DILLON CONSULTING

RESOLUTE BAY NU

Solid Waste Management Planning Study

Final Report

October 2021 – 18-8896

October 21, 2021

Department of Community and Government Services
Government of Nunavut
3rd Floor, W. G. Brown Building
Iqaluit, Nunavut

Attention: Mr. Gord Marinic
Senior Municipal Planning Officer

Solid Waste Management Planning Study, Resolute Bay, NU

Dear Gord Marinic,

Dillon Consulting Limited (Dillon) is pleased to submit our final report on the Solid Waste Management Planning Study completed for Resolute Bay, Nunavut. This report documents the current waste management system, as well as siting details and a Planning assessment of three preferred sites for future development of a new solid waste management facility.

We thank you for the opportunity to complete this project on behalf of Resolute Bay, Nunavut. If you have any questions pertaining to the enclosed information, please contact me directly at 780.664.0082, ext. 4604, or jbertrand@dillon.ca.

Sincerely,

DILLON CONSULTING LIMITED

Jeannie Bertrand, P.Geol
Project Manager and Partner

Howard Trofanenko, P.L. (Eng.)
Partner and Officer

Our file: 18-8896

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Dillon Consulting Limited

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Acronyms, Abbreviations, Definitions

-A-

Aboriginal Affairs and Northern Development Canada (AANDC)

Altus Group (Altus)

-B-

Bird Hazard Zones (BHZs)

-C-

Construction and Demolition (C&D)

Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC)

-D-

Government of Nunavut's Department of Community and Government Services (CGS)

Dillon Consulting Limited (Dillon)

-E-

Government of Nunavut's Department of Economic Development and Transportation (EDT)

Electronic Waste (E-Waste)

Environment and Climate Change Canada (ECCC)

-G-

Government of Nunavut (GN)

-H-

Household Hazardous Waste (HHHW)

-I-

Industrial, Commercial and Institutional (ICI)

Indigenous and Northern Affairs Canada (INAC)

-L-

Local Housing organization (LHO)

-M-

Metre (m)

Metres below grade (mbg)

Municipality of Resolute Bay (the Municipality)

Municipal Solid Waste (MSW)

-N-

Natural Resources Canada (NRC)

Nunavut Land Claims Agreement (NLCA)

Nunavut Solid Waste Management Plan (NSWMP 14)

Nunavut Water Board (NWB)

-P-

Polar Continental Shelf Program (PCSP)

-S-

Senior Administrative Officer (SAO)

Solid Waste Management (SWM)

Solid Waste Management Planning Study (the Study)

Solid Waste Management for Northern and Remote Communities, Planning and Technical Guidance Document (*SWMNRC –Guidance Document*)

Standards Council of Canada (CSA)

1.0 Introduction

Dillon Consulting Limited (Dillon) was retained by the Government of Nunavut (GN), Department of Community and Government Services (CGS) to conduct a Solid Waste Management Planning Study (the Study) in Resolute Bay, Nunavut (**Image 1**).

Image 1: Municipality of Resolute Bay, NU

The purpose of the Study was to identify and provide a Planning review of three different sites, and to determine the most favorable site for the development of a new solid waste management (SWM) facility. The landfill siting study area is illustrated in **Figure 1,** as part of the study Dillon investigated all areas shown in this image.

GOVERNMENT OF NUNAVUT

SOLID WASTE FACILITY SITE SELECTION
RESOLUTE BAY
NUNAVUT

FIGURE 1
LANDFILL SITING STUDY AREA

- Roadway
- Watercourses
- Community Parcel Boundaries
- Airport
- Water Body

SCALE 1:50,000

0 0.5 1 2 Kilometers

N W E S

MAP DRAWING INFORMATION:
DATA PROVIDED BY ESRI, DILLON, NRCAN & USGS

MAP CREATED BY: 44PH
MAP CHECKED BY: 46JB
MAP PROJECTION: NAD 1983 UTM Zone 15N

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PROJECT: 188896
STATUS: FINAL
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FILE LOCATION: G:\GIS\2018\188896 Resolute Bay SWMFS\MXD\Figure 1 - Landfill Siting Study Area.mxd

1.1 Background

Current SWM practices in the Municipality of Resolute Bay (the Municipality) are outdated, and do not align with the best practices described in the *Solid Waste Management for Northern and Remote Communities, Planning and Technical Guidance Document* (*SWMNRC -Guidance Document*) (Environment and Climate Change Canada, 2017). Waste is disposed at the current dump site, as well as at two additional waste storage areas. These areas were not chosen based on best practices, and the current dump site is located in close proximity to a historical Thule site, as well as the Relocation Memorial Site and former Town site. The location of the dump site and storage sites, and the solid waste disposal methods being practiced, have the potential to pose hazards to environment, as well as the health and safety of community members and staff, by way of animal interactions, smoke inhalation, unsanitary waste disposal methods, and other factors. There are currently no leachate management measures in place, and no environmental protection measures have been established.

A prior siting study was completed for the Municipality in 2009 (Resolute Bay Municipal Dump Site Selection Study, Arktis, 2009). It was noted upon completion of this Dillon Study, that the previous study reached a similar conclusion, that the most favourable site for future development would be in the area denoted in this report as Site A, and which was referred to as the 'Red Robin' site in the Arktis Report. It is our understanding that no action was taken to develop the 'Red Robin' site based on the Arktis Report recommendations.

A solid waste audit was completed for Resolute Bay in 2018 (exp Services Inc., 2018); the final report is provided in **Appendix A**. The data presented in this report was taken into consideration when estimating waste generation values for this Study. Since this Study was completed recently, a new solid waste audit was not included in the scope of work for Resolute Bay. The waste generation rates used for the conceptual solid waste facility design are based on values provided by the GN, which will be used across all of the similar solid waste studies currently underway in Nunavut, to allow for consistency in cell sizing and capital cost estimates.

At the start of this study, we learned that the Polar Continental Shelf Program (PCSP) Research Station had a small incineration unit which they use to incinerate waste generated at their own facility. At that time, Council indicated that they would be interested in incinerating waste at the PCSP facility if possible. Through initial discussions, PCSP staff indicated that they would be receptive to further discussion, but that they were not able to commit to processing the Municipality's waste at that time. It is confirmed that arrangements have been made for municipal staff to use the incinerator at predetermined times for the incineration of municipal waste.

1.2 Project Objectives

The objective of this project was to identify three sites which would be most suitable for future development of a new SWM facility. These three sites are intended to satisfy each of the setback requirements and constraints recommendations which are considered to be best practice in Nunavut. Based on the selection of three viable sites, an intrusive geotechnical site investigation was completed for two of the three sites, as one was inaccessible at the time of drilling, and identified a preferred site for future development.

The preferred sites were chosen based on the following tasks:

- Desktop Siting Study;
- Site Visit and Community Consultation;
- Constraints Mapping;
- Estimated Capital Costs for Site Development; and
- Comparison of preferred sites using a weighted decision matrix.

The Class D capital cost estimate and annual operations and maintenance estimates for the project were completed by Altus Group (Altus), and were based on assumptions provided by Dillon. These assumptions were developed from a Dillon conceptual design and take into account waste generation rates adjusted for the local population values, as well a landfill capacity analysis performed by Dillon.

2.0 Solid Waste Management System Review

2.1 Community Overview

The Municipality of Resolute Bay is located on the southern end of Cornwallis Island**,** in the Qikiqtaaluk Region of Nunavut Territory (**Image 2**). It is the second most northerly community in Canada, and is currently the permanent home to approximately 198 people, living in approximately 60 homes, as well as approximately 150 additional seasonal and temporary residents. Cornwallis Island is home to the PCSP facility, which is operated by Natural Resources Canada (NRC), and is also a tourist destination for visitors wishing to start expeditions further into Canada's Arctic. Canada also operates a military base on Cornwallis Island, which is located near the Municipality. These facilities share the Resolute Bay Airport, as well as local roads.

Image 2: Site Location Map

2.2 Current Waste Management System

Municipal solid waste (MSW) is manually collected daily by Municipality staff using a pick-up truck. Waste is collected from storage boxes located at each home (**Image 3 and 4**), which are built and provided by the Municipality. There are a total of 75 buildings in the Municipality, 15 of which are municipal buildings and local businesses.

Image 3: Example 1 of Household Garbage Box

Image 4: Example 2 of Household Garbage Box

The waste collected from homes is separated, with metal and bulky items taken to a metal recycling area north of the airport (**Image 5**). There is currently no charge for waste disposal to any of the commercial waste generators. Households are charged $30/month in waste disposal fees. Household waste generation is understood to vary substantially from day-to-day and week-to-week, but less significantly seasonally.

Image 5: Scrap Metal Disposal Site North of the Airport

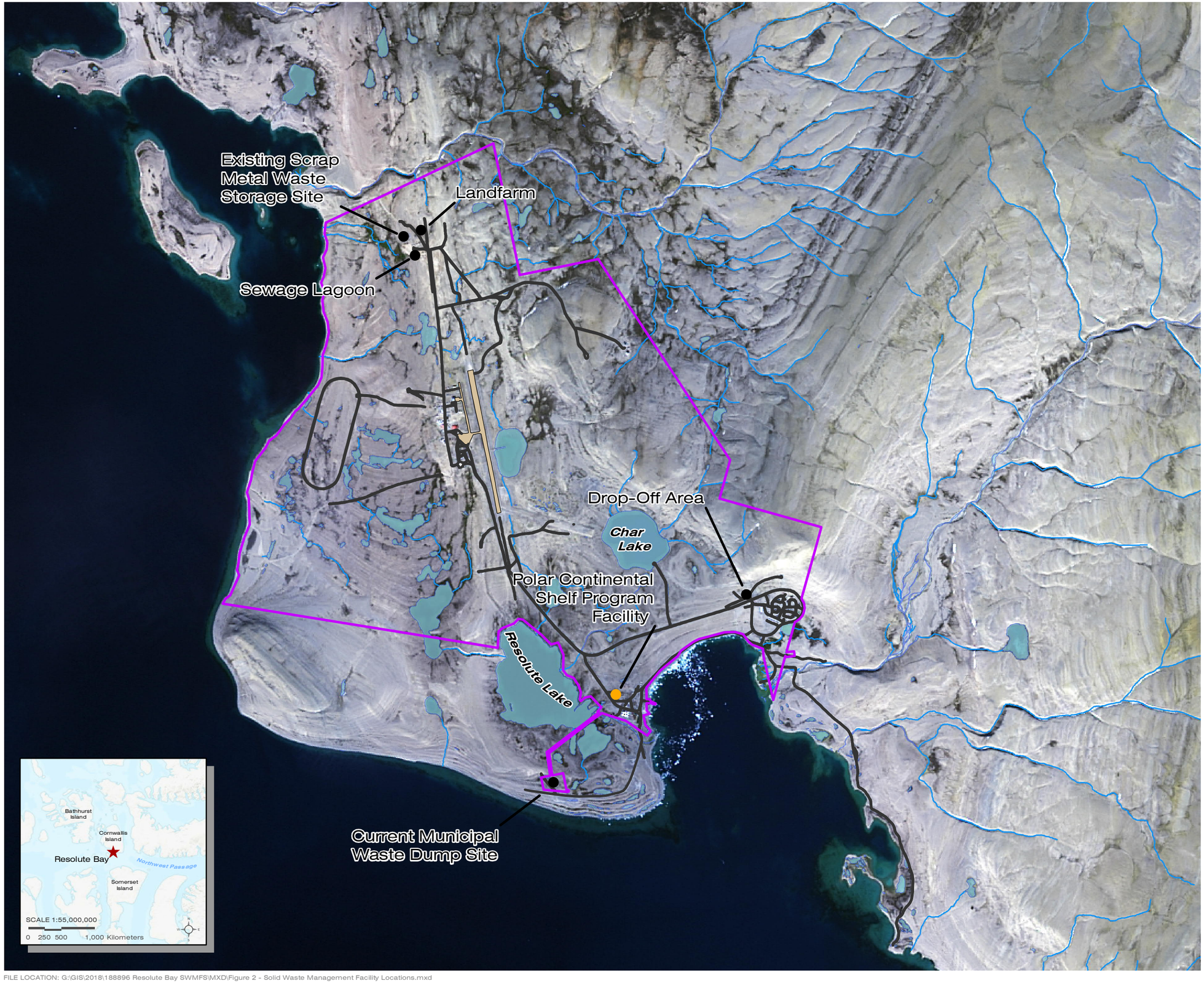
Waste is hauled to the current dump site for disposal and burned daily. The Municipality staff burns the waste to reduce organic material as much as possible, primarily to deter polar bears from coming to the site to scavenge for food. Polar bears continue to be attracted to the site, and are commonly observed searching through the burned waste material for food.

