Site Investigation Report for the Water Supply System In the Hamlet of Baker Lake, NU

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1.0 Introduction

1.1 Background

Baker Lake, or Qamanittuaq, is the only community situated inland in Nunavut, at the huge widening at the mouth of the Thelon River on the Northwest side of Baker Lake. It is the geographic centre of Canada, and the geographical settings are latitude of 64° 81' N and longitude of 96° 03' W. The community is about 230 air km northwest of Rankin Inlet and 940 air km east of Yellowknife.

Based on the projections by Nunavut Bureau of Statistics, the population in Baker Lake in 2004 was 1594.

The ground in the community slopes up from the lake towards a few rocky ridges located about 2 km inland. Permafrost conditions are prevalent. The maximum of the active layer is approximately 1.5m. Vegetations are typical arctic tundra and consist of mosses, lichens, and grasses.

Baker Lake receives an average of 15.6 cm of rainfall and 130.7 cm of snowfall per year. Mean annual precipitation totals 23.8 cm.

The mean high and low temperature in July are 16.0 and 6.0 °C, while in January the mean high and low temperature are -29.5 and -36.4 °C respectively.

Winds are generally from the north with annual average speed of 23.0 km/h.

1.2 The purposes of the site investigations

The purposes of the site investigations are

- To inspect the water intake/ treatment system and evaluate its effectiveness;

- To sample at the appropriate locations in the system for further chemical and biological analysis to establish the treated meet the requirements of the Guidelines for Canadian Drinking Water Quality (GCDWQ);
- To provide appropriate suggestions and solutions for the issues to be considered;

2.0 Site investigations and findings, test results reports, and discussions

Totally three site investigations were made from June to September in 2005 by the author and accompanied by the foreman in the Hamlet.

The water samples were collected directly from Baker Lake. The location was beside the water intake /treatment facilities (pump house). The Hamlet expressed their concern about the potential negative effect of the final effluent discharge from sewage system, hence in the 2nd site visit, two more samples were collected: one was collected at the place about 100 meters away from the final sewage effluent discharge point in the Baker Lake, another one was collected from the hotel tap.

The required tests for drinking water included turbidity, true color, pH, alkalinity, hardness, total organic carbon (TOC), total dissolved solids (TDS), total and fecal coliforms, fluoride, algae.

2.1 Water intake/ and treatment system

The community obtains its potable water from Baker Lake. A water intake/ truck-fill facility (pump house) was built beside the Lake. A single vertically-mounted drum screen intake and inclined shaft casing was installed. The intake is located at a depth of about 5 m. A100-meter long, 100 mm diameter heat traced HDPE pipe was lay out in the casing. Attached to the end of the supply pipe is wye-plus intake screen. The pipe

contains pyrotenax heating cables for winter freeze protection. The casing is ballasted and protected by a granular berm and riprap.

Water is supplied to the water trucks by means of an overhead truck-fill arm with flexible downspout, with thaw capability afforded by a manually activated heat trace (Figure-1).

A small piped system serves the health centre, hospice and nurse's residence building.

While the water delivery trucks are being filled, hypo-chlorine is added for disinfection. Water for the hypochlorite mixing tank is supplied from the discharge line. The hypochlorite feed pump is controlled by the rate of water supplied to the water trucks by means of a flow-sensing meter mounted on the discharge line. The chlorine is supplied to the main line by a tube and chlorine injector (Figure-2).

Residual chlorine persists throughout the distribution system and is tested everyday.

By measuring the survey drawing in the Hamlet office and calculating with the scale, the pump house is located around 2200 meters west the sewage final discharge point. Considering the prevailing wind in Baker Lake is from north, the final sewage effluent discharge at Baker Lake has little effect to the drinking water quality in most of the days during a year. However, in the summer, regular monitoring is necessary.

