

The sewage treatment lagoon in Hall Beach has been experiencing problems for a number of years; there have been several leaks in the past six years. The Government of Nunavut Department of Community and Government Services (GN-CGS) has taken a number of short term actions to repair the berm but now wants to focus their efforts on a long term solution. The following table outlines the past incidents and GN-CGS' efforts to repair the issue:

<b>Incident</b>	<b>Year</b>	<b>GN-CGS Action</b>
<b>Leak through bottom of lagoon near southeast corner</b>	2008	Removed topsoil from lagoon bottom and refilled with appropriate granular and compaction
<b>Leak developed in southeast corner of berm</b>	2010	Lined the corner of the berm
<b>Slumping of southern berm</b>	2012	
<b>Leak under southern berm</b>	2013	Recognized a long term solution is required

The Department of Community and Government Services are now focusing their efforts on a long term solution because the previous patchwork repairs did not meet long term needs. As part of the long term solution process, GN-CGS has contracted **exp** to assess the lagoon to try to determine the cause(s) of the leak. In their assessment report letter (Appendix A) they indicated the breach in the berm was most likely caused by wastewater seeping under the berm. This concentrated seepage flow washed out berm materials resulting in the slumping. In this report **exp** noted that the seepage from cell 1 flowed in an easterly and northerly direction, following the natural contours of the beach area around the lagoon. The seepage ultimately flowed toward the drainage ditches, ponds and wetland area that are components of the current treatment system. Shortly after **exp's** visit to Hall Beach, representatives from GN-CGS and Dalhousie University (who are conducting a large 5 year wastewater treatment research project in Nunavut) visited the community to take water samples of the leaked effluent. These results showed the effluent quality posed minimal risk to the environment<sup>1</sup> (Appendix B). The two sites sampled were HAL-5 and HAL-6. HAL-5 is the final SNP point in the water license and HAL-6 is located at N68°48.490' W081°15.532' which was a location closer to the lagoon system where water was ponding at the end of the drainage ditch. The flow path from the leaked effluent was thought to have flowed here based on the natural topography of the land and this ponded area eventually drains toward the ocean.

The lagoon system is located a few hundred meters from the shoreline and soil conditions are coarse sand to fine gravel based on visual inspection. This is ideal for wastewater treatment as it acts as a giant sand filter, cleansing and filtering the wastewater. It was reported that water levels in the lagoon were dropping before a leak was noted. This suggests there were subsurface flow conditions until the ground got saturated and surface flow conditions were established. When **exp** visited the site, they noted the gravel beach area was wet along the flow path and very little surface flow was evident. Therefore, most of the wastewater leaking from cell 1 essentially flowed through a giant sand filter before entering the wetland area. Subsurface flow is a very effective treatment method and constructed wetlands are often

<sup>1</sup> The lab results showed water quality parameters to be less than the new Environment Canada Wastewater Systems Effluent Regulations in effect for southern Canada.

designed with subsurface flow areas. The lab results of the effluent quality verify the effectiveness of this design.

Community and Government Services are currently looking at options for a permanent solution to address the leak in the sewage lagoon. GN-CGS is presently developing a design RFP which will be issued to hire a design consultant. It is the intention of GN-CGS to have a consultant on board by the end of the summer and a design finalized prior to the end of the fiscal year. It is anticipated that this schedule will allow the project to be tendered for construction next year.

Community and Government Services realize this does not solve the problem in the short term. Because cell 2 does not have the capacity to retain the overwinter wastewater generation, it will be necessary to discharge some wastewater to cell 1 once cell 2 is full. Operators will ensure that cell 2 is completely decanted prior to freeze-up to allow as much wastewater as possible to be discharged to cell 2 therefore minimizing the amount that must be discharged to cell 1. Once cell 1 is in use, the berms will already be frozen and the wastewater will be retained until the spring melt. Based on the nature of the surrounding landscape and the results of the water quality testing, it is believed that any wastewater that leaks from cell 1 in the spring will be sufficiently treated before its final discharge to the ocean with very minimal environmental risk. GN-CGS will also establish a monitoring program during the spring thaw to closely observe the conditions and water quality testing will be conducted to ensure there is minimal risk to the receiving environment.

