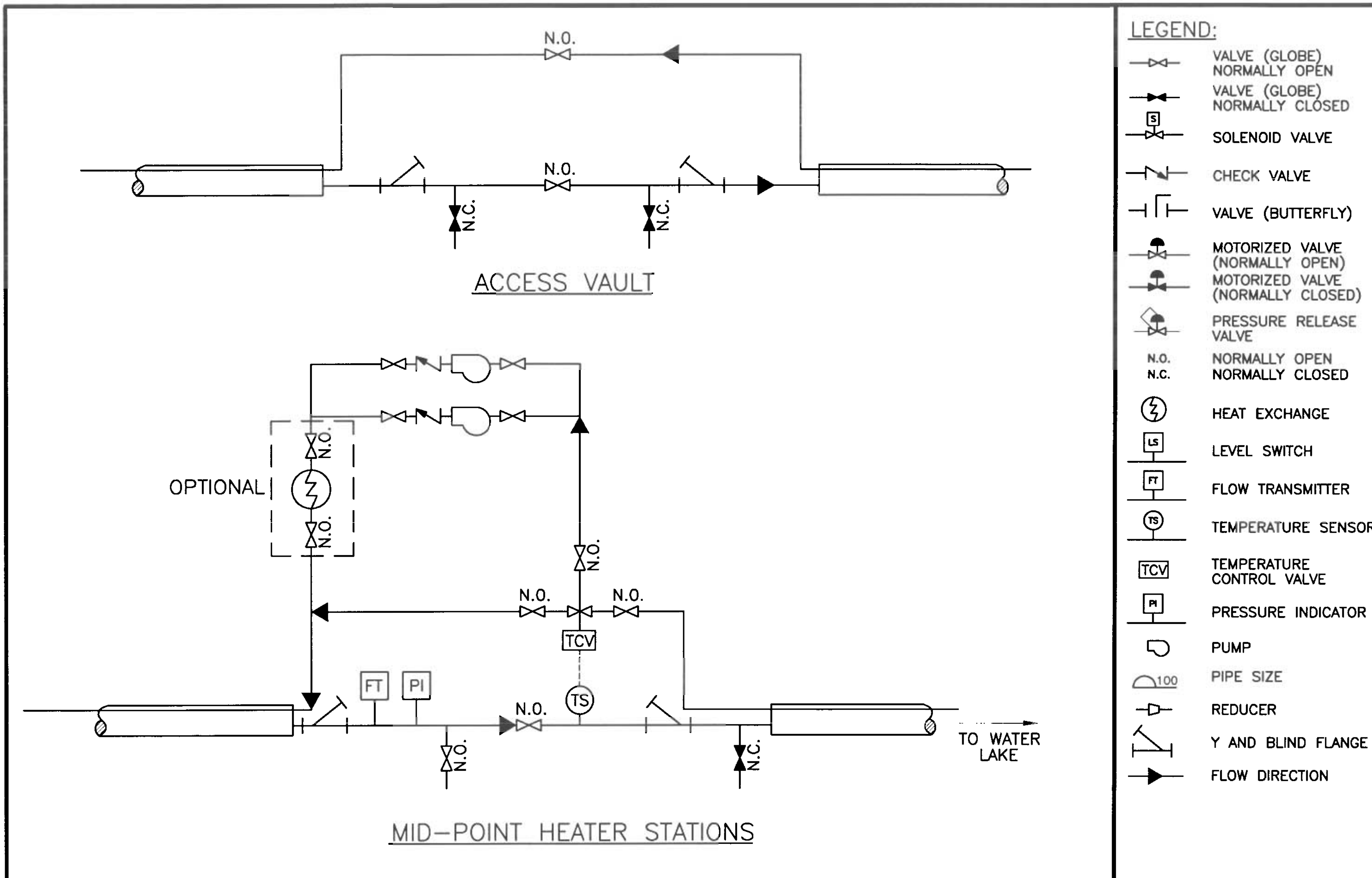
- PIPELINE ALIGNMENT
- ○ ACCESS VAULTS
- ▲ HIGH POINT (AIR VENTS)
- ■ LOW POINT DRAIN