The test results reports (Appendix) established that almost all the parameters tested with the water sample from the Baker Lake were below the maximum acceptable concentrations (MAC) proposed by the Guidelines for Canadian Drinking Water Quality (GCDWQ). In the first (June) and third (the end of August) sample tests, the turbidities were a little higher than the guidelines. This was probably due to the effect of spring-melting and summer rain run-off. It has to be mentioned that the water sample was raw

water. After pump station and treatment, the turbidity may be further decreased and would probably meet the guidelines requirements.

Generally speaking, the source drinking water in Baker Lake, for the time and location of sampling, was of good chemical quality for domestic use. The water in the Baker Lake was clear, soft, poorly buffered, neutral and low in dissolved solids.

According to the test results reports, although the concentration of Fluoride in the lake water was below MAC proposed by CCME guidelines, however, it was also far below the recommended optimum range for the control of dental caries. Hence appropriate fluoridation to the drinking water is advised for purpose of the people's dental health.

2.2 Issues to be concerned

Water intake /treatment facilities It was observed that the ground area round the water intake /treatment facilities (pump house) was not constructed and was full of loose earth and sand (Figure-3). This may potentially result in the deteorization of the drinking water quality, especially in the snow-melting and rainy seasons. In the first and third test reports, the turbidity of the sample water collected beside the pump house was 3.4 and 1.4 NTU respectively, both exceeded the GCDWQ requirements. This may probably be resulted from this. It is recommended that some vegetation be transplanted around the pump house, which may help to fix the loose earth and sand. This is an effective and economic solution to this issue.

On-site signage No signage was observed in the areas for water intake /treatment. It is advised that appropriate signage be placed in these locations.

3.0 Summary and Conclusions

- Based on the test results report, the source drinking water in Baker Lake, for the time and location of sampling, was of good chemical quality for domestic use. The water was clear, very soft, poorly buffered, neutral and low in dissolved solids. Affected by spring-melting and summer rain run-off, the turbidity of the lake water close to the pump house fluctuated.
- Appropriate fluoridation to the drinking water was suggested for the purpose of people's dental health;
- On-site signage was suggested to set up in the areas such as water intake/ treatment facilities;
- Appropriate vegetation plants were suggested to be transplanted around the pump house, which may help to fix the loose earth around to avoid potential deteriorization of water quality;

Acknowledgement

The Hamlet of Baker Lake office provided support for these site investigations.

Figures:

