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DEVELOPMENTAL CONSTRAINTS OF GRANULAR RESOURCES FOR THE MACKENZIE GAS PROJECT WITHIN THE GWICH'IN SETTLEMENT AREA

Alexander Cicuttini
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Dr. Wei – Chau Xie, P. Eng.
Associate Chair, Undergraduate Studies
Department of Civil Engineering
University of Waterloo
Waterloo, Ontario
N2L 3G1

Dear Sir:

This report, entitled "Developmental Constraints of Granular Resources for the Mackenzie Gas Project Within the Gwich'in Settlement Area", was prepared as my 2A Work Report for the Department of Indian and Northern Affairs Canada. The purpose of this report is to evaluate potential granular borrow sites along the Mackenzie Gas Pipeline in terms of environmental impacts and community demands. This report is my second of four work reports required by the Department of Civil Engineering at the University of Waterloo.

The Department of Indian Affairs and Northern Development (DIAND) is primarily responsible for meeting the federal government's constitutional, treaty, political, and legal responsibilities to First Nations, Inuit, and Northerners. The head office is located in Hull, Quebec.

Throughout my work term, I was employed in the Land and Water Management Division, and was supervised by Robert Gowan, P. Geol. The division is responsible for managing the use of lands, granular materials, and water resources in Canada's North.

The report was written by me and has not received any previous academic credit at this or any other institution. I would like to thank Robert Gowan and Steve Rozak for assisting me during the preparation of this report. I received no other help with this report.

Sincerely,

Alexander Cicuttini
Geological engineering
ID# 20065561

Canada

Developmental Constraints Of Granular Resources For The Mackenzie Gas Project Within The Gwich'in Settlement Area

Alexander Cicuttini
2A Geological Engineering
University of Waterloo
20065561

October 2003

Summary

The Mackenzie Gas Project is planning to connect three gas fields on the Mackenzie Delta to southern markets. The gas fields will be connected by a pipeline down the Mackenzie Valley. The project is being developed by five companies. Four of them are oil companies and one is an aboriginal group. The aboriginal group is made up of representatives of the various aboriginal groups affected by the pipeline. The project is expected to fill the forecast demand for natural gas, which is projected to be 40% above present levels by 2020. The Proponents of the project, plan for completion by 2008.

This report focussed on the 200km section of pipeline that passes through the Gwich'in Settlement Area. Around this section of pipeline, a development zone of 15km on either side of the pipeline was established. The zone encompassed 208 granular material sites. The history of the last glaciation was included to explain why the granular materials occur in the region. A description of each site was created in Appendix D. The description of each site included material classification, how or when the site is accessed, extraction methods, ground ice content, location of site, and environmental concerns. From that information, 35 potential sites were recommended for further study. Further study involves full environmental assessments on each site. The environment in permafrost regions is especially sensitive, and only the least disruptive sites should be developed.

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1.0 Introduction

Granular materials in the northern regions of Canada are rare and very important for development. This and a combination of difficult terrain, lack of transportation links, great distances between communities, and the difficulties of extraction, all increase transportation costs. Since developers want to keep costs down, they tend to exploit granular materials that are close to them. Local shortages caused by initial development may hinder further development in an area. This is why the Department of Indian Affairs and Northern Development (DIAND) promotes sustainable development of granular materials in northern Canada. Its goal is to allow development in the present while providing for future needs.

The most recent development to put a strain on available granular materials is the proposed Mackenzie Gas Project. This project is proposing to build a gas pipeline from the Mackenzie Delta, on the Beaufort Sea, down the Mackenzie Valley, and into northern Alberta. The pipeline will carry natural gas produced in the Mackenzie Delta. If construction plans are approved, numerous granular borrow sites will have to be developed. The project will be financed by Imperial Oil Resources Ventures Limited, the Aboriginal Pipeline Group, ConocoPhillips Canada Limited, Shell Canada Limited, and ExxonMobil Canada Properties.

The pipeline will pass through four distinct settlement regions in the Northwest Territories (NWT). They are the Inuvialuit Settlement Region, the Gwich'in Settlement Area, the Sahtu Settlement Area, and the Deh Cho Region. This report, which is intended to be the first in a series that may eventually encompass all the regions that the pipeline passes through, will focus on the granular resources within the Gwich'in Settlement Area. A development zone, 15km on either side of the pipeline, will be setup in the Gwich'in Settlement Area, and the granular resources within it will be evaluated. The evaluation will determine if the viability of each site is such that it can be used to provide granular materials for the pipeline.

Since the Mackenzie Gas Project is still in its preliminary design stage, information contained in this report could change. This is because the final route of the pipeline has not been chosen, and could be shifted before construction begins. As such, this information is correct as of April 2003.

2.0 The Gwich'in Settlement Area

The Gwich'in Settlement Area is located in the Northwest Territories of Canada (Refer to Figure 1). It borders the Yukon Territory, as well as the Inuvialuit Settlement Region, and the Sahtu Settlement Area (Refer to Figure 2). The settlement region and the settlement area are distinct land claims within the NWT.

2.1 The Gwich'in Land Claim

According to the Gwich'in Land Use Planning Board website at <http://www.gwichinplanning.nt.ca/theRegion.html>, the Gwich'in Comprehensive Land Claim Agreement was officially signed in April 1992. The Land Claim transferred title to 56,935 km² of land to the Gwich'in. The Land Claim also gave the Gwich'in surface and subsurface rights to specific areas within the claim. This allows the Gwich'in to control development within those areas. The rights transferred to the Gwich'in will affect the proposed Mackenzie Gas Pipeline. Figure two shows that the majority of the pipeline passes through land in which the Gwich'in control the surface and subsurface rights. This means that the Gwich'in control the granular materials needed to complete the pipeline. Consultation with the Gwich'in will be required before approval is given to develop any granular borrow sites.



Figure 1: Gwich'in Settlement Location in Canada

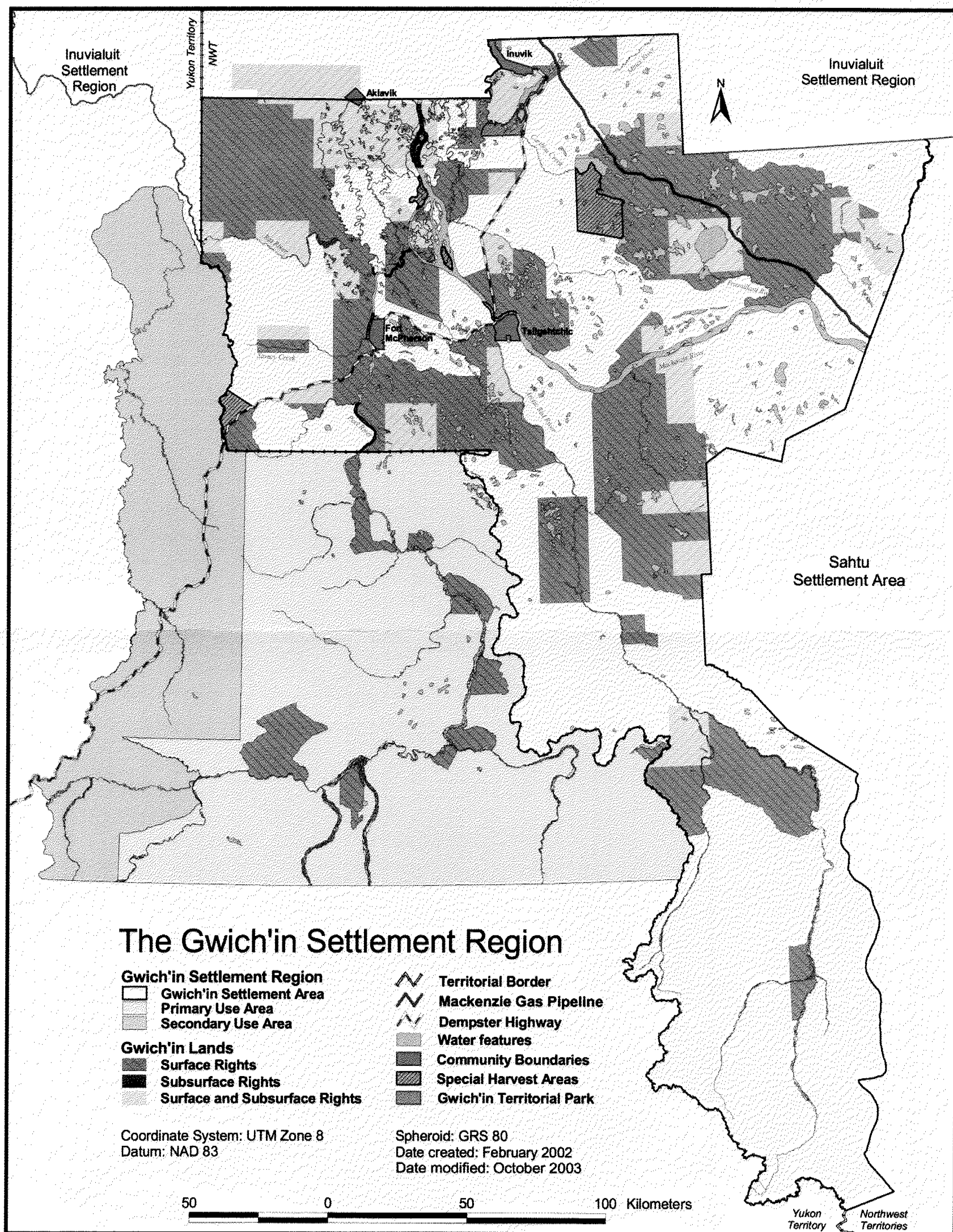


Figure 2: Gwich'in Settlement Area and Mackenzine Gas Pipeline

Produced by the Gwich'in Land Use Planning Board
Pipeline added by Alex Cicuttini, INAC