WATER WORKS & WATER SUPPLY
GJOA HAVEN, NT

PROPOSED PIPELINE ALIGNMENT
STA. 3+000.00 TO 3+415.00

DILLON CONSULTING

DWG. SCALE	HOR. 1:4000 VER. 1:100
DATE	SEPT 2002
DWG. NO.	02-0602-1000
DWG. NO.	FIG 6



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DILLON CONSULTING

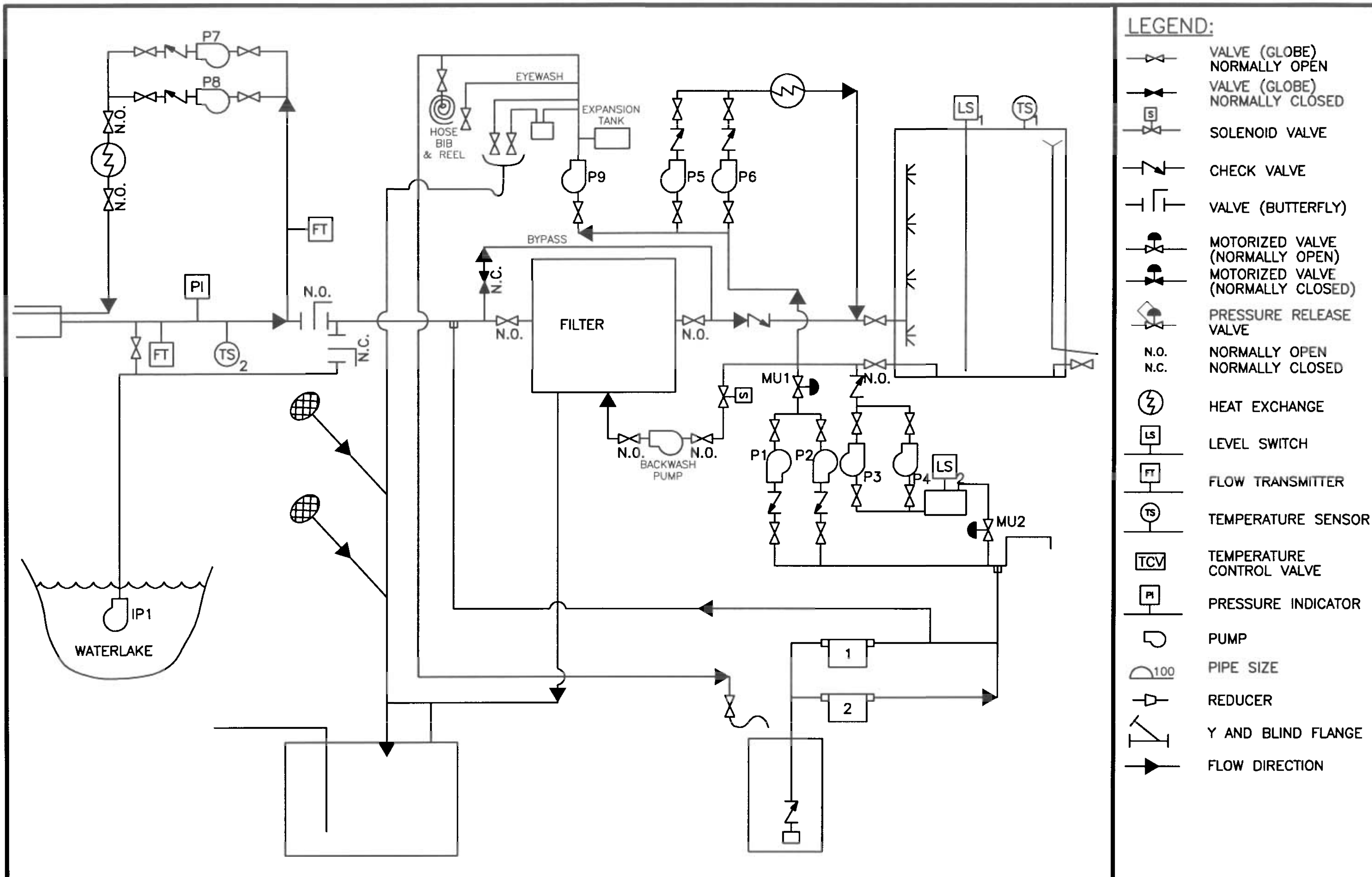
PROJECT: WATER WORKS & WATER SUPPLY
GJOA HAVEN, NORTHWEST TERRITORIES

TITLE: PROCESS WATER FLOW SCHEMATIC

PROJECT NUMBER: 02-0602-1000

DATE: OCT 02

FIGURE NUMBER: FIG 7



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DILLON CONSULTING

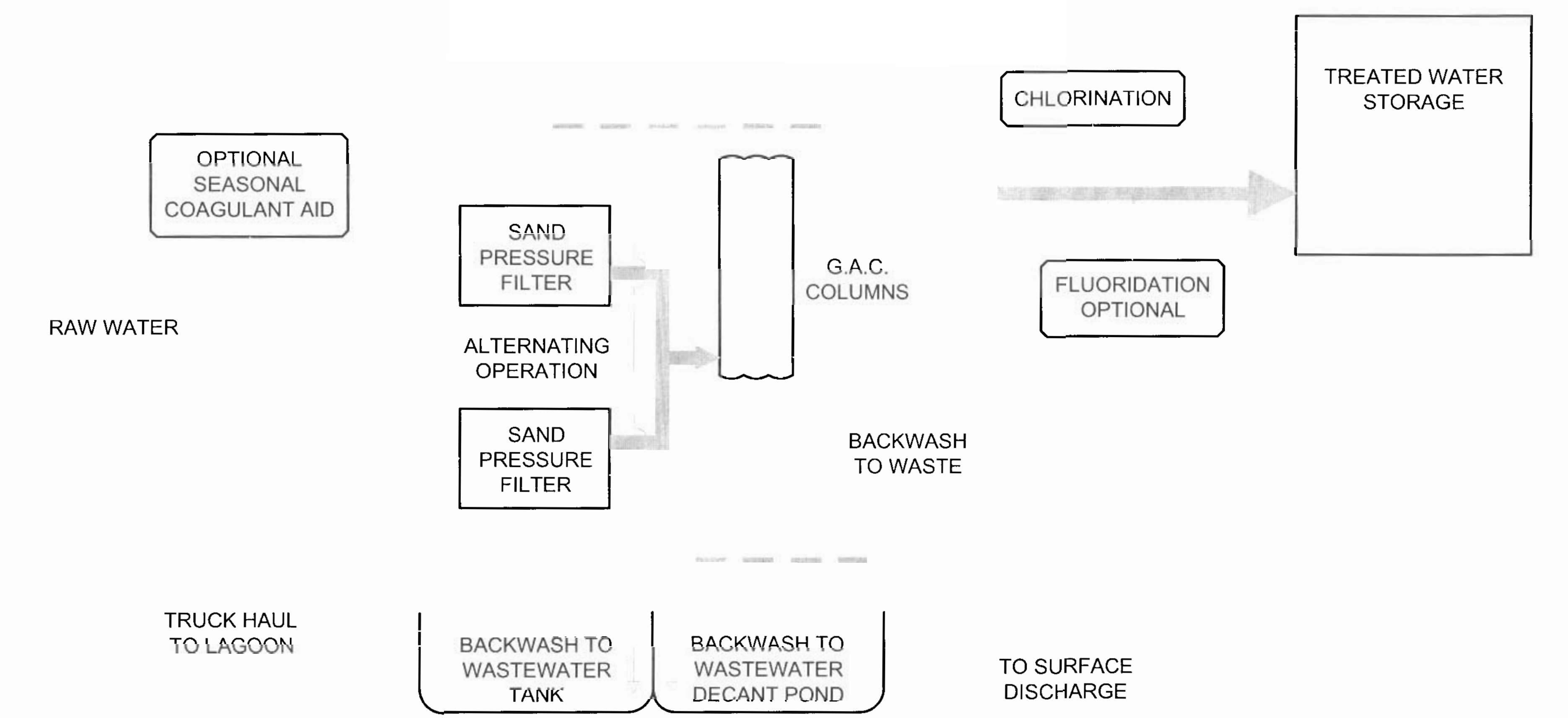
PROJECT
WATER WORKS & WATER SUPPLY
GJOA HAVEN, NORTHWEST TERRITORIES

TITLE
PROCESS WATER FLOW SCHEMATIC
WATER TREATMENT PLANT

PROJECT NUMBER
02-0602-1000

DATE
OCT 02

FIGURE NUMBER
FIG 8



EDIT DATE: 10/18/02 ACAD FILE: 41tpw g:\cad\020602\1000\gjoa-haven.dwg

DILLON CONSULTING

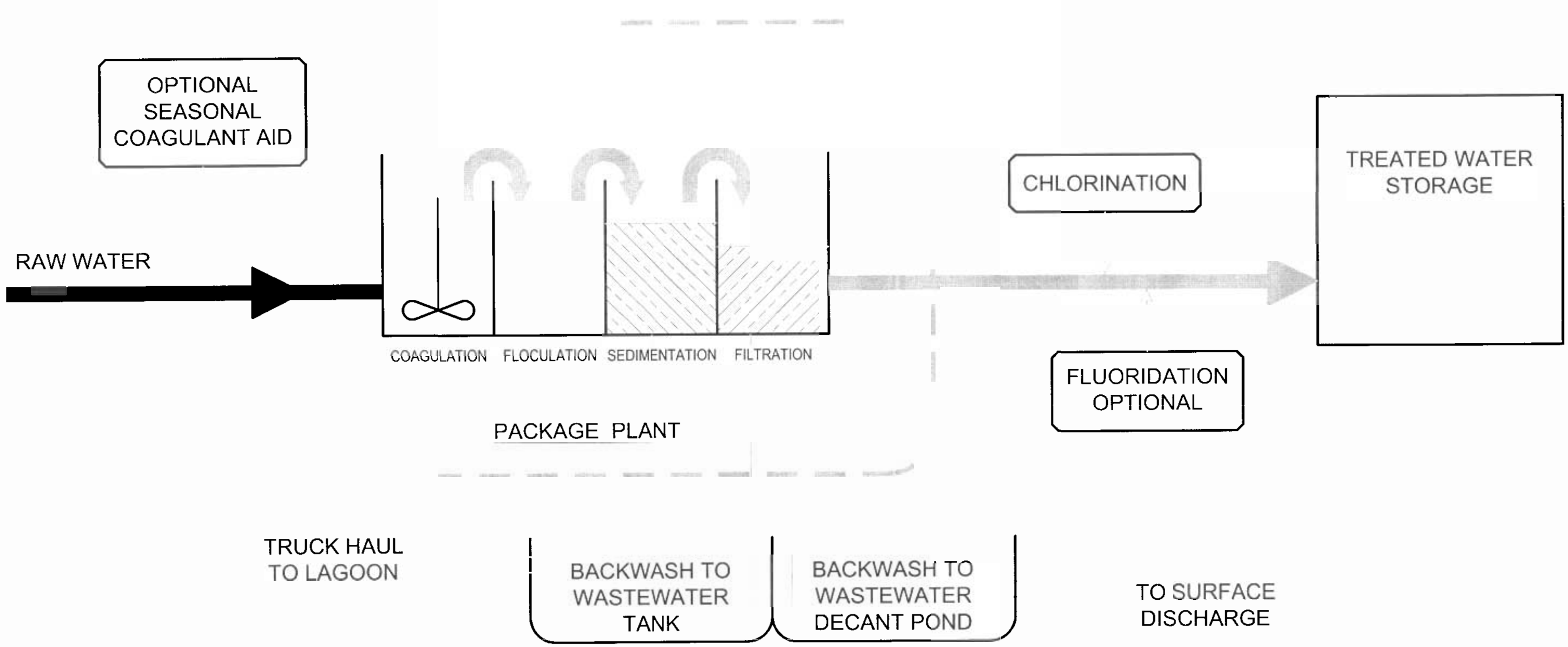
PROJECT
WATER WORKS & WATER SUPPLY
GJOA HAVEN, NORTHWEST TERRITORIES

TITLE
PROCESS SCHEMATIC
PRESSURE SAND FILTERS

PROJECT NUMBER 02-0602-1000

DATE OCT 02

FIGURE NUMBER FIG 9a



EDIT DATE: 10/18/02 ACAD FILE: 41tpw g:\cad\020602\1000\gjoa-haven.dwg

DILLON CONSULTING

PROJECT: WATER WORKS & WATER SUPPLY GJOA HAVEN, NORTHWEST TERRITORIES

TITLE: PROCESS SCHEMATIC COAGULATION / FILTRATION PACKAGE PLANT

PROJECT NUMBER: 02-0602-1000

DATE: OCT 02

FIGURE NUMBER: FIG 9b

APPENDIX B

PIPE CALCULATIONS

Water Demand Calcs

Assumptions:			
Convert L to usgal: X by	0.2642 gal/L		
Residential Water Demand per Capita:	90 lcpd		
	23.778 gcpd		used 108 usgcpd in Hfx for average day !!
Population projection Bureau Statistics	**2000**	**2010**	**2020**
	984	1173	1435
Population % yearly increase 2000 to 2010:	1.77%		
Population % yearly increase 2010 to 2020:	2.04%		

Litres

	2004	2014	2024
Population	1056	1272	1556
Water Demand per capita including additional for Industrial, commercial, institutional (lcpd):	112	116	122
Average Day Demand (lpd)	118,075	147,902	190,082
Additional Water for In-plant Use	10.0%	10.0%	10.0%
Total Average Day Demand (lpd)	**129,883**	**162,693**	**209,090**
Peak Day Factor	1.5	1.5	1.5
Peak Day Demand (lpd)	177,113	221,853	313,636
Total Peak Day Demand (lpd)	**177,113**	**221,853**	**313,636**

Gallons

	2004	2014	2024
Population	1056	1272	1556
Water Demand per capita including additional for Industrial, commercial, institutional (gcpd):	30	31	32
Average Day Demand (usgpd)	31,195	39,076	50,220
Additional Water for In-plant Use	10.0%	10.0%	10.0%
Total Average Day Demand (usgpd)	**34,315**	**42,983**	**55,242**
Peak Day Factor	1.5	1.5	1.5
Peak Day Demand (usgpd)	46,793	58,614	75,330
Total Peak Day Demand (usgpd)	**46,793**	**58,614**	**82,863**

Tank Requirements:

Case	Avg Day Demand (usgpd)	Equilization (1) US Gal	Fire Storage (2) US Gal	Emergency Storage (3) US Gal	Dead Storage (4) US Gal	Total Storage (US Gal)	Total Storage (Litres)
Existing Conditions	34,315	24,526	44,914	11,438	4,044	84,923	321,433
Future 2024 Conditions	42,983	40,000	44,914	14,328	4,962	**104,204**	**394,413**
FSC Report		*59,730*	*44,920*	*15,130*	*6,600*	*126,380*	*478,350*

1) Equilization Storage = storage needed for max day demand
2) Fire Storage = 170,000 L FSC directed by Fire Marshall

