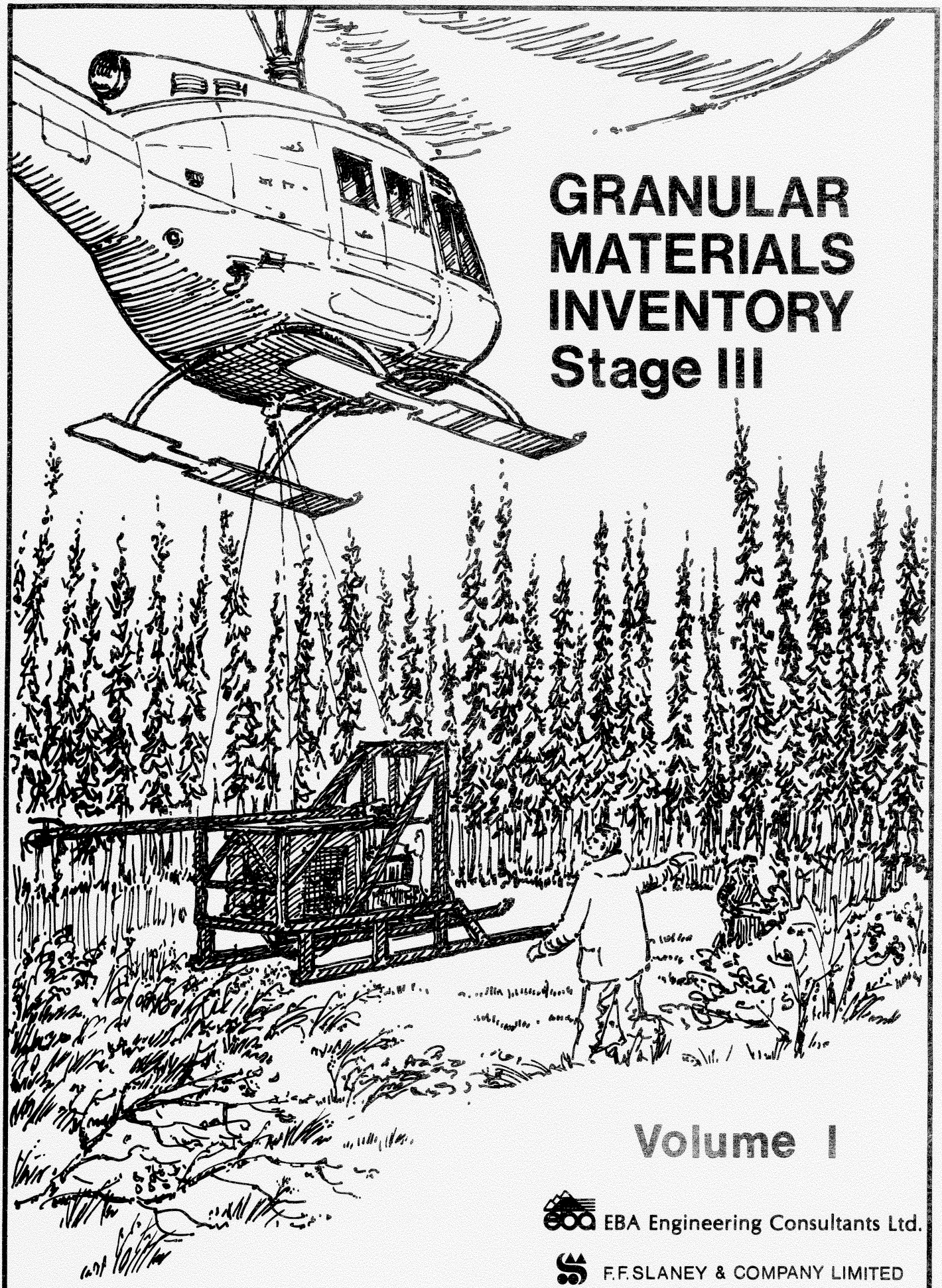

GRANULAR MATERIALS INVENTORY Stage III

Volume I

EBA Engineering Consultants Ltd.

F.F. SLANEY & COMPANY LIMITED

GRANULAR MATERIALS INVENTORY STAGE III

VOLUME I

GENERAL REPORT

Submitted to:

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AND NORTHERN AFFAIRS

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ecg Engineering Consultants Ltd.

ABSTRACT

This report forms part of comprehensive inventory of granular construction materials in the Mackenzie Valley. The particular study reported herein is Stage III, which is confined to a region located along the Mackenzie River, north of Fort Good Hope, south of Inuvik and east of Arctic Red River, N.W.T. The region has been sub-divided into "South Half and "North Half" for simplification of data presentation.

An initial assessment of the region was carried out by airphoto interpretation. Potential sources of granular material were identified and designated for investigation. Scope of the field investigation program consisted of; visual inspection of terrain and soil exposures, hand excavation of test pits, and detailed soil sampling by drilling. The field work was carried out in September and October, 1974 during which time some 130 sites were examined in varying degrees of detail depending upon the apparent potential for development. During this program, data were collected from 245 pits and 104 boreholes. Further information was subsequently acquired from other sources resulting in an additional 26 sites being included in the report.

Evaluation of each site included a preliminary assessment of material quality and quantity, potential access routes and a statement of environmental concerns relating to development. A unique relative environmental importance rating system has been utilized to assess the potential impact of site development.

The specific site evaluation and back up data are presented in Volumes II, III and IV of the report. Volume I is a general report including details pertaining to the field investigation, a general geotechnical assessment of granular resources within the region, a general environmental overview and guidelines for pit design and restoration.

TABLE OF CONTENTS

		PAGE
ABSTRACT		
I.	INTRODUCTION	1
	1.1 General	1
	1.2 Terms of Reference	1
	1.3 Project Organization	3
II.	EXPLORATION LOGISTICS	5
	2.1 Preliminary Assessment	5
	2.2 Field Reconaissance and Drilling Program	6
	2.2.1 General	6
	2.2.2 Site Selection	8
	2.2.3 Drill Rig Performance	8
	2.3 Laboratory Testing	10
	2.3.1 Objectives	10
	2.3.2 Test Program	11
III.	GEOTECHNICAL ASSESSMENT	12
	3.1 Regional Geology and Geomorphology	12
	3.2 Utilization of Granular Materials for Engineering Purposes	17
	3.2.1 Concrete Aggregates	17
	3.2.2 High Quality Granular Material	18
	3.2.3 General Fill	19
	3.2.4 Bedrock	19
IV.	ENVIRONMENTAL OVERVIEW	21
	4.1 General	21
	4.2 Scope of Environmental Investigation	21
	4.3 Relationship to Regional Development	22
	4.4 State of Knowledge	22
	4.5 Potential Impacts From Material Removal	23
	4.5.1 Important Factors	23
	4.5.2 Clearing	23
	4.5.3 Borrow Operations	24
	4.5.4 Access Roads	24
	4.5.5 Aggregate Processing	25
	4.6 Borrow Site Assessment	26

PAGE

V. PIT AND QUARRY DESIGN 28

5.1 Pit and Quarry Design 28

5.1.1 General 28
5.1.2 Pit Size 28
5.1.3 Access Roads 32
5.1.4 Slope Development 34

5.2 Clearing, Stripping and Stockpiling 36
5.3 Timing of Reclamation Procedures 38
5.4 Restoration Techniques 39

5.4.1 Vegetation 39

a. Seeding Methods 39
b. Seed Mixtures 39
c. Seeding and Fertilizing Rates 42

5.4.2 Aquatic 42
5.4.3 Birds 43
5.4.4 Mammals 43

5.5 Site Assessment Rationale 44

APPENDIX A PARTICULAR ENVIRONMENTAL CONCERNS

A.1 Climate A-1
A.2 Terrain A-1

A.2.1 General A-1
A.2.2 Dominant Terrain Features Within Study Area A-8
A.2.3 Site Assessment rationale A-9

A.3 Vegetation A-9

A.3.1 General A-9
A.3.2 Vegetation Types in the Study Area A-9
A.3.3 Site Assessment Rationale A-12

A.4 Mammals A-12

A.4.1 General A-12
A.4.2 Occurrence Within the Study Area A-12
A.4.3 Native Utilization A-16
A.4.4 Site Assessment Rationale A-17

PAGE

A.5 Birds A-17

A.5.1 General A-17
A.5.2 Waterfowl A-18
A.5.3 Raptors A-18
A.5.4 Upland Game Birds A-22
A.5.5 Passerine A-22
A.5.6 Site Assessment Rationale A-22

A.6 The Aquatic Systems A-22

A.6.1 The Mackenzie River Proper A-22
A.6.2 Tributaries of the Mackenzie A-24
A.6.3 Lakes and Marshes A-24
A.6.4 Utilization of Fisheries Resources A-25
A.6.5 Potential Impacts of Borrow Operations on Aquatic Systems A-25
A.6.6 Site Assessment Rationale A-30

A.7 Archaeology A-31

A.7.1 General A-31
A.7.2 Archaeological Sites Within the Study Area A-31
A.7.3 Archaeological Potential Within the Study Area A-31
A.7.4 Site Assessment Rationale A-32

APPENDIX B GLOSSARY AND LIST OF REFERENCES

Glossary B-1
List of References B-11

APPENDIX C PHOTOGRAPHS

Maps

LIST OF TABLES

		PAGE
Table 2.1	Exploration Logistics	7
Table 3.1	Bedrock Geology	13
Table 5.1	Recommended Grasses and Legumes Suitable for Northern Growing Conditions	41
Table A.1	Climatic Summary of Nearest Communities	A-2
Table A.2	Climatic Summary	A-3
Table A.3	Sensitivity of Mammals to Exploitation of Deposits of Granular Soils	A-13
Table A.4	Sensitivity of Birds to Exploitation of Deposits of Granular Soils	A-19
Table A.5	Sensitivity of Fish to Exploitation of Deposits of Granular Soils	A-27

LIST OF FIGURES

Figure 1.1	Key Map	2
Figure 5.1	Borrow Pit Design - Flat Land	30
Figure 5.2	Borrow Pit Design - Rock Quarries	31
Figure 5.3	Borrow Pit Design - Rolling Terrain	33
Figure 5.4	Benching of Slopes	35
Figure A-1	Mean Date of Last Frost (Spring)	A-5
Figure A-2	Mean Date of First Frost (Fall)	A-6
Figure A-3	Mean Annual Totals of Degree Growing Days	A-7

1. INTRODUCTION

1.1 General

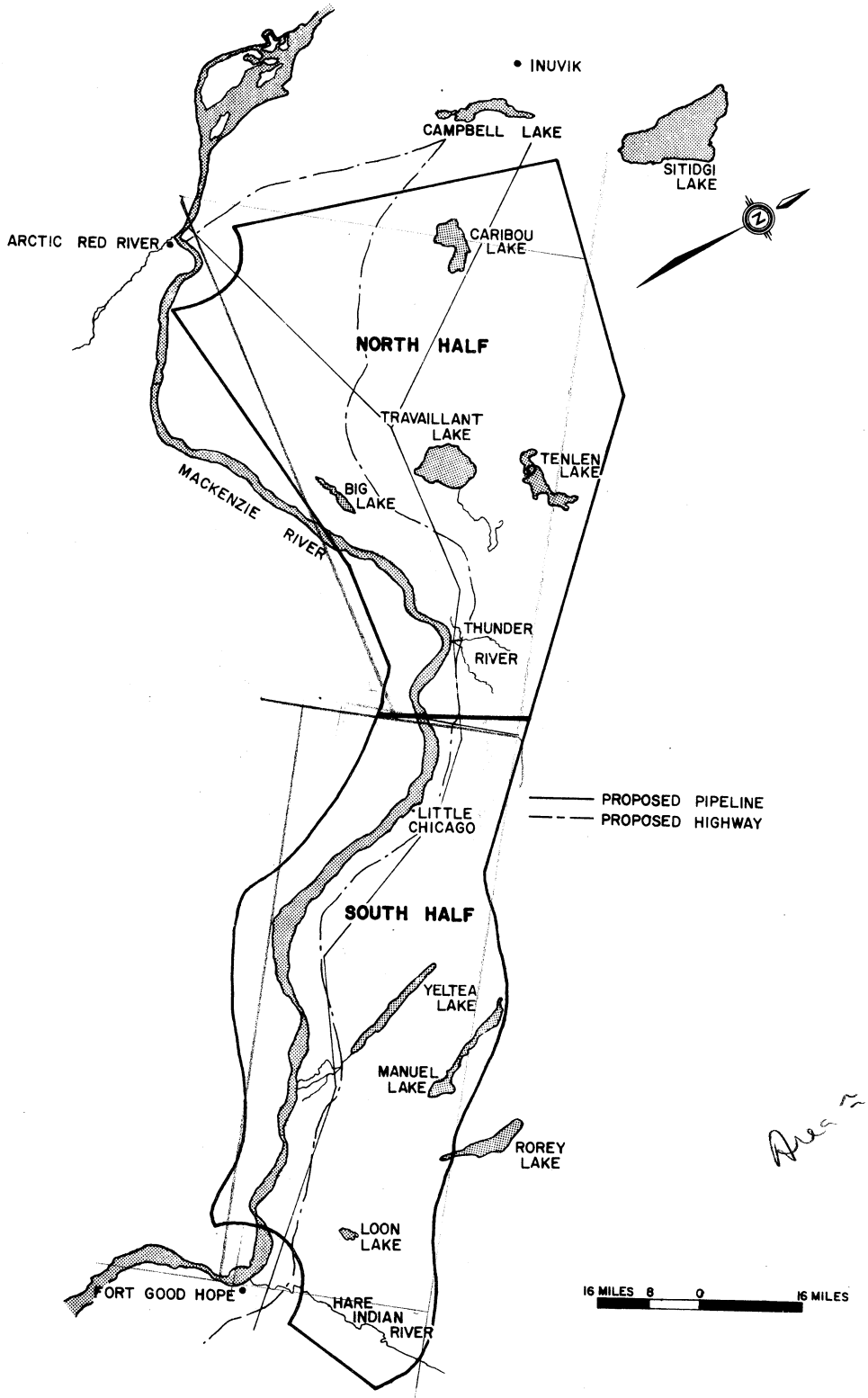
This report describes the third stage of a comprehensive inventory of granular material reserves in the Mackenzie Valley. The work is being conducted by the Government of Canada, Department of Indian and Northern Affairs (DINA) in order that development guidelines for construction materials can be formulated. EBA Engineering Consultants Limited were retained to carry out Stage III of the program, which includes the region of the lower Mackenzie Valley from Fort Good Hope, N.W.T. north to Sitidgi Lake and Northwest to Arctic Red River, N.W.T. The region is exclusive of a 20 mile diameter reserve zone around the communities of Fort Good Hope and Arctic Red River, respectively (Figure 1.1).

Details of the investigation procedure, general summary of the findings, statement of environmental concerns regarding development and pit design and restoration recommendations are contained in this general report. The pertinent information and overall assessment for each site examined is summarized in supplemental volumes.

1.2 Terms of Reference

The terms of reference for the study were outlined in detail by the Department of Indian and Northern Affairs prior to commencement of the study. In general, the scope of work included:

a) Review of existing data for the region which had been compiled by the Geological Survey of Canada, and others.



Area ≈ 6250 sq miles

KEY MAP
GRANULAR MATERIAL INVENTORY
STAGE III STUDY AREA

FIGURE 1.1

b) Locate and sample all granular material and potential bedrock quarry materials within the specified area.

c) Test and classify the material according to potential usage for construction purposes.

d) Provide recommendations for development and restoration of the available granular and bedrock resources in such a manner as to minimize environmental disturbance.

1.3 Project Organization

EBA was retained by the Department of Supply and Services under Contract No. OSR3-0053 on behalf of Indian and Northern Affairs to conduct the study. The possible environmental consequences of developing selected sites has been assessed by F.F. Slaney and Co., working under the direction of EBA. Sub-contractors, for drilling and field supports services, were selected by EBA. Contractural affairs have been managed by Mr. M.S. Fleiszer, Science Contract Manager, Department of Supply and Services and the entire project was overviewed by Mr. H.D. Dekker chairman of the Granular Materials Working Group, Indian and Northern Affairs with assistence from Mr. E.B. Owen.

The final report on the project is presented in four volumes as indicated below:

Volume I	General Report
Volume II	Site Descriptions - South Half Sites 1001 - 1053 and 1056 - 1060
Volume III	Site Descriptions - North Half Sites 1054 - 1055 and 1061 - 1110
Volume IV	Site Descriptions - North Half Sites 1111 - 1156

In this volume, the field exploration program is described and a general assessment of results is given. The regional geology and geomorphology as they relate to the distribution of granular materials are described and the potential uses for the various types of materials encountered is briefly discussed. Environmental studies, carried out by F.F. Slaney and Co., are presented together with recommendations pertinent to pit and quarry design and restoration.

A series of summary maps and compilation tables are included at the end of the text. The maps illustrate:

a. Site Locations
b. Wildlife Abundance Areas
c. Areas of Native Utilization of Wildlife Resources.

The compilation tables are an overall assessment summary for each site. The appropriate site location map and respective compilation table are contained in each volume of the report in order that the volumes may be utilized independently. A series of descriptive photographs is contained in Appendix C.

Specific data obtained for each of the examined sites are contained in Volumes II, III and IV. For convenience, the region has been divided into a South Half and a North Half with site descriptions for the South Half contained in Volume II and those for the North Half contained in Volumes III and IV. The sites have been numbered sequentially from south to north starting at 1001 and ending at 1156. The amount of detail devoted to any specific site varies considerably, depending upon the potential for development. Information is presented in the data volumes for all sites examined irrespective of detail. Those sites which seem obviously unsuitable for development are identified by a suffix "a" after the site designation number.

The primary source of data was the field exploration program conducted by the staff of EBA Engineering Consultants Limited. Supplementary data was obtained from borehole logs provided by the Department of Public Works (DPW), Mackenzie Valley Pipeline Research Ltd. (MVPL) and R.M. Hardy and Associates Ltd. (RMH). All borehole logs bear initials signifying the source of the data and the originator's field number. Moreover, field information collected in the region during previous studies by EBA for Canadian Arctic Gas Study Ltd. and Canadian National - Canadian Pacific Arctic Railway Study Group has also been helpful in formulating this report.