NAHN' GEENJIT GWITR'IT T'IGWAA'IN / GWICH'IN LAND USE PLAN

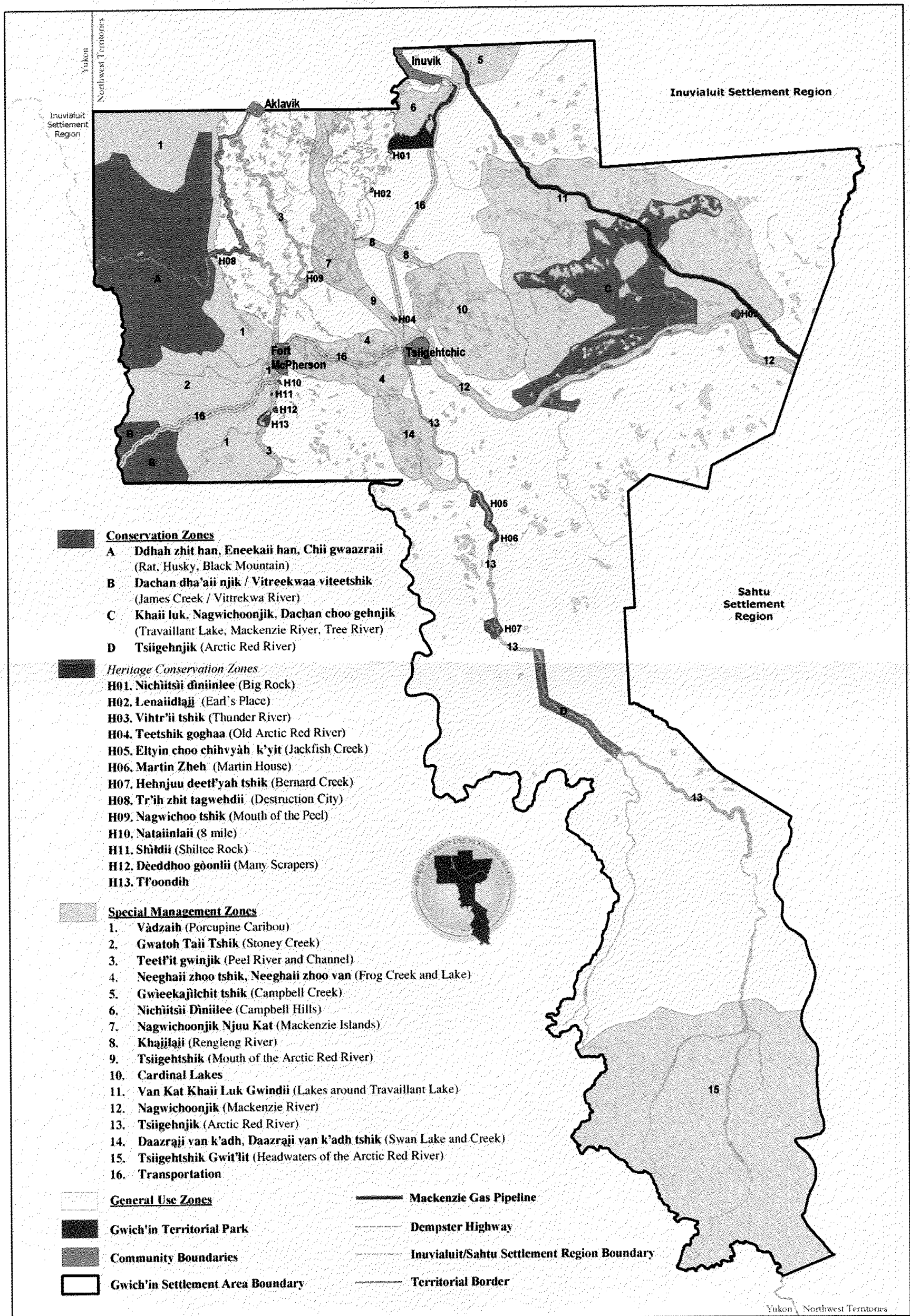


Figure 3: Gwich'in Land Use Plan and Mackenzie Gas Pipeline

Produced by the Gwich'in Land Use Planning Board
Pipeline added by Alex Cicuttini, INAC

2.2 The Gwich'in Land Use Plan

The Gwich'in Land Use Plan was approved by the Gwich'in Land Use Planning Board in August 2003, after six years of consultation. The Plan established four types of land use zones within the Settlement Area. The zoning system was introduced to control development in specific areas. This promotes sustainable land use and restricts development in sensitive or historically significant areas. The zones are conservation, heritage, special management, and general use (Refer to Figure 3). There are four conservation, and 12 heritage conservation zones. These zones restrict oil and gas exploration and development, mineral exploration and development, granular extraction, transportation, waste disposal, communication, power development, and commercial renewable resource activities. There are 16 special management zones. Within these zones, all land uses are permitted, if all regulatory approvals are obtained. Anything not covered by the previous zones has been designated a general use zone. General use zones impose no conditions on proposed developments (Gwich'in Land Use Plan, 2003).

Figure three shows that the pipeline crosses through a conservation zone. According to Section 4.2.4 of the Gwich'in Land Use Plan, this will be allowed as long as the Proponents follow the rules contained in that particular section. The approval of the Land Use Plan means the development of granular materials in any conservation zone is not allowed (Gwich'in Land Use Plan, 2003). The Land Use Plan only allows the Proponents to investigate sites within a zone. Sites 4.59 and 4.60 are examples of this. These sites are located in the conservation zone around Travaillant Lake, and the Planning Board has given its approval to perform a site investigation on them. The Land Use Plan would have to be amended if the Proponents wanted to develop those sites. The existence of granular materials outside that conservation zone makes developing any sites inside it redundant.

2.3 Population

The Gwich'in Land Use Planning Board website at <http://www.gwichinplanning.nt.ca/theRegion.html>, states that as of 2003, the population of the Gwich'in Settlement Area was approximately 5100 people. Of the total population, approximately 2400 people are Gwich'in. Most of the population live in four

communities. They are Aklavik (population 727), Inuvik (population 3,296), Fort McPherson (population 878) and Tsiigehtchic (population 162). Inuvik is the head of government for the region and is a base of operations for oil and gas exploration.

2.4 Physical Geography

The Gwich'in Settlement Area spans two physiographic regions, the Anderson Plain, and the Peel Plain. The Anderson Plain is located north of the Mackenzie River, and the Peel Plain is south. The majority of the granular sites in the Gwich'in Settlement Area are on the Anderson Plain, while only a few are on the Peel Plain. The sites on the Peel Plain are the sites south of the Mackenzie River (Hardy, 1986).

2.4.1 The Anderson Plain

The Anderson Plain is predominantly an upland area with topography that is generally 300m above sea level (Hardy, 1986). The Plain is underlain with shale, sandstone, and carbonate rocks that are Devonian to Cretaceous in age (Northern, 1995). The bedrock is frequently exposed in the sides of the valleys that cut across the Plain. The carbonate rocks and sandstone are resistant to weathering and form bedrock ridges and cliffs, while the shale bedrock is very unstable if ice rich and produces many flow slides. Drainage on the Anderson Plain is moderately developed (Hardy, 1986). Most of the borrow sites mentioned in this report are located on the Anderson Plain.

2.4.2 The Peel Plain

The Peel Plain is a low-lying plain that is incised with river valleys, and interspersed with muskeg. The Plain is underlain with shale, sandstone, and carbonate rocks that are Paleozoic to Cretaceous in age (Northern, 1995). The bedrock geology of the Anderson Plain also occurs on the Peel Plain, although the muskeg areas have formed because the Peel Plain is poorly drained (Hardy, 1986).

2.4.3 Glacial History

The borrow sites on the Anderson and Peel Plains exist because the region was heavily glaciated by the Laurentide Ice Sheet 16,000 years ago (French, 1983). The

glacier modified the landscape and deposited large amounts of granular materials as it retreated. The granular materials can be found in moraines, eskers, kames, and outwash plains. A moraine is the leftover material that is marginal to a glacier's advance. It is not sorted, so processing is required to extract useable material. An esker is a ridge of material that was once the bed of a river running through a glacier. It is sorted, which means that it contains high quality material. A kame is a mound of stratified drift composed of sand or gravel that was washed off a glacier. It is stratified, which means that it is layered. The layering of similar sized particles keeps processing costs down. An outwash plain is a broad plain formed when glacier meltwater carries sand and gravel away from the foot of a glacier. An outwash plain is a good source of material, but if its thickness is limited, it could make developing a borrow site too expensive (EBA, Volume 1, 1974).

3.0 The Mackenzie Gas Project

The idea of a Mackenzie Valley gas pipeline was first proposed in the mid 1970s. The pipeline was proposed as a way to bring natural gas, discovered on the Mackenzie Delta, to markets in southern Canada and the USA. In 1976, the Government of Canada established the Mackenzie Valley Pipeline Inquiry, headed by Mr. Justice Thomas R. Berger, to comment on the feasibility of building the pipeline. When all information was evaluated, the Inquiry recommended that a moratorium of ten years be placed on all gas development within the Mackenzie River Watershed. The moratorium was placed on development so that native land claims could be resolved (Berger, Volume 1, 1977). It would be 25 years, with the settlement of most land claims, and a forecast of increased natural gas demand, before the idea of a Mackenzie Valley Pipeline was resurrected (Imperial Oil, et al, 2003).

3.1 Project Proponents

In 2002, four Canadian oil companies, and an aboriginal group, combined finances to develop plans to build a natural gas pipeline from the Mackenzie Delta to northern Alberta. The first company is Imperial Oil Resources Ventures Limited. The company joins the project as operator of the Mackenzie Valley Pipeline, and the Taglu

gas field. This field is one of the anchor fields that will feed natural gas into the pipeline. The second company is the Aboriginal Pipeline Group. The company was formed by representatives of various aboriginal groups in the Northwest Territories to represent a 33.3% stake in the pipeline. The third company is ConocoPhillips Canada Limited. It owns and operates 75% of the Parsons Lake gas field. This field is the second anchor field. The fourth company is ExxonMobil Canada Properties. It owns and operates 25% of the Parsons Lake gas field. The final company is Shell Canada Limited. It owns and operates the Niglintgak gas field, which is the third anchor field for the pipeline (Imperial Oil, et al, 2003).

3.2 Project Description

The pipeline Proponents plan to build a buried pipeline, 1420km long, from the three anchor fields on the Mackenzie Delta to northern Alberta. The pipeline is expected to follow the historical routing of previous proposals, but the routing near Travaillant Lake has been modified and is subject to further change. The pipeline routing was modified to avoid sensitive areas. The three anchor fields, Taglu, Parsons Lake, and Niglintgak, are estimated to hold 164 billion cubic meters of natural gas. That amount will meet the rising demand for natural gas in Canada and the USA. The demand for natural gas is expected to grow by 40% by 2020. The Proponents plan to be pumping gas down the Mackenzie Valley by 2008 (Imperial Oil, et al, 2003).

3.2.1 Pipeline through Gwich'in Settlement Area

The pipeline plan shows that approximately 200km of pipeline will pass through the Gwich'in Settlement Area (Refer to Figure 2). The pipeline will be built on a cleared right-of-way that will be 40 to 50 meters wide. It will also require substantial amounts of granular materials. The preliminary design plan calls for the development of 12 granular sites. Seven of those sites occur on Gwich'in Private Lands. This means that their development will depend on approval from the Gwich'in and the Gwich'in Land Use Planning Board. The remaining sites are on General Use Lands. Their development requires Federal Government and Planning Board approval. Most of the proposed sites are within 6km of the pipeline. By being close to the pipeline, transportation costs will be

lowered (Imperial Oil, et al, 2003). Section 2.2 states that the construction of the pipeline through a conservation zone is allowed, if the rules in the Land Use Plan are followed. The routing of the pipeline changed from the original 2001 routing to a new routing in 2003. The changes were made to the pipeline route close to Travaillant Lake. They occurred between kilometer post 200 and kilometer post 250. The change moved the pipeline 5km north of the 2001 routing. The changes were made to meet the rules in the newly approved Land Use Plan (Imperial Oil, et al, 2003). The map in Appendix B shows granular sites that are within 15km of the pipeline. This means there are alternatives to using the 12 sites currently proposed by the Proponents. The closest alternatives to a Proponent site are sites that are above or below the Proponent site in Table 1 or Table 2 in Section 6.2. Alternative sites may have to be considered if Proponent sites do not meet environmental concerns.

4.0 Borrow Site Information

A “development zone”, 15km on either side of the pipeline, was established in the Gwich’in Settlement Area. The 15km distance was chosen because it allows for local re-routing of the pipeline in later planning stages. Most of the sites were identified in previous pipeline studies. The development zone contains 208 granular sites. Some of the sites are grouped together under one site number. This means Appendix D contains the summaries for each site number, instead of each site. Appendix D summarizes 126 sites. Most of the summaries come from Hardy (1986) and EBA Volume 1 – 4, but sites 2.57, 2.59, and 2.61 were updated from information in a report from Golder (2003). Sites 2.51 and 2.64 were updated from information in a report from Northwest (2003), and from the same report, sites 20.038 and 20.039 were added to the map in Appendix B, and summarized in Appendix D. The site numbers on the map in Appendix B are indicative of the numbers given to each site in the Hardy (1986) report. That report pulled information from previous reports to describe the borrow sites in the Mackenzie Valley.

4.1 Borrow Site Classification

Each granular site labelled on the map in Appendix B, and mentioned in Appendix D, falls into one of five classifications for granular materials. The

classifications are from class one to class four material, as well as a class for non-granular material. Class one materials are granular materials that contain sand and gravel suitable for concrete aggregate. Class two materials are granular materials that contain sand, gravel, and some silt. They are used as fill material for embankments, and road works. Extensive processing is needed before they can be used as a concrete aggregate. Class three materials are granular materials that contain poorly graded sand, gravel, and silt. They may be suitable for general (non-structural) fill, but are not suitable as concrete aggregate because processing costs are too high. Class four materials are granular materials that contain more silt than sand and gravel. Class four materials are considered unsuitable for most construction purposes. Non-granular materials include bedrock and materials such as clay for special uses (e.g. liners). The bedrock is only available if it is blasted, quarried, and crushed (Hardy, 1986). Within the development zone there were zero class one sites, 27 class two sites, 117 class three sites, 17 class four sites, and 47 non-granular sites.

