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March 28, 2005
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RE: RESOLUTE BAY UTILIDOR ASSESSMENT

Dear Sir:

The purpose of this report is to outline the operating parameters of the existing Char Lake pump house, the Signal Hill treatment plant and the utilidor systems in order to establish current operation and appropriate set points for the systems. This will aid in establishing how the system may best be upgraded and how the system may be expanded.

The water supply system at Resolute Bay was constructed circa 1977 and consists of the following interrelated facilities:

- Char Lake Pump House;
- Transfer Pipeline between Char Lake and Signal Hill;
- Signal Hill Reservoir and Water Treatment Plant;
- Water Supply Utilidor to Resolute Bay;
- Sewage System from Resolute Bay;
- Sewage Treatment Plant.

This report discusses the above inter-related facilities in relation to the original design flow rates, set points and performance.

WATER PRODUCTION

The following table summarizes data for water production and use from the Resolute Bay Utilidor system (data is presented in Igal as this is the unit of measure at the pump house):

Water Production Resolute Bay

Year	Population	Consumption (Igal)	Igal/Day	
1997	205	18,311,219	50,168	
1998	209	15,982,011	43,786	
1999	214	16,040,222	43,946	
2000	221	16,121,716	44,169	
2001	223	16,156,643	44,265	
2002	224	16,191,569	44,360	
2003	225	16,203,211	44,392	*During winter 2003 water use spiked up to 80,000 Igal day*
2004				
2005				

CHAR LAKE PUMP HOUSE

The Char Lake pump house is located about 2 km North-West of Resolute Bay. The pump house consists of an insulated metal building over a concrete reservoir. The concrete reservoir is connected to Char Lake with a 200mm intake pipe.

The Char Lake pump house has two main pumps. These pumps are operated to maintain the reservoir level at Signal Hill. As water is drawn into the reservoir heat is added to maintain the reservoir at a temperature of 7ºC (44ºF).

The pump house was originally heated with unit heaters from the boilers. There were problems with maintaining adequate temperature and flow across the unit heaters, thus heating was changed in 2004 to use an oil fired furnace in addition to the unit heaters. This has resolved the heating problem at the pump house.

The boilers consist of a four-section Hydrotherm boiler having a peak capacity of about 179,000 Watts (610 MBH). Boiler output should be limited to about 80% of this number or 143,200 Watts.

The required heating input at the pump house depends upon the Char Lake temperature, the heat loss of the reservoir, the set point temperature of the reservoir and the quantity of water taken from Char Lake.

- Char Lake temperature will have a minimum winter temperature of 0ºC (32ºF).
- The heat loss of the reservoir is estimated as follows:
  - Estimated reservoir size 2,400mm diameter x 4,800mm deep thus external surface area is 42m^2.
  - The reservoir is not insulated but is buried and is assumed to have a conduction coefficient of 0.57W/m^2/ºC (0.10 Btuh/ft^2/ºF). This is a very conservative assumption.
  - The external temperature affecting the reservoir would be somewhere between 0ºC and an assumed external ground temperature. Ground temperatures are generally significantly higher than coldest winter temperatures and for Resolute are assumed to be -23ºC (-9ºF).
  - Therefore an estimate of the reservoir heat loss at design conditions with a tank temperature of 7ºC is (42x.57x(7-(-23))=) 720 Watts. The original Char Lake drawings allow for a heat loss of up to 4,400 Watts (15 MBH). Thus the reservoir heat loss is insignificant.
- The set point temperature on the drawings is 7ºC. Recently, the Operator has been trying to operate the reservoir at 10ºC.

Required Boiler Size in Watts Versus Water Production and Reservoir Temperature

	Water Production (Igal/day Litres/Day)					
	-	20,000	40,000	60,000	80,000	100,000
Reservoir Temperature (C)	0	90,762	181,525	272,287	363,050	453,812
0.0	552	552	552	552	552	552
2.2	606	10,425	20,244	30,064	39,883	49,702
4.5	659	20,298	39,937	59,575	79,214	98,853
6.7	713	30,171	59,629	89,087	118,545	**148,003**
8.9	766	40,044	79,321	118,598	**157,876**	**197,153**
11.2	820	49,917	99,013	**148,110**	**197,207**	**246,303**

As can be seen from the above table the existing boilers must work harder as the water production rate is increased and the reservoir temperature is increased. The boilers are unable to supply more than 143,200 Watts of heat. As water production increases and reservoir temperatures increase the capacity of the boilers must also increase. Further, as the above two items increase the fuel oil usage will also increase.

TRANSFER PIPELINE BETWEEN CHAR LAKE AND SIGNAL HILL

The pipeline between Char Lake and Signal Hill is a 1,878m (6,160ft) 150mm (6") pipeline. The pipeline is polyethylene pipe and is insulated with 50mm of insulation. The pipeline is buried the entire way.

The pipeline is electrically heat traced for the entire length. The heat trace is intended to operate only when the main pipes are not operating.

The heat loss of the pipeline when the heat trace is off depends on:

- Char Lake Reservoir Temperature. The higher the reservoir temperature the higher the heat loss.
- Ground temperatures, which are assumed to be -23ºC (-9ºF).
- Heat transfer coefficients of the insulation system. The pipe insulation is assumed to have an insulation value of 5.88/inch and therefore the overall UA-value of the pipe is 0.18 Btuh/ºF/ft.
- The overall heat loss at 7ºC is therefore 9.15 W/m for a total loss of about 18,000 Watts along the pipeline.

Assuming the water temperature is 7ºC, if both flow and heat trace in the pipeline is lost then it would take about 17 hours for the pipeline to begin to freeze.