II. EXPLORATION LOGISTICS

2.1 Preliminary Assessment

The initial exploration work for the Stage III area involved the evaluation of existing data to provide an overview of the materials and conditions which might be encountered. This was supplemented by a study of the available airphotos to locate and evaluate specific deposits which might contain developable granular and bedrock materials.

The Department of Indian and Northern Affairs supplied 1:125,000 Granular Resources Inventory maps and material evaluation reports which had been prepared by the Geological Survey of Canada (GSC) for much of the Stage III area. The scale of the GSC report provided a regional overview and was the basis for the field reconnaissance work in areas where the existing airphoto coverage was poor or absent. In addition regional data was obtained from the Canadian Arctic Gas Study Ltd. (CAGSL) strip mosaics and borehole data. The borehole information collected previously by EBA for CAGSL provided a check on the accuracy of the surficial interpretations used in the compilation of the GSC maps and reports.

Initial airphoto coverage of approximately 70% of the Stage III area at a scale of 1":3000' was supplied by Indian and Northern Affairs. These airphotos were reviewed by Dr. J.D. Mollard of J.D. Mollard and Associates together with EBA Engineering Geologists. Approximately 200 sites were identified and classified as to their origin, probable material composition and general site conditions. A tentative rating system was devised to subdivide these sites into four levels of priority. All of the first and second priority sites were visited and most were test pitted. Many of the other sites received an aerial inspection. Most of the prospects noted on the GSC maps were designated for field exploration subsequent to the airphoto study and several other sites not shown on the GSC maps were identified and evaluated. Those sites that were considered to have a reasonable potential for development, were examined in more detail.

2.2 Field Reconnaissance and Drilling Program

2.2.1 General

The study region assigned for Stage III is approximately 6800 square miles in area, lying chiefly along the east bank of the Mackenzie River (Figure 1.1). The region is relatively inaccessible even during winter since the only established winter road follows the CNT line and the terrain is sufficiently heavily forested to make ground mobility be tracked vehicles difficult. Economics and logistics of carrying out the field exploration program therefore strongly favoured a summer program, with helicopter support services.

Two Bell 206, Jet Ranger helicopters were utilized to transport two field reconnaissance crews and a heavy turbine, Bell 205A, was contracted for moving the drilling equipment. The reconnaissance crews were each staffed with two native labourers for site clearing and test pit excavation.

The field work was carried out in September and October, 1974. Exploration for the north half of the study area was carried out from a survey base camp established by the Department of Public Works on the new Mackenzie Highway, approximately 30 miles south of Inuvik airport (mile 948). The field crew moved to the DPW camp at Fort Good Hope for exploration of the southern half of the study area. Exploration statistics for the field reconnaissance and drilling program are summarized in Table 2.1.

TABLE 2.1
EXPLORATION STATISTICS

No. days in the field	34
Lost Days due to weather	4
No. Days Drilling	22
No. of Boreholes Drilled	104
Average rate of Drilling Progress	4.7 holes/day
Total Depth Drilled	1700 Feet
Average Depth of Hole	16.3 Feet
Range of Borehole Depths	3 - 30 Feet
No. Days Test Pitting	19
No. of Test Pits	245
Average Rate of Test Pitting Program	13 pits/day
Typical Depth of Test Pit	3 Feet

2.2.2 Site Selection

The sites preselected by airphoto interpretation were visited in the field by a reconnaissance party. An area sufficiently clear of brush to land the Jet Ranger helicopter was sought and any natural soil exposures were inspected either on the ground or from the air. At least one test pit was dug to sample the soil below the surface organic cover. Based on the test pit findings and the general impression of the party chief a decision of whether to drill at that particular site was made. Sites which held sufficient promise to warrant drilling were cleared by hand to create a landing pad for the Bell 205 helicopter and drill rig.

Many sites were of sufficient aerial extent to require several test pits and boreholes. Up to 5 boreholes were drilled within one site in order that sufficient data regarding soil composition and extent of a deposit could be obtained. In most cases, the field data collected was sufficient to make a preliminary assessment of conditions. Where exploitable soil borrow materials are abundant and pit development is contemplated, more detailed drilling will be required to better delineate the deposit and to accurately establish quantity and quality of the material.

2.2.3 Drill Rig Performance

In view of the late (September) starting date, two rigs were mobilized for drilling service. These rigs are described briefly below:

a. Mobile "Arctic Auger". This rig was custom designed and built in Edmonton by Mobile Augers and Research Limited in conjunction with EBA Engineering for work on the proposed Canadian Arctic Gas Study Ltd. pipeline route. Drilling is carried out with a 4 inch hexagon drive,

continuous flight auger. The rig sits on skids and is carried by the helicopter as a single load. For the granular material investigation, an air compressor was added, to provide the option of converting to conventional seismic type drilling utilizing air as a circulating medium.

b. "Heli drill" with Becker Conversion. This rig was sub-contracted from Kenting Big Indian Drilling (KBI) with special modification to accept a double wall drill pipe. Air is forced down the hole in the annular space between inner and outer pipe and the cuttings are returned up the centre. This provides a hole which is cased during the drilling operation. Unfortunately the maximum size of drill pipe which can be utilized on the KBI drill was 2" ID which was not sufficient to allow free passage for the cuttings. This led to drilling difficulties with this equipment in the early stages of the program and the unit was released prematurely.

The auger was found to perform surprisingly well on the drilling program. Most holes were drilled with the auger and grab samples were taken from the auger flight when it was withdrawn from the hole. Special bits were utilized and the available downhole weight was increased by placing the basket of auger and miscellaneous drilling equipment on the skids. This procedure made drilling of frozen soil, including gravel possible with the auger. Drilling was generally involuntarily terminated only when cobble size materials were encountered. An advantage was gained by conducting the field work during late September and

early October since the active layer was thawed completely. The depth of unfrozen soil, even in the most northerly portion of the study area, was often 10 to 15 feet in the high, well drained granular deposits. This simplified drilling and sampling considerably.

In most instances a representative sample of soil was obtained from the auger. The soil was described in terms of its texture, gradation, plasticity and possible geologic origin using the guidelines established by the Natural Research Council (NRC). Whenever possible, permafrost soils were logged using the permafrost classification system developed jointly by NRC and CRREL. Soil samples were retained at approximately 2 ft. intervals of depth for laboratory testing. All samples were double bagged and carefully packed for shipment to the EBA Edmonton Laboratory to ensure moisture was not lost in transit.

2.3 Laboratory Testing

2.3.1 Objectives

A laboratory testing program was undertaken when field work was complete. The objective of the program was to provide:

a. Verification of the field description of soils by classification of selected samples.

b. Textural data required for assessing the acceptability for engineering purposes of the various soils encountered.

c. An indication of variability of engineering properties of soils within the same potential borrow area.

d. Some insight into geologic origin of the representative soils for correlation with airphoto interpretation work.

2.3.2 Test Program

The testing programs included the following:

a. Moisture Content
b. Gradation Analyses (Sieve analysis)
c. Organic Content
d. Petrographic Examination

The moisture content was measured as a routine on all samples returned to the laboratory. The degree of followup testing varied according to the initial assessment of site development possibilities. Most tests were performed in accordance with ASTM or CSA recommended practices. The petrographic analyses were essentially a rock identification of all gravel sized materials by an experienced engineering geologist. All laboratory test data is reported in each individual site description either on the respective borehole log or by gradation curve. Most of the laboratory test data reported is for those boreholes or test pits drilled by EBA personnel. Limited laboratory test data were available for borehole logs from other sources however, where available, it has been included.

III. GEOTECHNICAL ASSESSMENT

3.1 Regional Geology and Geomorphology

The region designated for study under the Stage III Granular Materials evaluation program is situated in the lower Mackenzie Valley within the Northern Interior Plains physiographic region. The Anderson Plain lies to the east of the Mackenzie River and the Peel Plain lies to the west. The landscape is characterized by undulating topography reflecting a relatively thin veneer of glacial drift overlying bedrock.

The region is underlain by relatively flat lying, undifferentiated, Cretaceous sandstones and Upper Devonian shales or siltstones, of the Imperial and Fort Creek (or Canol) Formations. The Fort Creek Formation overlies massive limestone of the Ramparts Formation. The characteristics of these sediments and their observed engineering behaviour are summarized in Table 3.1. Numerous flow slides, which occur along the Mackenzie River Valley escarpment near Little Chicago are characteristic of the unstable nature of the shale in this area.

In general, Cretaceous bedrock is located on the uplands to the east of the river, between Fort Good Hope and Little Chicago. The upland plateau formed by the Cretaceous sandstones and Devonian shales has been cut by three major north-south trending meltwater channels which are presently occupied by Yeltea Lake, Manual Lake, and the system of Loon, Rorey and Carcajou Lakes. Isolated small exposures of Cretaceous sandstone are also common in the Travaillant Lake area.

TABLE 3.1

BEDROCK GEOLOGY

FORMATION OR GROUP NAME	GEOLOGIC AGE	GEOLOGIC DESCRIPTION	ENGINEERING SURFACE
Cretaceous (undivided)	Cretaceous	Shale, siltstone, sandstone, and conglomerate in part non-marine. The shales are grey to black, clayey to silty, micaceous, concretionary with some local iron-staining and gypsum crystals. The siltstones are dark grey to grey-green, micaceous and laminated. Thin bedded bentonitic shales and bituminous beds are not uncommon.	This unit as a whole weathers into large slump blocks on moderate to steep slopes. Bentonite beds can be hazardous on any slope. The gypsum and iron-staining indicate a potential for sulphate attack on any concrete in contact with it.
Erosional Unconformity			
Imperial Formation	Upper Devonian	Brown and Greenish Brown fissile shales with subordinate impure, brown, fine-grained sandstone and siltstone. The beds are in part non-marine.	The dark coloured shales are known to be subject to mudflows.
Fort Creek or Canol Formation	Upper Devonian	The upper units are grey shales, thin sandstones, bituminous shales with coral reefs and limestone. The lower units are dark fissile shales.	The bituminous shales are subject to spontaneous combustion.
Ramparts Formation	Middle to Upper Devonian	The Ramparts part of the Formation is mainly medium bedded brown limestone.	Stable material, very durable. Excellent material for general construction usage.

The Imperial and Fort Creek formations, are commonly exposed in the study area along the scarps of the Mackenzie River Valley and the north-south trending meltwater channel system. The limestone of the Ramparts Formation forms a prominent scarp along most of the Ramparts plateau and the east and west banks of the meltwater channels.

A thin mantel of glacial till overlies bedrock in most of the area except where it has been removed along the Mackenzie River Valley. Glacio-fluvial deposits such as eskers, kames, and outwash plains are the original supply most of the granular soil in the region. Kames are the most common glacio-fluvial deposit located on the upland areas. Commonly, they have a small diameter and are relatively steep sided. The kames in the study region usually contain only minor amounts of gravel, which often is concentrated in the upper two feet of the kame by frost action. This characteristic resulted in promising test pit results at some sites which, when drilled, produced unsuitable granular material.

Eskers are found more commonly in the southern half of the study area. They are generally short and often partially segmented. Most eskers in the south half of the area are quite well formed and very steep sided. The sides are often bare of tree growth because of their steepness, however, some eskers have dense stands of relatively large trees on one side only. The material found in the eskers throughout the study area is heterogeneous and generally sand-rich.

Outwash deposits, outwash deltas, and glacio-fluvial terraces form many of the larger, better quality granular deposits in the study area. Although these deposits are usually of large aerial extent, the exploitable granular soil tends to be thin and often ice rich. These factors make feasibility of development questionable in many circumstances. The most remarkable system of outwash deposits was found along the east-west trending chain of lakes north of Travailland Lake (Sites 1121 - 1125). Another very extensive outwash was encountered north of Travaillant Lake (Site 1138). The material found in these deposits ranges from well graded sandy gravel with cobbles and some silt to poorly graded, silty sands with some gravel.

Glacio-fluvial terraces are found along the present major rivers in the study area. There are excellent terraces along the Hare Indian River (1009a) and Thunder River system (1085) and smaller terrace-like deposits along the Loon (1002, 1003) and Bluefish Rivers (1008a). A large glacio-fluvial outwash delta containing good quality granular materials was formed on the south-east side of the Mackenzie River, across from the mouth of the Thunder River (Sites 1061 and 1062).

A drumlin field was identified on the erosional valley lowland of the Mackenzie River (1048). It is located between the river on the west and a shale scarp on the east, lying between Payne Creek and Little Chicago. Some of these drumlinized forms appear to be related to glacio-fluvial terraces and esker deposits and do contain useable granular material. However, most of drumlins appear to be composed of remolded tills or possibly sculptured shale bedrock.

North of the line between Pointed Hill and the settlement of Arctic Red River and south of the Rengleng River is an extensive area of hummocky disintegration moraine. This area is poorly drained and although there are several small kames and two long but thin eskers, they are very poor sources of granular materials.

Existing landforms have been modified by recent geomorphic processes. In particular, solifluction has caused a mantle of high ice content silts to be deposited on gentle slopes and along the base of major river scarps and meltwater channels. Along the shale scarps east and north of the Mackenzie River between the Ramparts Plateau and Pointed Hill, most of the colluvial silt is weathered shale. These silts have a high susceptibility to sliding when the surface vegetation is disturbed by forest fires. Such a condition is evident in the vicinity of Little Chicago where many narrow flow slides have occurred at the base of the colluvial silts.

Peat, organic soil, fens, bogs and marshes overlie an extensive portion of the study area. These deposits are the result of the poorly developed surface drainage characteristic of a glaciated area and poorly developed subsurface drainage characteristic of permafrost regions. Thick deposits of organic material have accumulated in most shallow depressions, ponds and lakes. These organic soils are excellent thermal insulators in the unfrozen state. Where the peat covers lacustrine silts and clay, excess ice content of the soil is usually high, rendering the terrain sensitive to severe thaw subsidence if surface soils are disturbed by construction activities.

Permafrost is continuous in the northern half of the study area but becomes discontinuous in the southern half. Permafrost is not present under lakes, ponds and rivers which are more than about six feet deep. Also, in high well drained areas such as eskers, kames and high river terraces, the active layer has been found to be quite deep. In the summer the depth of thaw in these deposits is often greater than 15 feet depending on the vegetation cover drainage conditions and solar aspect.

3.2 Utilization of Granular Materials for Engineering Purposes

3.2.1 Concrete Aggregates

The findings of the program indicate that a severe scarcity of sand and gravel which can readily serve as concrete aggregate exists in the Stage III Region. Some of the gravel samples obtained from outwash deposits will, however, be acceptable after considerable processing. Generally, it has been found that this material is well-graded, but contains 10 to 20% fines (material passing a No. 200 sieve). On a large scale basis, it is usually not feasible to remove such a high proportion of fines by washing, thus the soil will have to be split on a No. 4 sieve and the fine fraction discarded. The coarse fraction will invariably have to be washed to remove residual fines and deleterious coatings on the particles. Further processing of the coarse fraction by screening and washing will probably produce an acceptable fine and coarse aggregate. This process will result in wasting of approximately 50% of all excavated material.

In some instances, petrographic examination of potential aggregates has shown that soft friable particles, such as shale and sandstone are prevelant in the gravels. Moreover, chert has been identified in proportions ranging from 0 to 8 percent. In view of the scarcity of granular materials in the region, such aggregates have not been rejected for concrete purposes. However, prior to processing on a large scale basis, they must be subjected to rigorous laboratory testing to evaluate soundness, durability and acceptable mix design criteria.

3.2.2 High Quality Granular Material

Granular soil, acceptable for use as sub-base and surface courses for gravel roadways are scarce within the study region. These materials are considerably more prevelant in the north half of the region, but even there, the haulage distance to proposed highway and pipeline routes is often very long. In general, these materials were found to be well-graded gravel with sand, cobbles and some silt. The cobbles would probably have to be removed by screening on a 3" sieve. A fines content between 5 and 10% is desirable for gravel surface courses, thus the material is suitable for this purpose. Compaction to a high density could be readily achieved with a vibratory drum roller.

The screened gravel fill is readily adaptable to other construction uses such as tank pads and building foundation pads. The excellent gradation and small content of fines would be effective in producing a dense pad which if properly constructed would be sufficiently impervious to shed water. Care must be taken however, to ensure such a fill is frost stable. The fines content is sufficiently great that the borrow material is marginally susceptible to frost action. These problems can however be overcome by ensuring good drainage and restricting the access of subsurface water to the pad.

3.2.3 General Fill

Granular soil, suitable for general fill has been located in outwashes, eskers and kames within the study region. Most materials designated for general fill have a high concentration of sand and some silt. The moisture content of these materials is sufficiently high that it will be difficult to handle and place them during winter. Frozen sand fill from some of the high, well drained eskers may however, break down readily under the weight of heavy compaction equipment.

These materials can be readily handled and placed during summer months. For the most part they are sufficiently well graded to allow compaction to a dense state. These soils are, however, subject to erosion thus they should be capped with a more resistant protective layer.

Frost instability may be a serious problem arising from construction with random granular fill. Careful consideration will have to be given to fill selection and subgrade design, in order to minimize the risk of frost heave.

3.2.4 Bedrock

Quarried bedrock has been used extensively as a source of construction material for the new Mackenzie Highway. Experimentation with local bedrock has been a direct result of the extreme shortage of acceptable granular soils in the region. Limestone can be successfully quarried either winter or summer and used as general fill. This material may require crushing, depending upon its end use and the insitu properties of the rock. Such fills are frost stable and relatively durable.

