Sewage and Water Works Technical Evaluation – Phase 1

Hamlet of Resolute Bay, Nunavut
CGSHQ-09023-01

Prepared For:
Government of Nunavut
P.O. Box 1000, Station 700
Iqaluit, NU X0A 0H0

Trow Associates Inc.
154 Colonnade Road South
Ottawa, ON K2E 7J5
Tel: (613) 225-9940 Fax: (613) 225-7337

Project No: OTCD00020312A
Report date: March, 2010

Executive Summary

General

The Government of Nunavut (GN) has retained Trow Associates Inc. (Trow) to conduct a technical evaluation of the existing water and sewer system serving the Hamlet of Resolute Bay (Hamlet). The GN is currently in the process of establishing a long term strategy for the provision of water and sewer services in Resolute Bay. In the interim the existing system must remain in service and this interim requirement will likely continue for five years. The following study was commissioned to examine the current systems and recommend measures to permit continued service for a further five years.

This study has been advanced in two phases. The initial phase represents an evaluation of the existing systems. In general terms this represented a cataloguing of activities since 1996 and an assessment of current conditions. The second phase presents recommendations targeted at continuing operation for a further five years. The recommendations presented in Phase 2 include capital rehabilitations and upgrades, operational improvements and a contingency plan.

Community Information

Resolute Bay, the second most northerly community in Canada is situated on Cornwallis Island at 74°42'N and 94°50'. Currently a population of approximately 250 is served by the existing piped water and sewer (utilidor) system.

The climate in Resolute Bay is especially challenging. Average annual temperature is -16.7°C and average annual wind speed is 21 km/hour. The lowest temperature recorded at this site is -52.2°C and the highest recorded hourly wind speed is 142 km/hr. A wind chill as low as -72°C has been observed. The extremely low temperatures are combined with a protracted period of dark during the winter. The sun does not rise above the horizon between early November and early February. The combination of temperature, high winds and lack of daylight create challenging operating conditions for much of the year.

The current water system was constructed as part of the relocation of the town site in the late 1970's. The system has encountered some operating challenges, including freeze of some of the piping and high rates of water bleeding. The question of replacement of the existing piped systems with trucked delivery of services has previously been examined. There is a strong sentiment within the community that the piped delivery of water and sewer services should continue.

System Description

Water System

Water is drawn from Char Lake through a heat trace intake into a pumping well below the Char Lake Pump House. Heated water is injected into the water in the well prior to pumping through a 1.8 kilometre heat traced and insulated transmission main to Signal Hill Water Treatment Plant. Incoming water from Char Lake refills a 570 m^3 welded steel storage tank. Water pressure to the townsite is boosted by pumps at the Signal Hill Water Treatment Plant. The primary purpose of these pumps is to assure circulation through the looped water mains, which loop back to the water treatment plant.

Water is distributed within the townsite through a looped system of insulated high density polyethylene piping. This piping is typically buried at a depth of 1 metre. Freeze prevention of the watermains is achieved through circulation, reheating at the water treatment plant and some bleeding. Access to valves and fittings on the water distribution system is provided by Access Vaults (AV's). The AV's are shared with the sewer system.

Service connections have been extended into each served building. These service connections were constructed using a pair polyethylene tubes enclosed within a 100 mm insulated duct. Circulating pumps have been installed in each served building to assure freeze protection for the service connections.

Both the Char Lake Pumping Station and the Signal Hill Water Treatment Plant are equipped with boilers and standby generators. The principle heating loads supported by the boilers is potable water heating. This heating is required to prevent freeze of the transmission main between Char Lake and Signal Hill, the town site water distribution system and the water storage tank.

Sewage System

The sewage collection system was constructed using insulated high density polyethylene piping buried in common trenches with the water distribution system at a typical depth of 1 metre. The sewer system flows by gravity to a macerator, prior to discharge to the ocean. Freeze prevention of the sewage collection system is largely achieved through bleeding of water into the sewer system. Bleed water is also used as a source of heat into the AV's.

Service connections have been extended into each served building. These service connections were constructed using 100 mm insulated polyethylene piping. Water is bled into almost all of the service connections as a freeze prevention measure.

There is currently no significant treatment of sewage. Sewage treatment is limited to a macerator. Effluent strength is likely very low due to the large amounts of bleed water that are directed into the sewer system.

Phase 1 Assessment

General

Phase 1 of the Technical Evaluation of the Resolute Bay Sewage and Water Systems focused upon the current status of these systems and the actions relating to these systems since 1996. During Phase 1 the following were conducted:

- A review of previous investigations and engineering studies.
- A field visit that included an examination of those various components that make up the systems.
- An evaluation of the current condition and technical status of the systems and components including:
  - The buildings,
  - Civil works (intake, piping, AV's, water storage and treatment and service connections),
  - Mechanical systems, and
  - Electrical systems.
- A compilation of improvements made to the sewer and water systems since 1996.
- A review of Preventative Maintenance, including an examination of practices and capabilities.

Findings

General

Various observations and conclusions were drawn based upon the observations and investigations. These included conditions that required urgent actions.

Conditions Requiring Urgent Actions

The following conditions were observed, for which action is urgently required:

- The fuel system at the Char Lake Pump House does not conform to codes and represents a contamination risk for the community water supply. The system should be replaced at the first opportunity.

- There is a significant risk to public health due to the potential for cross contamination between the sewer and water systems arising from conditions within the AV's.

- Water consumption rates should be monitored by the GN. Current consumption is approaching water supply pumping ability, which places the system at risk of depressurization due to lack of supply. Depressurization places the water system at risk of freeze and raises public health concerns.

- The GN should confirm that operating personnel have been provided with appropriate health and safety training. Specific concerns include fall prevention and confined space entry.

Conclusions

The following general conclusions are provided.

- High levels of water consumption are currently being experienced in Resolute Bay. These appear to be largely the result of operation efforts to avoid freeze of the piping. Water consumption in the mid 1990's was reported at 48,000 m^3/year, of which 80% was directed to bleeds. Current consumption is approaching 300,000 m^3/year.

- Risks to public health and safety arising from fuel storage arrangements and conditions within shared AV's have been identified.

- The water and sewer system piping was installed near the bottom of the active layer. The vertical location of the piping has led to deterioration of the insulated piping system due to external pressure exerted during re-freeze. Higher rates of heat loss are being experienced from both the sewer and water systems. This burial depth has also enhanced the risks of sags in the sewer profile due to thaw settlement and heave. The combination of greater heat loss and unstable sewer profile increases the risk of sewer freeze and blockage. An apparent operational response to this deterioration of the sewer system is increased rates of bleed flow to the sewer system. The service connections are especially suspectable to these forms of deterioration.

- It is likely that the existing system can continue to serve the community for 5 years. This will require high levels of water consumption and attentive and persistent operator effort.

Phase 2

General

Phase 2 of the Technical Evaluation the Resolute Bay Sewage and Water Systems focused upon responses to the status and conditions identified during Phase 1 of the assessment. The activities with Phase 2 provided the following:

- Rehabilitations for the various facilities.
- Capital upgrades for the various components and systems.
- Operations and preventative maintenance advice.
- A contingency plan.
- A series of recommendations relating to operations and preventative maintenance are provided. Potential improvements examined include reductions in water consumption, improved training and lowering water temperature. A preventative maintenance program was prepared that is based upon the current MMS. The recommended preventative maintenance program represents greater effort than is currently sought from the operating contractor.
- A contingency plan that provides responses to likely sewer and water system failures is provided.

Conclusions

The following are some general conclusions drawn during Phase 2 of the evaluation.

- Table 3.1 summarizes the recommended facility rehabilitations. This table presents the rational, priority and estimated cost for each of the recommended rehabilitations. The estimated value of the recommended rehabilitations is between $2.7 and $2.9 million.
- Table 4.1 summarizes recommended capital improvements. This table presents the rational, priority and estimated cost for each of the recommended rehabilitations. The estimated value of the recommended improvements is approximately $150,000.
- Recommendations are provided regarding operational improvements. It is recommended that efforts be directed towards reducing water consumption. Improved operator training with an emphasis upon the public health safety issues associated with the operation and repair of public water system should be provided. It is not currently recommended that the water temperature be reduced.
- A preventative maintenance program has been developed. This program is based upon the existing maintenance management system. The recommended program represents greater effort that is currently sought from the operating contractor.
- A contingency plan that provides responses for failures that are likely to occur with the sewer and water systems has been developed. This contingency plan includes general recommendations regarding materials and supplies that should be held in stock in Resolute Bay.

Summary

The GN is currently assessing the most appropriate actions in terms of the provision of sewer and water services for the long term in Resolute Bay. Some time will be required to assess these requirements and implement in the selected solution. In the interim the existing system must remain in service. A two phase was commissioned to examine existing conditions and develop actions in response to these existing conditions. Phase 1 of the investigation provided the following.

- A review of previous investigations and engineering studies.
- An evaluation of the current condition and technical status of the systems
- A compilation of improvements made to the sewer and water systems since 1996.
- A review of preventative maintenance

Phase 2 of the investigation provided the following to facilitate the continued operation of the existing systems.

- A program of recommended facility rehabilitations.
- A program of recommended capital upgrades.
- Recommend improvements to operating methods.
- Recommendations regarding enhanced preventative maintenance.
- A contingency plan that provides responses for unusual events.

Table of Contents

Appendices

1 Introduction

1.1 General

The Government of Nunavut has retained the services of a consulting engineering team to evaluate the Resolute Bay water and sewer systems. In broad terms, this assessment is to provide a course of action that will assure continued operation of the piped water and sewer systems for a further five years. This will provide an opportunity to develop a sound program to provide ongoing water and sewer services in Resolute Bay.

This is a two phase project. The first of these two phases entails the evaluation of the existing systems. Phase two of this project will provide recommendations, including upgrades, operational improvements and a contingency plan. The following report presents the Phase 1 activities of this project. These include:

- A technical assessment of the water and sewer system;
- A review of improvements carried out since 1996;
- A review of preventative maintenance practices; and
- A review of capacity to maintain the system.

Many of the findings of this report are based upon a field visit conducted during the week of November 23, 2009. The preparation of this report has been facilitated by the assistance and information provided by the various representatives of Community and Government Services (CGS) and by the candour of the operating contractor.

1.2 Community Description

Resolute Bay is located on Cornwallis Island at N74°42’ and W94°52’. Resolute Bay has a reported population of almost 250. The climate is especially challenging in this community. Average annual temperature is -16.7°C and average annual wind speed is 21 km/hour. The lowest temperature recorded at this site is -52.2°C and the highest recorded hourly wind speed is 142 km/hr. Wind chill as low as -72°C has been observed. The extremely low temperatures are combined with a protracted period of dark during the winter. The sun does not rise above the horizon between early November and early February. The combination of temperature, high wind and lack of daylight create challenging operating conditions for much of the year.

The current water system was constructed as part of the relocation of the town site in the late 1970’s. The system has encountered some operating challenges, including freeze of some of the piping and high rates of water bleeding. The question of replacement of the existing piped systems with trucked delivery of services has previously been examined. There is a strong sentiment within the community that the piped delivery of water and sewer services should continue.

The water system includes a supply from Char Lake, a pump house at Char Lake, a water treatment plant at Signal Hill, a transmission main connecting the pump house and the treatment plant, and a system of underground piping. The sewage system includes a collection network of underground piping, an outfall sewer and a macerator. The following report examines each of these system elements.

1.3 Inspection and Testing Methods

The project was initiated with a review of reports and drawings developed during the course of previous projects and assessments in Resolute Bay. This was followed by a briefing meeting with CGS staff in Iqaluit followed by a site visit. During the site visit most of the systems Access Vaults were inspected. Those members of the engineering team responsible for mechanical and electrical systems examined, in detail, the various components at the Char Lake Pump House and Signal Hill Treatment Plant.

During the course of the site visit, the need for additional information and documents became apparent. Various locations within the community were visited in an effort to locate additional information. Following the visit, additional meetings were held in Iqaluit to review additional information requirements identified during the site visit.

Close circuit television information for a portion of the sewer system was provided by representatives of the CGS office in Pond Inlet. This information has been very helpful in estimating the condition of the sewer system piping.

The team was provided with a list of contacts. These contacts have been solicited for information and comment. The results of these contacts are summarized later in this report.

One valuable source for information has been the current operating contractor. The contractor provided information regarding current maintenance activities, as well as vital historic information regarding changes and challenges with the water and sewer systems.

There are certain tests that could not be performed during the field visit due to weather and potential risk to the systems. One example of such testing that was not performed was flow testing of hydrants. Unfortunately, no other source of hydrant test data was identified during this investigation.

2 System Description

2.1 General

The water and sewer systems are made up from the following elements:

- Water supply and transmission works
- Water treatment and storage
- Water distribution and sewage collections systems
- Sewage treatment works

The water and sewer system are depicted on drawing C1.

2.2 Water Supply and Transmission

Water is drawn from Char Lake through a heat traced intake into a pumping well below the pump house floor. Heated water is injected into the pumping well to raise the temperature of the incoming water to 5°C. The water is then pumped to the Signal Hill water treatment plant through a 1.8 kilometre long, 150mm diameter, insulated and electrically heat traced high density polyethylene transmission main. A pair of pumping systems has been installed in the Char Lake pump house. Refill of the storage tank at the Signal Hill treatment plant is achieved using a pair of 15 HP vertical turbine pumps that operate in alternation. Between tank fill cycles a pair of 2 HP submersible pumps operate to maintain flow in the transmission main. The duty pumps currently operate at 12.6 L/sec (167 IGPM). The rate of flow and the total quantity of water pumped from Char Lake is measured by a magnet flow meter in the Char Lake pump house.

The Char Lake pump house also contains various systems that support the water supply system, including a pair of boilers, electrical supply, standby generator, fuel system and controls. With the exception of the boilers, much of this equipment dates to the original installation in the late 1970's.

2.3 Water Treatment and Storage

The water treatment and storage facility is located on Signal Hill, immediately above and behind the town site. Water from Char Lake is directed into a recently complete 570 m^3 welded steel storage tank. The original storage tank, which was constructed in the late 1970's, is also located at the Signal Hill facility. This older 530 m^3 tank is no longer in service due to leakage.

Treatment is limited to chlorination. Chlorine solution is injected into the water supply to town, immediately prior to the point where the piping leaves the building. Heat is injected into the water storage tank and into the flow leaving the treatment plant.

The water pressure for the flows to town is boosted by a pair of pumps that are rated at 28.3 L/s (448USGPM) at 25 m (82 feet) of head. These pumps operate on the basis of one duty pump and one in standby, with alternation of the duty pump. The pressure boost provided by the pumps is intended to ensure circulation of the water supply and return flow to the water treatment plant.

The water treatment plant also contains various equipment in support of the water system including an electrical supply, a standby generator, a pair of boilers, controls and alarms. Current instrumentation is limited to some temperature measurements and a circular chart recorder for storage tank level. The treated flow meter is not in service, and paper charts for the level recorder are currently difficult to obtain.

2.4 Water Distribution and Sewage Collection Systems

The water distribution and sewage collection systems were constructed using insulated high density polyethylene piping and concrete access vaults. In general terms, these systems in Resolute Bay may be described as shallow bury systems. The design provided for separation of these systems within the common access vaults through the use of sealed clean-out boxes on the sewer system. The water system is generally one continuous loop with two exceptions. That section of water main between Access Vaults (AV's) 23 and 25 is a dead end segment, protected from freeze by bleeding. The new section of water main between AV's 16 and 44 operates in parallel with that section of the original loop between AV's 16 and 13. The sewer system operates by gravity, without any pumping, draining to the sewage treatment works near the beach.

Freeze prevention of the water system is achieved through circulation and, to a lesser degree, by bleeding. Circulation is achieved by the pumps in the treatment plant that boost pressure prior to discharge from the treatment plant. Water is bled in several AV's from the water main into the sewer. One of the primary reasons for the bleeds is to provide heat input and flow into the sewer system to reduce the risk of freeze.

Service connections have been extended into each of the buildings within the town site. The water service connections make use of a pair of polyethylene pipes within a 100 mm insulated carrier pipe. Freeze protection of the water services is achieved through the use of a circulating pump on each service connection. Sewer services were constructed using 100 mm insulated piping. These sewer services drain by gravity to the sewer mains. Bleeds have been installed in almost all of the serviced buildings to direct flow into the sewer services. It is reported that these bleeds are necessary to avoid freezing of the service connections.

2.5 Sewage Treatment and Disposal

The sewage treatment works consist of a treatment plant building and an adjacent macerator facility. There is no equipment within the sewage treatment plant building. A comminutor (macerator) is located in a small Bally building adjacent to the treatment plant building. Currently there is no treatment beyond maceration. Sewage flows are then directed to an outfall on the beach above the high tide mark.

2.6 Water Consumption

Water consumption was reported by UMA (1996) as approximately 48,000 m^3 per year, of which 9,597 m^3 per year was consumed by the community. The remaining 38,400 m^3 per year, or 80% of consumption, was reportedly lost to bleeds and leakage. Dillon (1999) reported similar consumption for the year1997. Annual total consumption for 1997 is reported as 66,651 m^3 per year, of which 17,629 m^3 per year was consumed. The remaining 55,801 m^3 per year was lost to bleeds and leakage. AD Williams Engineering (July 2003) reported water consumption at between 70,000 and 80,000 I Gal/day, which represents 1300,000 m^3/year. Discussions with Hamlet staff indicate, during the site visit of November 2009, that recent billed water consumption is of the order of 11,000 to 13,000 m^3 per year, which is consistent with the values presented in the earlier reports.

Water production records have been located for the periods 1998 to 2002 and January 2008 to November 2009. A limited number of records (48 days) have been located for 2007. The records for 1998 through to 2002 were taken from log sheets for the water treatment plant. The flow meter at the treatment plant that these records are based upon is no longer in service. Production records for the Char Lake Pumping Station over this period have not been located. The data for 2007 through to 2009 is based upon log sheets for the Char Lake Pumping Station. The data recorded in these log sheets is taken from a magnetic flow meter at the pumping station. This flow meter reported a flow rate of 12.6 L/s (167 IGPM) during the site visit, which is consistent with the pump rating. The operating contractor reports that there have been questions relating to the totalizer on the magnetic flow meter. No record of recent calibration of the instrumentation has been located. Based upon these issues, the logged rates of water production must be examined with some degree of caution.

The Table 2.1, in Appendix B, summarizes the various water production records obtained during the site visit. The production records for 1998 to 2002 are substantially lower than consumption reported by UMA and Dillon. These production records yield an annual average consumption of approximately 90 litres per capita day, inclusive of bleeds and leakage, which is an unreasonably low estimate of total water use. It appears that these earlier records are in error by a factor of the order of 10. Recent water consumption has grown dramatically. The information for 2007 is not considered reliable as this is based upon only 48 days of records. Total consumption for 2008 and 2009 is approaching 300,000 m^3 per year. The current annual water use rate can be re-expressed as 9.1 L/sec, which is approaching the rated pump capacity of 12.6 L/sec. This is consistent with the observation during the site visit that the supply pump at Char Lake operated for all but 1 to 2 hours during a working day.

Fuel consumption has been reviewed in an effort to reconcile water consumption. A large heating load at both the pumping station and the treatment plant is town site water heating. Over the period from 1998 to 2006 fuel consumption was consistently in the range of 160,000 to 180,000 litres per year, with a gradual upwards trend. Fuel consumption increased dramatically in 2007. Fuel consumption in 2008 was more than double that seen in the earlier years. This trend continues into the present. A precise relationship cannot be developed between fuel use and water production as there are other heating loads, including building heating and heat loss from the storage tank at the water treatment plant. Increased fuel consumption would be consistent with higher water production. Figure 2.1 in Appendix B, illustrates fuel consumption over the period 1998 to 2008. It is also noted that increased fuel consumption was noted for 2003, despite the report by AD Williams of increased water consumption.

Historic water consumption is usually used to estimate the required capacity of the water supply and distribution works. Typically supply works are sized to maximum day demands, with shorter term requirements such as short duration high domestic demand, fire flows and emergency service served from storage. In the case of Resolute Bay, water system flows are made of two elements, domestic consumption and bleed and leakage flows. Recent domestic billed water use is reported as 11,000 to 13,000 m^3 per year. This is consistent with the domestic consumption reported by UMA (1996) and Dillon (1999), which is reasonable in view of the small growth in population. Seasonal and diurnal variations in domestic water demand are not possible to estimate, as these changes in demand are masked by the large amounts of bleed water use. Bleed flows were reported by UMA and Dillon as approximately three times billed consumption. Bleed flows appear to have recently grown to 25 times billed consumption.

The following summarizes various observations regarding water consumption.

- Consumption prior to 1998 is reported as between 48,000 and 66,600 m^3 per year.
- The production logged at the treatment plant appears to be in error by a factor of the order of 10 times. If the logged records are adjusted by a factor of 10, then water production between 1998 and 2002 was in the range of 73,000 to 100,000 m^3 per year.
- Water use increased dramatically following 2007.
- Current water use is approaching 300,000 m^3 per year.
- Current water use is approximately 75% of the rated capacity of the supply pumps at Char Lake.

- Increased combined fuel consumption at the pumping station and treatment plant is generally consistent with this increase in water consumption.

3 Previous Investigations

3.1 UMA Engineering Ltd. 1996

The UMA Engineering Ltd 1996 study entitled, "Resolute Bay Water and Sewer Facility Investigation," was commissioned by the Government or the Northwest Territories to assess the existing facilities, and evaluate options for future water and sewer service for Resolute Bay. This report is based, in part, upon a site visit conducted between June 14 and 16, 1994. The principle findings of this report include:

- Annual water pumping from Char Lake was reported as 48,000 m^3 or 132,000 L/day (29,000 IGal/day). Of this approximately 38,000 m^3 was lost due to leakage or bleeds.
- The various facilities had not been substantially altered since their original construction. The Char Lake Pump House and Signal Hill Treatment Plant were found to be in generally very good condition.
- The water supply main between Char Lake and Signal Hill could not be directly tested or examined. It was estimated that the supply main would be suitable for a further 20 years of service, providing that it did not become excessively oval due to external pressure.
- Regarding the buried water distribution system, it was anticipated that this piping has experience more deterioration than other portions of the water system, but that this piping would remain useable for a further 20 years. An increasing frequency of main breaks was predicted.
- The risk of cross contamination between the water and sewer systems due to condition within the Access Vaults was identified.
- Significant ground water infiltration into Access Vaults was reported.
- The sites of 7 repairs to the water mains were reported. All of these repairs were conducted in Stage 1A of the original construction.
- There were indications of settlement and ovalling of the sewer piping.
- Water bleeds into the sewers were required to maintain flow and prevent freeze.
- It was anticipated that the sewers could continue to provide service for a further 20 years. It was anticipated that replacement of some sections of the sewer system would continue as an ongoing requirement. The continued bleeding of water into the sewers was expected to be required.

- The sewage disposal system was reported to have performed satisfactorily to date. It was further reported that the comminutor may have been reaching the end of its useful life.

- It was recommended that a ruling be obtained regarding the acceptability of the current sewage treatment arrangement.

- A total of 16 upgrades to the existing system were recommended.

- Future infrastructure options of piped services and trucked services. It was recommended that water and sewer services be converted to truck.

3.2 Dillon Consulting Limited 1999

This report presented a review of the systems condition and upgrading requirements within the context of an intended transfer of water and sewer infrastructure from GNWT to the Hamlet. The report was prepared in three volumes dealing with utilidor upgrade; building assessment; and, sewage treatment and future system expansion. The findings and recommendations of this report included the following:

General Findings

- Total historic water consumption for 1998 was reported as 56,061 m^3, of which metered consumption totalled 11,061 m^3.

- A system description and schematic was depicted.

Volume 1 – Utilidor Upgrade

- Actions arising in connection with deficiencies noted in UMA 1996 were summarized.

- Information regarding 13 water main breaks dating from 1986 to 1991 was provided. All of these breaks were within Stage 1A construction.

- Locations of 6 historic sewer deficiencies were reported.

- The concerns relating to public health due to open sewer clean-outs was expressed. It was recommended that improved operation and maintenance effort be applied to this matter.

- A scope of upgrades was presented. This scope of work was based upon the assumption that $1,000,000 was available. The recommended works were limited to:

    - Check valves and flow metres on bleeders ($25,000).

- Provide a portable pump and generator as a means of reducing the risk of cross contamination in the AV's ($5,000).
- Replace a limited number of sections of water main experiencing an increased history of breaks ($700,000).
- Replace the mains between AV's 20 and 22 ($275,000).

Volume 2 – Water System Building Assessment

- The various building related deficiencies noted in UMA 1996 were reported. In general, it was noted that no action had been taken on these items.
- The following storage requirements were identified:
  - Emergency storage 366 m^3
  - Fire Storage 432 m^3
  - Demand Balancing 74.8 m^3
- It was reported that the storage tank that was in service at the time of the study could provide daily balancing and either emergency storage or fire flow. The combination of all three requirements could not be met from the volume of 530 m^3 that was available at that time. It was felt that this was generally satisfactory to meet a further 20 year requirement.
- It was generally concluded that the buildings met the needs that prevailed at the time of the study and that the buildings were appropriate for a further 20 years of service.

Volume 3 – Sewage Treatment and Future System Expansion

- The risk of cross contamination between the sewer and water system due to conditions within the AV's was reported.
- Regarding sewage treatment it was concluded that the Public Health Act requirements were limited to the protection of the receiving water. No further comment regarding sewage treatment compliance with regulation was provided.
- Computer hydraulic models for both the water and sewer models were prepared. It was concluded that the condition of fire flow plus average day could be met. It was also reported that 150 mm water mains could not satisfy fire flow requirements. There was adequate capacity in the sanitary sewer system for future conditions with the exception of the segment between AV's 11 and 35. The hydraulic analysis of the sewer system did not consider bleed water flows. No thermal modeling was conducted.

- An overview of an Environmental Impact Study relating to sewage discharge was presented. In summary it was reported that no significant issues were raised by the community. The potential for further consideration of impacts was noted due to some community activities such as seal harvesting, and clam harvesting in the area of the outfall.

- It was recommended that sewer temperatures be measured. Following the gathering of one year of data, some adjusting and balancing of bleed rates could be performed.

- It was recommended that additional data be gathered to assess the impact of sewage discharge.

3.3 A.D. Williams Engineering Inc

3.3.1 July 15, 2003

A letter report presenting an Utilidor Assessment was provided to PW&S, Kitikmeot Region. The report dealt with upgrades, immediate repairs and improvements to reduce the risk of freeze. The findings of this letter report included:

- Water production was reported as between 70,000 and 80,000 IGal/day (133,000 m^3/year). This increase in consumption was reported to be the result of a substantial increase in the number of bleeds.

- The Char Lake boiler lacked the capacity to support the increased demand.

- Additional boiler capacity at the treatment plant was viewed to be necessary.

- Bleeds within the houses were reported to be 1 L/hr.

- Sections of utilidor requiring replacement were identified.

- It was recommended that bleed water rates be reduced to lower overall consumption to 55,000 IGal/day.

3.3.2 March 28, 2005

A letter report presenting an assessment of the utilidor system was presented to CGS, Kitikmeot Region. The following were the major findings of this report.

- The supplementary oil fired heating at Char Lake was reported to have been installed in 2004.