4.2 Access to Sites

The development of any granular borrow site will require the construction of an access road. The road would be from the borrow pit to a point on the pipeline right-of-way. If summer access is needed, the road must be built with at least 0.6m (2 ft) of sub-grade and 0.1m (6in) of gravel surfacing. The sub-grade increases to 1.2m (4ft) if the road passes over thermally sensitive terrain. Winter access requires ice roads over frozen lakes and packed snow roads over land. Although winter roads are easier and cheaper to maintain, they can only be built when everything freezes. This limits the time available to move material off site. Summer roads are permanent, but are expensive to build and maintain. The type of road depends on the method of extraction chosen, and the distance between the site and the pipeline (EBA, Volume 1, 1974).

4.3 Extraction and Processing Methods

Many different methods can be employed to extract granular materials from the earth. In northern Canada, the method used depends upon the ice content of the material. If the ice content is high, blasting or ripping will be required to free the material. Once

free, the material is stockpiled over a summer, to thaw it, and then processed. Since the stockpiled material is not useable until after the summer, transportation is usually done in the winter. If the ice content is low, conventional extraction methods are employed. This indicates the use of dozers, backhoes, and trucks to pick up material and transport it off site. The material does not need to be thawed, and can be transported as soon as it is processed. For bedrock deposits, blasting, quarrying, and crushing is required before the material is transported (EBA, Volume 1, 1974).

4.4 Ground Ice Content

The Gwich'in Settlement Area is located in a region of continuous permafrost. This means that portions of the ground are frozen year-round. Granular deposits containing lots of ice are harder to extract than deposits that contain very little ice. The degree of ice content is a percentage of visible ice by volume of material. It is broken down into four categories. They are none, low, medium, and high. None refers to 0% visible excess ice or unfrozen material, low refers to less than 10% visible excess ice, medium refers to 10 – 30% visible excess ice, and high refers to visible excess ice greater than 30% (Hardy, 1986).

4.5 Location

The location of each borrow site within the development zone can be seen on the map in Appendix B. There are also a number of sites outside the zone. Those sites were included in this study because communities were using them, or they gave a better representation of the sites in the area. The exact location of each site is given in Universal Transverse Mercator (UTM) zone and coordinates, as well as latitude and longitude. The location is found in the source summary tables in Appendix D. Since the sources are not regularly shaped, the location represents an estimated “centre-of-gravity” point (Hardy, 1986). The distance from the pipeline to each site is also given in those summary tables. The distance is measured from the centre of each site, or group of sites, to the nearest point on the pipeline.

4.6 Estimated Recovery Depth

The estimated recovery depth of a borrow site represents the maximum recoverable thickness of the granular material in the site. This is estimated from initial surveys and borehole evidence (Hardy 1986). A deeper site will not affect the environment as much as a shallow site because deeper sites disrupt a smaller area. Only the least disruptive sites should be developed. Some sites in the summaries in Appendix D do not include information on the depth of the material at the site. This is because no testing was done, or the suitability of the site did not warrant the expense of testing.

4.7 Overburden Thickness

The overburden thickness of a site is an important issue when determining the cost of development. If the overburden is too thick, the cost of removing it will make developing the borrow site unprofitable. The overburden is the material, usually fine-grained or organic, overlying a granular deposit. It must be removed before the granular material can be extracted. It is usually scraped off and stockpiled on the side of the deposit. It will be used to cover the borrow site after it is depleted. This will help restore the site to pre-development levels (Hardy 1986).

4.8 Community Demands

The community of Inuvik currently extracts granular material from six sites, but only two of those sites are close to the study area (GVM Geological, 1995). The two sites are 2.48, 20km away from the pipeline, and 2.50, 21km away from the pipeline. The sites were developed to provide granular materials to Inuvik. The community of Inuvik uses that material to maintain, and expand its roads, and airport (Hardy BBT, 1988). The two sites were not recommended for development. No other communities within the Gwich'in Settlement Area use granular sites that are within the study area.

5.0 Environmental Concerns

Environmental concerns will be the number one reason why sites in the development zone are not recommended for development. Community demands on a site will be the second reason, but since most sites are far from communities, it will be a

minor reason. Environmental concerns are high because permafrost regions are easily damaged and natural restoration takes a long time (Environment, 1974).

5.1 Habitat Loss

Before a granular deposit is developed, overburden, the plants and soils, must be removed. This results in the temporary loss of habitat for moose, caribou, hares, lynx, marten, fox, beaver, muskrat, squirrel, birds, wolf, and bear. These animals use the plants for food and protection, and the small ones are food for larger animals (EBA, Volume 1, 1974). Revegetation of the site, after the deposit is depleted, is possible, but it will be years before it is fully recovered. If granular deposits are thin, then a relatively large area will be disturbed to recover the quantity of material needed. A site should be developed only if it minimizes the area disturbed, and thus, the impact it has on the wildlife around it.

5.2 Erosion

Land subsidence, gulying, slumping, and solifluction (material flow) are serious problems that occur when high ice content soils are disturbed. The disruption occurs when clearing of the insulating vegetation layer is done for access roads and borrow site development. The removal of the insulating layer causes the ice in the soil to melt. On level terrain, the melting causes subsidence and ponding. On sloped terrain, the melting causes slumping, gulying, and solifluction. If these processes occur under or across a road, they can make the road impassable. If they occur beside a river, they increase the sediment load of that river. These erosional problems can be prevented by accessing the site in the winter, limiting the time from clearing of vegetation to development, or not developing at all (Environment, 1974).

5.3 Aquatic Damage

Extensive lake and river systems exist within the Gwich'in Settlement Area. Almost all are in pristine condition, and have barely been touched by humans. The development of access roads and borrow sites could have adverse effects on these water systems. The rivers and lakes support healthy fish populations. Fisheries cannot tolerate

the blockage of migration routes, or the increase in sediment load. Access roads must be designed to cross the least number of creeks, and produce the least amount of runoff. Borrow sites should be designed to limit the amount of water they draw from lakes and rivers. Designs should also include settling ponds to clear sediment from that water before releasing it back into the environment (EBA, Volume 1, 1974). All efforts should be made to preserve the integrity of the water system. Sites deemed to be in sensitive areas, or unable to avoid aquatic damage, should not be developed.

5.4 Archaeology

Archaeological evidence suggests that the study area is an important archaeological region. This means that any site development could encounter relics of great historical significance. Site surveys prior to development should be conducted to identify relics. A full archaeological investigation should be initiated if a survey uncovers positive proof. The resulting investigation would delay development of that borrow site (EBA, Volume 1, 1974).

5.5 Environmental Sensitivity

The environmental sensitivity number on each source summary in Appendix D is a measure of how much a site affects the environment around it. It is simply a range of values with 100 being the least evasive, and 500 being the most evasive. This method of scoring environmental sensitivity was developed by F.F. Slaney and Company Limited, and was used to rate the sites mentioned in EBA Volume 1 – 4. The final number is arrived at by adding up the score determined in a number of sub-categories. The sub-categories take into account the developmental impacts on terrain, vegetation, mammals, birds, fish, archaeology, aesthetics, and site restoration. A site with a number between 100 and 250 is low in environmental risk, between 251 and 350 is moderate in environmental risk, and sites above 350 are high in environmental risk. Low risk sites are considered good candidates for development, moderate risk sites have special considerations, and high-risk sites should be avoided altogether. The special considerations for moderate risk sites may include building a bridge to reach the site, or

being too close to a river. To reach production, extra money and time would be required to develop those sites (EBA, Volume 1, 1974).

6.0 Borrow Sites

Of the 208 sites within the development zone, only a fraction will be recommended for development. Of the sites that are not recommended, some fulfill community needs, need to be saved for future needs, contain unsuitable material, or are too environmentally sensitive to develop. The sites that are recommended for development can be found in Section 6.2.

6.1 Reference Information

The authors of the Hardy (1986) report assigned unique numbers to each site, but included a cross reference number to track down the report that originally described the site. The cross-referenced reports can be found at the end of Appendix D. The EBA reports, Volume 1 – 4, also pulled information from other reports, but do not include a cross reference number. The EBA reports include environmental sensitivity rankings, while the Hardy (1986) report does not. The similarities between the Hardy (1986) report and the EBA reports are such that information from one can be used to supplement information from the other. With that in mind, the source summaries in Appendix D include information derived from all five reports, as well as reference material mentioned in Section 4.0.

6.2 Recommended Borrow Sites

Of the 126 numbered sites in Appendix D, 62 sites were determined to be good candidates for development. Of those 62 sites, 35 fell within the development zone, and 27 were beyond it. The sites beyond the development zone require longer access roads. This makes developing them more expensive, and increases the environmental disruption to the surrounding area. Sites within the development zone should be developed first and any shortages should be filled by sites outside the zone. The sites inside the development zone are found in Table 1, while the sites outside the zone are found in Table 2. The data

are grouped in terms of the distance they are from the pipeline. Within those groups each site number is given, along with the kilometer post that is closest to it.

Table 1: Recommended Sites Inside the Development Zone

0km to 5km		5.1 km to 10km		10.1km to 15km	
Site Number	Kilometer Post	Site Number	Kilometer Post	Site Number	Kilometer Post
20.038	125	*20.039	138	4.05	180
2.60	150	*2.51	146	4.08	185
*2.64	170	2.61	145	5.11	295
4.28	200	*4.26	200	5.25	330
*4.24	209	*4.20	225	5.29	330
*4.23	214	4.21	230		
*4.38	218	4.40	240		
4.36	220	4.54	280		
4.37	220	4.101	285		
*4.39	226	4.102	285		
4.100	280	5.15	320		
*4.103	288				
5.12	290				
*5.14	297				
5.17	320				
5.23	320				
5.24	325				
5.30	330				
5.31	330				

*Represents sites currently proposed in the Proponents' Preliminary Information Package

Table 2: Recommended Sites Outside the Development Zone

15.1km to 20km		20.1km to 25km		25.1km to 30km	
Site Number	Kilometer Post	Site Number	Kilometer Post	Site Number	Kilometer Post
4.65	210	4.03	180	2.55	140
4.112	220	4.66	190	4.48	290
4.19	235	4.67	190		
4.18	245	4.107	280		
4.52	280	4.108	280		
4.53	280	4.49	290		
4.50	290	5.19	290		
4.110	290	5.18	295		
5.06	300	5.05	300		
5.20	300	5.09	310		
5.16	320	5.26	340		
*5.20	320				
5.21	320				
5.27	340				

*Represents sites currently proposed in the Proponents' Preliminary Information Package

The asterisks in Table 1 and Table 2 represent granular sites that are currently being evaluated by the pipeline companies. There are 12 asterisks, but the actual number

of sites is 16. This is because the Proponents have labeled four sites as having an 'A' site and a 'B' site. The 'A' and 'B' sites have been combined under one site number to get 12 sites. An example of this is site 4.103. Before it was combined under one site number, it was 4.103A and 4.103B. Combining 'A' and 'B' sites was done because detailed design information was not available as of the date of publication, and could not be incorporated on the map in Appendix B.

It is recommended that the development of a large number of small sites be avoided in favor of a few large sites. This would disrupt a smaller area. It is also recommended that a full environmental assessment be performed on any site that is to be developed for the pipeline. The assessment should cover how the site is going to be developed, how it will be accessed, plans to prevent environmental damage, abandonment procedures, and restoration procedures.

7.0 Conclusions

Within the Gwich'in Settlement Area, 35 granular borrow sites have been recommended as suitable for development. These are the sites within 15km of the pipeline. These sites provide the Mackenzie Gas Project with the granular materials needed to build a pipeline down the Mackenzie Valley. The chosen sites do not take material away from communities that need it, and meet preliminary environmental concerns. The preliminary environmental concerns are only a surficial representation of how much a site affects the environment around it. For this reason, further environmental assessments should be completed on each potential site. Any problems discovered in a review could be fixed while still in the design stage, or the site could be scrapped altogether. The review process will decrease the number of available sites until only the least disruptive sites are left. Environmental disruption should be kept to a minimum because permafrost regions are very sensitive. The natural restoration of disrupted areas takes a long time.

