Appendix J: Sewage and Solid Waste Disposal Facilities Abandonment and Restoration Plan

DILLON CONSULTING

HAMLET OF PAULATUK

Sewage and Solid Waste Disposal Facilities

Abandonment and Restoration Plan

November 2017 – 17-6028

November 29, 2017

Hamlet of Paulatuk
Box 98
Paulatuk, NT X0E 1N0

Attention: Mr. John Holland
Senior Administrative Officer

Re: Sewage and Solid Waste Disposal Facilities Abandonment and Restoration Plan

Dear Mr. Holland

Please find attached a copy of the final Abandonment and Restoration Plan for the Hamlet of Paulatuk's sewage and solid waste disposal facilities. This plan outlines the work required to close the landfill cells as they become full, maintain the bulky waste area and wastewater lagoon to extend their useable lifetimes and establishes guidelines for monitoring and inspecting the site during closure and post-closure.

Following your review and comments, we will update the plan and submit it on your behalf to the Inuvialuit Water Board (IWB). Please provide us a letter of acceptance to issue with this report to verify support of this document if this satisfies your requirements.

Should you have any questions or concerns, please contact me at gstrong@dillon.ca or by phone at 867.920.4555 ext. 4111.

Sincerely,

DILLON CONSULTING LIMITED

Gary Strong, P.Eng.
Partner

GS:cj
Attachment:

Our file: 17-6028

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1.0 Introduction

The Hamlet of Paulatuk's (Paulatuk) current water licence expires on November 20, 2020. The Inuvialuit Water Board (IWB) issued Paulatuk's current water licence renewal, #N7L3-1619, on November 15, 2015. The following Abandonment and Restoration (A&R) Plan is an update to the draft report prepared in 2015, and has been prepared to outline the work required to close the landfill cells as they become full, maintain the bulky waste area and wastewater lagoon to extend their useable lifetimes, and establish guidelines for monitoring and inspecting the site during closure and post-closure. In addition, procedures for the monitoring and upkeep of the health of the wastewater lagoon are described. This A&R Plan has been completed in accordance with the *Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the Northwest Territories* (Kent, Marshall, & Hawke, 2003).

2.0 Site Description

2.1 Location

Paulatuk is located in the Northwest Territories approximately 400 km east of the Town of Inuvik and 855 km northwest of Yellowknife. The community is situated at the south end of Darnley Bay on the Arctic Coast as shown in Figure 1. The 2016 population of Paulatuk was 327, the highest population in the community since annual tracking began in 2001. This represents a 1.9% increase since 2015, or an average annual growth of 0.6% (2005-2016). The population has fluctuated up and down over the past 15 years reaching a low of 303 individuals in 2006 (Bureau of Statistics, 2017a). The community is located in an area underlain by continuous permafrost and is dominated by glacial till in addition to marine sands and silt. The mean daily temperature in July is 10.8 °C and the mean daily temperature in January is -25.0 °C (Bureau of Statistics, 2017b). The Hamlet is not serviced by road access and supplies are only available via annual barges or by plane.

Paulatuk receives its drinking water from New Water Lake, which is trucked to residents' homes after being disinfected by sodium hypochlorite. The Hamlet has two water delivery trucks which run throughout the week providing the community with approximately 12,000 m^3 of drinking water per year (Hamlet of Paulatuk, 2017). The current water licence details a maximum annual withdrawal limit of 17,000 m^3 (IWB, 2015).

There is an abandoned solid waste disposal facility and wastewater discharge lagoon approximately 350 m west from the existing municipal area as shown in Figure 2. Odour issues and the construction of a new airport in 1993 led to the landfill and wastewater discharge being relocated to a site 2 km south of the abandoned site (Dillon Consulting Limited, 2009). The abandoned and active facilities both fall within the municipal boundaries of the Hamlet of Paulatuk. The abandoned facilities are not included in this plan, which focuses on the abandonment and restoration of the currently active facilities.

2.1.1 White Goods

In addition to the white goods that are in the unsorted bulky waste area, some have been sorted and are stored in a designated area to the west of the unsorted bulky waste area (Figure 6). White goods typically include large household appliances such as washing machines, dryers, freezers, fridges, stoves and hot water tanks. These products often have hazardous components such as mercury switches and refrigerants which must be removed and properly disposed of before the metal and other components can be recovered. Many of the white goods currently stored in the designated areas have not been adequately stripped of hazardous components, something that should be completed promptly for all white goods stored in the solid waste disposal facility.

2.1.2 End-of-Life Vehicles and Tires

There are currently numerous end-of-life vehicles (ELVs) and used tires stored in a designated area to the west of the mixed bulky waste area. As discussed in the SWDF O&M Plan, the ELVs should have all hazardous components stripped including batteries, refrigerants, fuel, oils, antifreeze, windshield washer fluid, and other lubricants. Procedures for stockpiling and disposing of these hazardous materials are detailed in the SWDF O&M Plan. Once all hazardous materials are adequately recovered, ELVs should be stored in a manner that allows for parts recovery by community residents in order to reuse components as required and available. Once adequate storage space is no longer available for stockpiling ELVs, Hamlet staff should arrange to have vehicles shipped to a proper recycling facility for further dismantling and disposal. In addition to passenger vehicles, there are several graders and tanker/vacuum trucks stored in the ELV area of the solid waste disposal facility. The Hamlet should contact the manufacturer of the various vehicles or metal recyclers that specialize in large equipment recycling to determine how best to dismantle them to ship south.