- Limitations in the ability of the Char Lake boilers to respond to high water use were noted.

- Heat loss rate for the transmission main between Char Lake and Signal Hill was estimated at 18,000 Watts.

- It was estimated that the Signal Hill boilers had sufficient capacity to support the heat loss from the utilidor water system.

- Total bleed rate was estimated to be 38,000 IGal/day based upon 7 or 8 bleeds to the sewer mains at 4 IGPM and 73 house bleeds at 1 L/hr.

- Suggested operating parameters for the system were presented. These included a maximum water production rate of 60,000 IGal/Day and 33,700 IGal/day bleed water use.

- It was reported that the Char Lake and Signal Hill boilers were correctly sized.

4 Buildings

4.1 Char Lake Water Pumping Station

The Char Lake Pump House building is a pre-engineered structure that rests upon a slab on grade foundation. The foundation is a 200 mm thick concrete slab with reinforcement in both directions. The slab is thickened to 600 mm around the building perimeter to form a grade beam. The original construction drawings do not show insulation under the slab on grade. Exterior walls of the building are made up using prefinished panels with insulation and an interior liner.

The condition of this building was examined by UMA (1996) and Dillon (1999). It was reported that the buildings had not experienced significant deterioration aside from issues such as external paint, some vehicle damage to the exterior and poor thermal performance of the envelope. It was noted that there is no combustion air intake and that this requirement was being met through air infiltration through the building envelope. During the site visit that was conducted as part of this study it was noted that the building has not been substantially changed since the previous assessment. The foundation appears to be stable and the slab does not exhibit significant cracking. The superstructure appears to continue to meet the service requirement.

It was also noted that a combustion air intake has been provided. Other ventilation issues relating to the generator cooling air supply and exhaust were noted. These are reported in greater detail in Section 6 - Mechanical.

In general the current building at Char Lake is meeting the requirement of the water supply system. It is anticipated that this building will be able to continue to meet these needs for a further 5 years. The ventilation issues should be addressed as the current situation requires the operator to travel immediately to the facility should the generator start.

4.2 Signal Hill Water Treatment Plant

The Signal Hill Water Treatment Plant building is a pre-engineered structure that rests upon a slab on grade foundation. The foundation is a 200 mm thick concrete slab with reinforcement in both directions. The slab is thickened to 600 mm around the building perimeter to form a grade beam. The original construction drawings do not show insulation under the slab on grade. Exterior walls of the building are made up using prefinished panels with insulation and an interior liner. The building is attached to the adjacent water storage tank, which provides an enclosure for the piping to the tank.

The condition of this building was examined by UMA (1996) and Dillon (1999). It was reported that the buildings had not experienced significant deterioration aside from issues such as external paint, some vehicle damage to the exterior and poor thermal performance of the envelope. It was noted that there is no combustion air intake and that this requirement was being met through air infiltration through the building envelope. During the site visit it was noted that the building has not substantially changed since the previous assessment. The foundation appears to be stable and the slab does not exhibit significant cracking. The superstructure appears to continue to meet the service requirement.

It was also noted that the need for a combustion air intake has been addressed. Other ventilation issues relating to the generator cooling air supply and exhaust were noted. These are reported in greater detail in Section 6 - Mechanical.

In general the current building at Char Lake is meeting the requirement of the water supply system. It is anticipated that this building will be able to continue to meet these needs for a further 5 years. The ventilation issues should be addressed as the current situation requires the operator to travel immediately to the facility should the generator start.

5 Civil Works

5.1 Water System

5.1.1 Intake

Water is drawn from Char Lake through 200 mm diameter steel piping into a wet well below the floor of the pump house. It was reported that this piping had been inspected by divers and confirmed to be clear of obstructions prior to 1999 (UMA 1999). There is no report of subsequent inspections of this piping. There is also no evidence that this intake is not currently operating satisfactorily.

Freeze prevention is achieved through continuous flow and an electrical heat trace cable. The heat trace cable is addressed in Section 7 - Electrical. There have been no reports of freezing of the intake line.

There is no current indication that the existing intake will not meet community need for a further 5 years.

There have been no reported changes or improvements to the water intake since 1996.

5.1.2 Char Lake Pump House

The Char Lake pump house contains those works required to heat the town drinking water and pump it to the storage tank at the Signal Hill treatment plant. More specifically the Char Lake pump house contains a wet well, water supply pumps, low flow circulating (jockey) pumps, equipment to heat the potable water supply and various support services. The support equipment includes boilers, fuel system, electrical supply and controls.

The pumping well, below the Char Lake pump house floor, was constructed using corrugated galvanized bolted steel plates. This well serves both as a wet well and as a point for heated water injection. The Operations and Maintenance (O&M) manual from the original construction reports that this heated water injection was intended to maintain the well at 44°F (6.7°C).

A pair of water supply pumps each rated at 166 IGPM (12.6 L/s) at 215 feet (65.5 m) is located in the Char Lake pump house. At any given time, only one pump is in operation, with the second pump providing 100% backup. The condition of these pumps is considered in Section 6 - Mechanical. In terms of capacity, these pumps are currently meeting the water supply needs of the community. There is limited remaining capacity to support additional water demands, including additional bleeds as current average annual consumption is approximately 9.1 L/s.

A pair of low flow (jockey) pumps has been provided that operate continuously. The current jockey pumps are a pair of submersible pumps, individually rated at 20.8 IGPM (1.6 L/s) at

221 feet (67.4 M). In principle, continuous operating of the jockey pumps could lead to overfilling of the water storage at the treatment plant. As a practical matter, this is unlikely due to the quantities of bleed water flows from the water system. Comments relating to the condition of these pumps are provided in Section 6 - Mechanical.

An important function of the Char Lake pumping station is water tempering (heating) prior to pumping to the Signal Hill treatment plant. This tempering serves both as freeze protection for the transmission water main to Signal Hill and to provide a portion of the heating prior to pumping into the community distribution system. The heat injection system is currently raising the temperature in the pumping well to 5°C, which is slightly lower than the temperature reported in the original O&M manual. The continuing operation at this temperature demonstrates that the present system is serviceable. This continuing serviceability may be due, in part, to the continuous operation of the heat trace cable in the transmission main to Signal Hill. It is also noted that there is no effective control over the quantity of heat injected into the pumping well and that the current piping arrangement provides no heat injection directly into the transmission main. The matters of control and heat injection into the transmission main are examined in Section 7 - Electrical.

In summary, the Char Lake Pump House is meeting the community needs. The existing pumping equipment has sufficient capacity for a further 5 years of service if no significant additional bleed water flows are taken from the water system. These pumps are near the end of their useful life. The current heat injection equipment is meeting the present community requirements, but improvements to the heat injection method and control has the potential for operating savings in terms of electrical energy consumption.

The current control arrangements do not provide for starting of the second supply pump at Char Lake in response to low level in the storage tank. This places the town site water system at risk of depressurization should total demand (domestic use plus bleeds) exceed supply pump capacity for an extended period of several hours. Such a situation enhances, by a large degree, the risk of water system contamination.

There has been a recent program of mechanical improvements at Char Lake pump house relating to the heating equipment. These improvements are reported in Section 6 - Mechanical. Regarding the water supply equipment at Char Lake, there have been no substantial improvements since the original construction. It appears that jockey pumps have been replaced on an as required basis, but a record of recent replacement dates has not been located. Replacement of jockey pumps is a relatively routine and uncomplicated matter.

5.1.3 Transmission Main

Char Lake pump house is connected to the treatment plant at Signal Hill by a 1.87 kilometre long transmission main. This main was constructed using 150 mm diameter high density polyethylene, protected from freeze by 50 mm of factory installed insulation and a plastic jacket. Further freeze protection is afforded by heat injection at Char Lake and an internal electrical heat trace cable.

The O&M manual reports that the main was sized to provide for a flow of 146 IGPM (11.1 L/s). Observations during the site visit indicate that the main is currently operating at 167 IGPM (12.6 L/s). The current main size is appropriate for these flow rates.

Due to the electrical connections of the internal heat trace cable, this cable is continuously operating. This represents a continuous electrical heating load of 31.5 kW that is being dissipated into the water flow between Char Lake and Signal Hill. During the site visit it was noted that the incoming temperature at Signal Hill was comparable to the departure temperature at Char Lake. Thus the electrical input of 31.5 kW is comparable to the heat loss from the transmission main.

A heat loss of 31.5 kW is approximately twice the rate that would be expected for a new pipeline. The current transmission main has been in service for approximately 30 years. Over this period the insulation may have deteriorated and there may be some water intrusion due to various effects, including seasonal freeze back pressures. There is also the possibility that some of the current insulation reflects less precise methods of pipe insulation than prevail today.

Improvements to the insulation are not viewed to be warranted as this would require replacement of the piping. The present insulated main should continue to provide reliable service if sufficient heat input is provided. An alternative method of heat input, such as improved heated water injection at the Char Lake pumping station has the potential for substantial operating cost savings due to reduction in electrical energy consumption.

5.1.4 Water Storage and Treatment

The transmission water main discharges into a 570 m^3 welded steel storage at the Signal Hill water treatment plant. The current storage volume does not meet the emergency, fire and balancing requirements identified in Dillon 1999. The current tank was constructed during the summer of 2009, following the failure of the original storage tank. The design of this new storage tank includes R20 insulation on the walls and roof.

The water reservoir that was part of the original construction is an insulated 530 m^3 bolted steel. Base upon drawing from the original construction, it appears that the original tank was insulated with 50 mm of rigid board insulation. This tank experienced substantial leakage during the early winter of 1997 due to pin-hole corrosion. An internal epoxy coating was applied as an emergency repair in December 1997, but some leakage reoccurred in January 1998. This original water reservoir has been taken out of service, and can not be returned to service without substantial repairs.

The water level within the reservoir is continually measured. The water level provides the control signals that start and stop the supply pumps at Char Lake. The control intent incorporated in the original design cycled the pumps on at a water level of 3.7 m (12.2 feet) and off at a water level of 4.5 m (14.7 feet). A historic water level chart was reviewed during the site visit and it was note that the original reservoir was operated through a greater range of its depth in the past. A water level chart for current operations was reviewed. The new reservoir is currently operated over a range of 0.3m (1 foot). This appears to be a response to the high amounts of water consumption in the community. The jockey pumps will not shut down to unusually high water level in the storage tank. This is an unlikely occurrence due to the rates of bleed water flow. An overflow has been incorporated into the new storage tank.

During the site visit it was noted that the charts for the circular recorder have become very difficult to obtain. It was also noted that the current level measurement provided only a local indication of reservoir level and the pump start and stop signals. Modernization of the instrumentation and control provides an opportunity for better record keeping and remote monitoring of levels.

Water treatment is currently limited to chlorination. A single metering pumping adds a chlorine solution to the potable water supply immediately prior to discharge from the water treatment plant. There is no monitoring of the chlorine feed pump operation, nor is there a standby metering pump equipped to assume service upon failure of the service metering pump. Chlorine residual is measured once daily by the operating contractor using a sample taken at the hotel kitchen. There is no automated monitoring of chlorine residual at the water treatment plant. No records of chlorine residual measurements at the water treatment plant were located during the site visit. An estimate of chlorine contact time is difficult to calculate as a large portion of the flow pumped to town is returned to the water treatment plant as recirculation flow. The study team has not been able to locate bacteriological testing results for the Resolute Bay water supply.

Details regarding the pumping equipment are addressed in Section 6 of this report.

5.1.5 Water Distribution System

5.1.5.1 General

The town site is served by a looped system of water mains, with return flows to the water treatment plant. The system was constructed using HDPE piping installed in a common trench with the sewer mains. The various water system appurtenances, such as valves and hydrants, are installed in Access Vaults (AV's) shared with the sewer system. Drawing C2 illustrates the water system.

5.1.5.2 Access Vaults

During the Field visit of November 23 to 26, 2009 an inspection of the AV's was conducted. The following table summarizes the water main related observations made during this inspection.

Table 5.1 – Water Main Related Observations

Location	Observation
AV 2	- 19 mm copper bleed into clean-out; substantial flow - Contains supply and return mains
AV 3	- Water entry around water main from uphill side of AV; ground water or main leak.
AV 4	- 13 mm bleed valve; valve appears open but no bleed flow.
AV 5	- Generally clean and relatively dry
AV8	- Wall temperature 0.5 to 3°C - 13 mm plastic tube bleed with liberal flow draining into AV base - Piping immersed to top of lower clean-out - Refer to Photo 5.1.5.a
AV 13	- Modest accumulation of water in bottom of AV
AV 14	- Water in bottom to top of clean-out - Bleed installed; low or no bleed flow into AV - Refer to Photo 5.1.5.b
AV 16	- Water in bottom to top of clean-out
AV 17	- Connection to Hamlet garage in AV - Relatively clean and dry - Clean-out cover in place - Bleed connected to clean-out - Refer to Photo 5.1.5.c
AV 18	- Could not access; cover frozen in place
AV 19	- AV relatively clean and dry - Bleed connected but not in operation
AV 20	- Contains connection to Health Centre - Water inflow from carrier pipe for Health Centre water service - Water in AV to top of lower clean-out
AV 21	- Repair clamp on water main - Sewage in bottom of AV to top of lower clean-out - Refer to Photo 5.1.5.d
AV 23	- Significant water inflow around exterior of disconnected piping to west; ground water or water main leak.

Table 5.1 – Water Main Related Observations (Continued)

Location	Observation
AV 25	- Large bleed water flow; 13 mm plastic tube at full flow. - Refer to Photo 5.1.5.e
AV 27	- Inspection not possible as AV filled with sewage to within 0.3 of cover.
AV 32	- Water in bottom to top of clean-out - 19 mm PE bleed connection submerged in clean-out - Refer to Photo 5.1.5.f
AV 40	- 19 mm copper bleed piped to clean-out; substantial bleed flow
AV 41	- Water only in AV - Relatively clean and dry - Piping surrounded in ice to pipe mid-line - Refer to Photo 5.1.5.g
AV 42	- Relatively clean and dry
AV 43	- Evidence of sewage on all piping; likely result of sewage back-up - Refer to Photo 5.1.5.h
AV 44	- Clean out cover in place
Lot 53	- Top off of service box; appears to have been removed by snow clearing

The water and sewer system operating contractor reports that bleeds operate in AV's 4, 6, 12, 17, 21, 25 and 27.

The most important observations that are made in connection with Access Vaults relate to the risk of contamination of the water supply from the sewer system. In almost all instances the water system AV's are shared with the sewer system. In almost all of the AV's piping has been provided to permit bleeds from the water system into the sewers. In many instances these bleed connections are active. With the exception of a very limited number of locations these bleeds include no back-flow prevention measures. In those instances where some back-flow preventative measure is provided, this measure takes the form of a single check valve. In no instances was approved back-flow preventors noted.

The original construction of the AV's included sealed covers for the sewer clean-outs. In almost all instances these covers have proven to be operationally inconvenient. There is currently no method available to drain water that accumulates within the AV's, except through the open clean-outs.

In addition to the bleeds to the sewers, it was noted that there is other equipment within the AV's that represents potential routes for contamination. These include service saddles, various un-capped valves and hydrant drains. All of these locations represent points of potential contamination.

The risk of contamination arising from conditions within the AV's is exacerbated by water demands that are approaching supply capacity. A further increase in bleed rates could increase demands beyond supply creating a risk of loss of pressure in the water system due to a shortfall in supply.

During the inspections, evidence of sewage back-up was noted at AV's 21, 27 and 43. These sewage back-up had not been contained within the sewage system as the clean-out covers are generally not in place. Additionally, the AV's have not been cleaned following the resolution of sewer blockage or back-up.

In general, the conditions within the AV's indicate that there is no ongoing program of inspection or verification and that most operating action is in response to emergency conditions.

Electrical service panels have been provided to supply most of the AV's that are equipped with hydrants. These panels provide two functions. Firstly, electric heat trace cables and insulation has been installed on the hydrant barrels. Secondly, these panels provide a supply of electrical power during repairs.

Further comments regarding the AV's, as they relate to the sewer system, are provided in Section 5.2.2 of this report.

5.1.5.3 Water Distribution System Piping

The existing water system piping was installed in two phases of construction in the late 1970's. Recently an extension to the system was constructed within a new subdivision along the south limit of the town site. The original system was installed as a single loop with return flow to the water treatment plant. A short section of dead-end water main was installed between AV's 23 and 25. The recent extension from AV 16, though AV's 41 and 44 to AV 13 was installed in parallel with the existing loop between AV's 16 and 13.

The system may be described as shallow bury with typical cover of one metre. This places the piping near the bottom of the active layer. Shallow bury installation was a common practice in the Arctic during the era when this system was constructed. This vertical placement of the piping places the water system within the influence of annual freeze action, which can exert substantial pressure against the insulation system if free water is present during the annual re-freeze. There are few opportunities to increase cover during the course of repairs as elevations are fixed by existing AV's.

A review of the drawings for the water system has not provided information regarding the typical details of the trench. Thus, information such as depth of bedding or actions taken in response to ice rich soils is not available.

Pressure for water flow to the town site is boosted by a pump rated at 30.8 L/s (488 USGPM) at 25 metres (82 feet) head. Water not consumed within the town site, either in the form of domestic use or bleeds to the sewers, is returned to the water treatment plant for re-heating. The O&M manual suggests that water departing the treatment plant be heated to 10°C. During the site visit the departing water temperature was noted as 14°C (57°F) and the return flow temperature was 12°C (54°F). This represents a temperature drop of 2°C across the system. The Operations and Maintenance Manual does not provide guidance regarding the temperature depression estimated by the system designers.

A thermal analysis of the existing water system has been conducted. The following are the findings of this analysis:

- Heat loss is approximately 5 times greater than would be expected for a new system with modern insulation. This suggests that ongoing freeze and thaw has damaged the insulation system, and that there may some water penetration into the insulation.

- The predicted return temperature is not very sensitive to the rate of water consumption within the town site. This appears to arise from the capacity of the circulation pump in the water treatment plant. The total flow pumped into the town site is substantially greater than consumption.

- A reduction of the operating temperature to 10°C does not lead to a substantial change in the temperature drop across the water system. A careful review of all factors, including risks should be conducted prior to reducing the water temperature. Heat loss from the water system is driven by the total temperature difference across the insulation system. At the current water temperature of approximately 15°C the total temperature difference across the insulation is approximately 35°C. Reducing the water temperature to 10°C will reduce this temperature difference by 15% leading to a comparable reduction in heat loss. The risks associated with the modest reduction must be carefully examined.

- The recent system extension from AV 16, through AV's 41 and 44, to AV 13 has created parallel loops. The arrangement creates a portion of the water system, within which circulation rates and directions can not be predicted.

5.1.5.4 Service Connections

The construction drawings present the original service connections as a bundle that contained both the water and sewer services. This bundle was protected with 80 mm of polyurethane insulation. Most, if not all, of these services have been replaced with separate piping for water and sewer service. The current standard incorporates a pair of 25 mm polyethylene service tubes installed within a 100 mm preinsulated carrier pipe. The carrier pipe insulation is 50 mm in thickness.

The service connections are the most vulnerable portion of the water system in terms of freeze risk. This is the result of the service connections experiencing the lowest temperatures on the water system combined with the low mass of water contained within the two small diameter service tubes. Freeze protection is provided by a small circulating pump in each connected building. There has been some freezing of service connections, on an ongoing basis. This is usually the result of failure of the circulating pump. The community is aware of this risk and is capable of thawing frozen service connection. All of the circulating pumps within the building visited were found to be operating.

It was noted that PEX has been used for service tubing in several buildings. This is a variation from the normal practice in Nunavut, which is the use of high density polyethylene tubing. The current material appears to operating satisfactorily.

A system of plywood "curb boxes" has been developed to provide access to the connection points to the water and sewer mains. In general, a curb box has been provided for each service connection. These curb boxes appear to provide suitable access to the water service shut off valves. In some instances these boxes are vulnerable to various activities such as snow removal. There is no obvious resolution for this vulnerability. As a general observation the curb boxes have resolved earlier concerns regarding access to the service connections points, especially during winter conditions.

5.1.6 Water System Improvements

The Terms of Reference for this study request that various sources be canvassed and that the changes and improvements to the system since 1996 be documented. Recently substantial changes have been made to the heating equipment in both the Char Lake pump house and Signal Hill treatment plant. These changes are reported in those sections of this report dealing with the mechanical and electrical elements of the water system. Table 5.2 summarizes those changes to the civil works. In general there have been few, if any, changes within the Char Lake pumping station or within the Water Treatment Plant.

Table 5.2 – Summary of Water System Improvements

Date	Description	Source
1993	New heat trace between Char Lake and Signal Hill	Dillon 1999
Unknown	Provision of jockey pumps at Char Lake	Dillon 1999
1998	Electrical equipment removed from AV's	Dillon 1999
1998	New hydrant at AV 13	Dillon 1999
1998	Replace valves in AV 3	Dillon 1999

Table 5.2 – Summary of Water System Improvements (Continued)

Date	Description	Source
1998	Additional valve in AV 30	Dillon 1999
1985 or 1986	Pipe section replaced between AV's 10 and 12	Operating Contractor
1999	Drawing prepared for replacement: • AV 20 to 22 • AV 21 to 30 to 29 • AV 8 to 9 to 10 • Approximately 8 AV's with steel AV's Project not constructed	Dillon Drawings, Project Number 98-5748-000
2003	Piping replaced between AV's 5 and 6	Operating Contractor A. D Williams drawing G-03-1, April 2005
2003	Piping replaced between AV's 9 and 10	A. D Williams drawing G-03-1, April 2005
2003	Piping replaced between AV's 10 and 12	Operating Contractor
2003	Piping replaced between AV's 27 and 28	Operating Contractor A. D Williams drawing G-03-1, April 2005
2003	Piping replaced between AV's 29 and 30	Operating Contractor A. D Williams drawing G-03-1, April 2005
2005	Heat trace hydrants	T Livingston memo of January 14, 2005.
2008	Replaced most of piping between AV's 27 and 28 due to electrofusion failures. Previously replaced in 2003	Operating Contractor
2009	Piping replaced between AV's 10 and 12. Previously replaced in 2003	Discussion with Hamlet staff
2009	3 repair clamps instated between AV's 6 to 8	Operating Contractor
2009	Electrofusion coupling replaced west of AV 10	Operating Contractor CGS Staff
2009	System extension constructed from AV 16, through 41 and 44 to AV 13	CGS

5.2 Sewer System

5.2.1 General

The town site is served by a system of gravity sewers than drain through a macerator prior to discharge at an outfall on the beach. The system was constructed using HDPE piping, installed in common trenches with the water distribution system. Access to the sewer system for ongoing operation is provided at Access Vaults (AV's), which are shared with the water system. The sewer system is depicted in Drawing C 3.

5.2.2 Access Vaults

During the field visit of November 23 to 26, 2009 an inspection of most of the AV's was conducted. In general it was noted that, with few exceptions, the clean-out covers within the AV's had been removed. The implications of the removal of these covers, within the context of the potential risk of water system contamination, are discussed elsewhere in this report. Most AV's were filled with water to the cover elevation of the lowest clean-out. Currently water bleeds discharge into the AV's, with the overflow draining into the clean-outs. The operating contractor reports this measure was instituted to prevent freeze within the AV's. The relatively low internal wall temperatures (0.5°C to 3°C) noted during the site visit are consistent with this comment by the operator. Bleeds into the AV's are the only method currently available to introduce some heat into the AV's.

The following table summarizes various observations relating to the sewer system.

Table 5.3 – Sewer Related Observations

Location	Observation
AV 2	- Bleed into sewer; rocks in clean-out - Debris and rocks in clean-out - Refer to Photo 5.2.2.a
AV 3	- Substantial flow (clear water) in sewer
AV 4	- AV relatively clean and dry - No bleed flow into sewer at this location
AV 5	- Substantial flow in sewer - Refer to Photo 5.2.2.b
AV 8	- Substantial flow (clear water) in sewer - AV relatively clean - Refer to Photo 5.2.2.c
AV 13	- Large flow in sewer; large change from AV 14 upstream; large bleed flow from connected buildings

Table 5.3 – Sewer Related Observations (Continued)

Location	Observation
AV 14	- AV relatively clean - Low flow in sewer
AV 16	- Abandoned sump pump still in AV
AV 17	- Connection to Hamlet garage in AV - Relatively clean and dry - Clean-out cover in place - Bleed connected to clean-out - Refer to Photo 5.2.2.d
AV 18	- Could not access; cover frozen in place
AV 19	- Low flow in sewer - No bleed flow into sewer
AV 20	- Large flow in west to east direction - AV contains outlet from Health Centre; potential obstruction in elbow on Health Centre connection
AV 21	- Large flow (mostly water) towards south - Poor flow in west to east direction - Significant evidence of sewage in AV - Refer to Photo 5.2.2.e
AV 23	- Piping immersed to midline; otherwise unremarkable
AV 25	- Upstream end of sewer; large bleed into AV
AV 27	- AV filled with sewage to within 0.3 of cover. - Downstream blockage cleared by operating contractor on November 25, 2009. Blockage reported to be caused by ice.
AV 32	- Substantial flow in north to south direction; flow is largely clear water - Refer to Photo 5.2.2.f
AV 40	- New AV; clean out cover removed - Bleeder piped to clean-out; equipped with check valve - Substantial bleed flow into clean-out - Refer to Photo 5.2.2.g
AV 42	- New AV; relatively clean
AV 43	- Previous back-up evidenced by sewage on all piping and walls to approximately 0.3 above piping.

Table 5.3 – Sewer Related Observations (Continued)

Location	Observation
AV 44	- Clean-out cover appears to be in place - Miscellaneous debris in AV

During the AV inspections substantial flow that was very clear was noted at many locations. This is the result of large amounts of bleed water flow into the sewer system, both at AV's and from connected buildings. Arrangements to permit bleeding of water into the sewer system were noted in virtually every AV inspected.

Evidence of sewage backup was noted in AV's 21, 27 and 43. This suggests issues with the connected piping. These backups could have been the result of downstream pipe freeze or blockage due to accumulation of sediment. The high rates of bleed flow appear to be a response to operating challenges with pipe freeze.

Various forms of debris were noted in many AV's. This includes small rocks both within the AV's and in the clean-outs. It appears that an AV inspection and cleaning program has not occurred for an extended period of time.

The construction drawings for the AV's note an insulation thickness of 75 mm and internal electric heaters. The AV's experience high rates of heat loss, as the tops are exposed to winter weather, and the vault walls experience the lowest temperatures of any portion of the utility system. A recent program of insulating and heat tracing the hydrant barrels is a further indication of ongoing challenges with low internal temperatures within AV's.

The current generation of AV's, installed in other communities in Nunavut, incorporate 125 mm of insulation, which reduces heat loss from AV's by 67%.

5.2.3 Sewer System Piping

The sewer system was installed in two phases in the late 1970's. A recent extension was constructed to accommodate a subdivision. The system flows in 6 branches starting at AV's 3, 4, 17, 19, 27 and 40. The system may be described as shallow bury with typical cover of one metre, placing the pipe near the bottom of the active layer. This vertical location of the pipe places the system within the influence of annual freeze action. The design drawings did not indicate the trench cross section used. Information such as bedding depth, actions in response to ice rich soils and the anticipated interaction between the piping and the permafrost cannot be determined.