This project only addresses the SWM needs of the Municipality, including both permanent and non-permanent residents. The other interest groups (Military, PCSP facility, ATCO operated Hotel) in the area manage their own solid waste independently, and will not generate waste requiring management or disposal by the Municipality.

Hunting waste is managed by hunters, carcasses and animal parts are taken to the tundra outside of the Municipality for disposal to avoid attracting bears near the community.

2.3 Solid Waste Disposal Facilities

The current dump site is located south west of the Municipality, along the southern edge of the road (**Image 6 and 7**)**.** The current dumpsite is located across the road from an historical Thule Site, as well as the Relocation Memorial Site. The current dump is situated along the shoreline, approximately 40 metres (m) from the high tide line. The disposal site is flat, and slopes beyond the dump site towards the beach. The surface material at the disposal site is gravel and sand, with no clay observed at surface. The landfarm, sewage lagoon, drop-off area, and the existing solid waste management site are shown on **Figure 2**.



GOVERNMENT OF NUNAVUT

SOLID WASTE FACILITY SITE SELECTION
RESOLUTE BAY
NUNAVUT

FIGURE 2
SOLID WASTE MANAGEMENT FACILITY LOCATIONS

Polar Continental Shelf Program Facility

Solid Waste Management Facility Locations

Active Sites

Roadway

Watercourses

Community Parcel Boundaries

Airport

Water Body

SCALE 1:50,000

0 0.5 1 2 Kilometers

N W E S

MAP DRAWING INFORMATION:
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FILE LOCATION: G:\GIS\2018\188896 Resolute Bay SWMFS\MXD\Figure 2 - Solid Waste Management Facility Locations.mxd

The current dump site is not fenced, and there is no infrastructure in place (i.e., no scale house, staffed shelter, power supplies, waste bins, or enclosed waste containment areas of any type). The site does not have a large amount of waste accumulated, in part because waste is burned daily. The waste that remains is managed with a dozer operated by Municipality staff. During the summer months, sand and gravel are used as cover on occasion. Once an area has been used for waste and the residue from burning is substantial, the area is flattened with the dozer, and covered with gravel.

Image 6: Active Dump Site

Image 7: Close-up of Active Dump Site

There are two other sites identified by the community as 'waste diversion' areas. The first site is referred to as the 'metal storage site' (denoted as the '**Existing Scrap Metal Waste Storage Site' in Figure 2**), and is a fully fenced and gated area, and located northwest of the airport, along the coastal road (**Image 8**). This site is large, relatively flat, and has a good access road, however the entrance of the site is not well maintained during winter months. The site is used primarily for storage of scrap metal, appliances, bulky waste, fuel and propane tanks, and end-of-life vehicles. Other material has also been disposed at this site, including construction and demolition waste (C&D).

Image 8: Close-up of Metal Disposal Site Located north of the Airport

Image 9: Drop-Off Site Located near the Municipality

The second site is located west of the Municipality, and is referred to as the 'Drop-Off Site' and identified in **Figure 2**. It is commonly used by community members for dropping off large items including white goods, scrap metal, and bulky furniture waste (**Image 9**). This drop-off material is intended to be transferred by Public Works to the fenced site on the north side of the airport on an as-needed basis. There were no car or truck hulks visible at either site at the time of the site visit, but some snowmobiles and motorcycles were observed. It is understood that no one is directly responsible for Freon removal from white goods or fluid removal from vehicles and tanks, and it is understood that no one is currently providing this service. Abandoned car and truck hulks are present throughout the Municipality, as well as along the road to the airport. The presence of different interest groups (Municipality, Military, PCSP facility, ATCO operated Hotel) makes it difficult to assess which vehicles belong to whom.

2.4 Solid Waste Disposal Equipment

The Municipality has a vehicle garage located within the community which houses two waste collection trucks. There are no mechanics in the community at present who are able to provide on-going maintenance of the trucks.

2.5 Recycling Programs

At the time of reporting, the Co-op Grocery privately operates a program which accepts beverage containers and electronics, and back-hauls them out on the sea lift each year, at no cost to the Municipality. This recycling program is not affiliated with the Municipality. No other recycling programs are currently in place.

2.6 Current Solid Waste Management Challenges

The current SWM challenges which were identified by local community members including members of council and the SAO, include:

- Animal interactions, specifically with polar bears scavenging at the dump site;
- Smoke and air quality concerns resulting from burning at the dump site;
- Lack of control over use of the dump site by contractors and non-Municipality staff; and
- Lack of access to recycling options.

3.0 Site Selection

3.1 Project Initiation Meeting

Prior to starting the desktop siting study, Dillon met with the project manager from CGS by telephone. Dillon and CGS confirmed the scope of the project, and CGS provided background documents for review and reference as part of the Study.

3.2 Desktop Siting Investigation

Prior to visiting the site, a desktop siting investigation was completed to determine the constraints affecting landfill development, including relevant regulations and guidelines.

3.2.1 Background Document Review

As part of the desktop siting investigation, Dillon reviewed the following documents to identify sites that may be suitable for development of a future SWM facility:

- Public Health Act, Consolidation of General Sanitation Regulations, 1990;
- Resolute Bay Airport Zoning Regulations, C.R.C., c.106, February 16, 2017;
- Resolute Bay Community Plan;
- Resolute Bay Municipal Dump Site Selection Study, Arktis Solutions, 2009;
- Resolute Bay Solid Waste Audit, exp Services Inc., June 2018;
- Resolute Bay Water License, 3BM-RES1520;
- Resolute Bay, New Solid Waste Facility 100% Design, Arktis Solutions, May 2013; and
- Solid Waste Disposal Facility Design Report Resolute Bay, Arktis Solutions, May 2013.

3.2.2 Nunavut Solid Waste Management Regulations and Standards

SWM practices in Nunavut are governed by a number of overlapping regulations which are enforced by different agencies. There is no overarching regulatory body or guiding document which dictates the standards to which solid waste facilities are to be developed or maintained.

The three levels of government (municipal, territorial, federal) are all involved in different stages of waste management in Nunavut. The Federal Government is represented by Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC), which is only responsible for waste disposal that affects the water, as defined in the Water Licence, which is the mechanism for regulating solid waste facilities.

CGS is responsible for planning, designing, and constructing solid waste sites in cooperation and on behalf of the Municipalities. Once the solid waste site is constructed, the Municipality assumes ownership and operates and maintains the facility.

The municipal governments are responsible for coordinating collection and disposal services. Funding for upgrading the facilities, maintenance and operations of solid waste programs are the responsibility of the GN and the Federal Government.

The agencies and governing bodies who may play a role in the development and operations of solid waste facilities include:

- Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC);
- Nunavut Water Board (NWB);
- Department of Fisheries and Oceans;
- Environment and Climate Change Canada (ECCC);
- NAV Canada;
- Transportation Canada;
- Nunavut Airports (Government of Nunavut's Department of Economic Development and Transportation);
- Government of Nunavut: Department of Community and Government Services, Department of Health, and Department of Environment; and
- Municipalities.

The applicable Acts and Agreements which may influence the development and maintenance of solid waste facilities are as follows:

- Nunavut Land Claims Agreement (NLCA);
- NWB; Nunavut Waters and Nunavut Surface Rights Tribunal Act ss. 12(1) and 57(a). Renewal process required;
- Arctic Water Pollution Prevention Act, RSC, 1985;
- Environmental Protection Act, RSNWT 1988, c E-7, s.5;
- General Sanitation Regulations, RRNWT, 1990, c.P-16 Public Health Act; and
- Fisheries Act, RSC, 1985, c F-14, s. 36(3).

The following documents have been published by the Canadian and Nunavut Governments to inform communities about best practices related to management of solid waste. The following are a list of published documents which are relevant to solid waste management practices in Nunavut:

- Community Solid Waste, Technical Information Document (Public Works and Government Services Canada Real Property Services Branch, 2002);
- Environmental Guidelines for Waste Batteries (Department of Environment's Environmental Protection Division, 2011);
- Environmental Guidelines for Use Oil and Waste Fuel (Department of Environment's Environmental Protection Division, 2012);
- Environmental Guidelines for the General Management of Hazardous Waste (Department of Environment's Environmental Protection Division, 2010);
- Government of Nunavut, Nunavut Solid Waste Management Plan (exp Services Inc., 2014); and

- Solid Waste Management for Northern and Remote Communities: Planning and Technical Guidance Document (Environment and Climate Change Canada, 2017).

The primary regulatory tool for managing solid waste sites is the water license, which is administered through the NWB. This is the main approval that is required for construction, operation, and decommissioning of the landfill site. Licenses must be kept current, and municipalities are required to apply for renewal. Water Board legislation prohibits the disposal of waste into water without approval. Water licenses from the NWB include conditions which apply to the maintenance and monitoring of solid waste facilities.

The Government of Nunavut Department of Health also regulates solid waste management from a public health perspective. Their approval will be required for a solid waste facility development project to proceed, though no specific guidelines are in place.

A new solid waste facility also requires approval by the Nunavut Planning Commission, or otherwise by the Nunavut Impact Review Board.

In 2017, the Government of Canada published the *SWMNRC –Guidance Document;* this document was intended to provide an overview of waste management planning, site selection, operations, design, monitoring, and facility closure. The principles and guidelines discussed provide a clear picture of the general components needed. Since regulations do not cover the breadth of environmental issues that a community can encounter, the guidance document provides a framework for identifying potential risks and suggests possible mitigative actions.

For the purpose of this Study only two of the listed documents were used for guidance. The *SWMNRC – Guidance Document* was used as the primary guide for best practices, and the *Nunavut Solid Waste Management Plan* was used as a secondary reference for waste generation quantities. These documents are considered to be the most comprehensive, and have the most direct relevance to this project.

3.2.3 Airport Zoning Regulation

Airport Zoning Regulations apply to both land and the airspace surrounding the airport runway strip and applies to construction within this area. The zone in the regulation defined as the 'outer limit' regulates construction on land within a 4000 m radius from the centre of the runway, as represented in **Figure 3**. The 'approach surface' applies to the airspace that begins at each end of the runway strip, creating an inclined plane at a ratio of 1:50 m Vertical to Horizontal; the plane extends to a maximum of 15000 m horizontally and 300 m vertically.

Although Resolute Bay's Airport Zoning Regulation does not include any wildlife restrictions, the Transport Canada's *Aviation: Land Use in the Vicinity of Aerodromes* document identifies a putrescible waste landfill as a potentially high risk land use within the airport zone. The high risk is given because

landfills are known to be a bird attractant. It is typical for birds to fly to a height of 160 m and lower; the vertical height of 160 m along the airport zoning plane occurs at 8000 m horizontal, thus creating an 8000 m radius from the centre of the runway. The 8000 m radius encompasses all but Site F of the potential sites chosen for this Study. As part of the desktop study, Dillon reached out to Transport Canada, NAV Canada, and the Government of Nunavut's Department of Economic Development and Transportation (EDT) for their approval process for the new SMW facility. A summary of the correspondence has been included in **Section 3.6.**

It was further identified that potential sites at either end of the air strip pose a greater risk to the airport than those parallel to the airstrip.

