Gjoa Haven, NU Sewage Lagoon – Abandonment and Reclamation Plan

- Updated Fall 2014 -

FINAL

October 14, 2014

Abandonment and Reclamation Plan

Hamlet of Gjoa Haven, NU

11-5029

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Submitted by

Dillon Consulting Limited

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Executive Summary

This updated Abandonment and Reclamation (A & R) plan exists to replace the originally distributed document dated July 18th, 2014. Specifically, this plan takes into consideration the current site conditions (as of Fall 2014), and addresses the comments and recommendations received from AANDC and the NWB during a series of communications throughout August and September 2014[1].

As with the original document, the purpose of this A & R is to assist with the closure of the former Gjoa Haven sewage lagoon and help with the monitoring of the site post-closure. In particular, this plan outlines the most recent CCME guidelines for land applied biosolids and references all relevant remediation criteria (see **Section 3.1**), as recommended in AANDC's review of the original document. Additionally, the revised plan excludes the use of drying beds as a means to remediate the sludge contained in the former lagoon bed in favour of a more practical 'freeze-thawing in place' method (see **Section 3.2**).

In August 2014, the former sewage lagoon effluent was in compliance with the water licence criteria for decant and was thus discharged into the wetland to commence with the decommissioning of the site. Approximately 850 m^3 of the existing berm material was repurposed for a truck turnaround expansion at the new lagoon site, and 1800 m^3 was used to improve a service road to the wastewater treatment facilities site. As per AANDC directives, the repurposed berm material will be repatriated and stockpiled at its original site at the beginning of the 2015 construction season.

It is anticipated that the de-watered lagoon sludge will undergo further natural biological degradation after exposure to another freeze-thaw cycle (winter 2015) and throughout the summer 2015. In August 2015, it will be sampled and analyzed to ensure it meets the CCME requirements for land application. Once the sludge in the bottom of the former lagoon bed meets remediation criteria, it is recommended that the stockpiled berm material be combined with the remediated sludge and used as cover to finalize the decommissioning of the former site or can be used as landfill cover material. Monitoring and site inspections will continue post-closure as per water licence requirements, and as outlined in the new sewage lagoon's Operations and Maintenance Manual. This amended A & R plan fulfills the requirements of Part G, Item 1 of the Hamlet of Gjoa Haven's municipal water licence (#BM-GJO1318).

[1] **Referenced communications can be found in Appendix A of this document.**

1 INTRODUCTION

A new sewage lagoon has been constructed for the Hamlet of Gjoa Haven and was commissioned for use in November 2013. The purpose of this Abandonment and Reclamation (A&R) Plan is to assist with the closure of the former Gjoa Haven sewage lagoon and help with the monitoring of the site after its closure. This A&R Plan has been completed with guidance from the *Abandonment and Restoration of Sewage Lagoons in Nunavut* (FSC, 2005).

2 SITE DESCRIPTION

2.1 Location

The Hamlet of Gjoa Haven is located at 68°37' N latitude and 95°50' W longitude (according to Google Earth Pro, 2007), on the southern tip of King William Island, Kitikmeot Region, Nunavut. Topography consists mostly of sands and gravels with a continuous permafrost zone. Low lying vegetation such as mosses and lichens are predominant with hardy grasses found in some areas. Year round access to the Hamlet is limited to air travel, however, during the summer months freight may be brought in by sealift.

The former sewage lagoon is located 1.5 km from the community and has an approximate volume of 22,700 m^3 of sewage. It is a circular shaped, single-cell lagoon with a truck turnaround pad and decant structure. **Figure 1** shows the location of the former lagoon site in relation to the community.

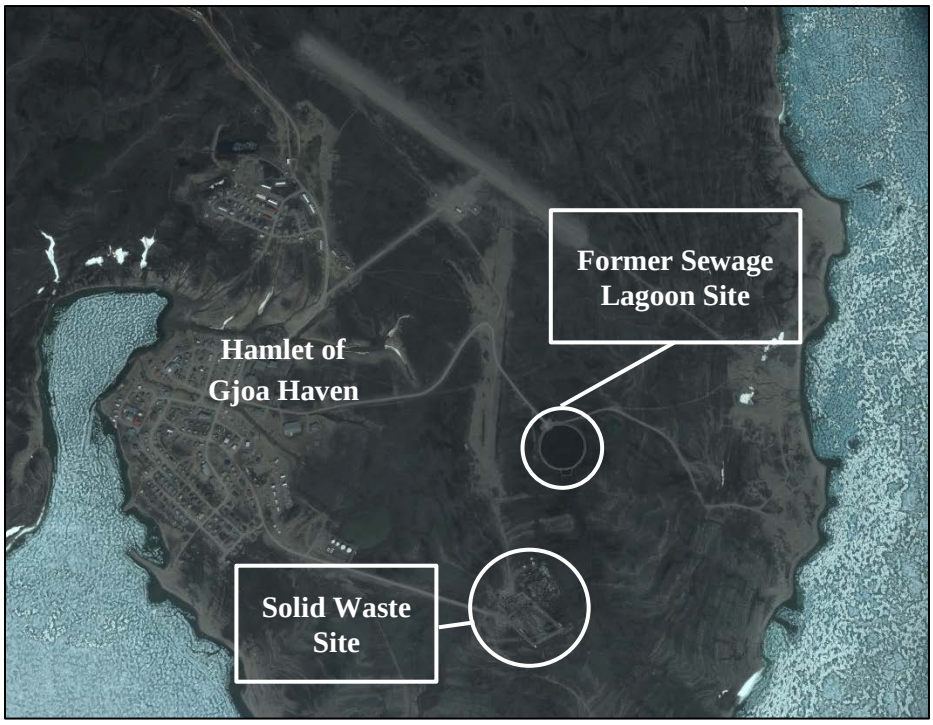

Figure 1: Gjoa Haven Sewage Lagoon Site Location

Image from Google Earth Pro registered to Dillon Consulting Limited

As of the fall of 2013, the hamlet has discontinued use of this site with the commissioning of the new sewage lagoon. The new sewage lagoon has been constructed adjacent to the former sewage treatment site. The **Figure 2** below shows the location of the new sewage lagoon in relation to the former lagoon.