Close circuit television (CCTV) data has been provided by CGS for the following sections of the sewer system:

- AV 6 to 5

- AV 29 to 6
- AV 25 to 23
- AV 23 to 13

Drawing C4 depicts the locations where CCTV inspections were conducted. This drawing has been annotated with comments regarding the observations made from the CCTV survey. The following provides additional comments relating to the CCTV inspection.

All of these sections displayed out of round distortion of the piping, both horizontally and vertically. All of the sewer sections also display sags and rises in the pipe profile. Internal ice accumulation was observed at some locations above the waterline. The observed pipe distortion and the sags in profile are not large enough to substantially change the hydraulic capacity of the system. The concern that arises from these observations is the impact upon the insulation system and the interaction of the piping system with the underlying permafrost.

The piping profile places the sewer near the bottom of the active layer and within the area where annual refreeze is experienced. It is likely that ice lensing, thaw settlement and heave has occurred. Ice lenses form during the annual refreeze, exerting pressure against the external surface of the insulated piping system. These pressures have been sufficient to be transmitted to the internal core pipe causing the internal distortions from the original circular cross section. This process has lead to compression of the insulation system, and has also likely caused water penetration into the insulation system, resulting in increased rates of heat loss.

The sags and rises observed from the CCTV inspection suggest heave and thaw settlement. This has occurred because the thaw influence from the piping has extended beyond the pipe bedding into the underlying permafrost. This heating influence has likely caused thaw of some ice rich soils, especially during the summer season. Heave is the result of ice lens formation in frost susceptible soils during the annual refreeze. Both of these behaviours have lead to sags in the pipe profile.

The sags in the pipe profile have not substantially changed the hydraulic capacity of the sewer system, but the risk of piping freeze has substantially increased. Pools of water accumulate in these sags, and the water within these pools is only displaced at the rate that new flows are discharged into the sewer. Ongoing heat loss into the surrounding colder soil occurs from this stagnating water. Gradual freeze will occur unless the incoming flows provide enough additional heat to offset the loss into the soil. The ultimate outcome of this process is piping freeze and blockage. It was noted in Section 5.2.2 above that there is considerable bleed water flow into the sewer system, both at AV's and from the connected buildings. These bleed flow represent an operational effort to avoid freeze of a deteriorated system.

In summary the following comments can be provided regarding the sewer system piping:

- Distortion of the piping system demonstrates that the piping has been subjected to external pressure due to annual refreeze.

- Sags in the pipe profile suggest thaw settlement has occurred.

- The combination of degraded insulation and sagged profiles substantially increases the risk of piping freeze.

- High rates of water bleeding are an operational effort to reduce the risk of freeze.

5.2.4 Service Connections

The construction drawings present the original service connections as a bundle that contained both the water and sewer services. This bundle was protected with 80 mm of polyurethane insulation. Most, if not all, of these services have been replaced with separate piping for water and sewer service. The current standard incorporates 50 mm of insulation.

In many locations the service connections are shallow and installed with relatively flat gradients. This is due to a combination of shallow burial of the sewer main and the elevation of the houses. The resulting gradients are sufficient to convey flows if the piping profile is stable and the piping is unobstructed. The shallow depth of the service connections places this piping within the active layer where it is vulnerable to heave and thaw settlement. Shallow depth also subjects the service connections to the lowest temperatures experienced along the sewer system.

Service connections represent that part of the sewer system that is most vulnerable to freeze. Heat loss is high due to low ambient temperature. There may be protracted periods, such as overnight, when there is no heat input as there is no flow. Installation in the active layer places this pipe at risk of sags due to heave and thaw settlement. The risk of freeze of the service connections is demonstrated by the operational experience with the system.

During the site visit a sample of houses were visited. In all cases bleeds directing flow to the sewer connections were installed. All but one of these bleeds was active. Representatives of the Housing Corporation reported that these bleeds are essential for the maintenance of service. On this basis, it is concluded that there are approximately 75 active water bleeds on sewer service connections. The flow at each individual connection is modest, but the combined outcome of these bleeds is significant. If each bleed represents a flow of only 0.04 L/s (1/2 IGPM), then the impact of service connection bleeds is approximately 1/3 of the total town site water consumption.

5.2.5 Sewage Treatment

The only sewage treatment measures currently in place in Resolute Bay is a macerator. During the site visit this macerator was out of service and the bypass was in operation. The existing macerator is the original, installed in the late 1970's. It has reached the end of its useful life.

Selection of an appropriate replacement for the macerator is a complex issue. The current arrangement is not providing an appropriate degree of treatment. Any treatment works must deal with all of the flow at the outfall. A suitable location for the treatment works must be identified and a more appropriate treatment method must be selected.

In summary, the current treatment works dispose of sewage into the sea, and will be able to continue to do so for a further 5 years. Sewage will continue to be untreated prior discharge.

5.2.6 Sewer System Improvements

Various sewer system improvements have been implemented since 1996. Table 5.4 summarizes the changes and presents the sources for this information.

In addition to the above repairs and replacements, Table 5.5 lists the remaining operating issues with the sewer system.

Table 5.4 - Sewer System Improvements

Date	Description	Source
1998	Electrical equipment, including sump pumps, removed from AV's	Dillon 1999
1999	Drawing prepared for replacement: • AV 20 to 22 • Approximately 8 AV's with steel AV's Project not constructed	Dillon Drawings, Project Number 98-5748-000
2006	Short section of piping (1.5 m) replaced north of AV 10	Operating Contractor
2007	10 m section of piping replaced between AV 9 and 10 due to collapse	Operating Contractor
2009	System extension constructed from AV 41 through 44 to 32	CGS

Table 5.5 - Sewer System Operating Issues

Location (AV to AV)	Issue
25 to 23	- Frequent freezing
27 to 12	- Noted blocked due to freeze on November 25, 2009
28 to 8	- Frequent freeze - Low flow - Grease build-up
29 to 6	- Frequent blockage
21 to 30 and 30 to 29	- Previous history of freeze

6 Mechanical

6.1 Char Lake Pumping Station

6.1.1 General

The Char Lake pump house is used to draw water from Char Lake which is the potable water source for the community of Resolute.

Water is drawn by gravity from Char Lake into a pumping well below the pump house floor. Heated water is injected into the pumping well to raise the temperature of the incoming water. The water is then pumped to the Signal Hill water treatment plant through a 1.8 kilometre long, 150mm diameter, insulated and electrically heat traced high density polyethylene transmission main.

Two pumps operating in alternation are used to refill the storage tank at the Signal Hill treatment plant. Between tank fill cycles, a pair of jockey pumps operates to maintain minimum flow in the transmission main.

The Char Lake pump house also contains various mechanical systems and equipment that support the water supply system. Two oil fired boilers provide most of the heating capacity for the building. Through a pair of heat exchangers, potable water is heated for injection into the wet well and to the outgoing pipe to Signal Hill water treatment plant. Two hot water unit heaters and one oil fired unit heater are used for heating the building.

The fuel distribution system includes one main storage tank, two day tanks and distribution piping. This system feeds, mainly by gravity, the various oil burning equipment in the building, including an emergency generator.

The boilers, hot water pumps and heat exchangers were installed in 2009, jockey pumps were installed in 1994 and the rest of the mechanical equipment dates to the original installation in the 1970's.

Refer to Drawing M2 for an overview of the pump house components.

6.1.2 Potable water system

6.1.2.1 Duty Pumps

A pair of pumping systems has been installed in the Char Lake pump house. Refill of the storage tank at the Signal Hill Water Treatment Plant is achieved using a pair of 20 HP, 12.6 L/sec (200 usgpm), vertical turbine pumps that are operating in alternation. During the site investigation, the two pumps were leaking and water was accumulating on the floor of the pump house. The pumps are original to the building and do not appear to have had an overhaul or major repair.

6.1.2.2 Jockey Pumps

Between tank fill cycles a pair of submersible jockey pumps operates to maintain a minimum flow of 3.2 L/s (50 usgpm) in the transmission main. The jockey pumps were installed in 1994. At the time of the site visit, one of the two pumps was not operational. A new pump had been ordered to replace the one that had failed.

6.1.2.3 Flow Monitoring

The rate of flow and the total quantity of water pumped from Char Lake is measured by a magnet flow meter in the Char Lake pump house.

6.1.2.4 Hot Water Injection

A portion of the water pumped is heated by heat exchangers to a temperature measured to be 33^{o}C (92^{o}F). This heated potable water is injected in the wet well to maintain a water temperature of 5^{o}C in the well. There are no automatic controls to maintain this temperature.

A small portion of heated water is also injected on the discharge side of the pumps to heat the water that is pumped to Signal Hill. However, there are no controls installed and when one of the duty pumps is in operation; the injection of hot water is negligible. Water temperature difference before and after was measured and confirmed to be insignificant. The heat trace cable installed in the main water supply piping between the Char Lake Pumping station and the Signal Hill Water Treatment Plant is not controlled. This heat tracing is always "ON" The connected load of the heat tracing is 31.5kW. If this system functions 365 days a year, 24 hours per day, this represents consumption of 275,940 kWhrs annually.

6.1.2.5 Piping

The potable water piping system in the Char Lake pump house is a mix of schedule 40 black steel, galvanized steel and newer copper piping.

6.1.2.6 Equipment Characteristics

Duty pumps characteristics:

- Quantity: 2
- Make : Layne & Bowler
- Model: Verti-line
- Type: Vertical turbine
- Flow: 12.6 L/s (200 usgpm)
- Head: 640 kPa (214 ft. H_2O)

- Motor: 20HP

Jockey pumps characteristics:

- Quantity: 2
- Make : Grundfos
- Flow: 1.6 L/s (25 usgpm)
- Motor: 2HP

6.1.3 Fuel System

6.1.3.1 General

The fuel system at the Char Lake pump house consists of three holding tanks: a 9090 L (2000 imp. gal.) tank installed outside, 1135 L (250 imp. gal.) day tank installed inside the building as well as a 115 L (25 imp. gal.) generator day tank. All tanks are interconnected. The system is used to feed the oil fired equipment that includes the emergency generator, two hot water boilers and one unit heater.

6.1.3.2 Main Storage Tank

The 9090 L (2000 imp. gal.) above-ground fuel storage tank is installed outside the building, across the road from the pump house. The tank is original to the building. The tank is without ULC Label, secondary containment, leak detection, overflow, overfilling protection and is vented directly to the exterior. After a leak in the transfer fuel line in the mid 80’s, the tank has been relocated to approximately 10 m away from the pump house.

6.1.3.3 Fuel Transfer Pumps

Single-wall black steel pipes installed underground, passing under a road, feed by gravity the 1135 L (250 imp. gal.) day tank installed inside the pump house. There is no leak detection installed between the main tank and the day tank. At the pump house, the pipe runs up against the exterior wall inside a wooden protective box, enters the building and then passes through a filtration station before entering the day tank. A fire valve is installed upstream of the filtration system.

6.1.3.4 Day Tanks

The larger day tank is a single wall tank, installed directly next to the potable water wet well (refer to Photo 6.1.3.a). The tank is gravity fed from the main tank outside. The tank has no ULC Label, secondary containment, leak detection, overflow, overfilling protection and is vented directly to the exterior. The termination of the vent line is higher than the vent of the main tank installed outside, in order to prevent a spill in case of overfilling.

The new oil fired unit heater and burners of the boilers are fed from the larger day tank.

The emergency generator has a small day tank gravity fed from the 1135 L (250 imp. gal.) day tank. This small day tank is a single wall tank, directly vented to the exterior with no secondary containment and no overfilling protection. There is a solenoid valve installed on the fill side of the tank. When the generator starts, the solenoid will open and the tank will fill, including the vent pipe, until the levels between the main tank outside the building and the generator tank are balanced, which will mean that the vent pipe is partially filled with fuel and that the tank is pressurized. This type of tank is not designed to be pressurized so the risk of failure is increased.

6.1.3.5 Current Status and Recommendations

According the National Fire Code and CSA-B139 standard, the underground fuel transfer lines between the main storage tank and the building should be of double-wall construction with leak detection. In the event of failure of the buried piping, fuel could contaminate the ground and eventually the water of the lake before the leak is noticed.

Fuel transfer pipes should be installed in such a way that fuel cannot be trapped anywhere, as required by CSA-B139. Because the fuel lines go from the above-ground storage tank, to under the ground and then up again in the pump house, the underground fuel line will always be full of fuel. In order prevent this from happening, fuel transfer pumps would have to be installed in a sump to fill the day tank. The transfer pumps and associated controls would also reduce the risk of overfilling and pressurizing the day tank.

The code also requires secondary containment with leak detection, low level and high level alarms for all the tanks, including tanks installed outside and inside. In the current configuration, a failure of one of the tanks installed in the building would mean that the entire volume of fuel contained in the day tank, the main storage tank and the piping would flow in the pump house, potentially contaminating the water in the wet well and/or cause a fire. The wet well is partially protected by a small concrete "berm" which cannot be considered as secondary containment for the fuel.

As required by the National Fire Code and CSA-B139, the day tanks should be vented through the main storage tank, in which case the vent of the day tank is also considered as its overflow. If the day tank is vented directly to the exterior, a variance generally accepted is to install redundant high level sensors to shut the transfer pumps off and prevent the overfilling of the tank.

Because of the criticality of the equipment fed by emergency power, good engineering practice would require to reduce to a minimum the number of single points of failure in the fuel transfer system to the generator. The generator small day tank is one high risk point of failure and must be removed. The generator could be fed directly from the larger day tank in the same way as the heating equipment installed in the room or from a dedicated day tank that would have a dedicated set of transfer pumps and transfer lines to the outside fuel storage tank.

The fuel system's performance is unsatisfactory. The fuel tanks and fuel transfer system have zero years of remaining service life. Because of these reasons, code violations and associated risk, the replacement of the entire fuel system is mandatory.

Fuel storage quantity, according to the Government of Nunavut Good Building Practices Guideline, would be of a minimum of two weeks calculated at continuous maximum operating load, including heating and emergency power. The rational is that blizzards and storms can make delivery difficult for periods up to two weeks. Based on a fuel consumption of 3 gal/hr and one boiler used for redundancy, the minimum required fuel storage capacity would be of 22,275 L (4,900 imp. gal.). The current fuel storage capacity would provide autonomy of 128 hours (5 days and 8 hours) at full load. Fuel consumption for the previous years should dictate the amount of fuel storage required.

Because of the potential leaks and comments from the maintenance contractor about a leak that occurred approximately twenty years ago, it is desirable to test the drinking water for benzene, toluene xylene (BTX) contamination.

(Refer to Drawing M4 for fuel system diagram)

6.1.4 Boilers, Heat Exchangers and Heating Pumps

6.1.4.1 Boilers

Two oil fired cast iron boilers, using Riello fully modulating burners with UV scanner for flame detection were installed in 2009. The boilers are used to provide part of the heating necessary for the building and to heat the potable water that is injected in the well and to the water line at the discharge of the potable water pumps. The boilers operate to maintain the hot water supply temperature setpoint. There is no controller to allow sequential operation and no means to control the potable temperature in the well or in the piping between Char Lake pump house and the Signal Hill water treatment plant. Both boilers were operating at the time of site review. (refer to Photo 6.1.4.1.a)

6.1.4.2 Heating Pumps

Two primary pumps installed in parallel ensure flow through the boilers and heat exchangers. The pumps operate at constant volume and only one pump operates at a time in a lead/lag configuration. The capacity of one pump is sufficient to operate both boilers and both heat exchangers. The pumps were installed in 2009.

6.1.4.3 Heat Exchangers

Two stainless steel plate and frame heat exchangers are installed to transfer heat from the heating water to the domestic water. The heat exchangers were installed in 2009. (refer to Photo 6.1.4.3.a)

6.1.4.4 Equipment characteristics

Boilers characteristics:

- Quantity: 2
- Make : DeDietrich
- Model: GT 430-9 A
- Construction Type: Cast Iron
- Input: 570 kW (1947 MBH), 13.50 usgph of nb. 2 oil
- Output: 485 kW (1655 MBH)
- Fluid: Water
- Flame detection: UV scanner
- Burner Make/Model: Riello / RL 50/M

Heating pumps characteristics

- Quantity: 2
- Make : Grundfos
- Model: TP 80/240-2
- Type: Centrifugal inline
- Flow: 11 L/s (175 usgpm)
- Head: 142 kPa (47.4 ft. H_2O)
- Motor: 3HP

Heat exchangers characteristics:

- Quantity: 2
- Make: AIC
- Model: A 70X-1G1-50/22
- Type: Plate and Frame
- Material: Stainless Steel 316, nitrile gaskets
- Flow hot-water: 5 L/s (79 usgpm)
- Flow cold water: 7.2 L/s (114.1 usgpm)
- Hot water Temperature in: 87.8 ^{o}C (190 ^{o}F)
- Hot water Temperature out: 65.5 ^{o}C (150^{o}F)
- Cold water Temperature in: 5 ^{o}C (41 ^{o}F)
- Cold water Temperature out: 20 ^{o}C (68 ^{o}F)
- Capacity: 1543 MBH

6.1.4.5 Current Status and Recommendations

There is no make-up water to the boilers. In the event of a leak, the boilers would shut-down until someone comes to fill the system back up. This would represent a serious risk for freezing. There is another source of heating for the building which is an oil fired unit heater, also installed in 2009; however the boilers are the only source of heat for the water in the well. The oil fired unit heater was not operational at the time of the site review.

There is no alarm for boiler failure. Because boilers are a critical element to maintain the water well temperature and building temperature above freezing point, it is desirable to provide a failure alarm.

There is a chemical pot feeder installed, but the system has been filled with untreated water. Chemical treatment should be added to the system to prevent premature corrosion and scaling.

The hot water piping system was designed and built in such a way that glycol could easily be used instead of water. This would eliminate the risk of damaging the boilers and piping in case of freezing of the building. Good Building Practices for Northern Facilities recommend the use of a 50% non-toxic Propylene-Glycol for this type of installation.

6.1.5 Ventilation and Building Heating

6.1.5.1 Generator Ventilation

The Char Lake pump house has minimal ventilation. The only mechanical ventilation in the building is a supply fan that starts when the emergency generator starts.

The generator supply fan starts in the event of a power failure. The suction side of the fan is connected to a set of two motorized dampers, one for outside air and the other for recirculation air. The dampers are not operational, the outside air damper remains fully opened and the recirculating air damper remains closed.

There is a relief damper connected to an opening in the roof that was designed to open when the generator fan starts. The damper is not operational. In the event of a power failure, the operator has to open the door of the building to prevent overheating of the generator engine.

A new combustion air intake has been added in 2009. Outside air enters the building at floor level. In order to prevent risk of freezing of nearby water piping, a “skirt” should be added from the floor to allow the air to heat up before entering the building at high level in accordance with Good Building Practices Guideline for Northern Facilities.

The radiator of the generator is not connected to any ductwork or opening to the exterior. It therefore discharges hot air directly in the room, which heats up rapidly and can cause the generator to fail if the building heat losses, especially in summer, are insufficient. This is also in contradiction with the requirements of CSA-B139, the code for oil burning equipment.

6.1.5.2 Unit Heaters

There are two hot water unit heaters and one oil fired unit heaters to maintain the building’s indoor air temperature. The oil fired unit heater was not operational at the time of the visit.

6.1.5.3 Current Status and Recommendations

The discharge of the generator supply fan is directly aimed in the direction of water piping. In the event of an extended power failure during winter; there is a risk of freezing the water piping which could cause failure of the pipe.

The ventilation of the building is not satisfactory and can cause various failures such as generator failure from overheat or pipe failure from freezing water. The provision of a new ventilation system for the building is a high priority.

6.1.6 Controls

6.1.6.1 Alarms

Controls are very limited at the plant. Most of the control devices are original to the building and are either de-commissioned or not operational. Presently, the only alarm from the building's controls is a low building temperature alarm. There is no alarm for failure of the boilers or for low water temperature.

6.1.6.2 Ventilation System Controls

Controls for the ventilation system must form part of the high priority revision of the ventilation system of the building.

6.1.6.3 Water Temperature Controls

It is desirable that the water temperature in the wet well be monitored and controlled as well as the water leaving the pump station going to the treatment plant. In the current configuration, water flows at nearly constant rate into the wet well. There is no balancing valve installed and no way to control the flow of water injected in the well. The operators have partly closed ball valves to limit the amount of water being heated by the heat exchangers and injected in the well. Ball valves are not designed to control flow.

Because the injection of hot water is on the discharge side of the potable water pumps, which are the same that are used to circulate water through the heat exchangers (refer to diagram), the injection of hot water is not possible, leaving the electrical heat tracing as the only source of heat between Char Lake pump house and the Signal Hill water treatment plant.

Hot water injection into the flows to the Signal Hill treatment plant is a passive system, dependent upon pressure differences between the supply point to the heat exchanger and the injection point. The current arrangement does not provide a meaningful quantity of heat injection due to the piping arrangement. The sole current means of heat input into the supply main to Signal Hill is the electrical heat trace cable.

In order to reduce the energy costs for heating the water, the water temperature from the pumping station should be measured inside the water treatment plant. A system of control valves should be added to control the quantity of hot water required to be mixed to maintain acceptable water temperature between the two buildings.

A two way valve controlled by a temperature sensor monitoring the wet well's water temperature should modulate the quantity of hot water injected in the well.

6.1.6.4 Boilers Controls

Also to reduce the energy costs by improving the boilers efficiency, a controller should be added to sequentially control the operation of the boilers. A three way valve on the hot water side would have to be added to ensure constant flow of water through the boilers.

To improve the reliability of the installation, the new boiler control system should provide the ability to remotely start and stop the boilers via internet, provide information on the status of the boilers and send alarms for failure.

6.1.7 Improvements

The following are recent improvements to the Char Lake pumping station

2009: Replacement of boilers

2009: Replacement of hot water pumps and hot water piping

2009: Installation of heat exchangers

2009: Installation of oil fired unit heater

6.2 Signal Hill Water Treatment Plant

6.2.1 General

The water treatment and storage facility is located on Signal Hill, immediately above and behind the town site. Water from Char Lake is directed into a recently complete 570 m^3 welded steel storage tank. The storage tank, which was constructed as part of the original installation in the late 1970's, is also located at the Signal Hill facility. Due to leakage, this older tank is no longer in service.

Treatment is limited to chlorination. Chlorine solution is injected into the water supply to town, immediately prior to point where the piping leaves the building. Heat is injected into the water storage tank and into the flow leaving the treatment plant.

The water pressure for the flows to town is boosted by a pair of pumps that operate in alternation. The pressure boost provided by the pumps is intended to ensure circulation of the water supply and return flow to the water treatment plant. With a system of butterfly valves and check valves, it is possible to by-pass the pumps at the water treatment plant to rely only on the pumps at the Char Lake Pump Station to circulate water through the town. This can only be used temporarily because those pumps will also fill the storage tank up which will eventually overflow. It is also a possibility to rely on gravity to pressurize the potable water supply to town, however, in this arrangement, there would be no circulation of water in the return line so the system would therefore be subject to freezing.

The water treatment plant also contains various mechanical systems and equipment that support the water supply system. Three oil fired boilers provide all of the heating capacity for the building. Through a pair of heat exchangers, potable water is heated for injection into the suction header of the potable water circulating pumps in order to maintain acceptable temperature to prevent freezing. Three hot water unit heaters are used for heating the building.

Current instrumentation is limited to some temperature measurements and a circular chart recorder for storage tank level. The treated flow meter is not in service, and paper charts for the level recorder are currently difficult to obtain.

The fuel distribution system includes one main storage tank, two day tanks and distribution piping. This system feeds, mainly by gravity, the various oil burning equipment in the building, including an emergency generator.

The boilers, hot water pumps, heat exchangers and chlorine injection pump have been installed in 2009 along with the new piping to the new water storage tank. The rest of the mechanical equipment dates to the original installation in the 1970's.

Refer to diagram M3 for an overview of the pump house components.

6.2.2 Potable water system

6.2.2.1 Circulating Pumps

The water pressure for the flows to town is boosted by a pair of pumps that are rated at 28 L/s (444 usgpm) at 209 kPa (70 feet H_2O) of head. These pumps operate on the basis of one duty pump and one in standby, with alternation of the duty pump. The pressure boost provided by the pumps is intended to ensure circulation through town of the water supply and return flow to the water treatment plant. (refer to Photo 6.2.2.1.a)

6.2.2.2 Hot Water Injection

A portion of the water pumped is heated by heat exchangers to a temperature measured to be 40^oC (115^oF). This heated potable water is injected into the storage tank to maintain the water temperature above freezing. There are no automatic controls to maintain this temperature.

A portion of heated water is also injected on the suction side of the circulating pumps to heat the water that is pumped to town. A three way valve installed on the hot water side of the heating system controls the temperature of the water leaving to town. However, at the time of the site visit, the controls were not operational. There is also no means to balance the flow of hot water between what is injected in the storage tank and what is injected in the circulating water.

6.2.2.3 Storage Tank Level Control

A level sensor installed in the water storage tank starts the transfer pumps at Char Lake Pump Station at low level and stops them at high level.

6.2.2.4 Water Piping

The potable water piping system in the water treatment plant is a mix of schedule 40 black steel, newer copper and stainless steel piping.

6.2.2.5 Equipment Characteristics

Duty pumps characteristics:

- Quantity: 2
- Make: Ebara
- Model: 125 SFM
- Type: centrifugal
- Flow: 23.3 L/s (370 usgpm)
- Head: 209 kPa (70 ft. H_2O)
- Motor: 15HP

6.2.3 Fuel System

6.2.3.1 General

The fuel system at the water treatment plant consists of three holding tanks: a 9090 L (2000 imp. gal.) tanks installed outside, 1135 L (250 imp. gal.) day tank installed inside the building as well as a 115 L (25 imp. gal.) generator day tank. All tanks are interconnected. The system is used to feed the oil fired equipment that includes the emergency generator, three hot water boilers and one unit heater.

6.2.3.2 Main Storage Tank

The 9090 L (2000 imp. gal.) above-ground fuel storage tank is installed outside the building, approximately 3 m from the treatment plant. The tank is original to the building.

6.2.3.3 Transfer Piping

Single-wall black steel pipes, feed by gravity the 1135 L (250 imp. gal.) day tank installed inside the pump house. There is no leak detection installed between the main tank and the day tank. A fire valve is installed upstream of the filtration system of the day tank inside the building. (refer to Photo 6.2.3.3.a)

6.2.3.4 Day Tanks

The larger day tank is a single wall tank, installed directly next to the potable water wet well. The tank is gravity fed from the main tank outside. The tank is without ULC Label, secondary containment, leak detection, overflow, overfill protection and is vented directly to the exterior. The termination of the vent line is higher than the vent of the main tank installed outside, in order to prevent a spill in case of overfilling. The burners of the boilers are fed from the larger day tank.

The burners of the boilers are fed from the larger day tank.

The emergency generator has a small day tank gravity fed from the 1135 L (250 imp. gal.) day tank. This small day tank is a single wall tank, directly vented to the exterior with no secondary containment and no overfilling protection. There is a solenoid valve installed on the fill side of the tank. When the generator starts, the solenoid will open and the tank will fill up, including the vent pipe, until the levels between the main tank outside the building and the generator tank are balanced, which will mean that the vent pipe is partially filled with fuel and that the tank is pressurized. This type of tank is not designed to be pressurized so the risk of failure is increased.