3) FSC used 8 hours of avg day demand so 1/3 of ADD however if the disruption is during the day then then the entire ADD should be used.
However under avg day conditions from 2004 to 2024, only a portion of equilization storage is used so additional for emergency.
4) Dead Storage is 5% of overall volume - FSC report

Flow from Truckfill:

Days Truckfill operates out of 7 days (W) **6 days /week**

Truckfill hours of operation avg day (X): **8 hrs/day**

** significantly alters the storage/pump requirement

Truckfill hours of operation Max day **9 hrs/day**

Flow from Truckfill AVERAGE DAY:	**2004**	**2014**	**2024**
Average Day Demand (gpd)	34,315	42,983	55,242
Truckfill operates W out of 7 days so daily demand is increased to:	40,034	50,147	64,449
Flow from tank to Truckfill over X hours (gpm):	**83.4**	**104.5**	**134.3**

Flow from Truckfill MAX DAY:	**2004**	**2014**	**2024**
Max Day Demand (gpd)	46,793	58,614	82,863
Truckfill operates W out of 7 days so daily demand is increased to:	54,592	68,383	96,673
Flow from tank to Truckfill over X hours (gpm):	**101.1**	**126.6**	**179.0**

Pipe Size:

Pipe Hydraulic Radius Calcs:

(Large watermain with 1.5" heated pipe inside)

Pipe size:	1.5" (38 mm)	**3" (75 mm)**	**4" (100 mm)**	**5" (125 mm)**	**6" (150 mm)**
Inside Diamter (m):		0.0675	0.092		0.133
Inside Radius (ft):	0.063	0.111	0.151	0.208	0.218
Area (ft2):	0.012	0.039	0.072	0.136	0.150
Perimeter (ft):	0.393	0.696	0.948	1.309	1.371
Flow Area subtracting 1.5" heat pipe (ft2):	**na**	**0.026**	**0.059**	**0.124**	**0.137**
Wetted Perimter including 1.5" heat pipe (ft):	na	1.088	1.341	1 702	1.764
Hydraulic Radius (ft) R:	**na**	**0.024**	**0.044**	**0.073**	**0.078**

Assumptions:

C Value for HDPE:	**140**	** significantly alters headloss
Pipe Length:	**3.4**	km
Pipe Length:	**11154.8556**	ft
max allowable Velocity:	5	ft/s
min allowable Velocity:	2	ft/s
Max Pressure:	50	psi
Min Pressure:	20	psi

Design pipe and tank for 20 yr population with pump running 20 hrs per day.
Design initial pump for 10 yr population running 20 hrs per day.

AVERAGE DAY			
Pump Running Time Y:	20 hours		
Year	**2004**	**2014**	**2024**
Pump Flow rate needed to refill daily demand over Y hrs (gpm):	33.4	41.8	53.7
Equilization Volume for X hours based on above inflow and outflow (gal):	**24,021**	**30,088**	**38,669**
check pump can refill in Y-X hours:	24,020.5	30,088.4	38,669.2

MAX DAY			
Pump Running Time Y:	20 hours		
Year	**2004**	**2014**	**2024**
Pump Flow rate needed to refill daily demand over Y hrs (gpm):	45.5	57.0	80.6
Equilization Volume for X hours based on above inflow and outflow (gal):	**26,689**	**33,432**	**47,262**
	32,755.3	41,029.6	58,003.8

Design Pump & Pipe Based on set equilization volume rather than set pump time

Pump Flow Rate needed if used a set equilization volume for tank:

Equilization Volume: 40000 us gal

AVERAGE DAY			
Year	**2004**	**2014**	**2024**
Pump Flow rate needed to keep up with demand and only use a set equilization volume over X hrs (gpm):	*0.07*	*21.14*	*50.93*
Hours to refill tank:	*9350.27*	*31.54*	*13.09*

MAX DAY			
Year	**2004**	**2014**	**2024**
Pump Flow rate needed to keep up with demand and only use a set equilization volume over X hrs (gpm):	*17.76*	*43.30*	95.69
Hours to refill tank:	*37.53*	*15.40*	6.97

