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

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September, 2005

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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 treatment and sewage disposal system on site and evaluate their treatment effectiveness;

- To sample at the appropriate locations in the drinking water intake/ treatment and sewage disposal area for further chemical and biological analysis to establish the final effluent meet relevant federal and territorial water quality guidelines' requirements;
- 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 Hamlet is applying for the water license from Nunavut Water Board and hasn't received formal approved water license. Considering this, the sample locations and the required tests were selected referring to the NWB water license requirements (for other communities) as well as relevant CCME water quality guidelines for drinking water and for the protection of aquatic life (fresh water). During each visit, totally four samples were collected from the sewage disposal system: three samples were from the three ponds in the sewage disposal area, the last was collected at the final discharge point at the Baker Lake. The current solid waste disposal facilities were close to the second pond (P2), hence the sample from P2 was used to represent the effluent (leachate) of the solid waste disposal facilities. The drinking water sample was 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.

Specific sampling locations were indicated in Appendix-1.

The required tests for sewage samples included pH, BOD, TSS, oil and grease, total Phenols, Fecal Coliforms, metals, ammonia nitrogen, nitrite and nitrate nitrogen, sulphate, conductivity, etc. 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-2) 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 reservoir 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 Sewage treatment system

The sewage disposal system in the Hamlet of Baker Lake is located in the natural valley about 1.5 km north of the community and is composed of three ponds in series extending

from west to east. The ponds are separated by areas of natural wetlands. The sewage disposal area is confined to the north, south and west by rock ridges. At the end of third pond, the effluent turns south and proceeds down to Baker Lake.

The truck-collected sewage was dumped to the bermed pond on the road side (Figure-3). The sewage was found to seep from this bermed pond. This bermed pond may partially be regarded as a primary treatment, for large particles in the sewage may settle or be screened.

The effluent from the dumping pond flowed over the slope area and down to the first pond (P1). The slope area between the dumping pond and P1 was covered by a thick layer of slime (Figure-4).

Effluent from the first pond flowed through a defined channel to the second pond while the effluent from the second pond proceeded over a large area of wetland with abundant vegetation plants to the third pond, P3 or Landing Lake, as was locally called (Figure-5, 6). The effluent from the P3 flowed by gravity through a defined sloping gravel ditch, and finally was discharged at Baker Lake (Figure-7, 8).

From visual inspection, the water in P1 and P2 appeared to be turbid and green in color due to algae boom (Figure-9). This was probably due to the combined functions of the rich organics and nutrients (nitrogen, phosphorous, etc.) in the water as well as the long daylight in the summer. However, the effluent from P2, after flowing over the area of wetland with abundant vegetation plants, became significantly clear when it entered the Landing Lake (P3). No smell could be smelted.

The test result reports (Appendix-2) established that all the tested items with the final discharged effluent from the sewage disposal system met the requirements by CCME quality guidelines for the protection of aquatic life (fresh), and also met the requirements proposed by

NWB for other similar facilities. This indicated that the current sewage disposal system was effective in disposing organics and up-taking the nutrients in the sewage.

2.3 Vegetation in the wetlands

In the wetland area, abundant and thick vegetation was observed. In the relatively dry area, mosses and lichens were dominated, while in the swampy areas, sedge marshes and grasses were dominated (Figure-5, 6, 7, 10).

The vegetation plants within wetland can substantially increase their biomass through the absorption and assimilation of nutrients, thereby increasing ambient oxygen levels as by-product of their growth. This in turn provides the aerobic bacteria with more oxygen in decomposing organics. Hence the vegetation plants play an important role in the wetland disposal system.

2.4 Wildlife

Wildlife observed in the upland areas included sparrows, plovers, geese, mouse, as well as bugs and mosquitoes. Some ducks were seen swimming on the surface of water in all three lagoons (Figure-11). Bones of dead animals (probably caribous) were also nod. Small fishes were found in the last pond (Landing Lake). By talking to a local resident, it was learned that there were lots of fishes in the Landing Lake (P3). No fish was found in the first two ponds.

2.5 Issues to be concerned

Discarded metal oil barrels The current solid waste disposal facilities are located on the southern slope to the second pond. Some discarded trucks and metal auto parts were

observed there. The landfill is about 20 meters away from the pond (Figure-11). On the east shore of the Landing Lake (P3), almost thirty discarded metal oil barrels were observed (Figure-12). This would potentially affect the quality of sewage effluent in the wetlands, especially in the melting and rainy seasons due to release of oil and grease, metals, etc. On the third site visit and sampling, it rained almost everyday. According to the third test results report, some of the metals, such as Zinc, exceeded the guidelines limit. There was close relations between these two.