3.2.4 Siting Considerations

Based on guidance provided in the *SWMNRC –Guidance Document* and the *Nunavut Solid Waste Management Plan* along with a review of the relevant regulations, Dillon created a map of the area surrounding the Municipality showing the relevant setback requirements and constraints which included:

- Geology;
- Land use planning;
- Flood plains;
- Airport safety;
- Residential buildings;
- Municipality boundaries;
- Seasonal access;
- National or Territorial Parks;
- Inuit-owned lands;
- Coastal areas;
- Drinking water sources;
- Waterbodies;
- Traditional and recreational use areas;
- Proximity to existing access roads;
- Availability of daily cover material;
- Suitability for future expansion;
- Prevailing wind direction; and
- Line-of-site to public use areas.

Additionally the constraints included the exclusion of sites with > 10% topographical slopes. Some constraints, such as Inuit owned land, did not impact the study area and so, are not visible on the constraints map but remain in the legend. Other factors, including geology, prevailing wind direction, estimated capital cost and line-of-site aesthetics, were evaluated individually for each proposed site.

The *SWMNRC –Guidance Document* provides best practices for setback distances, which are frequently expressed in a range of distances (e.g., 300 m to 1500 m). For this Study, Dillon identified which setback distance should be used based on the relevance of each to the community, with a priority placed on health and safety. The setback ranges are included in **Table 1**, and the setback distances used during the siting review are specifically identified.

Table 1: Siting Consideration Requirements

Siting Considerations	Setback Range	Applied Setback Distance	Satisfaction of Setback Requirements						Siting Details
			Site A	Site B	Site C	Site D (current disposal site)	Site E	Site F	
Suitability of surface and subsurface geology			✓	✓	✓	✓	✓	✓	All sites have been assessed based on aerial photos, and are considered viable for development. Additional subsurface geotechnical investigation was conducted for sites A and B. Site C is not accessible without bridge construction. Site visits were performed to the sites, but visibility was limited due to winter conditions. Sites will be visually assessed for fracture-free bedrock during final design stages.
Alignment with the community land use plan			✓	✓	✓	✓	✓	✓	Sites A, B, C, E and F have been confirmed, and do not appear to conflict with current community land use plans. Site D is currently designated as a waste disposal area.
Outside of known flood areas			✓	✓	✓	✓	×	×	Sites A, B, C and D are outside of any known flood areas. Sites E and F were identified as flood areas, and these sites have been disqualified based on this information.
Airport outer limits of lands setback from centre of runway	4,000 m[1]	4,000 m	×	×	✓	✓	✓	✓	Sites E and F are outside of the airport setback area. Sites A and B are within the airport setback radius, while Sites B, C and D align with flight paths. Site A is preferred over Sites B, C, and D, as it is furthest from the flight path and is anticipated to have the least amount of risk associated with the airport.
Setback from homes or recreational cabins outside of the Municipality	300-1,600 m[2]	500 m	✓	✓	✓	✓	✓	✓	All sites meet this criteria.
Setback from edge of the Municipality	300-1,600 m[2]	1,000 m	✓	✓	✓	✓	✓	✓	All sites are outside of the Municipality footprint. Sites B and C are considered to be a long distance from the Municipality for daily travel, but are still considered viable options.
Setback from National or Territorial Parks and other protected areas	100 m[2]	100 m	✓	✓	✓	✓	✓	✓	All sites have been confirmed to comply with the setback distance from any National or Territorial parks or other protected areas.
Setback from beach and coastal area	30-100 m[2]	100 m	✓	✓	✓	✓	✓	✓	All sites have been confirmed to comply with the setbacks from the ocean.
Setback from drinking water sources	300-1,500 m[2]	1,500 m	✓	✓	✓	✓	✓	✓	All sites are located outside of the most rigorous drinking water source setback.
Setback from waterbodies	30-100 m[2]	100 m	✓	✓	✓	✓	✓	✓	All sites meet the waterbody setback requirements.
Setback from heritage, cultural and archeological sites, and recreational use areas	100 m[2]	100 m	✓	✓	✓	×	✓	✓	All proposed sites are confirmed to be at a suitable distance from any known traditional or recreational use areas. Site D is located near a Thule site, as well as the Relocation Monument.
Proximity to existing access roads		300 m[3]	✓	✓	✓	✓	✓	✓	Sites A, B and D are the most accessible from the existing access roads therefore reducing the need for road improvements. Sites E and F are only accessible via a 4x4 during summer, Site C is only accessible if a bridge is built across the waterway.
Accessibility of daily cover material		1,500 m[3]	✓	✓	×	✓	×	×	The borrow area is located on the west side of the Municipality, and is readily accessible to Sites A and B.
Availability of land for future expansion			✓	✓	✓	✓	✓	✓	All sites have room to expand in the future to reduce the need to site another facility.
Downwind of the community relative to the prevailing wind direction	Prevailing wind direction is from the North[4]		✓	✓	✓	✓	×	×	All sites are downwind from the prevailing wind direction.
Line-of-site to public roads, public use areas, and aesthetics	100 m[2]	100 m	✓	✓	✓	✓	✓	✓	All sites are beyond the 100 m setback to a public road and are outside of the line-of-site of any public use area.
Suitable topography, preferably <10 % slope			✓	✓	✓	✓	×	×	Sites A, B, C and D have slopes less than 10%. Parts of Sites E and F have a slope greater than 10%.
Placement outside of Inuit owned land			✓	✓	✓	✓	✓	✓	All sites and access roads are located on non-Inuit Owned land.
Seasonal accessibility			✓	✓	✓	✓	×	×	Access to Sites A, B, C and D are not affected by seasonal changes to waterways. Sites E and F are located across a waterway that floods during freshet. Sites E and F were deemed unsuitable because of their inaccessibility for parts of the year, specifically during freshet.

[1] Resolute Bay Airport Zoning Regulations (Canadian Minister of Justice, 2017)
[2] Solid Waste Management for Northern and Remote Communities – Planning and Technical Guidance Document (Environment and Climate Change Canada, 2017)
[3] Selected setback value based on reasonable proximity to currently developed road network.
[4] Average Weather at Resolute Bay Airport – Wind (Weather Spark, 2019)

3.2.5 Constraints Mapping

The relevant setback distances, siting considerations, topography, and areas of known interest to the community were illustrated on a constraints map (**Figure 3**). This map was used to identify areas for investigation and discussion as potential sites for future development. A version of this map was presented to the SAO, Mayor, and Council, and during the open house hosted on February 19, 2019. Additional information shared by the community was subsequently added to the map for completeness, such as the drop-off area.

The application of the siting constraints on the map of the study area indicated that favourable sites for site development were limited. The airport setback requirements, combined with the setback from the drinking water source, occupy the majority of the land available to the west of the Municipality. The remaining available land located along the coastline is occupied by an archeological site, a cemetery, and the Relocation Monument.

The east side of the Municipality is only accessible up to the river, which is reported to be impassable by truck. The area directly north-east of the Municipality is a popular picnic and recreational area.

The area directly north of the Municipality is very steep, and considered to be unsuitable for development due to challenges associated with construction and road maintenance.

Despite the airport setback requirements on the west side for the Municipality, this area was identified as the best area for future development, due mainly to accessibility. The large number of lakes and cultural sites further limits the options for site development.

Sites E and F were disqualified due to access and flooding concerns. Lack of truck access would make development and maintenance of these sites impractical. The current dump site was reviewed as part of the Study, and was determined to be unsuitable for future development.

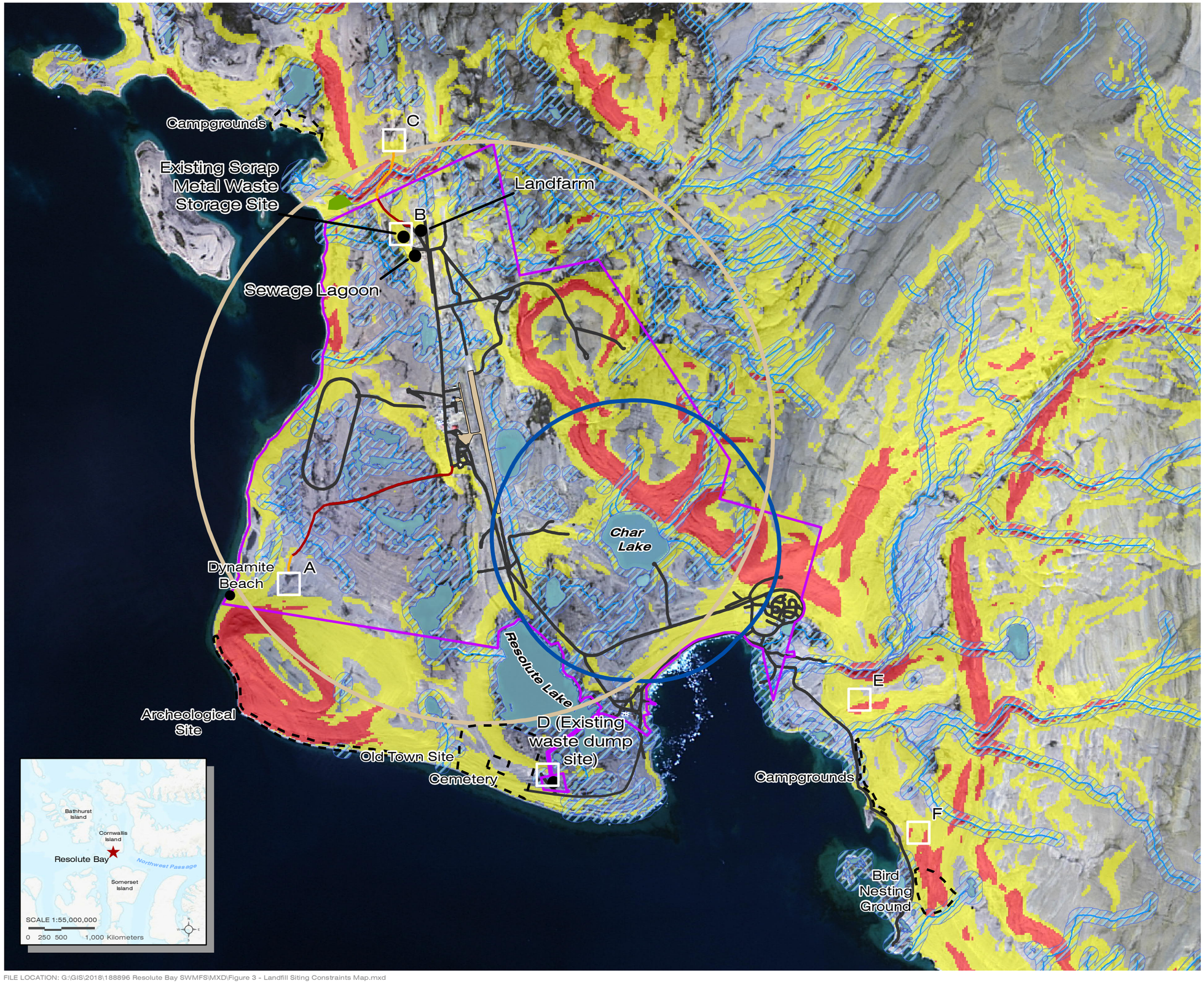

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FIGURE 3
LANDFILL SITING CONSTRAINTS MAP

- Potential development site identified during desktop study
- Proposed New Road Construction
- Proposed Road Improvements
- Community Parcel
- Inuit Owned
- Tupirvik Territorial park
- Airport Setback (4 km)
- Drinking Source Setback (1.5 km)
- Water
- Water Body Setback (100 m)

Surface Slope (degrees)

- 0 -
- 5 -
- 15 -

SCALE 1:50,000

0 0.5 1 2 Kilometers

MAP DRAWING INFORMATION:
DATA PROVIDED BY ESRI, DILLON, NRCAN & SPOT IMAGERY

MAP CREATED BY: 44PH
MAP CHECKED BY: 46JB
MAP PROJECTION: NAD 1983 UTM Zone 15N

DILLON CONSULTING

PROJECT: 188896
STATUS: FINAL
DATE: 2020-12-17

FILE LOCATION: G:\GIS\2018\188896 Resolute Bay SWMFS\MXD\Figure 3 - Landfill Siting Constraints Map.mxd

3.3 Site Visit and Community Consultation

As part of the site selection process, Dillon completed a site visit and meeting with the SAO, Mayor, Council, and community members in the Municipality on February 19, 2019. The purpose of the site visit was to observe the current waste disposal site, as well as to visit the proposed sites and confirm their viability based on access and a visual assessment.