6.2.3.5 Current Status and Recommendations

According the National Fire Code and CSA-B139 standard, the underground fuel transfer lines between the main storage tank and the building should be of double-wall construction with leak detection. In the event of failure of the buried piping, fuel could contaminate the ground.

Fuel transfer pipes should be installed in such a way that fuel cannot be trapped anywhere, as required by CSA-B139. Because the fuel lines go from the above-ground storage tank, to under the ground and then up again in the treatment plant, the underground fuel line will always be full of fuel. In order to prevent this happening fuel transfer pumps would have to be installed in a sump to fill the day tank. The transfer pumps and associated controls would also reduce the risk of overfilling and pressurizing the day tank.

The code also requires secondary containment with leak detection, low level and high level alarms for all the tanks, including tanks installed outside and inside. In the current configuration, a failure of one of the tanks installed in the building would mean that the entire volume of fuel contained in the day tank, the main storage tank and the piping would flow into the treatment plant and potentially cause a fire.

As required by the National Fire Code and CSA-B139, the day tanks should be vented through the main storage tank, in which case the vent of the day tank is also considered as its overflow. If the day tank is vented directly to the exterior, a variance generally accepted is to install redundant high level sensors to shut down the transfer pumps and prevent overfilling of the tank.

Because of the criticality of the equipment fed by emergency power, good engineering practice would be required to reduce to a minimum the number of single points of failure in the fuel transfer system to the generator. The generator small day tank is one high risk point of failure and must be removed. The generator could be fed directly from the larger day tank in the same way as the heating equipment installed in the room or from a dedicated day tank that would have a dedicated set of transfer pumps and transfer lines to the outside fuel storage tank.

The fuel system's performance is unsatisfactory. The fuel tanks and fuel transfer system have zero years of remaining service life. Because of these reasons, code violations and associated risk, the replacement of the entire fuel system is high priority.

Fuel storage quantity, according to the Government of Nunavut Good Building Practices Guideline, would be of a minimum of two weeks calculated at continuous maximum operating load, including heating and emergency power. The rational is that blizzards and storms can make delivery difficult for periods up to two weeks. Based on a fuel consumption of 3 gal/hr and one boiler used for redundancy, the minimum required fuel storage capacity would be of 38,165 L. (8395 imp. Gals). The current fuel storage capacity would provide autonomy of 90 hours (3 days and 18 hours) at full load. Fuel consumption for the previous years should dictate the amount of fuel storage required. (refer to Drawing M4 for fuel system diagram)

6.2.4 Boilers, Heat Exchangers and Heating Pumps

6.2.4.1 Boilers

Three oil fired cast iron boilers, using Riello fully modulating burners with UV scanner for flame detection have been installed in 2009. The boilers are used for building heating and to heat the potable water. The boilers operate to maintain the hot water supply temperature setpoint. (refer to Photo 6.2.4.1.a)

There is no controller to allow sequential operation. .Two boilers were operating at the time of site review, the other boiler was turned off and valves in a closed position. This is necessary from the fact that the hot water pumps are sized to provide enough flow for only two boilers. Since no controls are installed, the boilers would all fail on low water flow if they were to all be on line simultaneously. In the event of a failure of one boiler, the back-up boiler has to be started manually.

There is no means to control the temperature in the water storage tank. Hot water is injected at constant volume in the tank.

6.2.4.2 Hot Water Pumps

Two primary pumps installed in parallel ensure flow through two of the boilers and to the heat exchangers. The pumps operate at constant volume and only one pump operates at a time in a lead/lag configuration. The capacity of one pump is sufficient to operate two boilers and both heat exchangers. The pumps were installed in 2009. (refer to Photo 6.2.4.2.a)

6.2.4.3 Heat exchangers

Two stainless steel plate and frame heat exchangers are installed to transfer heat from the heating water to the domestic water. The heat exchangers were installed in 2009. The heat exchangers operate at variable flow. A three-way valve is installed to maintain the water temperature supplied to town. The controls were not operational at the time of the visit.

6.2.4.4 Equipment Characteristics

Boilers characteristics:

- Quantity: 3
- Make : DeDietrich
- Model: GT 430-9 A
- Construction Type: Cast Iron
- Input: 570 kW (1947 MBH), 13.50 usgph of nb. 2 oil
- Output: 485 kW (1655 MBH)
- Fluid: Water
- Flame detection: UV scanner
- Burner Make/Model: Riello / RL 50/M

Heating pumps characteristics

- Quantity: 2
- Make : Grundfos
- Model: TP 80/240-2
- Type: Centrifugal inline
- Flow: 11 L/s (175 usgpm)
- Head: 142 kPa (47.4 ft. H_2O)
- Motor: 3HP

Heat exchangers characteristics:

- Quantity: 2
- Make: AIC
- Model: A 70X-1G1-50/22
- Type: Plate and Frame
- Material: Stainless Steel 316, nitrile gaskets
- Flow hot-water: 5 L/s (79 usgpm)
- Flow cold water: 7.2 L/s (114.1 usgpm)
- Hot water Temperature in: 87.8 ^{o}C (190 ^{o}F)
- Hot water Temperature out: 65.5 ^{o}C (150^{o}F)
- Cold water Temperature in: 5 ^{o}C (41 ^{o}F)
- Cold water Temperature out: 20 ^{o}C (68 ^{o}F)
- Capacity: 1543 MBH

6.2.4.5 Current Status and Recommendations

There is no make-up water to the boilers. In the event of a leak, the boilers would shut-down until someone comes to fill the system back up. This would represent a serious risk for freezing. There is no other source of heating for the building. The boilers are also the only source of heat for the water in the storage tank for the water supplied to town.

There is no alarm for boiler failure. Because boilers are a critical element to maintain the water temperature and building temperature above freezing point, it is desirable to provide a failure alarm as well as automatic controls to start and stop the boilers in sequence, based on hot water demand.

There is a chemical pot feeder installed, but the system has been filled with untreated water. Chemical treatment should be added to the system to prevent premature corrosion and scaling.

The hot water piping system was designed and built in such a way that glycol could easily be used instead of water. This would eliminate the risk of damaging the boilers and piping in case of freezing of the building.

6.2.5 Ventilation and Building Heating

6.2.5.1 Generator Ventilation

The water treatment plant has minimal ventilation. The only mechanical ventilation in the building is a supply fan that starts when the emergency generator starts. This fan was not operational at the time of the visit.

The generator supply fan is designed to start in the event of a power failure. The suction side of the fan is connected to a set of two motorized dampers, one for outside air and the other for recirculation air. The dampers are not operational, the outside air damper remains fully opened and the recirculating air damper remains closed.

There is a relief damper connected to an opening in the roof that was designed to open when the generator fan starts. The damper is not operational. The operator mentioned that air leaking out and infiltration in the building has always been sufficient to prevent overheating of the generator engine.

No combustion air intake is installed. Code for oil burning equipment, CSA-B139, requires having a permanent opening for combustion air intake. Combustion air is presently coming from infiltration through the building envelope.

The radiator of the generator is not connected to any ductwork or opening to the exterior, and therefore discharges hot air directly in the room which heats up rapidly and can cause the generator to fail if the building heat losses, especially in summer, are insufficient. This is also in contradiction with the requirements of CSA-B139, code for oil burning equipment. However, it did not cause any operational problems in the past.

6.2.5.2 Unit Heaters

There are three hot water unit heaters to maintain the building’s indoor air temperature.

6.2.5.3 Current Status and Recommendations

The ventilation of the building is not satisfactory and can cause various failures such as generator failure from overheating or pipe failure from freezing water. To provide new ventilation system for the building is desirable.

6.2.6 Controls

6.2.6.1 Alarms

Controls are very limited at the plant. Most of the control devices are original to the building and are either de-commissioned or not operational. There is no alarm for failure of the boilers.

6.2.6.2 Ventilation System Controls

Controls for the ventilation system must form part of the desirable revision of the ventilation system of the building.

6.2.6.3 Water Temperature Controls

It is also desirable that the water temperature in the storage be monitored and controlled. In the current configuration, hot water flows at constant volume in the storage tank. There is no balancing valve installed and no way to control the flow of water injected into the tank. Since there have been no failures caused by the freezing of the storage tank, it is easy to conclude that there is a waste of energy by injecting hot water into the storage tank even when it is not required.

A two way control valve could be added to control the quantity of hot water required to be injected into the tank to maintain acceptable water temperature in the storage tank. The ability to control the leaving water temperature to town is already installed, but the control devices were not operational.

6.2.6.4 Boilers Controls

Also to reduce the energy costs by improving the boilers efficiency and to increase the reliability of the installation, a controller should be added to sequentially control the operation of the boilers and start standby units, should the need arise. A new boiler control system could provide the ability to remotely start and stop the boilers via internet, provide information on the status of the boilers and send alarms for failure.

6.2.7 Improvements

Recent improvements include the following.

2009: Replacement of boilers

2009: Replacement of hot water pumps and hot water piping

2009: Installation of heat exchangers

6.3 Macerator

6.3.1 General

The sewage treatment works consist of a treatment plant building and an adjacent macerator facility. There is no equipment within the sewage treatment plant building. A comminutor (macerator) is located in a small Bally building adjacent to the treatment plant building. Currently there is no treatment beyond maceration. Sewage flows are then directed to an outfall on the beach above the high tide mark.

6.3.2 Ventilation

The building in which the macerator is installed has no mechanical equipment in operation. There was a wall mounted propeller exhaust fan installed in the past, but the fan is now not operational and the opening is filled with thermal insulation. (refer to Photo 6.3.2.a). Ventilation should be provided to remove any noxious gases that could accumulate in the space.

6.3.3 Radiant Heater

Heating is provided by a low density electrical radiant heater that keeps the surface of the macerator warm. (refer to Photo 6.3.3.a)

6.3.4 Macerator

The macerator was not in operation at the time of the visit and sewage was flowing directly through the by-pass.

7 Electrical

7.1 Char Lake Pump House

7.1.1 Main Service

The service to the site is supplied by Qulliq Energy Corporation at 4160 volts.

This service supplies 3-25 kVA pole mounted transformers which provide 75 kVA of service capacity to the pump house.

The secondary service from the main service pole is run overhead and terminated on a service mast on the north side of the building.

The design drawings from 1975 indicate that the secondary service voltage is 120/208 volt, 3 phase, 4 wire.

Recorded voltages on the service entrance point would indicate that the secondary service is configured as a 120/240 volt, 3 phase, 4 wire service with a grounded delta secondary.

Voltages recorded were as follows:

A-B	242V	A-N	115V
B-C	235V	B-N	212V
C-A	230V	C-N	115V

From visual inspection of the pole mounted transformers and the electrical service to the building, the system is in good condition.

Adjustment to the tap settings on the pole mounted transformers and the verification of the primary voltage at the transformers should be reviewed with Qulliq Energy Corporation in an attempt to adjust the secondary voltage to the building closer to 2 volts phase to phase, on all three phases. Actual secondary system voltages need to be verified by the Utility and adjusted accordingly so that they are in line with the design configuration. Discrepancies in the record readings at the time of the site visit may be due to the metering used.

The voltage on Phase “B” (as marked) to neutral and ground is over 120 volts and was recorded at 212 volts. Care must be taken when connecting 120 volt loads to any three phase panels to ensure that single pole breakers are not installed on Phase B (as marked). There are no warning signs identifying this voltage condition and system configuration.

There is no Transient Voltage Surge Suppressor (TVSS) in the incoming service entrance. Even though the region is not considered to have lightning activity the installation of a TVSS will address Utility transient conditions. Electronic components recently installed and motors in the building can be affected by supply system transients and cause damage to the related components.

The service to the building is of sufficient capacity to support the present equipment load.

There were not noted code violations.

7.1.2 120/208 Volt Secondary Distribution

The main overhead secondary service from the utility transformers enters the building and terminates in an enclosed main breaker. The breaker is rated 300 amps, only visible label noting interrupting capacity was 600 volts was 22 kA rms symmetrical. The main breaker is equipped with an adjustable instantaneous trip adjustments low = 1500 amps and high = 3000 amps. The instantaneous setting on the breaker was set at low. (refer to Photo 7.1.2.a)

Load side cables from Main Breaker Service Entrance terminate in the metering current transformer (CT) cabinet on the bar CT's for energy consumption metering. The utility meter is located in a separate cabinet above CT cabinet. It was noted peak demand of 300 kW on the service. There were two connections made on the load side of the metering CT's:

1. Normal power, 3 phase, 120/208 volt connection to automatic transfer switch for the building. (refer to Photo 7.1.2.b.

2. Single phase 208 volt connection for the main water service pipe heat tracing 50 kVA, 208 to 600 volt step-up transformer on Phases A, C. (refer to Photo 7.1.2.b)

The Automatic Transfer Switch is a single solenoid type motor operated breaker Onan Model 306-3488-04, 50/60 Hz, 220/240V, 3 phase, 300 amps in service in 1992. Service label on the transfer switch was marked - Simpson Maxwell - Aug 10/93 – WO 29857. (refer to Photo 7.1.2.c.)

This transfer switch was installed in approximately 1995 to replace the original manual and automatic transfer switches for the building. Load side of the transfer switch supplies the main distribution splitter rated 400 amps, 120/208 volts. (refer to Photo 7.1.2.d)

Loads fed from the main distribution splitter are as follows:

- 125 amp, 120/208 volt, 3 phase, 4 wire panel complete with 60 amp, 3 pole main breaker for new boiler system installed in 2009. (refer to Photo 7.1.2.e)

  Panel supplies the following loads:

  - 20A, 3 pole breaker for Pump 1 contactor

    - 20A, 3 pole breaker for Pump 2 contactor
    - 20A, 1 pole breaker for Boiler A contactor
    - 20A, 1 pole breaker for Boiler B contactor.

- 225A, 120/208 volt splitter. This splitter supplies the following loads: (refer to Photo 7.1.2.f)
    - Reduced voltage auto transformer starter for main water distribution Pump P1 (20 HP)
    - Reduced voltage auto transformer starter for main water distribution Pump P2 (20 HP)
    - Heat tracing combination Contactor for intake water pipe from Char Lake (starter in HAND Position – No control). (refer to Photo 7.1.2.g)
    - 50A, 2 pole enclosed breaker rated 18 kA @ 240 volts, this breaker supplies panels designated as lighting panel and is rated 120/240 single phase 24 circuit lighting panel . Panel contains 21-15A, 1P breakers, 1-30A, 2P breaker and one spare breaker. This panel supports lighting loads, receptacles and miscellaneous control circuits. (refer to Photo 7.1.2.g)

A 50 kVA – 208/240 volt to 600 volt single phase dry type transformer was installed in 1994 to support heat tracing system installed on main water supply piping from Char Lake to Signal Hill. This transformer is connected directly to the metering CT cabinet and is protected with a 300 amp 2 pole enclosed breaker. Feeder conductors from the CT cabinet to the 300 amp breaker run through the transfer switch and 400 amp splitter before terminating on the breaker. Conductors appear to be 2/0 RW90. (refer to Photos 7.1.2.h, 7.1.2.i. and 7.1.2.j)

The distribution components noted are in good condition and have a remaining service life of 5 to 10 years.

Feeder conductors from the CT cabinet to the supply breaker for the heat tracing step up transformer are undersized based on the rating of the 300 amp feeder breaker and are run through equipment that are not be used as pull boxes.

Panel interiors and enclosures should be cleaned out.

The system and associated components have sufficient capacity to support the associated loads

The electrical service connection conductors from the CT cabinet to the heat tracing step up transformer run through the transfer switch and service splitter before they terminate on the

300 amp feeder breaker. This is a Code violation as equipment enclosures are not to be used as a pull box. (refer to Photos 7.1.2.h and 7.1.2.j)

In addition to this condition, it appears that the transformer feeder conductors are #2/0 AWG conductor which is rated to 185 amps and connected to the 300 amp breaker to feed the transformer. With the secondary protection for the heat tracing at 70 amps the primary current on the transformer is limited to approximately 162 amps based on a 208 volt primary connection, therefore the installed # 2/0 AWG conductor is protected..

7.1.3 Secondary Distribution Equipment, Starters, Heat Tracing

125 amp, 24 circuit, 120/240 volt single phase branch circuit panel identified as Lighting Panel, feeds minor branch circuit loads contains 21-15A, 1 pole breaker and 1-30A, 2 pole breaker, 1 spare. A number of the breakers are in the OFF position and panel schedule has not been properly updated over the years. (refer to Photo 7.1.2.g.)

Lighting panel is in good operating condition and has 10 to 15 years of remaining service life. Panel schedule is not up to date.

7.1.3.1 Heat Tracing

The 50 kVA, 240 to 600 volt step-up dry type transformer supplies a 70A, 3 pole breaker on the south wall of the building. This breaker supplies a 50 amps rated 600 volt contactor intended for the control of heat tracing cables on the water supply piping from Char Lake to Signal Hill.

The temperature sensor intended for the control of the heat tracing contactor is installed in a typical section of insulated pipe section, which is mounted on the exterior of the building.

Presently the heat tracing cables are connected on the line side of the contactor and not the controlled side of the contactor, therefore the heat tracing is not controlled and on 24 hours a day year round. Information from 1994 drawings indicate that seven lengths of heat tracing at 5 watts per foot for a total length of 630 feet was installed or a total of 31.5 kW of heat tracing or 52.5 amps at 600 volts. This was confirmed by verifying the load on the heat tracing conductors. (refer to Photos 7.1.2.k.and 7.1.2.l)

Based on the connected load of 31.5 kW of heat tracing the annual consumption of this cable if operated 24 hours a day, 35 days a year, would be 275,940 kWhrs per year or approximately 22,995 kWhrs per month, if not controlled or physically turned off by the operator in the summer months. The available utility bills do not support these calculated values. The utility metering system should be reviewed and verified.

The 50 kVA step-up transformer that supplies the heat tracing for the water distribution piping is in good operating condition and has 10 to 15 years of remaining service life.

The heat tracing contactor for this system in not properly rated and needs to be upgraded to a 70 amp 600 volt contractor to suit the supply breaker and the related load. Once this is corrected the control system for the contactor can be connected.

Contactor installed for heat tracing system is not rated to address connected load or service breaker size.

7.1.3.2 Main Distribution Pump Starters

The motor starters for the main water circulation pumps P1 and P2 (20 HP) are reduced voltage auto transformer type starters complete with run pilot lights and HAND/OFF/AUTO Control (HOA) selector switch.

Control switch on both starters are placed in the AUTO position. Starter for P1 also has an additional control selector switch marked P1 and P2; from discussions with the Operator this is not used or ever operated. This selector switch is presently in the P2 position.

7.1.3.3 Pump Starters

The starters have the following characteristics.

Pump 2 Starter (refer to Photo 7.1.2.f)

Run time meter 21098.4 hrs

H.O.A. - run pilot light

SQ-D starter, reduced voltage Auto Transformer

Breaker -125 A, 3P, SQD KAL 36125

MAG adjustment set @ high

Breaker IC – 25 kA @ 240V

Main contactor – CEMA3, SQ-D

Class 8536 Type SE01

Series A, 7011.350009, 600V max

480/600 - 60 max, HP

Overloads on main contactor CC 87.7, CE 80

1S & **2S** contactors sized as follows:

1S CEMA 3, 8502 Class

SE01 – Type Series A

70113-402-01

440/550V 25 HP, 1 phase

2S CEMA 3, Class 8502

Type SE02, Series A

70113-500-05

480/600V – 50 HP, poly P4AS

Tracon Engineering Ltd, 3ph, Class F

Transformer taps set @ 65/100/0

Type CL-230V taps – 50/65/80

Cat# 3- 2303060, 30 HP Med Duty

Pump P1 Starter (refer to Photos 7.1.3.a and 7.1.3.b)

Run time meter – 6141.9 hours

H.O.A. control

Run pilot light

SQ-D Starter – reduced voltage auto transformer

8606 Class Type SQ-D

3 PH 240V 60 Hz, 25 HP

Coil voltage SE 362983-JK

Main Breaker 125 A KAS 36125

IC, 65 kA2250V, 40°C

Instantaneous Set on Lo

Main contactor CEMA3

Class- 8536 type SE01

Form S Series A

7011340216, 208/240V – 30 HP, poly phase

480/600V – 50 HP poly phase

Tracon Engineering Ltd, 3ph, Class F

Overloads on main contactor CC 87.7, CE 80

1S and **2S** contactors sized as follows:

1S contactor, NEMA3 contactor, Class 8502, Type SE01

Series A, 70113-402-01

110V, 7 ½ HP, 220V 15 HP, 440/550 – 25 HP

2S contactor, NEMA3 contactor, new contactor, not original

Class 8502, type SE02, Series A

97461/78811, Poly phase rating

Transformer taps set @ 65/100/0

Type CL-230V taps – 50/65/80

Cat# 3- 2303060, 30 HP Med Duty

The main water distribution Pumps P1 and P2 are controlled by level sensing in the Signal Hill water tank to maintain flow and water level in the water tank at Signal Hill. Pumps alternate automatically via relay control system that is only partially operational due to the fact that old relays in the original 1975 control panel are no longer available.

Only one pump operates at any given time and pumps alternate automatically via control relays in control panel.

Operating Contractor indicated that when the power fails and the generator starts and the main water distribution pump does not start automatically and Operator intervention is necessary.

The motor starters for the main water circulation pumps P1 and P2 are in good operating condition and have 5 to 10 years of remaining service life. From discussions with the station Operator, the control that starts the pumps does not function when the power fails to the site even after the generator starts to support the related load. Manual reset and intervention is necessary to restart the pump. Pumps and starters are controlled and alternated from the simple control system located in the Char Lake Building. Control diagrams to the starters and control system were available.

7.1.3.4 Jockey Pump Starters P1 and P2

There are two combination magnetic starters, one for each of the water distribution Jockey Pumps identified as P1 and P2. These starters are interconnected supplied with a single set of conductors from the 225 amp, 120/240 volt splitter. (refer to Photos 7.1.3.a and 7.1.3.b)

The starters are breaker type and equipped with HAND/OFF/AUTO (H.O.A.) control. The selector switch on P1 starter was placed in the HAND position and the P2 starter has been turned OFF due to previous failure and damage. Based on previous reports and design documents, Jockey Pumps are intended to run 24/7 with no control.

Starters for the Jockey Pumps are in unsatisfactory condition and have zero years of remaining service life. With the connection of both pump starters directly to the service splitter, failure of the first starter could/would have an effect on the other pumps. Components such as contactors and control transformers have been salvaged to rebuild the starter. Starters should be completely replaced with new, fed separately from the service splitter, if control for the pumps is not required.

7.1.3.5 Control System

The Control System is in unsatisfactory condition and has zero years of remaining service life. Parts are no longer available and the only function that the system services at this time is alternating the main pumps. None of the other alarm point such as loss of power, low temperature, no flow, no longer function.

7.1.4 Emergency Power

The building and all of the associated equipment in the pump house with the exception of the heat tracing on the main water supply piping is supported by the onsite emergency generator. (refer to Photo 7.1.4.a.and 7.1.4.b) The generator was installed as part of the original construction in 1975. The generator is an air cooled unit manufactured by Onan with the following characteristics:

- 30 kW, 37.5 kVA, 3 phase, 4 wire
- 104 amps at 120/208 volts
- 12 volt starting
- Serial No. C474800531

- Model 30.000A-15R-1337A

A digital control unit TTI MEC 200 with digital display for all parameters has been installed on the generator and replaces the analog control. This controller may have been installed on the generator when the transfer switch was replaced in 1994/95. There was no record on site to confirm when the controller was replaced. . The run time meter on the digital control indicated 174.1 hours of run time during the site visit November 2009. There was no record of the original run time on the generator. The expected actual run time on this generator is similar to the Signal Hill Generator which was 1266 hours, during the site visit in November 2009.

In addition to the digital display unit, the original analog gauges and alarm indicator lights are still present on the control panel. Generator is equipped with an “Exciter Circuit Breaker” as the means of isolation and protection of the generator and emergency feeder to the transfer switch.

The battery charger manufactured by Thompson Technologies 12V DC, 120/208V, 12 amp input with a manual battery equalizer switch was installed in 1994.

The automatic transfer switch is a single solenoid type motor operated breaker Onan Model 306-3488-04, 50/60 Hz, 220/240V, 3 phase, 300 amps in service sometime in early 1993/94 - Simpson Maxwell - Aug 10/93 – WO 29857. (refer to Photo 6.1.2.d)

The load side of the transfer switch supplies the main splitter rated 400 amps, 120/208 volts.

The generator fuel system consists of a small day tank which is connected to main fuel tanks. Refer to Mechanical Section for a detailed description and all associated operational issues.

The generator and its associated components are in satisfactory condition and have a remaining service life of 0-5 years.

The generator is operated on a monthly basis under load for approximately one hour based on discussions with the operator. No records of the generators operating parameters that occur during these tests are recorded or maintained on site. The Operator conducts a visual inspection of the generator during their routine daily site visit. During the load test, they check the lube oil.

Maintenance and repair of the generator does not form part of the operations contract and is carried out as part of a separate maintenance contract that the GN administers..

The operator indicated that they have disconnected the water jacket temperature sensor from the engine controller due to the fact that although the generator runs fine and maintains an operating temperature of 140°F, it would shut down on high temperature. This sensor is very close to the engine exhaust and the generator technician who had conducted the previous inspection, indicated to the operator that it could be due to a cracked manifold.

The generator radiator is not exhausted to the outdoors and there is no exhaust fan to reject the heat outside. When the generator runs, the building will overheat and in turn cause the generator to shut down in a very short period unless the operator gets to the site and opens the doors to assist the ventilation.

There is no remote monitoring or alarm from the generator when it is running. The auto-dialer that is intended to transmit this information does not work.

Maintenance /Operations Contractor for the site does not have any specific testing and record keeping required for the generator or transfer switch. There are no maintenance records of any kind on site.

Detailed logs and records of all testing and maintenance are not kept which makes ongoing maintenance difficult. Although the CSA C282-05, Emergency Electrical Power Supply for Buildings does not directly apply to this type of installation/application, it is suggested and recommended that the testing, maintenance schedule and data recording outlined in this standard be adopted for this site.

The generator has sufficient capacity to support jockey pumps, one main circulation pump and general operational loads in the building. Heat tracing of the main supply piping is not connected to the generator.

7.1.5 Lighting

Interior lighting inside the building is a mix of incandescent and fluorescent fixtures that provide sufficient illumination within the operational area. All lighting is switches. Exterior lighting: HID wall packs with photo cell control.

Lighting is in good operating condition.

Proper wire guards should be added to fixtures to replace plastic show fencing.

7.1.6 Instrumentation Control and Annunciation

The original building monitoring and control system was installed in 1976 and is equipped with stop, start control and pump alternating control of the Main Water Distribution Pumps P1 and P2.

Control of these pumps is from level switches located in the reservoir at Signal Hill. Pump control is configured to operate one pump at any given time. (refer to photo 7.1.6.a)

In addition to the level control, the control panel was designed to include the following alarms:

- Low discharge temperature

- Low building temperature
- Wet well low level
- Control power failure
- Water main heating failure

All of these alarm points are wired in series to auto dialer control system located in the station. The dialer was installed in 1994 as part of the heat tracing installation and transfer switch replacement.

