

ᓄᓇᑭᑦ ᐃᑦᑎᑦᓇᓂᐃᑦ ᑲᑎᐱᓂᑦᑦᑎᑎᑦ ᑐᑲᓯᑦᑐᑦ ᑭᑦᑎᑦᑭᑦᓴᑦ #125296

## Impacts of Wastewater at Baker Lake

ᑐᑲᓯᑦᑐᑦᑭᑦᓴᑦ ᑭᓄᐃᑦᑐᑦᓂᑦᓴᑦ: New

ᐱᑦᓇᓇᓇᓂᐃᑦᓴᑦ

ᑭᓄᐃᑦᑐᑦᓂᑦᓴᑦ:

Scientific Research

ᐅᑦᓇᓂᑦ ᑐᑲᓯᑦᑐᑦᑎᑦᐃᐱᑦᐅᑦ: 3/20/2018 5:22:33 PM

Period of operation: from 0001-01-01 to 0001-01-01

ᑲᓴᓯᑦᑲᐃᓂᐅᑦᐃᑦᑎᑦᑭᑦᐅᑦ: from 0001-01-01 to 0001-01-01

ᐱᑦᓇᓇᓇᑭᑦᑭᑦᓴᑦ:

Charles S Wong

University of Winnipeg

515 Portage Ave.

Winnipeg MB R3B2E9

R3B2E9

ᐅᑦᑲᑦᐃᑦᑎᑦ: 2047869335, ᓯᑲᓴᓂᐃᑦ:

## ᑐᑲᓴᐱᓴᑦ

ᑭᓄᐃᑦᑐᑦᑎᑦᓂᑦ ᐱᑦᓇᓇᓇᑭᑦᓂᐃᑦᓴᑦᓂᑦᓴᑦ

ᑭᑦᓇᓇᑎᑦᑐᑦ: We are a group of University-based researchers: Dr. Charles Wong of the University of Winnipeg, Drs. C.J. Mundy and Mark Hanson of the University of Manitoba, Drs. Brendan McConkey and Joshua Neufeld of the University of Waterloo, and Dr. Rob Jamieson of Dalhousie University. Our proposed project is titled “Impacts of wastewater release at Baker Lake, Nunavut”. Our project’s goal is to understand impacts of wastewater releases at Baker Lake. This will provide for improved water quality for the community and region, by providing needed information, and to have a baseline for potential future work to improve the community’s treatment facilities (for example, through improving treatment wetlands). Our objectives are to measure the sewage lagoon treatment system’s wastewater, and waters affected by its release, for traditional wastewater contaminants such as nutrients (nitrogen and phosphorus), abundances and composition of algae and bacteria (beneficial and harmful), and chemicals such as over-the-counter and prescription drugs excreted from the body and not removed during lagoon treatment. Sampling will use trucks and small boats hired through the HTO as appropriate to access proposed sampling sites. Buoys or poles may be necessary to secure some samplers to offshore and onshore sites, respectively, and removed once the project is complete. This work is funded by Polar Knowledge Canada, with support from partner Agnico Eagle Mines Ltd. Potential further funding may also be available through the Natural Sciences and Engineering Research Council of Canada via a Collaborative Research and Development proposal being prepared. For methods, we propose to sample during June (ice melt) and September 2018, and potentially once more in between, with follow-up work over the same periods in 2019 to evaluate year-over-year trends. Sampling work would be done by members of our team, for example, 2-3 undergraduate and graduate students and technicians at any given time, working with individuals hired by the HTO as above. Six sites are directly in the wastewater flow path: the lagoon itself, the water inputs and outputs at Finger Lake and Airplane Lake, and the outfall at Baker Lake. In Baker Lake itself, we will also sample water near the drinking water source and another offshore site to evaluate wastewater impacts to this lake. Two additional lakes near but upstream of the lagoon will be sampled as background; these are labeled as the upstream background site on the map associated with this application. Water samples (approximately 1 L each) will be collected and sent to our laboratories for testing. We will measure algal production, chemical contaminants, and water flow rates using growth meters and passive samplers put in place during the ice-free period, then removed. Given concerns brought up in a 2007 consulting report that wastewater may affect the drinking water source, we can characterize flow direction by adding a small amount (1 L) of non-toxic, water-soluble dye to the lagoon, a standard hydraulic tracer test. Vegetation near the lagoon would be characterized by walking the area on foot, placing a temporary 1 m 1 m PVC frame on the ground, taking photographs, and at times collecting soil samples (<500 g). This characterization is useful to evaluate compositions and