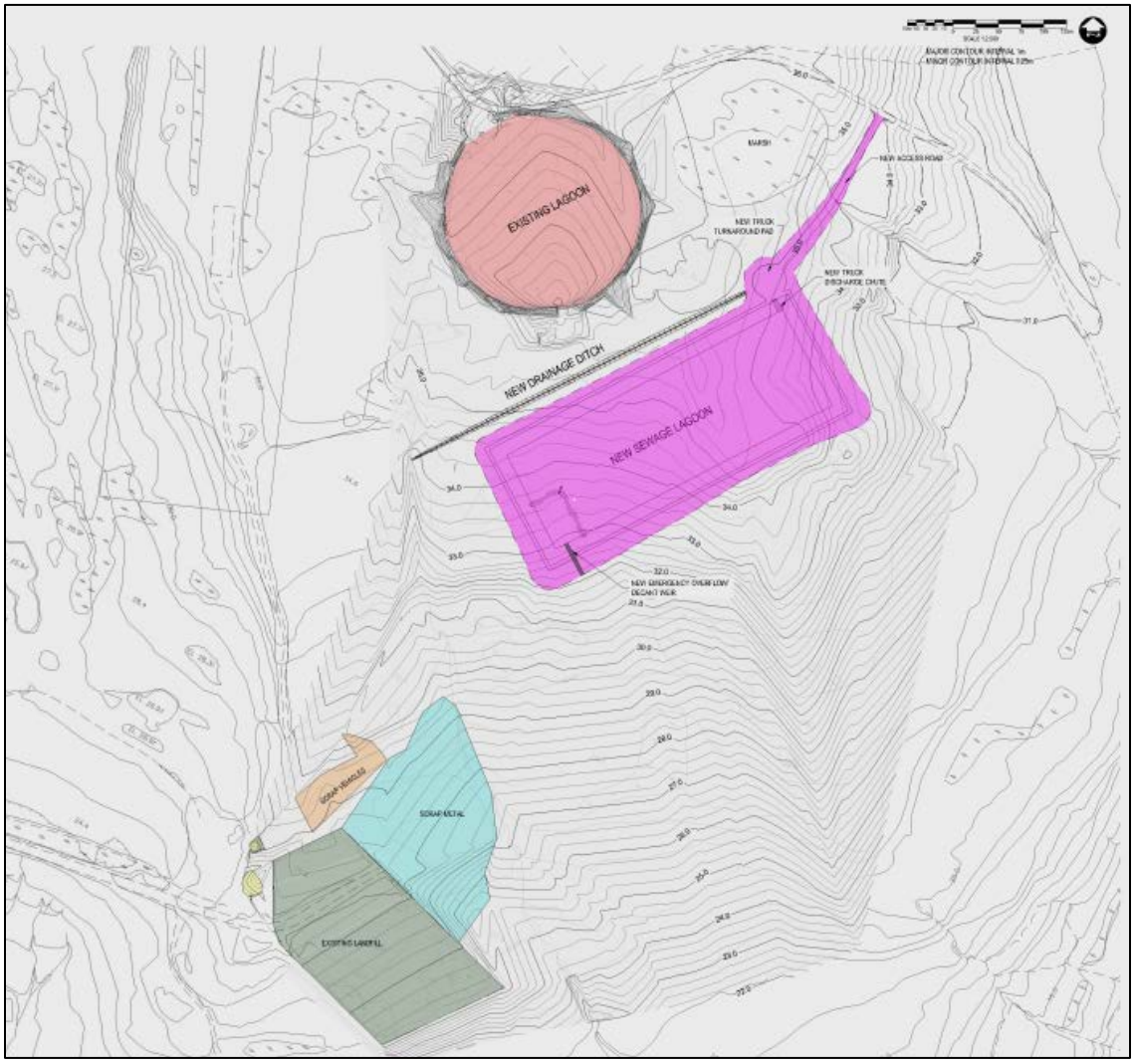

Figure 2: Site Plan of Existing Sewage Lagoon and New Sewage Lagoon

2.2 Sewage Treatment Facility

The former sewage lagoon in Gjoa Haven had experienced a number of problems relating to the stability of the berm wall surrounding the lagoon. The first report of berm instability was in July 2004 when it was noted that raw sewage was being discharged from the lagoon each time a sewage truck disposed of its cargo. In September 2005, the berm walls were reinforced and built back up in order to stop the flow of the raw sewage from the lagoon. However, an inspection in September 2006 revealed that a section of the berm wall had collapsed and a continuous stream of raw sewage was being discharged into the surrounding wetland area. A smaller secondary containment berm was constructed in 2008 to hold effluent that had leaked out of the lagoon. However, a section of the secondary containment berm

subsequently failed, allowing effluent to seep from the secondary cell into the surrounding environment. This resulted in the free flow of sewage from the lagoon along a 1.2 km path through a natural wetland. As discharge from the wetland percolates into the sandy soil matrix before it reaches the ocean edge a direct discharge route from the wetland into the ocean is effectively eliminated. Hence, to resolve the collapsed berm situation, a decant pipe was placed within the wall to allow for drainage of the effluent into the surrounding wetland, which permitted continuous seepage through the berm wall as opposed to an annual decant event.

The following photos were taken during a site visit in July of 2014, representing the state of the former lagoon after eight months of inactivity. **Photo 1a** and **1b** show the former sewage treatment lagoon from the inlet. **Photo 2a** shows the outflow pipe within the berm, and **2b** shows the secondary containment cell. **Photo 3a** and **3b** show the low-laying area adjacent to the secondary containment cell where effluent was allowed to decant through an alternate wetland path. **Photo 4** shows the 1.2 km path through the un-engineered wetland to the eventual discharge into the ocean from the intended decant point in the berm.

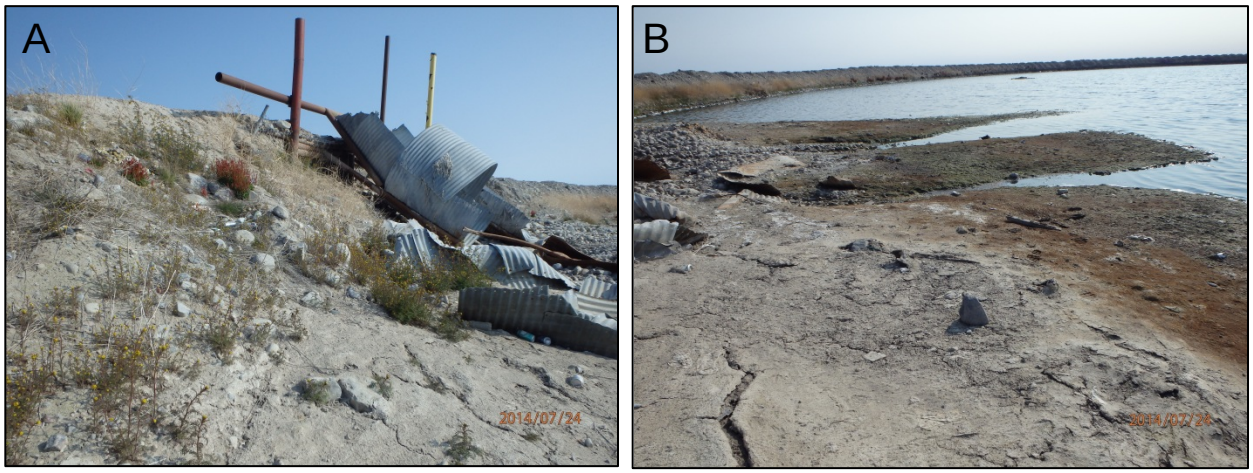

Photo 1: a – Former lagoon truck offload chute, b – View of Former Lagoon from inlet

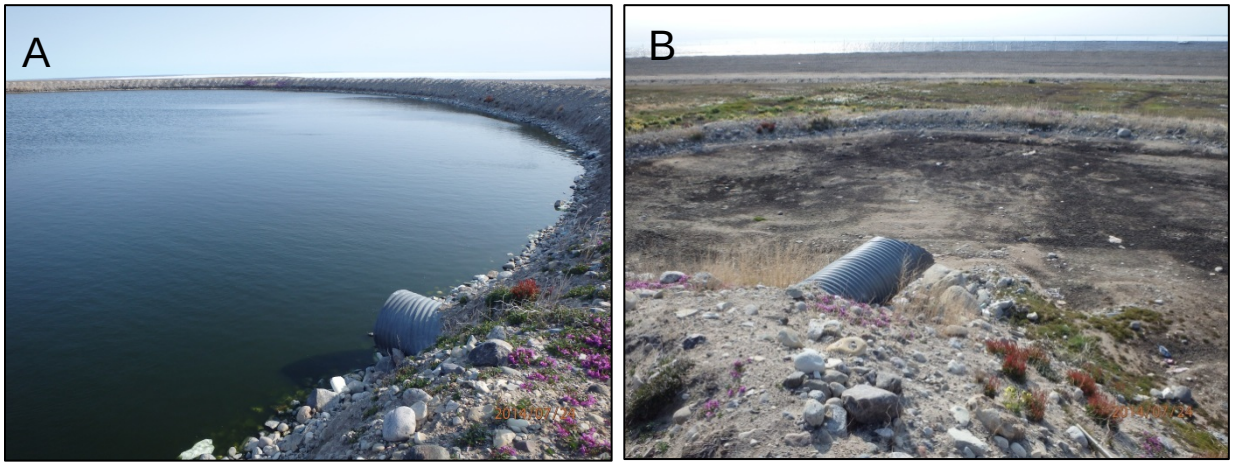

Photo 2: a – Former lagoon outflow pipe, b – Secondary containment cell

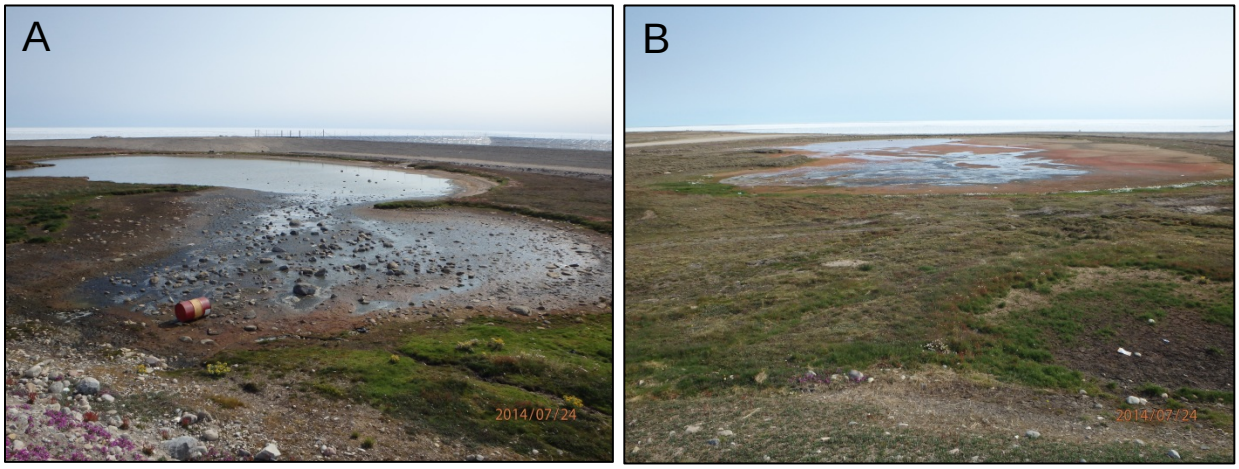

Photo 3: a – Pooling Adjacent to secondary containment cell, b – Low-laying area south of site