As discussed in the SWDF O&M Plan, used vehicle tires are not considered hazardous and can be stored above ground in a manner allowing for recovery by community residents as required and available. However, tires are susceptible to fire, which produces hazardous fumes so care must be taken to store tires far from ignition sources. Tires should also be stored to limit the amount of water collected in the tires. Standing water in tires can provide a breeding ground for insects. Once the quantity of tires surpasses available storage space, arrangements should be made to ship stockpiled tires south for recycling at a properly equipped facility. Photographs of the ELV and tire storage areas are shown in Figure 7 and Figure 8.

2.2 Solid Waste Disposal Facilities

There are currently no mining or other industrial activities in Paulatuk that would contribute industrial waste to the solid waste facility. Additionally there is not significant commercial activity in the community and the majority of the waste is from general municipal sources. Waste is collected twice per week by truck or more frequently as required such as during holidays. During a site visit on May 27, 2015, the solid waste disposal facility was found to contain the following categories of material:

- General municipal waste;
- Unsorted bulky waste;
- White goods;
- End-of-life vehicles (ELVs) and tires;
- Mixed metal (barrels, culverts, mixed metal, etc.); and
- Hazardous waste.

All materials are currently being stored and sorted above ground as shown in Figure 3. Several landfill cells within the current facility boundaries have been developed for general household waste to the west of the access road and have been filled in and covered. Final cover of these cells was completed in 2014. The specific design for the cap and cover of these completed cells on site could not be determined. It is known that neither cell was constructed with an engineered leachate collection system. Based on the May 27, 2015 site visit, the ground surface over these capped cells is flat to grade.

Historical site photos have shown the presence of standing water in the areas of old, capped cells. The same areas did not show any evidence of standing water during the July 2017 site visit, however, it is not known if this is due to seasonal variations in surface water or if the standing water issue has been effectively addressed. If standing water remains an issue, it may infiltrate the landfill caps and get into the waste below causing leachate issues from the landfill cells into the wastewater lagoon. Since the site is very close to sea level and underlain by permafrost it is not expected that this leachate will contaminate groundwater supplies, but the potential to contaminate the sewage lagoon as it drains into the Darnley Bay is a concern. It is recommended that the old landfill cell areas to the west of the access road be monitored for standing water throughout the year. If water is detected, these areas should be tested, drained to an appropriate location (if contaminated, drained to a holding pond for further treatment) and the low lying areas filled and graded to ensure proper drainage away from the landfill cells and the sewage lagoon.

There is a chain link fence around part of the site perimeter to catch any windblown waste material. The fence has been damaged and is falling down to the east of the facility entrance, where the fencing was installed in sand. This section is currently undergoing reconstruction, and should be monitored once completed to ensure it remains upright and functional. Future damage should be addressed promptly to manage windblown litter.

2.2.1 General Municipal Waste Storage Area

The general municipal waste storage area includes a variety of different types of waste including household waste, beverage containers, paper/cardboard, miscellaneous plastics, as well as smaller pieces of scrap metal, rubber and scrap wood, as shown in Figure 4. Since the closure of the landfill cells originally designed for the facility in 2014, general municipal waste has been disposed of in a cell to the east side of the access road which has an estimated capacity of 800 m^3. The community currently produces approximately 550 m^3 of non-compacted solid waste each year (200 m^3 of compacted waste), based on generation rates specific to the Hamlet. The municipal solid waste cell is surrounded by a berm to help mitigate wind sweeping waste out of the cell.

This cell is covered by overburden periodically to prevent odour, wind, and pest issues. Overburden should be applied on a regular basis when waste is collected, delivered, and compacted into the cell as per the *Hamlet of Paulatuk Solid Waste Disposal Facilities Operations and Maintenance Plan* (SWDF O&M Plan). The lack of regular overburden application presents many hazards including attracting nuisance animals. Current management practices may also lead to a potential fire hazard. Piling waste in excess of the 2 m recommended by the *Guidelines for the Planning, Design, Operation and Maintenance of Modified Solid Waste Sites* may lead to increased temperatures within the waste pile which can cause smoldering and burning of waste. If the general municipal waste were to catch fire, the fumes would be hazardous to community members downwind. Waste should be managed as per the SWDF O&M Manual to lessen the chance for fire.

2.2.2 Unsorted Bulky Waste

The majority of the area to the northeast of the sewage lagoon is occupied by unsorted bulky waste that has not been properly processed into its component categories (Figure 5). This area contains white goods (fridges, freezers, washing machines, furnaces, hot water tanks, etc.), construction waste, mixed metal, household furniture, vehicle components, and other large waste items. Many of the white goods and other products have not been properly processed to remove hazardous components such as mercury temperature switches and hazardous refrigerants.

Construction waste products should be sorted by Hamlet staff and recoverable materials made available for reuse by community residents. Particularly wood products and metal fixtures should be stored in a manner that protects them from further damage and avoids safety hazards to residents when combing through the materials.

Clean, non-recoverable wood products that have not been painted, stained or otherwise treated should be sorted for burning. Any disposal by burning is subject to the conditions of the Municipal Solid Wastes Suitable for Open Burning guidelines from the Department of Environment and Natural Resources (Environmental Protection Division, 1993). Conditions for burning include, but are not limited to, applying the principles of reduce, reuse, recycle, burning in a controlled manner when conditions are favourable (no or low wind blowing away from the community), receiving applicable permits and abiding by permit conditions, removal of all non-burnable material, and compliance with any other site specific conditions. Treated wood products can be broken down and included in the general municipal waste disposal. Metal products should be sorted to remove any hazardous materials and stockpiled to ship south for recycling and recovery.