## **APPENDIX A**



June 27, 2012

Mr. Bill Westwell  
Senior Manager Municipal Planning  
Government of Nunavut  
Department of Community & Government Services  
PO Box 1000, Station 700  
Iqaluit, NU X0A 0H0

**Re: OTT-00213472-A0 – Assessment of Sewage Lagoon Cell #1  
Hamlet of Hall Beach, Nunavut**

Dear Mr. Westwell:

The Hamlet of Hall Beach's sewage lagoon cell #1 was reported to have developed a leak during the spring of 2013 and exp Services Inc. (exp) was requested to complete an assessment of the sewage lagoon cell with a goal of trying to determine the cause(s) of the leak and based upon the observations recommend remedial measures for the sewage lagoon cell.

On June 20<sup>th</sup>, 2013, Mr. Stephen Douglas and Mr. Surinder Aggarwal, P.Eng. of exp completed a site visit and assessment of sewage lagoon cell #1 in the Hamlet of Hall Beach as requested by the Department of Community & Government Services (CGS), Government of Nunavut (GN). At the time of site inspection, cell #1 was reported to completely empty while cell #2 still retained sewage. It should be noted that at the time of site visit cell #1 earth berms were void of any snow, therefore there is no impedance for visual inspection of the berms. There was however snow present in the drainage ditch leading away from the facility which restricted any observation as to the condition of cell #2 and if there was any sewage seeping from that cell.

### **Background Information**

The sewage lagoon system at Hall Beach comprises of two cells orientated in a north south direction. The southern cell is commonly referred to as cell #1 and the northern cell is commonly referred to as cell #2. It is noted that a set of design drawings of the proposed sewage lagoon system were prepared by FSC Group in 2002, however the lagoon system does not reflect the layout shown in these drawings, and a set of as-built drawings have not been made available to exp.

It is reported that the present lagoon systems were constructed in the general vicinity of former lagoon. The design of the lagoon system was to decommission the existing cells and incorporate the land into the present lagoon system. However, whether the present lagoon was built according to the proposed plans is not known.

It was also reported that the berm connecting the two cells, and north and east berm in cell #2 were designed as exfiltration berm to facilitate flow from cell #1 to cell #2 and the discharge of the effluent to the wetlands located to the north east of cell #2. The berm connecting the two cells is report not to function as an exfiltration berm as per its intended design.

## Site Assessment

On-site observations by the **exp** team revealed that cell #1 and cell #2 both measure approximately 110 m x 100 m. The berms are approximately 3 - 3½ m high, with their crests approximately 5 to 6 m and berm slopes varying between 2H:1V to 3H:1V.

It is reported that a portion of the east and south berms of cell #1 developed a leak in 2008. In 2010 this leak was repaired by lining the south and east berms of cell #1 at the south east corner, approximately 20 m in each direction. Information regarding the type of liner used was not available at the time of the site visit. The south berm of cell #1 started to leak again in 2013 which initiated the assessment of the facility by **exp**.

A visual examination of cell #1 revealed that leak appears to have formed on the southern berm immediately to the west of the end of the liner installed in 2010. The leak appeared to be a result of seepage under as opposed to through the berm. The seepage of effluent underneath the berm has resulted in washing of soil from underneath the berm and the area located immediately to the south of the berm. This in turn has resulted in part of the berm failing in a crescent-shape failure with soil slumping approximately 1 m on the outside face of the southern berm. In addition, soil on the outside toe of the berm has settled approximately 0.5 m over an area approximately measuring 5 x 10 m. The settlement of the soil in this area has exposed garbage comprising of metal pieces, timber, rags, paper etc. It was reported that a garbage dump was previously located in the area, although the exact location and extent is not known in relationship to the present sewage lagoon system. It has also been reported that some garbage was previously observed in the bottom of cell #1.

The seepage from cell #1 traverses in an easterly and northerly direction around cell #1 through a series of drainage ditches and ponds, eventually discharging to the wetlands identified as part of the wastewater treatment process for the Hamlet of Hall Beach.