Dillon was accompanied on the site visit by the Municipality SAO, Kimberley Young, who escorted Dillon around the Municipality and surrounding areas in a pick-up truck. As part of this tour, Dillon visited the current dump site location, as well as both metal salvage areas, and areas near the airport and Polar Shelf Research Station. Access to proposed sites was limited due to the winter road conditions at the time of the site visit.

Prior to arriving in the Municipality, Dillon provided the Municipality SAO, Mayor and Council, with a meeting agenda and map of proposed sites for their consideration (**Figure 4**). On February 19, 2019, a meeting was facilitated by Dillon in the Municipality Council chambers with the Mayor and Councilors to discuss potential sites for development of a new SWM facility. Proposed sites were presented on a large format map of the Municipality and surrounding areas, and each site was discussed. Feedback was provided to Dillon on each of the sites, and comments were recorded.

The following is a summary of Council's feedback for each site. **Green** indicates favourable, **orange** indicates acceptable, and **red** indicates sites that have been deemed unsuitable for development.

Site A: Preferred Site, unanimously favoured by Mayor and Council.

Site B: Supported by Council as an option for future consideration. Concerns were raised related to proximity to the airport runway, and possible bird interactions with aircraft.

Site C: Supported by Council as an option for future consideration. Concerns were raised related to proximity to the airport runway, as well as anticipated challenges crossing the river to gain access to Site C.

Site D: *Site D is the current dump site.* This site was not considered for future development, as it was understood that this site was not favoured by Council for continued use, due to its proximity to the shoreline, as well as the proximity to areas of cultural and historical significates.

Site E: Identified by Council as unfavourable, due to concerns over access, specifically during spring freshet. Access to this site is limited due to a wide, braided river crossing.

Site F: Identified by Council as unfavourable, due to concerns over access, specifically during spring freshet. Access to this site is limited due to a wide, braided river crossing.

An open house was held in the evening in the school gymnasium. Posters were displayed in the week prior to the meeting to invite community members to attend and share their thoughts on possible sites for a new SWM facility site. The meeting was attended by 11 community members, who reviewed the site maps, and commented on the current waste management system. The most common concerns were raised over polar bear interactions at the existing dump site and the lack of recycling options available in the community. The dump site is currently frequented by polar bears throughout most of the year. It is understood that it is very common for polar bears to be seen scavenging for food waste, even after waste has been burned. A concern with the location of the current dump site, is the community member's safety when visiting nearby recreation areas due to polar bears frequenting the area.

As part of consultation with the SAO and Council, it was understood that polar bears are one of the most significant concerns with the current solid waste management system. Polar bears are attracted to the food waste which is disposed of at the dump site, making bears a common hazard at the site. The opportunity to potentially incinerate waste was identified by the SAO and Council, and they indicated that incineration would be their preferred waste disposal option, as a way to mitigate bear interactions. Dillon was in contact with one of the staff who operates the Polar Shelf Incinerator, and he provided a basic explanation of the system that they have in place. At the time of the call, the incinerator was in use, but was still in early stages of commissioning. The person we spoke with was not able to offer their services at that time, but did indicate that the opportunity could be re-visited at a later date.

This opportunity was not explored in depth, as it was not originally included in the scope of this study. However, we are aware that as of January 2021, arrangements have been made between the Municipality of Resolute Bay and the PCSP, and that municipal solid waste is now being disposed and incinerated at the PCSP facility. It is our understanding that PCSP facility required use of the incinerator to maintain its temperature for on-going operation during the months that it's closed, September to February. The Municipality is responsible for operating the unit for the incineration of its municipal waste. Additional details have not been provided as part of this Study.

Managing municipal solid waste through incineration at Resolute Bay is anticipated to reduce bird and animal attraction. It should be noted however that not all waste streams generated by the Municipality will be suitable for incineration. Additional investigation will be required to determine which material streams are being incinerated, and which materials will still require landfill disposal, or can be diverted for recycling. It should also be noted that the incineration process will generate residual ash, which will require end-of -life disposal. It is recommended that any residual material be characterized to determine whether it is hazardous, and would be suitable for landfill disposal, or whether it would require treatment as a hazardous waste substance.

GOVERNMENT OF NUNAVUT

SOLID WASTE FACILITY SITE SELECTION
RESOLUTE BAY
NUNAVUT

FIGURE 4
PRELIMINARY PROPOSED LOCATIONS FOR FUTURE LANDFILL DEVELOPMENT

- Potential development site identified during desktop study
- Roadway
- Proposed New Road Construction
- Proposed Road Improvements
- Watercourses
- Community Parcel Boundaries
- Inuit Owned Land
- Tupirvik Territorial park (campground)
- Drinking Source Setback (1.5 km)
- Airport
- Airport Setback (4 km)
- Water Body

SCALE 1:50,000

0 0.5 1 2 Kilometers

MAP DRAWING INFORMATION:
DATA PROVIDED BY ESRI, DILLON, NRCAN & USGS

MAP CREATED BY: 44PH
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DILLON CONSULTING

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FILE LOCATION: G:\GIS\2018\188896 Resolute Bay SWMFS\MXD\Figure 4 - Preliminary Proposed Locations for Future Landfill Development.mxd

3.5 Weighted Decision Matrix

A multi-criteria decision matrix was used to integrate the quantitative measures and qualitative feedback given during the Mayor and Council meeting. Prior to completing the decision-matrix, Sites E and F were disqualified due to access limitations, and so were not included in the evaluation. Each of the factors listed in **Section 3.2.4** have also been considered for all proposed sites. The identified criteria were all satisfied for Sites A, B, and C, and a weighted decision matrix **Table 3** was applied to identify the most favourable of the three potential sites. The existing waste disposal site was also included in the decision matrix for comparative purposes only.

The evaluation consisted of a number of site options, a defined set of evaluation criteria, and corresponding weights for the criteria (**Table 2**). Inputs to the decision matrix (**Table 3**) were the degree to which each site option satisfied the criteria. The output was an overall ranking of site options. The site locations were scored with a ranking index which indicated the degree to which each site satisfies all the weighted criteria. The ranking index is a relative comparison of one site to the other alternatives rather than an absolute measure. The option with the highest ranking index suggests that it is a better option compared to an alternative with a lower ranking index.

Weighting was applied based on the understanding that all sites meet the minimum setback criteria laid out in the *SWMNRC –Guidance Document*. Council approved a weighting system which allowed for a heavier emphasis on safety, community, and cost considerations. As such, the criteria for the airport, traditional and recreational areas, council approval, all-season road access, and capital costs where weighted higher than the other criteria. The weighted values are intended to compare the proposed options to each other, and not to rate them on a universal basis. A description of the ranking criteria parameters and scoring application can be found below in **Table 2**.

Table 2: Ranking Criteria Details

Criteria	Parameters of Criteria	Scoring Application	Weighting
Drinking Water Source	The proximity to the community's drinking water source.	If outside of the designated setback the site would receive the best rank.	1 - 3
Airport	The proximity to the airport and the flight path.	The best rank is given to one that is outside of the airport setback and not along the flight path.	1 - 15
Access Road	The length of access road that would be required for the given site.	The best rank is given to the site with the shortest access road as it would require less road upgrades.	1 - 3
Traditional and Recreational Areas	The proximity to traditional and recreational areas.	The best rank is given to the sites that are the furthest from the traditional and recreational areas.	1 - 5
Availability of Granular Material	The proximity to available granular material	The best rank is given to the site that is nearest a source of granular material.	1 - 3
Hauling Distance	The distance required to transport waste from the community to the site.	The best rank is given to the site that is required to haul waste the shortest distance.	1 - 3
Community Setbacks	The proximity to the community setback.	The best rank is given to the sites that are outside of the community setback.	1 - 3
Visibility from Community Use Areas	The visibility of the site from community use areas.	The best rank is given to the site that is furthest from community use areas, including roadways.	1 - 3
Area for Future Expansion	The amount of area available for future expansion.	The best rank is given to the site with the ability to double its current footprint.	1 - 3
Council Approval	Council's approval of the site.	The best rank is given to the site that the Council considers to be most favourable.	1 - 15
All-Season Road Access	Accessibility of the site in all seasons.	The best rank is given to sites that are accessible in all seasons and conditions.	1 - 8
Prevailing Winds	The location of the site relative to the prevailing winds.	The best rank is given to the sites that are downwind from the community.	1 - 3
Slope of Selected Sites	The slope of the selected site relative to the other considered sites.	The best rank is given to the site that is less than 3% slope, and the site with the least amount of slope relative to the other considered sites.	1 - 3
Capital Cost (includes relevant infrastructure)	The cost of the site relative to the other considered sites.	The best rank is given to the site with the lowest cost. O&M cost is not evaluated, as O&M costs are comparable for all sites.	1 - 10

Table 3: Weighted Decision Matrix

Site	A	B	C	D
Location	East of Dynamite Beach	North End of Airstrip	North End of Airstrip across river	Existing Waste Disposal Site
Distance From				
Drinking Water Source *(1=Close, 3=Far)*	3	3	3	3
Airport *(1=Close, 15=Far)*	12	2	6	3
Access Road *(3=Close, 1=Far)*	2	3	1	3
Traditional and Recreational Areas *(1=Close, 5=Far)*	5	2	1	1
Availability of Granular Materials *(3=Close, 1=Far)*	3	1	1	3
Hauling Distance *(3=Close, 1=Far)*	3	2	1	3
Community Setbacks *(1=Close, 3=Adequate)*	3	3	3	3
Community Considerations				
Visibility from Community Use Areas *(1=Visible, 3=Not Visible)*	3	2	3	1
Area for Future Expansion *(1=None, 3=Considerable)*	3	2	3	2
Council Approval *(1=Against, 15=In Favour)*	15	6	6	1
Land Features				
Seasonal Road Access *(1=Inaccessible, 8=Accessible)*	7	8	2	3
Prevailing Winds *(3=Favourable, 1=Unfavourable)*	2	2	2	2
Slope of Selected Site *(3=<3%, 1=>10%)*	3	2	2	3
Cost				
Capital Cost *(10=Low Cost, 1=High Cost)*	7	10	1	N/A
Overall Scoring	**71**	**48**	**35**	**31**

Based on the weighted decision matrix, **Site A** ranks as the preferred site for development, and Site B ranks as the second preferred site. Site C is primarily limited by access as a result of steep topography, though its location relative to the Municipality and the airport is favourable.