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APPENDIX A

Procedures to Create Appendix B Map

Appendix A: Procedures to Create Appendix B Map

The map in Appendix B was created by utilizing procedures created by Calvin Simmie. He created those procedures in his report entitled “Developing Northern Granular Resource Maps Using ArcView GIS”¹, which was completed during his work term with DIAND. The procedures he created explained how to convert digitized data from QuickMAP to MAPINFO, and finally to ArcView. The granular sites and pipeline were first digitized from paper maps, and then converted to ArcView shape files using Calvin’s procedures.

The granular sites were digitized from a Hardy (1986)² paper map. The report the map came from had researched granular materials along the Mackenzie Valley. The pipeline was digitized from paper maps contained in the Mackenzie Valley Preliminary Information Package³. The digitizing tablet is located in Steve Rozak’s office, which is room 615A.

When the granular sites and the pipeline were converted to the right format, they were added to a new ArcView View. The granular sites were then labelled using the ‘label’ function, and a buffer was set up around the pipeline. The buffer was created using the ‘create buffers’ function under the theme menu. Once that was completed, a base map of lakes and rivers was added to the view. The outlines for the lakes and rivers came from the ‘Global (G:)’ drive, and the file that filled most of them in, came from Mythily Thadchanamoorthy, who is working for Tom Duncan. Mythily also supplied the land claim boundaries. The lakes, rivers, and land claim boundaries were then labelled using the ‘label’ function.

When everything was labelled, a new layout was created. The layout was named ‘Final Map’ and was set to portray the map at a scale of 1:250,000. The latitude and longitude grid was added using the ‘graticules and grids’ button, and a custom legend was added using the ‘custom legend tool’.

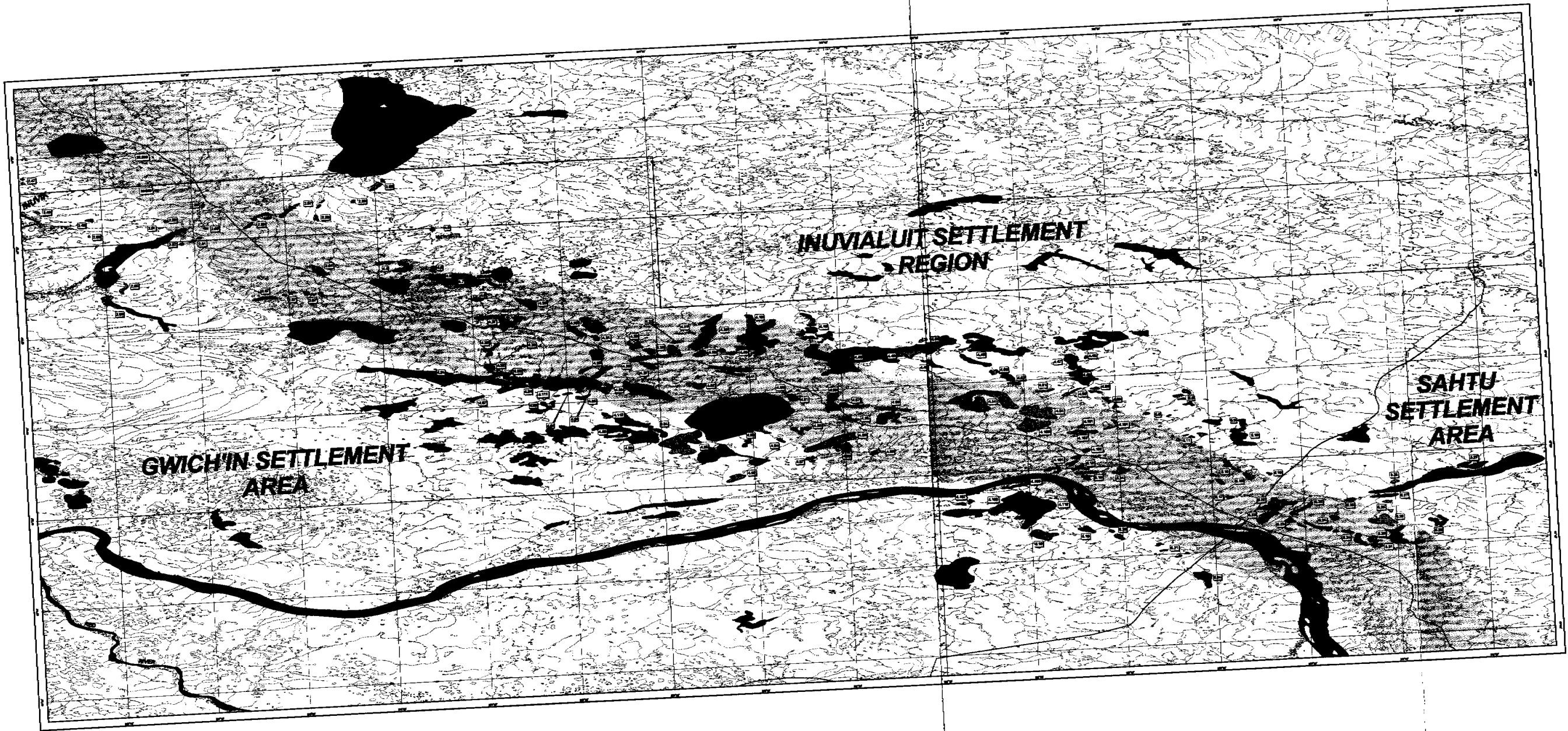
The map was printed by converting the layout to PDF format, and then printing the PDF on the plotter on the 17th floor. Len Worrell helped with this print job.

- 1) Simmie, Calvin (2002), Developing Northern Granular Resource Maps Using ArcView GIS. Prepared for Indian and Northern Affairs, and the University of Waterloo Faculty of Environmental Studies.
- 2) Hardy Associates (1978) Ltd. (1986), Granular Resource Potential, Lower Mackenzie Valley. Calgary, Alberta. Submitted to Indian and Northern Affairs Canada.
- 3) Imperial Oil, APG, ConocoPhillips, Shell Canada, ExxonMobil (2003), Mackenzie Gas Project, Preliminary Information Package, Volume 2: Project Maps. Submitted to Indian and Northern Affairs Canada.

APPENDIX B

Granular Materials Along The Proposed
Mackenzie Pipeline Within The
Gwich'in Settlement Area

Granular Materials Along The Proposed Mackenzie Pipeline Within The Gwich'in Settlement Area



Legend

- Proposed Pipeline Alignment
- Shaded Development Zone
- Land Claim Boundaries
- Material Classification
 - Class 1
 - Class 2
 - Class 3
 - Class 4
 - Class M3

1:250 000

0 10 20 Kilometers



Part of a report entitled: Developmental Constraints
Of Granular Resources For The Mackenzie Gas Project
Within The Gwich'in Settlement Area

Prepared By: Alex Coudine
Date: December 2003

APPENDIX C

Digital Copy Of Report And Map

APPENDIX D

Granular Source Summaries

The following tables represent summary information on the borrow sites within the development zone. The cross reference number was assigned by Hardy (1986), and a reference list will follow at the end of the appendix.

NA – means not available/applicable

ND – means not determined

Some non-granular material volumes were deemed unlimited because the sites are bedrock outcrops.

Granular Material Source Number 2.47

Cross Reference Number			3, 9	
Material	Classification Description		Class 3 Sand and gravel, some silt/clay	
Location	UTM Coordinates Zone	Latitude Longitude	552,500E, 7, 592,000N 8	N68.435 W133.719
Distance to Pipeline (km)			15.5	
Estimated Volume of Material (m ³)			750,000	
Ground Ice Content			High	
Method of Extraction			Stockpiling	
Access to Site			Winter road, summer barge	
Overburden	Thickness (m) Type		0.3 – 1.8 Peat/silt	
Estimated Recovery Depth (m)			3.5	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 2.48

Cross Reference Number			3, 9	
Material	Classification Description		Class 3 Sand, some gravel	
Location	UTM Coordinates Zone	Latitude Longitude	554,000E, 7,582,700N 8	N68.370 W133.687
Distance to Pipeline (km)			20	
Estimated Volume of Material (m ³)			850,000	
Ground Ice Content			Low to high	
Method of Extraction			Stockpiling	
Access to Site			All weather road	
Overburden	Thickness (m) Type		0.3 – 0.9 Peat/silt	
Estimated Recovery Depth (m)			3.5	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Not recommended, already being used by Inuvik	

Granular Material Source Number 2.49

Cross Reference Number			9	
Material	Classification Description		Class NG Shale	
Location	UTM Coordinates Zone	Latitude Longitude	560,500E, 7,579,300N 8	N68.320 W133.532
Distance to Pipeline (km)			18	
Estimated Volume of Material (m ³)			Depleted	
Ground Ice Content			NA	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			All weather road	
Overburden	Thickness (m) Type		3.3 NA	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Not recommended, already depleted for Mackenzie Highway	

Granular Material Source Number 2.50

Cross Reference Number			3, 9	
Material	Classification Description		Class NG Shale	
Location	UTM Coordinates Zone	Latitude Longitude	560,400E, 7,577,300N 8	N68.302 W133.535
Distance to Pipeline (km)			21	
Estimated Volume of Material (m ³)			Unlimited	
Ground Ice Content			None	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			All weather road	
Overburden	Thickness (m) Type		0 – 0.6 Topsoil	
Estimated Recovery Depth (m)			9	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Not recommended, already being used by Inuvik	

Granular Material Source Number 2.51

Cross Reference Number			3, 9	
Material	Classification Description		Class NG Limestone	
Location	UTM Coordinates Zone	Latitude Longitude	568,500E, 7,576,400N 8	N68.292 W133.340
Distance to Pipeline (km)			9	
Estimated Volume of Material (m ³)			Unlimited	
Ground Ice Content			None	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			All weather road	
Overburden	Thickness (m) Type		0 – 0.9 Topsoil	
Estimated Recovery Depth (m)			7.5	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Recommended, already developed for Dempster Highway	

Granular Material Source Number 2.52

Cross Reference Number			3, 9	
Material	Classification Description		Class NG Limestone	
Location	UTM Coordinates Zone	Latitude Longitude	569,000E, 7,576,200N 8	N68.290 W133.328
Distance to Pipeline (km)			7.1	
Estimated Volume of Material (m ³)			Unlimited	
Ground Ice Content			None	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			All weather road	
Overburden	Thickness (m) Type		0 – 0.9 Topsoil	
Estimated Recovery Depth (m)			13	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Not recommended, already used for Dempster Highway	

Granular Material Source Number 2.53

Cross Reference Number			3, 9	
Material	Classification Description		Class 3 sand and Gravel	
Location	UTM Coordinates Zone	Latitude Longitude	573,000E, 7,578,100N 8	N68.306 W133.230
Distance to Pipeline (km)			1.3	
Estimated Volume of Material (m ³)			250,000	
Ground Ice Content			Low to medium	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m)		0.3 – 0.6	
	Type		Topsoil	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			NA, siltation of streams	
Recommendation			Not recommended, siltation of streams	

Granular Material Source Number 2.55

Cross Reference Number			2, 7, 9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	593,600E, 7,586,500N 8	N68.376 W132.738
Distance to Pipeline (km)			29.8	
Estimated Volume of Material (m ³)			4.5 x 10 ⁶	
Ground Ice Content			Low	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.3 – 0.9 Peat and silt	
Estimated Recovery Depth (m)			7.5	
Environmental Sensitivity Number			NA, winter range for reindeer	
Recommendation			Favorable, but far from pipeline	

Granular Material Source Number 2.56

Cross Reference Number			2, 9	
Material	Classification Description		Class 4 Sand	
Location	UTM Coordinates Zone	Latitude Longitude	589,600E, 7,582,500N 8	N68.341 W132.824
Distance to Pipeline (km)			21.8	
Estimated Volume of Material (m ³)			250,000	
Ground Ice Content			Low to medium	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.3 – 0.9 Peat and silt	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			NA, winter range for reindeer	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 2.57