Based on a review of the site conditions and review of the available information we are of the opinion that the primary cause of leakage from cell #1 is that the cell has been partially constructed on an old garbage dump. Garbage dumps fills typically have large voids due to wedging timber and metal pieces. These voids form a conduit for the effluent to flow through. The seepage of water through the garbage under the berm has led to a cave-in of the berm materials into the voids in the garbage fill resulting in failure of the berm slope and large settlement of the area immediately south of the berm slope failure.

At the time of the site visit effluent was observed being discharged in cell #1. The Hamlet was advised that effluent should not be discharged in cell #1 until the cell has been repaired. It was noted that continual discharge of effluent into the cell may result in a progressive failure of the slope berm, eventually leading to a complete collapse of the berm.

## Recommended Remedial Measures

It is **exp's** understanding that it is the GN's desire to repair the lagoon this year to provide for storage of effluent during the upcoming winter months. As part of our assessment of the sewage lagoon facility we have identified the following remedial measure options. Based upon unknown site conditions such as the extent of garbage fill present under cell #1, the lack of available information regarding geotechnical conditions at the site and whether the lagoon is subject to hydrostatic uplift pressures, it is considered difficult to recommend a specific remedial measure.

### **1. Temporary Remedial Option**

A temporary solution would be repairing the leak in a manner similar to the method used previously in 2010. That is installing a liner across the area of the berm currently leaking. This solution may include sub-excavating beneath the berm or the sewage lagoon cell to remove the solid waste and replace with sand and gravel fill.

It is noted that this option is unlikely to perform satisfactorily in the long term as the leak may shift to the adjacent unlined area of the berm as occurred subsequent to the 2010 repair.

### **2. Semi-Permanent Remedial Option**

The semi-permanent remedial option would entail lining the entire cell #1 with a synthetic liner. However, with the current lack of geotechnical information on the soil conditions throughout the base of the sewage lagoon cell and the presence of old garbage dump within the sewage lagoon, this option may be prone to settlement within the base of the lagoon due to the consolidation of either the soil or the garbage fill present under cell #1. Depending on the magnitude of the settlement, the liner may rupture resulting in the cell leaking.

This option would require a sand cushion being placed beneath and above the synthetic liner with additional fill placed on top of the sand cushion to provide protection from erosion and provide some ballast. In addition, a dead zone for the collection of sewage sludge is normally provided in a lined sewage lagoon cell. Therefore, the option of providing a fully lined sewage lagoon cell would result in the reduction of storage capacity of the sewage lagoon. An assessment of the required storage capacity within the Hamlet will have to be undertaken to determine if the sewage lagoon berms would have to be raised to accommodate this loss of storage capacity.

As a semi-permanent remedial option it is anticipated that this option may perform satisfactorily in the short to medium term, however, its long term performance cannot be assured due to the lack of information regarding the conditions of the base of the sewage lagoon cell.

### **3. Permanent Remedial Option**

A permanent remedial option is similar to the semi-permanent option, i.e. it would entail lining the entire sewage lagoon with a synthetic liner. However, as part of the permanent remedial option an investigation of the condition of the bottom sewage lagoon cell would be undertaken. This investigation would be in the form of test pits and / or boreholes to determine the soil conditions and their suitability for the installation of a liner. In addition, the investigation would attempt to delineate the existing garbage dump located within the sewage lagoon cell. This information would determine if the soil conditions were prone to settlement and the extent of garbage fill that should be removed. Based on the information gather a decision regarding the suitability of this option and the scope of work required could be made.

Similar to the Semi-Permanent Remedial Option, this option would require a sand cushion being placed beneath and above the synthetic liner with additional fill placed on top of the sand cushion to provide protection from erosion and provide some ballast. In addition, a dead zone for the collection of sewage sludge would be provided. Therefore, the option of providing a fully lined sewage lagoon cell would result in the reduction of storage capacity of the sewage lagoon. An assessment of the required storage capacity within the Hamlet will have to be undertaken to determine if the sewage lagoon berms would have to be raised to accommodate this loss of storage capacity.