Shale has been successfully used for subgrade construction along the most northerly portions of the new Mackenzie and Dempster Highway systems. The shale is preferable to many natural granular deposits because of its low moisture content (less than 10%) and consequent ease of handling. As stated previously, the Upper Devonian Shale weathers rapidly on exposure to wet-dry and freeze-thaw cycles reverting to a medium plastic clay. This can result in serious stability problems similar to those observed on some of the exposed natural slopes in the region. In order to cope with these problems, designers have utilized flatter than normal side slopes and thick granular surface courses. The shale deposits which were found to have a thick covering of overburden, an extensive weathered zone, undesirable plasticity characteristics or high natural moisture content have been classified as unsuitable for construction purposes.

IV. ENVIRONMENTAL OVERVIEW

4.1 General

This Environmental Overview was undertaken to assess potential impacts and suggest mitigation techniques for granular borrow operations in the general region bounded by Fort Good Hope, Arctic Red River and Inuvik. Investigations included: appreciation of fish, wildlife and plant species of the region; an assessment of sensitive areas; and the development of a rating system for comparing individual sites to indicate a priority base for future developments.

These data are designed to complement the assessment of the granular material on the site and the combined data will form the basis for identifying potentially acceptable sites.

4.2 Scope Of Environmental Investigation

Some 110 of 156 sites identified by EBA Engineering Consultants Limited, within the 6,800 square mile area inventoried for granular material, were investigated for environmental impact. Environmental assessments were based on a field reconnaissance of 40 sites, analysis of vertical air photographs of 34 sites, analysis of published reports and the extrapolation of data from similar sites in the general region. Charts were used to capsulize data. A preliminary rating system adapted from Battelle, 1973, was used to depict the relative environmental values at each site.

Potentials for restoration have been considered according to landform, soils and surrounding resource levels. Sketches of restoration techniques are presented in the following section. Specific mitigation measures should be determined when the extent and type of development is designed in detail.

4.3 Relationship To Regional Development

Priorities for pit development will be dictated primarily by the borrow area's proximity to future developments. The proposed locations of the Mackenzie Highway and a Natural Gas Pipeline are tentatively identified. Distances of borrow sites from the highway and pipeline have been recorded.

Other developments, albeit uncertain, could include: an Arctic railway, barge transport systems, tributary highway networks, national defense establishments, mines, residential and recreational development.

Lengthy access roads through thermally sensitive terrain could cause greater environmental degradation than actual pit development. Restoration costs would increase substantially if long access roads are required. Borrow areas within five miles of the highway should receive top priority for intensive investigation.

4.4 State of Knowledge

Within the Inventory Area, a relatively broad base of knowledge of environmental concerns has been accumulated about the communities along the Mackenzie River. Recent studies associated with highway and pipeline development have expanded scientific knowledge to a broader regional base. Site specific environmental data about the sources of granular material identified during this study is minimal.

Observations from an aerial reconnaissance, perusal of pertinent literature and the extrapolation of known characteristics of similar sites form the basis of these preliminary estimates. All evaluations were formulated by scientists with local knowledge of the Mackenzie Valley region. Further on site inspections would be required before a final design of development and restoration could be prepared.

4.5 Potential Impacts From Material Removal

4.5.1 Important Factors

Environmental changes which enhance one element may depreciate another. Factors which will affect the amount of impact are:

a. Relative number of sites developed
b. Extent of disturbance at each site
c. Type of operation
d. Quality of planning
e. Timing
f. Stability of structures
g. Physical conditions
h. Biological sensitivity
i. Restoration procedures
j. Maintenance provisions
k. Regional resource patterns

Large borrow pits in close proximity to the construction project would limit disturbances to a localized area and are usually preferred to a series of small developments which effect a disturbance over a wide area.

4.5.2 Clearing

Bulldozer shearing stems over frozen ground is a most efficient and environmentally sound method of clearing. Sheared stems remain clean and are readily piled for disposal. The intact root mat maintains insulation of thermally sensitive soils, disperses surface runoff and filters sediments.

Woody materials can be disposed by chipping, burning or burying. Chipping is environmentally sound but is an expensive alternative requiring specialized equipment. In the forest cover typical of the

ection the chipping costs of $15 to $50 per 100 cubic feet of solid wood are indicated, depending on type of machine and working conditions. Burning should be avoided on thermally sensitive terrain since the blackened organic mat absorbs radiation and may initiate thermokarst features. Woody material could be burned within pit areas or on gravelly soils with deep active layers and low ice content. Burying of debris on the floors of excavations and covering them with spoil can provide naturally appearing appearing undulations or terraces which may be incorporated into the restoration plan.

4.5.3 Borrow Operations

The initial design for clearing and the layout of the excavation areas often control the extent of impacts and the effectiveness of restoration procedures. Overburden stripping and piling procedures material excavation, drainage control, transportation systems and stabilization designs all have effects on habitat quality. Denning disruption, hydrologic alteration, siltation and noise are possible negative effects while improved or extended habitats are positive potentials.

Development plans for each site should be assessed prior to development and a team of specialists could design operating and restoration guidelines for sensitive developments.

4.5.4 Access Roads

Access roads to borrow sites have the potential to create a corridor of disturbance which may exceed the impact of utilizing the borrow material. Location, design, length, right-of-way, width, alignment standards and season of use are factors which determine the amount of disturbance.

High volume traffic on long roads would require cut and fill construction similar to highway standards and therefore similar construction and stabilizing safeguards are essential. Winter roads should be located with care to avoid sensitive terrain. Routes along ridge areas are preferred to those traversing lower slopes or wetlands. Highway stability standards would be required for roads supporting summer operations.

Four acres per mile are disturbed by clearing a 30 foot right-of-way. The accumulated acreage of disturbance from roads may be more significant from habitat removal or restoration considerations than the actual pit development.

Temporary creek crossing structures and approaches should be removed before the onset of breakup. Log and fill materials which wash out often form debris dams downstream and can degrade aquatic habitats by migration blockage, scouring and siltation.

Ditching, culverts and waterbars should insure that water flows along the road surface are channelled into undisturbed vegetation, particularily near streams.

4.5.5 Aggregate Processing

Washing, crushing and blending operations will be most efficient if conducted in summer at accessible locations. Quarries or bedrock pits could be used as settling ponds. Logistical problems of transporting processing equipment, operating in summer and moving material into and out of the plant may force location of processing areas closer to construction sites than to pits. Raw materials could be transported over temporary roads to storage areas and aggregate could be moved over permanent roads to construction sites. Large areas to be occupied by stockpiles should be assessed for environmental impact.

Other disturbances additional to borrow pits and access road developments are possible. Serious habitat alterations could result from lowering of water levels of intake sources, increased flows and scouring of outflow systems, increased siltation from waste water, noise and dust from the crushing operation. Fire hazards must also be controlled near summer operations in forested areas. Good camp care and personnel briefing would minimize many minor impacts.

4.6 Borrow Site Assessment

Environmental concerns were assessed on a regional basis and for site specific levels. Regional species and their characteristics have been summarized for mammals, birds and fishes potential impacts and recommend mitigation procedures are presented in Appendix A. Maps showing fish and wildlife concentration areas and resource utilization areas are contained in the appendix titled "Maps".

Quality assessment sheets have been prepared for each site and a subjective rating was assigned for the purpose of comparing the potential for environmental degradation at each site. The regional assessments provide insight into the rationale of site specific tabulations.

The relative Importance Rating weights the environmental categories according to importance within the spectrum of concerns as understood by the study team. Impacts on one concern often affect assessments in several other categories, i.e. furbearing mammal values are also reflected in trapline resource utilization.

As social values change and knowledge of the biota in the region improve the relative ratings can be readily adjusted to accommodate new values. In this study 100 units was the given base and the units distributed in accordance with the particular biases of the study group.

The relative quality of a particular element or parameter was rated for each site. Quality assessments were prepared by a team of specialists where each category was rated by the same member. The criteria used in assessing each category are included in the respective section of Appendix A. Although personal biases are present, the relative qualities between potential sites should be in the proper order.

Category Ratings are simply a product of the assigned Relative Importance Units (100 total) and the Relative Quality Assessment (1, 2, 3, 4, or 5). If all elements were assessed as minimal quality, 1, the total is 100. If all elements were assessed as maximum quality, 5, the total is 500. Therefore the total assessments range from 100 to 500.

The rationale for the quality ratings are indicated by the elements underlined. The rationale for the Relative Importance Rating is wholly subjective and reflects the collective biases of the study team.

The exceptional case is protected by the remarks section where, identified, unique or otherwise critical elements are given precedent over all other considerations.

The above process obviously has limitations and should not be taken too literally. It does however, provide the decision maker with a reasonable understanding of the study team's concerns for particular sites.

V. PIT AND QUARRY DESIGN AND RESTORATION

5.1 Pit and Quarry Design

5.1.1 General

Borrow pits will vary in size and design depending upon the material demand, the quantity of material available, and the type of deposit encountered at the site. Esker deposits tend to be the most readily exploited borrow sources as it is often possible to begin excavation at one end and work to the other end, completely removing the esker. The equipment required for excavating unfrozen esker material is generally a front-end loader or payloader and trucks. It may be necessary to remove and stockpile pockets of glacial till which may be encountered within the esker. Borrow pits in eskers tend to be confined to a relatively small area. Excavations into drumlins will be similar to those into eskers.

Kame deposits are often frozen thus ripping or blasting will be required to loosen the material. Equipment required for handling and transport of the loosened material includes dozers, front-end loaders or payloaders and trucks. The deposit is expected to exhibit considerable variation which will necessitate selective extraction of the better quality material. Overburden thickness will be variable and overburden will usually have to be removed and stockpiled for use in restoration.

Terrace and outwash deposits are generally quite thin and usually have a relatively thin overburden cover. Frozen gravel deposits will have to be blasted, ripped and dozed. If unfrozen, the material can probably be excavated by a front-end loader or payloader. These deposits are generally quite uniform which will allow for a relatively simple pit design. Aerial extent of the pit, however, will likely be large because of their thin nature.

The initial design of borrow excavations should include restoration as an integral part of the development program. Configuration of the clearing should conform to the general terrain pattern. Clearing should be designed in accordance with natural landforms rather than as a rectangular intrusion (Figure 5.1).

In rolling terrain where several knolls are excavated for borrow, several interconnected clearings in an irregular pattern would blend with the landscape. Leaving undisturbed "islands" of vegetation between pits would break up the large cleared area. Small volume pits should be an elongated shape for ease of borrow removal. If the long axis of the excavation is oriented in a north-south direction, only a short section of cut slope will be exposed to the more severe freeze-thaw conditions of a southern exposure. Freeze-thaw conditions are detrimental to young plant growth.

Bedrock quarries have particular design problems. The most feasible solution is to excavate the rock in a series of descending benches. Trees or grasses could be planted on the benches using overburden as a planting medium. The soft shale would eventually erode to a gradual slope retained by trees. Some quarry faces that overlook lakes or rivers could be left as a steep face with narrow ledges to serve as raptor habitat.

Another possible method of reclamation would be to blast sections of the rock face to create a talus rock slope. Overburden could be placed in pockets in the rock slope and revegetated. Highly visible quarry scars along scarp faces should be avoided (Figure 5.2).

BORROW PIT DESIGN

FLAT LAND

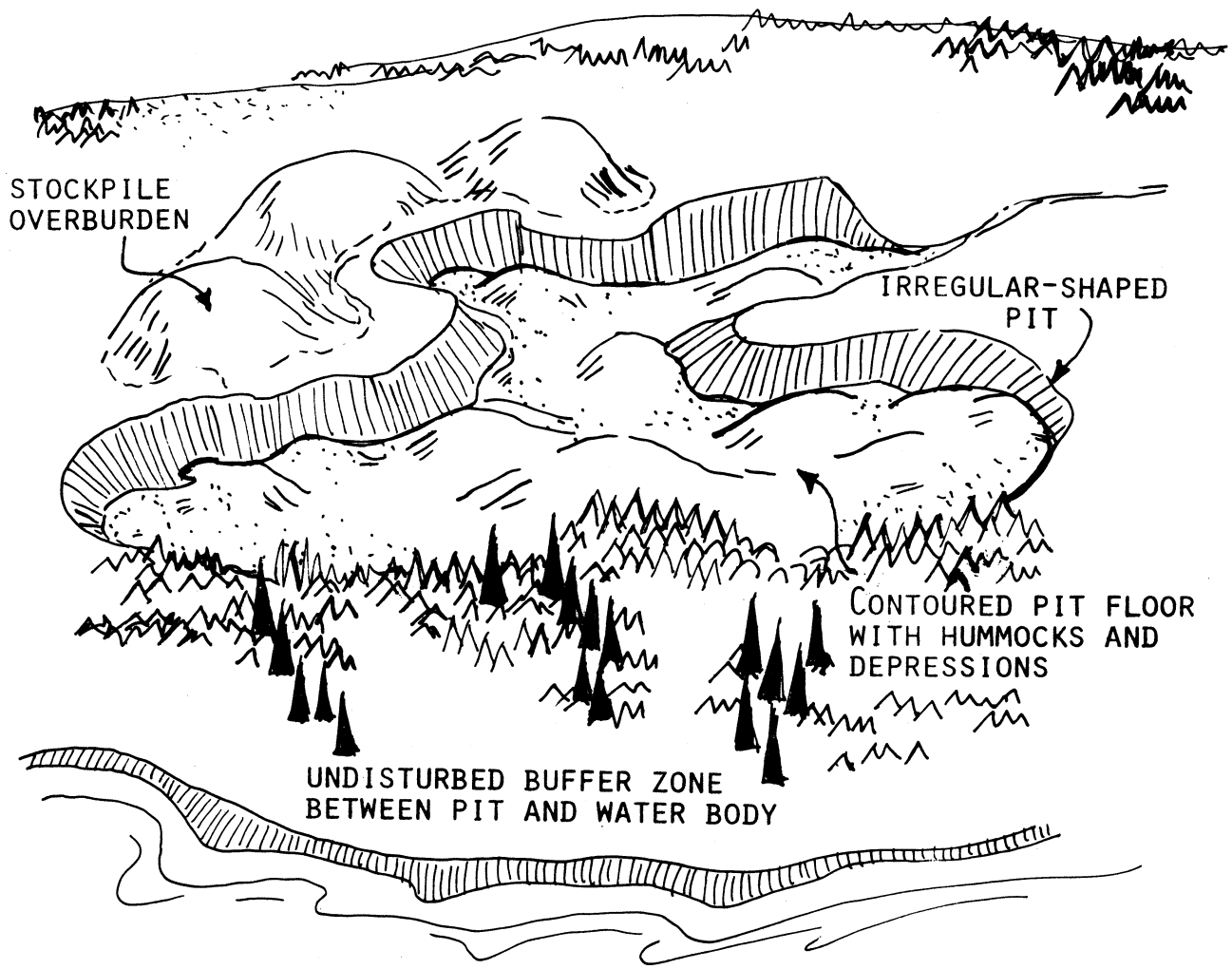


FIGURE 5·1

BORROW PIT DESIGN

ROCK QUARRIES

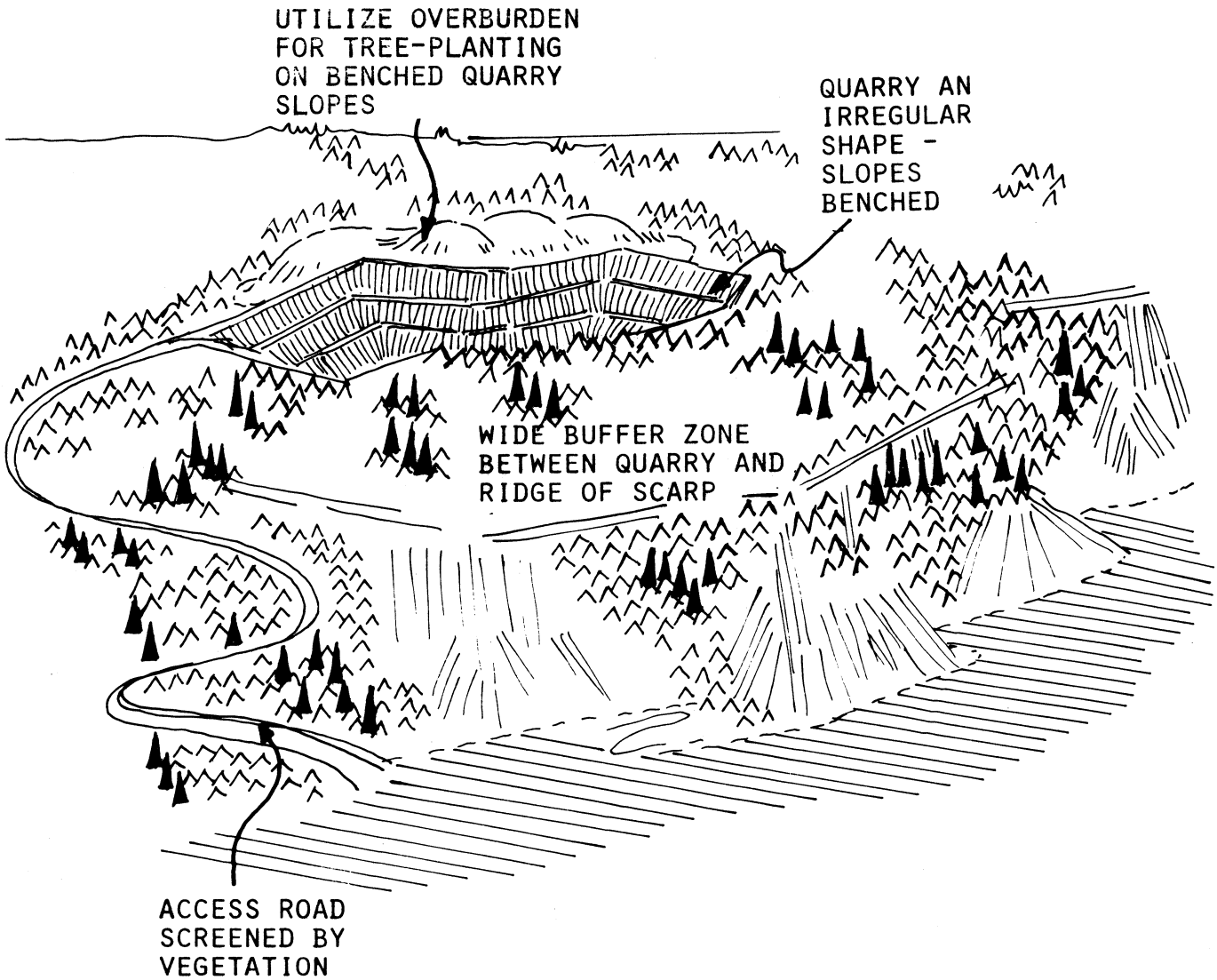


FIGURE 5·2

South and west slopes with the relatively greater amounts of solar radiation and deeper active layers are favoured animal habitats. Where possible, borrow excavations should be carried out on north (Figure 5.3).