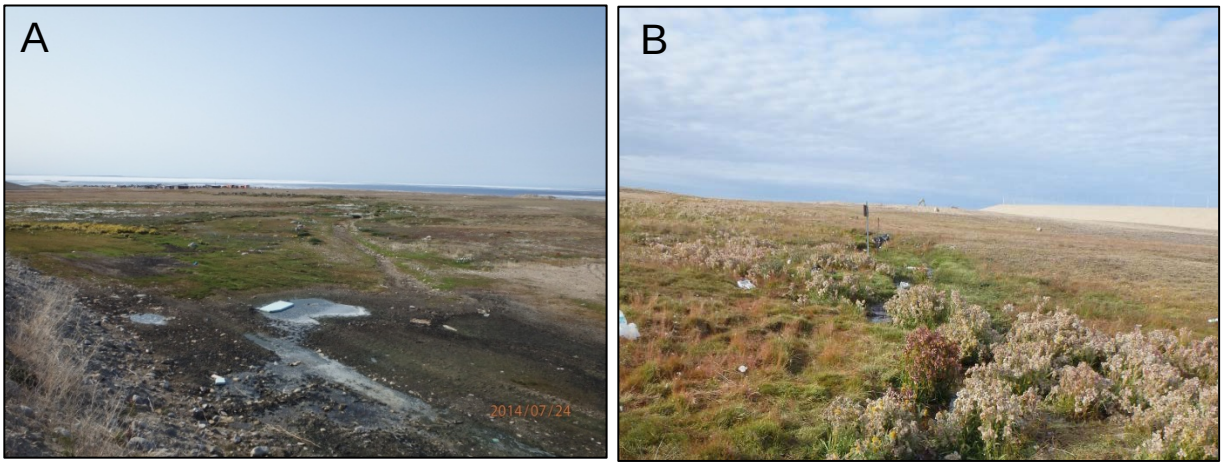

Photo 4: a – Un-engineered wetlands from former lagoon discharge point, b – View of wetland, looking north towards SNP GJO-4

2.3 Contents of the Former Lagoon

The former lagoon has an estimated capacity of 22,700 m^3. The current volume of sludge and effluent in the former lagoon is unknown due to continuous seepage from the lagoon. At the time of a summer 2014 site visit (prior to discharge), the freeboard was approximately 0.5 m below the base of the berm on the north end **(Photo 5a**). The liquid effluent level was approximately 0.15 m below the outflow pipe on the south end of the lagoon. **Photo 5b** shows the outflow pipe into the secondary containment cell. The base of the outflow pipe measures approximately 0.65 m above ground level in the secondary containment cell (**Photo 6**).

Photo 5: a - Effluent level below berm in former lagoon, b - Effluent level below outflow pipe

Photo 6: Outflow pipe to secondary containment berm

Based on a site survey completed by Dillon Consulting Limited in 2011, it is estimated that the lagoon berm walls consist of approximately 6300 m^3 of mostly sandy gravel material that can be reused by the GN or municipality. At minimum, it is recommended that the material be graded or removed from the site to prevent ponding of water. The clean material on the outside of the berm can be considered for use in the truck turnaround pad expansion and associated roadwork as shown in **Figure 3**, or for use in the solid

waste site as cover material. The use of this material should be limited to areas surrounding the lagoon site and solid waste facilities outside of the community.

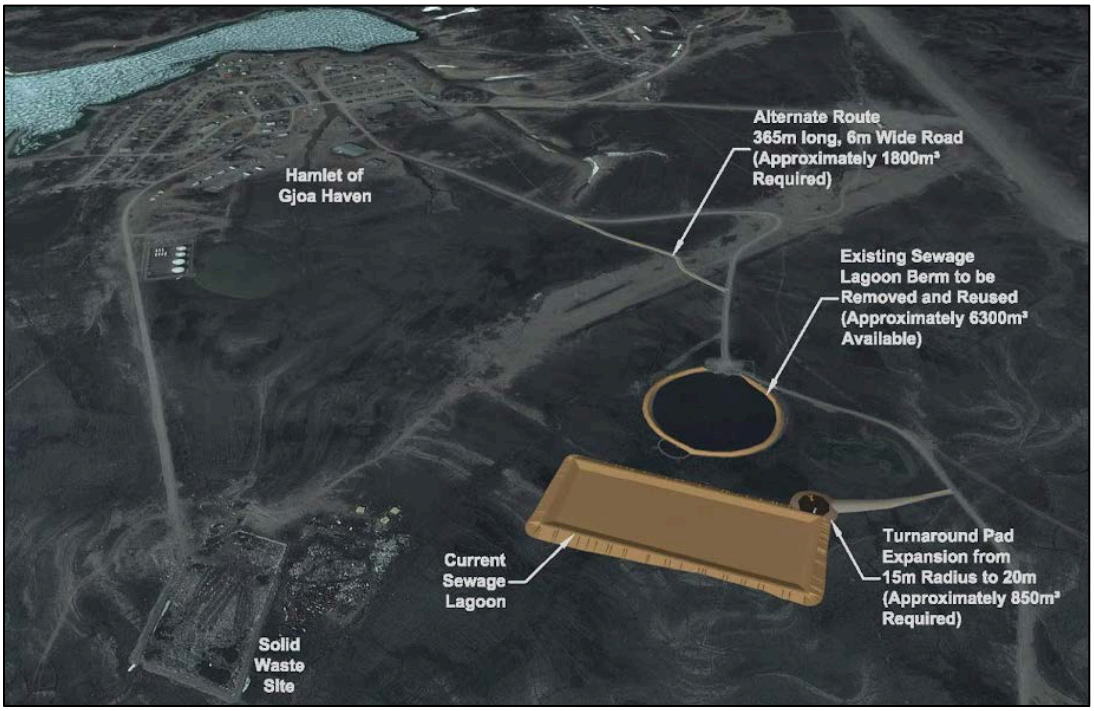

Figure 3: Proposed works for turnaround pad expansion and service road

In August 2014, discharge of the lagoon effluent was commenced along with relocation of the berm material for the planned truck turn-around pad expansion and localized road improvements within the sewage treatment site (**Photo 7 & Photo 8**). Approximately 850 m^3 of sandy gravel material was relocated from the site for the turnaround pad, and 1800 m^3 for the road.

Photo 7: a – Removal of berm material at north end of site, b – Graded berm at north end of site

A B

Photo 8: a – Removal of clean berm material at south end of site, b - Preparing for truck turnaround expansion at the new lagoon site.

As per AANDC directives, any of the berm material used in the construction of the new turn-around pad and road will be repatriated and stockpiled adjacent to the former lagoon site as soon as weather permits at the beginning of construction season 2015 (refer to **Section 3.5**, Granular Material Reuse).

3 CLOSURE

The former sewage lagoon will be closed in an environmentally responsible manner in order to mitigate health and safety risks to the community residents, according to sewage lagoon and reclamation technical practices northern climates and applicable regulatory regimes in Nunavut.

3.1 Regulatory Guidelines

The Government of Nunavut DOE has no published standards for lagoon A&R. Past practice has been to apply CCME guidelines, in the absence of published Nunavut standards. Accordingly, the Nunavut Water Board guidelines for the discharge of domestic wastewater in Nunavut provide some guidance on the proper treatment, management and disposal of sewage sludge. The GN has existing guidelines for waste discharge remediation criteria, however, the most recent revisions of the guidelines for waste discharges may not be suitable choice for lagoon discharge criteria because it is intended for the management of industrial wastes (refer to the 2002 Government of Nunavut Environmental Guideline for Industrial Waste Discharges, and the 2014 revision titled "Environmental Guideline for Industrial Waste Discharges into Community Solid Waste and Sewage Treatment Facilities").

It has been determined that the criteria for category 'B' compost specified in Section 3 of the 2005 Canadian Council of Ministers (CCME) of the Environment "Guidelines for Compost Quality" is a more appropriate sewage sludge discharge criteria, as it is applicable to the disposal of recovered sewage sludge. Hence, the remediation criteria for the disposal of sewage sludge described herein will be in accordance with the most recent revisions of the aforementioned guidelines set forth by the CCME and the NWB, and will be in compliance with the Hamlet's municipal water licence.