The scrap metal content in the unsorted bulky waste area should be sorted and stockpiled with the construction scrap metal to ship south for recycling and recovery. Household furniture and other large, non-hazardous, non-recoverable items removed from the unsorted bulky waste area should be broken down to increase compaction and disposed of in the general household waste area.

2.2.3 Mixed Metal

In addition to the metal found in the unsorted bulky waste area, some metals have been sorted and stored separately in an area to the west of the bulky waste area. Materials stored in this area include scrap construction metal, old corrugated steel pipe culverts and old fuel tanks (Figure 9). There are also several locations throughout the bulky waste area where used metal barrels are stored (Figure 10). It is not known if all of these barrels have been properly cleaned or if they are still contaminated by hazardous waste. If they have not been properly cleaned out, the Hamlet should make arrangements to have an environmental contractor clean them out, as described in the SWDF O&M Plan, so that they can be properly crushed and shipped south for material recovery. This should be completed promptly to prevent any residual fluids in the barrels from contaminating the surrounding site. Barrels that need to be cleaned should be stored upright in a lined area to prevent the migration of any leaking fluids into soils and water on site. Once cleaned, barrels should be crushed and transported off site promptly.

2.2.4 Hazardous Waste Storage

There is not a significant quantity of hazardous wastes on site in the bulky storage area. The primary hazardous waste source on site consists of vehicle batteries, several buckets of waste oil and any residual substances in the barrels on site which are awaiting proper cleaning. Hazardous wastes should be stored in a way that prevents the potential for contamination of the surrounding soils, waterways, and air. They should be shipped out promptly on the annual barge to prevent contamination of the surrounding area. All materials should be stored as per the Solid Waste Disposal Facilities Operations and Maintenance Manual.

It is recommended that the Hamlet develop a dedicated hazardous waste storage facility within the bulky waste area for storing these materials in addition to the uncleaned metal barrels, ELV fluids, and white good hazardous components. A hazardous waste storage area would need to be lined with a chemically stable, impermeable material overlain with a layer of backfill to prevent damage to the liner. It would also need to be surrounded by an impermeable berm to prevent the migration of any fluids out of the storage area. This hazardous waste storage area would not be intended for long term storage of materials and hazardous waste should still be shipped south promptly to avoid containment degradation and excess contamination.

2.2.5 Contaminated Soils

In the 2009 water licence renewal application (Dillon Consulting Limited, 2009), two mounds of soil were identified within the solid waste facility, one that had been remediated and one that was contaminated. The soil mounds were shown on a drawing in a designated area for contaminated soils to the south of the two capped landfill cells and to the west of the access road turn-around pad. This material consisted of 550 m^3 of soil placed at the landfill site following remediation activities in 2005 and 2007. The soil was reportedly treated with nutrient addition in 2008 and samples were collected for analysis. Records could not be located for the final testing and fate of this soil but it is no longer in the location that it occupied in site photos from 2009. Based on site observations and communications with Hamlet staff, it is believed that this material was utilized as overburden in the capping of previous cells however its fate could not be determined with certainty based on the materials available.

2.3 Sewage Disposal Facilities

2.3.1 Background Review

The current wastewater management system consists of a truck haul disposal system which collects wastewater from residences by a sewage collection truck with an older vacuum truck providing emergency support as required. All homes in the community have septic holding tanks and no homes rely on honey bags. Sewage is discharged into the wastewater lagoon down a metal chute located at the end of the access road for the wastewater and solid waste disposal facilities (Figure 11). The community does not have significant industrial or commercial wastewater sources and the wastewater is assumed to be entirely of domestic household origin.

Sewage is discharged into the sewage lagoon, a natural lake that has been used for sewage disposal since the early 1990s. Solids are allowed to settle out and the sewage is naturally attenuated in the sewage lagoon. The sewage lagoon discharges to the west through a natural wetland approximately 300 m long which provides additional polishing before effluent discharges into Darnley Bay (Figure 12 and Figure 13). The sewage lagoon continuously drains through the wetland during the summer months.

The 2009 water licence renewal application (Dillon Consulting, 2009) reported that the overflowing of the lagoon occurs periodically, particularly in the spring during runoff and periods of heavy precipitation. It was reported that there are holes/tunnels along the perimeter of the lagoon that cause particular overflowing issues. This concern was highlighted again during the 2017 site visit. The lagoon does not have an engineered berm surrounding the perimeter. The truck discharge area is built up upon a mound but it does not offer any overflow containment since the mound does not extend past the discharge.

2.3.2 Surveillance Network Program

The most recent Environment and Natural Resources inspection was performed in October 2015, and reported that samples collected at SNP station 1619-2 (lagoon to wetland) returned parameters under criteria (ENR, 2015). Total suspended solids (TSS) at SNP station 1619-3 (wetland to Darnley Bay) were measured at 388 mg/L, which exceeds the 120 mg/L limit (ENR, 2015). Samples were taken in July 2017, and sites 1619-3 and 1619-4 were found to exceed the TSS limit, while 1619-2 exceeded the pH limit (too alkaline). The Hamlet has established plans and protocols to begin sampling the discharged water on a regular basis.

2.3.3 Lagoon Volume and Sludge Thickness

Sludge build-up in the base of the lagoon due to sediment deposition is not routinely measured though this is also a component that the Hamlet has integrated into their routine operations and maintenance manual. During the July 2017 site visit conducted by Dillon, the sludge and effluent depths in the lagoon were measured. The volume of 'Lake A' was determined to be approximately 128,000 m^3. Approximately 15,000 m^3 of this volume is occupied by accumulated sludge. The average depth of the lagoon is 1.81 m, with a maximum depth exceeding 4.36 m.