Cross Reference Number			2, 7, 9	
Material	Classification Description		Class 3 Sand, some gravel	
Location	UTM Coordinates Zone	Latitude Longitude	586,500E, 7,581,600N 8	N68.334 W132.900
Distance to Pipeline (km)			13.5	
Estimated Volume of Material (m ³)			3.5 x 10 ⁶	
Ground Ice Content			Medium	
Method of Extraction			Stockpiling	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.4 – 3 Peat and silt	
Estimated Recovery Depth (m)			9	
Environmental Sensitivity Number			NA, critical wildlife area	
Recommendation			Not recommended, habitat destruction	

Granular Material Source Number 2.58

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	586,200E, 7,577,000N 8	N68.293 W132.911
Distance to Pipeline (km)			14.5	
Estimated Volume of Material (m ³)			5,000	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			6	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 2.59

Cross Reference Number			3, 7, 9	
Material	Classification Description		Class 4 Sand and silt	
Location	UTM Coordinates Zone	Latitude Longitude	579,300E, 7,578,200N 8	N68.305 W133.077
Distance to Pipeline (km)			4.3	
Estimated Volume of Material (m ³)			15 x 10 ⁶	
Ground Ice Content			Medium	
Method of Extraction			Stockpiling	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.4 – 1.8 Topsoil	
Estimated Recovery Depth (m)			9	
Environmental Sensitivity Number			NA, siltation of streams	
Recommendation			Not recommended, siltation of streams	

Granular Material Source Number 2.60

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	573,500E, 7,575,000N 8	N68.278 W133.220
Distance to Pipeline (km)			4.2	
Estimated Volume of Material (m ³)			250,000	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0 – 0.3 Topsoil	
Estimated Recovery Depth (m)			6	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Recommended, favorable conditions	

Granular Material Source Number 2.61

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	572,500E, 7,572,000N 8	N68.252 W133.246
Distance to Pipeline (km)			7.6	
Estimated Volume of Material (m ³)			10 x 10 ⁶	
Ground Ice Content			medium	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			9	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Recommended, favorable conditions	

Granular Material Source Number 2.62

Cross Reference Number			2, 9	
Material	Classification Description		Class 3 Sand, some gravel	
Location	UTM Coordinates Zone	Latitude Longitude	570,600E, 7,570,200N 8	N68.236 W133.293
Distance to Pipeline (km)			15	
Estimated Volume of Material (m ³)			Depleted	
Ground Ice Content			Low	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.3 – 0.6 Topsoil	
Estimated Recovery Depth (m)			6	
Environmental Sensitivity Number			NA, wildlife reserve	
Recommendation			Not recommended, depleted	

Granular Material Source Number 2.64

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Shale and siltstone	
Location	UTM Coordinates Zone	Latitude Longitude	589,613E, 7,558,603N 8	N68.127 W132.844
Distance to Pipeline (km)			1.5	
Estimated Volume of Material (m ³)			50,000	
Ground Ice Content			High	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			Winter road	
Overburden	Thickness (m) Type		2.5 Ice rich silt	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			280, caribou winter range	
Recommendation			Recommended	

Granular Material Source Number 2.65

Cross Reference Number			2, 9	
Material	Classification Description		Class NG Silt	
Location	UTM Coordinates Zone	Latitude Longitude	564,500E, 7,558,000N 8	N68.128 W133.448
Distance to Pipeline (km)			22.5	
Estimated Volume of Material (m ³)			450,000	
Ground Ice Content			Medium	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.3 – 0.9 Topsoil	
Estimated Recovery Depth (m)			1.5	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 2.66

Cross Reference Number			9	
Material	Classification Description		Class 3 Gravel and silt	
Location	UTM Coordinates Zone	Latitude Longitude	566,000E, 7,550,000N 8	N68.056 W133.417
Distance to Pipeline (km)			26.3	
Estimated Volume of Material (m ³)			20 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			3	
Environmental Sensitivity Number			NA, siltation of adjacent river	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 2.67

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Silt	
Location	UTM Coordinates Zone	Latitude Longitude	585,000E, 7,550,000N 8	N68.051 W132.961
Distance to Pipeline (km)			8	
Estimated Volume of Material (m ³)			NA	
Ground Ice Content			Medium to high	
Method of Extraction			NA	
Access to Site			NA	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			250, siltation of lakes and streams	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 4.03

Cross Reference Number			7, 9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	600,000E, 7,570,000N 8	N68.225 W132.583
Distance to Pipeline (km)			23.9	
Estimated Volume of Material (m ³)			10 x 10 ⁶	
Ground Ice Content			Medium to high	
Method of Extraction			Stockpiling	
Access to Site			Winter road	
Overburden	Thickness (m) Type		3 NA	
Estimated Recovery Depth (m)			6	
Environmental Sensitivity Number			NA, adjacent to minor river	
Recommendation			Favorable, but far from pipeline	

Granular Material Source Number 4.04

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Clay	
Location	UTM Coordinates Zone	Latitude Longitude	595,500E, 7,562,000N 8	N68.155 W132.699
Distance to Pipeline (km)			10.9	
Estimated Volume of Material (m ³)			NA	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			315, headwater area	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 4.05

Cross Reference Number			7	
Material	Classification Description		Class 2 Gravel	
Location	UTM Coordinates Zone	Latitude Longitude	600,000E, 7,560,000N 8	N68.136 W132.593
Distance to Pipeline (km)			13	
Estimated Volume of Material (m ³)			450,000	
Ground Ice Content			None	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.1 - 1 NA	
Estimated Recovery Depth (m)			1.5	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Recommended	

Granular Material Source Number 4.06

Cross Reference Number			4, 7, 9	
Material	Classification Description		Class 3 Sand	
Location	UTM Coordinates Zone	Latitude Longitude	600,000E, 7,557,000N 8	N68.109 W132.596
Distance to Pipeline (km)			11.5	
Estimated Volume of Material (m ³)			2.5 x 10 ⁶	
Ground Ice Content			Low to Medium	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0 – 0.3 Peat	
Estimated Recovery Depth (m)			6	
Environmental Sensitivity Number			315, shore of Lost Reindeer Lake	
Recommendation			Not recommended, high environmental risk	

Granular Material Source Number 4.07

Cross Reference Number			4, 9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	602,000E, 7,554,600N 8	N68.087 W132.550
Distance to Pipeline (km)			9.6	
Estimated Volume of Material (m ³)			5 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		3.3 Peat	
Estimated Recovery Depth (m)			7.5	
Environmental Sensitivity Number			325, west shore of Lost Reindeer Lake	
Recommendation			Not recommended, high environmental risk	

Granular Material Source Number 4.08

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Shale	
Location	UTM Coordinates Zone	Latitude Longitude	587,200E, 7,559,200N 8	N68.133 W132.901
Distance to Pipeline (km)			12.7	
Estimated Volume of Material (m ³)			Unlimited	
Ground Ice Content			None	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			Winter road	
Overburden	Thickness (m) Type		5.6 Silt and till	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			280, lake complex, caribou winter range	
Recommendation			Recommended	

Granular Material Source Number 4.09

Cross Reference Number			7, 9	
Material	Classification Description		Class 3 Till	
Location	UTM Coordinates Zone	Latitude Longitude	605,500E, 7,550,000N 8	N68.044 W132.470
Distance to Pipeline (km)			7.9	
Estimated Volume of Material (m ³)			25 x 10 ⁶	
Ground Ice Content			Medium	
Method of Extraction			Stockpiling	
Access to Site			NA	
Overburden	Thickness (m) Type		0 – 3 Peat	
Estimated Recovery Depth (m)			11	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 4.18

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	391,000E, 7,535,000N 9	N67.908 W131.597
Distance to Pipeline (km)			16.3	
Estimated Volume of Material (m ³)			30 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			12	
Environmental Sensitivity Number			NA, siltation of adjacent lakes	
Recommendation			Favorable, but on edge of development zone	

Granular Material Source Number 4.19

Cross Reference Number			9	
Material	Classification Description		Class 3 Gravel	
Location	UTM Coordinates Zone	Latitude Longitude	385,200E, 7,539,500N 9	N67.946 W131.740
Distance to Pipeline (km)			15.3	
Estimated Volume of Material (m ³)			1.5 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Favorable, but on edge of development zone	

Granular Material Source Number 4.20

Cross Reference Number			4, 7, 9	
Material	Classification Description		Class 2 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	380,000E, 7,537,000N 9	N67.866 W131.861
Distance to Pipeline (km)			8.8	
Estimated Volume of Material (m ³)			4 x 10 ⁶	
Ground Ice Content			Low	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0 – 0.6 Peat	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			355, denning area	
Recommendation			Approved for site investigation	

Granular Material Source Number 4.21

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	377,500E, 7,537,000N 9	N67.921 W131.921
Distance to Pipeline (km)			8.5	
Estimated Volume of Material (m ³)			2 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m)		NA	
	Type		NA	
Estimated Recovery Depth (m)			12	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Recommended	

Granular Material Source Number 4.22

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Clay	
Location	UTM Coordinates Zone	Latitude Longitude	376,900E, 7,534,900N 9	N67.902 W131.933
Distance to Pipeline (km)			5.9	
Estimated Volume of Material (m ³)			NA	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			NA	
Overburden	Thickness (m)		NA	
	Type		NA	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			260, headwater area	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 4.23

Cross Reference Number			4, 7, 9	
Material	Classification Description		Class 2 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	619,000E, 7,534,900N 8	N67.904 W132.164
Distance to Pipeline (km)			3	
Estimated Volume of Material (m ³)			4 x 10 ⁶	
Ground Ice Content			Low	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.6 Peat	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			NA, straddles lake drainage	
Recommendation			Recommended	

Granular Material Source Number 4.24

Cross Reference Number			4, 9	
Material	Classification Description		Class 4 Silt and some sand	
Location	UTM Coordinates Zone	Latitude Longitude	618,800E, 7,536,900N 8	N67.920 W132.170
Distance to Pipeline (km)			2	
Estimated Volume of Material (m ³)			NA	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			NA	
Overburden	Thickness (m)		NA	
	Type		NA	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			295, no major concerns	
Recommendation			Approved by the Gwich'in Land Use Planning Board	

Granular Material Source Number 4.25

Cross Reference Number			7	
Material	Classification Description		Class NG Till	
Location	UTM Coordinates Zone	Latitude Longitude	607,500E, 7,535,000N 8	N67.909 W132.437
Distance to Pipeline (km)			5.8	
Estimated Volume of Material (m ³)			NA	
Ground Ice Content			High	
Method of Extraction			NA	
Access to Site			NA	
Overburden	Thickness (m)		Thin	
	Type		NA	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			NA, siltation of lakes & Travaillant River	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 4.26

Cross Reference Number			4, 7, 9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	630,000E, 7,546,000N 8	N67.998 W131.889
Distance to Pipeline (km)			7.9	
Estimated Volume of Material (m ³)			20 x 10 ⁶	
Ground Ice Content			Low to medium	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.3 – 3 Peat	
Estimated Recovery Depth (m)			5	
Environmental Sensitivity Number			270, straddles Travaillant river, fish migration passage	
Recommendation			Recommended	

Granular Material Source Number 4.27

Cross Reference Number			4, 9	
Material	Classification Description		Class 4 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	607,000E, 7,544,400N 8	N67.993 W132.440
Distance to Pipeline (km)			3	
Estimated Volume of Material (m ³)			5.5 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.6 Peat	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			ND, no major concerns	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 4.28

Cross Reference Number			4, 9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	610,600E, 7,535,300N 8	N67.911 W132.363
Distance to Pipeline (km)			5	
Estimated Volume of Material (m ³)			100,000	
Ground Ice Content			ND	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.15 Moss	
Estimated Recovery Depth (m)			6	
Environmental Sensitivity Number			ND, no major concerns	
Recommendation			Recommended	