Magnetic flow meter installed on the main water discharge pipe. The flow meter is manufactured by ABB – MAG –XE Model complete with remote reader. (refer to Photo 7.1.6.b) Magnetic flow meter is not connected to any remote monitoring or control system. Display is used to record daily flow and usage.

Digital thermometer is installed on the main water discharge pipe ahead of the flow meter. The temperature sensor is a visible monitor but does not provide any feed back to control system.

Mechanical temperature sensors are located in the building to monitor building temperature. This system does not function.

The control and instrumentation system is in an unsatisfactory condition and is not operational. The only control feature functioning is the starting and alternating of the Main Water Distribution Pumps P1 and P2. The auto dialler does not function.

The operator has to rely on alternate means to verify if systems are functioning or have failed such as the power has failed. If the aviation warning light on the radio tower adjacent to the Char Lake pump house is not on, more than likely the power.

The flow meter display malfunctions on a regular basis. Reset the display power to the unit has to be turned off and on; sometimes this takes a few tries.

The wiring from the transducer to digital thermometer is run loose (hanging on a pipe) to a control transformer and extension cord not a proper or permanent installation. Wiring from MAG floor meter to display unit installed in flexible liquid tight conduit, conduit connect at MAG meter head broken.

Old original well temperature sensing boxes, piping and control valves no longer in use have not been removed. (refer to Photo 7.1.6.c)

Control/relay panel no longer functions due to the fact that relays are longer available, relays have been salvaged as required only to maintain the pump control.

Loose 120 volt wiring (extension cord) and loose control transformer for digital temperature sensor to be properly installed and connected.

7.2 Signal Hill Water Treatment Plant

7.2.1 Main Service

The service to the site is supplied by Qulliq Energy Corporation at 4160 volts.

This service supplies 3-10 kVA pole mounted transformers which provide 30 kVA of service capacity to the pump house.

The secondary service from the main service pole is run overhead and terminated on a service mast on the north side of the building.

The design drawings from 1975 indicate that the secondary service voltage is 120/208 volt, 3 phase, 4 wire.

Record voltages on the service indicate that the secondary service is configured as a 120/208 volt, 3 phase, 4 wire service with a grounded wye secondary.

Voltages recorded were as follows:

A-B	215V	A-N	115V
B-C	210V	B-N	115V
C-A	215V	C-N	115V

Actual secondary system voltage need to be verified by the utility and adjusted accordingly so that they are in line with the design configuration. Discrepancies in the record readings at the time of the site visit may be due to the meter used.

From visual inspection of the pole mounted transformers and the electrical service to the building, the system is in good condition.

There is no transient voltage surge suppressor (TVSS) in the incoming service entrance. Electronic components recently installed and motors in the building can be affected by supply system transients and cause damage to the related components.

7.2.2 120/208 Volt Secondary Distribution

The secondary service from the utility transformers enters the building underground and terminates in a utility consumption meter on the outside of the building and then to the enclosed main breaker. The breaker is rated 100 amps, SQ-D KAL 36100 interrupting capacity was 240 volts was 42 kA rms symmetrical. The main breaker is equipped with an adjustable instantaneous trip adjustments min = 500 amps and max = 1500 amps. The instantaneous setting on the breaker was set at min. (refer to Photos 7.2.2.a and 7.2.2.b)

Load recorded on the service was as follows:

- Phase A – 53.7 amps
- Phase B – 61.6 amps
- Phase C – 41.1 amps
- Neutral - 16.7 amps

The Automatic Transfer Switch is a multiple contactor type with relay type control installed as part of the original construction in 1974 complete with built-in battery charger, analog controls and timers.

Onan Model LTD-100-5D/17476E, Serial No. 1174893663; voltage 120/240, 3 phase, 4 wire, rated 100 amps, motor LRA-600; 100% rated front panel equipped with voltmeter; ammeter. The run time meter indicates 1265. 3 hours of operation. Off/Auto/ Test switch located inside the transfer switch door.

Loads fed from the main distribution splitter are as follows:

- 125 amp, 120/208 volt, 3 phase, 4 wire panel complete with 60 amp, 3 pole main breaker for new boiler system installed in 2009. (refer to Photo 7.2.2.c)

  Panel supplies the following loads:

  - 20A, 3 pole breaker for Pump A contactor (marked as Pump1)
  - 20A, 3 pole breaker for Pump B contactor (marked as Pump 2)
  - 20A, 1 pole breaker for Furnace 1 contactor
  - 20A, 1 pole breaker for Furnace 2 contactor.
  - 20A, 1 pole breaker for Furnace 3 contactor

- Reduced voltage auto transformer starter for water distribution Pump P1 (15 HP)
- Reduced voltage auto transformer starter for water distribution Pump P2 (15 HP)

  - 50A, 2 pole enclosed breaker rated 18 kA @ 240 volts, this breaker supplies a panel designated as Panel A and is rated 120/240 single phase 24 circuit. Panel contains 22-15A, 1P breakers, 3 spaces with no protective cover. This panel supports lighting loads, receptacles and miscellaneous control circuits. (refer to Photo 7.2.2.b)

- 30A, 2 pole enclosed breaker rated 18 kA @ 240 volts, this breaker supplies a panel designated as Panel B. The panel is rated 125 amps, 120/240 volt, single phase, 3 wire, 12 circuits. Circuit breakers on and identified as feeding various control circuits for heat tracing. All heat tracing was disconnected. A sub panel was fed off of Panel B feeds and self-regulating heat tracing.

- Exhaust fan starter combination type for building exhaust. Fan runs when generator is operational.

The distribution components noted are in good condition and have a remaining service life of 5 to 10 years.

Panel interiors and enclosures should be cleaned out.

The system and associated components have sufficient capacity to support the associated loads

All open breaker spaces require fillers.

7.2.3 Secondary Distribution Equipment, Starters, Heat Tracing

Branch Circuit Panels A & B are 120/240 volt, single phase branch circuit panels

7.2.3.1 Main Distribution Pump Starters

The motor starters for the main water circulation pumps P1 and P2 (15 HP) are reduced voltage auto transformer type starters complete with run pilot lights and HAND/OFF/AUTO Control (HOA) selector switch.

Control switch on P2 starters was in the HAND position. Control of starters is manual and pumps are alternated by the Operator on a regular basis.

The starters have the following characteristics.

Pump 2 Starter (refer to Photo 7.2.3.a)

Run time meter 20416.5 hrs

H.O.A. - run pilot light

SQ-D starter, reduced voltage Auto Transformer

Breaker -100 A, 3P, SQ-D KAL 36125

Main contactor – CEMA2, SQ-D

Class 8536 Type SD01

Series A, 7012.503-15, 3 phase, 208/240 volt

1S & **2S** contactors sized as follows:

1S CEMA 2, B502 Class

SD01 – Type Series A

70112-503-02

208/240 volt, 7.5 HP, 3 phase

2S CEMA 2, Class 8502

Type SE02, Series A

70113-500-05

Tracon Engineering Ltd,

Type CC-230V– 80/65% tap

Cat# 3T- 2301560

15 HP Med Duty

Series 75-857m, Class F

Pump P1 Starter. (refer to Photo 7.2.3.a)

Run time meter – 5169.0 hours

H.O.A. control

Run pilot light

SQ-D starter, reduced voltage Auto Transformer

Breaker -100 A, 3P, SQ-D KAL 36125

Main contactor – CEMA2, SQ-D

Class 8536 Type SD01

Series A, 7012.503-15, 3 phase, 208/240 volt

1S & **2S** contactors sized as follows:

1S CEMA 2, B502 Class

SD01 – Type Series A

70112-503-02

208/240 volt, 7.5 HP, 3 phase

2S CEMA 2, Class 8502

Type SE02, Series A

70113-500-05

Tracon Engineering Ltd,

Type CC-230V– 80/65% tap

Cat# 3T- 2301560

15 HP Med Duty

Series 75-857m, Class F

Panel A is in good operating condition and have 5 to 10 years of remaining service life. Panel schedule is not up to date.

Panel B is in unsatisfactory condition and has zero years of remaining service life.

The motor starters for the main Water Circulation Pumps P1 and P2 are in good operating condition and have 5 to 10 years of remaining service life.

The Control System is in unsatisfactory condition and has zero years of remaining service life. Parts are no longer available. This system is connected to the Delta Vox Dialex 3006 Dialer in the treatment plant and will send a common alarm out to the Operator.

Install Filler plates in the panels

7.2.4 Emergency Power

The building and all of the associated equipment in the water treatment plant is supported by the onsite emergency generator. (refer to Photos 7.2.4.a and 7.2.4.b) The generator was installed as part of the original construction in 1975. The generator is an air cooled unit manufactured by Onan with the following characteristics:

- 30 kW, 37.5 kVA, 3 phase, 4 wire
- 104 amps at 120/208 volts
- 12 volt starting
- Serial No. 1174 89 3581
- Model 30.0.DDA-15R-12974A

Analog gauges for engine temperature, alarm, and ammeter are located on the control panel. Generator is equipped with an "Exciter Circuit Breaker" as the means of isolation and protection of the generator and emergency feeder to the transfer switch.

The Automatic Transfer Switch at this site is the original dual contactor type Onan Model LTD-100-SD/14746E, 120/240V 3 phase 4 wire, 100 amps with local run time, volt meter and ammeter run time at the time of the site visit was 1265.3. (refer to Photo 7.2.4.a)

The battery charger for the generator starting system is part of the transfer switch.

The generator fuel system consists of a small day tank which is connected to main fuel tanks. Refer to mechanical section for a detailed description and all associated operational issues.

The generator and its associated components are in satisfactory condition and have a remaining service life of 0-5 years.

The generator is operated on a monthly basis under load for approximately one hour based on discussions with the operator. No records of the generators operating parameters that occur during these tests are recorded or maintained on site. The operator conducts a visual inspection of the generator during their routine daily site visit. During the load test, they check the lube oil.

Maintenance and repair of the generator does not form part of the operations contract and is completed separately by the GN.

The generator radiator is not exhausted to the outdoors and there is an exhaust fan in the building to reject the heat outside when the generator runs.

There is no remote monitoring or alarm from the generator when it is running.

Maintenance /Operations Contractor for the site does not have any specific testing and record keeping required for the generator or transfer switch. There are no maintenance records of any kind on site.

Detailed logs and records of all testing and maintenance are not kept which makes ongoing maintenance difficult. Although the CSA C282-05, Emergency Electrical Power Supply for Buildings does not directly apply to this type of installation/application, it is suggested and recommended that the testing, maintenance schedule and data recording outlined in this standard be adopted for this site.

The generator has sufficient capacity to support one Main Circulation Pump and General Operational loads in the building and the heat tracing installed.

7.2.5 Lighting

Interior lighting inside the building is a mix of incandescent and fluorescent fixtures that provide sufficient illumination within the operational area. All lighting is switches. Exterior lighting: HID wall packs with photo cell control.

Lighting is in good operating condition.

Proper wire guards should be added to fixtures to replace plastic show fencing.

7.2.6 Instrumentation Control and Annunciation

The original building monitoring and control system was installed in 1976 and is equipped with stop, start control and pump alternating control of the Main Water Distribution Pumps P1 and P2. This control is bypassed by placing the control for one pump in the HAND position. (refer to Photo 7.2.6.a)

The control panel was designed to include the following alarms:

- Low utilidor temperature
- Low building temperature
- Utilidor circulation lost
- Low inlet temperature
- Low reservoir level
- High reservoir level
- Control power failure

All of these alarm points are wired in series to an auto dialer control system located in the station. A common alarm is sent to the operator via telephone.

Paper type flow chart system is located in the building. Charts are not available for system, so paper is reused and flow is confirmed. (refer to Photos 7.2.6.b and 7.2.6.c)

Mechanical temperature sensors are located in the building to monitor building temperature.

In the event that system water flow is lost, a siren and strobe light on the exterior of the building is activated to notify the Hamlet.

The control and instrumentation system is in unsatisfactory condition and has zero to five years of remaining service life.

All of the flow and water temperature recorders are original and no longer record data properly.

System is still operational but parts are no longer available.

7.3 Macerator

7.3.1 Macerator

The Macerator Building consists of a 125 amp, 120/240 volt, 24 circuit panel which feeds lighting, receptacles, radiate heat and the Macerator pump. (refer photo 6.3.1.a 6.3.1.b)

The equipment functioning in the building is the heating.

The pump is not functional and is not equipped with a starter.

Electrical equipment is in good condition but depending on the hazardous classification of the space, the equipment may need to be replaced as it is not rated for hazardous location installation.

Equipment not rated for hazardous locations may be an issue.

8 Summary of Technical Status

Table 8.1 summarizes the technical status of the components of the Water and Sewer System detailed in Sections 4 through 7. The terminology for "Remaining Life", Action Priority" and "Performance" are as per the GN standard Technical Status Evaluation Standard Definitions as detailed in Appendix D.

Table 8.1 - Summary of Technical Status

Component	Performance	Remaining Service Life	Action Priority	Required Action
Water System				
Water intake	Satisfactory	5 to 10 years	High priority	Continue monitoring
Char Lake Pump House	Satisfactory	5 to 10 years	High Priority	Continue monitoring See mechanical and electrical for internal works
Transmission watermain • Piping • Freeze protection	 Satisfactory Desirable	 5 to 10 years 5 to 10 years	 High Priority High Priority	 Continue monitoring Modify heat injection at Char Lake Reinstate control of heat trace cable
Signal Hill Treatment Plant • Storage tank • Chlorination • Pumping • Heat injection	 Very good Satisfactory Satisfactory Satisfactory	 Over 15 years 0 to 5 years 0 to 5 years 5 to 10 years	 High Priority High Priority High Priority High Priority	 Continue monitoring Continue monitoring See mechanical and electrical See mechanical and electrical
Access Vaults	Unsatisfactory	0 to 5 years	High Priority	Reduce contamination risk; general clean-up, disinfection, cap valves Reduce and manage ground water entry Reduce heat loss and freeze risk

Table 8.1 - Summary of Technical Status

Component	Performance	Remaining Service Life	Action Priority	Required Action
Water Distribution Piping	Satisfactory	0 to 5 years	High Priority	Continue monitoring Repair and replace as required
Sewer System				
Access Vaults	Unsatisfactory	0 to 5 years	High Priority	General clean-up; remove debris and foreign materials Reduce and manage ground water entry Reduce heat loss and freeze risk
Sewer Piping	Satisfactory	0 to 5 years	High Priority	Continue monitoring System wide CCTV inspection System wide sewer cleaning Repair and replace as required
Service Connections	Satisfactory	0 to 5 years	High Priority	Continue monitoring Thaw, repair and replace as necessary
Mechanical Systems				
Fuel Tanks Char Lake • Outdoor tank • Day tank 1 • Gen. tank	Unsatisfactory	0 years	Mandatory	Replace all system
Fuel Tanks WTP • Outdoor tank • Day tank 1 • Gen. tank	Unsatisfactory	0 years	Mandatory	Replace all system
Boilers Char Lake • B-1 & B-2	Very Good	Over 15 years	None	None
Boilers WTP • B-1, B-2 & B-3	Very Good	Over 15 years	None	None

Table 8.1 - Summary of Technical Status

Component	Performance	Remaining Service Life	Action Priority	Required Action
Pumps Char Lake • HW P-1 & P-2 • JP-1 & JP-2 • P-1 & P-2	 Good Satisfactory Unsatisfactory	 Over 15 years 5 to 10 years 0 years	 None None Desirable	 None None Replace or Re-build
Pumps WTP • HW P-1 & P-2 • P-1 & P-2 • Cl P-1 • Cl P-2	 Good Satisfactory Good Not Installed	 Over 15 years 0 years Over 15 years N/A	 None Suggestion None N/A	 None Maintenance None N/A
Heat Exchangers Char Lake • EX-1 & EX-2	 Very Good	 Over 15 years	 None	 None
Heat Exchangers WTP • EX-1 & EX-2	 Very Good	 Over 15 years	 None	 None
Unit Heaters Char Lake • UH-1 & UH-2 • UH-3	 Satisfactory Not Operational	 0 to 15 years Over 15 years	 None Desirable	 None Commission
Unit Heaters WTP • UH-1, UH-2 & UH-3	 Satisfactory	 0 to 5 years	 None	 None

Table 8.1 - Summary of Technical Status

Component	Performance	Remaining Service Life	Action Priority	Required Action
Electrical Systems				
Char Lake				
Main Service				
25kVA Pole mounted transformers	Satisfactory	5 to 10 years	High Priority Suggestion High Priority Desirable	Adjust primary transformer service tap Review availability of replacement transformers with Qulliq Energy Corporation Add warning sign on main service breaker Install TVSS on incoming service entrance
120/208 Volt Secondary Distribution			Desirable	Conduct thermographic scan on all feeder termination points and correct any issue
• Main breaker	Satisfactory	5 to 10 years	None	
• Utility meter	Satisfactory	5 to 10 years	None	
• Automatic transfer switch	Satisfactory	5 to 10 years	Desirable	Testing
• 50kVA dry type transformer	Satisfactory	5 to 10 years	Code Upgrade	Re-wire heat tracing transformer
• Feeder conductor	Unsatisfactory	5 to 10 years	Code Upgrade	Rewire so that wiring is outside other equipment and directly to the breaker
Secondary Distribution Equipment, Starters, Heat Tracing			Desirable	Arrange for detailed annual inspection of all equipment.
• Lighting panel	Good	10 to 15 years	None	None

Table 8.1 - Summary of Technical Status

Component	Performance	Remaining Service Life	Action Priority	Required Action
• Heat tracing	Unsatisfactory	0 years	Code upgrade	Upgrade contactor size to address connected load. Connect controls.
• Temperature monitoring control system	Unsatisfactory	0 to 5 years	Desirable	Upgrade controls to monitor ground/pipe temperature.
• Pump P1&P2 starters	Good	5 to 10 years	High Priority	Conduct detailed inspection to determine why P1 & P2 do not start automatically under back-up power.
• Jockey pumps starters	Unsatisfactory	0 years	Desirable	Replace starters. Feed each pump separately from distribution splitter.
• Control system	Unsatisfactory	0 years	Desirable	Replace existing system with digital controls suitable for direct Internet connection.
Emergency Power			Desirable	Detailed record keeping procedures to be implemented
• Generator	Satisfactory	0 to 5 years	Desirable	Testing and Repairs - Detailed inspection and testing. Complete maintenance should be performed.
• Digital control unit	Good	5 to 10 years	Desirable	
• Battery charger	Good	5 to 10 years	Desirable	
• Automatic transfer switch	Good	5 to 10 years	Desirable	
• Main splitter	Good	5 to 10	Suggestion	Conduct thermographic scan of all electrical connections
• Generator fuel system	Refer to mechanical	Refer to mechanical	Refer to mechanical	Refer to mechanical

Table 8.1 - Summary of Technical Status

Component	Performance	Remaining Service Life	Action Priority	Required Action
Lighting	Good	5 to 10 years	Suggestion	Install proper wire guards on fixtures. Replace lamps and ballasts as required. Add light fixture in work bench area.
Instrumentation Control and Annunciation				
• Building monitoring and control system	Unsatisfactory	0 years	Desirable	Replace control system.
• Magnetic flow meter	Unsatisfactory	0 years	Desirable	Replace
• Digital thermometer	Unsatisfactory	0 years	Code upgrade	Wiring and control transformer to be properly installed and connected.
• Mechanical temperature sensors	Unsatisfactory	0 years	Suggestion	Remove all unused components and obsolete equipment.
Signal Hill				
Main Service				
• 10kVA Pole mounted transformers	Good	5 to 10 years	Suggestion Desirable	Review availability of replacement transformers with Qulliq Energy Corporation Install TVSS on incoming service entrance
120/208 Volt Secondary Distribution	Good	5 to 10 years	Suggestion	Conduct thermographic scan on all feeder termination points and correct any issue
• Main breaker	Satisfactory	5 to 10 years	Code upgrade	Install fillers on open breaker spaces
• Automatic transfer switch	Unsatisfactory	5 to 10 years	High Priority	Replace
• Panel A	Good	5 to 10 years	None	None

Table 8.1 - Summary of Technical Status

Component	Performance	Remaining Service Life	Action Priority	Required Action
• Panel B	Unsatisfactory	0 years	Code Upgrade	Disconnect and remove panel reefed circuit from Panel A
• Pump P1&P2 starters	Good	5 to 10 years	Suggestion	Conduct detailed inspection to determine why P1 & P2 do not start automatically under back-up power.
• Control system	Unsatisfactory	0 years	Desirable	Replace existing system with digital controls suitable for direct Internet connection.
Emergency Power			Desirable	Detailed record keeping procedures to be implemented. Update operations maintenance contract.
• Generator	Satisfactory	0 to 5 years	Desirable	Testing and Repairs - Detailed inspection and testing. Complete maintenance should be performed.
• Analogue gauges and control panel	Good	5 to 10 years	Desirable	
• Battery charger	Good	5 to 10 years	Desirable	
• Automatic transfer switch	Good	5 to 10 years	Desirable	
Lighting	Good	5 to 10 years	Suggestion	Install proper wire guards on fixtures. Replace lamps and ballasts as required. Add light fixture in work bench area.
Instrumentation Control and Annunciation				
• Building monitoring and control system	Unsatisfactory	0 to 5 years	Desirable	Replace control system.
• Paper type flow chart system	Unsatisfactory	0 years	Desirable	Install digital monitoring system

Table 8.1 - Summary of Technical Status

Component	Performance	Remaining Service Life	Action Priority	Required Action
• Mechanical temperature sensors	Unsatisfactory	0 year	Desirable	Remove all unused components and obsolete equipment.
Sewage Plant				
• Panel	Satisfactory	5 to 10 years	Code upgrade	Evaluate hazard level to determine if upgrades are required to meet code. Replacement may be required based on code evaluation
• Electric heater	Satisfactory	5 to 10 years	Code upgrade	
• Macerator pump	Unsatisfactory	0 year	Code upgrade	

9 Record of Improvements

Table 9.1 – Record of Improvements

Subsystem	Description	Date	Source
Civil Works			
Water Storage	Repairs attempted on storage tank at Signal Hill	2007	P. Fuentes
Water Storage	New storage tank provided at Signal Hill; old tank taken out of service	2009	Stantec Drawing
Water Distribution	New heat trace between Char Lake and Signal Hill	1993	Dillon 1999
Water Distribution	Provision of jockey pumps at Char Lake	Unknown	Dillon 1999
Water Distribution	Electrical equipment removed from AV’s	1998	Dillon 1999
Water Distribution	New hydrant at AV 13	1998	Dillon 1999
Water Distribution	Replace valves in AV 3	1998	Dillon 1999
Water Distribution	Additional valve in AV 30	1998	Dillon 1999
Water Distribution	Pipe section replaced between AV’s 10 and 12	1985 or 1986	Operating Contractor
Water Distribution	Drawing prepared for replacement: • AV 20 to 22 • AV 21 to 30 to 29 • AV 8 to 9 to 10 • Approximately 8 AV’s with steel AV’s Project not constructed	1999	Dillon Drawings, Project Number 98-5748-000
Water Distribution	Piping replaced between AV’s 5 and 6	2003	Operating Contractor A. D Williams drawing G-03-1, April 2005

Table 9.1 – Record of Improvements

Subsystem	Description	Date	Source
Water Distribution	Piping replaced between AV's 9 and 10	2003	A. D Williams drawing G-03-1, April 2005
Water Distribution	Piping replaced between AV's 10 and 12	2003	Operating Contractor
Water Distribution	Piping replaced between AV's 27 and 28	2003	Operating Contractor A. D Williams drawing G-03-1, April 2005
Water Distribution	Piping replaced between AV's 29 and 30	2003	Operating Contractor AD Williams drawing G-03-1, April 2005
Water Distribution	Repairs to service connections for Units 29, 85, 86, 92, 93, 98, and 104.	2003	CCN #1, Contract CCT03-2017
Water Distribution	Electrical heat trace installed on hydrants in AV's 2,3,4,5,7,9,13,14,16, 23 and 28.	2003	AD Williams Drawing E-01; Project Number 17731.10
Water Distribution	Replaced most of piping between AV's 27 and 28 due to electrofusion failures. Previously replaced in 2003	2008	Operating Contractor
Water Distribution	Piping replaced between AV's 10 and 12. Previously replaced in 2003	2009	Discussion with Hamlet staff
Water Distribution	3 repair clamps instated between AV's 6 to 8	2009	Operating Contractor
Water Distribution	Electrofusion coupling replaced west of AV 10	2009	Operating Contractor CGS Staff
Water Distribution	System extension constructed from AV 16, through 41 and 44 to AV 13	2009	CGS

Table 9.1 – Record of Improvements

Subsystem	Description	Date	Source
Sewage Collection	Drawing prepared for replacement: • AV 20 to 22 • Approximately 8 AV's with steel AV's Project not constructed	1999	Dillon Drawings, Project Number 98-5748-000
Sewage Collection	Short section of piping (1.5 m) replaced north of AV 10	2006	Operating Contractor
Sewage Collection	10 m section of piping replaced between AV 9 and 10 due to collapse	2007	Operating Contractor
Sewage Collection	System extension constructed from AV 41 through 44 to 32	2009	CGS
Mechanical – Char Lake Pumping Station			
Boilers and Heat Exchange	2 DeDietrich boilers with Riello burners installed	2009	Stantec Drawings – Project 07-2007
Boilers and Heat Exchange	2 plate and frame heat exchangers rated at 1,543 MBTU installed	2009	Stantec Drawings – Project 07-2007
Boilers and Heat Exchange	2 Grundfos TP80/240-2 circulators installed	2009	Stantec Drawings – Project 07-2007
Boilers and Heat Exchange	Combustion air intake provided	2009	Stantec Drawings – Project 07-2007
Building Heating	Oil fired standby unit heater installed	2009	Stantec Drawings – Project 07-2007

Table 9.1 – Record of Improvements

Subsystem	Description	Date	Source
Mechanical – Signal Hill Water Treatment Plant			
Boilers and Heat Exchange	2 DeDietrich boilers with Riello burners installed	2009	Stantec Drawings – Project 07-2007
Boilers and Heat Exchange	2 plate and frame heat exchangers rated at 1,543 MBTU installed	2009	Stantec Drawings – Project 07-2007
Boilers and Heat Exchange	2 Grundfos TP80/240-2 circulators installed	2009	Stantec Drawings – Project 07-2007
Electrical – Char Lake			
120/208 Volt Distribution	Panel and wiring provided to supply new boilers and pumps	2009	Stantec Drawings – Project 07-2007
Electrical – Signal Hill			
General	No improvements noted.		

10 Preventative Maintenance Practices

10.1 Review of Past Preventative Maintenance Practises

The Resolute Bay water and sewer system was originally owned by the Government of the Northwest Territories (GNWT), with responsibility for operation and maintenance assumed by personnel of the GNWT. In approximately 1999, discussions were initiated with the intent of turn-over of these systems to the Hamlet. It appears that this turn-over did not take place and operating responsibility fell to the Government of Nunavut (GN) upon creation of the territory.

Following the creation of the GN, operation and maintenance was conducted by GN personnel. Operator log sheets from a portion of the era of GN operation have been reviewed. Log sheets were maintained for the Char Lake pumping station and the Signal Hill water treatment plant. These sheets recorded the important operating parameters, and were found to be generally diligently completed. No records of other maintenance activities over this period have been located.