3.6 Correspondence

Email communications with regulatory bodies including NAV Canada, Transport Canada, and the EDT were conducted to determine their approval process and presented below.

Communications with the EDT was not established until preferred Site A was selected. The EDT was able to provide their approval requirements at that time. It is Dillon's understanding that the EDT and NAV Canada will require further design details, once they are available, to proceed with assessing the location for development.

Additionally, the EDT required that an Airport Bird Hazard Risk Assessment be completed prior to granting approval to proceed to the design phase of the project. Dillon was tasked with and completed the Bird Hazard Risk Assessment, the results are included in **Section 3.7**.

3.6.1 NAV Canada

Preliminary approval from NAV Canada was received in a letter dated July 16, 2019, for the development of a landfill and waste diversion facility at proposed Site A. The letter states that "NAV CANADA has evaluated the captioned proposal and has no objection to the project as submitted." Both the letter of preliminary approval and the captioned development proposal submission are included in **Appendix B**. This letter was valid for a period of 12 months, and expired July 16, 2020.

Another application will be required to be submitted once further design details are available, such as structure heights. Additional applications may be required to be submitted to NAV Canada as the design progresses into the construction phase.

3.6.2 Transport Canada

An email was sent to John Mcfee, Civil Aviation Inspector for Aerodromes and Air Navigation from Transport Canada, on April 17, 2019, requesting review and approval of the planned waste facility location Site A. A reply was received that stated:

> "While many airports' zoning regulations contain clauses restricting land use related to wildlife attractions, Resolute Bay's zoning regulations do not include any wildlife restrictions. The only restriction at Resolute Bay is for elevation of structures. There is no exemption from the Aeronautics Act required for this project.
>
> Some thoughts:
> - While there are no zoning issues, a landfill in the vicinity of an airport may pose a safety hazard due to attraction of birds and other wildlife.
> - I've attached Transport Canada's publication on land use in the vicinity of aerodromes. There is general information and recommendations that may be relevant to the project.

- While there is no requirement to submit anything else to Transport Canada Civil Aviation, there may be other local, territorial, or federal notifications or authorizations required.
- Obtaining a NAV Canada land-use assessment and requesting input from Nunavut Airports would be prudent."

Based on this response, Dillon understood that a bird study may be required for this study site, but additional communications with Transport Canada are not required for approval. A copy of this complete email is included in **Appendix C**.

3.6.3 Nunavut Airports

Correspondence with Pierre Lamothe, the Manager of Standards and Program Development for the EDT at the GN, was established on July 7, 2020. The email correspondence with Transport Canada, the preliminary approval letter received from NAV Canada, and the site's location map were sent as supporting documents. On July 21, 2020, the correspondence with Mr. Lamothe established that the GN requires an approval from NAV Canada, Transport Canada, and the undertaking of an Airport Bird Hazard Risk Assessment prior to any preliminary approvals being granted. The Airport Bird Hazard Risk Assessment is to be used to evaluate the potential risk of the project on aviation safety and is required to gain preliminary approval to proceed to the design phase of the project. Once the conceptual design has reached 60% completion, it is to be submitted to the EDT to gain final approval to proceed to construction of the site. A copy of the correspondence can be found in **Appendix D.**

3.7 Airport Bird Hazard Risk Assessment

An Airport Bird Hazard Risk Assessment was conducted as part of the approval process required by the GN's EDT.

The Airport-Bird Hazard Risk Assessment – For the Proposed Solid Waste Management Facility report was prepared to examine the bird-related risks associated with the construction of the proposed SWM facility, as per the process outlined in the Transport Canada Airport Bird Hazard Risk- Assessment Process (Transport Canada, 2007). The Airport Bird Hazard Risk Assessment is intended to examine and evaluate the relationship between land use, bird species, and aircraft movements in terms of the relative risk to aircrafts (Transport Canada, 2007). A desktop assessment was conducted to quantify the risks associated with the development of this facility. The desktop assessment was comprised of a review of publicly available environmental information including aerial/ satellite imagery, bird species listings based upon current species ranges, bird species migratory patterns based upon species groups, bird species breeding and foraging behaviour and habitat, Canadian Important Bird Areas (IBAs), Government of Canada Migratory Bird Sanctuaries, Government of Canada National Parks, and Government of Nunavut Territorial Parks and Special Places. In addition, phone interviews were

conducted with community members to supplement the information collected and provide local context to this assessment.

Four Bird Hazard Zones (BHZs) were defined by the Transport Canada Airport Bird Hazard Risk-Assessment Process (Transport Canada, 2007). These include the Primary Bird Hazard Zone, Secondary Bird Hazard Zone, Category B Event Zone, and Special Bird Hazard Zone, in order of highest to lowest risk to aircrafts. SWM facilities are considered high risk land use types by Transport Canada and as such, they are not recommended to occur within Primary or Secondary BHZs. The current uncontrolled dump site (Site D) has been identified as the highest risk land use type within the region. Site D is located approximately 4 km south of the Resolute Bay Airport runway, aligned with the approach and departure flight paths and within the Primary BHZ. Local knowledge suggests that only the Common Raven (*Corvus corax*) and several gull species are known to be attracted to and forage at the current dump site. This dump site is considered a high risk for Category A and Category B loss events based upon Transport Canada (2007) and no mitigation measures are in place to deter birds from this site. However, no bird-related issues or incidents have been reported in association with the Resolute Bay Airport. This suggests that the risk posed by a similar facility would also be limited based upon the species likely to be present. No other land use features were identified that frequently attract birds.

The proposed development of a SWM facility (Site A) is located in the Secondary Bird Hazard Zone, a lower risk zone in comparison to the Primary Bird Hazard Zone (location of Site D), and is expected to result in a moderate to high risk for bird strike events, including Category A and Category B loss events, if no mitigation measures are implemented. A bird deterrence program may be considered to further reduce the potential risk of attracting Hazardous Bird Species to the SWM facility. Potential management techniques include:

- **Exclusion Fencing/ Overhead Exclusion System**: Exclusion systems can be designed from a variety of materials but are costly to maintain in remote communities and have varying degrees of success depending upon the size of the landfill.
- **Visual Deterrents**: This may include scarecrows or bird deterrence flagging. This technique is subject to potential habituation and may require active management (e.g., changing decoy types and locations) to reduce habituation.
- **Noise Deterrents**: The benefits include initial effectiveness at dispersing congregations of birds and the ability to be deployed day and night (i.e., gas cannons). This technique is subject to potential bird habituation and may cause disturbance to the surrounding community.

The level of effectiveness of these measures depend on several factors including the type of species, weather conditions, and time of year. Installation, maintenance, and cost must be considered, given the challenges of operating in northern communities. These factors will impact which, if any, of the potential management techniques could be implemented to reduce the presence of the targeted bird species. Potential mitigation techniques should be discussed in consultation with relevant regulatory agencies.

In summary, the development of a new engineered landfill located at Site A is expected to reduce the overall risk associated with waste management facilities in the Resolute Bay area as Site A is within the lower risk Secondary BHZ. It is therefore recommended that the existing landfill site, which is located within the Primary BHZ, be decommissioned.

A complete copy of the assessment can be found in **Appendix E.**

4.0 Conceptual Design

Based on the site selection process, and initial knowledge of the three preferred sites for future development of a solid waste facility, Dillon developed a conceptual design for a SWM facility. This process has taken into account the estimated waste generation rates of the Municipality, the geology and topography of the region, the climate and associated challenges with road access and leachate management.

4.1 Capacity Analysis

A capacity analysis was conducted to project the current and future (20-year) needs of the proposed landfill site. The original capacity analysis used waste generation data from the 2018 Solid Waste Audit (exp Services Inc., 2018) and supplemented that data for specific materials with the Nunavut Solid Waste Management Plan (exp Services Inc., 2014). Following this initial analysis, the values were updated to use a standardized generation rate. The permanent population growth rate of 2.9%, which is the same value applied to each community in the Qikiqtaaluk region, was based on the Nunavut, Regional and Community Population Projections 2009-2036 (Nunavut Bureau of Statistics, 2010). This value was used to project the future population of the Municipality, as represented in **Table 4**.

Table 4: Projected Permanent Community Population Based on Historic Growth

Year	Total Population, Resolute Bay[5]
2021	216
2026	249
2031	287
2036	331
2041	382

The capacity requirements were assessed for the landfill cell and segregated areas for recyclable and hazardous materials. Initially, the landfill cell analysis used tonnages reported in the 2018 Solid Waste Audit (exp Services Inc., 2018) found an annual generation of 513 tonnes for a population of 229 based on the 2006 census data, and the generation rate was calculated to be 2,240 kg/year/capita, which is more than triple the national average of 750 kg/year/capita (The Conference Board of Canada, 2012).

Following meetings with the GN, as well as other stakeholders, a standardized generation rate for all municipalities in Nunavut was identified to be 1,075 kg/year/capita. This standard solid waste generation rate will be used for all communities completing similar studies in Nunavut going forward. Based on research completed by Dillon, it is assumed that of that value, 962 kg/year/capita of the waste generated will be disposed of in the landfill. This rate was applied to a 20-year waste generation

[5] Total population excludes seasonal and temporary population mentioned in Section 2.1 of this Study.

forecast, based on anticipated population growth, to project the total waste capacity for a new landfill design. This standardized generation rate is an average of several studies completed in Nunavut and Northern Canada, and is assumed to reflect waste generated in residential, Industrial, Commercial and Institutional (ICI), and construction and demolition (C&D) as well as bulky waste. The data is presented in **Table 5.**

Table 5: Waste Generation Forecast, 2021-2041

	2021 (tonnes/year)	2041 (20-year Waste Accumulation) (Total tonnes)
All Generating Sectors	208	5,888

To determine the storage area size required for each of the segregated materials, values were used from the following sources:

- Nunavut Solid Waste Management Plan (NSWMP 14) (exp Services Inc., 2014);
- Statistics Canada (Stats Canada) waste diversion values (Government of Canada, 2016); and
- Interviews with local maintenance managers for the Local Housing Organization (LHO); an affiliation of Nunavut Housing Corporation.

The NSWMP 14 reported generation rates broken out into the three regions of Nunavut, and the values provided for the Qikiqtaaluk region were applied to the Municipality.

Stats Canada only reports on diversion values for E-waste. Reported diversion values account for material which is diverted away from the landfill, thus generation values would be higher than diversion values. Dillon calculated the rate by dividing the generation value by the population of the given year and assumed that Nunavut has a lower E-waste generation rate relative to the national average reported by Stats Canada. It was assumed that communities within Nunavut would have a lower generation rate because there is less access and availability of electronic upgrades relative to the national average. It is considered reasonable to apply the national E-waste diversion rate as Nunavut's generation rate, as a conservative estimate.

Dillon spoke with LHO maintenance managers from five communities, who provided estimated quantities of appliances and fuel tanks disposed at the landfill annually. An average volume for each appliance type was applied to the quantity in conjunction with the population, to estimate the generation rate. The calculated quantities, projections, and assumptions are provided in **Table 6.** To determine the estimated volumes of material generated for household hazardous waste (HHHW), E-Waste, Tires and Clean Wood, density values were applied from the Waste Materials – Density Data sheet (Australia Environment Protection Authority Victoria, n.d.).

The data provided for HHHW only considered automotive batteries, and it was assumed that due to the density of the batteries and the limited number of automotive vehicles found in Nunavut communities that this value is acceptable for the entire HHHW category.