5.1.2 Pit Size

A few large productive sites should be developed in preference to many small pits. Environmental disturbance is then confined to a minimal number of locations, the total length of access routes is reduced, and comprehensive reclamation plans are justifiable.

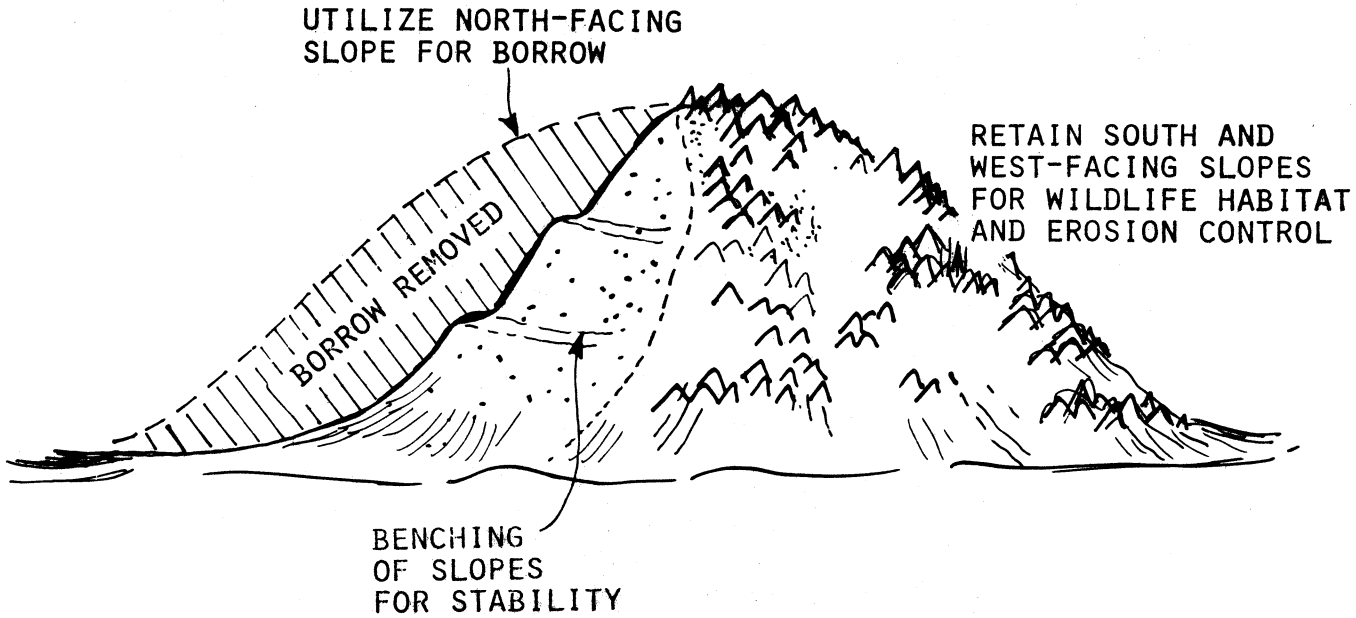
5.1.3 Access Roads

Access roads to borrow sources should be dog-legged to screen the pit or quarry from view. Road length will generally fall between 1 1/2 and 3 times the air mileage distance between the proposed route and the site to be developed.

Temporary roads for summer use will require at least a two foot thick sub-grade topped by six inches of gravel surfacing or, alternatively, two feet of wood chips for sub-grade and one foot of gravel surfacing. The latter method requires a wood chipping operation but utilizes the trees and brush which must be removed from the highway or pipeline corridors, borrow pit access roads and site clearing. If thermally sensitive peatlands must be crossed in summer, at least four feet of sub-grade fill will probably be required to provide adequate support for heavy truck traffic and protect the thermally sensitive terrain. Road allowances may be cleared by hand during the summer or by dozer during the winter.

BORROW PIT DESIGN

ROLLING TERRAIN



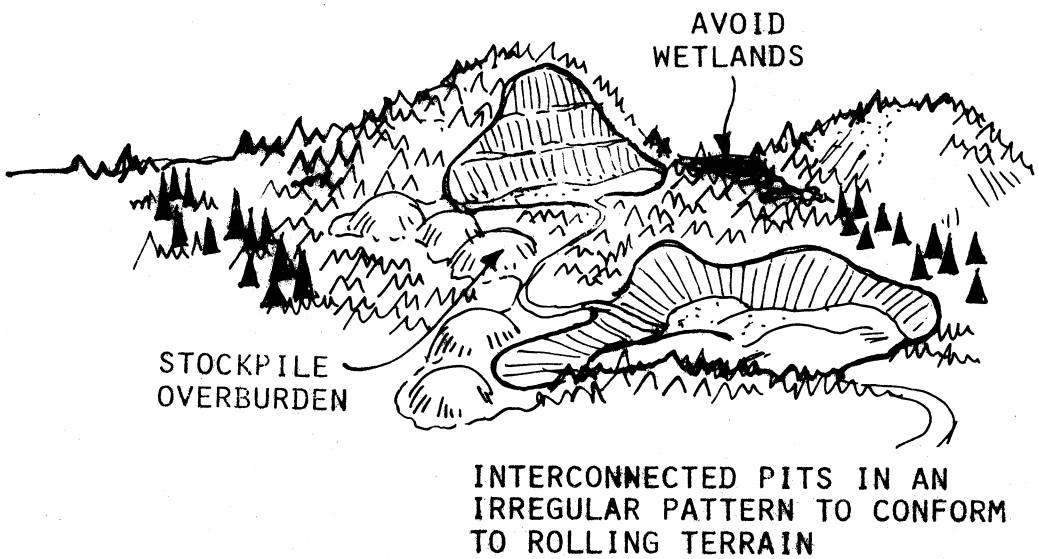


FIGURE 5-3

Access roads destined for winter use only may be cleared during winter provided care is taken not to disturb the surface organic cover. These roads should be covered with packed snow to protect the vegetation beneath. For severe traffic conditions and extended use ice roads will be necessary. Ice road construction will require alternately packing and flooding of the snow.

5.1.3 Slope Development

Generally, the pit walls should be sloped to the desired grade during the excavation operations. Upon completion of the excavating, slopes should be graded at least 3:1 to facilitate revegetation. Once the slope is established overburden can be pushed down over the slope from above or built up from below.

Creating a series of benches or terraces in the pit slope during the excavation will aid in revegetation and erosion control. Terraces also provide convenient surfaces for planting trees, and will revegetate more quickly than a straight cut slope. The width of a terrace will depend on the amount of space required for manoeuvering equipment, usually the width of a haul road. It is recommended that the terrace be pitched back toward the slope to drain water into the cut. At intervals along the bench the water can be blocked to hold runoff on the benches until it is absorbed. The water-holding capacity of terraces can be useful in promoting tree growth where rainfall is low. Terraces provide a convenient location for transplanting trees and shrubs to screen the cut slopes (Figure 5.4).

BENCHING OF SLOPES

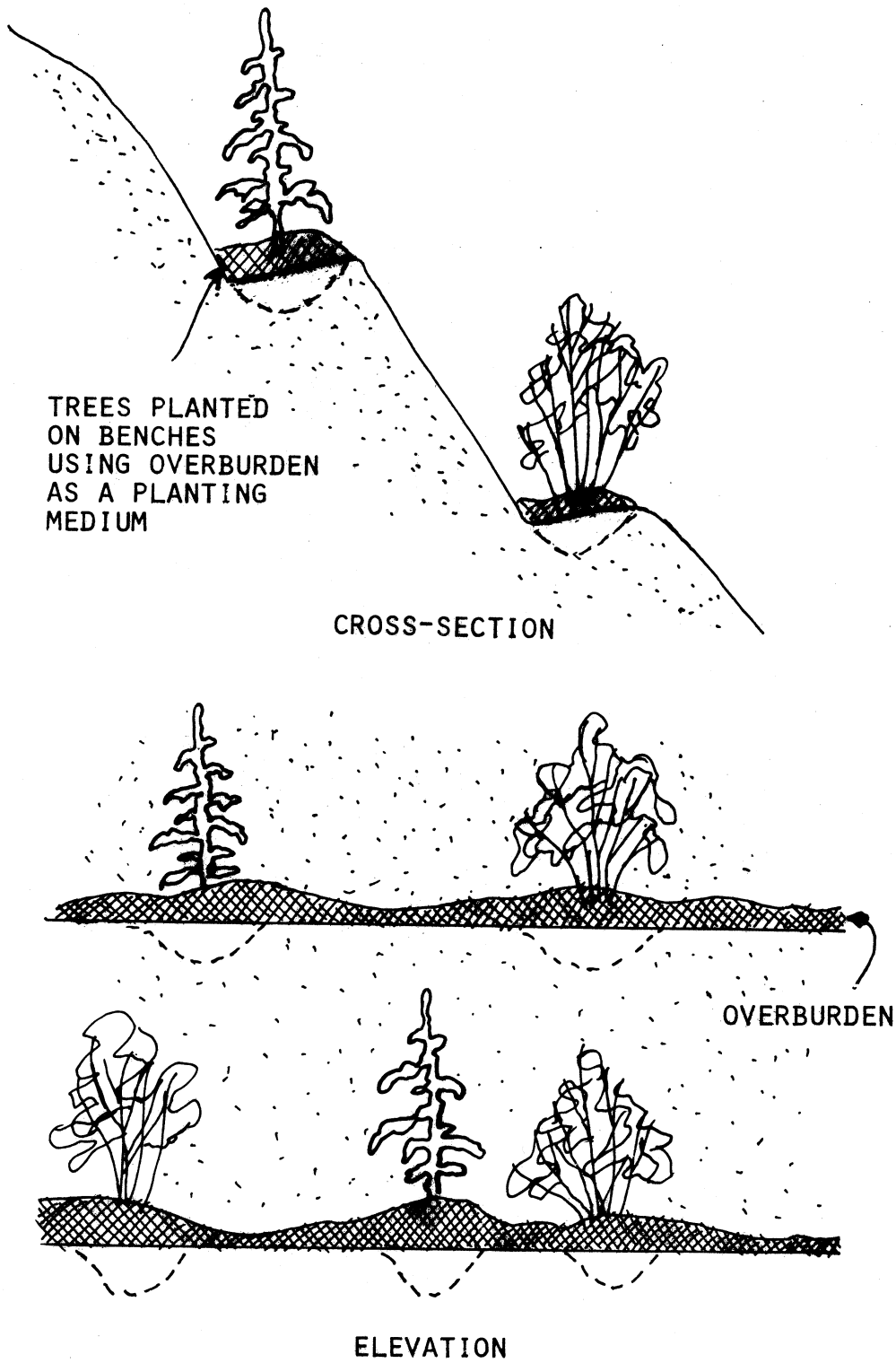


FIGURE 5·4

5.2 Clearing, Stripping and Stockpiling

Stockpiling of overburden should be a requirement of all developments. It is often feasible to stockpile overburden in a disused part of the excavation or use the material immediately for restoration of completed sites. As a rule the clearing and stripping operations should be co-ordinated with the projected rate of excavation. Stripping should not be carried out more than one year in advance of actual excavation requirements.

Tree specimens and clumps of trees and shrubs can be removed from the site prior to clearing, and stored for future replanting after borrow has been removed.

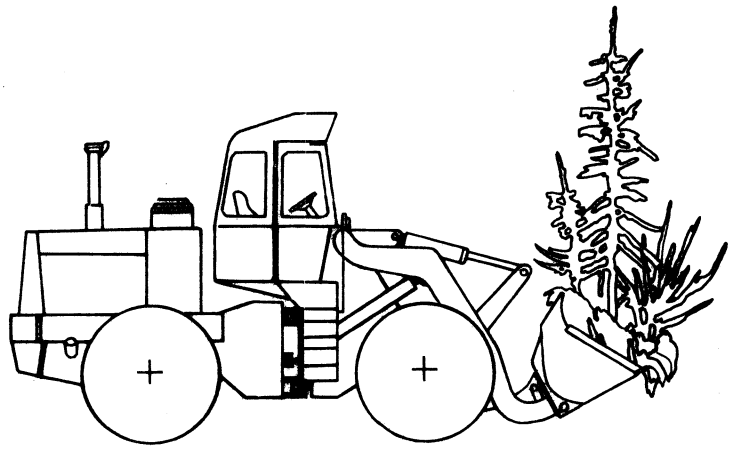
Clumps of vegetation, including young trees and ground cover species could be dug in the fall and transported by machine to a site where they are "heeled in" until spring planting time (Figure 5.5). Poplars spruce and willow are most suitable for transplanting. Many native species would become naturally established on the overburden.

There is little apparent use for timber removed from borrow sites in remote areas. Woody debris from clearing operations could be burned on the cleared site preferably during the winter season. The preferred use of the forest cover is to incorporate the material in sculptured mounds as a medium for plant growth. On sites close to highway or pipeline construction, large timber could be limbed and stacked for possible use in construction.

Reducing woody material to a mulch by means of chippers is an ideal means of waste disposal. Chippers work most effectively during the summer when wood is not frozen.

Waste boulders may be used to retain the toe of a slope or line a watercourse. Piles of waste material unsuitable for borrow may be shaped to form "islands" or "peninsulas" in the pit and revegetated.

TRANSPLANTING TREES



CLUMPS OF TREES, SHRUBS AND GROUND COVERS
TRANSPLANTED BY MACHINE

FIGURE 5·5

Waste material remaining after excavation is completed may be buried in the pit floor. Debris from construction activities may also be disposed of in disused borrow pits provided that all waste is well covered by overburden and no waste material drains into watercourses.

5.3 Timing of Reclamation Procedures

Overburden on borrow sites should be stripped and stockpiled immediately prior to borrow removal operations. In most cases, stripping and stockpiling would be done in the autumn months. Clumps of trees for replanting would be removed and stored in a protected site before the stripping operation.

Following winter removal of borrow material, a grooming operation should be scheduled as a final clean-up and shaping of the pit before equipment is moved out of the site. A pit floor contoured with depressions, hummocks and ridges will be more natural and will revegetate more readily than a flat floor. Overburden stripped from the site and "fines" remaining after processing should be spread over the pit area to aid in revegetation procedures. Pits may be used as settling ponds in washing operations. The peaty, organic surface material found on most sites in the area makes an excellent mulching material. Compacted areas should be scarified and coarse organic material added to the surface and worked in. Pockets of deep rich soil separated by poorer material would provide maximum benefit from the limited topsoil resource.

Seeding can be carried out in the late fall, or early spring. The use of a slow-release type fertilizer is recommended.

Trees and shrubs should be transplanted in the spring to pockets of soil on benched slopes or depressions on the pit floor. Mulching transplants will help to conserve moisture.

Borrow areas scheduled for continuous maintenance use will require reclamation operations in several stages.

5.4 Restoration Techniques

5.4.1 Vegetation

Excavation and rehabilitation of the site can proceed simultaneously. As one part of the site is depleted of borrow, slopes can be groomed to the desired grade, overburden spread over the slopes and the area seeded. The use of cereals such as rye and barley for nurse crops or for improving the biomass of sterile mineral soils is recommended for the poorer sites.

a. Seeding Methods

Hand seeding and fertilizing is the most economical method for areas under five acres in size. On larger sites, hydro-seeding techniques may be used. Hydro-seeding is an effective but expensive method of seeding cut slopes, however special equipment and a good water source is required for mixing and applying the slurry of seed fertilizer and mulch.

Seed and fertilizer may also be applied to remote sites using a helicopter or fixed-wing aircraft.

b. Seed Mixtures

While it would be desirable to seed pit areas with mixtures of native grasses and forbs, the supply of seed is insufficient to meet requirements. Tests have shown that many agronomic grasses and legumes are suitable for growing in the north. Most species tested set seed under northern conditions but did not

readily invade neighbouring areas of native vegetation.

Seed mixtures should be formulated for various types of soils, slopes, aspect and moisture regime encountered in the region. Ideally each mix should contain fast-growing short-lived species for quick control of unstable soils and slower-growing long-lived species for a permanent vegetation cover. Legumes are useful additions to most mixtures for their nitrogen-fixing capability, drought resistance and soil improvement qualities. Seed mixtures generally include five or more species.

Several varieties of fescues (Festuca sp.) have been shown to be the most widely adapted to many soils and sites under northern conditions. Red fescue spreads by underground root systems to form dense mats useful in erosion control.

The wheatgrasses are adaptive to many soils and are very tolerant of drought. Some strains are also rhizomatous (Mat-forming).

Brome grass, meadow foxtail and orchard grass are better adapted to cool moist conditions, while Reed canary grass will grow in poorly drained moist areas such as drainage channels.

Alfalfa is the most drought-tolerant of the legumes. Some strains are rhizamatous. The true clovers are adaptable to more moist conditions. Sweet clover is a short-lived legume useful for temporary soil improvement.