The diligence in completing the various log sheets suggests an active and ongoing review of the status of the water and sewer system. The scope of ongoing repairs reported in earlier sections of this report suggest that ongoing operating issues exceeded the capabilities of the operating resources.

10.2 Review of Current Practices

The GN engaged the services of the current operating contractor in 2007. Operations and maintenance services are provided under the terms of service contract SC-260-USN-08. Within this contract the operator is to provide 730 hours per year, or 2 hours per day, of routine preventative maintenance (PM). The contract provides equipment and labour rates for repairs beyond routine PM.

An allocation of 2 hours per day is sufficient to conduct routine checks of the pumping house and treatment plant, together with logging of operating data observed. This allocation is not sufficient to include an ongoing broader review of the water and sewer system.

The current contract lists the included work as:

- Routine PM checks and minor repairs
- Emergency repairs to the utilidor system and associated buildings
- Other repairs as directed by facilities manager

The bid form contains a fixed price for only routine PM checks of the pump house, water plant, macerator building and underground water and sewer utilidor system. Schedule A of the service contract lists routine PM. The Schedule A, included in the service contract, is not applicable to the water and sewer system, as it appears to be related to a health care facility.

From a review of log sheets located during the site visit and from discussions with the current service contractor, it appears that a quantity of service consistent with that sought by the service contract is being provided. A general sense of good intent on the part of the contractor was noted.

10.3 Capacity to Maintain the System

The capacity to maintain the system is dictated by the physical and human resources available to be applied to PM and repair tasks. In terms of equipment and materials, there appear to be suitable resources at hand. The equipment supplied by the GN includes a sewer cleaner (blaster) and a steamer for pipe thawing. The contractor's fleet includes an excavator, earth moving and hauling equipment and additional thawing equipment. There is a stock of both water and sewer main piping in the Hamlet. On this basis there appears to be sufficient physical resources.

The operating contractor can draw from his pool of several employees to undertake PM and repairs. There are some training and safety issues relating to this staff resource that should be addressed. Worker safety requires that this staff receive training in several areas including confined space access and fall prevention. Public health and safety requires that staff receive training and certification directly relating to the operation and maintenance of water and sewer systems. One focus of this training would be upon increased sensitivity and recognition of the issues relating to potential contamination of the water system. It is in the interest of the system owner to confirm, on an ongoing basis, that operating staff have received appropriate training.

11 Conditions Requiring Urgent Action

During the site visit to Resolute Bay between November 23rd and 25th, there were some observations made which should be addressed as soon as possible. These issues were previously brought to the Government of Nunavut's attention in separate correspondence.

11.1 Fuel Storage

During the site visits of the Char Lake pumping station many code violations were observed with the diesel fuel system in place. The present set up represent great risk of contamination of the ground and Char Lake, which is the only source of potable water for the community.

The following observations were made and require immediate attention:

- A single-wall 9090 L (2000 imp. gal.) above-ground fuel storage tank is installed outside the building, across the road from the pump house. Single-wall black steel pipes installed underground, passing under a road, feed by gravity a 1135 L (250 imp. gal.) day tank and a smaller 1135 L.(25 imp. gals) installed inside the pump house. There is no leak detection installed between the main tank and the day tank. In the event of failure of the buried piping, fuel could contaminate the ground and eventually the water of the lake before the leak is noticed.

- The larger day tank is a single wall tank, installed directly next to the potable water wet well. The tank is gravity fed from the main tank outside. The tank has no ULC Label, no secondary containment, no leak detection, no overflow, no overfilling protection and is vented directly to the exterior. The termination of the vent line is higher than the vent of the main tank installed outside, in order to prevent a spill in event of overfilling of the main tank.

- All tanks are interconnected and gravity fed. In the current configuration, a failure of one of the tanks installed in the building would mean that the entire volume of fuel contained in the day tank, the main storage tank and the piping, representing over 10,230L (2250 imp. gals) would flow in the pump house, potentially contaminating the water in the wet well and/or cause a fire.

The entire fuel system must be replaced to meet the current codes. Work shall include:

- Provide secondary containment with leak detection, low level and high level alarms for all the tanks, including tanks installed outside and inside as required by the National Fire Code and CSA B-139.

- Provide fuel transfer pumps in a sump to allow drainage by gravity of all fuel lines without risk of fuel being trapped.

- Replace the underground fuel transfer lines between the main storage tank and the building with double-wall construction piping with leak detection, in accordance with the National Fire Code and CSA-B139 standard.

- The emergency generator has a small day tank gravity fed from the 1135 L (250 imp. gal.) day tank. This small day tank is a single wall tank, directly vented to the exterior with no secondary containment and no overfilling protection. There is a solenoid valve installed on the fill side of the tank. When the generator starts, the solenoid will open and the tank will fill up, including the vent pipe, until the levels between the main tank outside the building and the generator tank are balanced, which will mean that the vent pipe is partially filled with fuel and that the tank is pressurized. This type of tank is not designed to be pressurized so the risk of failure is increased.

- As required by the National Fire Code and CSA-B139, provide venting of the day tanks through the main storage tank or provide redundant high level sensors to shut the transfer pumps and prevent the overfilling of the tank.

Fuel storage quantity, according to the Government of Nunavut Good Building Practices Guideline, would be of a minimum of two weeks calculated at continuous maximum operating load, including heating and emergency power. The rational is that blizzards and storms can make delivery difficult for periods up to two weeks. Based on a fuel consumption of 3 gal/hr and one boiler used for redundancy, the minimum required fuel storage capacity would be of 22,275 L (4,900 imp. gal.). The current fuel storage capacity would provide autonomy of 128 hours (5 days and 8 hours) at full load. Fuel storage capacity should be reviewed as part of the overall fuel system upgrade.

11.2 Public Health

With regards to public health, there is a significant risk of contamination of the water supply due to current conditions within the access vaults. These vaults are shared by the water and sewer. Their design includes enclosure of the sewers using sealed clean-outs, which provided separation of these systems. Currently the covers on these clean-outs have been removed. There are several locations where various valved connections to the water system are not capped. There are also several locations where bleed water is directed from the water system into the sewers. At these locations no backflow prevention measures are provided.

11.3 Water Consumption Monitoring

Current average day water is approaching the supply ability at the Char Lake pump house. Additional demands, including additional bleeds, may increase water consumption beyond supply capabilities. This will create the risk of water system depressurization. Challenges that would arise from a loss of pressure in the water system include water contamination and system wide water and sewer piping freeze. It is recommended that the GN personnel monitor, on a continuing and ongoing basis the rates of water use in Resolute Bay.

11.4 Worker Safety Observations

With regards to worker safety, we must report concerns relating to confined space entry and fall arrest. Concerns arise in both of these areas in relation to any work within the access vaults. As a participant in this water system, the GN may, as a matter of due diligence, confirm that workers have been provided the prescribed training and that appropriate procedures are followed.

12 Summary and Conclusions

12.1 Summary

The various findings of the preceding report may be summarized as follows.

12.1.1 General

1. The existing water and sewer system has served the Hamlet of Resolute Bay since the late 1970's. This system operates in one of the most challenging climates found anywhere in Canada. Climate has been an ongoing issue in maintaining the water and sewer systems.

2. The system can be generally described as being made up of water supply and transmission works, water treatment and storage, a water distribution network, a sewage collection network and sewage disposal works.

3. Water consumption was reported in the mid 1990's to be approximately 48,000 m^3/year, with approximately 80% of this volume lost to bleeds. There was a substantial increase in water consumption after 2007. Current use is approaching 300,000 m^3/year. Fuel consumption has risen substantially in a similar pattern to the increase in water use.

4. Average day water use is approaching the capacity of the supply works. This raises a concern in regards to the risk of depressurizing the water system should there a shortfall in supply capacity.

5. Various previous reports and investigations of the water and sewer system have been previously conducted. Section 3 of this report summarizes those investigations located during the preparation of this report.

6. The existing buildings at Char Lake and Signal Hill demonstrate their age, but continue to remain serviceable. The principal issues with the buildings include poor insulation, air infiltration through the building envelope, a lack of combustion air intake and inadequate ventilation during generator operation.

12.1.2 Civil Works

1. The current intake from Char Lake appears suitable to meet the community needs for a further 5 years.

2. The existing pumping and heating equipment in the Char Lake pump house are meeting the current needs of the community. Current water consumption is approaching the capacity of the supply pumps. This is the result of high bleed flow. The water heating arrangements are raising the supply water temperature to 5°C.

This is despite a lack of controls and ineffective injection of heated water into the flows transmitted to the town site.

3. The transmission watermain between the Char Lake pump house and the Signal Hill water treatment plant is meeting current community needs. It is estimated that the insulation is loosing heat at twice the rate of modern installation. The internal electric heat trace cable is operating continuously.

4. The current water storage tank was recently constructed. It should meet community needs for the next 5 years.

5. Water treatment is currently limited to chlorination. Chlorine monitoring is limited to once daily sampling and testing based upon a sample taken in the hotel kitchen. No bacteriological testing results were located during this study.

6. The water distribution system includes access vaults and looped piping. The access vaults are shared with the sewer system. Current conditions within the access vaults raise significant concerns relating to the risk of cross contamination of the water system from the sewer system.

7. The water distribution system is a looped system with forced circulation. The circulation is induced by pumps at the water treatment plant. A recently installed extension to the system represents a paralleling of existing piping. This may enhance the risk of freeze of a portion of the water system due to disruption of earlier circulation patterns.

8. It is estimated that the water distribution system is loosing heat at 5 times the rate that would be seem for modern piping. This may be the result of freeze pressure against the exterior of the piping insulation system. This annual re-freeze pressure is the result of the piping being situated near the bottom of the active layer.

9. Table 5.2 summarizes improvements to the water system. These improvements included the replacement of several sections of piping.

10. The town site is served by a system of gravity sewers that ultimate discharge to an outlet on the beach. This system is made up of access vaults that are shared with the water system and piping.

11. Water is bled from the water system into the sewer system at several locations to add heat to the access vaults, to add heat to the sewer piping and to enhance flow in the sewers.

12. The CCTV inspection of a portion of the sewer system identified internal ice, sags in pipe profile and evidence of external pressure upon the sewer piping. The sags in profile suggest heave and thaw settlement. Evidence of external and indications of

internal icing suggest that the insulation has been affected by external pressures due to annual re-freeze. Sags in the sewer profiles and deteriorated insulation will enhance the risk of freeze of sewer piping. The high rates of bleed water flow appear to be an operational effort to reduce the risk of freeze.

13. The sewer service connections represent the portion of the sewer system that is most vulnerable to freeze. All of the service connections are equipped with bleed water connections. These service connection bleeds could make up as much as 1/3 of the Hamlet's water consumption.

14. The current sewage treatment works are limited to a macerator. Although this is not currently viewed to be an acceptable method of sewage treatment, several other issues, such as high flows must be addressed during the course of selection of a site and the method for sewage treatment.

12.1.3 Mechanical Systems

1. The potable water service pumps are meeting current community requirements. These pumps do not appear to have had an overhaul or major maintenance since original installation. These pumps are near the end of their useful life.

2. Hot water is injected into the wet well to raise the water temperature prior to pumping to the town site. There is no control over the water injection and no assurance that water is leaving the pump house at an appropriate temperature. Heated water injection into the water leaving the pump house is ineffective.

3. The fuel system at Char Lakes includes a 9090 litre external fuel tank and a pair of internal day tanks. The current fuel system represents a substantial risk of contamination for the Hamlet's water supply.

4. The boilers and heat exchangers at Char Lake were recently replaced. There are no controls to allow sequential operation of the boilers. There is no control over the rate of heated water injection into the wet well. The boilers do not currently have a method for make-up water addition to the boilers.

5. The current ventilation arrangement at Char Lake does not support unattended operation of the standby generator. The operator must currently open the door to allow generator heat to escape.

6. There are currently very few functional controls at Char Lake.

7. The current alarms at Char Lake are inadequate; both in terms of the number of parameters monitored and the method that alarms are reported to the operator.

8. The storage tank at Signal Hill was recently installed.

9. The potable water circulation pumps at the Signal Hill treatment plant are currently operating satisfactorily. These pumps appear to be part of the original installation, and despite the current satisfactory operation, they should be viewed as near the end of their service life.

10. Hot water is injected into the potable water flow pumped to the town site and into the storage tank. Control over heat injection into the water supply to the town site is currently not functioning. There is no control over the heat injection into the storage tank.

11. The fuel system at Signal Hill does not meet current codes for fuel handing and storage systems.

12. The boilers and heat exchangers at Signal Hill were recently replaced. There are no controls to allow sequential operation of the boilers. The boilers do not currently have a method for make-up water addition to the boilers.

13. The current ventilation arrangement at Signal Hill does not support unattended operation of the standby generator. The operator must currently open the door to allow generator heat to escape.

14. There is no combustion air supply at Signal Hill. Combustion air for the boilers and generator is currently provided by infiltration through the building envelope.

15. There is a very limited system of controls. Much of this system is not functional due to a lack of spare parts.

16. The current alarms at Signal Hill are inadequate; both in terms of the number of parameters monitored and the method that alarms are reported to the operator.

17. There is currently no operational mechanical equipment at the macerator. This includes process equipment and ventilation.

12.1.4 Electrical Systems

1. The electrical distribution components at Char Lake and Signal Hill are generally in satisfactory condition.

2. The standby generator at Char Lake is suitable to support the current loads, with the exception of the heat trace cable in the transmission water main to Signal Hill.

3. There is currently no control over the operation of the heat trace cable in the supply water main to Signal Hill. As a result the heat trace cable operates continuously.

4. The starters for the jockey pumps at Char Lake should be replaced.

5. No logs or records have been located in relation to standby generator maintenance for either Char Lake or Signal Hill.

6. In general the control and instrumentation systems are not operational. This is the result of several issues including a lack of spare parts.

7. The alarms at Char Lake and Signal Hill are, in general unsatisfactory, both in terms of the parameters monitored and the method that alarms are reported.

12.1.5 Maintenance

1. Maintenance is currently provided by a service contractor. It appears the contractor is meeting the requirements of his contract. A broader scope of maintenance activities would be appropriate.

2. There is appropriate equipment available with the community to conduct preventative maintenance. A suitable stockpile of pipe material is available.

3. Training of operation staff should be provided. This includes confined space entry and fall arrest. One specific area where training is required is in the area of operations and repair of a municipal water supply and sewage system. Specific issues that this training will address include reduction of risk of water main contamination due to system operational activities.

12.1.6 Urgent Actions

Some conditions that require urgent action have been identified. These include:

1. Improved fuel storage and reduction of the risk of water contamination due to fuel spills.

2. Reduction of the risk of cross contamination between the sewer and water systems due to conditions within the access vaults.

3. Monitoring of water consumption by the GN to insure that demand does not exceed supply capacity.

12.2 Conclusions

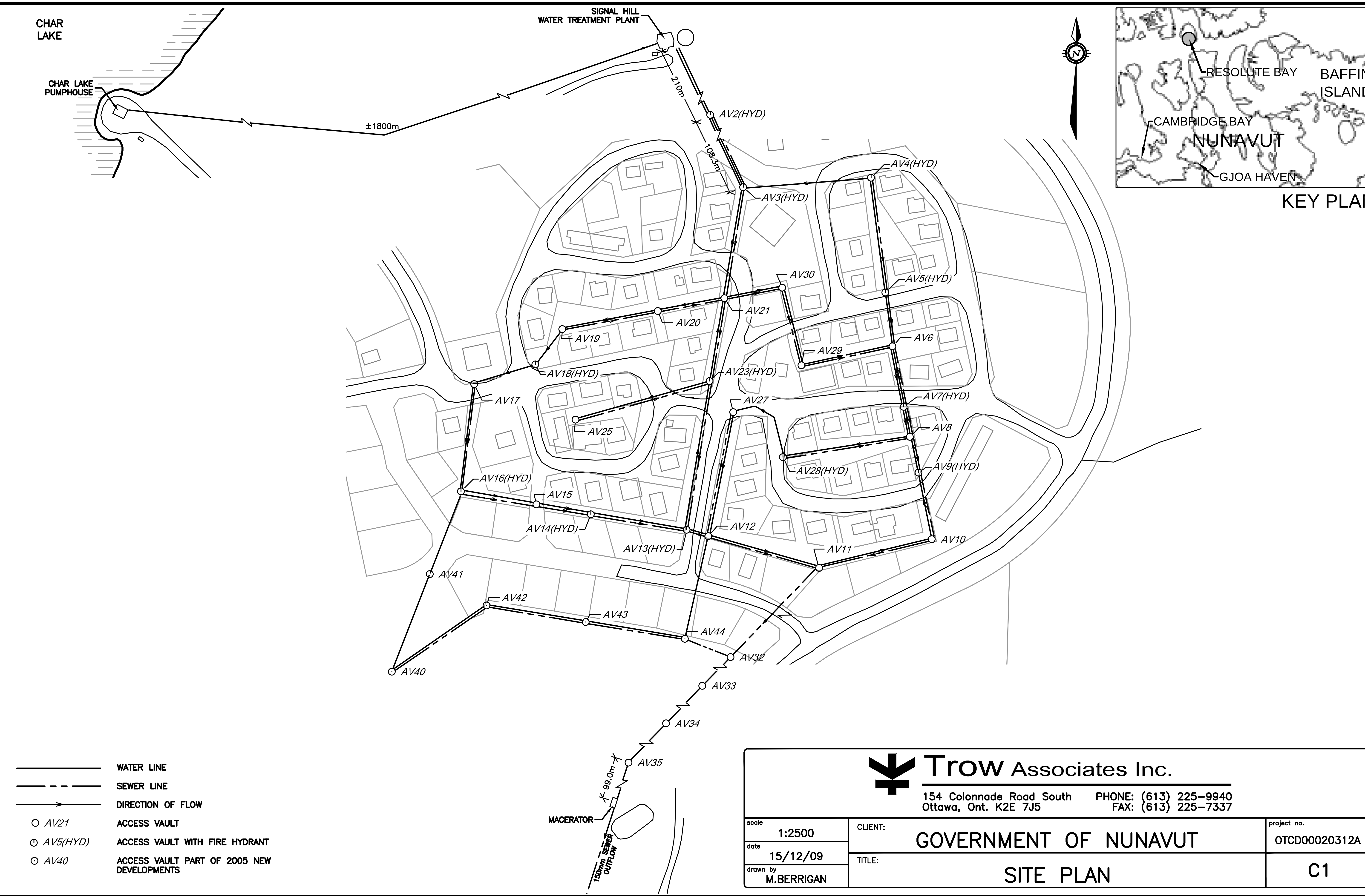
1. High levels of water consumption are currently being experienced in Resolute Bay. These appear to be largely the result of operation efforts to avoid freeze of the piping.

2. Risks to public health and safety arising from fuel storage arrangements and conditions within shared access vaults have been identified.

3. The water and sewer system piping was installed near the bottom of the active layer. The vertical location of the piping has lead to deterioration of the insulated piping system due to external pressure exerted during re-freeze. This location has also enhanced the risks of sags in the sewer profile due to thaw settlement and heave.

4. It is likely that the existing system can continue to serve the community for 5 years. This will require high levels of water consumption and attentive and persistent operator effort.

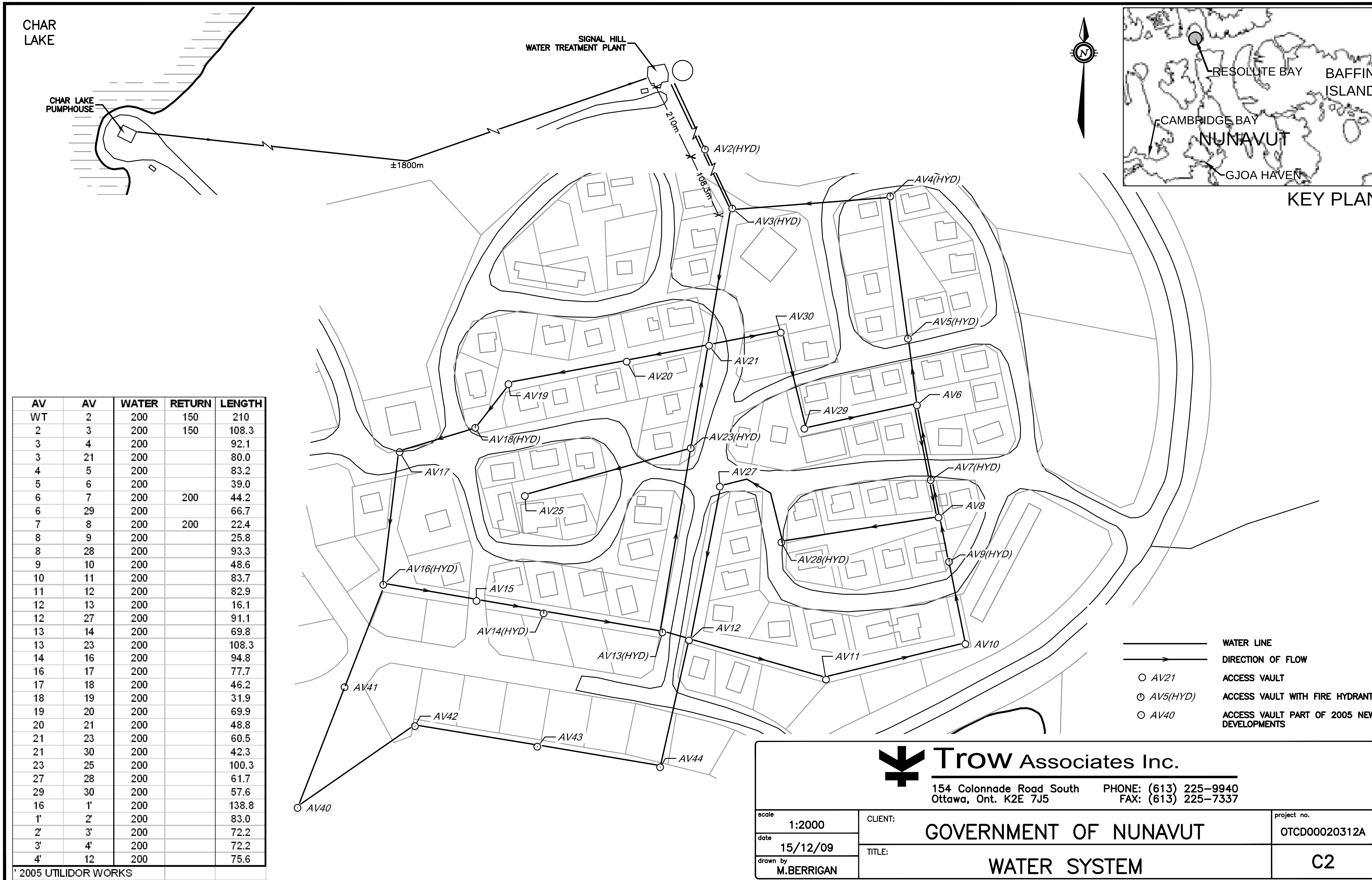
Appendix A:
Drawings



———	WATER LINE
— — —	SEWER LINE
——▸——	DIRECTION OF FLOW
○ AV21	ACCESS VAULT
○ AV5(HYD)	ACCESS VAULT WITH FIRE HYDRANT
○ AV40	ACCESS VAULT PART OF 2005 NEW DEVELOPMENTS

Trow Associates Inc.
154 Colonnade Road South
Ottawa, Ont. K2E 7J5
PHONE: (613) 225-9940
FAX: (613) 225-7337

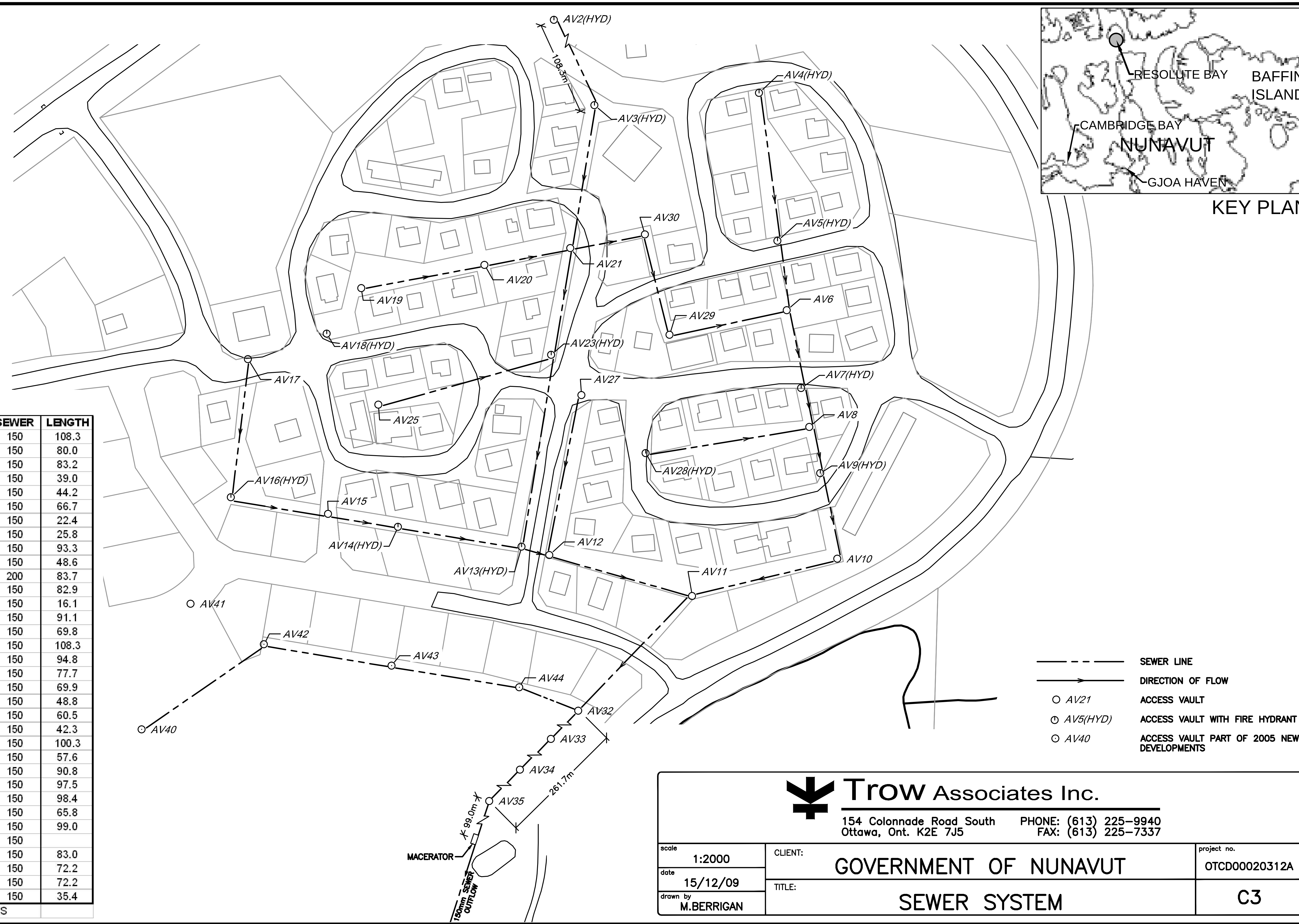
scale 1:2500	CLIENT: GOVERNMENT OF NUNAVUT	project no. OTCD00020312A
date 15/12/09	TITLE: SITE PLAN	C1
drawn by M.BERRIGAN		