Excessive sludge build-up decreases the available volume of the lagoon for sewage storage and treatment and increases the risk of lagoon overflow or inadequate treatment. As outlined in the Sewage Disposal Facilities Operation and Maintenance Plan, the sludge level should be measured once a year and appropriate steps taken if the sludge build-up level is excessively high. Sludge dredging procedures are discussed in the Closure section below.

3.0 Site Closure Considerations

The time horizon for closure of the currently active sewage disposal facility is not known exactly since the area still contains considerable useable life. The closure of the municipal solid waste cell is anticipated in the next 12 months. The use of the area method is expected to increase the lifespan of the facility until 2036.

This section outlines the procedures to be followed when closing and capping an individual landfill cell, for maintaining the health and efficacy of the wastewater treatment lagoon, and for the ultimate closure of the landfill, bulky waste sorting area, and wastewater lagoon when that time arrives. The services of an engineer should be enlisted to develop a specific closure plan and design for both facilities when they are to be closed. The remaining usable life of the facility is discussed further in the 2017 Sewage and Solid Waste Facility Site Assessment. Factors that will impact the remaining usable life for each facility include population rates, sewage and solid waste generation rates, materials recovery efforts including reducing, reusing and recycling of solid waste, and the efficient sorting and shipping of bulky wastes. The existing sewage and solid waste facility will be closed in an environmentally responsible manner in order to mitigate health and safety risks to the community, scavenging by wildlife and birds, and impacts on the surrounding environment and waterways. As per Paulatuk Municipal Water Licence #N7L3-1619 Part I, Item 1, the following items are addressed in this closure plan:

- Contaminated site remediation (Section 3.4);
- Hazardous waste removal, transportation, and disposal (Section 3.5);
- Groundwater contamination by leachate prevention (Section 3.6);
- Consideration of altered drainage patterns (Section 3.7);
- Type and source of cover materials (Section 0);
- Future area use (Section 4.3);
- Implementation schedule (Section 3.13);
- Maps delineating all disturbed areas, borrow material locations, and site facilities (Appendix B); and
- A restoration monitoring plan (Section 4.2).

3.1 Solid Waste Area Ponded Water Removal and Treatment

Pools of standing water have been observed at the capped general municipal waste cells in historical satellite imagery in addition to the bulky waste storage areas during the site visit on May 27, 2015. This standing water presents several potential hazards including infiltrating the landfilled material causing leachate, making access to the site more difficult, making transportation of materials more difficult, and causing corrosion and degradation of potentially recoverable materials.

This water should be sampled when it is noted on site during periods of run-off, and tested by an approved laboratory to determine if it is contaminated by heavy metals or other contaminants of concern. If the standing water on site is found to be contaminated it should be pumped into a lined detention pond and treated according to the level and nature of the contaminants. If the water is safe to discharge, it should be pumped into the sewage lagoon for treatment of any organic or solids loading and discharge into Darnley Bay. Low spots where water previously pooled should be backfilled compacted and graded to provide adequate drainage and avoid standing water in the future.

Pooled water to the east of 'Lake A' Sewage Lagoon, near the white goods area at the solid waste disposal facility was sampled in July 2017 for SNP station 1619-5. Laboratory results will be appended to the Hamlet of Paulatuk Annual Report for 2017.

3.2 Infrastructure Removal

The current facility does not contain any permanent storage or maintenance buildings on site that will need to be removed. Items to be shipped to southern recycling/disposal facilities will be properly stored on site until arrangements for shipping have been determined.

3.3 Site Fencing

The existing chain link fence to the west of the access road is in disrepair, and is currently undergoing repairs. Proper fencing fulfils many roles at a site such as stopping any windblown material from leaving the property, preventing wildlife from getting into the solid waste and becoming a nuisance or safety hazard, and controlling access to the site to prevent illegal dumping and safety hazards.

3.4 Contaminated Site Remediation

There are not any expected sources of contamination that will result from the closure of the solid waste management facility. If contaminated soils are identified prior to the facility being closed, an engineer should be engaged to develop a plan for the proper treatment and disposal of those contaminated soils. This may include land farming, enhanced bioremediation, landfilling, or chemical treatment.

3.5 Hazardous/Bulky Waste Removal, Transportation, and Disposal

Once the bulky waste storage and sorting area reaches the end of its useable life, all remaining materials should be sorted, salvaged, and shipped south for further materials recovery or disposed as described in the SWDF O&M Plan. The bulky waste storage area was not used to store or dispose of any significant amounts of hazardous material, however the materials that are stored there require proper treatment and the development of a more appropriate storage area to prevent the contamination of the surrounding area.

A hazardous waste storage and processing area within the bulky waste sorting area of the solid waste management facility should be developed. This area should be lined with an impermeable liner and surrounded by a berm. Hazardous materials should be stored as per the SWDF O&M Plan until they can be shipped to a proper disposal facility.

3.6 Leachate Management, Ground and Surface Water Monitoring

This site closure plan has been developed to limit the infiltration of surface water into the buried waste mass. This site has not been lined with an engineered retention layer nor a leachate collection and treatment system. The exact depth of the waste is unknown. All depressions or other areas where surface water may pool within the site should be backfilled to ensure proper drainage. Surface drainage works (ie. ditches) will be constructed to direct surface water away from waste disposal areas to further minimize the potential for infiltration of surface water through to the buried waste cells.