Granular Material Source Number 4.29

Cross Reference Number			4, 9	
Material	Classification Description		Class 4 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	606,600E, 7,534,400N 8	N67.904 W 132.459
Distance to Pipeline (km)			7.4	
Estimated Volume of Material (m ³)			5.5 x 10 ⁶	
Ground Ice Content			Medium	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.6 Clay	
Estimated Recovery Depth (m)			4	
Environmental Sensitivity Number			310, located between lakes	
Recommendation			Not recommended, highly sensitive area	

Granular Material Source Number 4.31

Cross Reference Number			4, 9	
Material	Classification Description		Class 2 Sand and some gravel	
Location	UTM Coordinates Zone	Latitude Longitude	604,000E, 7,529,200N 8	N67.858 W132.526
Distance to Pipeline (km)			15.7	
Estimated Volume of Material (m ³)			55 x 10 ⁶	
Ground Ice Content			Low	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.3 Peat	
Estimated Recovery Depth (m)			6	
Environmental Sensitivity Number			340, denning and aquatic habitat	
Recommendation			Not recommended, high environmental risk	

Granular Material Source Number 4.32

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Silt	
Location	UTM Coordinates Zone	Latitude Longitude	607,000E, 7,529,200N 8	N67.857 W132.455
Distance to Pipeline (km)			12.4	
Estimated Volume of Material (m ³)			NA	
Ground Ice Content			High	
Method of Extraction			Stockpiling	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			305, straddles tributary to Point Lake	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 4.33

Cross Reference Number			4, 9	
Material	Classification Description		Class 2 Gravel	
Location	UTM Coordinates Zone	Latitude Longitude	609,000E, 7,525,000N 8	N67.819 W132.412
Distance to Pipeline (km)			14.8	
Estimated Volume of Material (m ³)			13 x 10 ⁶	
Ground Ice Content			Low	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.45 Peat	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			350, shores of Point Lake	
Recommendation			Not recommended, high environmental risk	

Granular Material Source Number 4.34

Cross Reference Number			4, 9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	612,500E, 7,523,600N 8	N67.805 W132.330
Distance to Pipeline (km)			14.8	
Estimated Volume of Material (m ³)			10 x 10 ⁶	
Ground Ice Content			High	
Method of Extraction			Stockpiling	
Access to Site			Winter road	
Overburden	Thickness (m) Type		1 Peat	
Estimated Recovery Depth (m)			4	
Environmental Sensitivity Number			355, straddles drainage system	
Recommendation			Not recommended, high environmental risk	

Granular Material Source Number 4.35

Cross Reference Number			4, 9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	619,800E, 7,526,600N 8	N67.829 W132.154
Distance to Pipeline (km)			6.8	
Estimated Volume of Material (m ³)			12 x 10 ⁶	
Ground Ice Content			Low	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.15 Moss	
Estimated Recovery Depth (m)			8	
Environmental Sensitivity Number			365, straddles tributary lake system	
Recommendation			Not recommended, high environmental risk	

Granular Material Source Number 4.36

Cross Reference Number			4, 7, 9	
Material	Classification Description		Class NG Shale	
Location	UTM Coordinates Zone	Latitude Longitude	626,000E, 7,532,000N 8	N67.875 W132.001
Distance to Pipeline (km)			4.5	
Estimated Volume of Material (m ³)			Unlimited	
Ground Ice Content			ND	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			Winter road	
Overburden	Thickness (m) Type		6 Silty sand and gravel	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			ND, denning area, siltation of Travaillant River	
Recommendation			Favorable, but environmentally sensitive	

Granular Material Source Number 4.37

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Shale	
Location	UTM Coordinates Zone	Latitude Longitude	625,000E, 7,528,000N 8	N67.839 W132.029
Distance to Pipeline (km)			0, pipeline passes through site	
Estimated Volume of Material (m ³)			Unlimited	
Ground Ice Content			High	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			Winter road	
Overburden	Thickness (m) Type		3.7 Clayey silt	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			285, siltation control, winter caribou range	
Recommendation			Recommended, area will already be disturbed by pipeline	

Granular Material Source Number 4.38

Cross Reference Number			4, 7, 9	
Material	Classification Description		Class 2 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	380,000E, 7,537,000N 9	N67.922 W131.861
Distance to Pipeline (km)			1	
Estimated Volume of Material (m ³)			25 x 10 ⁶	
Ground Ice Content			Low	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0 – 0.6 Peat	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			355, denning area, caribou winter range	
Recommendation			Recommended, proximity to pipeline will already disrupt environment	

Granular Material Source Number 4.39

Cross Reference Number			4, 7, 9	
Material	Classification Description		Class 2 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	380,000E, 7,531,000N 9	N67.868 W131.855
Distance to Pipeline (km)			4.1	
Estimated Volume of Material (m ³)			1 x 10 ⁶	
Ground Ice Content			Low	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.6 Moss	
Estimated Recovery Depth (m)			6	
Environmental Sensitivity Number			225, straddles creek drainage	
Recommendation			Recommended	

Granular Material Source Number 4.40

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	384,000E, 7,530,000N 9	N67.961 W131.759
Distance to Pipeline (km)			5.2	
Estimated Volume of Material (m ³)			7.5 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			12	
Environmental Sensitivity Number			NA, siltation of adjacent lakes	
Recommendation			Recommended	

Granular Material Source Number 4.41

Cross Reference Number			4	
Material	Classification Description		Class NG Clay	
Location	UTM Coordinates Zone	Latitude Longitude	382,500E, 7,525,000N 9	N67.816 W131.789
Distance to Pipeline (km)			0, pipeline passes through site	
Estimated Volume of Material (m ³)			NA	
Ground Ice Content			ND	
Method of Extraction			NA	
Access to Site			NA	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			ND, siltation of adjacent lakes	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 4.42

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Till	
Location	UTM Coordinates Zone	Latitude Longitude	394,500E, 7,525,000N 9	N67.820 W131.504
Distance to Pipeline (km)			10.1	
Estimated Volume of Material (m ³)			7.5 x 10 ⁶	
Ground Ice Content			Low	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			380, siltation of Large Lake	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 4.43

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Clayey sand	
Location	UTM Coordinates Zone	Latitude Longitude	402,600E, 7,526,400N 9	N67.835 W131.313
Distance to Pipeline (km)			22.4	
Estimated Volume of Material (m ³)			NA	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			NA	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			ND, siltation of adjacent lake	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 4.44

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	406,000E, 7,530,000N 9	N67.869 W131.236
Distance to Pipeline (km)			26.5	
Estimated Volume of Material (m ³)			10 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			NA, siltation of adjacent lake	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.45

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	405,000E, 7,523,000N 9	N67.806 W131.254
Distance to Pipeline (km)			18.8	
Estimated Volume of Material (m ³)			15 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.46

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	411,000E, 7,526,500N 9	N67.839 W131.114
Distance to Pipeline (km)			24.6	
Estimated Volume of Material (m ³)			20 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			NA, adjacent to the south shore of Tenlen Lake	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.47

Cross Reference Number			4, 9	
Material	Classification Description		Class 4 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	421,000E, 7,521,700N 9	N67.799 W130.873
Distance to Pipeline (km)			24	
Estimated Volume of Material (m ³)			10 x 10 ⁶	
Ground Ice Content			High	
Method of Extraction			Stockpiling	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.3 Peat	
Estimated Recovery Depth (m)			9	
Environmental Sensitivity Number			270, parallels lake edge	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 4.48

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	423,000E, 7,521,700N 9	N67.799 W130.826
Distance to Pipeline (km)			27	
Estimated Volume of Material (m ³)			3 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			NA, siltation of adjacent lake	
Recommendation			Favorable, but far from pipeline	

Granular Material Source Number 4.49

Cross Reference Number			4, 9	
Material	Classification Description		Class 2 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	421,500E, 7,515,500N 9	N67.743 W130.857
Distance to Pipeline (km)			20.2	
Estimated Volume of Material (m ³)			15 x 10 ⁶	
Ground Ice Content			Low	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.3 Peat	
Estimated Recovery Depth (m)			7.5	
Environmental Sensitivity Number			230, straddles lake drainage	
Recommendation			Favorable, but far from pipeline	

Granular Material Source Number 4.50

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	423,000E, 7,510,000N 9	N67.695 W130.818
Distance to Pipeline (km)			17.4	
Estimated Volume of Material (m ³)			10 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Favorable, but far from pipeline	

Granular Material Source Number 4.51

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Clay	
Location	UTM Coordinates Zone	Latitude Longitude	417,600E, 7,512,500N 9	N67.716 W130.947
Distance to Pipeline (km)			15	
Estimated Volume of Material (m ³)			NA	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			NA	
Overburden	Thickness (m)		NA	
	Type		NA	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			ND, no major concerns	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 4.52

Cross Reference Number			4, 9	
Material	Classification Description		Class 3 Sand, some gravel	
Location	UTM Coordinates Zone	Latitude Longitude	414,000E, 7,515,600N 9	N67.742 W131.034
Distance to Pipeline (km)			15.2	
Estimated Volume of Material (m ³)			2.5 x 10 ⁶	
Ground Ice Content			ND	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.3 Peat	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			210, siltation of lake	
Recommendation			Favorable, but on edge of development zone	

Granular Material Source Number 4.53

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	412,000E, 7,519,500N 9	N67.777 W131.085
Distance to Pipeline (km)			18	
Estimated Volume of Material (m ³)			15 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Favorable, but far from pipeline	

Granular Material Source Number 4.54

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Shale	
Location	UTM Coordinates Zone	Latitude Longitude	416,000E, 7,502,500N 9	N67.625 W130.977
Distance to Pipeline (km)			8	
Estimated Volume of Material (m ³)			Unlimited	
Ground Ice Content			High	
Method of Extraction			Blasting, quarrying, crushing	
Access to Site			Winter road	
Overburden	Thickness (m) Type		2 - 5 Clay	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			195, no concerns	
Recommendation			Recommended	

Granular Material Source Number 4.55

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	400,000E, 7,507,500N 9	N67.665 W131.358
Distance to Pipeline (km)			3.2	
Estimated Volume of Material (m ³)			2.5 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			6	
Environmental Sensitivity Number			NA, siltation of adjacent lake	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.56

Cross Reference Number			4, 9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	394,300E, 7,507,900N 9	N67.667 W131.493
Distance to Pipeline (km)			5.5	
Estimated Volume of Material (m ³)			1 x 10 ⁶	
Ground Ice Content			Low	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0 – 1 Peat, moss	
Estimated Recovery Depth (m)			3	
Environmental Sensitivity Number			260, surrounded by Upland Lake	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.57

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Clay	
Location	UTM Coordinates Zone	Latitude Longitude	395,500E, 7,511,600N 9	N67.700 W131.468
Distance to Pipeline (km)			2.7	
Estimated Volume of Material (m ³)			NA	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			NA	
Overburden	Thickness (m) Type		NA	NA
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			ND, siltation of adjacent lake	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 4.58

Cross Reference Number			4, 9	
Material	Classification Description		Class 3 Sand	
Location	UTM Coordinates Zone	Latitude Longitude	394,300E, 7,502,600N 9	N67.619 W131.488
Distance to Pipeline (km)			0, pipeline passes through site	
Estimated Volume of Material (m ³)			3 x 10 ⁶	
Ground Ice Content			Low	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		1.3 Clay	
Estimated Recovery Depth (m)			2	
Environmental Sensitivity Number			265, swans spring staging and moulting area	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.59

Cross Reference Number			4, 7, 9	
Material	Classification Description		Class 2 Sandy gravel	
Location	UTM Coordinates Zone	Latitude Longitude	393,000E, 7,513,000N 9	N67.712 W131.528
Distance to Pipeline (km)			0, pipeline passes through site	
Estimated Volume of Material (m ³)			20 x 10 ⁶	
Ground Ice Content			Low	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0 NA	
Estimated Recovery Depth (m)			9	
Environmental Sensitivity Number			255, surrounds Upland Lake	
Recommendation			Approved for site investigation	

Granular Material Source Number 4.60

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	389,000E, 7,517,000N 9	N67.746 W131.627
Distance to Pipeline (km)			2	
Estimated Volume of Material (m ³)			1 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			6	
Environmental Sensitivity Number			NA, siltation of adjacent lake	
Recommendation			Approved for site investigation	