TABLE 5.1

Recommended Grasses and Legumes Suitable for Northern Growing Conditions

Agropyron	
Crested wheatgrass	A. cristatum
Tall wheatgrass	A. elongatum
Intermediate wheatgrass	A. intermetium
Slender wheatgrass	A. trachycaulum
Pubescent wheatgrass	A. trichophorum
Sodar streambank	A. riparium
Agrostis	
Red top	A. alba
Alopecurus	
Meadow foxtail	A. pratensis
Arctagrostis	
Tall arctic grass	A. latifolia
Astragalus	
Cicer Milkvetch	A. cicer
Bromus	
Smooth brome	B. inermis
Polar brome grass	B. spp.
Carleton brome grass	B. inermis
Calamagrostis	
Bluejoint	C. canadensis
Coronilla	
Crown vetch	C. varia
Dactylis	
Orchard grass	D. glomerata
Elymus	
Sauki Rusian wild rye	E. junceus
Festuca	
Tall fescue	F. arundinaceae
Creeping red fescue	F. rubra
Durar hard fescue	F. ovina duriscula
Chewings fescue	F. rubra var. commutata
Lolium	
Annual rye grass	L. multiflorum
Lotus	
Birdsfoot trefoil	L. carniculatus
Melitotus	
White sweet clover	M. alba
Yellow sweet clover	M. officinalis
Medicago	
Falcata alfalfa	M. falcata
Rhizoma alfalfa	M. sativa
Phleum	
Timothy	P. pratense
Phalaris	
Frontier reed canary grass	P. arundinacea
Poa	
Canada bluegrass	P. compressa
Highland bluegrass	P. glaucantha
Kentucky bluegrass	P. pratensis
Trifolium	
Aurora alsike clover	T. hybridum
Red clover	T. pratense
White clover	T. repens

A short-lived grass commonly included in mixtures as a nurse crop is annual rye grass.

c. Seeding and Fertilizing Rates

Approximately 50 lbs/acre is an average rate of application for grass/legume mixtures. Fertilizer requirements vary with site. A soil test of overburden to be used as a planting medium would indicate any soil acidity or nutrient deficiencies. Revegetation trials in the Mackenzie region have shown that applications of fertilizers in various ratios, in particular, nitrogen and phosphorus, have been useful in establishing plantings.

5.4.2 Aquatic

Some sites will form lakes after borrow is removed. Pit lake bottoms should be shaped to form gradually sloping shorelines to support aquatic vegetation and provide shoreline habitat. An irregular meandering shoreline will have a greater length of littoral zone for colonization by plants and animals.

Fishing potential of shallow pit lakes is minimal due to expected winter kill. The lakes would need several years of maturation prior to fish stocking to allow colonization by benthic organisms.

Excavations near lake shore of natural lakes could be opened to the lake to become a part of the lake system and allow colonization by resident lake fauna. It is recommended that a channel between a lake and a borrow pit be excavated in winter to avoid siltation problems. Where there is any doubt about the advantages of incorporating pits with adjacent lakes the integrity of the existing aquatic system should be maintained.

5.4.3 Birds

Shallow irregular shorelines planted with sedges and reeds would provide good waterfowl habitat in water-filled excavations. "Islands" could be constructed of spoil in large borrow sites for additional shoreline areas, particularly in regions extensively utilized by waterfowl. The establishment of willow and other deciduous browse species around borrow sites will create habitat for various passerine species in summer and winter habitat for ptarmigan. Willow plantings would be particularly effective in areas near the banks of the Mackenzie River and its tributaries.

Quarry rock faces in upland regions would probably not be utilized by raptors. Irregular perpendicular rock cuts overlooking water-bodies, particularly the Mackenzie River, are preferred raptor habitat. Such cuts in rocky escarpments should be avoided for aesthetic reasons.

5.4.4 Mammals

Suitable denning sites should be retained in known denning areas; generally, south and west-facing slopes are preferred. Bears prefer coarse sandy and gravelly sites in tall shrub cover overlooking water. They den on grades over 60% at mid-slope to the toe of the slope. The den requires at least an eight-foot depth of suitable material. Fox and wolf denning sites are located in sandy or sandy-loam close to water, usually on south-facing open slopes. They prefer areas mid-slope to the brow of 10% - 60% slopes, a minimum of four feet in depth.

Ground squirrels will utilize any well-drained material on open slopes above the water line. They prefer the tops of knolls or ridges. Thus, the main disruption of denning sites will occur in sites of south or west facing slopes near water. Wherever possible, such locations should not be used for borrow.

Shallow pit lakes will be attractive areas for moose, especially where adjacent to dense spruce cover.

Willow plantings will enhance the usefullness of lakes as habitat for moose, hare and ptarmigan in winter, along with their predator species. Willow plantings are attractive to both birds and small mammals.

5.5 Site Assessment Rationale

Sites which will require extensive restoration to maintain wildlife habitat were given moderate to high ratings. Borrow sites visible from the highway or river received high ratings. Areas where wildlife and aesthetic considerations were low received low ratings.

Associated disturbance ratings were based on length and amount of disturbance related to access roads. Roads longer than 10 miles which traverse sensitive terrain received maximum ratings.

APPENDIX A
PARTICULAR ENVIRONMENTAL CONCERNS

A.1 Climate

Climate summaries for Inuvik and Fort Good Hope, presented in Tables A.1 and A.2, were taken from "The Climate of the Mackenzie Valley Beaufort Sea", B.M. Burns. Climatic conditions within the Inventory Area would often be more extreme than those near the communities since hamlet sites are generally selected in lower elevation areas with greater protection from wind exposure.

Growing conditions are severe within the Area. Figures A.1, A.2 and A.3 indicate the pattern of thaw and freeze and total degree days within the Mackenzie corridor. The last spring frost occurs between May 30 and June 30 and first fall frost between August 10 and 30. Between 1,000 and 1,600 growing degree-days are available for vegetative growth. Successful revegetation of disturbed sites will require careful co-ordination of species to micro-climatic conditions of temperature, soil moisture and active layer depth.

Extreme rainfalls of two to three inches within a twenty-four hour period are particular concerns during summer. Downpours can cause severe sheet erosion and gullying of unstabilized slopes and produce unseasonally high creek levels. Operations should be planned accordingly with toxic materials stored above high water levels and contingency structures readied for rapid installation to prevent washouts or gullying.

A.2 Terrain

A.2.1 General

The Inventory Area lies within two similar physiographic regions, the Peel Plain on the west side of the Mackenzie, and the Anderson Plain on the east. The flat lowlands, terraces and plateaus have

TABLE A.1

CLIMATIC SUMMARY OF NEAREST COMMUNITIES

	FORT GOOD HOPE	INUVIK
Mean daily temperature		
Above 32 deg. F.	May to September	June to September
Above 42 deg. F.	June to August	June to August
Extreme maximum temperature	94 deg. F.	89 deg. F.
Extreme minimum temperature	-68 deg. F.	-70 deg. F.
Mean annual precipitation		
Rain	6.3 in. (max. Aug.)	4.0 in. (max. Aug.)
Snow	48.8 in.	68.5 in.
Total	11 to 12 in.	10 to 11 in.
Maximum precipitation in 24 hr.		
Rain	2.7 in. (Aug.)	1.3 in. (Aug.)
Snow	12.0 in. (Feb.)	9.8 in. (May)

	NORMAN WELLS	INUVIK
Wind Speeds		
Mean, all directions	Greater than 8 m.p.h. - April to October Greater than 6 m.p.h. - Year round	Greater than 6 m.p.h. - March to October
Extremes, all directions	30 to 50 m.p.h. - Year round	25 to 30 m.p.h. - April to Oct. 30 to 40 m.p.h. - Nov. to March

CLIMATIC SUMMARY

This appendix contains a station catalogue and several climatic tables for selected stations in the Northwest Territories and the Yukon. A map of climatic zones (Figure A) for the region under consideration may be found at the beginning of the volume. In the tables of climatic normals, the actual period of record used to compute the means of temperature and precipitation may be determined through the use of code numbers which appear in the column labelled "Type of Normal".

The code is as follows:

1) 30 years between 1941 and 1970
2) 25 to 29 years between 1941 and 1970
3) 20 to 24 years between 1941 and 1970
4) 15 to 19 years between 1941 and 1970
5) 10 to 14 years between 1941 and 1970
6) less than 10 years
7) combined data from 2 or more stations
8) adjusted
9) estimated

The determination of the climatic zones (Figure A) was based on a number of climatic parameters, physiographic features, and the vegetative cover. Biotic nomenclature is used to delineate the climatic classification. It should be realized, however, that due to a paucity of data, this map is a first approximation and the boundaries are not fixed (indicated by dashed lines) nor do they precisely reflect vegetation boundaries.

STATION CATALOGUE

NEW PERIOD NORMALS BASED ON PERIOD 1941-1970

EXTREMES AND STANDARD DEVIATIONS BASED ON ENTIRE PERIOD OF RECORD

* CONTINUING PROGRAM

SEE FIGURE 1.1 FOR LATEST CONTINUOUS PERIOD OF RECORD

STATION NAME	LAT ° '	LONG ° '	ELEV. FT. ASL	TEMP BGN-END	PRECIP BGN-END	WIND BGN-END	SUNOS BGN-END	HOURLY BGN-END	SUNSHINE BGN-END	RADIATION BGN-END	REMARKS
Fort Good Hope	66 16	128 38	174	1944-1970*	1944-1970*	1945-1970*	1944-1950				
Fort Good Hope 2	66 15	128 38	137	1908-1966	1897-1966		1908-1955				
Inuvik A	68 18	133 29	200	1957-1970*	1957-1970*	1957-1970*	1960-1970*	1960-1970*	1961-1970*	1960-1970*	Inuvik East 3 1955-1957
Norman Wells A	65 17	126 48	209	1943-1970*	1943-1970*	1949-1970*	1943-1970*	1955-1970*	1959-1970*	1967-1970*	Norman Wells 1946-1949 1950-1958

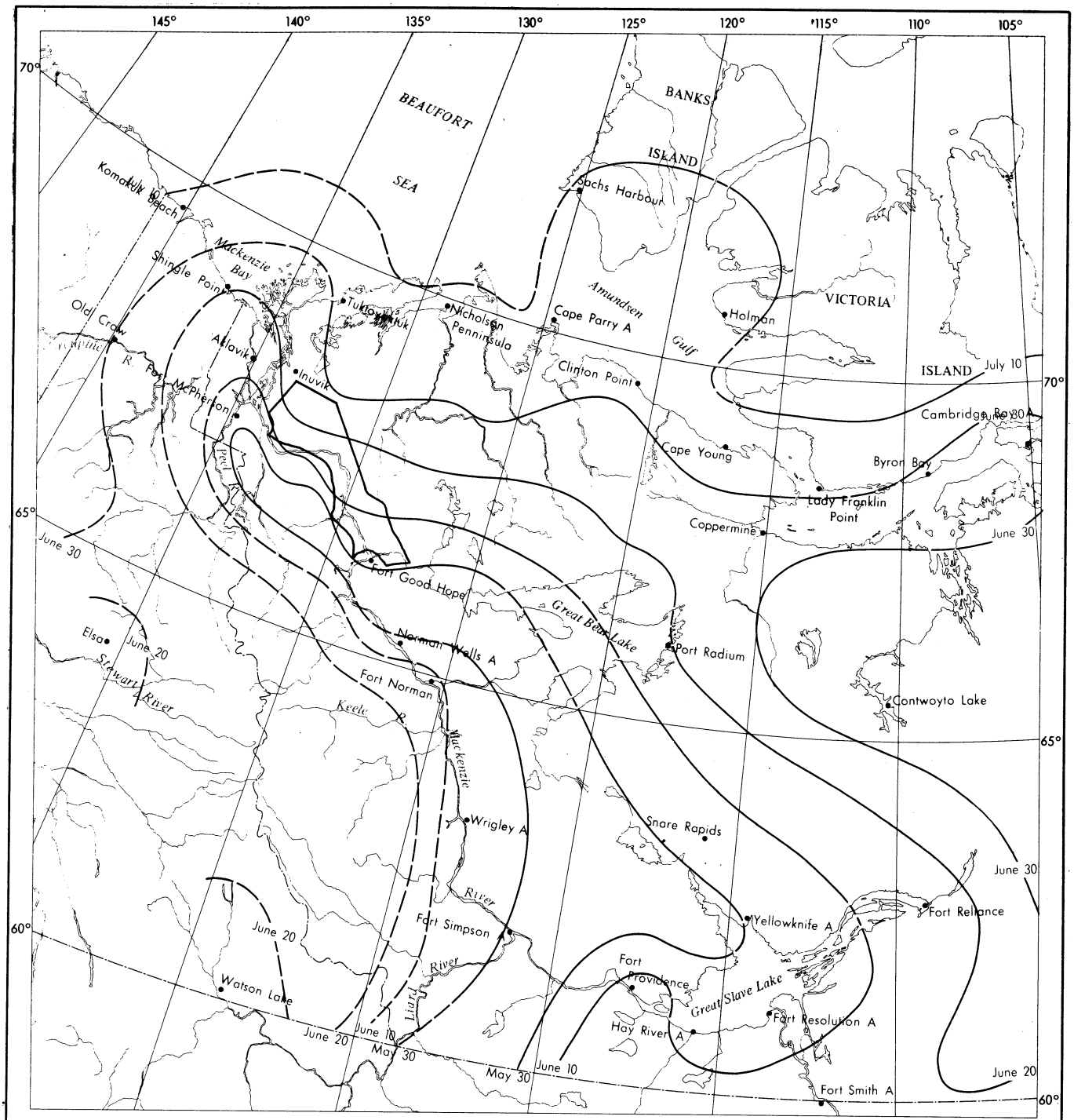
TABLE A.2

TABLE A.2 (cont'd)

NORTHWEST TERRITORIES

ELEMENT and STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	YEAR	Type of Normal
□□□ FORT GOOD HOPE	LATITUDE 66 16 N			LONGITUDE 128 38 W			ELEVATION		174 FT ASL					
MEAN DAILY TEMPERATURE (DEG F)	-23.8	-19.8	- 4.9	15.1	38.8	55.7	60.7	54.8	41.2	22.3	- 4.3	-17.1	18.2	2
MEAN DAILY MAXIMUM TEMPERATURE	-16.4	-11.8	6.0	27.3	49.6	67.2	72.2	66.0	50.3	29.2	2.5	- 9.8	27.7	2
MEAN DAILY MINIMUM TEMPERATURE	-30.9	-27.6	-15.9	2.9	28.0	44.1	49.2	43.5	32.0	15.4	-11.3	-24.4	8.8	2
EXTREME MAXIMUM TEMPERATURE	44	42	47	61	81	90	94	93	83	66	37	39	94	2
NO. OF YEARS OF RECORD	24	24	24	25	25	25	24	26	26	25	25	26		
EXTREME MINIMUM TEMPERATURE	-61	-68	-52	-37	- 8	26	30	22	5	-33	-53	-62	-68	2
NO. OF YEARS OF RECORD	25	25	25	25	25	24	25	26	26	25	26	27		
NO. OF DAYS WITH FROST	31	28	31	30	21	1	*	2	16	30	30	31	251	2
MEAN RAINFALL (INCHES)	0.01	0.00	0.00	0.06	0.29	1.27	1.62	1.89	1.04	0.11	T	0.00	6.29	2
MEAN SNOWFALL	6.2	4.5	4.4	3.6	2.6	0.2	0.0	0.1	2.2	9.1	8.5	7.4	48.8	2
MEAN TOTAL PRECIPITATION	0.63	0.45	0.44	0.42	0.55	1.29	1.62	1.90	1.26	1.02	0.85	0.74	11.17	2
GREATEST RAINFALL IN 24 HRS	0.08	T	T	0.50	0.50	1.60	2.08	2.33	1.08	0.30	0.01	0.00	2.33	2
NO. OF YEARS OF RECORD	23	25	25	26	23	23	25	24	23	25	26	26		
GREATEST SNOWFALL IN 24 HRS	5.0	5.4	7.3	4.5	6.0	1.5	0.0	1.5	3.9	5.4	5.5	5.1	7.3	3
NO. OF YEARS OF RECORD	23	25	25	26	23	23	25	24	23	25	25	26		
GREATEST PRECIPITATION IN 24 HRS	0.50	0.54	0.73	0.50	0.60	1.60	2.08	2.33	1.08	0.66	0.55	0.51	2.33	3
NO. OF YEARS OF RECORD	23	25	25	26	23	23	25	24	23	25	25	26		
NO. OF DAYS WITH MEASURABLE RAIN	*	0	0	*	3	7	8	11	7	2	*	0	38	2
NO. OF DAYS WITH MEASURABLE SNOW	9	8	8	5	3	*	0	*	2	9	10	10	64	2
NO. OF DAYS WITH M. PRECIPITATION	9	8	8	5	5	7	8	11	9	11	10	10	101	2
□□□ FORT GOOD HOPE 2	LATITUDE 66 15 N			LONGITUDE 128 38 W			ELEVATION		137 FT ASL					
MEAN DAILY TEMPERATURE (DEG F)	-23.4	-20.1	- 8.2	13.0	38.3	55.0	59.7	53.8	40.2	21.4	- 5.6	-19.5	17.1	2
MEAN DAILY MAXIMUM TEMPERATURE	-15.0	-11.0	3.8	25.9	49.6	66.8	71.6	65.3	49.2	28.3	2.1	-11.7	27.1	2
MEAN DAILY MINIMUM TEMPERATURE	-31.8	-29.3	-20.0	0.1	27.0	43.2	47.6	42.2	31.1	14.4	-13.4	-27.2	7.0	2
EXTREME MAXIMUM TEMPERATURE	44	56	60	65	84	95	95	93	87	63	41	41	95	1
NO. OF YEARS OF RECORD	57	57	57	57	57	57	58	57	58	58	58	57		
EXTREME MINIMUM TEMPERATURE	-69	-69	-57	-49	-14	22	27	19	1	-38	-55	-64	-69	1
NO. OF YEARS OF RECORD	56	57	57	57	57	57	56	57	58	58	58	58		
NO. OF DAYS WITH FROST	31	28	31	30	22	2	*	4	17	30	30	31	256	2
MEAN RAINFALL (INCHES)	T	0.00	0.00	0.07	0.32	1.39	1.80	2.02	1.12	0.15	0.02	0.00	6.89	2
MEAN SNOWFALL	6.3	6.4	6.2	4.8	3.1	T	0.0	0.0	1.7	9.1	10.2	6.2	54.0	2
MEAN TOTAL PRECIPITATION	0.63	0.64	0.62	0.54	0.62	1.39	1.80	2.02	1.29	1.06	1.03	0.62	12.26	2
GREATEST RAINFALL IN 24 HRS	0.02	0.21	0.10	0.59	1.07	1.64	2.26	2.73	1.10	0.60	0.20	0.11	2.73	1
NO. OF YEARS OF RECORD	63	64	63	61	64	63	60	63	62	65	65	65		
GREATEST SNOWFALL IN 24 HRS	7.2	12.0	7.8	7.0	7.0	3.0	0.0	2.5	10.9	7.4	7.8	6.0	12.0	1
NO. OF YEARS OF RECORD	60	63	63	61	64	64	63	63	65	65	65	63		
GREATEST PRECIPITATION IN 24 HRS	0.72	1.20	0.78	0.70	1.07	1.64	2.26	2.73	1.10	0.74	0.78	0.60	2.73	1
NO. OF YEARS OF RECORD	60	63	63	61	64	62	60	63	61	65	65	63		
NO. OF DAYS WITH MEASURABLE RAIN	*	0	0	*	4	9	10	13	9	2	*	0	47	2
NO. OF DAYS WITH MEASURABLE SNOW	9	9	9	6	3	*	0	0	2	9	11	10	68	2
NO. OF DAYS WITH M. PRECIPITATION	9	9	9	7	6	9	10	13	11	11	11	10	115	3
□□□ INUVIK A	LATITUDE 68 18 N			LONGITUDE 133 29 W			ELEVATION		200 FT ASL					
MEAN DAILY TEMPERATURE (DEG F)	-20.8	-21.0	-10.9	5.8	30.5	49.7	55.9	50.5	36.9	19.0	- 5.1	-16.7	14.5	8
MEAN DAILY MAXIMUM TEMPERATURE	-11.4	-11.0	0.2	17.8	39.1	60.8	66.5	59.9	44.2	25.1	2.3	- 7.7	23.8	8
MEAN DAILY MINIMUM TEMPERATURE	-30.1	-31.0	-22.0	- 6.2	21.8	38.6	45.3	41.0	29.6	12.8	-12.4	-25.7	5.1	8
EXTREME MAXIMUM TEMPERATURE	35	37	43	56	74	89	88	85	78	59	51	31	89	5
NO. OF YEARS OF RECORD	13	13	14	14	14	14	14	14	14	14	14	14		
EXTREME MINIMUM TEMPERATURE	-61	-70	-59	-47	-18	21	26	21	- 2	-31	-51	-58	-70	5
NO. OF YEARS OF RECORD	13	13	14	14	14	14	14	14	14	14	14	14		
NO. OF DAYS WITH FROST	31	28	31	30	26	7	1	3	21	30	30	31	269	5
MEAN RAINFALL (INCHES)	0.01	0.00	0.00	T	0.20	0.42	1.34	1.51	0.43	0.08	T	0.00	3.99	8
MEAN SNOWFALL	8.5	4.7	7.5	5.9	5.5	0.9	0.1	1.7	4.5	13.6	7.3	8.5	68.5	8
MEAN TOTAL PRECIPITATION	0.80	0.41	0.65	0.55	0.69	0.51	1.35	1.82	0.83	1.33	0.58	0.73	10.25	8
GREATEST RAINFALL IN 24 HRS	0.06	T	T	0.01	0.76	0.71	0.87	1.30	0.38	0.52	0.03	0.00	1.30	5
NO. OF YEARS OF RECORD	13	13	14	14	14	13	13	13	14	13	14	14		
GREATEST SNOWFALL IN 24 HRS	4.5	5.4	5.1	7.0	9.8	4.0	0.5	8.9	4.8	5.3	4.1	4.8	9.8	5
NO. OF YEARS OF RECORD	13	13	14	14	14	13	13	14	14	13	14	14		
GREATEST PRECIPITATION IN 24 HRS	0.41	0.54	0.42	0.70	0.84	0.76	0.87	1.69	0.48	0.56	0.41	0.40	1.69	5
NO. OF YEARS OF RECORD	13	13	14	14	14	13	13	13	14	13	14	14		
NO. OF DAYS WITH MEASURABLE RAIN	*	0	0	*	2	6	10	10	6	1	*	0	35	5
NO. OF DAYS WITH MEASURABLE SNOW	12	11	12	10	6	1	*	1	6	14	11	15	99	5
NO. OF DAYS WITH M. PRECIPITATION	12	11	12	10	7	6	10	10	10	14	11	15	128	5