The FSC report Abandonment and Restoration of Sewage Lagoons in Nunavut, March 2005, outlines various methods for sludge disposal. The most allocable method described in that report for Gjoa Haven is Landfilling (surface spreading).

3.2 Treatment Method

In the north, available reclamation technologies in common practice are limited primarily due to climate, material and equipment. The treatment method recommended for the former lagoon in Gjoa Haven, NU is a hybrid process focussing on natural biological degradation though freeze-thaw conditioning.

Typically, lagoon sludge tends to accumulate in the bottom of the lagoon and unless brought to the surface and exposed to a warm environment, the sludge remains with low biological activity and retains a high organic content. Heavy metal and most organic contaminants are not treated and may become concentrated in the stabilization process. Additionally, a high organic content in the sludge provides the potential for pH fluctuations, thus, increasing the potential for mobilizing metals. Natural processes will, over time, reduce pathogenic organisms to acceptable levels.

In order to increase biological activity and stimulate degradation, the lagoon effluent will be discharged and the water excluded from the site. The sludge in the former lagoon will be exposed to air while confined to the former lagoon bed, and allowed to freeze over the winter. As the sludge thaws in the

spring, water contained within the sludge will evaporate or will be decanted as needed. Effluent samples will be collected and analyzed in accordance with the requirements set forth in the water licence prior to any decanting. Once fully thawed and dried (anticipated for fall 2015), the de-watered sludge will be tested to determine if it meets the required guidelines for its intended use. If it does not meet the guidelines, the sludge can remain in the lagoon bed for another freeze-thaw cycle.

Once the sludge has reached acceptable quality levels, it can be landfilled on-site using the existing lagoon berm material as cover. Through the on-site activities in 2014, the old lagoon site has been converted into a sludge drying bed for treatment of sludge. Further, the completed A&R works of the old lagoon could be used for a sludge treatment area for the new lagoon. If the new lagoon is de-sludged on a regular basis (approximately every 3 – 5 years), a number of benefits will occur. These benefits may include more efficient treatment of sewage effluent in the lagoon, less sludge to treat at one time, less drying bed space required and a consistent source of cover material for the solid waste site.

3.3 Effluent Treatment and Disposal from Former Lagoon

The effluent from the former lagoon was discharged in August 2014. Prior to discharge, the effluent was sampled in accordance with the Water Licence (3BM-GJO1318, Type "B"), Part D, 2 (**Table 1** below), and the results were submitted to the Nunavut Water Board. Refer to **Appendix B** for the results of the effluent analysis.

Table 1: Quality Standards for Effluent Discharged to Wetlands

Parameter	Maximum Average Concentration
BOD_5	80 mg/L
Total Suspended Solids	100 mg/L
Fecal Coliforms	$1x10^4$ CFU/dl
Oil and Grease	No visible sheen
pH	Between 6 and 9

Any effluent still remaining in the lagoon will be left in the lagoon until spring 2015. Leaving effluent in the lagoon will expose it to freeze-thaw processes that will allow for some physical treatment such as settling of solids to occur. Once the effluent thaws in the spring and is exposed to warmer temperatures, biological activity in the lagoon will increase and further treatment of effluent will occur.

Any further effluent discharge will undergo the same sampling procedure, in accordance with the Water Licence, Part D, 2. Decant should occur at a controlled rate so as not to overwhelm vegetation within the wetland. The wetland will be able to provide better polishing through greater nutrient uptake and removal from the effluent. Once all the effluent has been removed from the former lagoon bed, the remaining sludge layer will be exposed to air for further biological treatment and volume reduction.

3.4 Sludge Removal and Disposal

3.4.1 Landfilling

The recommended method of sludge disposal for the former lagoon is landfilling. The landfilling method will involve the following:

- Sampling of faecal coliforms, metals, hydrocarbons and nutrients in effluent and sludge prior to disposal.
- Release/discharge the wastewater (effluent) and disposal adjacent wetland. Nutrients should not be a problem for a summer time tundra discharge.
- Using the existing old lagoon site as the approved sludge landfill site.
- Pushing the berms in over the sludge, levelling the lagoon cell to promote positive drainage off the cell area.

3.4.2 Criteria

The sludge will be disposed by incorporating it into the soil, taking into consideration the future land use of the disposal site. Generally, this means compliance with the Guidelines published by Canadian Council of Ministers of the Environment (CCME). Criteria for land applied sludge are as follows:

1. *Sludge must be considered stabilized by having a ratio of volatile suspended solids (VSS) to total suspended solids (TSS) of less than 0.6.*

2. *Must have less than 100mg/L of the following substances:*

Ammonia sulphide	Maleic anhydride
Benzidine	Methylamine
Benzyl chloride	Potassium Permanganate
Diethylamine	Quinoline
Ethylamine	Strychnine
Ethylenediamine	Tetrachloroethanes

3. *Must have less than 0.001mg/L of the following substances:*

Hexachloro-dibenzo-p-dioxins
Pentachloro-dibenzo-p-dioxins
Dichlorobenzodioxinstetrachloro-dibenzo-p-dioxins
Hexachloro-dibenzofuranspentachloro-dibenzofurans
Tetrachloro-dibenzofurans

4. *Must meet microbiological requirements for applying sewage sludge to the land:*
    - **Type 1** sludge may be applied to the land for immediate residential / parkland use, or public contact with some restrictions (refer to FSC, 2005).

Organism	**Maximum acceptable concentration**
Faecal coliform	1000 CFU / gram Total Dry Solids
Salmonella	3 MPN / 4 grams Total Dry Solids
Viruses	1 PFU / 4 grams Total Dry Solids
Helminth ova	1 ova / 4 grams Total Dry Solids

- **Type 2** sludge is the minimum level of microbiological reduction for land application and is only acceptable for immediate use on commercial / industrial land, with some restrictions (refer to FSC, 2005).

Organism	Maximum acceptable concentration
Faecal coliform	2,000,000 CFU / gram Total Dry Solids

- **Type 3** sludge is sewage sludge that does not qualify as Type 1 or Type 2 sludge and cannot be land applied. Type 3 sludge may be placed in a solid waste site or landfarm approved by the Water Board.

These criteria are stated as per the FSC report Abandonment and Restoration of Sewage Lagoons in Nunavut, March 2005 and are consistent with CCME guidelines.

CCME Criteria for Category B Compost

The CCME category B compost (restricted use) guidelines (as per the CCME "Guidelines for Compost Quality", 2005) for trace elements and pathogen limits may also be suitable licence requirements, as follows:

- Maximum trace element limits in category B compost:

Trace Elements	Category B Compost (mg/kg, air-dried mass)
Arsenic (As)	75*
Cadmium (Cd)	20
Cobalt (Co)	150
Chromium (Cr)	**
Copper (Cu)	**
Mercury (Hg)	5
Molybdenum (Mo)	20
Nickel (Ni)	180
Lead (Pb)	500
Selenium (Se)	14
Zinc (Zn)	1850

- The pathogenic organism content must not exceed the following limits:
  - the quantity of faecal coliforms must be < 1,000 Most Probable Number (MPN)/g of total solids calculated on a dry weight basis; and
  - there can be no salmonellae present (< 3 MPN/4g total solids).

3.5 Granular Material Reuse

As per AANDC directives, any of the berm material used in the construction of the new turn-around pad and road will be repatriated and stockpiled as soon as weather permits at the beginning of construction season 2015. Material will be stockpiled adjacent to the former lagoon in a dry, high-laying area until the sludge in the lagoon bed is deemed remediated. **Figure 4** shows a proposed stockpile area as well as the volume and movement of the material to be repatriated.