Granular Material Source Number 4.61

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Siltstone	
Location	UTM Coordinates Zone	Latitude Longitude	388,800E, 7,515,200N 9	N67.730 W131.630
Distance to Pipeline (km)			3.4	
Estimated Volume of Material (m ³)			NA	
Ground Ice Content			High	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			Winter road	
Overburden	Thickness (m) Type		1.5 Silt	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			ND, no major concerns	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.62

Cross Reference Number			4	
Material	Classification Description		Class NG Clay	
Location	UTM Coordinates Zone	Latitude Longitude	379,800E, 7,521,000N 9	N67.779 W131.848
Distance to Pipeline (km)			6.8	
Estimated Volume of Material (m ³)			NA	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			NA	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			11	
Environmental Sensitivity Number			ND, siltation of Travaillant River	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 4.63

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	620,000E, 7,521,500N 8	N67.783 W132.155
Distance to Pipeline (km)			11.1	
Estimated Volume of Material (m ³)			35 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			11	
Environmental Sensitivity Number			NA, siltation of adjacent lake	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.64

Cross Reference Number			4	
Material	Classification Description		Class 2 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	616,000E, 7,520,000N 8	N67.771 W132.251
Distance to Pipeline (km)			14.2	
Estimated Volume of Material (m ³)			100,000	
Ground Ice Content			ND	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		Thin NA	
Estimated Recovery Depth (m)			1	
Environmental Sensitivity Number			350, whistling swan habitat	
Recommendation			Not recommended, high environmental risk	

Granular Material Source Number 4.65

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	618,000E, 7,518,500N 8	N67.757 W132.205
Distance to Pipeline (km)			15.4	
Estimated Volume of Material (m ³)			20 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			11	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Favorable, but on edge of development zone	

Granular Material Source Number 4.66

Cross Reference Number			9	
Material	Classification Description		Class 3 Gravel, some sand	
Location	UTM Coordinates Zone	Latitude Longitude	614,000E, 7,516,000N 8	N67.736 W132.302
Distance to Pipeline (km)			21	
Estimated Volume of Material (m ³)			35 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			11	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Favorable, but far from pipeline	

Granular Material Source Number 4.67

Cross Reference Number			4, 9	
Material	Classification Description		Class 2 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	605,200E, 7,519,400N 8	N67.770 W132.507
Distance to Pipeline (km)			22.1	
Estimated Volume of Material (m ³)			2.5 x 10 ⁶	
Ground Ice Content			Medium	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.6 Peat	
Estimated Recovery Depth (m)			3	
Environmental Sensitivity Number			340, siltation of creek, denning area	
Recommendation			Favorable, but far from pipeline	

Granular Material Source Number 4.82

Cross Reference Number			4, 9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	620,000E, 7,506,800N 8	N67.651 W132.171
Distance to Pipeline (km)			21.5	
Estimated Volume of Material (m ³)			2.5 x 10 ⁶	
Ground Ice Content			Medium	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.3 – 1.3 Topsoil	
Estimated Recovery Depth (m)			6	
Environmental Sensitivity Number			280, shore of Jiggle Lake	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.83

Cross Reference Number			9	
Material	Classification Description		Class 4 Silt, sand, and gravel mixture	
Location	UTM Coordinates Zone	Latitude Longitude	625,000E, 7,506,000N 8	N67.642 W132.054
Distance to Pipeline (km)			22.6	
Estimated Volume of Material (m ³)			2 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			NA	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			9	
Environmental Sensitivity Number			NA, siltation of Jiggle Lake	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 4.84

Cross Reference Number			4, 9	
Material	Classification Description		Class 2 Sandy gravel	
Location	UTM Coordinates Zone	Latitude Longitude	627,000E, 7,508,000N 8	N67.659 W132.005
Distance to Pipeline (km)			21	
Estimated Volume of Material (m ³)			4 x 10 ⁶	
Ground Ice Content			ND	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.15 NA	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			270, whistling swans habitat	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.85

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Shale	
Location	UTM Coordinates Zone	Latitude Longitude	374,000E, 7,503,500N 9	N67.619 W131.966
Distance to Pipeline (km)			24.8	
Estimated Volume of Material (m ³)			Unlimited	
Ground Ice Content			NA	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			Winter road	
Overburden	Thickness (m) Type		2.7 Clay	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			290, upland area west of Travaillant Lake	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.92

Cross Reference Number			4	
Material	Classification Description		Class NG Shale	
Location	UTM Coordinates Zone	Latitude Longitude	381,000E, 7,492,500N 9	N67.524 W131.790
Distance to Pipeline (km)			28	
Estimated Volume of Material (m ³)			Unlimited	
Ground Ice Content			NA	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			NA	
Overburden	Thickness (m) Type		4.19 Clay	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			220, siltation of Travaillant River	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.93

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	393,000E, 7,507,000N 9	N67.658 W131.523
Distance to Pipeline (km)			16.6	
Estimated Volume of Material (m ³)			7.5 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			6	
Environmental Sensitivity Number			NA, siltation of adjacent lake	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.94

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Shale	
Location	UTM Coordinates Zone	Latitude Longitude	386,300E, 7,502,600N 9	N67.616 W131.876
Distance to Pipeline (km)			14	
Estimated Volume of Material (m ³)			Unlimited	
Ground Ice Content			ND	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			Winter road	
Overburden	Thickness (m) Type		4.6 Clay	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			210, no major concerns	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.95

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	389,000E, 7,505,000N 9	N67.639 W131.615
Distance to Pipeline (km)			8.3	
Estimated Volume of Material (m ³)			10 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.96

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Shale	
Location	UTM Coordinates Zone	Latitude Longitude	392,000E, 7,502,200N 9	N67.615 W131.541
Distance to Pipeline (km)			6.5	
Estimated Volume of Material (m ³)			Unlimited	
Ground Ice Content			ND	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			Winter road	
Overburden	Thickness (m) Type		1.3 – 2.5 Clay	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			225, fisheries on river	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.97

Cross Reference Number			4, 9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	389,000E, 7,496,400N 9	N67.562 W131.606
Distance to Pipeline (km)			12.7	
Estimated Volume of Material (m ³)			400,000	
Ground Ice Content			High	
Method of Extraction			Stockpiling	
Access to Site			Winter road	
Overburden	Thickness (m) Type		1 Silt	
Estimated Recovery Depth (m)			5.5	
Environmental Sensitivity Number			260, no major concerns	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.98

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	393,500E, 7,500,000N 9	N67.596 W131.504
Distance to Pipeline (km)			8	
Estimated Volume of Material (m ³)			25 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			NA, siltation of Travaillant River	
Recommendation			Not Recommended, in Conservation Zone	

Granular Material Source Number 4.99

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Sand and silt	
Location	UTM Coordinates Zone	Latitude Longitude	397,200E, 7,497,500N 9	N67.575 W131.415
Distance to Pipeline (km)			7.8	
Estimated Volume of Material (m ³)			NA	
Ground Ice Content			High	
Method of Extraction			Stockpiling	
Access to Site			NA	
Overburden	Thickness (m) Type		Thin NA	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			ND, siltation of Travaillant River	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 4.100

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Shale	
Location	UTM Coordinates Zone	Latitude Longitude	416,000E, 7,502,500N 9	N67.625 W130.977
Distance to Pipeline (km)			3	
Estimated Volume of Material (m ³)			Unlimited	
Ground Ice Content			NA	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			Winter road	
Overburden	Thickness (m) Type		2.1 – 4.6 Clay	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			205, no major concerns	
Recommendation			Recommended	

Granular Material Source Number 4.101

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	424,000E, 7,501,000N 9	N67.614 W130.788
Distance to Pipeline (km)			9.6	
Estimated Volume of Material (m ³)			6 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			3	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Recommended	

Granular Material Source Number 4.102

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Shale	
Location	UTM Coordinates Zone	Latitude Longitude	421,000E, 7,499,000N 9	N67.595 W130.857
Distance to Pipeline (km)			5.6	
Estimated Volume of Material (m ³)			NA	
Ground Ice Content			High	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			Winter road	
Overburden	Thickness (m) Type		2.1 – 4.6 NA	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			275, moderately sensitive area	
Recommendation			Recommended	

Granular Material Source Number 4.103

Cross Reference Number			4, 9	
Material	Classification Description		Class 3 Sand	
Location	UTM Coordinates Zone	Latitude Longitude	422,000E, 7,493,000N 9	N67.542 W130.829
Distance to Pipeline (km)			1	
Estimated Volume of Material (m ³)			5.5 x 10 ⁶	
Ground Ice Content			Medium	
Method of Extraction			Conventional	
Access to Site			NA	
Overburden	Thickness (m) Type		0.3 Organics	
Estimated Recovery Depth (m)			7.5	
Environmental Sensitivity Number			335, important fish spawning area	
Recommendation			Approved for site investigation	

Granular Material Source Number 4.104

Cross Reference Number			4, 7	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	420,000E, 7,490,000N 9	N67.514 W130.874
Distance to Pipeline (km)			4.3	
Estimated Volume of Material (m ³)			10 x 10 ⁶	
Ground Ice Content			High	
Method of Extraction			Stockpiling	
Access to Site			Winter road	
Overburden	Thickness (m) Type		Thin Topsoil	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			335, fish migration, bear denning, native use area	
Recommendation			Not recommended, high environmental risk	

Granular Material Source Number 4.105

Cross Reference Number			4, 9	
Material	Classification Description		Class 4 Sand	
Location	UTM Coordinates Zone	Latitude Longitude	412,500E, 7,484,000N 9	N67.459 W131.045
Distance to Pipeline (km)			14.5	
Estimated Volume of Material (m ³)			20 x 10 ⁶	
Ground Ice Content			High	
Method of Extraction			Stockpiling	
Access to Site			Winter road across Mackenzie River	
Overburden	Thickness (m) Type		0.15 Moss	
Estimated Recovery Depth (m)			8	
Environmental Sensitivity Number			365, west bank of Mackenzie River	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 4.107

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	406,500E, 7,480,000N 9	N67.421 W131.182
Distance to Pipeline (km)			21	
Estimated Volume of Material (m ³)			20 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road across Mackenzie River	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			4	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Favorable, but far from pipeline	

Granular Material Source Number 4.108

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand, some gravel	
Location	UTM Coordinates Zone	Latitude Longitude	406,000E, 7,476,500N 9	N67.389 W131.191
Distance to Pipeline (km)			24	
Estimated Volume of Material (m ³)			25 x 10 ⁶	
Ground Ice Content			None	
Method of Extraction			Conventional	
Access to Site			Winter road across Mackenzie River	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			4	
Environmental Sensitivity Number			285, no major concerns	
Recommendation			Favorable, but far from pipeline	

Granular Material Source Number 4.110

Cross Reference Number			4	
Material	Classification Description		Class 2 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	424,000E, 7,467,400N 9	N67.313 W130.765
Distance to Pipeline (km)			18.5	
Estimated Volume of Material (m ³)			20 x 10 ⁶	
Ground Ice Content			None	
Method of Extraction			Conventional	
Access to Site			Winter road over Mackenzie River	
Overburden	Thickness (m) Type		Thin NA	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			295, moose winter habitat, denning areas	
Recommendation			Favorable, but far from pipeline	

Granular Material Source Number 4.111

Cross Reference Number			4, 9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	614,000E, 7,522,400N 8	N67.794 W132.296
Distance to Pipeline (km)			14.5	
Estimated Volume of Material (m ³)			4 x 10 ⁶	
Ground Ice Content			ND	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		Thin Topsoil	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			350, shore of Sandy Lake, whistling swan habitat	
Recommendation			Not recommended, high environmental risk	

Granular Material Source Number 4.112

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand	
Location	UTM Coordinates Zone	Latitude Longitude	620,500E, 7,513,000N 8	N67.707 W132.152
Distance to Pipeline (km)			18.8	
Estimated Volume of Material (m ³)			5 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			11	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Favorable, but far from pipeline	