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

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-15). 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.

3 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;
- The test result reports established that all the tested items with the final discharged effluent from the sewage disposal system met the requirements by CCME quality guidelines for the protection of aquatic life (fresh water), and also met the requirements proposed by NWB for other similar facilities. This indicated that the current sewage disposal system was effective in disposing organics and up-taking the nutrients in the sewage.
- The discarded metal oil barrels were advised to be removed from the sewage disposal area to avoid potential negative effect for the final discharged effluent quality;
- On-site signage was suggested to set up in the areas such as water intake/ treatment facilities, solid waste and sewage disposal 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

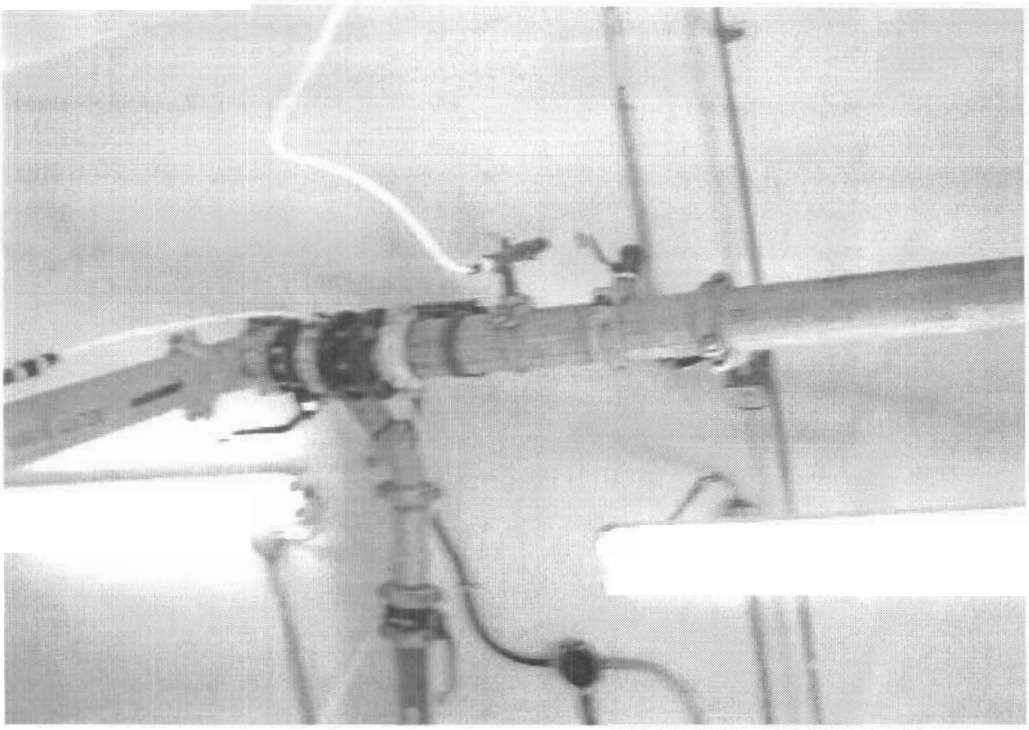

Figure-2 Addition point of chlorine at the discharge pipe

Figure-3 Sewage dumping pond

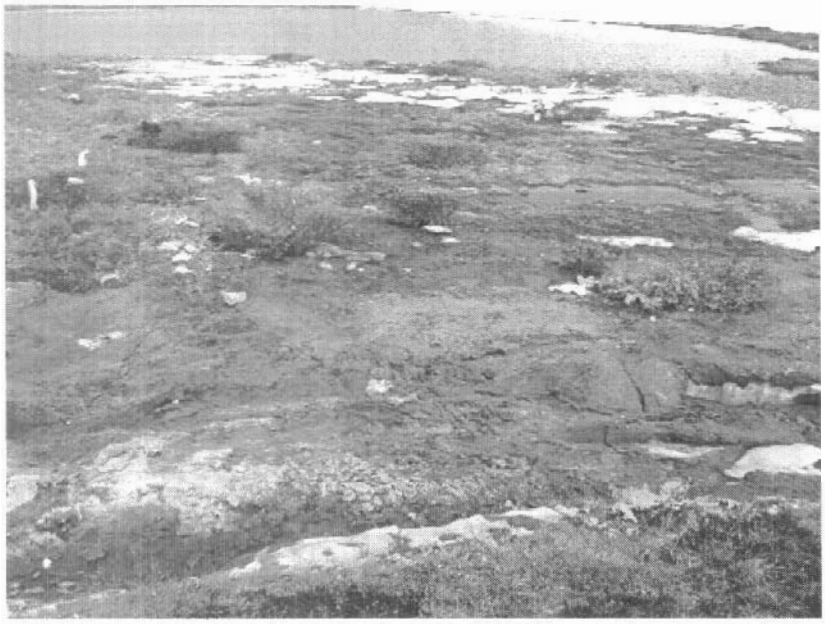

Figure-4 Slime layers on the slope after the dumping pond

Figure-5 Defined channel from pond1 to pond 2

Figure-6 Shallow water area with species of sedges between pond 2 and pond 3