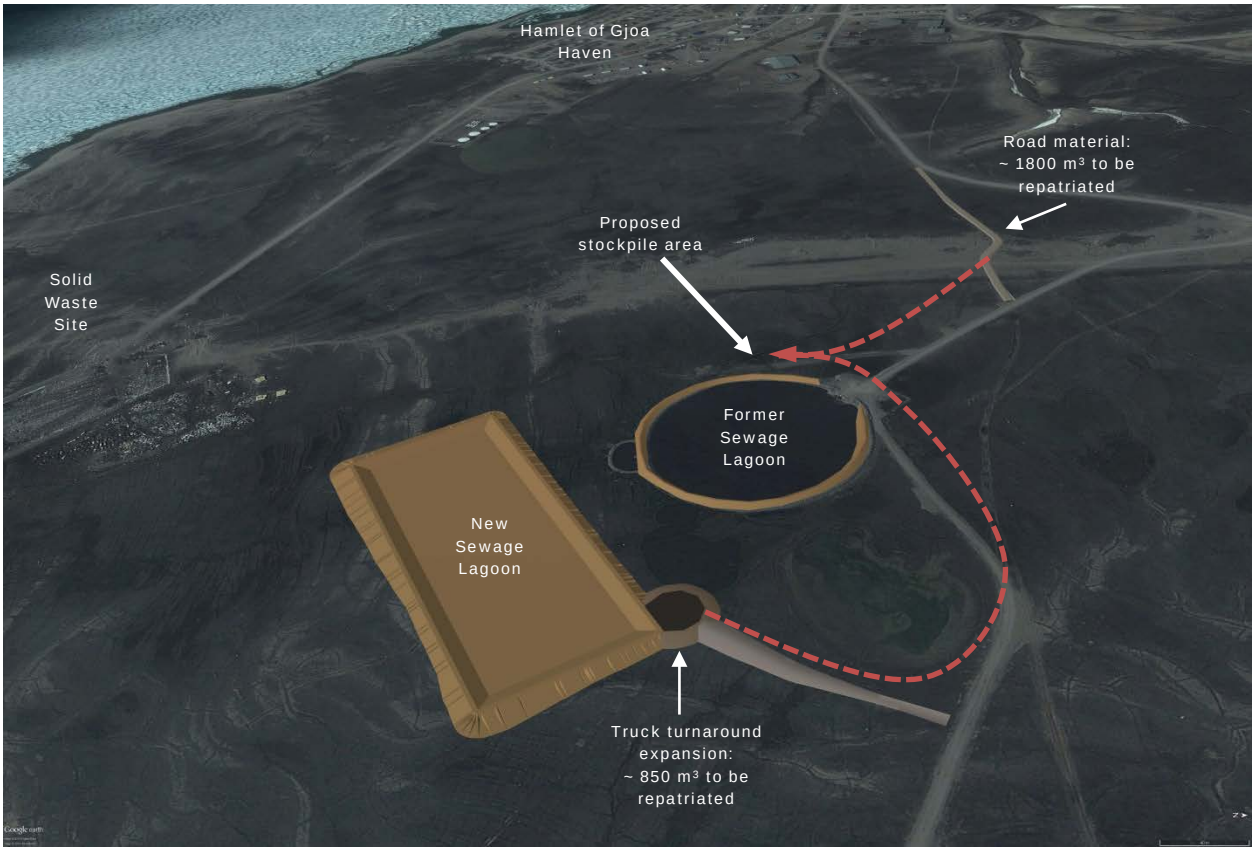

Figure 4: Proposed stockpile area and material to be repatriated

Once the sludge in the former lagoon bed meets the remediation criteria for land application, we propose that the existing berm and stockpiled material be removed and deposited in the bottom of the lagoon as fill, thereby reducing the required material to rehabilitate the facilities. The remediated lagoon sludge can safely be disposed by incorporating it with the sandy berm material for land disposal, as described in **Section 3.4.2**. The former lagoon bed should be filled to a minimum 2 % grade. The proposed finished grade shall result in the lagoon base being higher than the surrounding tundra, thus preventing pooling at the site.

Any additional fill material shall be well graded material with a maximum aggregate size of 200 mm and shall be placed in layers with a maximum depth of 300 mm. The material should be spread in 300mm lifts by a bulldozer to obtain a final compaction rate of at least 80% standard Proctor.

3.6 Monitoring Program and Annual Reporting Requirements

3.6.1 Effluent

Effluent from both the former and new lagoon sites discharged to the surrounding wetland must meet the requirements of the Nunavut Water Board. As per the requirements of the hamlet's current water licence (3BM-GJO1318, Type "B"), Part D, Item 2 (as shown in **Table 1**, above) and the results submitted to the Nunavut Water Board.

The former lagoon was subjected to a final discharge of effluent in August 2014. Effluent sample testing was conducted prior to discharge of lagoon effluent and should continue as per the requirements of the water licence until all effluent has been discharged from the lagoon.

Sewage from the community is currently being brought to the new lagoon for treatment and storage. Effluent from the new lagoon may need to be discharged over the summer and fall as well. Both the new and former sewage lagoons share the same wetland area, therefore it will be very important to discharge both lagoons at a slow steady rate for the duration of the summer and fall. Monitoring of the secondary polishing action of the wetland will be done according to the standards specified in the Operations and Maintenance Manual for the new sewage lagoon. Effluent discharged from the new lagoon must also meet the requirements stated in Part D, Item 2 of the water licence.

As per the requirements of the water licence, monthly water quality sample results from the former sewage lagoon to the receiving wetland environment must be monitored during the months of May to August, inclusive. Part H, Item 2 indicates the following monitoring program station for the sewage disposal facility (**Photo 9**):

Monitoring Program Station Number	Description	Frequency	Status
GJO-4	Effluent final discharge point from sewage disposal facility	Monthly (May – August)	Active (quality)

Photo 9: Monitoring station GJO-4 during discharge of former lagoon in August 2014

Monitoring SNP GJO-4 at the end of wetland ensures the effluent final discharge to ocean in compliance with DFO regulation and EC guidelines. Part H Item 4 of the water licence requires samples taken at GJO-4 to be analyzed for the following parameters:

BOD	Faecal Coliforms
pH	Conductivity
Total Suspended Solids	Ammonia Nitrogen
Nitrate-Nitrite	Oil and Grease (visual)
Total Phenols	Sulphate
Sodium	Potassium
Magnesium	Calcium
Total Arsenic	Total Cadmium
Total Copper	Total Chromium
Total Iron	Total Lead
Total Mercury	Total Nickel
Total Zinc	

As stated in the water licence, all sampling, sample preservation and analyses must be conducted in accordance with methods prescribed in the current edition of Standard Methods for the Examination of Water and Wastewater, or by such other methods approved by the Nunavut Water Board in writing. All analyses shall be performed in a laboratory accredited by the Canadian Association for Laboratory Accreditation (CALA) according to ISO/IEC Standard 17025, whose accreditation is current and in good standing.

3.6.2 Sludge

Sludge monitoring will include visual inspections of the sludge layer, visual inspections of effluent and sample analysis of the de-watered sludge according to the parameters stated in **Section 3.4**.

The former lagoon bed should be inspected regularly to check for leakage of effluent or sludge and to assess when sludge is undergoing freeze-thaw conditioning.

Sampling of de-watered sludge should only be necessary after the first freeze-thaw conditioning cycle has been completed (summer 2015). If the results of the sampling meet the requirements specified by the CCME for land disposal (outlined in **Section 3.4.2**), the sludge can be incorporated with the sandy berm material and used to fill the former lagoon bed. Alternatively, the sludge can be removed from the old lagoon bed and used in the landfill as cover material. Results from the sampling of the de-watered sludge will be provided to the NWB prior to moving any of the sludge for final disposal.

3.7 Inspections

Inspection of the old lagoon bed is necessary to ensure there are no leaks in the system. This is required periodically over the summer months while the sludge is drying. This inspection can be completed by hamlet staff. If hamlet staff identify any leaks or other problems with the system, the SAO must be immediately notified. Further actions must be effected according to the protocol described in the Spill Contingency Plan.

A report detailing the findings of each inspection and sample analysis results will be prepared and sent to the NWB on an annual basis. The report will include the following items:

- Timeframe of inspections;
- Frequency of inspections;
- Items inspected including drainage issues, erosion control problems, vegetative growth, etc.;
- Measures taken to correct site issues or problems;
- Regulatory compliance requirements such as SNP monitoring locations and test parameters; and,
- Results of effluent sampling at SNP monitoring locations;
- All observations noted during the inspection.

The AANDC inspector will provide further direction as to what items will be inspected, what time of year and frequency of inspections.

3.8 Infrastructure Removal and Signage

When the effluent and sludge has been removed from the lagoon, the lagoon can be decommissioned and repurposed. Infrastructure removal at the site will be limited to removal of the existing lagoon berms and discharge pipe. Material from the berms can be used to cover over the lagoon and grade the site. In order to promote soil stability, the area should be seeded with natural vegetation. Depending on the nature of the soil, topsoil or soil amendments may be required in order to support vegetative growth.

There are no buildings at the site of the former sewage lagoon. The truck discharge chute and outflow pipe will be removed from the site and disposed of in the solid waste facility (**Photo 10**). Signs for the newly constructed site will be erected. Existing signs from the former lagoon must be taken down and replaced with signs to notify the public that the site is closed. New signs are also required to indicate the

location of the new facility where the sewage will now be received. Any old signs, fencing and gates will be removed and disposed of in the solid waste facility.

Photo 10: Truck discharge chute and structures to be removed from the former lagoon site.