The temperature of the water entering Signal Hill depends on the rate of flow along the pipeline and how long the flow has been occurring. Flow depends on how many transfer pumps are operating and the pressure loss and change in elevation along the pipeline.

- Operating level in Char Lake Reservoir is 109' +/- 1'
- Operating level in Signal Hill Reservoir is 253.6' +/- .1'
- Thus the change in elevation is 144.6'
- Pressure loss in the 6" pipeline about 14ft at 166gpm.
- Thus total pressure loss to Signal Hill is about 160ft.

In 2003 the transfer rate to Signal Hill was typically maintained at 60gpm (86,400 Igal/day) using jockey pumps and the main pumps were only run if reservoir levels dropped exceptionally low. In that way transfer was more or less continuous.

At 60gpm the temperature drop on the water line to Signal Hill should be about 1.1°C.

SIGNAL HILL TREATMENT PLANT

At Signal Hill the water from Char Lake is treated (chlorine and calcium?) then the water enters the aboveground heated reservoir. The reservoir is a nominal 117,000Igal reservoir. The bottom 12'2" of the reservoir is the fire reserve for the town. The active reservoir is to 15'0" in height.

The reservoir is to be maintained at 5.6ºC (42F). Direct heat losses from the reservoir are estimated to be about 12,300 Watts (42MBH).

Heating of the Signal Hill buildings is also by the boilers and is estimated to use about 24,600 Watts (84MBH) of heat.

The boilers consist of a five-section Hydrotherm boiler having a peak capacity of about 221,000 Watts (756 MBH). Therefore after the reservoir and building heat losses are removed the boiler has available about 80% of its capacity to heat the utilidor system.

Water flows out of Signal Hill to the town site through one of two circulation pumps. The pumps each have a capacity of 370gpm versus 70'TDH. Water also flows to the truck fill.

WATER SUPPLY UTILIDOR

The water supply utlidor is a looped water supply system consisting of insulated 2,044m of 200mm (8") mains and 323m of 150mm (6") mains looping around the town site and back to the Signal Hill Reservoir.

The heat loss consists of losses from the insulated pipe and losses from each of the 30 manholes the water lines pass through. In addition there are losses (or gains) at the lateral connections to the housing units. The heat losses are estimated as follows:

- Insulated pipelines: 29,000 Watts (102 MBH) total loss
- Access Vaults: 46,000 Watts (157 MBH) total loss or 1.5kW per vault to maintain a vault temperature of 5.6°C. Note this rate of heat loss is conservatively high. It assumes that the entire access vault is maintained at the 5.6°C temperature.
- Lateral Connections: 0 Watts (most laterals will add more heat from the unit than is lost in the run).
- Thus total water supply heat losses are about 75,000 Watts.

The existing Signal Hill boilers have adequate capacity to supply the 75,000 Watt loss.

The circulation pumps are to loop flow through the system. The pressure drop, assuming no water use in the system and at 370 gpm through the system, would be 11.2psi.

It is our understanding that the differential pressure across the pumps is typically about 5psi. The lower pressure drop indicates that the pump is operating at a higher flow rate than 370gpm.

At a flow rate of 370 gpm the temperature drop on the return line to Signal Hill is estimated to be about 0.8°C (1.4°F).

BLEEDERS

Bleeders are established to ensure flow in dead end portions of the system and to ensure adequate flow goes to the sanitary system especially the upper portions. The only dead end portion of the water system is at AV25. Sanitary lines dead end at:

- Signal Hill Water Treatment Plant
- AV4?
- AV17
- AV19
- AV25
- AV27?
- AV28?

It is our understanding that there is also a bleeder at AV2.

- AV2?

So there are 7 or 8 major bleeders in the system. Each bleeder is set to about 900 L/hr (4 gpm) each.

In addition there are bleeders in most of the housing units. However these bleeders are assumed to be set at 1 litre/hr flow rates. There are about 73 units for a total of 73 L/hr from the housing units.

Total bleed rates are thus estimated to be about 175m^3/day (38,000 Igal/day).

The purpose of the bleeders is to ensure that the sanitary lines remain unfrozen even when there is no water use in the community. Assuming water enters the system at 5.6°C (42°F), the heat loss through the sewage piping systems is estimated to be about 41,900 Watts (182 MBH). With only the bleeders going at a rate of 24.3 gpm (29,000Igal/day), the temperature of the sewage at AV25 may be as low as –1.5°C (29.3°F). This does not occur; on average there is more water going through the sewage system, taking the average water use into account the outfall temperature rises to 0.9°C (33.7°F).

RECOMMENDED SYSTEM OPERATING PARAMETERS:

.1	Maximum water production:			60,000 Igal/day	
.2	Main bleeds:	900	L/hr	4 gpm each	
.3	Residential bleeds:	1	L/hr	.004 gpm each.	
.4	Maximum total bleeds:	6,373	L/hr	28 gpm 33,700 Igal/day	
.5	Community Water Usage:			26,300 Igal/day	
.6	Char Lake Reservoir Temperature:	8	°C	46	°F
.7	Signal Hill Reservoir Temperature:	8	°C	46	°F
.8	Minimum sewage temperature:	0.5	°C	32.9	°F
.9	Char Lake Boilers: The existing boilers are adequately sized.	125	kW	425	MBH
.10	Signal Hill Boilers: The existing boilers are adequately sized.	164	kW	560	MBH
.11	Signal Hill Recirculation Pumps: The existing recirculation pumps are adequately sized.			370	gpm

We trust the above meets with your expectations at this time. If you have any questions or comments, please do not hesitate to contact our office at your earliest convenience. Please have the above data reviewed by the Operator. He should challenge us wherever our assumptions are incorrect.

Sincerely,
A.D. Williams Engineering Inc.

Brian George, P.Eng.
Principal