Figure-1 Water intake /treatment facilities

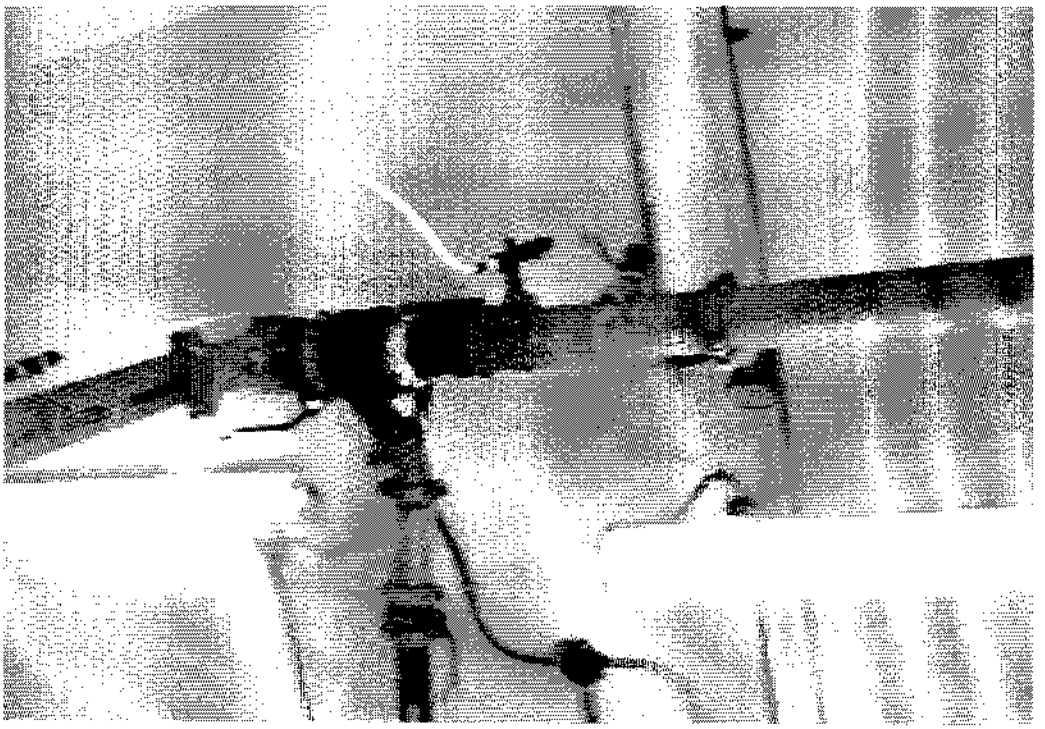

Figure-2 Addition point of chlorine at the discharge pipe

Figure-3a Loose earth and sand beside the pump house

Figure-3b Loose earth and sand beside the pump house

Appendix

Summary of Laboratory Test Results
For the Source Drinking Water in Bake Lake, NU

C.G.S. Rankin Inlet Office, 2005

Parameters	Units	06/29/05	07/28/05			08/31/2005	GCDWQ
		L2	L1	L2	Tap	L	
Turbidity	NTU	3.40	0.45	0.40	0.50	1.4	1.0
True Color	TCU	5	10	10	10	10	15
pH		7.35	7.22	7.06	7.09	7.12	6.5~8.5
Alkalinity (as $CaCO_3$)	mg/L	12	11	11	10	14	N/A
Bicarbonate(HCO_3^-)	mg/L	14	13	13	12	17	N/A
Carbonate (CO_3^{2-})	mg/L	<0.6	<0.6	<0.6	<0.6	<0.6	N/A
Hydroxide (OH^-)	mg/L	<0.4	<0.4	<0.4	<0.4	<0.4	N/A
Hardness (as $CaCO_3$)	mg/L	10.0	17.4	23.1	16.2	28.6	N/A
TDS	mg/L	14	52	92	50	87	500
TOC	mg/L	4	4	4	4	4	N/A
Total Coliforms	CFU/100mL	<1	<1	<1	<1	7	
Fecal Coliforms	CFU/100mL	<1	<1	<1	<1		
Algae		small amount	small amount	small amount	small amount	Small~moderate amount	N/A
Fluoride, soluble	mg/L	<0.1	0.1	0.2	0.2	<0.1	MAC 1.5
Calcium (Ca^{2+})	mg/L	2.37	3.26	2.88	2.88	5.55	N/A
Magnesium (Mg^{2+})	mg/L	1.01	2.25	2.18	2.18	3.59	N/A

- L1: sample collected at 100 meter west away from the sewage discharge point in Baker Lake;
  L2: sample at water intake facility; Tap: sample collected from Hotel tap water;

- Comments for the test results:
  1. All the test items with the sample water meet the requirements by Guidelines for Canadian Drinking Water Quality (GCDWQ); In the first and third tests, the turbidities were high probably due to the spring melt run-off and the rain run-off.