AVERAGE DAY

Pipe size:	**3**	**inches**
Hydraulic Radius (ft) R:	**0.02411417**	**ft**
Flow Area subtracting 1.5" heat pipe:	**0.02624649**	**ft2**

	2004	**2024**
Flow (gpm):	33.36	53.71
Flow (ft3/s):	0.07	0.12
Headloss Total (ft):	376.45	909.15
Headloss (ft/1000ft):	33.75	81.50
Velocity (ft/s):	2.83	4.56

Pipe size:	**4**	**inches**
Hydraulic Radius (ft) R:	**0.04420932**	**ft**
Flow Area subtracting 1.5" heat pipe:	**0.05928243**	**ft2**

	2004	**2024**
Flow (gpm):	33.36	53.71
Flow (ft3/s):	0.07	0.12
Headloss Total (ft):	**41.05**	**99.14**
Headloss (ft/1000ft):	3.68	8.89
Velocity (ft/s):	**1.25**	**2.02**

Pipe size:	**5**	**inches**
Hydraulic Radius (ft) R:	**0.07291667**	**ft**
Flow Area subtracting 1.5" heat pipe:	**0.124082**	**ft2**

	2004	**2024**
Flow (gpm):	33.36	53.71
Flow (ft3/s):	0.07	0.12
Headloss Total (ft):	**5.83**	**14.08**
Headloss (ft/1000ft):	0.52	1.26
Velocity (ft/s):	**0.60**	**0.96**

Pipe size:	**6**	**inches**
Hydraulic Radius (ft) R:	**0.07783793**	**ft**
Flow Area subtracting 1.5" heat pipe.	**0.13727017**	**ft2**

	2004	**2024**
Flow (gpm):	33.36	53.71
Flow (ft3/s):	0.07	0.12
Headloss Total (ft):	4.48	10.82
Headloss (ft/1000ft):	0.40	0.97
Velocity (ft/s):	0.54	0.87

MAX DAY

Pipe size:	**3**	**inches**
Hydraulic Radius (ft) R:	**0.024114**	**ft**
Flow Area subtracting 1.5" heat pipe:	**0.026246**	**ft2**

	2004	**2024**
Flow (gpm):	45.49	95.69
	0.10	0.21
Headloss Total (ft):	668.57	2649.42
Headloss (ft/1000ft):	59.94	237.51
Velocity (ft/s):	3.86	8.12

Pipe size:	**4**	**inches**
Hydraulic Radius (ft) R:	**0.044209**	**ft**
Flow Area subtracting 1.5" heat pipe:	**0.059282**	**ft2**

	2004	**2024**
Flow (gpm):	45.49	95.69
Flow (ft3/s):	0.10	0.21
Headloss Total (ft):	**72.90**	**288.90**
Headloss (ft/1000ft):	6.54	25.90
Velocity (ft/s):	**1.71**	**3.60**

Pipe size:	**5**	**inches**
Hydraulic Radius (ft) R:	**0.072917**	**ft**
Flow Area subtracting 1.5" heat pipe:	**0.124082**	**ft2**

	2004	**2024**
Flow (gpm):	45.49	95.69
Flow (ft3/s):	0.10	0.21
Headloss Total (ft):	**10.36**	**41.04**
Headloss (ft/1000ft):	0.93	3.68
Velocity (ft/s):	**0.82**	**1.72**

Pipe size:	**6**	**inches**
Hydraulic Radius (ft) R:	**0.077838**	**ft**
Flow Area subtracting 1.5" heat pipe	**0.13727**	**ft2**

	2004	**2024**
Flow (gpm):	45.49	95.69
Flow (ft3/s):	0.10	0.21
Headloss Total (ft):	7.96	31.54
Headloss (ft/1000ft):	0.71	2.83
Velocity (ft/s):	0.74	1.55

If set the following:
Equilization Volume (us gal): 40000

Pipe Size 3" :

Flow Description:	Flow (usgpm)	Equilization Volume used (us gal):	Pump run time	Headloss (ft):	Velocity
Avg Pump Flow 2004 (usgpm)	33.36	24,021	**20**	376.45	2.83
Max Pump Flow 2004 (uspgm)	45.49	26,689	**18**	668.57	3.86
Avg Pump Flow 2014 (usgpm)	41.79	30,088	**20**	571.28	3.55
Max Pump Flow 2014 (uspgm)	56.99	**33,432**	**18**	1014.59	4.84
Avg Pump Flow 2024 (usgpm)	53.71	38,669	**20**	909.15	4.56
Max Pump Flow 2024 (uspgm)	**95.69**	**40,000**	**15**	**2649.42**	**8.12**

Pipe Size 4" :

Flow Description:	**Flow (usgpm)**	**Equilization Volume used (us gal):**	**Pump run time**	**Headloss (ft):**	**Velocity**
Avg Pump Flow 2004 (usgpm)	33.36	24,021	**20**	41.05	1.25
Max Pump Flow 2004 (uspgm)	45.49	26,689	**18**	72.90	1.71
Avg Pump Flow 2014 (usgpm)	41.79	30,088	**20**	62.29	1.57
Max Pump Flow 2014 (uspgm)	**56.99**	**33,432**	**18**	110.63	2.14
Avg Pump Flow 2024 (usgpm)	53.71	38,669	**20**	99.14	2.02
Max Pump Flow 2024 (uspgm)	**95.69**	**40,000**	**15**	**288.90**	3.60

Pump Flow Sizing:
Looks like 4" pipe is required.

Pump 2004 to 2014
If Size pump for 2014 running 20 hrs per day:

Avg Flow Truckfill 2014 (usgpm)	104.47	
Max Flow Truckfill 2014 (usgpm)	126.63	
Equilization Volume (us gal):	40000	
Pump Run Time:	20	hrs/day
If 4" pipe then min flow to obtain 1.5 ft/s	40	usgpm
If pump run 20 hrs in 2014 then flow:	57	
So if use set flow:	**50**	**usgpm**

Then the following equilization usage, and pipe Velocities and headlosses:

Flow Description:	Flow (usgpm)	Equilization Volume used (us gal):	Pump run time	Headloss (ft):	Velocity
Avg Pump Flow 2004 (usgpm)	50.00	16,034	13	86.84	1.88
Max Pump Flow 2004 (uspgm)	50.00	24,526	16	86.84	1.88
Avg Pump Flow 2014 (usgpm)	50.00	26,147	17	86.84	1.88
Max Pump Flow 2014 (uspgm)	50.00	36,785	20	86.84	1.88

Pump 2014 to 2024
If Size pump for 2024 running 20 hrs per day:

Avg Flow Truckfill 2024 (usgpm)	134.27	
Max Flow Truckfill 2024 (usgpm)	179.02	
Equilization Volume (us gal):	40000	
Pump Run Time:	20	hrs/day
For set equilization volume, flow needed to keep up on max day:	95.69	usgpm
If pump run 20 hrs in 2024 then flow:		
So if use set flow:	**95.69**	**usgpm**

Then the following equilization usage, and pipe Velocities and headlosses:

Flow Description:	Flow (usgpm)	Equilization Volume used (us gal):	Pump run time	Headloss (ft):	Velocity
Avg Pump Flow 2014 (usgpm)	95.69	4,216	9	288.90	3.60
Max Pump Flow 2014 (uspgm)	95.69	14,853	11	288.90	3.60
Avg Pump Flow 2024 (usgpm)	95.69	18,517	11	288.90	3.60
Max Pump Flow 2024 (uspgm)	95.69	40,000	15	288.90	3.60

Volume of water in main pipe:

Volume in 4" (ft3):	661.28698
Volume in 4" (gal):	4946.42661
Volume in 1.5" (ft3):	136.890674
Volume in 1.5" (gal):	1023.94224