Due to the wastewater and solid waste management facilities being close to sea level and underlain by an area of continuous permafrost, it is not anticipated that groundwater contamination will be a significant concern for either the wastewater lagoon or the landfill cells. There has been concern expressed in the community that leachate from the solid waste management facility is entering Old Water Lake to the east and impacting the water quality there. SNP Station 1619-6 is in place to sample run-off from the existing solid waste disposal facility before entering Old Water Lake.

3.7 Altered Drainage Patterns

Surface drainage patterns may be altered by the placement of the cap material which may change elevations, infiltration of water and directions of surface water flow. Once the site has been capped, a final survey and inspection of the site and surrounding area should be conducted to determine any changes in elevations, potential infiltration areas and surface water drainage patterns. As discussed in the above sections, the site should be graded to ensure drainage of surface water off the site and to minimize water ponding. Based on the results of the final survey, construction of drainage ditches around the capped waste cell to direct water off site may be required.

3.8 Grading and Capping

Once each cell has been filled to capacity it should be capped with 600 mm of cover material with a maximum hydraulic conductivity of 10^{-7} m/s or an acceptable alternative (Alberta Environment, 2010). Typically landfill cells should be covered with 200 mm of organic material after the cell has been capped to allow for seeding of vegetation native to the area. In the Paulatuk solid waste management facility, the surrounding ecosystem consists primarily of sandy, glacial till soil with small brush growth. Given the observed sandy nature of the surrounding soil, it is recommended that when a landfill cell is being capped an engineer be engaged in the design and hydraulic conductivity measurements be taken of the surrounding soil to determine its suitability as a capping material. If the surrounding soil does not possess a high enough hydraulic conductivity, a chemically stable, impermeable liner should be installed to prevent precipitation infiltrating the landfill cell and causing the generation of leachate. Vegetation growth will likely be slow to take hold. Additional monitoring of the cell cover material should be performed and remedial action taken while vegetation is being established. The final cover should be graded to ensure proper drainage of precipitation away from the buried waste pile. Monitoring of the site will continue for 25 years or as directed by the Inuvialuit Water Board.

3.9 Survey

Upon completion of the closure and capping of each cell, a survey of the site should be performed to map out the exact area of the facility extents. The mapping will show areas of the landfill cells, potential contamination or disturbed areas, borrow material, site topography and monitoring locations. The survey should also include final capping, berms and drainage details.

3.10 Registration

Upon final closure of the facility, the site will be identified and registered as a former solid waste disposal facility on the subsequent land title documents associated with the property.

3.11 Signage

New signs should be erected to provide instructions to community residents looking to salvage recoverable materials from the bulky waste storage areas. When the entire site is closed, new signage will be required to inform residents and direct them to the new solid waste disposal facility.

3.12 Sludge Management

The capacity of the sewage lagoon to store and treat wastewater will be reduced over time as suspended solids settle out of the sewage and form a sludge blanket on the base of the lagoon. This reduced capacity can be restored by dredging the base of the lagoon to remove the built up sludge layer. As noted in Section 2.3.1, overflowing of the lagoon has been observed in the past.

As detailed in the *Sewage and Solid Waste Disposal Facilities Assessment* report produced by Dillon (2017), it is not believed that inadequate capacity is the cause of this overflow, however manual decanting is recommended in place of current continuous natural flow. Additionally, the construction of a berm around the lagoon is recommended to reduce surface run-off from entering the lagoon. When sludge layers reach 0.5 m in depth, dredging is recommended as an effective option to increase lagoon capacity. Once the sludge is removed, it is treated typically by dewatering using a freeze/thaw detention system and then either landfilled or composted depending on its level of contamination. Dewatered sludge should be stockpiled on site and tested for heavy metals and other contaminants. Pending the results of the tests the dewatered sludge may be used as overburden for the active landfill cells. Prior to initiating lagoon desludging operations, the Hamlet should enlist an engineer to assist with the design and oversight of the desludging and sludge dewatering plan. Further, within 60 days prior to the removal of sludge from the lagoon, a Sludge Removal Plan must be submitted to the IWB for approval, as per Part D, Item 14 of the water licence. It is understood that the Hamlet has sufficient capacity to undertake desludging and dewatering by their own forces but if this is not the case then a qualified contractor should be enlisted to undertake the desludging activities.

3.13 Implementation Schedule

Based on the approximate volumes that remain in the active landfill cells and fill rates, an approximate closure and post-closure plan has been generated below. With proper maintenance and operations, the bulky waste sorting area can be used for many years to come if materials are shipped south on the annual barge as their stockpiled quantity surpasses the available storage space. Proper dredging and maintenance of the sewage lagoon will also ensure that it will remain useable for many years into the future.

Item	Proposed Completion Date
Reconstruction of chain link fence*	Ongoing
Drainage of standing water on site and backfilling and grading of depressions	September 2016
Compaction of general municipal waste and placement of overburden	Daily when waste is being placed, at minimum weekly
Removal of stockpiled materials	Annually
Dredging of wastewater sludge	As Required
Surface water sampling	As per Hamlet's Water Licence Requirements
Final capping and closure of landfill cells	Once Full
Closure and Post-Closure Inspection	Annually
Final closure and abandonment of current solid waste disposal site	TBD
Final survey	TBD

** Perimeter fencing was discussed with the Hamlet of Paulatuk Council, Thursday July 27, 2017, and was deemed unnecessary for the facility due to the strong winds and community use of the site access road to reach hunting/fishing lands.*

4.0 Post Closure

Following 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 and solid waste facility site, regular 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. Following closure of the site, an engineer will determine the specific inspection and monitoring requirements for the post closure and will incorporate the requirements stated by the regulatory agencies.