Table 6: Segregated Materials

Material	Segregation Method	Annual Generation Rate	20-Year Projection	Source	Assumptions
Appliances	Sea Can	15 m^3/yr	450 m^3	LHO	Combination of washers, dryers, fridges, and stoves
HHHW	Sea Can	0.09 tonnes/yr	3 tonnes	NSWMP 14	Only reported on automotive batteries
E-Waste	Sea Can	0.04 tonnes/yr	1 tonnes	Stats Canada	Diversion rates were applied to the population from Statistics Canada for that year
Tires	Sea Can	0.2 tonnes/yr	5 tonnes	NSWMP 14	
ELV	Separated Pile	3 tonnes/yr	90 tonnes	NSWMP 14	
Oil/ Fuel Tanks	Separated Pile	7 m^3/yr	220 m^3	LHO	Switching from metal to fibreglass as an initiative for longevity, likely to see a decrease in the coming years
Wood Waste	Separated Pile	75 m^3/yr	2300 m^3	NSWMP 14	

Community-specific details were provided by a LHO representative for that community. In Resolute Bay, an estimation of the annual disposal for large items are as follows:

- 4-5 Stove Ranges;
- 4-5 Fridges; and
- Predominantly old wood, old ABS piping, old vinyl, glass, and other construction materials from renovations.

During the interview it was understood that the PCSP Facility accepts HHHW for disposal from the LHO; this includes fluorescent lights, emergency batteries, and mercury thermostats. In 2019, the LHO was in the process of transitioning from metal oil and fuel tanks to fibre glass ones to reduce replacement frequency; this change will likely decrease the disposal quantity of oil/fuel tanks in the future.

As with other communities in Nunavut, Resolute Bay's LHO strives to reuse and repair appliances and furniture until it is no longer an option. Flat top cooking ranges are preferred over stoves; this is anticipated to reduce the number of waste appliances generated, as they are smaller and easier to repair for a longer lifespan.

Sample calculations of the data provided in this capacity analysis section can be found in **Appendix F.**

4.2 Geotechnical Intrusive Investigation

An intrusive geotechnical investigation was completed by Canadrill between November 9 and 12, 2019. The purpose of this geotechnical subsurface investigation program was to determine the geotechnical suitability of Sites A, B, and C for landfill development. The purpose of the geotechnical investigation was to assess the surface and subsurface conditions at the sites and provide geotechnical recommendations to support the design and construction of the facility, including associated buildings, roadway/parking areas, and general site grading.

The scope of the geotechnical program consisted of:

- Compilation and Review of Available Information;
- Geotechnical Field Program;
- Laboratory Testing; and
- Geotechnical Reporting.

A geotechnical field program consisting of drilling six boreholes at Site A and four boreholes at Site B was completed. Due to accessibility issues, a drilling program at Site C could not be completed. At each of the investigated sites, the geotechnical program determined the depth to bedrock, developed a geotechnical profile of overburden material, confirmed the presence and depth of permafrost, and confirmed the depth of the groundwater table. Samples were collected and analyzed for moisture content, gradation, pore water salinity, and electrical resistivity. A thermistor was installed at each proposed site to monitor subsurface temperatures, specifically permafrost conditions.

Based on the geotechnical findings, both Site A and Site B appear to consist of coarse-grained sand and gravel down to shallow bedrock. The bedrock surface was within 0.3 to 2.4 metres below grade (mbg) throughout Site A and was either exposed or within 0.6 m throughout the explored areas of Site B. As noted above, some extensive areas of severely fractured bedrock were observed at the borehole locations, resulting in a highly variable depth to sound bedrock at both sites. Some areas of thicker overburden/shattered bedrock may exist within the unexplored extents of the sites. Overall, it appears both sites are similar from a geotechnical perspective and both do not appear to be in close proximity to a seismic fault, or a low-lying coastal area that could be affected by storm surges or sea level rise.

Based on the geotechnical investigation conducted at Site A and Site B, it is understood that both sites are technically suitable for construction of a SWM facility. The geotechnical report provides recommendations for geothermal considerations, building foundation design, solid waste cell and leachate pond design and construction, as well as roadway, gravel pads, and general site grading/drainage. The final geotechnical report included in **Appendix G**, provides geotechnical recommendations.

4.3 Schematic Layout

Using the results of the capacity analysis, as well as our understanding of the solid waste disposal needs of the community, a schematic site layout (**Appendix H**) was developed and applied to each of the three preferred sites. For Resolute Bay, each site layout is similar, and also includes a site-specific preliminary access route for future road development, as well as a landfill and solid waste diversion facility designed for a 20-year lifespan. The areas allocated for diverted waste storage are sized based on common practices in other jurisdictions. The volume of material anticipated to be generated will vary depending on the specific materials in question, and the material volumes can be managed through ongoing site management efforts.

The proposed facilities include features as described below in **Table 7**.

Table 7: Facility Features

Site Feature	Description	Dimensions (Where Applicable)
20-Year Lifespan MSW Cell	MSW landfill cell complete with leachate collection system.	• Interior Dimensions: 85 x 85 m • 5 m high
Leachate Evaporation Pond	Evaporation pond complete with geomembrane liner sized to accommodate leachate produced by the MSW cell.	• Interior Dimensions: 17.5 x 21 m
Driving Surface	Gravel roadway complete with subgrade, granular base, and granular surface course.	• Approximately 8,000 m^2 • 2% Crossfall • 10 m wide
Gravel Pad for End-of-Life Vehicle Decommissioning	Gravel pad underlain with geomembrane liner.	• 10 x 20 m
Gravel Pad for Used Oil Storage Tanks	Gravel pad underlain with geomembrane liner.	• 10 x 20 m
End-of-Life Vehicle Storage	Allotted area for ELOV storage. Required to provide positive drainage.	• 38 x 60 m
Empty Fuel Tank Storage	Allotted area for empty fuel tank storage. Necessary to provide positive drainage.	• 25 x 38 m
Surface Water Run-on Control Ditching	For purposes of conveying surface water away from new development.	• Approx. 1,600 lin.m • 1 m deep (typical) • 1 m wide (typical) • 3:1 slopes (typical)
Perimeter Chain Linked Fence	Galvanized steel.	• 1,200 lin.m • 2 m high
Chain Linked Fence Gates	Galvanized steel.	• 10 m length • 2 m high
Site Lighting	Concrete supported steel posts with light fixture.	N/A
Sea-Cans	For the collection and storage of diverted waste prior to shipping	• 3 x 3 x 12 m

Site Feature	Description	Dimensions (Where Applicable)
ATCO Office Trailer	Pre-fabricated office trailer available from numerous suppliers.	• 7 x 13 m
Contaminated Soil Treatment and Storage	Gravel pad(s) complete with oil-water separator.	• 12 x 65 m (treatment) • 12 x 65 m (storage)
Truck Storage Building	Pre-fabricated membrane-type structure for storage of dump truck and dozer	• 9 x 20 m
Signage	As required.	N/A

As part of the conceptual design process, Dillon reviewed the Planning of continuing to use the current metal dump site as a storage area for scrap metal. Due to the challenges that the community faces related to road maintenance during winter months, and desire for operational ease of use, this option was not pursued. Instead, the conceptual design layout includes all of the required waste storage areas and waste sorting areas in one site, which will significantly decrease the labour requirements to maintain the site. In the event that Site B be chosen for future development, a site visit is recommended during the summer months, to determine whether the detailed design could feasibly use the existing scrap metal site for future scrap metal storage.

4.3.1 Landfill Cell Design Basis

The conceptual approach for the development of the Resolute Bay Landfill is to design a “natural attenuation” facility. This approach relies in part on the ability of the natural environment to mitigate impacts through a combination of biodegradation, dilution, freeze back, and other factors.

The *SWMNRC –Guidance Document* differentiates Class 1 and Class 2 facilities. Class 1 facilities are considered larger landfills (e.g., > 5,000 tonnes per year), and Class 2 facilities are < 5,000 tonnes per year. Best practices (e.g., Table 5-1, ECCC 2017) for Class 1 facilities recommend a highly engineered containment liner system. However, the guidance acknowledges that natural attenuation may be an effective approach for the smaller Class 2 facilities. Key factors supporting use of natural attenuation in northern climates are noted to include:

- Landfill is located in an arid and/or semi-arid region or measures are put in place to prevent the Infiltration of precipitation into the waste mass;
- Landfill is located in a permafrost region where biodegradation of solid waste is considered negligible; and
- Low waste generation rates and small landfill footprint.

Based on the following key factors specific to Resolute Bay, this conceptual design has been based on a ‘natural attenuation’ design concept:

- Resolute Bay has a very dry climate, with an annual precipitation rate of 161.2 mm (6.35 in) per year[6]. Most of the precipitation falls in the winter months, allowing snow to be managed through operational measures, further decreasing the surface water volume expected to be impacted by waste in the active landfill cell.
- Resolute is located in a permafrost region, and biodegradation of waste is anticipated to be negligible.
- Permafrost aggradation is expected below the landfill cells which will aid in the containment of leachate.
- The Resolute Bay landfill is anticipated to receive less than 1,000 tonnes per year of waste, which places it at the low end of the Class 2 Facility classification.

The landfill is proposed to consist of two combined landfill cells enclosed by a perimeter berm. The cells are to be constructed 300 mm above existing site grade and the berms will be constructed 2 metres above the cell base with a 2 m wide crest. The intent of the design is for leachate to be collected within the cells in shallow sumps and to drain out of the active landfill cells by gravity to the leachate pond during the summer months. This leachate is anticipated to partially evaporate during the summer months, and the remainder pumped over the waste mass near the end of the summer, until the capacity of the waste mass to absorb leachate is reached. Some of the leachate may remain in the leachate pond at the end of the summer. The leachate that is absorbed by the waste mass, should freeze to create a frozen core within the waste mass. As additional waste is placed in the cells, permafrost is likely to aggrade through the waste mass potentially rendering the leachate sumps inactive. As such, aggrade of permafrost will need to be considered in the detailed design of the leachate collection system.

In the event that permafrost does begin to deplete, leachate that is already being diverted to a leachate pond can begin to be captured and treated by the most appropriate process determined at that time.

4.4 Class D Cost Estimate

The schematic layout for a new SWM facility and waste diversion area, including access road requirements, were provided to Altus to prepare a Class D cost estimate for the development of each of the three preferred sites. Conceptual designs and corresponding quantity estimates were provided to Altus, as well as estimated road upgrades required for development of each site. The access road upgrades were based on the road's length and improvements requiring either full new road construction or improvements to an existing road for haul truck access; these road segments are denoted in **Figure 5.** Select design assumptions were also provided to Altus, based on the outcomes from the consultant design meeting held in Iqaluit in June 2019.

Altus has provided three cost estimate reports that have been included in **Appendix I**. The cost estimate reports include one for construction that excludes the cost of a landfill cell liner, one for the operations

[6] https://en.wikipedia.org › wiki › Resolute Bay, Nunavut

and maintenance cost, and one for construction that includes the cost of a landfill cell liner. The values reported in **Table 8** are based on the cost estimate that excludes a landfill cell liner.

4.4.1 Capital Cost Estimate

The following **Table 8** includes the summarized values from the Class D cost estimates for landfill development at each of the three preferred proposed sites. The conceptual design was based on naturally attenuating landfill cells, as per the landfill design basis described in **Section 4.3.1.**

Table 8: Class D Cost Estimate Summary

	Site A	Site B	Site C	
Length of Road Requiring New Construction	300 m	0 m	700 m	Bridge 110 m
Length of Road Requiring Upgrades	2700 m	200 m	500 m	N/A
MSW Facility Estimate Total	$9,511,900			
Site Access Road Estimate Total	$1,886,700	$173,500	$1,587,900	$34,195,800
Estimate Total (Excluding GST)	**$11,398,600**	**$9,685,400**	**$45,295,600**	

The detailed cost estimate (**Appendix I**) includes item descriptions, quantity and unit rates for the assumed materials, and works to be conducted for the MSW facility and site access roads. Subtotals additionally include a 17% lump sum for general requirements and contractor's fees, and a 32% contingency for design, escalation to work season 2021, and construction. The cost estimates exclude costs associated with site closure activities for the active dump site.