  2. The concentration of Fluoride is far below the recommended concentration range for dental disease control;

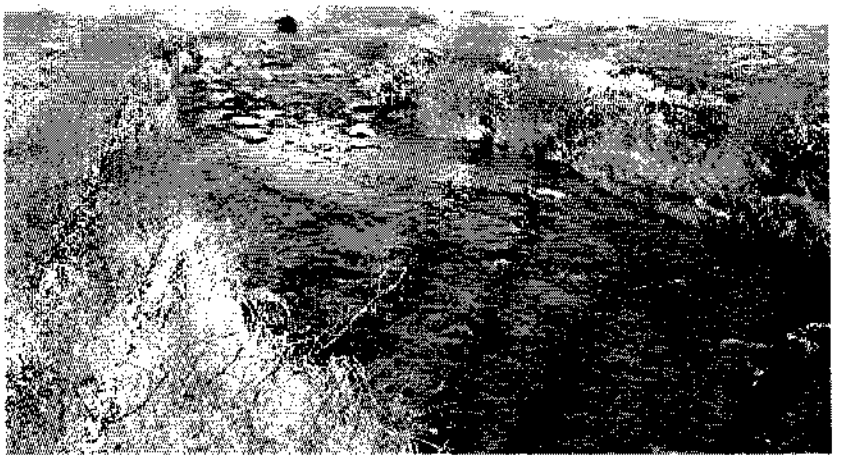

Figure-5 Confined gravel ditch for effluent to Bake Lake

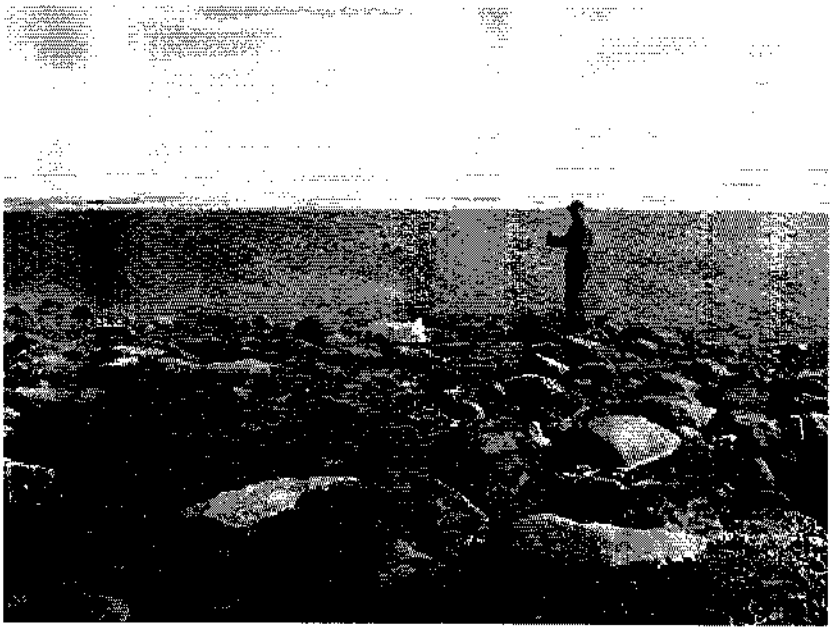

Figure-6 Final discharge point to Baker Lake

Figure-7 Algae boom in P2

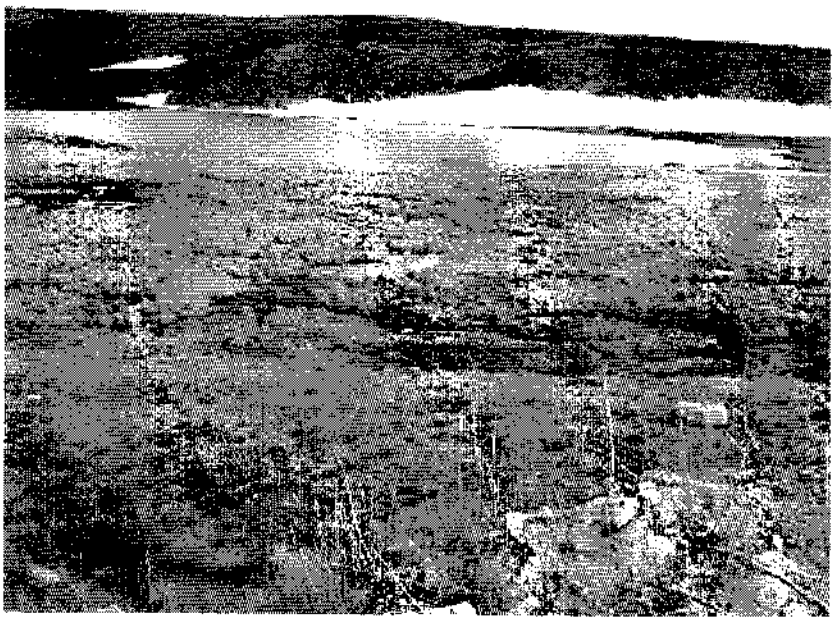

Figure-8a The vegetation plants around the P1

Figure-8b The vegetation plants wetland area before P3

Figure-9 Wild swimming ducks in pond 1

Figure-10 Landfill area beside pond 2

Figure-11 Garbage cans close to the pond 3

Appendix-1 Sampling Locations' Drawing

Appendix-2

Summary of Laboratory Test Results
For the Sewage Disposal System in Bake Lake, NU

C.G.S. Rankin Inlet Office, 2005

Parameters	Units	06/ 29/ 2005				07/ 28/ 2005				08/ 31/ 2005			CCME Guidelines		NWB Requirements
		P1	P2	P3	P_{fd}	P1	P2	P3	P_{fd}	PJ	P2	P_{fd}	Fresh	Marine	
BOD	mg/L	16	8	<6	<6	6	<6	<6	<6	7	<6	<6			120
TSS	mg/L	10	18	<5	<5	<5	<5	25	<5	15	6	6			180
Oil & Grease	mg/L	<1	<1	<1	<1	<1	<1	<6	<1	<1	<1	<1			Not Visible
pH		7.14	9.12	7.44	7.29	7.85	7.23	7.38	7.40	6.80	6.86	6.96	6.5~9	7.0~8.7	6~9
Fecal Coliforms	CFU/100mL	110000	23	<3	<3	<3	4	<1	<3	>200	>200	8			1×10^6
NH_4-N	mg/L	13.20	1.22	0.02	<0.01	0.05	0.11	1.62	<0.01	6.01	3.43	<0.01	4.84		
NO_3-N $+NO_2$-N	mg/L					0.02	0.06	0.27	0.04	0.77	0.69	<0.01	13	16	
Total Phenols	µg/L	<2	<2	<2	<2	<2	<2	<2	<2	2	2	<2	4.0		