4.1 Inspections

Inspections of the site will be implemented through a post closure inspection checklist (found in Appendix A). The inspection checklist will be completed and a report will be prepared and sent to the IWB annually. The report will include the following items:

- Time and date of inspection;
- Frequency of inspection;
- Items inspected including:
    - Erosion control: Visually is there any evidence the drainage patterns are causing erosion? If any problems are identified they will be addressed in the annual report and based on recommendations provided by the IWB appropriate measures will be taken; and
    - Surface Water: Must be draining into the drainage ditches provided, if problems exist, consult design engineer, find a solution and record in annual report.
- Regulatory compliance requirements such as SNP monitoring locations and test parameters; and,
- Any other noteworthy observations during inspection.

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

4.2 Monitoring

Operational monitoring shall be continued into the post closure period until one or more of the following conditions apply:

- 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.

Proponents shall submit a report to the IWB that justifies termination of monitoring. A minimum of 25 years is typically required for monitoring of a closed solid waste site.

The monitoring program of the site shall consist of the following tasks:

- Cover material should be monitored for settling and re-graded or filled in as required to prevent pooling;
- Vegetation should be monitored to ensure sufficient growth and additional seed and growth media should be applied as required;
- Drainage pathways should be kept clear of obstructions;
- Water as well as leachate draining from the site should be tested for contaminants as per the Hamlet's water licence and Solid Waste Disposal Facilities Operations and Maintenance Plan;
- Wildlife levels within the area should be monitored; and
- Results of the above monitoring programs should be reported to the relevant authorities.

The monitoring program will include twice annual sampling of the sampling points identified in the SWDF O&M Plan.

4.3 Future Land Use

The solid waste site and sewage lagoon both lay within the municipal boundaries. Once closed, the land area of the former solid waste disposal site will continue to be part of the wastewater disposal site. The area of the solid waste disposal site will be seeded with naturally occurring vegetation. Because the area will continue to accommodate the sewage lagoon, there is no future plan for use of the land that the buried waste cells utilize.

4.4 Regulatory Requirements

This closure and reclamation plan has been completed in accordance with the *Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the Northwest Territories* (Kent et al., 2003). The IWB will require updated reports on the monitoring of the site annually.

Figures

Figure 1: Paulatuk Location Plan (NWT Bureau of Statistics)