Operations Phase: from 2018-05-31 to 2020-05-29

ለሮሲታሪያው ምርመራ

ለሮሲታሪያው ምርመራ

ጠቅላላ	የምርመራ ስፋት ለሮሲታሪያው ምርመራ	የምርመራ ዓይነት	የምርመራው ዓላማ የምርመራው ዓላማ	የምርመራው ዓላማ የምርመራው ዓላማ	የምርመራው ዓላማ የምርመራው ዓላማ
Upstream background site	Sampling sites	Municipal	There are two small freshwater lakes hydrologically upstream of the sewage lagoon, that we would sample as reference to characterize ambient water quality.	None known.	These lakes are just northwest of the sewage lagoon.
Wastewater lagoon	Sampling sites	Municipal	This is the sewage lagoon, with a maximum depth of approximately 1.5 m, servicing the hamlet of Baker Lake. Wastewater has been deposited here regularly by pump trucks for 30+ years. The water is frozen throughout the winter, and thaws in spring to run downstream.	None known.	The site is approximately 1 km north of the hamlet of Baker Lake.
Airplane Lake inflow	Sampling sites	Municipal	Airplane Lake receives runoff through channels that run southeast from Finger Lake for 1000 m before emptying into the northwest corner of Airplane Lake. This channel is rocky and covered in ice-free months with a thick layer of algae. Water quality at this point must comply with effluent criteria as per the hamlet's wastewater discharge license.	None known.	The inflow of Airplane Lake is approximately 1000 m downstream of the outflow of Finger Lake.
Airplane Lake outflow	Sampling sites	Municipal	The outflow of Airplane Lake is at the southeast corner, where it feeds Garbage Creek.	None known.	This site is approximately 300 m south of the inflow of water from Finger Lake to Airplane Lake.
Wastewater inflow to Baker Lake	Sampling sites	Municipal	This is the site at which lagoon wastewater enters Baker Lake. It is connected to Airplane Lake through Garbage Creek, a 1300 m rocky creek with algal growth and thick vegetation in	None known.	This site is approximately 2 km east of the hamlet.

			the form of sedges upstream and shrubs downstream near Baker Lake itself. Water flow is fast, wide, and turbulent.		
Baker Lake receiving water	Sampling sites	Municipal	Sampling at Baker Lake itself would be done to evaluate wastewater impacts. Previous consultant work in 2007 have suggested that elevated metals levels at offshore points may not necessarily be from sewage discharges, but from other sources within the hamlet.	None known.	The area within Baker Lake offshore of the hamlet.
Shoreline Baker Lake (drinking water intake)	Sampling sites	Municipal	The hamlet's drinking water intake is approximately 120 m offshore, and at 5-6 m depth. Water is treated by membrane filtration before use. Previous consulting work in 2007 suggested that wastewater discharges from the lagoon were unlikely to affect the drinking water supply, but could not rule out this possibility. Sampling work here would near this site (e.g., at least 50 m away) to avoid interference or contamination of the drinking water source.	None known.	The drinking water intake is approximately 120 m offshore from the hamlet.
Finger Lake outflow	Sampling sites	Municipal	Finger Lake covers about 7.4 ha and averages 1.4 m in depth. During spring and summer, wastewater flows from the lagoon, through a small wetland, and into Finger Lake. The hamlet's solid waste disposal facility, which accepts both municipal and hazardous waste, is upstream of this site. Runoff from the solid waste facility has been observed to discharge into Finger Lake and influence metal concentrations downstream, as noted by a consultant (Numani Jacques Whitford Ltd.) in	None known.	The outflow of Finger Lake is approximately 500 m east and downstream of the inflow.



		of personnel by sampling via regular charter flights to and from Baker Lake	
Water	0	A small boat would be used to access offshore sampling sites.	
Land	0	A pickup truck would be used to access onshore sampling sites.	