Conductivity						93.2	72.3	57.9	59.3	185	226	67.9	N/A	N/A	
Arsenic	µg/L	0.7	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	0.7	<0.5	5	12..5	
Cadmium	µg/L	0.5	0.3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.02	<0.02	<0.02	0.017	0.12	
Calcium, total	mg/L	6.8	6.4	5.1	5.1	5.4	7.7	6.7	5.3	8.5	0.68	7.5	N/A	N/A	
Chromium, total	µg/L	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	9.9	57..5	
Copper	µg/L	38	8	2	3	2	2	6	2	9	5	3	2~4		
Iron	µg/L	580	500	490	460	240	420	520	230	0.88	0.68	0.16	300		
Lead	µg/L	9.9	2.3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	0.7	<0.5	1~7		
Magnesium	mg/L	1.63	1.44	1.02	1.01	1.07	1.24	1.27	1.02	1.77	2.88	1.33	N/A		
Mercury	µg/L										0.0038	0.0016	0.03	0.016	
Nickel	µg/L	76	13	<2	<2	<2	<2	<2	<2	<2	2	<2	25~150		
Potassium	mg/L	4.2	2.6	1.0	1.0	1.1	1.1	2.0	1.0	2.8	2.7	1.1			
Sodium	mg/L	17.4	11.0	3.92	3.88	4.42	4.82	8.96	4.12	14.3	14.8	4.30	N/A	N/A	
Sulphate	µg/L									12	25	9		N/A	
Zinc	µg/L	170	60	20	30	<10	10	10	10	20	20	40	30		

* P1 and P3: samples collected in P1 and P3; P2: the landfill leachate; P_{fd}: the final effluent discharged at the Baker Lake;

* Comments for the test results: all the tested items with the final effluent meet the requirements by CCME quality guidelines for the protection of aquatic life (fresh), and also meet the requirements by NWB for other similar hamlets; In the third test results report, the contents of Zinc exceeded the guideline limit.