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR	TYPE



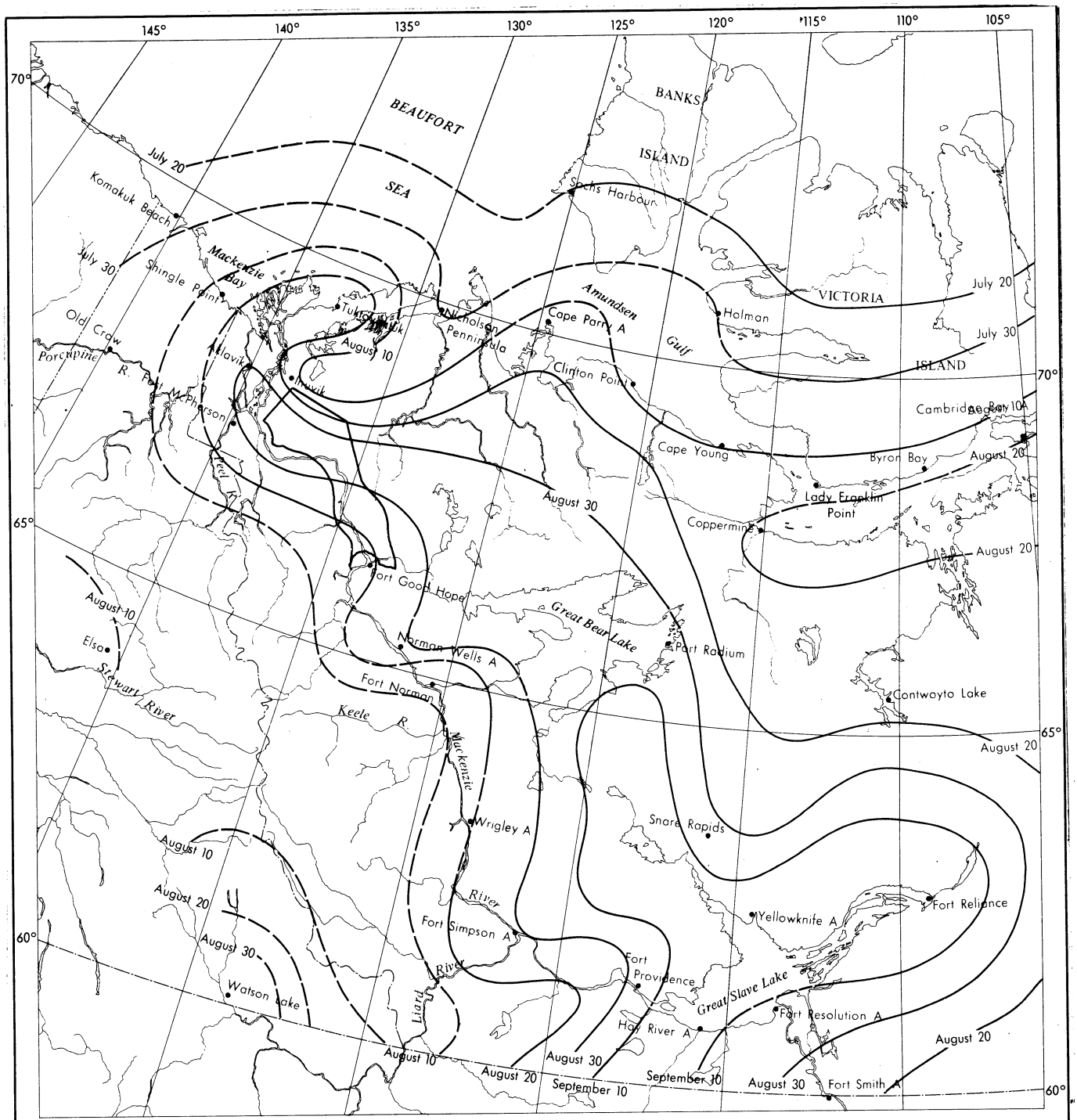
MEAN DATE
OF LAST FROST (SPRING)
Based on period 1941—1970

LEGEND

Isochrones
(Dashed over open water or mountain areas)

Scale in Statute Miles
100 50 0 100 200

FIGURE A·1



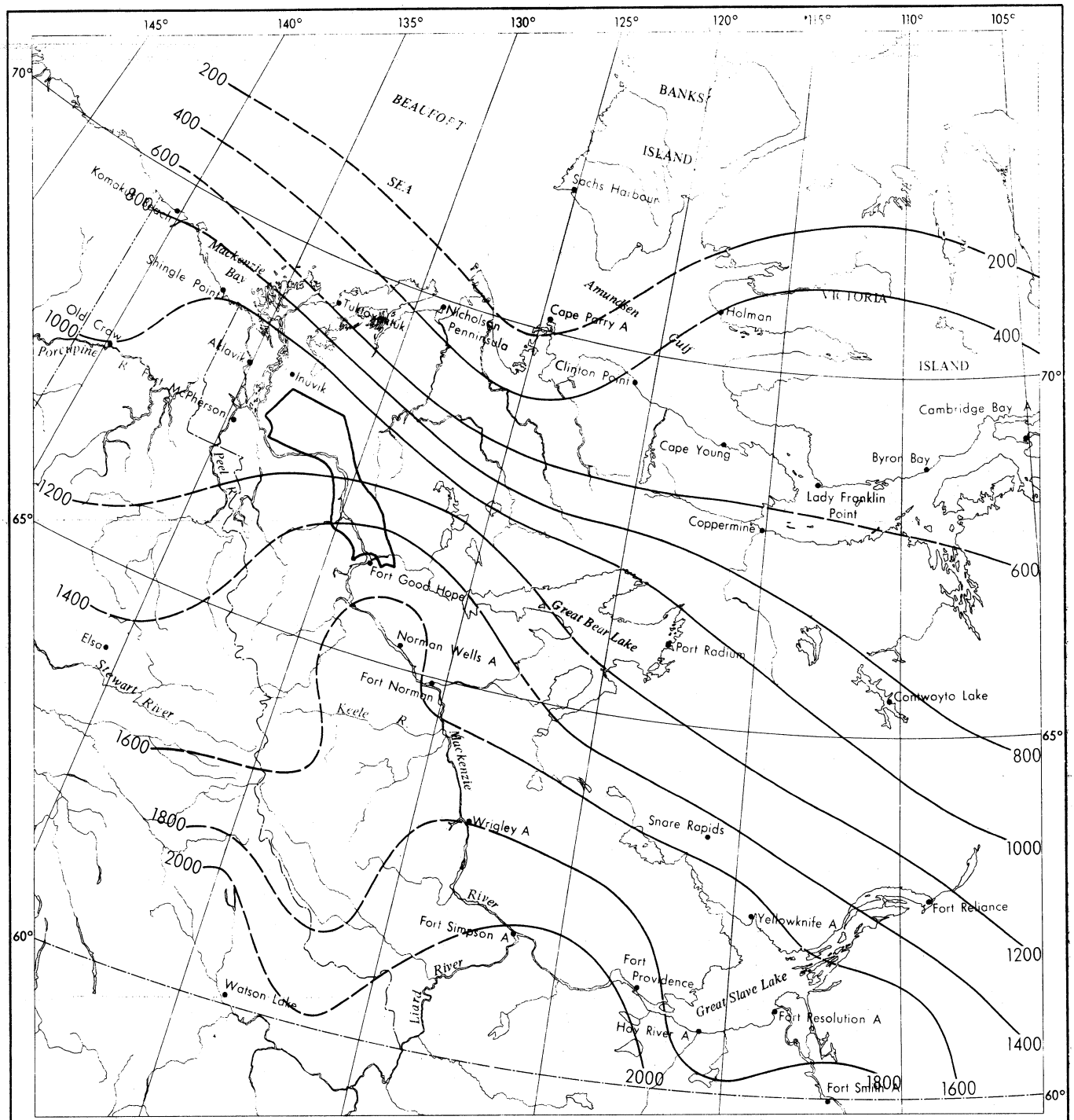
MEAN DATE
OF FIRST FROST (FALL)
Based on period 1941—1970

LEGEND

Isochrones
(Dashed over open water
or mountain areas)

Scale in Statute Miles
100 50 0 100 200

FIGURE A-2



MEAN ANNUAL TOTALS
OF GROWING DEGREE-DAYS
(Degree days above 42°F)

Based on period 1941—1970

LEGEND

——— Degree-day isolines
(Dashed over open water
or mountain areas)

Scale in Statute Miles
100 50 0 100 200

FIGURE A-3

occasional outcrops of Devonian limestone and shale, and Cretaceous sandstone. Thin surficial glacial deposits are common throughout the area.

A.2.2 Dominant Terrain Features Within Study Area

a. Mackenzie Lowlands

Two major wet lowlands occur to the east of the Mackenzie River. These are Payne Creek to Little Chicago and Travaillant River to Rabbit Hay River. Another smaller wetland area is situated along the Mackenzie, south of the Thunder River. Localized low, wet areas are common in the southern portion of the study area.

b. Large Lake Complexes

Large lake complexes occur in two regions of the study area: the Sunny-Travaillant Lake complex in the north; and the Yeltea-Manuel-Loon Lake complex in the south.

The Sunny-Travaillant Lake complex is characterized by irregular shorelines and complex topography. Such surficial glacial deposits as eskers, kames and outwashes are abundant.

The Yeltea-Manuel-Loon Lake complex has well defined shorelines with rock outcrops and scarps.

c. Ramparts Plateau

The Ramparts Plateau extends east from the Yeltea-Manuel-Loon Lake complex and north from the Mackenzie lowlands. Thin glacial deposits with shale and limestone outcrops and scarps are characteristic of these uplands. Small pothole lakes dominate the plateau.

d. Thunder River Uplands

This rolling upland has diverse topography with a few glacial deposits or shale outcrops.

e. Northern Flatlands

Poorly drained permafrost and bedrock flatlands dominate the extreme north and northeast portion of the study area.

A.2.3 Site Assessment Rationale

Monotonous, well-drained flatlands were rated low whereas areas of diverse landforms and drainages were rated high. Rocky scarps were rated high.

A.3 Vegetation

A.3.1 General

Fire, permafrost and drainage have major influences on the vegetation composition of the Peel and Anderson Plains. The taiga type vegetation ranges from dense stands of spruce, to 50 feet high, in the south to treeless bog and tundra in the northeast. A complex of lakes, streams and wetlands form a mosaic of vegetative cover.

A.3.2 Vegetation Types in the Study Area

a. Marsh

Marshes are generally treeless with dense low ericaceous shrubs, herbs and abundant sedges. The sites are moist or wet. Sizes range from small and local in southern portions to large in the

north. They can be associated with any terrain type. Marshes are utilized as beaver and muskrat habitat and waterfowl and shorebird staging and nesting areas. Moose and caribou utilize this type for summer food.

b. Muskeg

Poorly drained areas with a varied profile of black spruce and tamarack over dense labrador tea. Shrubs such as scrub birch, willow, and shrubby cinquefoil are often extensive, especially in the northern portions. This is a major type in the study area and is utilized by caribou as winter range.

c. Black Spruce

Dense stands of black spruce with deep moss layers form another major type, occurring on gentle slopes and flatlands. Lichens are often locally abundant. Rose is a common shrub and attracts hares and lynx. Woodland caribou occasionally use this type in summer. Marten and squirrels are present year-round.

d. White Spruce

Dense white spruce over a scattered alder understory is a common type on better drained slopes and flats. This type is frequent along creek and river bottoms. Rose is a common ground species. Hares, lynx, foxes, squirrels and marten utilize this type.

e. Mixed Conifer

Areas of moderate and diverse drainage often support a mosaic of dense black spruce, tamarack and white spruce with scattered shrub cover. This type is common in upland areas with complex topography. Hares, lynx, foxes, squirrels and martens occasionally utilize this type.

f. Conifer-Deciduous

Mixed stands of aspen and white spruce often occur on better drained areas. Shrub cover is usually moderate and diverse. Hares and small mammals are abundant in this type and are hunted by predators such as lynx and fox. Many small bird species are present during summer.

g. Deciduous

Well-drained areas support dense local stands of aspen or birch with dense alder and diverse ground cover. This type often pioneers on burned areas. Pine is often a secondary tree species. Moose and hares are frequent on this type. Many song birds and game birds are present. Beavers prefer streams through deciduous types.

h. Treeless Dry Slopes

Dwarf shrubs, herbs and grasses occur on very well-drained, steep slopes of creek or river banks, eskers, kames and drumlins. The sites are usually small. These slopes often have abundant small mammals (especially ground squirrels) and fox, wolf, or bear dens.

i. Riparian

Dense alder and willow shrubs occur along stream and lake edges. A variety of herbs, grasses and sedge are often associated. Riparian types are widespread but usually small in size. Large areas of riparian vegetation are found along the Mackenzie River. This type is very productive for wildlife and especially important as moose winter range.

A.3.3 Site Assessment Rationale

Homogeneous vegetation types such as black spruce stands with only habitat value were rated low. Areas with a mosaic of vegetation types and having value as habitat and for aesthetics, were rated high. Riparian areas were considered valuable habitat. Exposed slopes were considered valuable as habitat and for aesthetics.

A.4 Mammals

A.4.1 General

All mammals of the region are year-round residents, usually of widespread distribution and low abundance. Localized high densities of mammals are functions of microclimatic situations, topographic features, behavioural traits, or special habitat occurrence. Such concentration areas may be sentitive to many types of disturbances and therefore are of special concern.

The characteristics and information about mammals are summarized in Table A.3.

A.4.2 Occurrence Within the Study Area

a. Barren-ground Caribou

Found in the northeast section of the study area during winter, these animal's winter food source and shelter are sensitive to disturbance by fire or traffic.

b. Woodland Caribou

These caribou are found throughout the study area. A known winter concentration occurs northeast of Manuel Lake.