Project accomodation types

ᓄᓇᓕᓯᓪᓴᓐ

◀▷◀◻▶◻▶

Λ<sup>9</sup>D Δ<sup>6</sup>ΓΔ<sup>5</sup> ΔD<sup>5</sup>CΔσDΛ<sup>5</sup> Δε<sup>5</sup>βγDΠωΓC ΔjCΔC, ΓωΔPñC, β<sup>6</sup>λCj<sup>5</sup>, μεγD<sup>c</sup> Δρ<sup>6</sup>Γω

ᐃᓕᑦᑲᓚᓂ ᐱᓄᓂ ᐋᑐᒐᐅᓂᐋᓖᑐᓖ ᓖᑭᐃᓂᓂ	ᓖᑭᑦᑲᐅᓂᓂ	ᐋᓕᑦᑲᓂᓂ - ᓂᓖᓂᓂᓂ	ᓂᓂᓂ ᐋᑐᒐᐅᓂᐋᓖᑐᓖ
boat	1	< 20'	A small boat would be used to carry sampling equipment, including samplers, to offshore sites.
passive samplers	9	20 cm diameter x 30 cm length	Passive water samplers will be deployed at sites for up to 3 weeks each, during the sampling season. These require no power to operate, and would be deployed by cable attached to fixed points on shore (e.g., poles or existing structures) or buoys if offshore. All equipment will be removed at the end of the field season.
current meters	6	10 cm	We will be measuring stream flow downstream of the existing wastewater treatment plant using portable current meters. Water level loggers (10 cm in size) will be deployed in the stream beds in-stream for the season, to monitor water flow continuously, and removed at the end of the summer.
Hydraulic tracer testing	1	1 L	Hydraulic tracer tests may be conducted in the wastewater treatment system, using a small amount of non-reactive and non-toxic soluble dye tracer. This is to characterize water retention time in the wastewater treatment system, and ascertain flow directions.
Quadrats	1	1 m <sup>2</sup>	Quadrats will be used to characterize vegetation and wetland presence in the vicinity of the existing wastewater treatment system and reference site. This will involve transecting

			the tundra on foot, placing a temporary 1 m x 1 m PVC quadrat on the ground surface, and taking photographs, and at times collecting small soil samples (<500 g).
truck	1	standard size pickup truck	A pickup truck or similar vehicle would be used to carry sampling equipment to onshore sites.
primary productivity measures	9	1 m <sup>2</sup>	These consist of sealed bottles with known algal and nutrient compositions, and would be deployed on site to measure algal productivity. They would be removed after measurements are done.

#### በበናዎች ላይ ያሉ የፋኬልቲቲዲቲ ምርመራዎች

የሰው ልማት የፋኬልቲቲዲቲ ዕቅድ	የፋኬልቲቲዲቲ የፋኬልቲቲዲቲ	የፋኬልቲዲቲ የፋኬልቲዲቲ	የፋኬልቲዲቲ የፋኬልቲዲቲ	የፋኬልቲዲቲ የፋኬልቲዲቲ	የፋኬልቲዲቲ የፋኬልቲዲቲ	የፋኬልቲዲቲ የፋኬልቲዲቲ
Diesel	fuel	1	50	50	Liters	Diesel fuel for the small boat listed above. Estimated maximum amount used for sampling work during the season.
Gasoline	fuel	1	100	100	Liters	Gasoline for the sampling truck listed above. Estimated maximum amount used for sampling work during the season.

#### የፋኬልቲዲቲ ምርመራዎች

የፋኬልቲዲቲ ምርመራዎች	የፋኬልቲዲቲ ምርመራዎች	የፋኬልቲዲቲ ምርመራዎች
1	We will be sampling water and wastewater at the locations indicated. Total sampling will be approximately 1 L/day per site (i.e., far less than the 1 m <sup>3</sup> minimum value for Daily Amount).	Water sampled will be at the locations indicated on the map.

$$\Delta^b C d_c n_\sigma \Delta^a \sigma^a$$

ለፍርድ ቤቱ የሚገኙ የፍርድ ቤቶች	የፍርድ ቤቱ የፍርድ ቤቶች	የፍርድ ቤቱ የፍርድ ቤቶች	የፍርድ ቤቱ የፍርድ ቤቶች	የፍርድ ቤቱ የፍርድ ቤቶች
ለፍርድ ቤቱ የፍርድ ቤቶች	ለፍርድ ቤቱ የፍርድ ቤቶች	ለፍርድ ቤቱ የፍርድ ቤቶች	ለፍርድ ቤቱ የፍርድ ቤቶች	ለፍርድ ቤቱ የፍርድ ቤቶች
Sampling sites	ለፍርድ ቤቱ የፍርድ ቤቶች	< 10 L total	landfill	None necessary. These would be small amounts of waste products associated with consumable supplies for sampling (e.g., plastic wrap that seals sterile media used for collecting samples for bacterial DNA analysis), and can be disposed as regular trash.