### Estimated Costs

The estimated cost of the three remediation options are provided in the table below.

	Temporary	Semi-Permanent	Permanent
Capital cost	\$310,000	\$1,825,000	\$2,008,000
Investigation			\$125,000
Engineering (10%)	\$31,000	\$183,000	\$201,000
<b>Total Cost</b>	<b>\$341,000</b>	<b>\$2,008,000</b>	<b>\$2,334,000</b>

### Conclusions and Recommendations

Based on exp's understanding that it is the GN goal that cell #1 be repaired in 2013 and that any repair work provide a long term solution for the Hamlet, we provide the following conclusions and recommendations:

1. It is anticipated that the Temporary Remedial Option solution of installing a liner along a small section of the leaking berm will not perform satisfactorily in the long term and is not therefore recommended as a remedial action.
2. It is noted the Semi-Permanent Remedial Option is only marginally more costly than the Permanent Remedial Option, however, it does not provide the long term satisfactory performance desired by the GN. Therefore, it is recommended that this option not be considered unless no other viable options are present.
3. The Permanent Remedial Option, which is the most costly option, carries the risk that the geotechnical investigation reveals that either the soil conditions at the bottom of the sewage lagoon cell are unsatisfactory for the installation of a fully lined sewage lagoon cell, or that the extent of the old garbage dump is such that the remedial action of excavating and backfilling the solid waste becomes a very onerous and costly exercise. Either of which may result in the proposed permanent remedial option being unfeasible.
4. It is recommended that the Permanent Remedial Option be chosen as it has the highest probability of meeting the goals of the GN, i.e. repairing the leak in 2013 as well as providing a long term solution. This option does however entail the risk as previously referenced that the investigation may determine that this option is not feasible. If this is the case it would be recommended that the Temporary Remedial Option be implemented and the liner that has been purchased and shipped to Hall Beach as part of the Permanent Remedial Option be retained for the construction of a new sewage lagoon cell in 2014.

We trust that the above information is satisfactory for your purposes. Should you have any questions or require additional information or clarification of the above please do not hesitate to contact Steven Burden at 613-688-1899.

Sincerely,  
exp Services Inc.



Steven Burden, P.Eng.  
Manager – Municipal Services  
Infrastructure Services



Surinder K. Aggarwal, M.Sc., P.Eng.  
Senior Project Manager, Geotechnical Services  
Earth and Environment

## **APPENDIX B**

C.O.C.: G37698

REPORT No. B13-18632

**Report To:**

**Gov. of Nunavut Community & Gov. Services**  
 PO Box 1000 Stn 700, Brown Building  
 Iqaluit NU X0A 0H0 Canada

**Attention:** Erin Mentink

**Caduceon Environmental Laboratories**

2378 Holly Lane  
 Ottawa Ontario K1V 7P1  
 Tel: 613-526-0123  
 Fax: 613-526-1244

DATE RECEIVED: 19-Jul-13

JOB/PROJECT NO.: Hall Beach WW Sampling

DATE REPORTED: 29-Jul-13

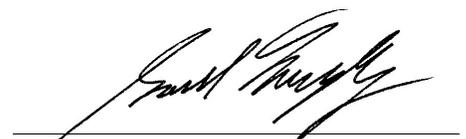
P.O. NUMBER:

SAMPLE MATRIX: Waste Water

WATERWORKS NO.

<b>Client I.D.</b>	HAL-5	HAL-6		
<b>Sample I.D.</b>	B13-18632-1	B13-18632-2		
<b>Date Collected</b>	16-Jul-13	16-Jul-13		