3.9 Implementation Schedule

The proposed schedule for the decommissioning of the existing sewage treatment facility is shown in Table 2 below.

Table 2: Lagoon Decommissioning Implementation Schedule

Item	Proposed Completion Date
Commissioning of new sewage treatment facility	November 2013
Commence decommissioning of existing sewage treatment facility – gradual discharge of effluent	Summer/Fall 2014
Sampling of de-watered sludge	July 2015
Mixing of the sludge and cover material	August 2015
Leveling of berms of the old lagoon cell and final grading	August/September 2015
Full decommissioning of the site complete	Fall 2015 (*)

*** NOTE: This schedule is tentative. Full decommissioning of the site will be contingent on the sludge sample results and may require an extension into the 2016 construction season.**

3.10 Registration

Upon closure of the facilities, the site will be identified and registered as a former Sewage Treatment Facility on the subsequent land title documents associated with the property.

3.11 Future Land Use

The sewage lagoon site is located in the same area as the solid waste site and the new sewage lagoon site. Once closed, the land area of the former sewage disposal site will continue to be part of the wastewater disposal site. However, the former sewage lagoon site will be monitored to ensure the growth of vegetation. Cover material will be allowed to settle and be re-graded as necessary. All cave-ins will be filled to prevent pooling. Because the area will continue to accommodate the solid waste site and the new sewage lagoon, there are no future plans for the land utilized by the former sewage lagoon.

The old lagoon site could potentially be turned into a sludge drying bed for treatment of sludge from the new lagoon as it builds up. If the new lagoon is de-sludged on a regular basis (approximately every 3 – 5 years), a number of benefits will occur. These benefits may include more efficient treatment of sewage effluent in the lagoon, less sludge to treat at one time, less drying bed space required and a consistent source of cover material for the solid waste site.

A final survey of the site should be performed to map out the exact area of the facility. The mapping will show areas of the site facilities, potential contamination, disturbed areas and monitoring locations.

4 POST CLOSURE

Following final closure of the site, periodic inspection and monitoring will be required to ensure that there are no intentionally harmful impacts to the environment. To prevent or mitigate potential environmental impacts generated from the sewage treatment facility site, testing and reporting for parameters of concern will be required until the regulatory bodies deem the site has reached a point where no long term environmental impacts will likely occur.

4.1 Inspection checklist

Inspection of the old lagoon site will be required periodically by Hamlet staff. A checklist is shown in the table below. Corrective actions `are suggested to deal with any potential issues. If hamlet staff identify any leaks or other problems with the system, they must immediately contact the SAO who will determine the appropriate course of action based on the Spill Contingency Plan.

Table 3: Post-Closure Inspection Checklist

Task	Timeframe	Corrective Actions
Check for signs of erosion and areas of no vegetative growth.	Spring/Summer	• Fill in and compacted areas of erosion • Re-grade area as necessary • Re-seed with native vegetation as necessary
Check old lagoon site for leaks.	Spring/Summer	• Report leaks to the NWB and AANDC, follow directions provided.
Sample sludge from old lagoon bed	Once in the Fall or as determined by the NWB	• With approval from the NWB, sludge meeting quality criteria may be applied to land or used in the solid waste site as cover material. Sludge not meeting quality criteria must remain in the sludge beds until quality criteria has been achieved.

4.2 Monitoring

The sampling programs for both the effluent and sludge are described in Section 3.5. According to FSC (2005), following closure of the site, monitoring will continue until either of the following conditions are met:

- It can be demonstrated that the site is no longer releasing contaminants; or
- It can be demonstrated that the site has reached an equilibrium state in which contaminant release poses no unacceptable risk to the environment.

Once it is believed that either of the above conditions has been satisfied, a report providing justification to discontinue the monitoring program should be submitted to the NWB for review. The monitoring program cannot be discontinued until approval to do so has been provided by the regulatory authorities.

4.3 Regulatory Requirements

The Abandonment and reclamation plan has been completed in accordance with the hamlet's former water licence issued by the NWB. Changes to the licence may result in changes to the Abandonment and Reclamation plan. The *Abandonment and Restoration of Sewage Lagoons in Nunavut* (FSC, 2005) was used as an additional guideline.

REFERENCES

1. FSC Architects & Engineers (2005). *Abandonment and Restoration of Sewage Lagoons in Nunavut, Final Review Report*. Yellowknife, NT.
2. Canadian Council of Ministers of the Environment. *Guidelines for Compost Quality*. Reference #PN1340. ISBN 1-896997-60-0. 2005.
3. Government of Nunavut Department of Sustainable Development Environmental Protection Service (2002). Environmental Guideline for Industrial Waste Discharges. Yellowknife, NT.
4. Government of Nunavut Department of Sustainable Development Environmental Protection Service (2014). Environmental Guideline for Industrial Waste Discharges into Community Solid Waste and Sewage Treatment Facilities. Yellowknife, NT.
5. Government of Nunavut, Department of Sustainable Development (revised 2002). Guideline for the General Management of Hazardous Waste in Nunavut. Iqaluit, NU.
6. Nunavut Water Board (2000) Guidelines for the Discharge of Domestic Wastewater in Nunavut. Yellowknife, NT.

APPENDIX A:

AANDC Comments and Communications

Your file - Votre reference
3BM-GJO1318

September 5, 2014

Our file - Notre reference
IQALUIT-#843008

Robin Ikkutisluk
Licensing Administrative Assistant
Nunavut Water Board
GJOA HAVEN, NU X0E 1J0

Re: Aboriginal Affairs and Northern Development Canada Review of the Hamlet of Gjoa Haven's Proposed Abandonment and Reclamation Plan for their Former Sewage Lagoon, Water Licence #3BM-GJO1318

Dear Ms. Beaulieu:

Thank you for your email of August 6, 2014, concerning the above mentioned Abandonment and Reclamation Plan. A memorandum is provided for the Board's consideration. Comments and recommendations have been provided pursuant to Aboriginal Affairs and Northern Development Canada's mandated responsibilities under the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* and the *Department of Indian Affairs and Northern Development Act*.

Please do not hesitate to contact me by telephone at 867-975-4555 or email at david.abernethy@aandc-aadnc.gc.ca for further information.

Sincerely,

David Abernethy
Regional Coordinator
Water Resources Division
Resource Management Directorate
Aboriginal Affairs and Northern Development Canada
IQALUIT, NU X0A 0H0

Encl.

c.c.: Andrea Morgan, A/Manager of Water Resources, AANDC Nunavut
Erik Allain, Manager of Field Operations, AANDC Nunavut

Memorandum

To: Robin Ikkutisluk, Nunavut Water Board

From: David Abernethy, Aboriginal Affairs and Northern Development Canada

CC: Andrea Morgan (AANDC) and Erik Allain (AANDC)

Date: September 5, 2014

Re: Review of Proposed Abandonment and Reclamation Plan for Former Sewage Lagoon, #3BM-GJO1318

Licensee: Hamlet of Gjoa Haven
Project: Municipal water licence
Region: Kitikmeot

Comments:

A. Background

On August 5, 2014, the Nunavut Water Board (**"NWB"**) provided notification that it had received an Abandonment and Reclamation Plan for the Hamlet of Gjoa Haven's (**the "Licensee"**) former sewage lagoon from the Government of Nunavut's Department of Community and Government Services on the Hamlet's behalf. This plan was submitted pursuant to Part G, Item 1 of the Hamlet of Gjoa Haven's municipal water licence, #3BM-GJO1318.

Interested parties were asked to review this application and provide comments by September 6, 2014.