4.4.2 Operation and Maintenance Cost Estimate

Table 9 includes the Class D cost estimates for operations and maintenance at each of the three proposed sites for a 30-year lifecycle. The access road maintenance cost was provided by Altus based on a road length of 1000 m; the 1000m value has been extrapolated by Dillon and applied to the specified access road length to determine the site-specific costs. Dillon combined the mobilization and 30-year lifecycle estimates with 30 years of the annual operating estimate to find a combined 30-year operations and maintenance estimate based on the information provided by Altus.

Table 9: Operations and Maintenance Costs Estimate

Operations and Maintenance Cost Estimate	Site A	Site B	Site C
1. Total Mobilization Estimate		**$527,330**	
Annual Operating (Site Services) Estimate			
Site Services		$353,401	
Access Road Length	3000 m	200 m	1200 m
Access Road Site Services	$47,850	$3,190	$19,140
2. Total Annual Operating Estimate	**$401,251**	**$356,591**	**$372,541**
30-Year Lifecycle Estimate			
Site 30-Year Lifecycle Estimate		$785,991	
Access Road 30-Year Lifecycle Estimate	$652,050	$43,470	$260,820
3. Total 30-Year Lifecycle Estimate[7]	**$1,438,041**	**$829,461**	**$1,046,811**
Combined 30-Year Estimate			
Total 30-Year Estimate (Line 1 + (Line 2 x30[7]) + Line 3	**$14,002,901**	**$12,054,521**	**$12,750,371**

The assumptions that guided the operations and maintenance cost estimates are as follows:

- Three full time staff, two site operatives, and one collection driver;
- Staff rate of pay $25 per hour;
- Seven Sea-Can's to remain on-site from shipped construction materials;
- Excludes utility costs;
- Excludes costs of collection truck hauling;
- Excludes costs of hauling daily cover material;
- Includes heavy equipment and associated depreciation; and
- The estimate assumed one months' pay for new staff hiring; the amount can be applied to developing staff training as staff will only require one week of training.

These cost estimates were used as part of the decision matrix, and influence the outcome of that process and the recommendation for a preferred site for future development. These costs are intended for use in future budgeting applications, specifically in planning for the development of a new SWM facility.

In correspondence with the CGS, observations and compression testing results on the snow amounts and properties in Resolute Bay were provided. The CGS advised that the snow conditions in Resolute Bay "will undoubtly result in much higher snow removal costs than [the above] data is suggesting" and procurement of more capable equipment would be required to maintain the site in the winter months. Dillon contacted the Municipality to provide cost estimate for snow clearing costs of the roads to the site. The following approximate annual estimate was provided by the Municipality in **Table 10.**

[7] Estimates exclude inflation

Table 10: Approximate Annual Cost of Snow Clearing to the Site

	Value
Length of time (hours per round trip)	1 to 1.25
Frequency of snow clearing (per day)	2x
Equipment Cost (per hour)	$400
Winter Season (October 1 - May 31)	36 weeks
Cost per week	**$4,000 to $5,000**
Annual Cost	**$144,000 - $180,000**

The suggested equipment included a Caterpillar 950H Wheel Loader and a 950M Wheel Loader, or equivalent, with snow plow blade, seven yard snow bucket and snow blower attachments. It was suggested a skid steer would also be required to clear and maintain other areas on-site, such as along the fence line and structures. Given that line items for equipment costs were not provided by Atlus, it is not possible to determine the exact increase in operation and maintenance costs associated with snow clearing in Resolute Bay.

At the request of the GN, Dillon has provided day-to-day annual operational and maintenance cost estimates with the goal of allowing the GN to compare municipalities in Nunavut undertaking similar studies. Based on Dillon's previous experience with similar disposal sites, **Table 11** provides a summary of the annual operation and maintenance costs in alignment with the assumptions presented in planning studies completed for other municipalities. The unit rate assumptions that guided the operations and maintenance cost estimates are summarized in **Table 12.**

Table 11: Operation and Maintenance Cost Estimate for Comparison to Planning Studies Conducted in Other Municipalities

Estimate Components	Unit	Units/ Year	Cost/Unit	Subtotal/ Year	30% Contingency	Total
Staffing Requirements (1.5 Persons)[1]	Hours	3120	$45	$140,400	$42,120	$182,520
Loader[2]	Hours	416	$200	$83,200	$24,960	$108,160
Bulldozer[3]	Hours	208	$250	$52,000	$15,600	$67,600
Leachate Treatment System Management	Lump Sum	1	$6,000	$6,000	$1,800	$7,800
Cover Material	Cubic Meters	2200	$60	$132,000	$39,600	$171,600
Hazardous Waste Shipping	Shipping Container	0.5	$25,000	$12,500	$3,750	$16,250
Metal Shipping	Shipping Container	1	$7,623	$7,623	$2,287	$9,910
Snow Removal[4]	Hours	288	$200	$57,600	$17,280	$74,880

Estimate Components	Unit	Units/ Year	Cost/Unit	Subtotal/ Year	30% Contingency	Total
Berm And Liner Inspection	Lump Sum	1	$20,000	$20,000	$6,000	$26,000
Routine Site Repairs And Maintenance	Lump Sum	1	$10,000	$10,000	$3,000	$13,000
Total			**Total/Year**	**$521,323**	**$156,397**	**$677,720**

[1] Staff pay rate includes allowances for vacation, sick and statutory holiday pay.

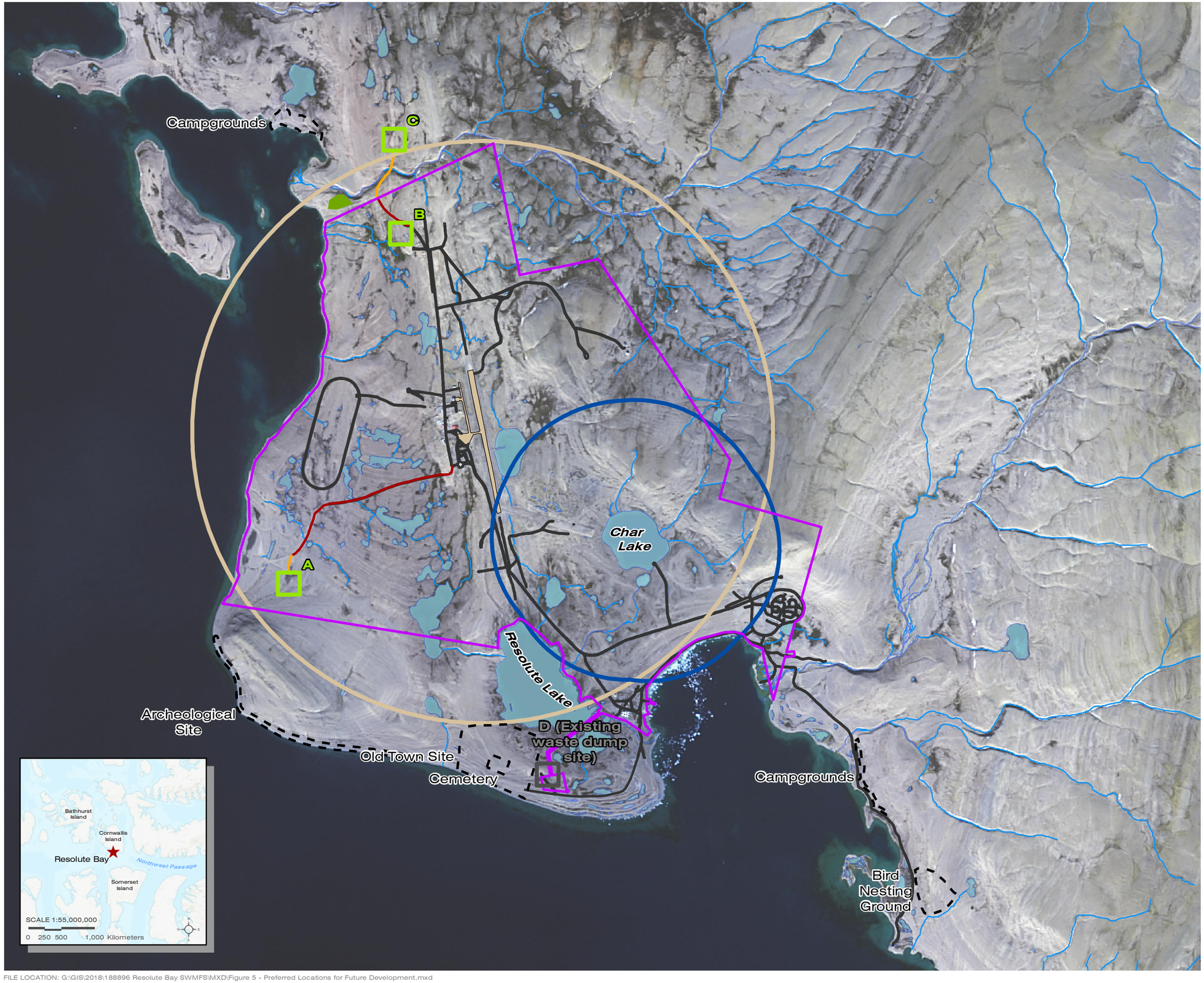
[2] Loader hours are based on an operating time of eight hours per week per year.

[3] Bulldozer hours are based on an operating time of four hours per week per year.

[4] Snow removal is based on a clearing occurrence of eight hours per week, nine months of the year. However, actual hours will vary based on the location of the final disposal site selected.

Table 12: Summary of Operation and Maintenance Cost Estimate Assumptions

No.	Item	Cost/unit	Notes
1	Staff pay	$45/hour/person	Rate includes vacation, sick and statutory holiday pay.
2	Loader	$200/hour	Rate includes labour.
3	Bulldozer	$250/hour	Rate includes labour.
4	Granular materials	$60/$m^3$	
5	Snow Removal	$200/hour	



GOVERNMENT OF NUNAVUT

SOLID WASTE FACILITY SITE SELECTION
RESOLUTE BAY
NUNAVUT

FIGURE 5
PREFERRED LOCATIONS FOR FUTURE DEVELOPMENT

- Preferred Locations
- D (Existing waste dump site)
- Roadway
- Proposed New Road Construction
- Proposed Road Improvements
- Watercourses
- Inuit Owned Land
- Community Parcel Boundaries
- Tupirvik Territorial park (campground)
- Drinking Source Setback (1.5 km)
- Airport
- Airport Setback (4 km)
- Water Body

SCALE 1:50,000

0 0.5 1 2 Kilometers

N W E S

MAP DRAWING INFORMATION:
DATA PROVIDED BY ESRI, DILLON, NRCAN & USGS

MAP CREATED BY: 44PH
MAP CHECKED BY: 46JB
MAP PROJECTION: NAD 1983 UTM Zone 14N

DILLON CONSULTING

PROJECT: 188896
STATUS: FINAL
DATE: 2020-12-17

FILE LOCATION: G:\GIS\2018\188896 Resolute Bay SWMFS\MXD\Figure 5 - Preferred Locations for Future Development.mxd

5.0 Conclusion and Recommendations

5.1 Recommended Future Solid Waste Facility Site Location

Based on the desktop review, a total of six potential sites were identified for discussion and evaluation (**Figure 5**). After meeting with the Mayor and Council, three of the six sites were confirmed as suitable for additional investigation, and the remainder of the sites (D, E, and F) were identified as unsuitable for further investigation. Each of the three preferred sites (A, B, and C) were included in a weighted decision matrix analysis, which indicated that Site A was most favorable for development of a new SWM facility. This preferred site also aligned with the preferences expressed during the consultation meeting with Mayor and Council.