$\Delta \rho_{\text{NFC}}^{\text{C}} = \Delta \rho_{\text{NFC}}^{\text{b}} + \Delta \rho_{\text{NFC}}^{\text{L}}$

There are no negative environmental impacts of the proposed work. Sampling will be of very small amounts of water (mostly wastewater) and soil. We will use a non-toxic, water-soluble dye added to the sewage lagoon to trace the path of wastewater; this is commonly done for water flow studies and is not expected to have any environmental impact. This work should provide a net positive impact on the community, as we will seek help as applicable from local residents in sampling (e.g., hiring boats for offshore work) . In a more general sense, this work will provide information useful for potential future upgrades to waste treatment at Baker Lake, and thus improved human health.

## **Additional Information**

**SECTION A1: Project Info**

**SECTION A2: Allweather Road**

**SECTION A3: Winter Road**

**SECTION B1: Project Info**

**SECTION B2: Exploration Activity**

**SECTION B3: Geosciences**

**SECTION B4: Drilling**

**SECTION B5: Stripping**

**SECTION B6: Underground Activity**

**SECTION B7: Waste Rock**

**SECTION B8: Stockpiles**

**SECTION B9: Mine Development**

**SECTION B10: Geology**

**SECTION B11: Mine**

**SECTION B12: Mill**

**SECTION C1: Pits**

**SECTION D1: Facility**

**SECTION D2: Facility Construction**

**SECTION D3: Facility Operation**

**SECTION D4: Vessel Use**

**SECTION E1: Offshore Survey**

**SECTION E2: Nearshore Survey**

**SECTION E3: Vessel Use**

## SECTION F1: Site Cleanup

## SECTION G1: Well Authorization

## SECTION G2: Onland Exploration

## SECTION G3: Offshore Exploration

## SECTION G4: Rig

## SECTION H1: Vessel Use

## SECTION H2: Disposal At Sea

## SECTION 11: Municipal Development

**ᐱᓪᑲ ᐃᑦᐅᐅᑦ ᖃᓄᐃᑦᑐᑦ ᑕᓚᐅᓂᖅ:** ᓄᓇᐅᑦ ᖃᓄᐃᑦᑐᓂᖅ

The hamlet of Baker Lake is on the northern shore of Baker Lake, a large freshwater lake. The area is in a zone of continuous permafrost, with bedrock exposed in many areas. Surficial soils are characterized by silty sand and silty clays overlying boulder till, beach deposits, and reworked till. The Thelon River connects the Lake to upstream catchments and inlets into Baker Lake 11 km west of the hamlet.

[illegible]

Vegetation in Baker Lake is characterized by low-lying mosses, sedges, lichens, shrubs, and willows. These are contained in the wetland area downstream of the sewage lagoon. The waters in the lagoon and wetland are enriched with algae from sewage nutrients.

ᐱᓪᓇ ᐱᑦᑎᐅᑦ ᑦᑲᓂᐱᑦ)ᑦᑕᑎᐅᓂᓪᓴᑦ: ᐱᓂᑦᑎᓂᑦᑭᓪᓴᐅᑦ-ᐱᑦᑕᐱᑦᑕᑎᓂᑦᑭᓪᓴᐅᑦ

Baker Lake has a population of approximately 2,069. Drinking water comes from the Lake, approximately 120 m from the shoreline at 5-6 m depth below the surface. This water is treated with membrane filtration before use. Municipal wastewater is stored in holding tanks of individual buildings, then collected by pump trucks for discharge into the lagoon.

### Miscellaneous Project Information

$\frac{d}{dt} \Delta^{\text{fb}} CD_{\sigma^0} \Gamma^C = \Delta^{\text{fb}} CD_{\Gamma L} \dot{\Gamma}^C - \dot{\Delta}^{\text{fb}} C \dot{D}_{\sigma^0} \Gamma^C + \langle d\Gamma' \rangle \dot{\Gamma}^{\text{fb}} CD_{\sigma^0} \dot{\Gamma}^C$

Impacts on the existing physical and biological environment will be minimal. Small amounts of water and wastewater will be sampled. We will deploy sampling equipment onshore and offshore by attachment to fixed points to prevent them from being washed away (e.g., existing fences or posts as applicable onshore, buoys offshore). Any posts and such put up for sampling would be removed at the end of the sampling season.

## Cumulative Effects

None expected.

## Impacts

$\omega \rightarrow \omega \Delta^{9b} CD \sigma^{9b} r^C \quad d \leftarrow n \Gamma D C \dot{\sigma}^C D^C \quad d^b \rightarrow^{9b} CD r^L r^C$

[illegible][illegible]