AV	AV	WATER	RETURN	LENGTH
WT	2	200	150	210
2	3	200	150	108.3
3	4	200		92.1
3	21	200		80.0
4	5	200		83.2
5	6	200		39.0
6	7	200	200	44.2
6	29	200		66.7
7	8	200	200	22.4
8	9	200		25.8
8	28	200		93.3
9	10	200		48.6
10	11	200		83.7
11	12	200		82.9
12	13	200		16.1
12	27	200		91.1
13	14	200		69.8
13	23	200		108.3
14	16	200		94.8
16	17	200		77.7
17	18	200		46.2
18	19	200		31.9
19	20	200		69.9
20	21	200		48.8
21	23	200		60.5
21	30	200		42.3
23	25	200		100.3
27	28	200		61.7
29	30	200		57.6
16	1'	200		138.8
1'	2'	200		83.0
2'	3'	200		72.2
3'	4'	200		72.2
4'	12	200		75.6
' 2005 UTILIDOR WORKS				

Trow Associates Inc.
154 Colonnade Road South
Ottawa, Ont. K2E 7J5
PHONE: (613) 225-9940
FAX: (613) 225-7337

scale 1:2000
date 15/12/09
drawn by M.BERRIGAN
CLIENT: GOVERNMENT OF NUNAVUT
TITLE: WATER SYSTEM
project no. OTCD00020312A
C2

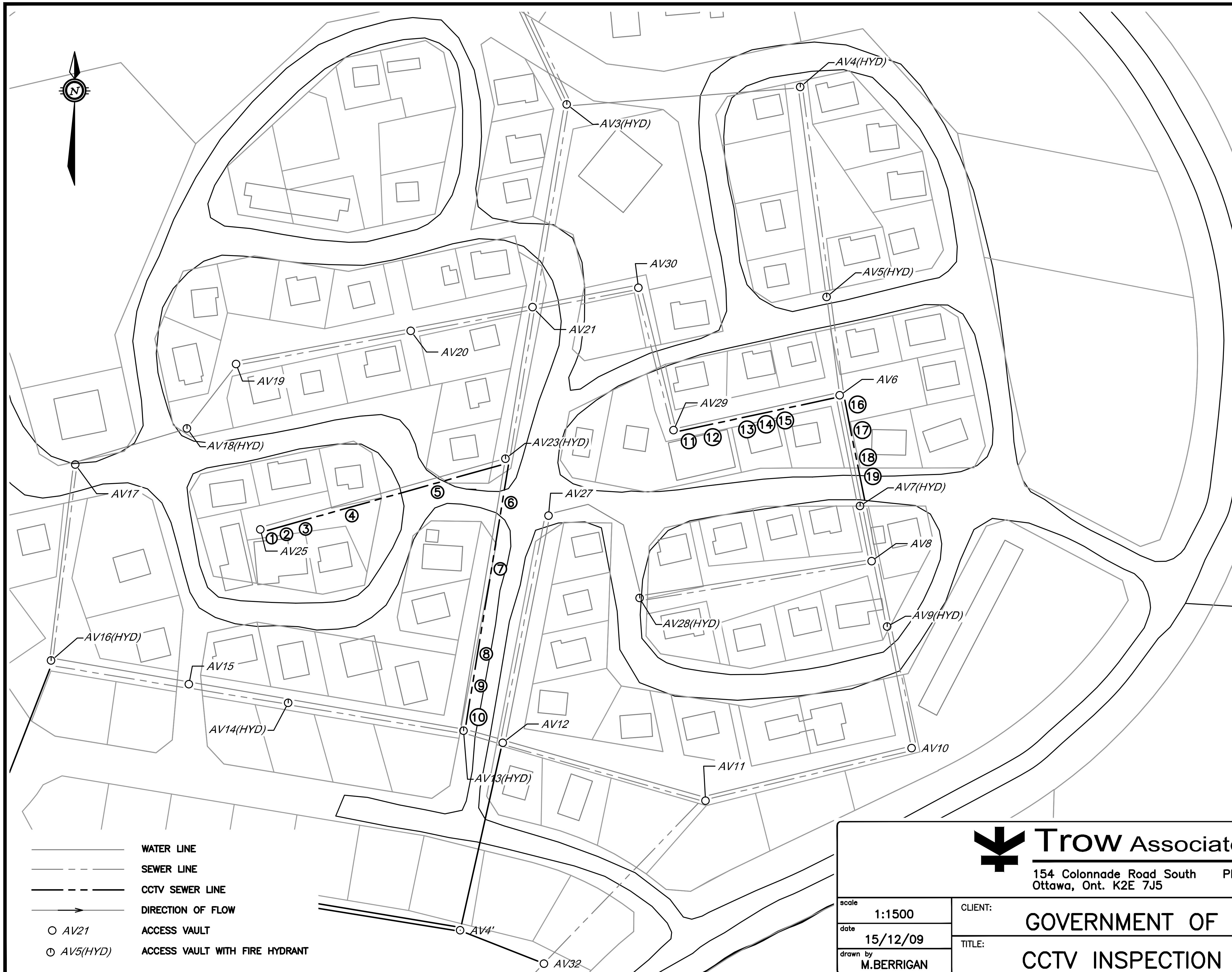


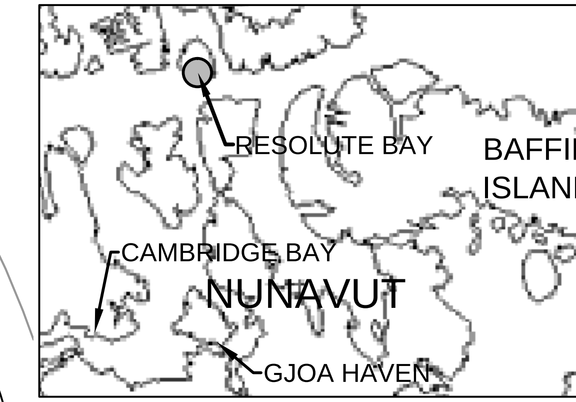
AV	AV	SEWER	LENGTH
2	3	150	108.3
3	21	150	80.0
4	5	150	83.2
5	6	150	39.0
6	7	150	44.2
6	29	150	66.7
7	8	150	22.4
8	9	150	25.8
8	28	150	93.3
9	10	150	48.6
10	11	200	83.7
11	12	150	82.9
12	13	150	16.1
12	27	150	91.1
13	14	150	69.8
13	23	150	108.3
14	16	150	94.8
16	17	150	77.7
19	20	150	69.9
20	21	150	48.8
21	23	150	60.5
21	30	150	42.3
23	25	150	100.3
29	30	150	57.6
11	32	150	90.8
32	33	150	97.5
33	34	150	98.4
34	35	150	65.8
35	MACE	150	99.0
MACE	OUT	150	
1'	2'	150	83.0
2'	3'	150	72.2
3'	4'	150	72.2
4'	32	150	35.4
' 2005 UTILIDOR WORKS			

Trow Associates Inc.

154 Colonnade Road South
Ottawa, Ont. K2E 7J5
PHONE: (613) 225-9940
FAX: (613) 225-7337

scale	CLIENT:	project no.
1:2000	GOVERNMENT OF NUNAVUT	OTCD00020312A
date: 15/12/09	TITLE:	
drawn by: M.BERRIGAN	SEWER SYSTEM	C3





KEY PLAN

AV25 TO AV23

1. APPEARS TO BE PRESSURE ALONG THE SIDES OF THE PIPE DEFORMING THE PIPE INWARDS AT THE 9 O'CLOCK.
2. PIPE DEFLECTS DOWNWARD, APPEARS TO BE PRESSURE DEFORMING THE PIPE INWARD AT THE 3 O'CLOCK.
3. UNEVEN GRADE OF PIPE. SIGNS OF BASE SETTLEMENT.
4. OVAL PIPE, NARROW AT THE SIDES.
5. OVAL PIPE, NARROW AT THE VERTICAL.

AV23 TO AV13

6. BUCKLE IN BOTTOM OF PIPE.
7. PIPE BUCKLES AND DEFLECTS DOWNWARDS.
8. OVAL PIPE NARROW AT THE VERTICAL.
9. OVAL PIPE NARROW AT THE VERTICAL.
10. BUCKLE IN BOTTOM OF PIPE.

AV29 TO AV6

11. APPEARS TO BE PRESSURE ON THE PIPE AT THE 4 O'CLOCK DEFORMING THE PIPE.
12. OVAL PIPE NARROW AT THE SIDES, APPEARS TO BE ICE BUILDUP ALONG SIDES.
13. SUMP FOUND IN PIPE.
14. DEBRIS FOUND IN PIPE, POSSIBLY STRUCTURAL DAMAGE. SURVEY STOPPED.
15. SUMP FOUND IN PIPE

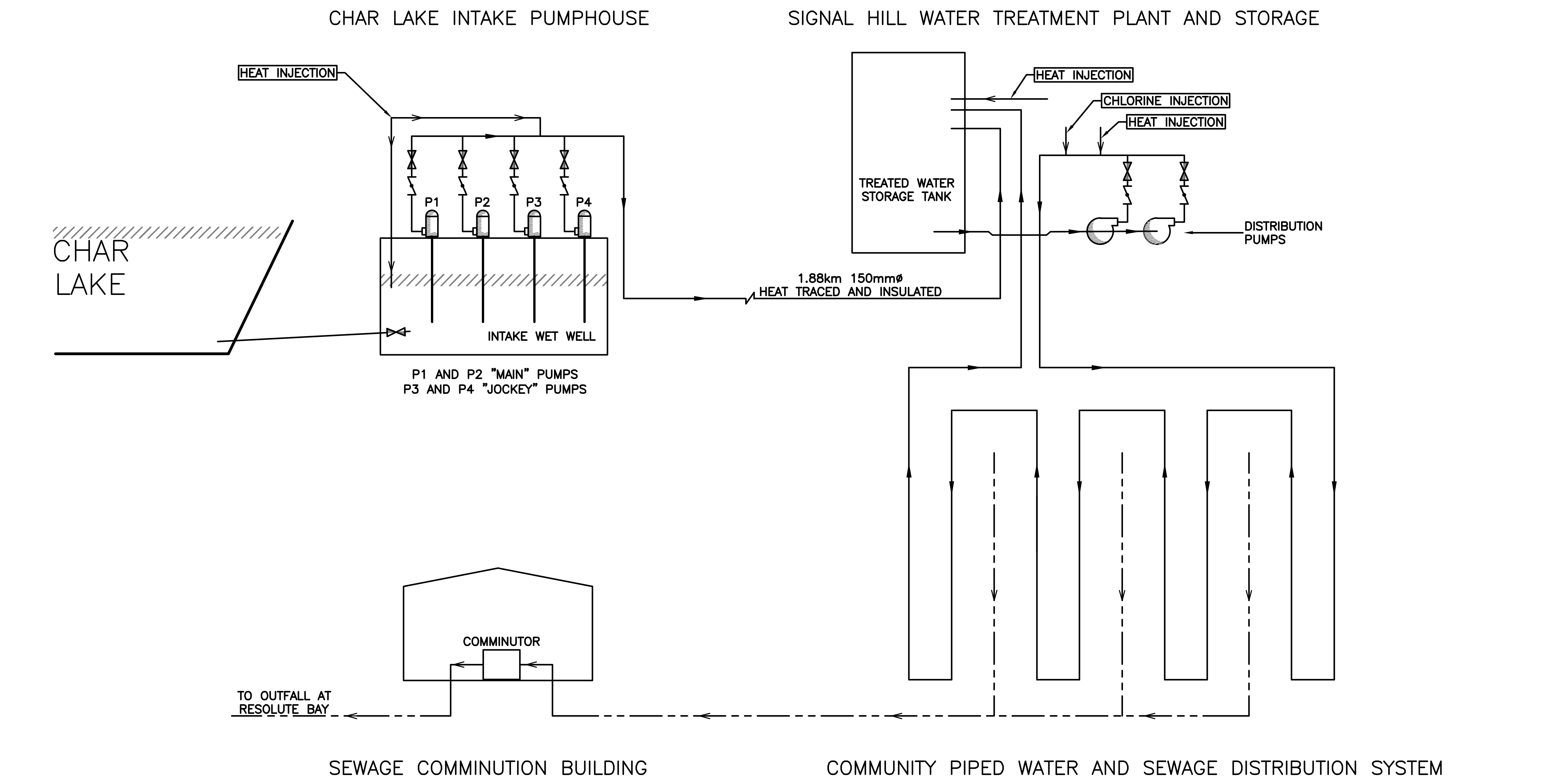
AV6 TO AV7

16. UNEVEN GRADE TO PIPE, SETTLEMENT OF BASE.
17. ICE BUILDUP ALONG OBVERT OF PIPE.
18. ICE BUILDUP ALONG OBVERT OF PIPE.
19. ICE BUILDUP ALONG OBVERT OF PIPE.

	WATER LINE
	SEWER LINE
	CCTV SEWER LINE
	DIRECTION OF FLOW
AV21	ACCESS VAULT
AV5(HYD)	ACCESS VAULT WITH FIRE HYDRANT

Trow Associates Inc.
154 Colonnade Road South
Ottawa, Ont. K2E 7J5
PHONE: (613) 225-9940
FAX: (613) 225-7337

scale 1:1500	CLIENT: GOVERNMENT OF NUNAVUT	project no. OTCD00020312A
date 15/12/09		
drawn by M.BERRIGAN	TITLE: CCTV INSPECTION FINDINGS	C4



WATER LINE

SEWER LINE

Trow Associates Inc.
154 Colonnade Road South
Ottawa, Ont. K2E 7J5
PHONE: (613) 225-9940
FAX: (613) 225-7337

date 17/12/09	CLIENT: GOVERNMENT OF NUNAVUT	project no. OTCD00020312A
drawn by M.BERRIGAN	TITLE: WATER/SEWAGE FLOW SCHEMATIC	C5

PLUMBING / HEATING

GATE VALVE (OPEN)	THREE WAY MOTORIZED VALVE
GATE VALVE (CLOSE)	TWO WAY MOTORIZED VALVE
ECCENTRIC OR PLUG VALVE (OPEN)	PRESSURE REDUCING VALVE
EXCENTRIC OR PLUG VALVE (CLOSED)	PRESSURE GAUGE
BUTTERFLY VALVE (OPEN)	AUTOMATIC AIR VENT
BUTTERFLY VALVE (CLOSED)	MANUAL AIR VENT
DRAIN VALVE WITH HOSE CONNECTION	THERMOMETER
SAVETY VALVE	HW-S HEATING WATER, SUPPLY
CHECK VALVE	HW-R HEATING WATER, RETURN
M WATER METER	DOMESTIC COLD WATER
STRAINER	DOMESTIC HOT WATER
	CIRCULATOR OR PUMP
EXPANSION TANK	IN LINE FILTER
UNIT HEATER	AIR SEPARATOR
BOILER: BOILER	HEAT EXCHANGER PLATE TYPE
T TEMPERATURE SENSOR (C/W PROBE WELL)	DAY TANK: DIESEL FUEL TANK
FS FLOW SWITCH	

DRAWING LIST

M1	LEGEND & DRAWING-LIST
M2	CHAR LAKE, WATER INLET PUMP HOUSE – PIPING DIAGRAM
M3	WATER TREATMENT PLANT – PIPING DIAGRAM
M4	CHAR LAKE AND WATER TREATMENT PLANT – DIESEL PIPING DIAGRAM

No	DATE	REVISION	BY	OIQ
0	09-12-07	ISSUED FOR REVIEW	P.S.O.	

0 M
0 PO.
DETAIL DRAWING

STAMP

DESIGNED

DRAWN

VERIFIED

APPROVED

VODO BANANI BOUTHILLETTE PARIZEAU

Ottawa :
3740 Richmond Road, Suite 100, K2H 5B9
T.(613) 596.6454 F.(613) 596.3346
www.WBBPengineering.com

Gatineau :
430 de l'hôpital bld, suite 210, J8V 1T7
T.(819) 778.2448 F.(819) 778.5031

Consulting Engineers

PROJECT
RESOLUTE BAY, NUNAVUT
SEWAGE & WATER TREATMENT PLANT

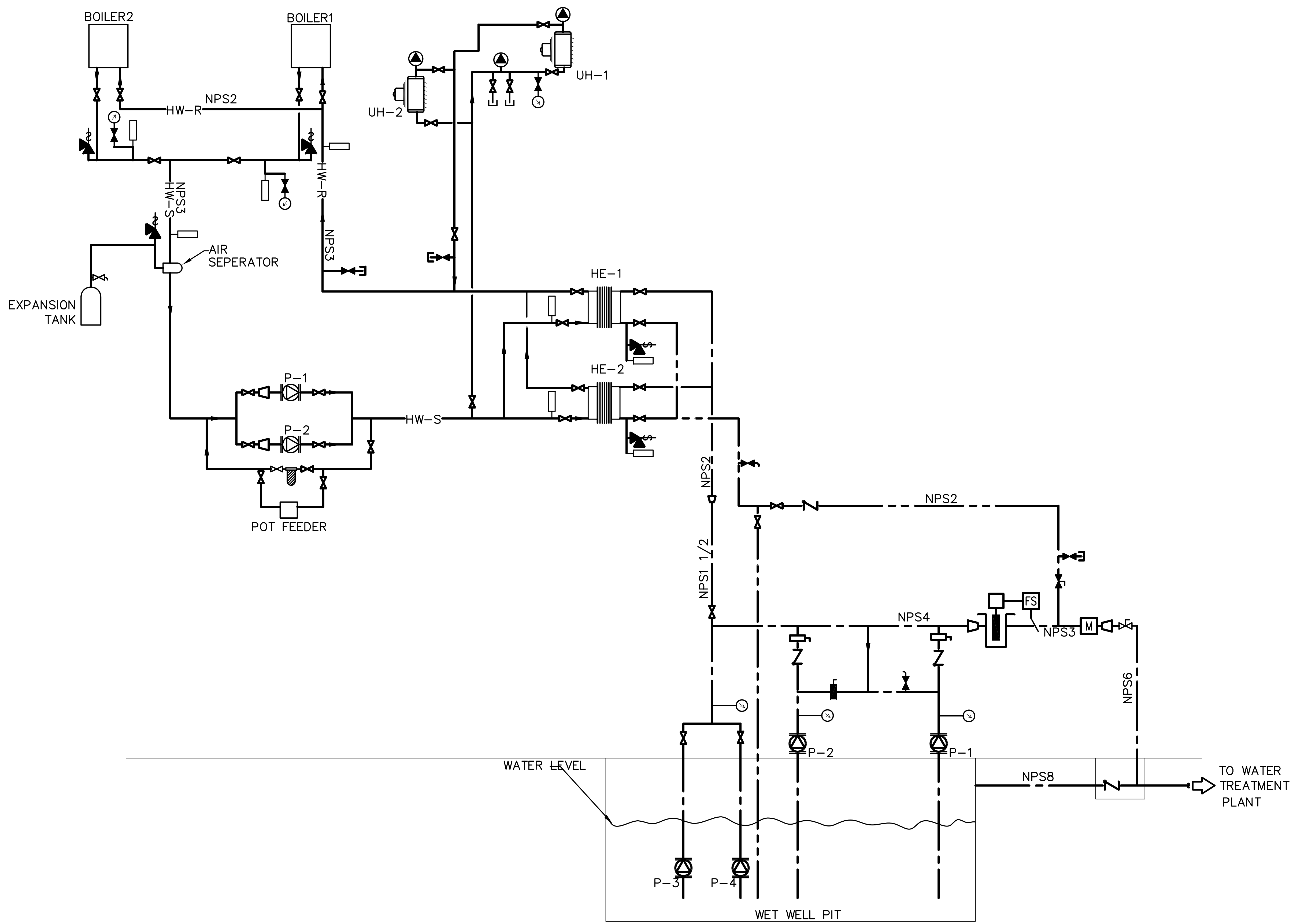
DRAWING TITLE
LEGEND & DRAWING LIST

SCALE	DATE	PAGE
N.T.S.	DECEMBER 2009	1/4
PROJECT No	DRAWING No	REVISION
09-135	M1.	0

FILE

Dec 16, 2009

G:\2009\8009135\WBBP Drawings\Mech\1-Review\8009-135-M1-0-01P.dwg



No	DATE	REVISION	BY	OIQ
0	09-12-07	ISSUED FOR REVIEW	P.S.O.	

0 M
0 PO.

DETAIL DRAWING

STAMP

DESIGNED

DRAWN

VERIFIED

APPROVED

WOOD BANANI BOUTHILLETTE PARIZEAU

Ottawa :
3740 Richmond Road, Suite 100, K2H 5B9
T.(613) 596.6454 F.(613) 596.3346
www.WBBPengineering.com

Gatineau :
430 de l'hôpital bld, suite 210, J8V 1T7
T.(819) 778.2448 F.(819) 778.5031

Consulting Engineers

PROJECT

RESOLUTE BAY, NUNAVUT
SEWAGE & WATER TREATMENT
PLANT

DRAWING TITLE

CHAR LAKE
WATER INLET PUMP HOUSE

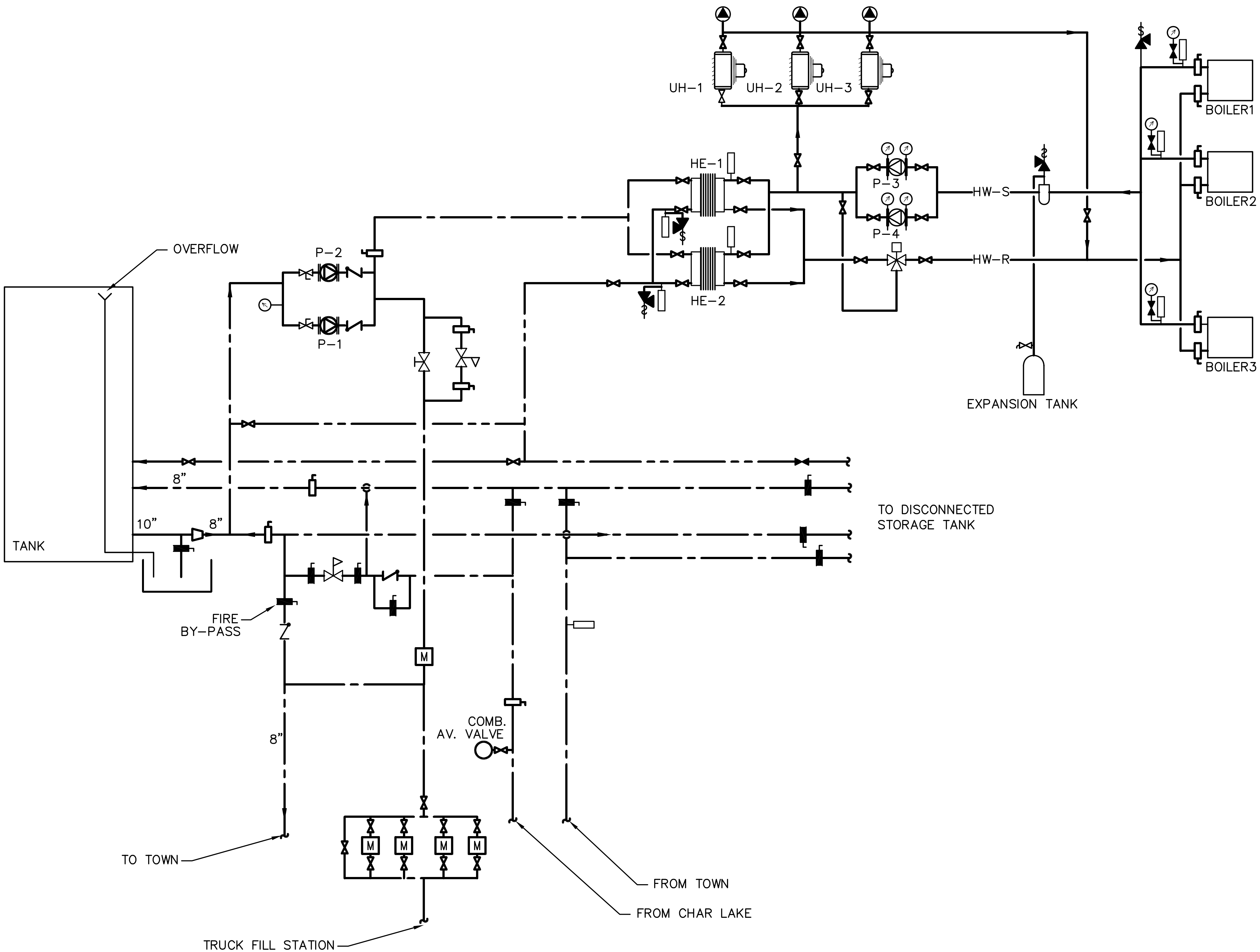
SCALE	DATE	PAGE
N.T.S.	DECEMBER 2009	2/4

PROJECT No	DRAWING No	REVISION
09-135	M2	0

FILE

Dec 16, 2009

G:\2009\8009135\WBBP Drawings\Mech\1-Review\8009-135-M1-0-01P.dwg



No	DATE	REVISION	BY	OIQ
0	09–12–07	ISSUED FOR REVIEW	P.S.O.	

0 M
0 PO.

DETAIL DRAWING

STAMP

DESIGNED

DRAWN

VERIFIED

APPROVED

VODO BANANI BOUTHILLETTE PARIZEAU

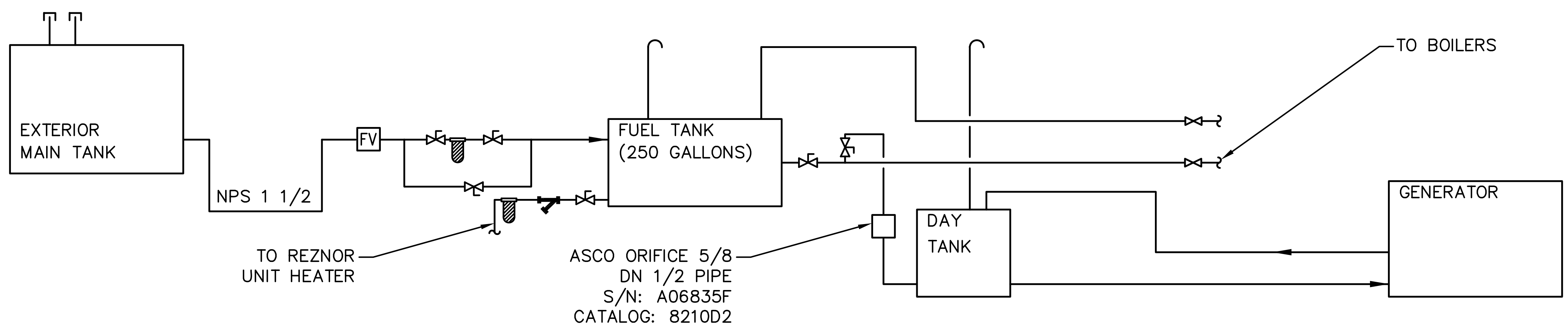
Ottawa :
3740 Richmond Road, Suite 100, K2H 5B9
T.(613) 596.6454 F.(613) 596.3346
www.WBBPengineering.com
Gatineau :
430 de l'hôpital bld, suite 210, J8V 1T7
T.(819) 778.2448 F.(819) 778.5031
Consulting Engineers

PROJECT
RESOLUTE BAY,NANUVUTE
SEWAGE & WATER WORKS

DRAWING TITLE
WATER TREATMENT PLANT
PIPING DIAGRAM

SCALE	DATE	PAGE
N.T.S.	DECEMBER 2009	3/4
PROJECT No	**DRAWING No**	**REVISION**
09–135	M3	0

FILE



No	DATE	REVISION	BY	OIQ
0	09-12-07	ISSUED FOR REVIEW	P.S.O.	