Granular Material Source Number 5.05

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	434,000E, 7,508,000N 9	N67.679 W130.557
Distance to Pipeline (km)			21.6	
Estimated Volume of Material (m ³)			7.5 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			NA, siltation of Thunder River	
Recommendation			Favorable, but far from pipeline	

Granular Material Source Number 5.06

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	431,000E, 7,503,500N 9	N67.638 W130.625
Distance to Pipeline (km)			15.2	
Estimated Volume of Material (m ³)			6 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			NA, siltation of Thunder River	
Recommendation			Favorable, but on edge of development zone	

Granular Material Source Number 5.09

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	423,000E, 7,510,000N 9	N67.695 W130.818
Distance to Pipeline (km)			22.7	
Estimated Volume of Material (m ³)			6.5 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Favorable, but far from pipeline	

Granular Material Source Number 5.10

Cross Reference Number			4, 9	
Material	Classification Description		Class 4 Sand, some silt	
Location	UTM Coordinates Zone	Latitude Longitude	439,200E, 7,495,100N 9	N67.565 W130.427
Distance to Pipeline (km)			19	
Estimated Volume of Material (m ³)			8 x 10 ⁶	
Ground Ice Content			Low	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.3 Peat	
Estimated Recovery Depth (m)			5	
Environmental Sensitivity Number			255, moderately sensitive area	
Recommendation			Not recommended, location unsuitable	

Granular Material Source Number 5.11

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	434,000E, 7,495,000N 9	N67.563 W130.549
Distance to Pipeline (km)			12.2	
Estimated Volume of Material (m ³)			5.5 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			NA, siltation of Thunder River	
Recommendation			Recommended	

Granular Material Source Number 5.12

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	421,000E, 7,487,000N 9	N67.488 W130.849
Distance to Pipeline (km)			3.5	
Estimated Volume of Material (m ³)			20 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Recommended	

Granular Material Source Number 5.13

Cross Reference Number			4, 7, 9	
Material	Classification Description		Class 3 Sand	
Location	UTM Coordinates Zone	Latitude Longitude	421,200E, 7,486,600N 9	N67.484 W130.844
Distance to Pipeline (km)			5.8	
Estimated Volume of Material (m ³)			2 x 10 ⁶	
Ground Ice Content			Low	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.3 Peat and silt	
Estimated Recovery Depth (m)			2.5	
Environmental Sensitivity Number			385, on tributary to Thunder River	
Recommendation			Not recommended, high environmental risk	

Granular Material Source Number 5.14

Cross Reference Number			4, 9	
Material	Classification Description		Class 3 Sand	
Location	UTM Coordinates Zone	Latitude Longitude	426,700E, 7,486,500N 9	N67.485 W130.715
Distance to Pipeline (km)			2.5	
Estimated Volume of Material (m ³)			2 x 10 ⁶	
Ground Ice Content			Medium	
Method of Extraction			Stockpiling	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.15 Peat	
Estimated Recovery Depth (m)			7.5	
Environmental Sensitivity Number			ND, no major concerns	
Recommendation			Recommended	

Granular Material Source Number 5.15

Cross Reference Number			4, 9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	437,700E, 7,483,000N 9	N67.456 W130.456
Distance to Pipeline (km)			8.9	
Estimated Volume of Material (m ³)			70,000	
Ground Ice Content			Medium	
Method of Extraction			Stockpiling	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0 – 0.3 Peat	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			190, no major concerns	
Recommendation			Recommended	

Granular Material Source Number 5.16

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	433,000E, 7,483,000N 9	N67.455 W130.566
Distance to Pipeline (km)			15.5	
Estimated Volume of Material (m ³)			4 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			12	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Recommended, but on edge of development zone	

Granular Material Source Number 5.17

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	437,700E, 7,476,500N 9	N67.398 W130.452
Distance to Pipeline (km)			4.1	
Estimated Volume of Material (m ³)			6 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Summer or winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			12	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Recommended	

Granular Material Source Number 5.18

Cross Reference Number			4, 9	
Material	Classification Description		Class 2 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	420,000E, 7,469,300N 9	N67.329 W130.860
Distance to Pipeline (km)			21	
Estimated Volume of Material (m ³)			3.5 x 10 ⁶	
Ground Ice Content			Low to medium	
Method of Extraction			Conventional	
Access to Site			Summer barge, winter road across Mackenzie River	
Overburden	Thickness (m) Type		0.15 Peat	
Estimated Recovery Depth (m)			6	
Environmental Sensitivity Number			205, no major concerns	
Recommendation			Recommended, but far from pipeline	

Granular Material Source Number 5.19

Cross Reference Number			4, 9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	413,500E, 7,477,500N 9	N67.401 W131.017
Distance to Pipeline (km)			25	
Estimated Volume of Material (m ³)			4 x 10 ⁶	
Ground Ice Content			None	
Method of Extraction			Conventional	
Access to Site			Summer barge, winter road across Mackenzie River	
Overburden	Thickness (m) Type		0.15 Peat	
Estimated Recovery Depth (m)			4.5	
Environmental Sensitivity Number			295, moose habitat	
Recommendation			Recommended, but far from pipeline	

Granular Material Source Number 5.20

Cross Reference Number			4, 9	
Material	Classification Description		Class 3 Gravel, some sand	
Location	UTM Coordinates Zone	Latitude Longitude	424,000E, 7,466,400N 9	N67.304 W130.765
Distance to Pipeline (km)			16.5	
Estimated Volume of Material (m ³)			3 x 10 ⁶	
Ground Ice Content			Medium	
Method of Extraction			Stockpiling	
Access to Site			Summer barge, winter road across Mackenzie River	
Overburden	Thickness (m) Type		0 – 0.6 Peat and clay	
Estimated Recovery Depth (m)			6	
Environmental Sensitivity Number			225, no major concerns	
Recommendation			Approved by the Gwich'in Land Use Planning Board	

Granular Material Source Number 5.21

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	430,000E, 7,462,000N 9	N67.266 W130.623
Distance to Pipeline (km)			15.6	
Estimated Volume of Material (m ³)			5 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road across Mackenzie River	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			12	
Environmental Sensitivity Number			NA, moose habitat	
Recommendation			Recommended, but on edge of development zone	

Granular Material Source Number 5.22

Cross Reference Number			4, 6, 9	
Material	Classification Description		Class NG Shale	
Location	UTM Coordinates Zone	Latitude Longitude	444,000E, 7,471,300N 9	N67.352 W130.303
Distance to Pipeline (km)			6	
Estimated Volume of Material (m ³)			NA	
Ground Ice Content			Low to medium	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.15 – 2.1 Peat	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			295, siltation of Mackenzie River	
Recommendation			Not recommended, difficult access	

Granular Material Source Number 5.23

Cross Reference Number			7, 9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	444,500E, 7,466,500N 9	N67.309 W130.289
Distance to Pipeline (km)			3.4	
Estimated Volume of Material (m ³)			40 x 10 ⁶	
Ground Ice Content			Low	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.6 - 1 NA	
Estimated Recovery Depth (m)			12	
Environmental Sensitivity Number			NA, moose habitat	
Recommendation			Recommended	

Granular Material Source Number 5.24

Cross Reference Number			4, 7, 9	
Material	Classification Description		Class 2 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	450,000E, 7,464,000N 9	N67.288 W130.160
Distance to Pipeline (km)			4.7	
Estimated Volume of Material (m ³)			10 x 10 ⁶	
Ground Ice Content			Low	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0.3 Peat	
Estimated Recovery Depth (m)			9	
Environmental Sensitivity Number			210, no major concerns	
Recommendation			Recommended	

Granular Material Source Number 5.25

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	443,500E, 7,472,000N 9	N67.359 W130.315
Distance to Pipeline (km)			14	
Estimated Volume of Material (m ³)			5.5 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			12	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Recommended	

Granular Material Source Number 5.26

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	457,000E, 7,478,000N 9	N67.415 W130.003
Distance to Pipeline (km)			23	
Estimated Volume of Material (m ³)			1.5 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			12	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Favorable, but far from pipeline	

Granular Material Source Number 5.27

Cross Reference Number			4, 9	
Material	Classification Description		Class 2 Gravel, some sand	
Location	UTM Coordinates Zone	Latitude Longitude	465,000E, 7,480,000N 9	N67.434 W129.817
Distance to Pipeline (km)			17	
Estimated Volume of Material (m ³)			150 x 10 ⁶	
Ground Ice Content			Low to medium	
Method of Extraction			Conventional	
Access to Site			Winter road	
Overburden	Thickness (m) Type		0 – 0.3 Organic silt	
Estimated Recovery Depth (m)			11	
Environmental Sensitivity Number			245, siltation of tributary to Iroquois River	
Recommendation			Favorable, but far from pipeline	

Granular Material Source Number 5.28

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Clay	
Location	UTM Coordinates Zone	Latitude Longitude	462,000E, 7,465,800N 9	N67.306 W129.882
Distance to Pipeline (km)			14.5	
Estimated Volume of Material (m ³)			NA	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			NA	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			ND, no major concerns	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 5.29

Cross Reference Number			4, 9	
Material	Classification Description		Class NG Shale	
Location	UTM Coordinates Zone	Latitude Longitude	455,200E, 7,466,500N 9	N67.311 W130.040
Distance to Pipeline (km)			10.4	
Estimated Volume of Material (m ³)			Unlimited	
Ground Ice Content			None	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			Winter road	
Overburden	Thickness (m) Type		1.2 Clay	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			190, no major concerns	
Recommendation			Recommended	

Granular Material Source Number 5.30

Cross Reference Number			9	
Material	Classification Description		Class 2 Gravel	
Location	UTM Coordinates Zone	Latitude Longitude	454,000E, 7,461,000N 9	N67.262 W130.066
Distance to Pipeline (km)			4.4	
Estimated Volume of Material (m ³)			3.5 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			12	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Recommended	

Granular Material Source Number 5.31

Cross Reference Number			9	
Material	Classification Description		Class 3 Sand and gravel	
Location	UTM Coordinates Zone	Latitude Longitude	454,000E, 7,459,000N 9	N67.244 W130.065
Distance to Pipeline (km)			4	
Estimated Volume of Material (m ³)			3 x 10 ⁶	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			12	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Recommended	

Granular Material Source Number 5.34

Cross Reference Number			4, 9	
Material	Classification Description		Class 4 Silt and clay	
Location	UTM Coordinates Zone	Latitude Longitude	433,000E, 7,452,600N 9	N67.182 W130.548
Distance to Pipeline (km)			17.5	
Estimated Volume of Material (m ³)			NA	
Ground Ice Content			NA	
Method of Extraction			NA	
Access to Site			Winter road across Mackenzie River	
Overburden	Thickness (m) Type		NA NA	
Estimated Recovery Depth (m)			NA	
Environmental Sensitivity Number			ND, moose habitat	
Recommendation			Not recommended, material unsuitable	

Granular Material Source Number 20.038

Cross Reference Number			NA	
Material	Classification Description		Class NG Shale	
Location	UTM Coordinates Zone	Latitude Longitude	567,590E, 7,596,100N 8	N68.469 W133.349
Distance to Pipeline (km)			0.8	
Estimated Volume of Material (m ³)			220,000	
Ground Ice Content			NA	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			Winter road	
Overburden	Thickness (m) Type		Thin Topsoil	
Estimated Recovery Depth (m)			10	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Recommended	

Granular Material Source Number 20.039

Cross Reference Number			NA	
Material	Classification Description		Class NG Shale and siltstone	
Location	UTM Coordinates Zone	Latitude Longitude	566,603E, 7,585,258N 8	N68.372 W133.380
Distance to Pipeline (km)			6.5	
Estimated Volume of Material (m ³)			50,000	
Ground Ice Content			NA	
Method of Extraction			Blasting, quarrying, and crushing	
Access to Site			Winter road	
Overburden	Thickness (m) Type		Thin Moss	
Estimated Recovery Depth (m)			10	
Environmental Sensitivity Number			NA, no major concerns	
Recommendation			Recommended	

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Number**

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