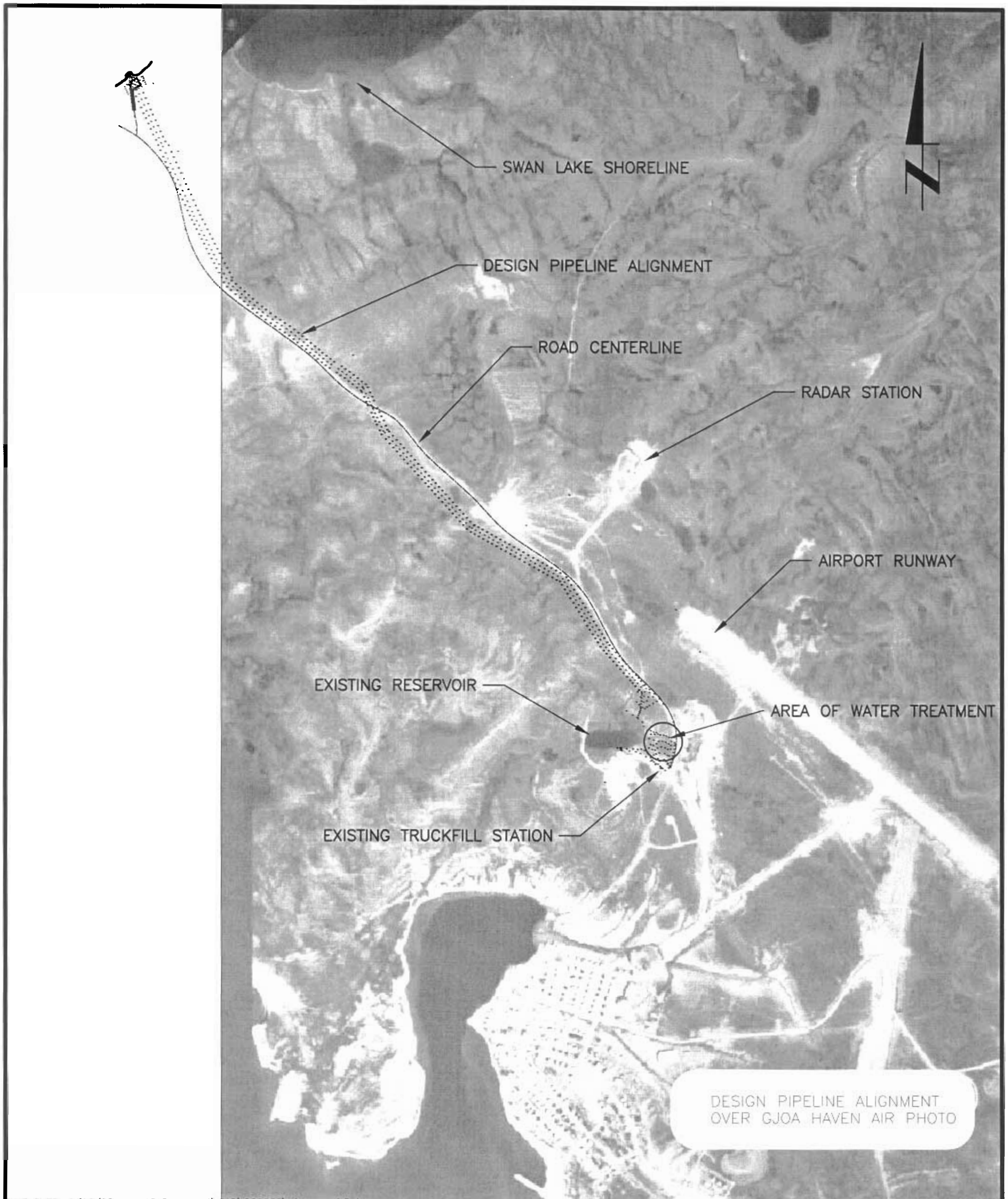
Items to be complete:

- Tank Size
- Check all work by hand
- Check all assumptions

- Pump head calcs for both pumps

APPENDIX C

PHOTO OF PIPELINE ALIGNMENT AND FACILITY LOCATION



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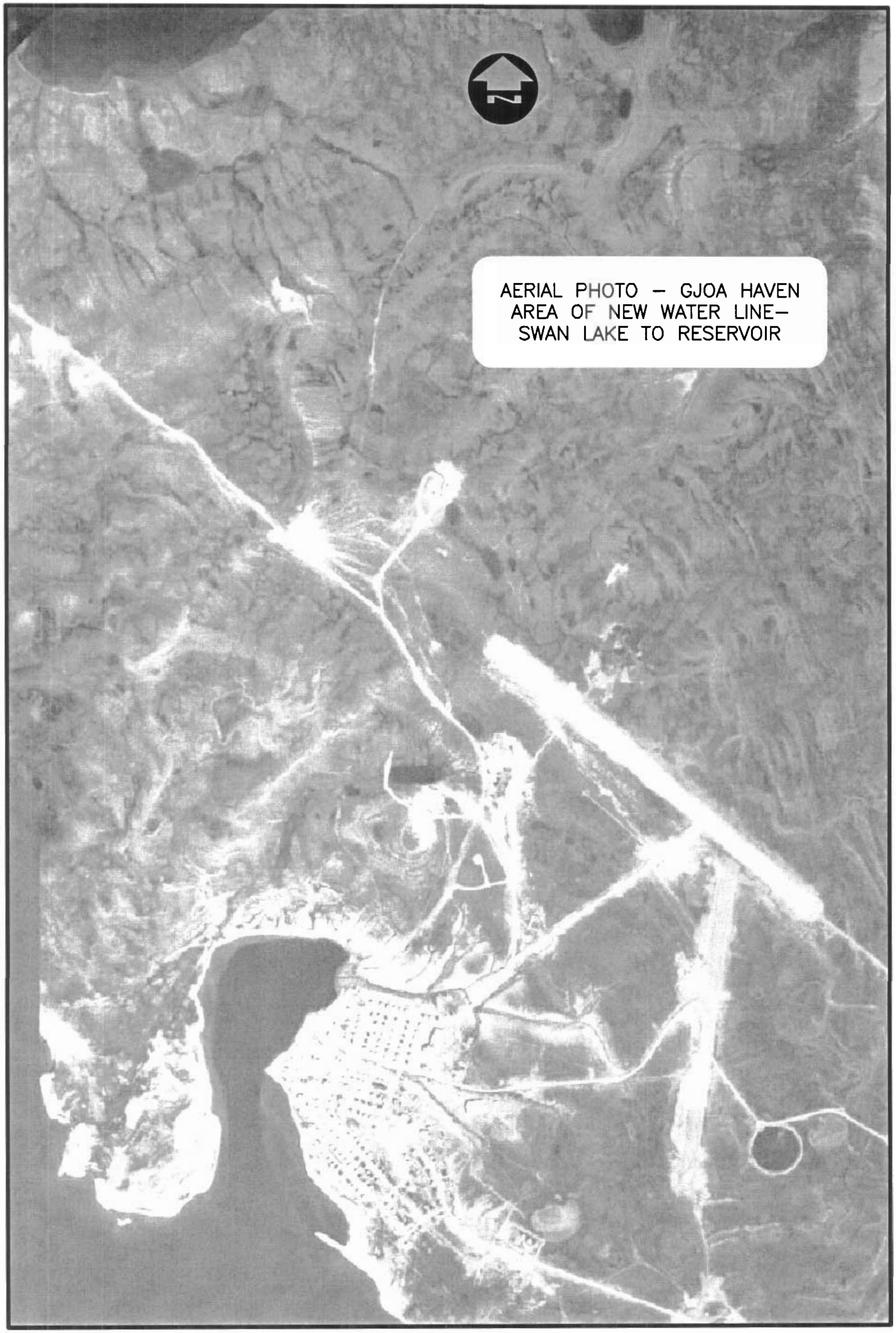
DILLON CONSULTING