Figure 2: Active and abandoned Sewage and Solid Waste Facilities

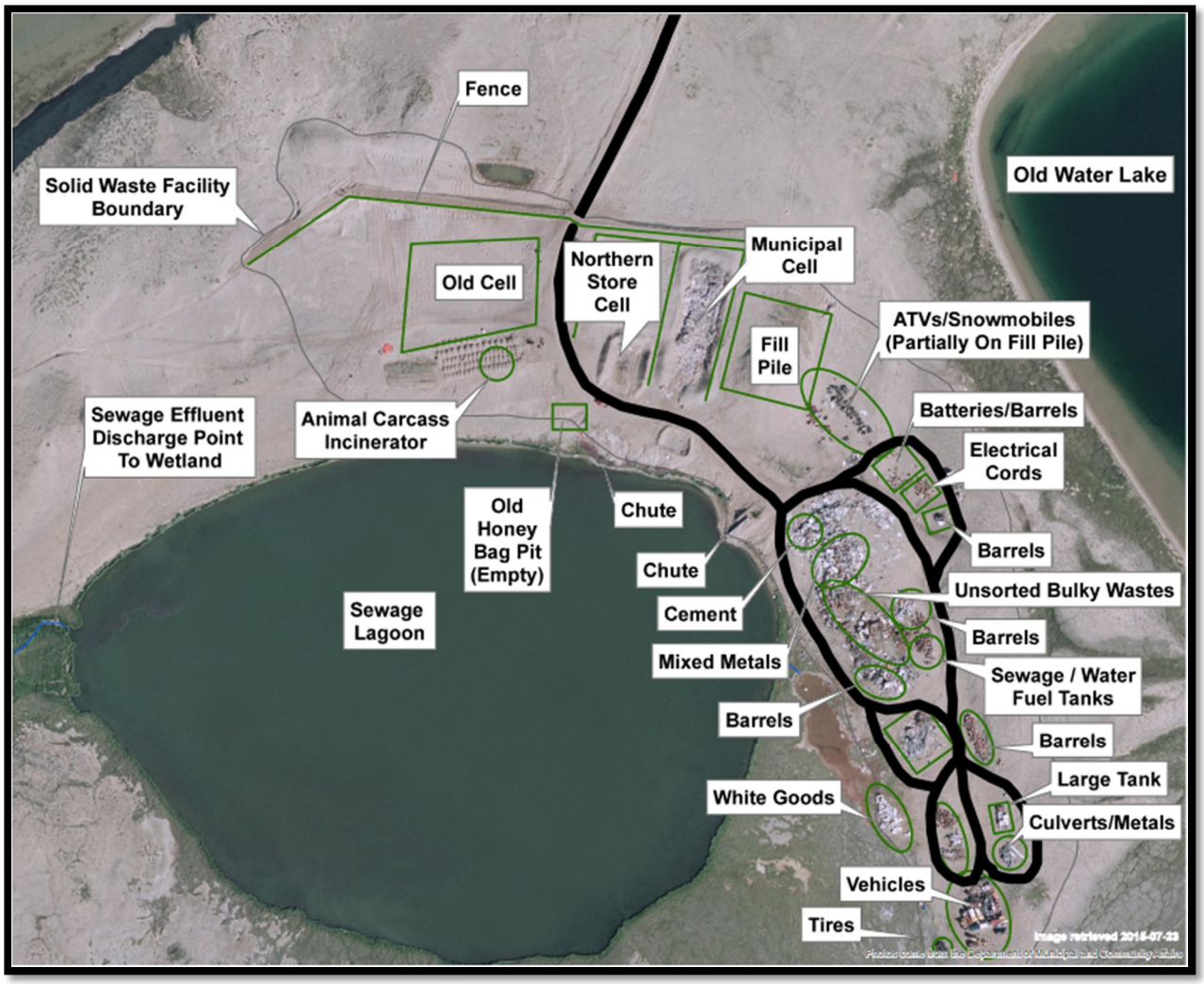


Figure 3: Active Sewage and Solid Waste Disposal Facilities Site Plan

Figure 4: Municipal Solid Waste Cell

Figure 5: Unsorted Bulky Waste

Figure 6: White Goods Storage and Sorting Area

Figure 7: End of Life Vehicle Storage Area

Figure 8: Used Tire Storage Area

Figure 9: Mixed Metals Pile

Figure 10: Used Barrels Storage

Figure 11: Sewage Disposal Facilities Discharge Chute

Figure 12: Sewage Lagoon Discharge to Wetland

Figure 13: Wetland Discharge to Darnley Bay

Appendix A

Closure/Post-Closure Inspection Checklist

Closure/Post-Closure Inspection Checklist

Result	Inspection Item
	Did closure commence no later than 30 days following the submission of the Final Landfill Closure Report?
	Was closure completed within 180 days following the initiation of closure?
	Was notification of closure posted at all of the facility access points, indicating where the new facility was?
	Was site properly engineered to prevent erosion and drainage problems?
	Was the final cover capped with 600 mm of material or approved alternative and properly graded?
	Was a final survey taken to mark the designated areas, locate monitoring wells and SNP locations and document the extent of the site? Should be tied to a permanent benchmark if available.
	Inspection frequency will be annually for 25 years and reports will be sent to the IWB after every inspection.
	Items to be inspected are the leachate monitoring, sewage lagoon adjacent to cell, surface water drainage, areas of on-site ponding, landfill cap and vegetative cover and other items as directed by the IWB.
	Was the site returned to post closure land use specified in the permit?
	Was the entire necessary infrastructure removed from site?
	Was all the necessary waste removed from site?
	Was a final landfill closure report submitted within 60 calendar days of completion of the final landfill closure?
	Was the post closure annual report submitted to the operating record by March 31 of this year?
	Was end of post-closure report submitted within 60 days following the end of post-closure?