Parameter	Units	M.D.L.	Reference Method	Date/Site Analyzed	HAL-5	HAL-6		
Hardness (as CaCO3)	mg/L	1	SM 3120	23-Jul-13/O	96	215		
Alkalinity(CaCO3) to pH4.5	mg/L	5	SM 2320B	23-Jul-13/O	72	193		
Conductivity @25°C	µmho/cm	1	SM 2510B	23-Jul-13/O	318	891		
pH @25°C	pH Units		SM 4500H	23-Jul-13/O	7.98	7.96		
BOD	mg/L	3	SM 5210B	24-Jul-13/O	< 3	11		
Fecal Coliform	cfu/100mL	1	MOE E3371	19-Jul-13/O	30	10		
Total Suspended Solids	mg/L	3	SM 2540D	24-Jul-13/O	< 3	8		
Nitrite (N)	mg/L	0.1	SM4110C	23-Jul-13/O	< 0.1	0.2		
Nitrate (N)	mg/L	0.1	SM4110C	23-Jul-13/O	< 0.1	1.1		
Chloride	mg/L	0.5	SM4110C	23-Jul-13/O	36.8	144		
Sulphate	mg/L	1	SM4110C	23-Jul-13/O	24	45		
Ammonia (N)-Total	mg/L	0.01	MOEE 3364	23-Jul-13/O	< 0.01	4.21		
Total Organic Carbon	mg/L	0.2	EPA 415.1	22-Jul-13/O	5.0	10.5		
Phenolics	mg/L	0.001	MOEE 3179	25-Jul-13/O	< 0.001	0.002		
Aluminum (total)	mg/L	0.01	SM 3120	23-Jul-13/O	0.02	0.04		
Arsenic	mg/L	0.0005	EPA 200.8	23-Jul-13/O	< 0.0005	0.0040		
Calcium	mg/L	0.02	SM 3120	23-Jul-13/O	29.0	60.8		
Cadmium	mg/L	0.005	SM 3120	23-Jul-13/O	< 0.005	< 0.005		
Cobalt	mg/L	0.005	SM 3120	23-Jul-13/O	< 0.005	< 0.005		
Copper	mg/L	0.002	SM 3120	23-Jul-13/O	< 0.002	0.002		
Chromium	mg/L	0.002	SM 3120	23-Jul-13/O	< 0.002	< 0.002		
Iron (Total)	mg/L	0.005	SM 3120	23-Jul-13/O	0.028	0.367		
Potassium	mg/L	0.1	SM 3120	23-Jul-13/O	1.5	11.6		
Magnesium	mg/L	0.01	SM 3120	23-Jul-13/O	5.81	15.3		
Manganese (Total)	mg/L	0.001	SM 3120	23-Jul-13/O	< 0.001	0.033		
Mercury	mg/L	0.00002	SM 3112 B	24-Jul-13/O	< 0.00002	< 0.00002		
Sodium	mg/L	0.2	SM 3120	23-Jul-13/O	20.4	82.5		
Nickel	mg/L	0.01	SM 3120	23-Jul-13/O	< 0.01	< 0.01		



Gord Murphy  
 Lab Supervisor

M.D.L. = Method Detection Limit

Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill

The analytical results reported herein refer to the samples as received. Reproduction of this analytical report in full or in part is prohibited without prior consent from Caduceon Environmental Laboratories.

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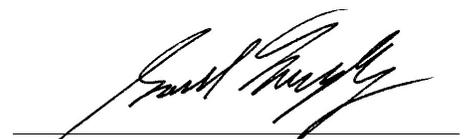
SAMPLE MATRIX: Waste Water

WATERWORKS NO.

Parameter	Units	M.D.L.	Reference Method	Date/Site Analyzed	Client I.D.	HAL-5	HAL-6		
					Sample I.D.	16-Jul-13	16-Jul-13		
Lead	mg/L	0.02	SM 3120	23-Jul-13/O	B13-18632-1	< 0.02	< 0.02		
Zinc	mg/L	0.005	SM 3120	23-Jul-13/O	B13-18632-2	< 0.005	< 0.005		
Oil and Grease-Anim/Veg.	mg/L	1.0	SM 5520	25-Jul-13/K		2.4	1.7		
Oil and Grease-Mineral	mg/L	1.0	SM 5520	25-Jul-13/K		< 1.0	< 1.0		
Oil & Grease-Total	mg/L	1.0	SM 5520	25-Jul-13/K		2.4	1.7		

M.D.L. = Method Detection Limit

Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill



Gord Murphy  
 Lab Supervisor

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