PROJECT WATER WORKS & WATER SUPPLY GJOA HAVEN, NU		PROJECT NUMBER 02-0602
		DATE SEPT 02
TITLE DESIGN PIPELINE ALIGNMENT OVERLAY ON AIR PHOTO		FIGURE NUMBER FIG 1

APPENDIX D

AIR PHOTOS


AERIAL PHOTO – GJOA HAVEN
AREA OF NEW WATER LINE–
SWAN LAKE TO RESERVOIR

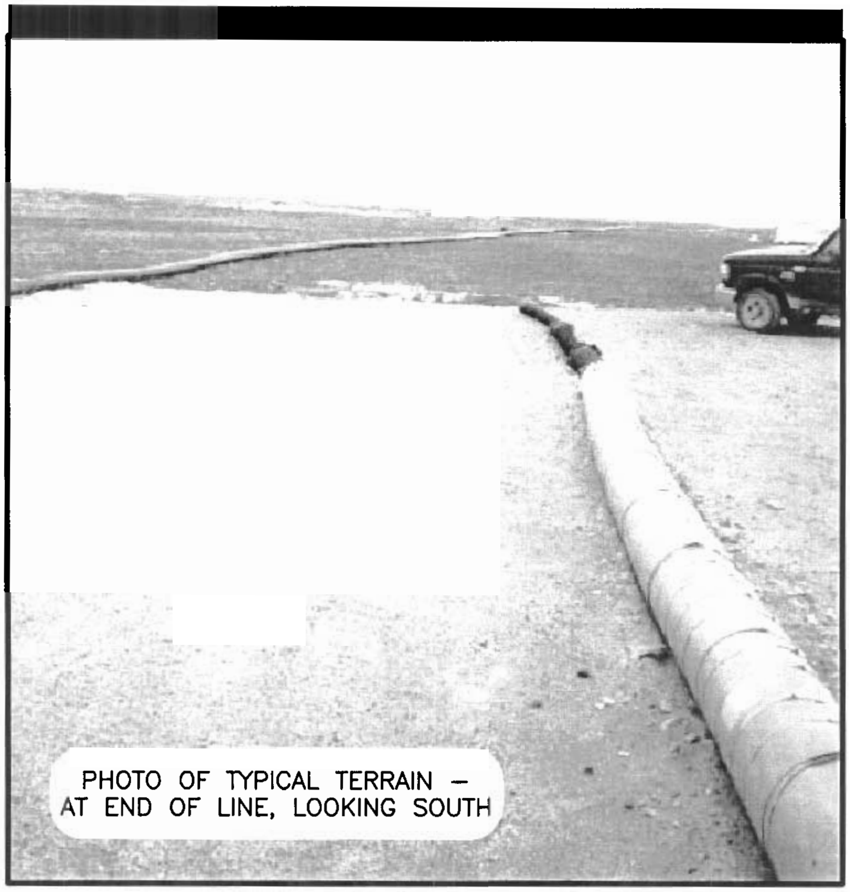
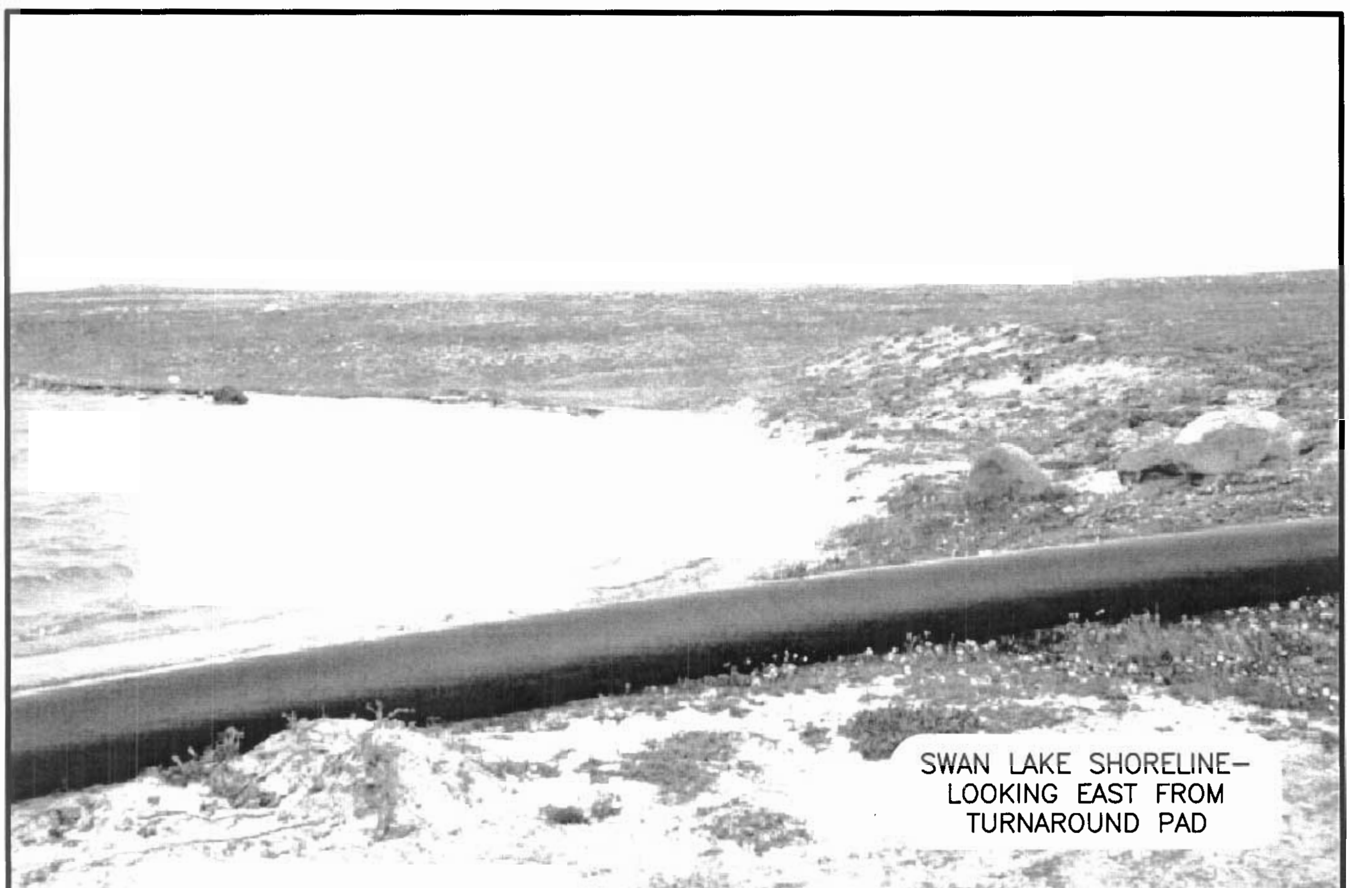
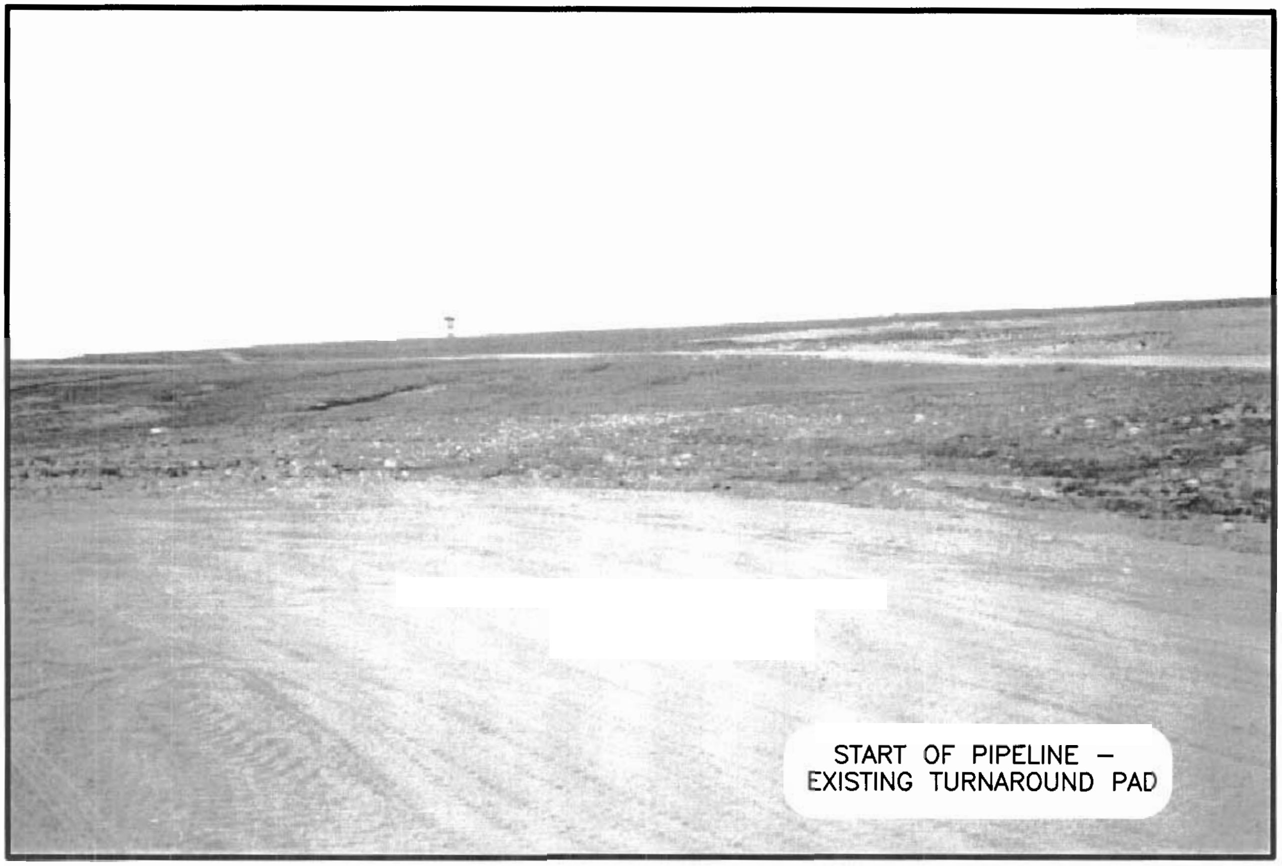