Table A.3

SENSITIVITY OF MAMMALS TO EXPLOITATION OF DEPOSITS OF GRANULAR SOILS

SPECIES	ROLE	RELATIVE ABUNDANCE	HABITAT REQUIREMENTS	BEHAVIOUR AND SENSITIVITY	MOVEMENTS AND MIGRATION	POTENTIAL DISTURBANCES	MITIGATION RECOMMENDATIONS
BARREN-GROUND CARIBOU Rangifer tarandus arcticus	Valuable game animal for domestic use. Prey species for wolf and grizzly bear.	Generally rare but locally abundant in winter.	Summer - open treeless hills and bogs with abundant lichens and cottongrass. Winter - areas of abundant lichens and little snow, often on frozen lakes and in timbered regions. Spring - exposed hills with abundant cotton grass are used as calving areas.	Bold and undisturbed by most noise, very adaptive. Sensitive to close approach on ground. Form large herds. Can be diverted for short distances during migration.	Spring migration - timberline to open barrens northeast of Inuvik; timing is critical. Fall - broad front during return to timberline.	Winter habitat degration. Harassment in winter, causing energy depletion.	Control fires in wooded areas. Avoid drainage alterations. Avoid close approach on ground during winter, November to May. Avoid wintering grounds.
WOODLAND CARIBOU Rangifer tarandus sylvestris	Valuable game animal for domestic use. Prey species for wolf.	Generally uncommon and widespread, but locally common in winter.	Summer - open muskeg areas with abundant arboreal and ground lichens and lakeshore vegetation. Winter - congregate in semi-open upland areas with numerous lakes and little snow. Open burns are avoided.	Shy and wary, especially of ground approach when with calves, poorly adaptive. Tolerant of noise. Less wary in larger groups.	Short and local from lowlands in summer to uplands in winter. Dispersed in summer.	Winter harassment, causing energy depletion.	Avoid approaching animals in November to May.
MOOSE Alces alces andersoni	Important domestic game animal. Secondary prey species for wolf.	Generally common and widespread but locally abundant in winter.	Summer - swamps and muskegs with aquatic vegetation or old burns and river valleys with abundant deciduous shrubs, especially willow. Winter - riparian and lowland areas with abundant willow near dense spruce for shelter. Some patchy upland burns provide good winter habitat.	Wary and easily disturbed by noise or close approach. Cows and calves very easily disturbed in spring. Form groups of 1-3 in summer, and large congregations in winter.	Short and local, usually along valleys or wetland routes.	Winter habitat depreciation. Winter harassment, causing increased mortality. Improved access for human predation.	Avoid riparian shrub destruction during summer operations in known wintering areas. Replant willows on disturbed wintering areas. Avoid winter concentration areas, September to April.
GRIZZLY BEAR Ursus arctos horribilis	Major predator. Valuable game animal for sport and domestic use.	Rare and restricted.	Rough broken terrain with open vegetative cover. Food availability is a limiting factor. Denning areas are an important feature requiring coarse granular material on steep slopes near stream banks or lake shores. Dens are often used year after year for birth, rearing and hibernation.	Intolerant of disturbance and noise, especially near denning areas. Very aggressive. Hibernate in winter, October to April. Usually solitary - require large "individual space".	No migration. Large diurnal range.	Depreciation of and disturbance to denning areas. Mortality due to winter disturbance. Human-bear encounters are hazardous.	Allow minimum of 1/2 mile buffer around denning areas. Avoid denning regions, October to May. Require high standards of camp maintenance and immediate disposal of garbage.
BLACK BEAR Ursus americanus americanus	Important furbearer and domestic game animal. Valuable sport game animal. Major predator.	Common and widespread.	Forested areas and muskegs. Prefer wetlands in spring. Food habits are largely herbivore, (roots and berries) but opportunistic. Denning areas are limited but less specific in requirements than those of grizzly bears. Generally den near water.	Shy but adaptive. Intolerant and aggressive when with young or near dens. Hibernate in winter. Solitary or form groups of 2-4.	No migration. Moderately large diurnal range.	Depreciation of and disturbance to denning areas. Mortality due to winter disturbance. Human-bear encounters are hazardous.	Allow minimum of 1/2 mile buffer around denning areas. Avoid denning regions, October to May. Require high standards of camp maintenance and immediate disposal of garbage.
WOLF Canis lupus mackenzii Canis lupus occidentalis	Major predator. Minor furbearer and sport animal.	Uncommon and widespread.	Utilize all habitats, especially those of moose and caribou. Denning areas are limited, usually on moderate slopes with southerly exposure, near water with dense tree or shrub cover.	Wary and intolerant of disturbance. Poorly adaptive. Generally in family groups.	Follow moose and caribou migration. Large diurnal range.	Depreciation and disturbance of den sites may cause increased mortality.	Avoid denning areas during whelping period, March to July.
RED FOX Volpes fulva alascensis	Major small animal predator. Valuable furbearer. Minor prey for larger predators.	Common and widespread.	Utilize all habitats but prefer riparian edges and upland habitats of white spruce, pine or aspen. Denning areas are sometimes limiting and concentrating elements, usually near tops of semi-open, moderate slopes. Dens are vital to winter survival.	Very shy but tolerant and adaptive to disturbances. Found in small groups except when concentrated by den sites.	No migration. Small to moderate diurnal range.	Winter or spring displacement from dens by disturbance may cause increased mortality.	Avoid denning areas, October to July.
LYNX Lynx canadansis canadensis	Very important furbearer. Major snowshoe hare predator.	Common and widespread.	Snowshoe hare distribution and abundance is the primary determinant of lynx habitat. Old burns with conifer and deciduous regeneration, riparian habitats and pine stands are favoured.	Shy and intolerant to disturbance, moderately adaptive. Reside in small family groups.	No migration. Small diurnal range in summer, large in winter.	Minimal impact though normal granular removal operations.	Avoid large habitat alterations such as fire or drainage alterations.
WOLVERINE Gulo luscus luscus	Very valuable furbearer. Major predator and scavenger.	Rare and widespread.	Generally prefer muskegs and riparian areas. Depend largely on small mammal prey and carrion.	Wary and intolerant. Unadaptive to disturbances. Very aggressive and destructive. Solitary or paired groups, often nomadic.	No migration. Very large ranges and diurnal movements.	No significant disturbance anticipated.	None.
WEASELS AND MINK Mustela erminea arctica M. e. richardsonii Mustela rixosa rixosa M. r. eskimo Mustela vison ingens M. v. inergumenos	Minor furbearers. Small mammal and fish predators.	Common and widespread.	Found in habitats where mice and moles are abundant, especially riparian areas. Often forage along creek and lake shores.	Secretive and nocturnal, bold when near food. Very adaptive to disturbances. Solitary or in small groups.	No migration. Very local and limited in range.	No significant disturbance anticipated.	None.

Table A.3

SENSITIVITY OF MAMMALS TO EXPLOITATION OF DEPOSITS OF GRANULAR SOILS

SPECIES	ROLE	RELATIVE ABUNDANCE	HABITAT REQUIREMENTS	BEHAVIOUR AND SENSITIVITY	MOVEMENTS AND MIGRATION	POTENTIAL DISTURBANCES	MITIGATION RECOMMENDATIONS
OTTER Lutra canadensis preblei	Very valuable furbearer. Major predator of fish, muskrat and beaver.	Rare and restricted to watercourses.	Prefer larger streams, swamps and lakes containing fish, muskrat and beaver. In winter seek out fast flowing water with ice-free patches.	Shy, intolerant and moderately adaptive to disturbances. Reside in family groups, nomadic.	No migration. Usually small ranges restricted to waterways.	Deterioration of the quality of aquatic habitats by siltation or drainage alteration is critical in winter when habitat and food reserves are limited.	Avoid siltation and drainage alterations, especially during winter freezeup in large streams and lakes.
BEAVER Castor canadensis canadensis	Important furbearer. Prey for otter.	Common in wetlands; locally abundant.	Beaver seek out creeks and wetlands with suitable food supplies. Aspen is preferred; willows and alders are also used. A stock pile of food and deep water are vital for winter survival. Maintenance of water level and quality at lodges is critical year round. Banks of lakes and larger rivers are occasionally used for ledges.	Shy but tolerant to noise and activity, mainly nocturnal. Very intolerant of water quality disturbances. Juveniles (2 yr. olds) dispersed from family groups in May-June. Reside in family groups of 5-9 animals. Attracted to easily dammed stream locations.	No migration. Very localized and restricted range. Juveniles may disperse up to 20 miles overland.	Deterioration of quality and extent of aquatic habitat by drainage alteration or siltation. Beavers attracted to culverts on access roads.	Avoid siltation and drainage alteration in beaver areas. Avoid dam or lodge destruction in winter. Beaver management program required during May-August at selected culverts on access roads.
MUSKRAT Ondatra Ziebethicus spatulatus	Important furbearer. Prey species for otter, mink and raptors; also fox and wolf in winter.	Common in wetlands, locally abundant.	Water depth, quality and presence of aquatic food plants important. Habitats include sluggish streams, marshes and lakes. Deep unfrozen water, food caches and pushups in ice are vital for winter survival.	Shy and nocturnal but highly adaptive to noise and activity disturbance. Large concentrations may occur in good habitats. Will cohabitate with beavers.	No migration. Very localized. Restricted to waterways for most travel. Little dispersion.	Deterioration of water quality is a prime concern. Direct effects of siltation, spills and drainage alterations on animals and indirect effect through aquatic food plants can be critical.	Avoid siltation and drainage alteration, especially in winter. Material spill prevention and contingency plans should be initiated.
MARTEN Martes americana actuosa	Very important furbearer. Prime predator of red squirrels, mice, hares and small birds. Minor prey for lynx and raptors.	Common and widespread.	Usually restricted to dry, dense pine, spruce and mixed forests, especially where red squirrels are abundant. Not found in open or semi-open areas.	Very shy and intolerant of noise and human activity. Usually in small family groups.	Periodic short migrations. Diurnal range is small in summer and large in winter.	Removal of forest cover and human activity will reduce local densities. Large habitat changes by fire or drainage alteration.	Minimize timber removal and avoid known areas of marten abundance. Employ winter activities only in areas of abundance. Avoid drainage alterations and fire damage of habitat.
SNOWSHOE HARE Lepus americanus macfariani	Minor furbearer and domestic game animal. Basic prey of lynx, and important prey of fox, wolf, mink, weasels and raptors.	Abundant and widespread. Cyclic.	Succulent deciduous shrubs and forbs are critical in spring. Sheltering timber is important year round, especially in winter. Riparian and "edge" habitats are preferred.	Bold and highly adaptive to noise and activity. Gregarious and prolific.	No migration. Very localized. Little dispersion.	Minimal disturbances.	Avoid destruction of riparian areas (traffic, erosion, fire and drainage alteration).
RED SQUIRREL Tamiasciurus hudsonicus preblei	Minor furbearer. Basic prey species for marten; also minor prey species for mink, weasel and raptors.	Abundant and widespread.	Prefer dry mature white and black spruce and immature pine stands. Active all winter - require seed caches.	Bold and diurnal, highly adaptive to human disturbance.	No migration, very localized.	Minimal disturbances	None
FLYING SQUIRREL Glaucomys sabrinus sabrinus	Minor prey species.	Rare and widespread.	Inhabit stands of semi-open large conifers. Active all year.	Secretive, diurnal and moderately adaptive to human disturbance.	No migration. Very localized.	Minimal disturbances	None
GROUND SQUIRREL Spermophilus undulatus parryii S. u. kennicottii	Minor furbearer. Important prey species for fox, grizzly bear and raptors.	Generally rare; abundant in restricted areas.	Require granular substrate for burrows in an open area above the water table. Feed on grasses, forbs and shrubs. Good burrows are vital to winter survival.	Very wary, diurnal and intolerant of noise and activity. Hibernate in winter. Form gregarious colonies.	No migration, very localized.	Disturbance at burrow areas and removal of granular materials can seriously reduce colonies, especially in winter.	Avoid large burrow areas and/or avoid complete removal of good burrow substrate.
SHREWS Sorex cinereus cinereus Sorex arcticus arcticus S. a. tundrensis Microsorex hoyi intervectus	Insectivores. Incidental prey species for raptors and large mammals. Scavenger and incidental mouse predator.	Uncommon and widespread.	Shrubby habitats are preferred for diverse invertebrate niches and therefore abundant food. Require abundant and constant food and water.	Very secretive, usually nocturnal. Highly adaptive to human disturbance. Prolific and short-lived with distasteful musk, thus poor prey species.	**No migration.** **Extremely localized.**	**Potential disturbance of winter runs by indiscriminal travel over snow.**	**Confine winter and summer traffic to prescribed access routes.**
MICE AND VOLES Peromyscus maniculatus borealis Microtus pennsylvanicus drummondi Microtus oeconomus macfarlani Microtus xanthognathus Lemmus trimucronatus trimucronatus Dicrostonyx groenlandicus kilangmiutak Synaptomys borealis borealis Clethrionomys rutilus dawsoni	Important prey species for fox, weasels, mink, wolf, bears, lynx and raptors.	Uncommon and widespread Common and widespread; locally abundant. Rare and widespread. Abundant and widespread.	Mixed forest with dense ground cover. Riparian and marsh areas with abundant sedge, herbs and grasses. Treeless areas with abundant cotton-grass and shrubs. Muskegs and bogs with shoreline vegetation. Conifer and mixed forests with dense shrub and herb growth.	Very secretive and nocturnal, but highly adaptive to human disturbance. Prolific and short-lived, often in high densities.	**No migrations.** **Extremely localized.**	**Potential disturbance of winter runs by indiscriminant travel over snow.**	**Confine winter and summer traffic to prescribed access routes.**

c. Grizzly Bear

The extreme northwest corner of the study area is known grizzly bear range. Denning habitats are a special concern for these animals.

d. Black Bear

Common throughout the study area, especially towards the south, the black bear have a known denning area on the lower Thunder River.

e. Moose

The Mackenzie River islands and shore, especially south of Little Chicago, provide important wintering habitat for moose.

f. Muskrat

Muskrat concentrations are moderate and infrequent, occurring in the Mackenzie River lowlands and islands near Fort Good Hope.

g. Beaver

Several areas of beaver concentration are identified. The most important habitats are the Mackenzie lowlands from Rabbit Hay River to Travaillant River, and from Little Chicago to Payne Creek.

h. Marten

The southwest corner of the study area supports an abundant population of marten. Other areas with lower marten abundance occur throughout the study area.

i. Other Mammals

Wetlands, especially along the Mackenzie River, are usually productive habitats for carnivores, predators, and small mammals although these animals range throughout the study area.

A.4.3 Native Utilization of Mammals

Native utilization of mammal resources is basically opportunistic. However, the following areas of traditional use have been identified.

The upland areas in the northeast corner of the study area, from North Caribou Lake to the Kugaluk River are occasionally trapped for marten, lynx, and fox by Inuvik natives. Some winter moose hunting occurs along the larger streams.

The upland area between Sandy Lake and Travaillant Lake is trapped yearly by Arctic Red River natives for marten, lynx and mink.

The northwest wetlands from Whirl Lake and Clearwater Lake to Sandy Lake support annual traplines for beaver, mink, lynx, fox, muskrat and marten. The Clearwater to Beaver Lake area is mainly trapped by the Arctic Red River community.

The lower Rabbit Hay River area from Pierre Lake to Rat Lake is utilized from a permanent camp at Tree River (west side of Mackenzie River). Marten, lynx, mink and beaver are trapped. Muskrat and beaver are hunted in the spring (April to June) near Rat Lake.

Fort Good Hope and Arctic Red River natives hunt muskrat and beaver in the wetlands around Big Lake during April, May and June.

A permanent family camp is maintained at a trading post near the mouth of Travaillant River. Mink, beaver, lynx and marten are trapped from Big Lake to Thunder River and on the west side of the Mackenzie River. Local lakes are hunted for muskrat and beaver in the spring.

Marten and beaver are trapped on short day lines from the seasonal native camp at Little Chicago. Traplines are also run on the west side of the Mackenzie River.

Fort Good Hope natives hunt woodland caribou in December from Manuel and Rorey Lakes to Carcajou Lake. The most productive area is northeast of Carcajou Lake, immediately outside the study area.

The wetlands from Rorey Lake to Loon Lake are trapped in November and December by Fort Good Hope natives. Marten is the main harvest, with some beaver, muskrat and mink taken.

A.4.4 Site Assessment Rationale

Homogeneous habitats on flatlands outside of known animal abundance areas were considered low in rating. Sites within animal abundance areas were rated highly, especially when the habitat on the sites was suitable for the identified mammal present.

A.5 Birds

A.5.1 General

The avifauna of the region are primarily summer residents. Most of these migratory birds are of international importance to hunting groups. The major potential impact to avifauna would occur from operations during the nesting season. Fall and winter operations should impart a minimal impact.

The characteristics and information about birds are summarized in Table A.4.

A.5.2 Waterfowl

At least 15 species of waterfowl breed in or migrate through the area. The spring migration is a critical period for most waterfowl. A high energy reserve is required for successful reproduction and undue stress on these birds should be avoided. Staging and feeding areas are limited. Disturbance of staging birds or critical habitat during the prenesting period could have a serious effect on major flocks.

The Mackenzie River islands and adjacent open wetland are extensively used during spring migration, May 10 to June 20. Numerous lakes associated with the Travaillant Lake system also provide a major staging area particularly for whistling swans. Numerous waterfowl nest and rear brood in the wetlands over the spring and summer months. The Travaillant Lake area is utilized by non-breeding whistling swans during moulting (July and August).

A.5.3 Raptors

Raptors prefer nesting in forested areas or rocky bluffs adjacent to water. Nesting birds are particularly sensitive to noise and activity disturbance during the period, May to July. Peregrine falcons, considered rare and endangered, nest in rocky bluffs along the Mackenzie River and its tributaries such as the Tieda River.