Figure-7 Confined gravel ditch for effluent to Bake Lake

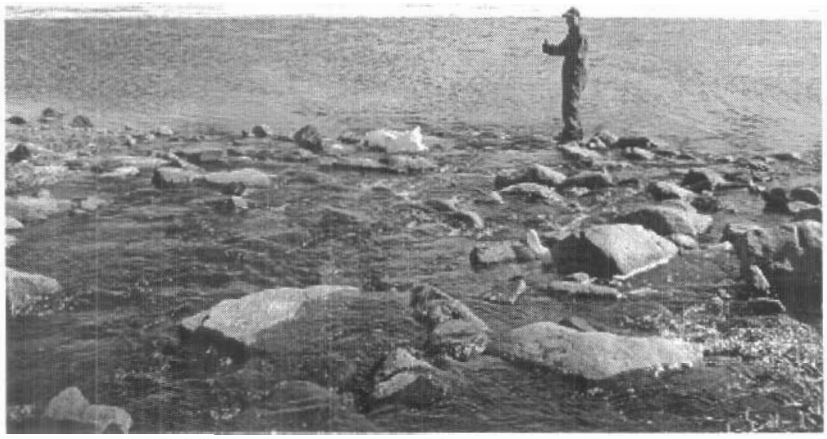

Figure-8 Final discharge point to Baker Lake

Figure-9 Algae boom in P2

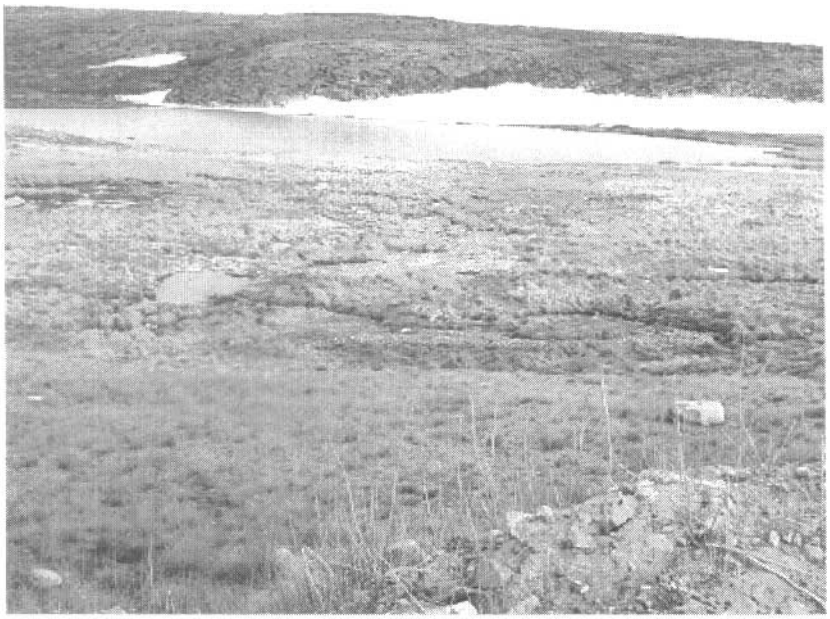

Figure-10a The vegetation plants around the P1

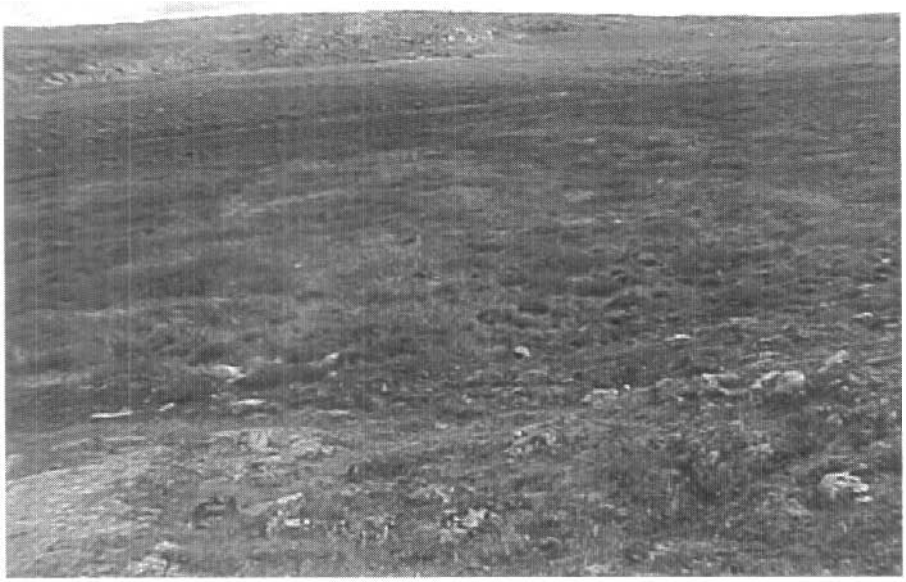

Figure-10b The vegetation plants wetland area before P3

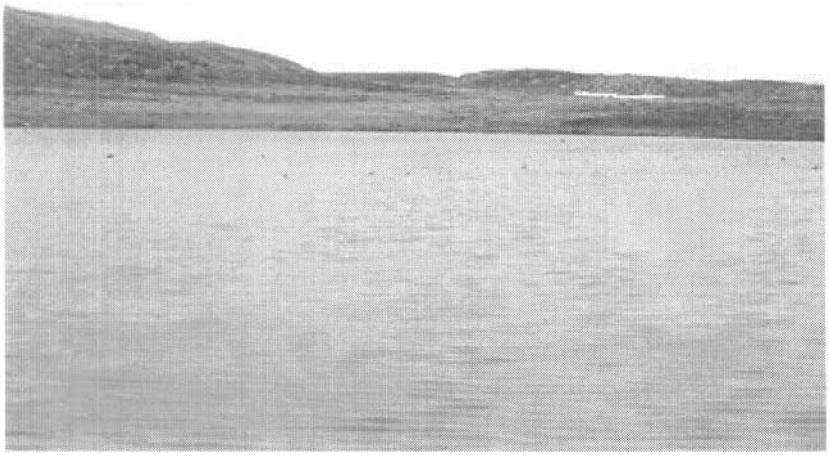

Figure-11 Wild swimming ducks in pond 1

Figure-13 Landfill area beside pond 2

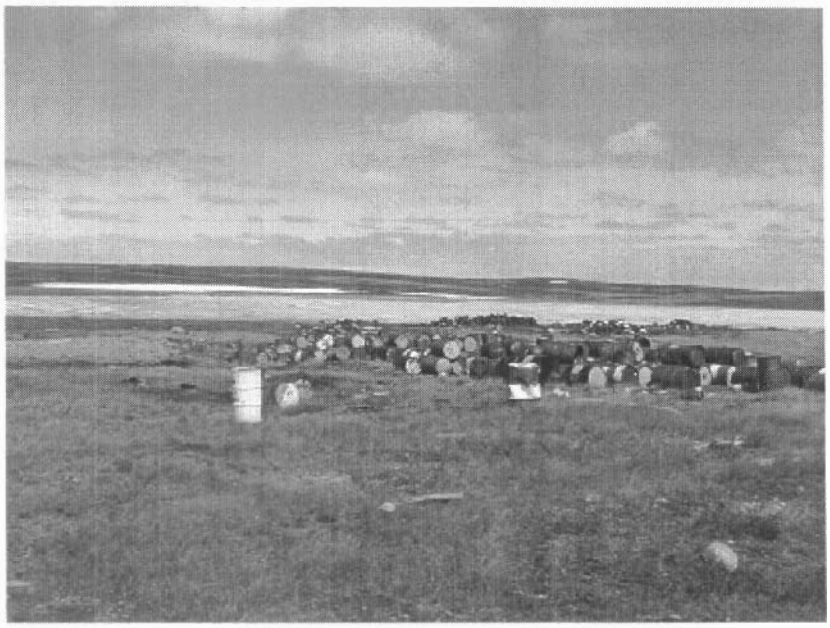

Figure-14 Garbage cans close to the pond 3

Figure-15 Loose earth and sand beside the pump house

Figure-15b Loose earth and sand beside the pump house

Appendix-1 Sampling Locations' Drawing