B. Results of review

On behalf of Aboriginal Affairs and Northern Development Canada (**"AANDC"**), the following comments and recommendations are provided:

1.	**Engineering Design Requirements for the Construction of Sludge Drying Beds, Leachate Collection System, etc.** **Comment:** The proposed Abandonment and Reclamation Plan does not include construction drawings stamped and signed by a Professional Engineer for the planned sludge drying beds, leachate collection system, and associated project components. These drawings are needed to allow for an understanding of the planned sludge management system. Following the construction of these structures, the Licensee should provide a Construction Summary Report along with as-built plans and drawings in accordance with licence requirements. **Recommendation:** Pursuant to Part E, Item 1 of the Licence, the Licensee should submit to the NWB for approval construction drawings stamped and signed by a qualified Engineer registered in Nunavut at least 60 days prior to the commencement of any construction of the sludge drying beds,

	leachate collection system, and other associated project components. These drawings should demonstrate how the structures will prevent migration of contaminants to groundwater and surface water. Furthermore, pursuant to Part E, Item 4 of the Licence, the Licensee should submit to the NWB a Construction Summary Report along with stamped as-built plans and drawings providing explanation to reflect any deviation from the construction drawings taking into account construction and field decisions and how they may affect the performance of the engineered facilities.
2.	**Sludge Drying Beds and Leachate Collection System Information Requests** **Comment:** Section 3.2 of the proposed Abandonment and Closure Plan states that sludge will be removed from the former sewage lagoon and placed on a sand layer within drying beds where it will freeze during the winter months and thaw during the following spring and summer seasons. As the sludge thaws, "water contained within the sludge will drain through the sand layer and be collected via a collection pipe." This leachate will be subsequently directed to the Hamlet's new sewage lagoon for additional treatment. Details pertaining to the design of the sludge drying beds and leachate collection system are not included in the application. **Recommendation:** The Licensee should provide the following information with respect to the design of the sludge drying beds and leachate collection system as an addendum or revision to the Abandonment and Reclamation Plan: a. hydrogeological study results, including soil characteristics and hydraulic conductivity of existing soils where the sludge drying pads will be constructed; b. sludge characteristics showing contaminant types; c. technical specification of sand/filter material; d. leachate collection system (under the drying pads) details; e. setback of sludge treatment system from surrounding water bodies; and f. materials and methods that will be used for the proposed construction activities
3.	**Alternate Sludge De-watering Techniques** **Comment:** Section 3.4.2 of the 2005 FSC Architects & Engineers Report referenced in the Abandonment and Reclamation Plan, *Abandonment and Restoration of Sewage Lagoons in Nunavut*[1], proposes an alternative to drying beds for de-watering sludge: leave the sludge within its existing containment area (i.e., the former sewage lagoon) following the removal of effluent. Allow the sludge to freeze over the winter and remove it either the next summer, or the next winter after it re-freezes. Provided that effluent released from the de-watered sludge is managed according to licensed effluent discharge quality limits, this may be a viable option for dewatering sludge. **Recommendation:** The Licensee should consider the practicality of de-watering sludge from the former sewage lagoon by allowing it to freeze-thaw in place as described in the 2005 FSC Architects & Engineers report titled, *Abandonment and Restoration of Sewage Lagoons in Nunavut*.

[1] FSC Architects and Engineers. *Abandonment and Restoration of Sewage Lagoons in Nunavut, Final Report*. Prepared for Aboriginal Affairs and Northern Development Canada. Project # 2004-1180. March 8, 2005.

4.	**Annual reporting requirements** **Comment:** Sections 3.4.1, 3.4.2, and 4.2 of the proposed Abandonment and Reclamation Plan identify monitoring activities that should be followed when reclaiming the former sewage lagoon. These include: • the quality of effluent reporting form the former sewage lagoon to the surrounding wetland; • visual inspections of the sludge drying beds; • visual inspections of effluent collection basins; and • sample analysis of de-watered sludge. **Recommendation:** All monitoring information collected as part of the former sewage lagoon's reclamation, including the operation of the sludge drying bed and leachate collection system should be included in annual reports submissions to the NWB pursuant to Part B, Item 1 of the licence. At a minimum, the following information should be provided: • When applicable, monthly water quality sample results of effluent released from the former sewage lagoon to the receiving environment (must satisfy Part D, Item 2 and Part H, Item 2 of the licence); • Inspections of sludge drying beds, inspections of effluent collection basins, and sample analysis of dewatered sludge o As stated in section 3.4.2 of the plan, sludge drying beds and collection basins should be monitored regularly to check for leakages of effluent of sludge from the beds and to assess when sludge is undergoing freeze-thaw conditioning. Effluent collection basins should be inspected regularly once the sludge begins to thaw.
5.	**Sludge Remediation Criteria** **Comment:** Section 3.4.2 of the Abandonment and Reclamation Plan provides remediation criteria for sludge to be used as a landfill cover material. This criteria is drawn from a 2005 FSC Architects and Engineers report that was prepared for AANDC, titled, *Abandonment and Restoration of Sewage Lagoons in Nunavut, Final Report*.[2] The proposed remediation criteria is only a portion of the remediation criteria summarized in the report that was sourced from the *Guidelines for the Discharge of Domestic Wastewater in Nunavut* (dated 2000). Although a copy of these guidelines cannot be located, the remediation criteria is consistent with those included in the 2002 Government of Nunavut *Environmental Guideline for Industrial Waste Discharges*.[3] This guideline was subsequently revised in April 2011 and April 2014. The April 2014 revision is titled *Environmental Guideline for Industrial Waste Discharges into Community Solid Waste and Sewage Treatment Facilities*.[4] The Government of Nunavut guideline may not be a suitable choice for selecting discharge criteria because it is intended for the management of industrial wastes. The 2014 revision defines process residuals as "solid, semi-solid or sludge waste resulting from an industrial operation" (i.e., not domestic sewage sludge) and defines solid waste as "not including biomedical waste, hazardous waste, or sewage sludge."[5]

[2] Ibid.
[3] Government of Nunavut, Department of Sustainable Development. *Environmental Guideline for Industrial Waste Discharges*. Prepared by the Environmental Protection Service. January 2002.
[4] Government of Nunavut, Department of Environment. *Environmental Guideline for Industrial Waste Discharges into Community Solid Waste and Sewage Treatment Facilities*. April 2014.
[5] Ibid, p. 2.

	Alternate sewage sludge discharge criteria should be considered. The criteria for category 'B' compost specified in Section 3 of the 2005 Canadian Council of Ministers (CCME) of the Environment *Guidelines for Compost Quality*[6] is more reasonable because it is applicable to the disposal of recovered sewage sludge. Category 'A' compost can be used in any application, such as agricultural lands, residential gardens, horticultural operations, the nursery industry, and other business. Category 'B' compost is for restricted use because of the presence of foreign matter and/or higher trace elements. Section 2.2 the 2005 FSC Architects and Engineers references criteria that are consistent with the CCME guidelines. **Recommendation:** The category 'B' compost criteria presented in Section 3 of the 2005 CCME *Guidelines for Compost Quality* should be considered for the remediation of recovered sewage sludge. More specifically, the criteria for: • trace elements in compost and cumulative trace element additions to soil; and • pathogen limits (fecal coliforms and salmonella) may be suitable licence requirements.

Prepared by David Abernethy and Amjad Tariq

[6] Canadian Council of Ministers of the Environment. *Guidelines for Compost Quality*. Reference # PN1340. ISBN 1-896997-60-0. 2005

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Building Nunavut Together
Nunavuliuqatigiingniq
Bâtir le Nunavut ensemble

Nunavut

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Department of Community and Government Services
Nunalingni Kavamatkunnilu Pivikhaqautikkut
Ministère des Services Communautaires et gouvernementaux

Date: September 30, 2014

To: Andrew Keim, Inspector, Aboriginal Affairs and Northern Development Canada (AANDC)

From: Kevin Niptanatiak, Regional Director, Community and Government Services (CGS)

Re: Response to AANDC Inspector's Direction report dated August 26th 2014

Location: Gjoa Haven , NU

GN Project # 10-4008 – Gjoa Haven Waste Treatment Facilities

Mr. Keim,

As per the directives to the Government of Nunavut (GN) stated in the Letter of Direction issued on August 26th, 2014, we plan to complete the required works related to these orders. However, due to the arrival of winter in Gjoa Haven, NU, the construction season and availability of equipment and labour is limited. Hence, we propose to initiate the following measures as soon as weather permits in 2015:

- To rectify existing non-compliance with the water licence.
- To repatriate all contaminated soils to their original location.
- To complete the closure of the old sewage lagoon according to the measures cited in an approved abandonment & restoration plan.

We are currently in the process of reviewing the Hamlet's existing abandonment and restoration plan for the former lagoon site and the newly commissioned lagoon. In the next two weeks (Tuesday 14th October), we will submit a revised abandonment and restoration plan which will respond to all amendments noted during a discussion with the inspector and further comments and recommendations provided in a written communication from AANDC. Moving forward, we trust that these actions will be deemed suitable to fulfill the requirements of the aforementioned directives as we work together towards a successful resolution to this process.

Please be advised that we intend to provide a response by October 1st to item d of your letter dated 26th August 2014.

(d) To develop and submit a report to me, Andrew Keim, or a successor AANDC Water Resources Officer, in writing, no later than October 1, 2014 on the Government of Nunavut' s Plan to address this further occurrence of Non-compliance in a community already under an earlier Direction to achieve compliance with an issued Water License.