PHOTO OF TYPICAL TERRAIN — AT END OF LINE, LOOKING SOUTH



SWAN LAKE SHORELINE— LOOKING EAST FROM TURNAROUND PAD


START OF PIPELINE –
EXISTING TURNAROUND PAD


SWAN LAKE SHORELINE –
LOOKING SOUTH TO THE
EXISTING TURNAROUND PAD

APPENDIX E

HEAT LOSS AND BOILER SYSTEMS

Heat Loss Calcs:

Equations:

Static Heat Loss

Rate of heat loss per unit length q (W/m):	q= (Tw - Ta)/RT pg 18 Rankin
	where Tw is water temp (C) and Ta is exterior ambient temp (C) and RT is total thermal resistance per length (Cm/W)
	RT (total thermal resistance per length (Cm/W)) can be taken from TABLE 1 pg 19 Rankin
	q can be read from TABLE 2 page 20 Rankin

Heat Loss & temp drop in a flowing pipe

Temperature at x location along watermain:	Tx = (Ti-Ta)e(-X/(m*C*Rt) + Ta
	where Ti is water temp (C) at input and Ta is exterior ambient temp (C) and RT is total thermal resistance per length (Cm/W) and X is length of pipe in m
	and m is the mass flow rate m = (V*Area)*d where area is m2 and V is velocity m/s and d is density of fluid 1000kg/m3
	Tx can be read from TABLES 3-1 to 3-4 but must be calculated for 100 mm pipe.

Freeze up time in pipe in permafrost with no flow	Tf = (pi * Dip^2 *d*C*(Tx-Tf)*Rt)/(2*(Tx-2*Ta+Tf))	Time to drop to freezing temp
	Ts = (pi * Dip^2 *d*Hf*Rt)/(4*(Tf-Ta)) where Hf = 334720 J/kg	Time to freeze solid

Knowns:

Dip Pipe Inside diameter 4"(100 mm) (m) :	0.092	m	
Flow Area 4" subtracting 1.5" heat pipe:	0.0055	m2	
Pipe Length:	3400	m	
C Fluid Specific heat (J/KgC):	4190	J/KgC	
Ti Input water temp:	1	C	
Rule:	**Temp drop along pipe should be less than 2.5C**		
Hf Heat of fusion of fluid (J/kg):	334720	J/kg	
d density of fluid (kg/m3):	1000	kg/m3	
Tf Temp freezing	0	C	
Ta Ambiant Soil Temp:	-10	C	
Insulation thickness:	50	mm	
Depth of Bury:	1	m	
Velocity 2004 to 2014 (ft/s):	1.88	ft/s	
Velocity 2004 to 2014 (m/s):	0.57	m/s	
Flow 2004 to 2014 (m3/s):	0.0032	m3/s	0.00315473 check
Velocity 2015 to 2024 (ft/s):	3.60	ft/s	
Velocity 2015 to 2024 (m/s):	1.10	m/s	
Flow 2015 to 2024 (m3/s):	0.0060	m3/s	

Static Heat Loss

Rate of heat loss per unit length q (W/m): q= (Tw - Ta)/RT — pg 18 Rankin

where Tw is water temp (C) and Ta is exterior ambient temp (C) and RT is total thermal resistance per length (Cm/W)

RT (total thermal resistance per length (Cm/W)) can be taken from TABLE 1 pg 19 Rankin

q can be read from TABLE 2 page 20 Rankin

RT for 1 m bury, 50 mm insul, 100mm pipe:	**4.38735 Cm/W**	from TABLE 1
Rate of heat loss per unit length q (W/m):	**2.51 W/m**	q= (Tw - Ta)/RT
Rate of heat loss for pipeline:	**8524.51 W**	

Heat Loss & temp drop in a flowing pipe

Temperature at x location along watermain: Tx = (Ti-Ta)e(-X/(m*C*Rt)) + Ta

where Ti is water temp (C) at input and Ta is exterior ambient temp (C) and RT is total thermal resistance per length (Cm/W)
and X is length of pipe in m

and m is the mass flow rate m = (V*Area)*d where area is m2 and V is velocity m/s and d is density of fluid 1000kg/m3

Tx can be read from TABLES 3-1 to 3-4 but must be calculated for 100 mm pipe.