DETAIL DRAWING

STAMP

DESIGNED

DRAWN

VERIFIED

APPROVED

WOOD BANANI BOUTHILLETTE PARIZEAU

Ottawa :
3740 Richmond Road, Suite 100, K2H 5B9
T.(613) 596.6454 F.(613) 596.3346
www.WBBPengineering.com

Gatineau :
430 de l'hôpital bld, suite 210, J8V 1T7
T.(819) 778.2448 F.(819) 778.5031

Consulting Engineers

PROJECT

RESOLUTE BAY,NANUVUTE
SEWAGE & WATER WORKS

DRAWING TITLE

CHAR LAKE – WATER TREAMENT
PLANT, DIESEL PIPING DIAGAM

SCALE	DATE	PAGE
N.T.S.	DECEMBER 2009	4/4
PROJECT No	**DRAWING No**	**REVISION**
09-135	M4	0

FILE

Dec 16, 2009

G:\2009\8009135\WBBP Drawings\Mech\1-Review\8009-135-M1-0-01P.dwg

Appendix B: Tables and Figures

Figure 2.1
Yearly Fuel Consumption

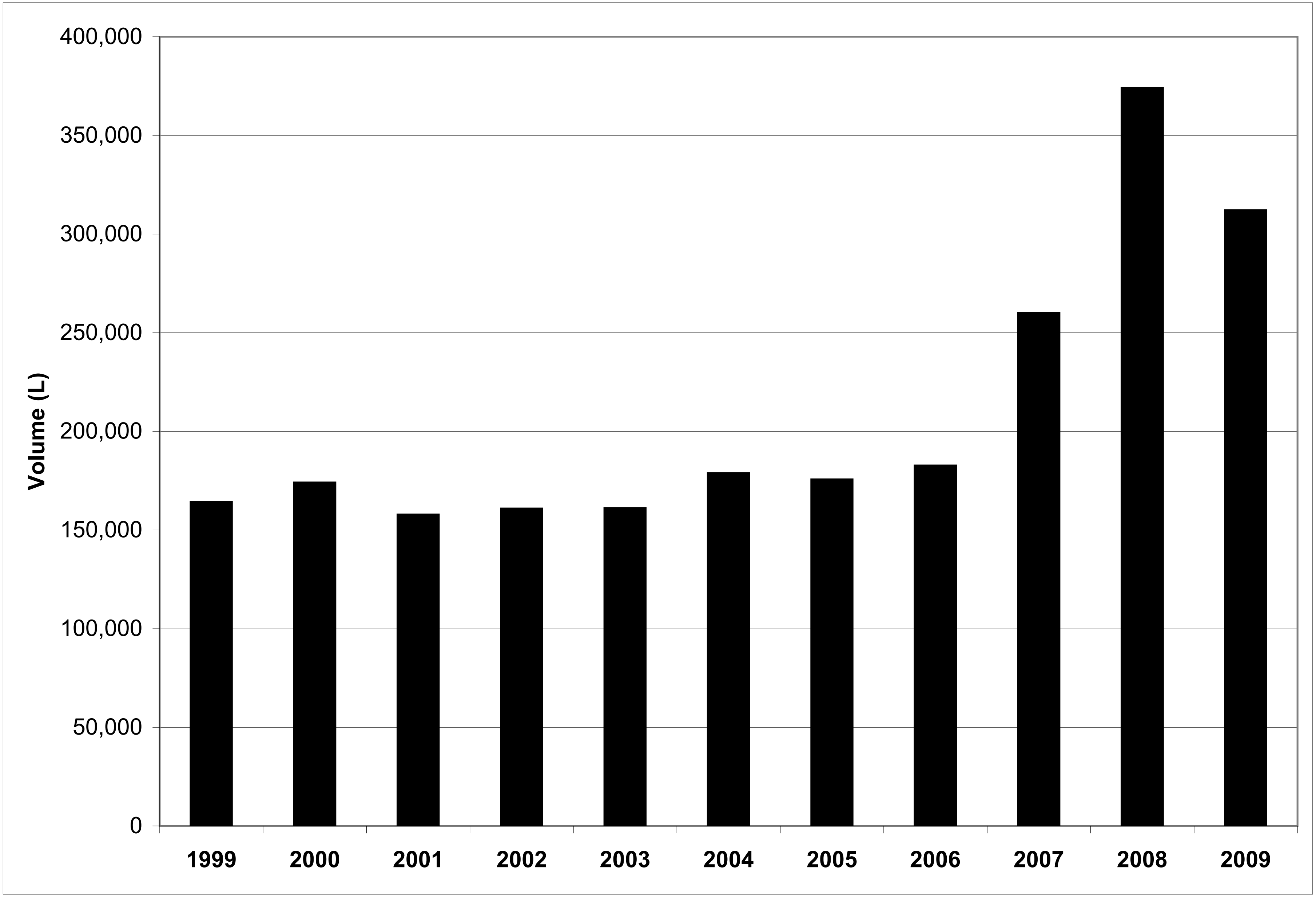


Table 2.1 - Resolute Bay Water Consumption

Dates		No of Days	Consumption	Average Day	Annual Use	
From	To		I Gal	I Gal	I Gal	m^3
1/1/98	25/12/98	358	1,584,378	4,426	1,615,490	7,344
29/1/99	21/12/99	328	1,529,253	4,662	1,701,630	7,736
9/1/00	30/12/00	356	1,913,846	5,376	1,962,240	8,921
3/1/01	28/12/01	359	1,711,824	4,768	1,740,320	7,912
2/1/02	27/12/02	359	2,154,211	6,001	2,190,365	9,958
10/11/07	29/11/07	19	2,956,615			
30/11/07	29/12/07	29	2,636,118			
		48	5,558,733	116,432	42,497,680	193,198
1/1/08	31/12/08	365	60,780,160	166,521	60,780,165	276,312
1/1/09	28/11/09	331	57,442,618	173,543	63,343,195	287,964

Appendix C: Photographs

Photograph 5.1.5.a – AV 8

Photograph 5.1.5.b – AV 14

Photograph 5.1.5.c – AV 17

Photograph 5.1.5.d – AV 21

Photograph 5.1.5.e – AV 25

Photograph 5.5.1.f – AV 32

Photograph 5.1.5.g – AV 41

Photograph 5.1.5.h – AV 43

Photograph 5.2.2.a – AV 2

Photograph 5.2.2.b – AV 5

Photograph 5.2.2.c – AV 8

Photograph 5.2.2.d – AV 17

Photograph 5.2.2.e – AV 21

Photograph 5.2.2.f – AV 32

Photograph 5.2.2.g – AV 40

Picture 6.1.3.4.a – Diesel day tank and potable water transfer pumps

Picture 6.1.4.1.a – Char Lake boilers

Picture 6.1.4.3.a – Char Lake hot water pumps and heat exchangers

Picture 6.2.2.1.a – Water Treatment Plant circulating pumps

Picture 6.2.3.3.a – Water Treatment Plant diesel fuel day tank

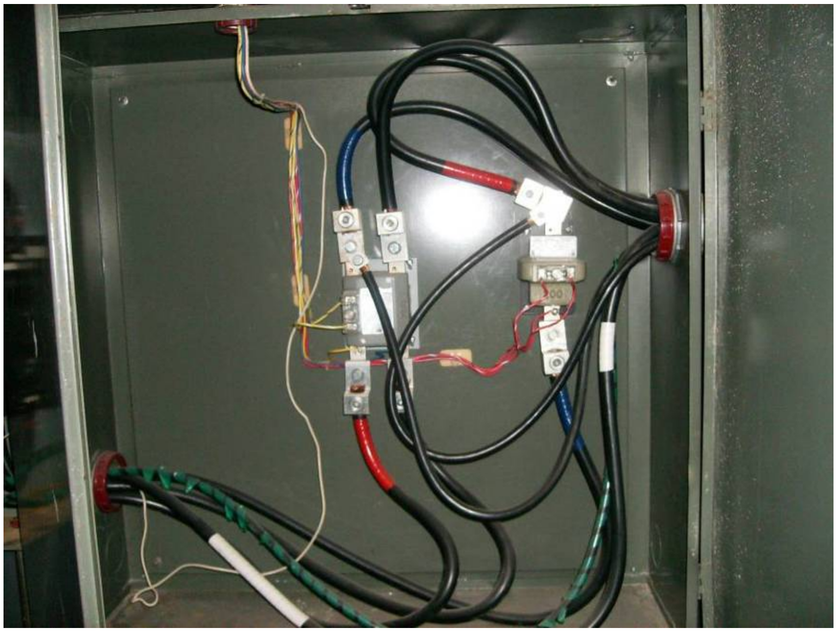
Picture 6.2.4.1.a – Water Treatment Plant boilers

Picture 6.2.4.2.a – Water Treatment Plant hot water pumps and heat exchangers

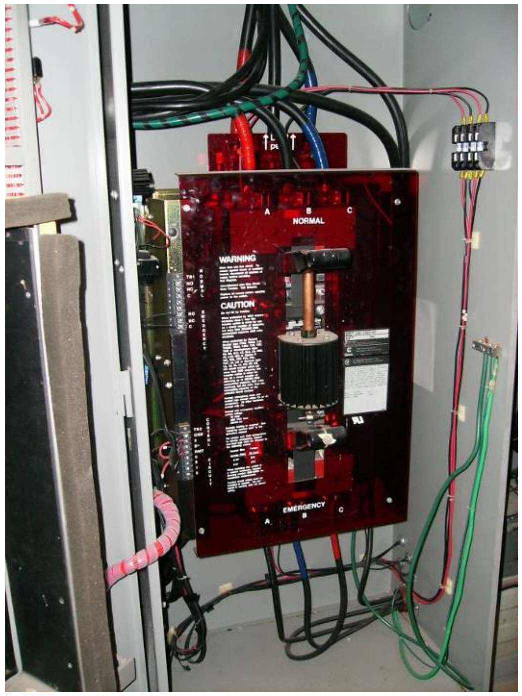
Picture 6.3.2.a – Macerator de-commissioned exhaust fan

Picture 6.3.3.a – Macerator radiant heater

Photograph No. 7.1.2.a - 120/208 Volt Secondary Distribution: Main Service Breaker



Photograph No. 7.1.2.b - 120/208 Volt Secondary Distribution: CT Cabinet



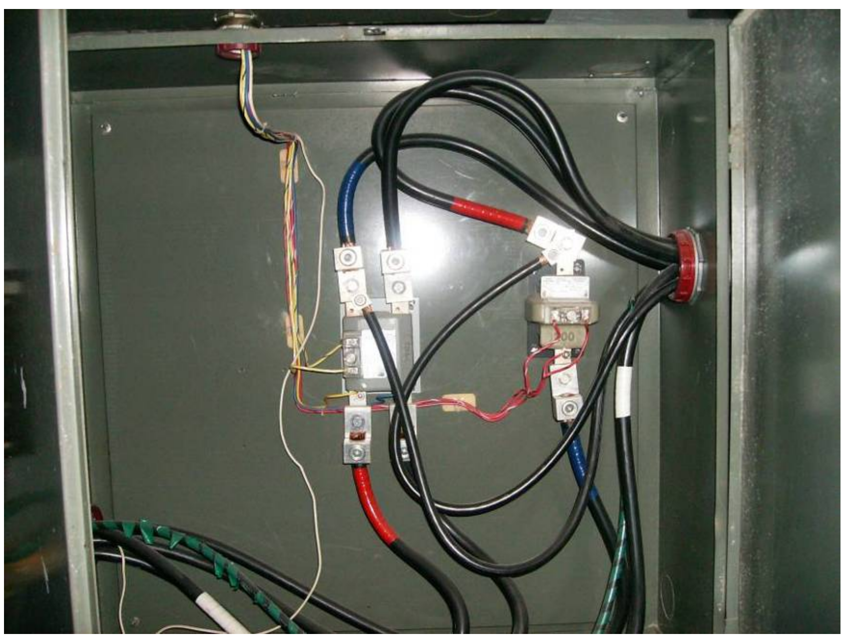
Photograph No. 7.1.2.c - 120/208 Volt Secondary Distribution: Automatic Transfer Switch

Photograph No. 7.1.2.d - 120/208 Volt Secondary Distribution: Automatic Transfer Switch and Starters

Photograph No. 7.1.2.e - 120/208 Volt Secondary Distribution: Boiler System Panel and Contactors

Photograph No. 7.1.2.f - 120/208 Volt Secondary Distribution: Main Feed Pump Starters and Heat Tracing Supply Contactor

Photograph No. 7.1.2.g - 120/208 Volt Secondary Distribution: Lake feed heat tracing, Main Breaker and Lighting Panel



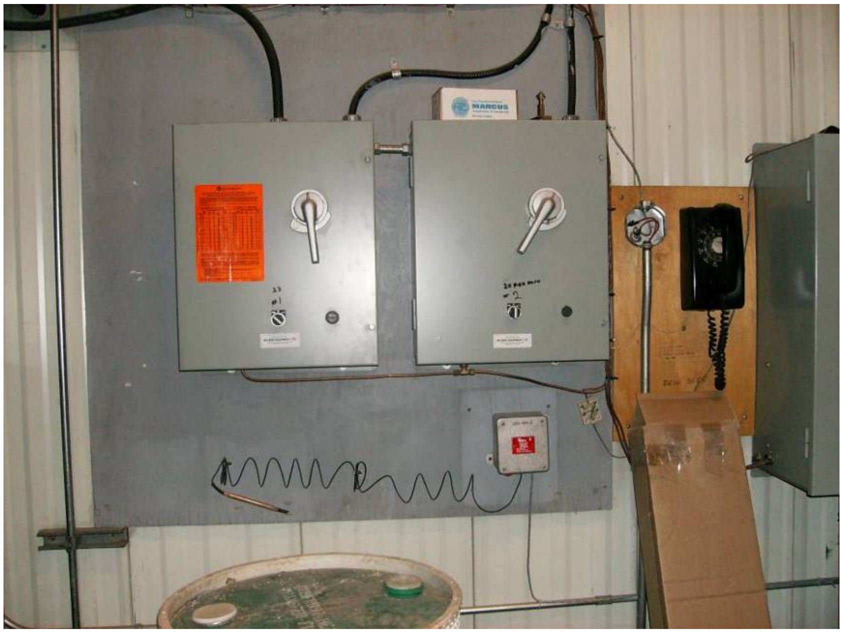
Photograph No. 7.1.2.h - 120/208 Volt Secondary Distribution: CT Cabinet

Photograph No. 7.1.2.i - 120/208 Volt Secondary Distribution: Main Water Supply Heat Tracing 50 kVA 208 to 600 volt Transformer

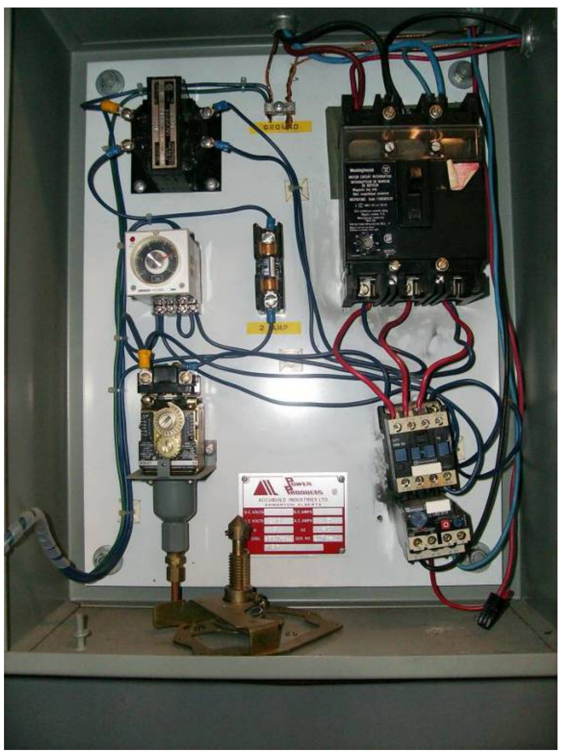
Photograph No. 7.1.2.j - 120/208 Volt Secondary Distribution: 300 Amp Feeder Breaker for Heat Tracing Transformer

Photograph No. 7.1.2.k - Secondary Distribution Equipment, Starters, Heat Tracing: Heat Tracing 7 Amp 2 Pole Breaker

Photograph No. 7.1.2.l - Secondary Distribution Equipment, Starters, Heat Tracing: Heat Tracing Control Contactor

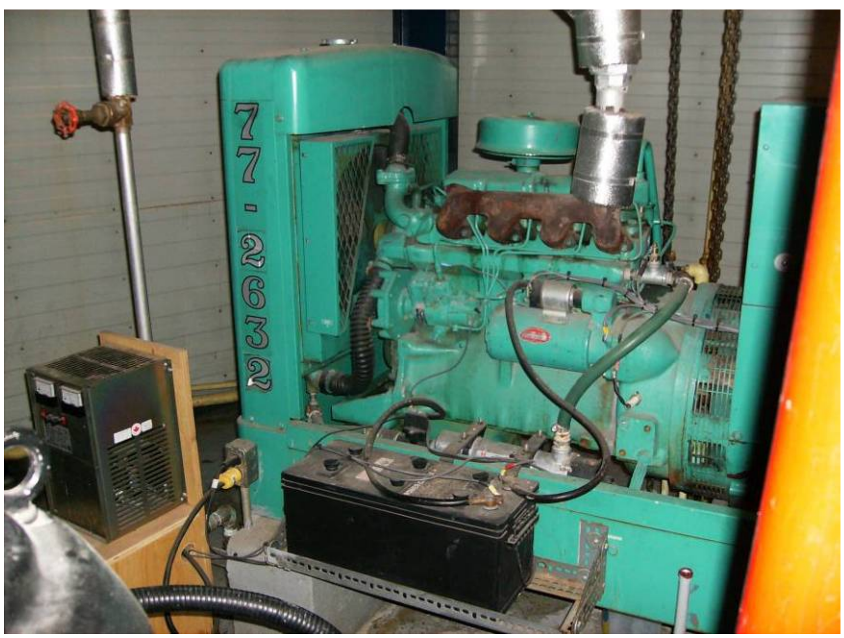


Photograph No. 7.1.3.a – Jockey Pump - Pump P1 Starter



Photograph No. 7.1.3.b – Jockey Pump Starters - Pump P1 Starter

Photograph No. 7.1.4.a : Emergency Power – 100 kW – 120/208 volt Generator



Photograph No. 7.1.4.b - Emergency Power: Starting Batteries and Charger

Photograph No. 7.1.6.a - Instrumentation Control and Annunciation

Photograph No. 7.1.6.b - Instrumentation Control and Annunciation: Flow Meter

Photograph No. 7.1.6.c - Instrumentation Control and Annunciation: Redundant and Unused piping and old control valve

Photograph No. 7.2.2.a - 120/208 Volt Secondary Distribution: Transfer Switch and Main Service Breaker

Photograph No. 7.2.2.b - 120/208 Volt Secondary Distribution: Branch Circuit Panel, Motor Starters and Transfer Switch

Photograph No. 7.2.2.c - Boiler Distribution: New Boiler Panel and Control Contactors

Photograph No. 7.2.3.a - Pump 1 & 2 Starters

Photograph No. 7.2.4.a - Emergency Power – Transfer Switch

Photograph No. 7.2.4.b - Emergency Power – Generator

Photograph No. 7.2.6.a - Instrumentation Control and Annunciation

Photograph No. 7.2.6.b - Instrumentation Control and Annunciation: Consumption Chart Recorder

Photograph No. 7.2.6.c - Instrumentation Control and Annunciation: Temperature Monitoring Unit

Photograph No. 7.3.1.a – Macerator: Branch Circuit Power Panel

Photograph No. 7.3.1.b - Macerator

Appendix D: Technical Status Evaluations Standard Definitions

The following is a list of the standard definitions to be applied in the process of evaluating the individual components of the facilities / services that form the Greater Resolute Area Sewage and Water Works.

Remaining Service Life refers to the remaining cost effective service life of the system or component being considered.

There are nine remaining service life ratings in the report:

Over 15 Years	Means that under normal operating conditions and receiving proper maintenance, the system or component is expected to remain economically in service exceeding 15 years. Often the system is in new or like new condition.
10 to 15 Years	Means that under normal operating conditions and receiving proper maintenance the system or component is expected to remain in service for 10 to 15 years.
5 to 10 Years	Mean that under normal operating conditions and receiving proper maintenance, the system or component is expected to remain in service for 5 to 10 years.
0 to 5 Years	Means the effective economic service life of this system or component is expected to remain in service for 5 to 10 years.
Zero Years	Means the system or component is still in service, however, its effective economic service life has been reached and could fail at any time.
Not Operational	Means the system or component is not in service, as intended. One or more systems or components may have failed as a result of reaching the expected service life, maintenance or operation circumstance.
Not Determined	Means that sufficient information could not be gathered on the system or component to assign a remaining service life.
Varies See Details	Is used to describe a system consisting of many subsystems and/or components, where the remaining service life of the subsystems and/or components may differ.
N/A	Not applicable to the specific asset.

Recommended Action Priority refers to the urgency of the recommended action. The urgency reflects the importance of the recommended action to either the safety, cost efficient operation of the conservation of the inspection element service life. Code related items are identified in the course of examining building technology. They should not be considered as forming an exhaustive analysis of current code compliance.

There are eight levels of action used in the report.

Mandatory	Means an action, which is a legal obligation arising from the requirement of a code, regulation or referenced standard, and involves life safety concerns. This action must be addressed immediately.
Code Upgrade	Means a building system or component, which does not meet current code requirements, regulations or standards and must be addressed as part of any contemplated building additions and/or renovations.
High Priority	Means an action, which is a legal obligation arising from the requirement of a code or regulation, and must be addressed at the first available opportunity. There may not be a life safety concern.
Desirable	Means an action, when taken, will improve substantially the safety, cost –efficient operation or extend the service life of the building system or component.
Suggestion	Means an action, which will have some benefit to the operation or longevity of the building and will be a discretionary item.
Varies See Details	Is used to describe a system consisting of many subsystems and/or components, where the remaining service life of the subsystems and/or components may differ.
None	Means there is no recommended action.
N/A	Not applicable to the specific asset.

Performance Rating refers to the degree to which the identified status or condition of the element conforms to technical performance requirements or standards called for in codes, standards and guidelines for design and construction quality, and current operating and maintenance standards.

Very Good	Means the element performance meets and exceeds the specified quality standard.
Good	Means the element conforms to the specified quality standard.
Satisfactory	Means the element generally conforms to the specified quality standard with some shortcomings.
Unsatisfactory	Means the element fails to meet the specified quality standard.
Not Determined	Means that sufficient information could not be gathered on the system or component to assign a performance rating.
Varies See Details	Is used to describe a system consisting of many subsystems and/or components, where the remaining service life of the subsystems and/or components may differ.
N/A	Not applicable to the specific asset.

Appendix E: Record of Contacts

Contacts were asked a series of questions regarding: 1) Records of operations; 2) Operational History; 3) Improvements and Maintenance; 4) Water Quality/Water Testing; and 5) Available background information regarding general concerns with the system and potential improvements needed.

To: Tom McDonald
Project Officer (Capital Planning & Technical Services)
Government of Nunavut (Qikiqtaaluk Regional Office)

Date: December 11, 2009

From: Matt Berrigan
Civil Technician, EIT
Trow Associates Inc.

Tom mentioned the recent works completed on the boilers and the utilidor plans from Williams Engineering. These documents will be passed on to Pat Fuentes and forwarded to Trow at a later date. The work on the new water storage tank was recently completed and still in the finalization process. Tom referred me to the Capital Planning Division in Iqaluit for water testing and water quality.

To: Pat Fuentes
Regional Project Manager (Capital Planning & Technical Services)
Government of Nunavut (Qikiqtaaluk Regional Office)

Date: December 14, 2009

From: Matt Berrigan
Civil Technician, EIT
Trow Associates Inc.

Pat mentioned that he is gathering all the additional information available and will be sending to all parties involved in the project.

To: Shane Slifka
Regional Project Manager (Capital Planning & Technical Services)
Government of Nunavut (Kitikmeot Regional Office)

Date: December 17, 2009

From: Matt Berrigan
Civil Technician, EIT
Trow Associates Inc.

Shane mentioned that all records of Resolute Bay were forwarded back to the Pond Inlet office a number of years ago in the regional changeover.

To: Paul Diamond
Manager, Facilities (Property & Asset Management)
Government of Nunavut (Qikiqtaaluk Regional Office)

Date: December 17, 2009

From: Matt Berrigan
Civil Technician, EIT
Trow Associates Inc.

Paul is unavailable, referred to Jonathan Palluq.

To: Jonathan Palluq
Assistant Regional Director
Government of Nunavut (Qikiqtaaluk Regional Office)

Bhabesh Roy
Assistant Regional Director (Capital Planning & Technical Services)
Government of Nunavut (Qikiqtaaluk Regional Office)

Date: December 17, 2009

From: Matt Berrigan
Civil Technician, EIT
Trow Associates Inc.

Jonathan connected me with Bhabesh. Bhabesh mentioned that documented information on water quality could be found in the Dillon report Volume 3, May 1999. Bhabesh also had access to recent photos taken in Resolute at the outflow he will be sending to Trow.

To: Nelson Pisco
Director, Technical Services (Capital Planning & Technical Services)
Government of Nunavut (Baffin Regional Office)

Date: December 17, 2009

From: Matt Berrigan
Civil Technician, EIT
Trow Associates Inc.

Nelson mentioned that Adam Gordon or Pat Fuentes would have forwarded the operational and maintenance records to Steve Burden already that he would have access to.
He believes that the water testing is for coli forms only, and in the past there have been no recorded problems. He however was not aware of the sampling points used for water testing and referred me to the Capital Planning Division in Iqaluit.

To: Roy Green
Director, Community Infrastructure (Capital Planning Division)
Government of Nunavut (Baffin Regional Office)

Rosemary Kilpatrick
Manager, Community Infrastructure (Capital Planning Division)
Government of Nunavut (Baffin Regional Office)

Date: December 18, 2009

From: Matt Berrigan
Civil Technician, EIT
Trow Associates Inc.

In a phone conference with both Roy and Rosemary they mentioned that they have access to the water testing records held by Health and Social Services that can be sent to Trow. They will try to gather as much historical testing data as possible, and mentioned that there is currently a community water testing inventory being constructed that might have all the requested date.
Roy had concerns with the fuel tank by the treatment plant which does not have the standard double lined walls and brought concerns of cross contamination between water lines and sewer line contained in the same AV. If one were to rupture, what chance if any is there that it could contaminate the community water supply?