Respectfully,

Kevin Niptanatiak, Regional Director, CGS

CC: Shane Slifka, Regional Project Manager | CGS
Shawn Stuckey, Senior Administrative Officer, Gjoa Haven
Phyllis Beaulieu, Manager of Licensing, NWB
Ralph Ruediger, Director of Community Development

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APPENDIX B:

Effluent Analysis Results

MEMO

TO: Stuart Rostant, Project Officer, Department of Community and Government Services, Government of Nunavut

CC: Phyllis Beaulieu, Manager of Licensing, Nunavut Water Board
Shah Alam, P. Eng., Municipal Planning Engineer, CGS
Andrew Keim, Inspector, AANDC

FROM: Gary Strong, P. Eng
DATE: September 8th, 2014
SUBJECT: Gjoa Haven, NU Old Lagoon Final Effluent Analysis
OUR FILE: 11-5029

Dillon Consulting Limited

4920 47th Street
Suite 303
Yellowknife, NORTHWEST TERRITORIES
X1A 2P1
Tel: 867.920.4555
Fax: 867.873.3328

OLD LAGOON SAMPLING

The results of the final supernatant sampling campaign executed on August 20th, 2014 for the old lagoon in Gjoa Haven, NU are summarized herein. Three supernatant grab samples were taken (one near the inlet, one near the middle and one near the outlet of the lagoon) and are reported as a composite to represent the effluent quality in the lagoon just prior to its scheduled final discharge. Sampling methodology was executed as per the water licence, Part D-2.

The analysis results for the old lagoon supernatant are shown in **Table 1** below, along with the relevant water licence criteria as recommended by the Nunavut Water Board (NWB).

TABLE 1: OLD LAGOON SUPERNATANT ANALYSIS RESULTS AND NWB CRITERIA

Parameter	Units	MDL	Measured Value (composite)	NWB Water Licence Criteria
Biochemical Oxygen Demand	mg/L	2	27.0 *	80 mg/L
Total Suspended Solids	mg/L	3	72.7	100 mg/L
Fecal Coliforms	CFU/100mL	1	< 10	1 x 10^4 CFU/dl
Oil and Grease	-	visual	Non-visible	No visible sheen
pH	pH units	-	9.0	Between 6 and 9

* The composite result for BOD_5 <21.73 mg/L, however, the lab reported BOD_5 results for samples Gjoa-02 and Gjoa-03 were deemed inconclusive due to insufficient depletion of sample during analysis. To be conservative, the above result is the value reported for sample Gjoa-1 only.

The results confirm that the lagoon supernatant sampled just prior to the scheduled berm breach of the old lagoon is well within the water licence criteria for all parameters of concern.

The lagoon supernatant was also analyzed for the parameters listed in Part H, item 4 of the water licence before breach. The results of this analysis are shown in **Table 2** below, and are

compared to CCME water quality guidelines (Protection of Aquatic Life, Protection of Agricultural Water Uses), the Health Canada Guidelines for Canadian Drinking Water Quality as well as Guidelines for the discharge of Treated Municipal Wastewater in the Northwest Territories (1992).

TABLE 2: OLD LAGOON SUPERNANT ANALYSIS RESULTS FOR PARAMETERS IN PART H, ITEM 4 OF THE WATER LICENCE

Parameter	Units	MDL	Measured Value	Water Licence Criteria	CCME/HC Water Quality Guideline	NWT Water Quality Guidelines
Inorganics, major Ions and organics						
Ammonia as N	mg/L	0.1	8.6	-	19	19
Calcium	mg/L	0.1	21.8	-	1000[1]	-
Magnesium	mg/L	0.01	19.0	-	200[2]	-
Nitrate+Nitrite as N	mg/L	0.1	0.11	-	60	60
Potassium	mg/L	0.1	28.5	-	-	-
Sodium	mg/L	1	109	-	200[2]	-
Sulphate	mg/L	0.1	16	-	-	500 000
Total Phenols	mg/L	0.001	0.0182	-	4	-
Trace Metals						
Arsenic	µg/L	0.2	1.2	-	12.5	50
Cadmium	µg/L	0.1	0.10	-	0.12	5
Chromium	µg/L	0.1	1.3	-	1.5	100
Copper	µg/L	0.2	11.9	-	200	200
Iron	µg/L	5	221	-	300	300
Lead	µg/L	0.1	0.4	-	1-7	50
Mercury	µg/L	0.01	0.01	-	0.026	.6
Nickel	µg/L	0.1	3.0	-	25-150	300
Zinc	µg/L	5	16.5	-	30	500

Guideline values are from Canadian Environmental Quality Guidelines for the Protection of Aquatic Life, CCME 2003, (Freshwater) unless indicated, as below:
[1] Canadian Environmental Quality Guidelines for the Protection of Agricultural Water (CCME 2003)
[2] Guidelines for Canadian Drinking Water Quality (Health Canada 1996)

The results for all parameters analyzed for the old lagoon supernatant were well within CCME recommended values for water quality, the Health Canada Guidelines for Canadian Drinking Water Quality as well as Guidelines for the discharge of Treated Municipal Wastewater in the Northwest Territories (1992).

It can be concluded that the effluent discharged from the old lagoon at this time is normal and within expected values, and is in compliance with water licence requirements and all applicable guidelines.

WETLAND SAMPLING

An additional effluent sample was taken at NWB monitoring station GJO-04, "Effluent Final Discharge Point from Sewage Disposal Facility" after breaching the lagoon berm to determine the quality of discharge at this point. This sample was analysed for all parameters as indicated in Part D, item 2 and Part H, item 4 of the water licence. Values were compared with CCME water quality guidelines (Protection of Aquatic Life, Protection of Agricultural Water Uses), the Health Canada Guidelines for Canadian Drinking Water Quality as well as Guidelines for the discharge of Treated Municipal Wastewater in the Northwest Territories (1992). **Table 3** below shows the results of the wetland effluent analysis along with the most sensitive or relevant guidelines.

TABLE 3: WETLAND EFFLUENT ANALYSIS RESULTS AFTER LAGOON BREACH

Parameter	Units	MDL	Measured Value	Water Licence Criteria	CCME/HC Water Quality Guideline	NWT Water Quality Guidelines
Nutrients and Physical characteristics						
BOD_5	mg/L	2	86	80 mg/L	80	80
TSS	mg/L	3	494	100 mg/L	100	100
Fecal Coliforms	CFU/100mL	1	4700	1×10^4 CFU/dl	10 000	10 000
Oil and Grease	-	visual	Non-visible	Non-visible	Non-visible	Non-visible
pH	pH units	-	8.16	6 – 9	6 – 9	6 – 9
Sp Conductivity	μS/cm	0.4	956	-	-	-
Inorganics, major Ions and organics						
Ammonia as N	mg/L	0.1	10.4	-	19	19
Calcium	mg/L	0.1	22.7	-	1000[1]	-
Magnesium	mg/L	0.01	19.6	-	200[2]	-
Nitrate+Nitrite as N	mg/L	0.1	1.90	-	60	60
Potassium	mg/L	0.1	32.5	-	-	-
Sodium	mg/L	1	113	-	200[2]	-
Sulphate	mg/L	0.1	19	-	-	50 000
Total Phenols	mg/L	0.001	0.0298	-	4	-
Trace Metals						
Arsenic	μg/L	0.2	20.2	-	12.5	50
Cadmium	μg/L	0.1	< 0.10	-	0.12	5
Chromium	μg/L	0.1	12.0	-	1.5	100
Copper	μg/L	0.2	35.1	-	200	200
Iron	μg/L	5	15000	-	300	300
Lead	μg/L	0.1	17.2	-	1-7	50

Mercury	µg/L	0.01	0.02	-	0.026	.6
Nickel	µg/L	0.1	10.4	-	25-150	300
Zinc	µg/L	5	65.6	-	30	500

Guideline values are from Canadian Environmental Quality Guidelines for the Protection of Aquatic Life, CCME 2003, (Freshwater) unless indicated, as below:

[1] Canadian Environmental Quality Guidelines for the Protection of Agricultural Water (CCME 2003)

[2] Guidelines for Canadian Drinking Water Quality (Health Canada 1996)

All parameters tested at NWB monitoring station GJO-04 were below the recommended Guidelines for the Discharge of Treated Municipal Waste Water in the Northwest Territories and Water Licence limits, with the exception of BOD_5 (exceeded by 7%) and TSS. It should be noted that at the time of sampling, the flow rate at the sampling site was higher than normal due to the recent breach of the lagoon berm, and would account for the high observed value for TSS.

Concentrations for arsenic, chromium, lead exceeded the CCME Guidelines for the Protection of Aquatic Life (2003), but were within the Guidelines for the Discharge of Treated Municipal Waste Water in the Northwest Territories. The reported iron concentration in the effluent at GJO-4 exceeded both the CCME and NWT water quality guidelines.

Yours sincerely,

DILLON CONSULTING LIMITED