2004 to 2014

Velocity 2004 to 2014 (m/s): 0.57 m/s

Flow 2004 to 2014 (m3/s): 0.0032 m3/s

X Distance along pipe (m):	**Tx Temp at point along pipe (C):**	
0	1	check using other equation
500	0.91	
1000	0.81	
1500	0.72	
2000	0.63	
2500	0.54	
3000	0.45	
3400	0.37	

2015 to 2024

Velocity 2015 to 2024 (m/s): 1.10 m/s

Flow 2015 to 2024 (m3/s): 0.0060 m3/s

X Distance along pipe (m):	**Tx Temp at point along pipe (C):**
0	1
500	0.95
1000	0.90
1500	0.85
2000	0.80
2500	0.75
3000	0.71
3400	0.67

Freeze up time in pipe in permafrost with no flow

t f = (pi * Dip^2 *d*C*(Tx-Tf)*Rt)/(2*(Tx-2*Ta+Tf)) — Time to drop to freezing temp
or replace with actual flow area:
t f = (A*d*C*(Tx-Tf)*Rt*2)/(Tx-2*Ta+Tf)

ts = (pi * Dip^2 *d*Hf*Rt)/(4*(Tf-Ta)) — Time to freeze solid
or replace with actual flow area:
t s = (A*d*Hf*Rt)/((Tf-Ta))

2004 to 2014

Tf Time to drop from Tx to freeze:

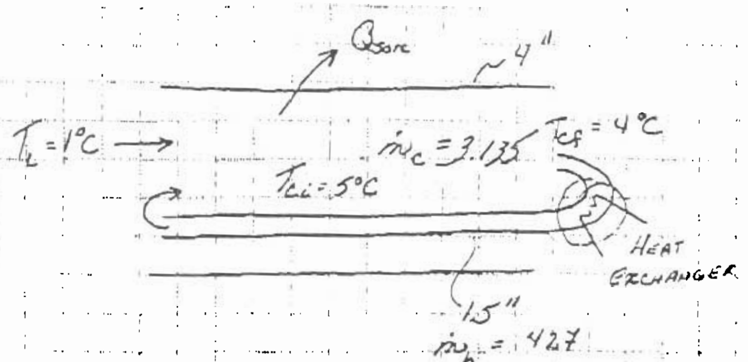
Tx=	0.37	C
Tf=	0.00	C
Time to drop to freeze from Tx:	**3713.52**	**sec**
	1.03	**hours**
Time to freeze solid from Tx:	808797.66	sec
	224.67	**hours**

2015 to 2024

Tf Time to drop from Tx to freeze:

Tx=	0.67	C
Tf=	0.00	C
Time to drop to freeze from Tx:	**6545.86**	**sec**
	1.82	**hours**
Time to freeze solid from Tx:	808797.66	sec
	224.67	**hours**

GJOA HAVEN - SUMMARY OF PRELIMINARY CALCULATIONS THE H. EXCHANGERS & BOILERS WERE BASED ON.



$V_c = .57 m/s$ ← as per K's calcs.
$A_c = .0055 m^2$ $\rho = 1000 kg/m^3$
$\dot{m}_c = (.0055 m^2)(.57 m/s)(1000 kg/m^3)$
$= 3.135 kg/s$

$V_h = .6096 m/s$ (2 ft/s)
using 4 mm wall thickness for 1.5" pipe
$A_h = .0007 m^2$
$\dot{m}_h = (.0007)(.6096)(1000)$
$= .427 kg/sec$

$v = 406$ US gal/hr

$\dot{m}_L + \dot{m}_h = \dot{m}_c$

$\dot{m}_L = 2.71 kg/sec$

ENERGY NEEDED TO HEAT LAKE WATER TO 5°C

$q_L = \dot{m}_L C_p (T_c - T_L)$
$= 2.71 kg/sec \cdot 4190 \frac{J}{kg \cdot °C} \cdot (5-1)°C$
$= 45\ 420 W$
or 155 000 BTU/hr

heat exchanger at WTP

$q = 45\ 420 = \dot{m}_h C_p (T_{hf} - T_{hi})$
$45\ 420 = (.427)(4190)(T_{hf} - 4)$
$T_{hf} = 29.4°C$
30°C

$v = 410$ US gal/hr $T_f = 30°C$ $T_i = 4°C$

Storage Tank

$q = 53\ 000$ BTU/hr
or 15 533 J/s

avg. temp from tank = 3°C
$V = 2 ft/s$ (.6096 m/s) using 1.5" pipe
$q = \dot{m} C_p (T_f - T_i)$
$15\ 533 = .427(4190)(T_f - 3)$
$T_f = 11.7°C$

$v = 410$ US gal/hr $T_f = 12°C$ $T_i = 3°C$

By		Date		Project Name	GJOA HAVEN
Checked		Date			
Page		of		Project No.	020602

DILLON CONSULTING

121-97

From: Angela Saranchuk
To: Strong, Gary
Date: 10/17/02 3:11PM
Subject: exchanger info

Afternoon, Gary.

Another quote for both the main and tank recirc lines is coming - original quote was on single walled, not double walled construction.

'main' recirculating line -
- 2 quotes - $2,750 (shell & tube) - make - Armstrong
  - $3,650 (plate) - make - Alfa Laval
- all double-wall construction
- assumed 50% ethylene glycol solution

tank recirc line
- 1 quote - $2,100 (shell & tube) - make - Armstrong
- waiting for a third to come in - forgot to ask them for this one as well as the 'main' one

boiler -
- 1 quote - $11,400 - make - Bryant
- CSA approved burners

* 2nd quote still to be in this afternoon (doubt it as it's already 4), sent info, but not price (make is Cleaver-Brooks)

I'll send off more info when I get it. I tried to get 3 quotes for all, but few boiler people listed in the yellow pages carry oil fired ones. Is there another brand you think I should be going for?

I'm faxing the calculations that I did to size the equipment. Please let me know if there are any errors.
Thanks.

APPENDIX F

COST ESTIMATES

Call to Norm Dei - PW/S
Vincent Tan - PW/S

List of Quantities

Pump house - $300,000

100 mm Insulated pipe - $300/m

40 mm Uninsulated Pipe - $100/m

Access Vaults - $25,000

Concrete foundations - 2,000 /m^3

Pre-engineered Building - 2,240 /m^2 YK

Stick Built Buildings - 2,350/m^2

Steel tanks. verticle tanks - $1.80/l

1 tank. 280,000 l -
vert Steel - insulated Cladded,
- Kinghand on Beth

Aklavik - Earthtech -
John Bonner 77? - 7254
McPherson

Gjoa Haven. Community factor 1.5

annual increase over Next 12 months 10%

Alberta Slowing down - but there is a back log
2006 might be the end of Spike

By		Date		Project Name	
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Page		of		Project No.	

DILLON CONSULTING

From: <John_Bulmer@gov.nt.ca>
To: <gstrong@dillon.ca>
Date: 10/21/02 2:25PM
Subject: RE: Tank estimates

Gary

The "reliable" computer is working again.

Actual Details

AKLAVIK

1999 - supply and install water tank (minimum 110 000 l size) $1.64/l
Total Cost: $ 180 453.00 (included small pipeline and connections to water plant).
Tank was insulated c/w metal cladding.
Contractor: Dowland Contracting

2001 - supply only one water tank
Total Cost: $ 169 383.00 including shipping charges from Hay River to Aklavik. $1.12/l.
Tank Size: H = 6.1 m, R = 2.8 m. Approximate Volume = 150 000 litres. no foundation
Foundation was already in place.
Tank was insulated c/w metal cladding.
Contractor: King Manufacturing

2001 - install second water tank and connections
Total Cost: $ 75 986.00
Contractor: Dowland Contracting

FORT MCPHERSON

2000 - supply two water tanks
Total Cost: $ 404 275.40
Tank Size: H = 7.0 m, R = 3.625 m. Approximate Volume = 290 000 litres (each). $1.39/l.
Tank was insulated c/w metal cladding.
Foundation was already in place.
Contractor: NTCL 1.63/l foundation incl.

2000 - construct Foundation
Total Cost: $ 67 800.00
Contractor: Terwood Industries (Fort McPherson).

That's about all the info I have for now.

If you have any additional questions please feel free to contact me.

jb

-----Original Message-----
From: gstrong /unix [mailto:gstrong@dillon.ca]
Sent: 21-Oct-02 01:57 PM
To: John Bulmer /IN /PWS

Cc: gstrong /unix
Subject: Tank estimates

Per our phone call, I'd appreciate knowing the construction costs for the installation of the water storage tanks in Aklavik and Fort MacPherson. Some other project details would help, such as tank size, and foundation cost, if that was separate.

Cheers

Gary Strong, P Eng

Dillon Consulting Limited

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