Based on our review of all of the potential locations, and based on our understanding of the community and its solid waste management needs, Dillon recommends that Site A be chosen for the development of a new SWM facility. The area around the Municipality of Resolute Bay is very limited for development options by the access constraints to the east, and by the airport setback to the northwest. Based on this understanding, Site A has been shown to meet the setback criteria for most factors, and allows for all-season access. Although it is located within the 4000 m radius airport setback, the site is not directly aligned with the runway.

Dillon's current understanding is that NAV Canada and the GN's EDT will require a detailed design once the GN proceeds with the design phase of developing the new SWM facility. The initial NAV Canada application was approved for a period of one year from submission, in July 2019, and was based on conceptual design information. EDT has indicated that a final approval is required from NAV Canada prior to EDT approving the site development. Dillon understands that submission of a detailed design is required to be submitted to both NAV Canada and EDT prior to a final approval.

The Bird Hazard Risk Assessment was submitted to and approved by the GN, and Dillon understands that the assessment was also submitted to NAV Canada and the GN's EDT.

5.2 Future Solid Waste Management Facility Design Considerations

The following steps have not been completed at the time of writing this report, and are recommended prior to, or as part of, the detailed design phase of a new SWM site.

5.2.1 Comprehensive Waste Generation Study

In order to gain a comprehensive understanding of the solid waste generation rates in Resolute Bay, a comprehensive multi-week waste generation study is recommended. This study should be completed at the active site, and would monitor all inbound material, including residential, ICI, C&D and bulky waste

disposal over several weeks. This study would allow for a more detailed understanding of the generation and composition of waste from each generating sector, and would provide a representative view of waste generation across seasons, as well as during sea-lift events. The data collected could be used to support the detailed design of the new SWM facility, including design and planning for waste diversion and recycling programs.

5.2.2 Final Site Assessment

Prior to detailed design, it is recommended that an in-person site assessment be completed to decide on the specific site and layout of the SWM facility. Current review has been based on aerial photos, topographic maps, and a drilling program carried out during the winter months. It is recommended that the site be visited in person to 'field fit' the final site footprint to the actual site conditions.

5.2.3 Northern Infrastructure Standardization Initiative

The Nunavut Climate Change Centre has been focusing on the impacts of climate change to infrastructure in the Canadian arctic. As part of their focus, they are working with the Standards Council of Canada (CSA) to address the issues associated with climate change. CSA has established the Northern Infrastructure Standardization Initiative to create standards that are specific to northern infrastructure. A standard for solid waste management is currently under development as CSA R111 Solid Waste Sites in Northern Communities: From Design to Closure, it states it will be available in 2020, however at the time of this report in 2021, it is currently still unavailable. It is recommended that these standard be reviewed once the document is available.

5.2.4 Landfill Freeze back Study Review

Verification of the potential evapotranspiration rates should be investigated prior to and during the detailed design of the new SWM facility to confirm the capacity of the leachate pond and surface evaporation.

5.2.5 Operations and Training Plan

One month prior to the new landfill being operational, it is recommended that three individuals be hired to receive orientation and site operations training. Dillon recommends that the GN develop an internal training for landfill site operators that includes both rural landfill and transfer station operations. The training program is recommended to include both operator training modules, as well as an operations manual, to be accessed by operators as required.

5.2.7 Site Closure

The decommissioning of a disposal site, such as the uncontrolled dump site located in Resolute Bay, will require the preparation of a closure and post-closure plan. It is recommended that closure and post-closure activities outlined in the *SWMNRC –Guidance Document* be followed as best management practices.

Once the new engineered landfill is operational, closure of the existing waste sites can commence. A topographic survey should be performed to confirm the amount of waste to be covered, and the amount of bulky waste to be backhauled for disposal at a licensed facility, such as HHHW and ELV. The topographic survey will serve as the basis to design the landfill closure final grades, estimate quantities of soil/liner requirements, areas requiring soil testing, and additional work required. It may also include taking an inventory of existing clean wood on-site that could be chipped and used as an amendment for daily and final cover leading up to, and upon closure of the dump site. If there is residual wood chips remaining, they can be transported to the new SWM facility to be used as cover material.

The final cover should consist, at a minimum, 600 mm of locally sourced soil material. Alternatively, a geosynthetic liner system may be considered subject to geosynthetic performance specification for cold environments. The final grades shall be sloped to promote positive drainage without erosion and allow for the future long-term use of the site. As part of the closure activities, the construction of drainage ditches, installation of groundwater wells, signs to avoid dumping, and possibly a fence to prevent unauthorized entry or illegal dumping at the site shall be considered.

As part of the post-closure phase, a report describing the final cover system and maintenances schedule, monitoring program, and remediation measures should be undertaken. Remediation measures should include contingences and repair instructions for settlement and erosion of the cover system, surface and groundwater impacts, and repair instructions for leachate seepage. The environmental monitoring of the groundwater and surface water should be performed on an annual basis and be adjusted over time based on the findings. As well, site inspections should be performed at regular intervals to confirm any maintenance requirements (i.e., final cover, monitoring wells, drainage, and fencing). It is important that the records associated with this post- closure plan are kept for reference in the event of future redevelopment of the site or the land surrounding it.

There are currently three disposal locations; the current municipal waste dump site, existing scrap metal waste storage site, and Drop-Off site, as identified in **Section 2.3 Figure 2**. All three sites, one is the dump site and two are diversion sites, will require individual assessments during the summer months to determine final site specific closure plans. It is recommended that the plans include communicating the closure of these sites to the community members.

5.4 Diversion Options

A SWM Regionalization Study is currently underway, and it is recommended that the Regionalization Study's findings be consulted when developing waste diversion and backhauling strategies for the Municipality.

5.4.1 Collaborate with the Polar Continental Shelf Program Facility

It is Dillon's understanding that Resolute Bay's LHO has historically brought their HHHW, including fluorescent lights, emergency batteries, and mercury thermostats, to the PSCP facility for recycling.

Although incineration was not included as part of this study, it is considered to be a viable option for managing organic waste in Resolute Bay. The removal of putrescible waste (mainly food waste) from the waste stream disposed of at their dump site has been shown to reduce bird and animal attraction. As a new SWM facility will take a number of years to be designed and constructed, and it is recommended that the SWM Regionalization Study (currently underway) be consulted for further information on alternate waste disposal options prior to a final design being completed.

Collaboration between the Municipality and the PCSP Facility began during the late stages of this Study, which has resulted in MSW from the Municipality being incinerated as an alternative to disposal at the dumpsite. The Municipality has made arrangements with PSCP to incinerate their solid waste in a batch incineration unit procured from ECO Waste, which is operated by PSCP. The Municipality reports that there have been two Polar bears sited at the current dumpsite this year, in comparison to the 12-14 bears sited scavenging through disposed waste in a typical year. The Municipality further reports that the amount of disposed garbage is significantly less, indicating that a two tonne load of MSW results in less than 200 kg of ash, and emissions have not been visible within the community. By decreasing the annual waste tonnage disposed at landfill, a final 20-year landfill design could be scaled back proportionally to reflect the overall waste volume over a twenty year span. Specific calculations would be required to reflect residual solid waste still requiring landfill disposal, including ash. An engineered landfill will be required in the case that incineration continues to be used, as residual ash will require a final disposal location. As the scope this Study was limited to an engineered landfill and waste transfer facility, specific information related to incineration was not reviewed. This information presented here was authored to reflect the current state of solid waste management practices in the Municipality. Additional work is currently being undertaking by the GN which will include a review of options for a regionalized approach for solid waste management options, including incineration. It is recommended that the Regionalization study be reviewed prior to making final decisions regarding the solid waste management disposal approach for the Municipality.

5.4.2 Segregation of Household Hazardous Waste

To manage environmental impacts, proper segregation and containment of HHHW should be in place at the SWM facility. HHHW, including fuel tanks, should be stored in a location with a liner system in place, and should be protected from snow and rainfall to minimize leaching into soil and groundwater.

5.4.3 Future Use of Current Metal Storage

The option to use the current metal storage area as a future storage area for scrap metal was taken into consideration. This option poses logistical challenges, and was not evaluated as a separate option due to the logistical complications of waste separation and additional handling to move scrap metal from one site to another. The current metal disposal site is considered to be a viable option as a contingency storage location.

5.4.4 Backhauling of Divertible Waste Materials

It is recommended that the Municipality consider the Planning of backhauling hazardous waste, as well as items managed under extended producer responsibility programs, on an as-needed basis, ideally at a minimum of every five years. HHHW would be a high priority for backhauling to avoid future environmental impacts or risks to human health and safety. Other items recommended for backhaul include E-waste, white goods, and tires. This can be conducted similar to what is outlined in the Northern Waste Diversion Program Details (**Appendix J**).

5.4.5 Re-Use and Repair of Household Goods and Building Materials

Due to the logistical challenges associated with waste management in Resolute Bay, it is also recommended that re-use of household goods and building materials be encouraged. These activities can be supported through the design of a safe waste transfer area, where community members can safely drop-off and collect materials and items for re-use. Repairing is also recommended; training could be provided to community members through various channels to enable repairing of goods.

5.5 Interim Alternatives

While decommissioning of the current waste disposal site is preferred, there are mitigation measures that can be taken in the event that funding is not yet available for upgrading to the engineered landfill at the proposed new location. The current site poses health and safety risks to the community and the surrounding environment, we strongly recommend a new site be developed for Resolute Bay that addresses these issues.

5.5.1 Basic Site Improvements

To improve the health and safety of the Municipality the following basic site improvements (**Appendix K**) are recommended to be carried out at the Existing Scrap Metal Waste Storage Site.

Three solid waste disposal and diversion sites are present in Resolute Bay and include the current Waste Dump Site, the Existing Scrap Metal Waste Storage Site and the Drop-Off Site. The scrap metal site is suggested for upgrades, as the current waste disposal site is not considered to be in a suitable location for ongoing use, and the scrap metal site has basic infrastructure in place to use as a starting point for a waste diversion area.

The location of the current waste dump site in Resolute Bay is located in proximity to the shoreline, as well as the proximity to areas of cultural and historical significates. This poses a potential risk to the surrounding environment and community users. The most significant potential risk arises from a lack of a liner for waste materials, specifically HHW, this allows for the migration of hazardous materials to runoff into the surrounding soil and/or ocean. The Waste Disposal Site has no attendant or instructions for users, this further leads to unauthorized dumping at the site and in areas reserved for specific material. Ultimately, diversion activities should be moved to a new location and the current Waste Dump Site grounds should be decommissioned as per the site closure recommendations (**Section 5.2.7**)

Further, arrangements have been made for municipal staff to use the PSCP facility at predetermined times for the incineration of municipal waste. It is assumed that all municipal solid waste, residuals and incineration by-products are managed by the PSCP and a municipal landfill is not required to meet Resolute Bay's disposal needs.

At the time of reporting the following items have been addressed throughout the duration of the study:

- Providing Options for Basic Site Improvements.

6.0 Closing

This report was prepared exclusively for the purposes, project, and site locations outlined in the report. The report is based on information provided to, or obtained by Dillon Consulting Limited ("Dillon") as indicated in the report, and applies solely to site conditions existing at the time of the site investigation(s). Although a reasonable investigation was conducted by Dillon, Dillon's investigation was by no means exhaustive. Rather, Dillon's report represents a reasonable review of available information within an agreed work scope, schedule, and budget. Further review and updating of the report may be required as conditions and the regulatory and planning frameworks change over time.

This report was prepared by Dillon for the sole benefit of our Client. The material in it reflects Dillon's best judgment in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. Dillon accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

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