Appendix B

Map and Detailed Site Plan

PAULATUK
SEWAGE AND SOLID WASTE SITE ASSESSMENT

SOLID WASTE FACILITY
SURVEILLANCE NETWORK PROGRAM
LOCATIONS

- BUILDING FOOTPRINT
- ROADS
- SOLID WASTE FACILITY
- DRAINAGE PATHS
- SNP LOCATIONS

SCALE 1:12,000

0 0.1 0.2 0.4 km

N W E S

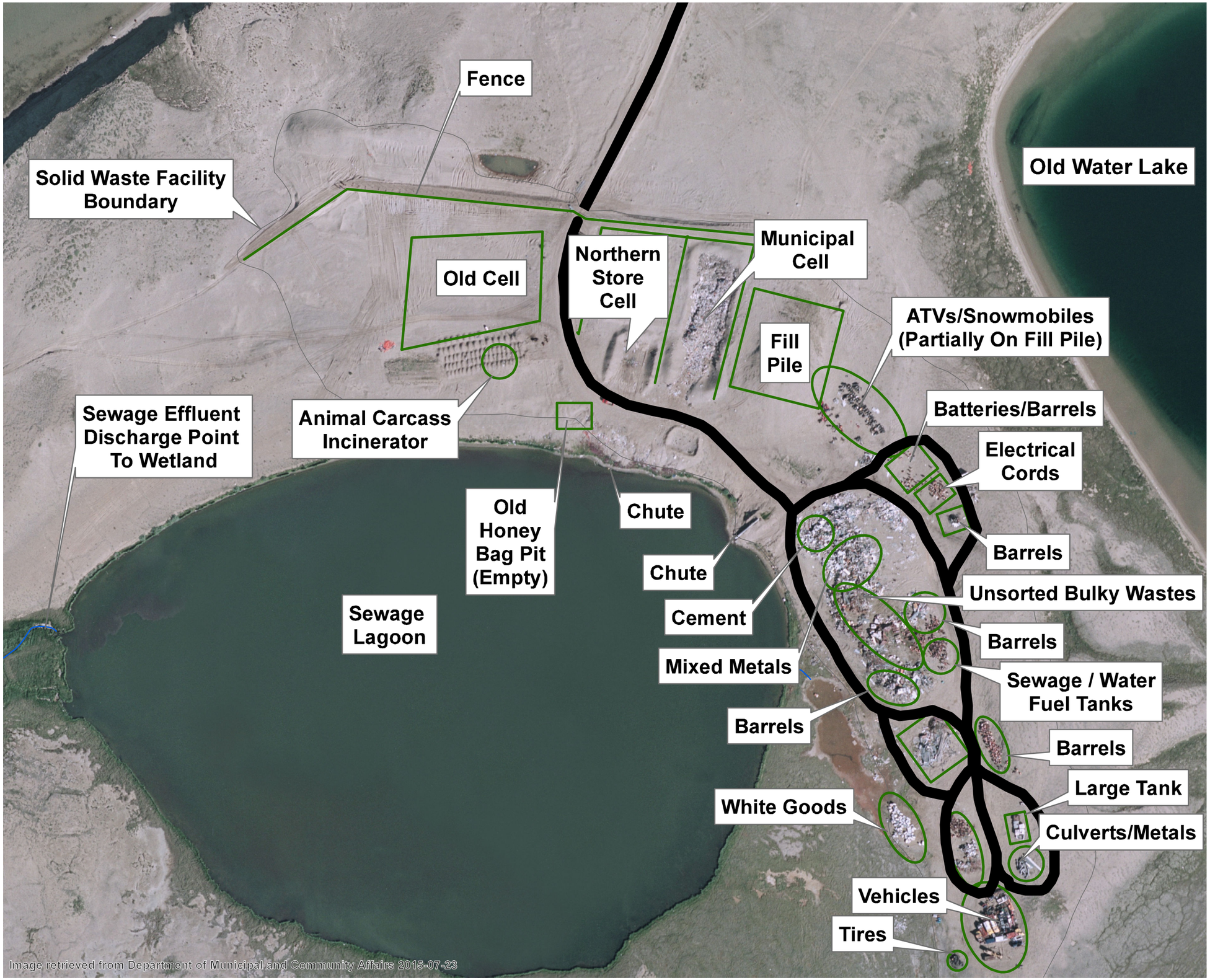
MAP DRAWING INFORMATION:
DATA PROVIDED BY GNWT AND DILLON CONSULTING

MAP CREATED BY: PH
MAP CHECKED BY: MH
MAP PROJECTION: NAD 1983 UTM Zone 10N

DILLON CONSULTING

PROJECT: 176028
STATUS: DRAFT
DATE: 2017-09-06

FILE LOCATION: G:\GIS\176028 Paulatuk Sewage and Solid Waste\mxd\Solid Waste Facility - SNP Monitoring Locations.mxd



FILE LOCATION: G:\GIS\176028 Paulatuk Sewage and Solid Waste\mxd\Solid Waste Facility - Detailed Site Plan.mxd

PAULATUK
SEWAGE AND SOLID WASTE SITE ASSESSMENT

SOLID WASTE FACILITY DETAILED SITE PLAN

- BUILDING FOOTPRINT
- ROADS
- DRAINAGE PATHS
- LANDFILL FEATURES

SCALE 1:1,750

0 12.5 25 50 Meters

N W E S

MAP DRAWING INFORMATION:
DATA PROVIDED BY GNWT AND DILLON CONSULTING

MAP CREATED BY: PH
MAP CHECKED BY: MH
MAP PROJECTION: NAD 1983 UTM Zone 10N

DILLON CONSULTING

PROJECT: 176028
STATUS: DRAFT
DATE: 2017-09-06

References

Aboriginal Affairs and Northern Development Canada, 2011. *Municipal Water Licence Inspection Form – Licence #N7L3-1619.* Aboriginal Affairs and Northern Development Canada. Retrieved on July 30, 2015 from: http://www.nwtwb.com/Downloads/Public%20Registry%20pdf%20files/1619%20IR%20August%2030,%202011_5-20-2012_250.pdf

Alberta Environment, 2010. *Standards for Landfills in Alberta.* Government of Alberta. Retrieved on July 30, 2015 from: http://environment.gov.ab.ca/info/library/7316.pdf

Bureau of Statistics, 2017a. *Population Estimates by Community; Community Totals, 2001 – 2016.* NWT Bureau of Statistics Government, Government of the Northwest Territories. Retrieved on August 14, 2017 from: http://www.statsnwt.ca/population/population-estimates/bycommunity.php

Bureau of Statistics, 2017b. *Paulatuk – Statistical Profile.* NWT Bureau of Statistics, Government of the Northwest Territories. Retrieved on August 14, 2017 from: http://www.statsnwt.ca/community-data/Profile-PDF/Paulatuk.pdf

Dillon Consulting Limited, 2009. *Hamlet of Paulatuk Water License Renewal Application.* Dillon Consulting Limited.

Environmental Protection Division, 1993. *Municipal Solid Wastes Suitable for Open Burning.* Department of Environmental and Natural Resources, Government of the Northwest Territories. Retrieved on July 22, 2015 from: http://www.enr.gov.nt.ca/sites/default/files/guidelines/solid_wastes_suitable_open_burning.pdf

Hamlet of Paulatuk, 2017. *Water Licence Number: N7L3-1619 Annual Report for the Year 2016.*

Inuvialuit Water Board (IWB), 2015. *Re: N7L3-1619 – Hamlet of Paulatuk, Municipal Water Licence Renewal.* Retrieved on August 14, 2017 from: http://www.inuvwb.ca/Downloads/Public%20Registry%20pdf%20files/1619%20WL%20Renewal%202015%20-%20151109.pdf.

Kent R., Marshall P., and Hawke L., 2003 *Guidelines for Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the Northwest Territories,* Department of Municipal and Community Affairs Government of the Northwest Territories. Retrieved on July 20, 2015 from: http://www.enr.gov.nt.ca/sites/default/files/guidelines/solidwaste_guidelines.pdf