Table A.4

SENSITIVITY OF BIRDS TO EXPLOITATION OF DEPOSITS OF GRANULAR SOILS

SPECIES	ROLE	STATUS	RELATIVE ABUNDANCE	HABITAT	BEHAVIOUR AND SENSITIVITY	POTENTIAL DISTURBANCE	MITIGATION
COMMON LOON Gavia immer ARCTIC LOON Gavia arctica RED-THROATED LOON Gavia stellata	Aquatic, prey on fish and other aquatic animals.	Common during spring and fall migration. Summer residents nest in the area.	Common and widespread. Frequent.	Coniferous lakes, large ponds. Coniferous lakes, tundra lakes and ponds. Tundra lakes, ponds and marsh.	Sensitive to approach. Sensitive to noise and activity disturbance during nesting.	Degradation of habitat by siltation and alteration of drainage patterns. Noise and activity disturbance near nesting sites.	Provide buffer zone around water bodies. Winter activities preferred.
RED-NECKED GREBE Podiceps grisegena HORNED GREBE Podiceps auritus	Aquatic, prey on small fish, crustaceans, aquatic insects.	Spring and fall migrant. Summer residents nest in	Common, widespread.	Marsh, shallow ponds.	Occasionally nests in colonies. Sensitive to approach during nesting. Sensitive to approach and noise during nesting.	Degradation of habitat by siltation and alteration of drainage patterns. Noise and activity disturbance near nesting sites.	Provide buffer zone about water bodies. Winter activities preferred.
WHISTLING SWAN Olor columbianus	Feeds on aquatic vegetation.	Spring and fall migrant, staging on Travaillant Lake System. Non-breeders-utilize this area for moulting.	Frequent.	Spring staging - lakes. rivers, ponds. Moult - large lakes. Breed on tundra lakes, ponds and marsh.	All species form into large flocks during migration (spring and fall). Sensitivity to approach. Swans - high Geese - high - moderate. Adaptation to changes. Swans - low Geese - low - moderate.	Disturbance of concentrated flocks on spring staging area Mackenzie River islands, ice free water bodies adjacent to the River. Disturbance of staging birds by noise and activities could prevent birds from building up energy reserves, which is necessary for successful reproduction. Noise and activity may cause delay in nesting, or abandoned nests. Degradation of preferred habitat by siltation or alteration of drainage patterns and material spills.	Avoid staging areas May 10 - June 20. Provide buffer zone, 1/2 to 1 mile around major water bodies. Maintain high construction standards to control erosion problems which could cause siltation of wetland. Winter activities preferred.
CANADA GOOSE Branta canadensis	Game species, aquatic and terrestrial feeders.	Spring migrant, resting and feeding on Mackenzie River islands and open lakes adjacent to River. Fall migrant widespread utilizing Mackenzie River and inland lakes. Breeds locally.	Frequent.	Summer: tundra lakes, ponds, marsh.			
WHITE-FRONTED GOOSE Anser albifrons SNOW GOOSE Chen caerulescens	Game species, aquatic and terrestrial feeders.	Spring migrant, resting and feeding on Mackenzie River islands and open lakes adjacent to River. Fall migrant - widespread utilizing Mackenzie River and inland lakes.	Common, during spring and fall migration.	Summer: tundra lakes, marshes, lakes.			
MALLARD Anas platyrhynchos AMERICAN WIGEON Anas americana	Game species, pond ducks, occasionally terrestrial feeder.	During migration concentrate in large numbers. Spring migrant. Utilizes Mackenzie River Islands and open lakes adjacent to River for resting and feeding (staging). Fall migrants tend to utilize inland wetlands more than spring migration for staging, Mackenzie River Islands are secondary. Breeds - all species breed locally in preferred wetlands, number of birds breeding varies yearly.	Common. Common.	Networks of marshes, ponds and small, shallow lakes with irregular shorelines and abundant cover of sedge and emergent plants.	All ducks form into large flocks during migration (spring and fall). Sensitivity to approach: Moderate to low Adaptation to changes: Moderate to high Puddle ducks may nest on land up to 400 yards from shore.	Disturbance of concentrated flocks on spring staging area. Mackenzie River Islands, ice free water bodies adjacent to the River. Disturbance of staging birds by noise and activities could prevent birds from building up energy reserves, which is necessary for successful reproduction. Noise and activity may cause delay in nesting, or abandoned nests. Degradation of preferred havitat by siltation or alteration of drainage patterns and material spills.	Avoid staging areas May 10 - June 20. Provide buffer zone - 1/2 - 1 mile around major water bodies. Maintain high construction standards to control erosion problems which could cause siltation of wetland. Winter activities preferred.
PINTAIL Anas acuta GREEN-WINGED TEAL Anas crecca SHOVELER Anas clypeata	Game species, pond ducks feed on aquatic vegetation and some aquatic insects.		Frequent. Frequent. Frequent.				
CANVASBACK Aythya valisineria	Game species, diver feed on aquatic vegetation and small aquatic animals.		Rare.	Marshes, ponds, lakes.	Diving ducks usually nest nearer shorelines. Legs set further back on bodies, poor walkers, require runway to take off, generally don't use land habitats.	Controlled water levels which rise during nesting period may inundate nests. Particular concern when nesting habitat is narrow band along shoreline.	Water levels should maintain normal regime during nesting period.
GREATER SCAUP Aythya marila LESSER SCAUP Aythya affinis COMMON GOLDENEYE Bucephala clangula	Game species, diver feeds on aquatic insects, crustaceans, and aquatic vegetation.		Common. Common. Rare.	Lakes, marsh, tundra, ponds, sluggish rivers. Small ponds and lakes. Woodland lakes, muskeg lakes and ponds.			
WHITE-WINGED SCOTER Melanitta deglandi	Diver, feed on aquatic insects, crustacenas, mollusks.		Common.	Lakes, rivers, strictly aquatic, except during nesting.			
SURF SCOTER Melanitta perspicillata			Common.	Lakes, rivers, strictly aquatic, except during nesting.			
RED-BREASTED MERGANSER Mergus serrator	Diver, aquatic feeder-fish. Occasionally hunted.		Frequent.	Lakes, rivers.			

Table A.4

SENSITIVITY OF BIRDS TO EXPLOITATION OF DEPOSITS OF GRANULAR SOILS

SPECIES	ROLE	STATUS	RELATIVE ABUNDANCE	HABITAT	BEHAVIOUR AND SENSITIVITY	POTENTIAL DISTURBANCE	MITIGATION
GOSHAWK Accipiter gentilis	Predator of birds and small mammals.	Resident breeder, northern breeders may migrate into area during winter months.	All species frequent to rare in study area.	Prefer dense, mixed forest, usually nest in trees.	Sensitive to noise and activities within nesting territories. Sensitive to encroachment on nesting territory. Sensitive to blasting. Adaptive to changes - low. Time spent defending territories is lost from normal nesting activities. Eggs and young are susceptible to chill or predation.	Destruction of nesting habitat about water bodies by borrow activities and fires. Blasting and quarry of rock outcrops and bluff will remove nesting habitat and could disturb nesting birds. Habitat destruction of prey species by borrow activities, activities	Provide 1 mile buffer zone about nesting habitat. Requirement of bedrock - quarry activity should be well away from face of outcrops, bluff, 1/2 - 1 mile. Activities should be avoided from May - August. Fire prevention.
SHARP-SHINNED HAWK Accipiter striatus	Predator of birds and small mammals.	Small local concentrations during spring and fall migrations. Breeding in low numbers.	Concerns have been expressed for the future well-being of the raptors, as a whole, as man continues to expand his development in wilderness areas				
RED-TAILED HAWK Buteo jamaicensis	Predator of small mammals.			Prefer woodland edges. Nest in trees or cliffs. Prefer semi-open habitats.			
ROUGH-LEGGED HAWK Buteo lagopus	Predator of small mammals.						
GOLDEN EAGLE Aquila chrysaetos	Predator of small mammals.	Year round resident. Some migrants from northern breeding range pass through area during the spring and fall migration.		Prefer rugged, mountainous habitats. Nest in trees or on cliffs.			
BALD EAGLE Haliaeetus leucocephalus	Predator of fish and small mammals.	Resident during the summer months. Small local concentrations during spring and fall migration.		Prefer forest edges near waterbodies containing fish.			
MARSH HAWK Circus cyaneus	Predator of small mammals and birds.			Prefer open marsh, muskeg, tundra. Nest on ground in shrubby habitats.			
OSPREY Pandion haliaetus	Predator of fish.			Nest in dead trees or on ground near waters containing fish.			
GYRFALCON Falco rusticolus	Predator of birds and small mammals.	Resident breeder, some arctic breeders may reside in the area during the winter months.		Prefer open barrens. Nest on ledges of cliffs.			
PEREGRINE FALCON* Falco pegegrinus	Predator of birds, (ducks and shorebirds).	Resident breeder during the summer months. Small local concentration during spring and fall migration as local and northern residents move to and from southern winter ranges.	*Peregrine falcon considered an endangered species.	Prefer forest lake edges. Nest in trees or cliffs.			
PIGEON HAWK Falco columbarius	Predator of small mammals and birds.			Prefer open woodlands. Nest in tree cavities, on cliffs or ground.			
SPARROW HAWK Falco sparverius	Predator of insects, small birds and mammals.						
SPRUCE GROUSE Canachites canadensis	Terrestrial. Upland game bird.	Resident.	Rare, widespread.	Conifer, deciduous forest, muskeg. Nest on ground in forest.	Easily caught-(fool's hen)	Degradation of nesting habitat, and winter habitat due to removal of cover, fires, alteration of drainage patterns.	Maintenance of existing vegetation along drainage systems. Limit forest cover removal to borrow area. Fire prevention.
SHARP-TAILED GROUSE Pedioecetes phasianellus		Resident, migratory in northern aspect of range.	Frequent, locally.	Muskeg, bogs, burned areas. Nest on ground in brush.	Concentrate in flocks during winter months.		
WILLOW PTARMIGAN Lagopus lagopus		Resident, migratory in northern aspect of range.	Common, locally.	Winter - riparian along creeks, river, lakes, bog. Summer - muskeg, taiga, uplands. Nest on tundra.	Concentrate in flocks during winter months. Moderate adaptability and sensitivity to disturbance.		
SANDHILL CRANE Grus canadensis	Terrestrial associated with aquatic habitats.	Spring and fall migrants.	Common - during spring and in open muskeg.	Muskeg, bogs, tundra. Nest on grass mounds in marshes.	Travel in small to large flocks during migration - spring and fall.	Harrassment of birds on staging areas, during spring and fall migration.	Confine activities to borrow area.
GREAT HORNED OWL Bubo virginianus	Predator of small mammals birds, reptiles, fish, large insects.		Frequent to rare.	Conifer, deciduous forest. Nest in trees, cliffs or on ground.	Owls tend to be secretive, rarely seen as they tend to hunt at night. Territorial when nesting.	Destruction of habitat by fires or removal of cover. Destruction of habitat for prey species. Incursion into nesting territories.	Restrict destruction of habitat to development area.
HAWK OWL Surnia ulula		Residents year round.		Coniferous, conifer-deciduous, muskeg. Nest in tree cavities or snags.			
GREAT GREY OWL Strix nebulosa				Conifer - deciduous, forest-wooded muskeg. Nest in trees.			
SHORT-EARED OWL Asio flammeus		Spring and fall migrant. Breeds locally during the summer.		Open muskeg, meadows, tundra. Nest on ground.	Hunt during daylight.		
COMMON FLICKER colaptes auratus	Insectivorous.	Resident during the summer months, migrate south for winter months.	Common - widespread.	Coniferous-deciduous, semi-open. Prefer late seral stages.	Sensitive to removal of nesting trees. Adaptive to most habitats.	Extensive removal of forest habitat.	Restrict destruction of habitat to development area.
NORTHERN THREE-TOED WOODPECKER Picoides tridactylus		Resident, northern breeders may migrate to south part of breeding range.	Common.	Coniferous forest, muskeg. Require dead topped conifers for nesting.			

Table A.4

SENSITIVITY OF BIRDS TO EXPLOITATION OF DEPOSITS OF GRANULAR SOILS

SPECIES	ROLE	STATUS	RELATIVE ABUNDANCE	HABITAT	BEHAVIOUR AND SENSITIVITY	POTENTIAL DISTURBANCE	MITIGATION
SHOREBIRDS Charadriiformes	Terrestrial associated with with aquatic habitats	Most species are spring and fall migrants, as they nest in the Mackenzie Delta and Arctic Islands. Small flocks concentrate on river mud bars, lake shores, during migration periods. Low number of species will breed locally in the area.	Common to rare.	Edges of lakes, ponds, marsh. Migration - concentrate on mud flats, bars along rivers, marsh. Prefer open shoreline types.	Nest singly or in colonies. Sensitivity and adaptability depend on species habitat requirements.	Destruction of habitat along lake shores, rivers. Main concern to habitats used during migrations.	Maintain buffer zone about water bodies.

SPECIES PRESENT

SEMIPALMATED PLOVER	Charadrus semipalmatus	LONG-BILLED DOWITCHER	Limnodromus scolopaceus
AMERICAN GOLDEN PLOVER	Pluvialis dominica	STILT SANDPIPER	Micropalama himantopus
BLACK-BELLIED PLOVER	Pluvialis squatarola	SEMIPALMATED SANDPIPER	Calidris pusillus
RUDDY TURNSTONE	Arenaria interpres	BUFF-BREASTED SANDPIPER	Tryngites subruficollis
COMMON SNIPE	Capella gallinago	HUDSONIAN GODWIT	Limosa haemastica
WHIMBREL	Numenius phaeopus	SANDERLING	Calidris alba
SPOTTED SANDPIPER	Actitis macularia	RED PHALAROPE	Phalaropus fulicarius
SOLITARY SANDPIPER	Tringa solitaria	NORTHERN PHALAROPE	Lobipes lobatus
Lesser YELLOWLEGS	Tringa flavipes	GLAUCOUS GULL	Larus hyperboreus
KNOT	Calidris canutus	HERRING GULL	Larus argentatus
PECTORAL SANDPIPER	Calidris melanotos	MEW GULL	Larus canus
WHITE-RUMPED SANDPIPER	Calidris fuscicollis	BONAPARTE'S GULL	Larus philadelphia
BAIRD'S SANDPIPER	Calidris bairdii	ARCTIC TERN	Sterna hirundo
LEAST SANDPIPER	Calidris minutilla		

SPECIES	ROLE	STATUS	RELATIVE ABUNDANCE	HABITAT	BEHAVIOUR AND SENSITIVITY	POTENTIAL DISTURBANCE	MITIGATION
PERCHING BIRDS Passeriformes	Insectivorous and/or seed eaters.	All species are resident only during the summer months except where noted. Migrants concentrate in small flocks during the spring and fall migration as they move to and from summer and winter ranges.	Common to rare - widespread and local.	Encompass all habitat types within study area.	Species in successional habitat stages. High - moderately adaptive. Climax species - adaptation - low.	Extensive removal of habitat.	Restrict destruction of habitat to development area. Revegetation of borrow sites will be beneficial to species favouring successional cover.

SPECIES PRESENT

SAY'S PHOEBE	Sayornis saya	NORTHERN WATERTHRUSH	Seiurus noveboracensis
ALDER FLYCATCHER	Empidonax alnorum	WILSON'S WARBLER	Wilsonia pusilla
HORNED LARK	Eremophila alpestris	RUSTY BLACKBIRD	Euphagus carolinus
TREE SWALLOW	Iridoprocne bicolor	PINE GROSBEAK	Pinicola enucleator
BANK SWALLOW	Riparia riparia	HOARY REDPOLL	Acanthis hornemanni
CLIFF SWALLOW	Petrochelidon pyrrhonota	COMMON REDPOLL	Acanthis flammea
AMERICAN ROBIN	Turdus migratorius	WHITE-WINGED CROSSBILL	Loxia leucoptera
VARIED THRUSH	Ixoreus naevius	SAVANNAH SPARROW	Passerculus sandwichensis
GREY-CHECKED THRUSH	Catharus minimus	DARK-EYED JUNCO	Junco hyemalis
RUBY-CROWNED KINGLET	Regulus calendula	TREE SPARROW	Spizella arborea
BOHEMIAN WAXWING	Bombycilla garrulus	CHIPPING SPARROW	Spizella passerina
NORTHERN SHRIKE	Lanius excubitor	HARRIS'S SPARROW	Zonotrichia querula
ORANGE-CROWNED WARBLER	Vermivora celata	WHITE-CROWNED SPARROW	Zonotrichia leucophrys
YELLOW WARBLER	Dendroica petechia	FOX SPARROW	Passerella iliaca
BLACKPOLL WARBLER	Dendroica striata	LINCOLN'S SPARROW	Melospiza lincolnii
YELLOW-RUMPED WARBLER	Dendroica coronata		

Residents

GRAY JAY	Perisoreus canadensis
COMMON RAVEN	Corvus corax
BOREAL CHICKADEE	Parus hudsonicus
PINE GROSBEAK	Pinicola enucleator
HOARY REDPOLL	Acanthis harnemanni
COMMON REDPOLL	Acanthis flammea

Migrants*

LAPLAND LONGSPUR	Calcarius lapponicus
SMITH'S LONGSPUR	Calcarius pictus
SNOW BUNTING	Plectraphenax nivalis

*Breeds north of inventory area.

A.5.4 Upland Game Birds

Abundance of upland game species is generally low. Willow ptarmigan concentrate in small flocks during the winter months and utilize the riparian vegetation along drainages.

A.5.5 Passerine

Specific habitat loss will occur for many species of these smaller song birds. Minimal impact is anticipated on a regional basis. Revegetation of disturbed sites should provide alternate habitat for some species.

A.5.6 Site Assessment Rationale

Wetland habitats associated with the Mackenzie River, tributaries and major lakes were rated as moderate to high quality, while those in the uplands were rated as low. Areas of exposed scarp associated with water bodies were given a high rating, while exposed slopes in dry areas were rated as low.

A.6 The Aquatic Systems

A.6.1 The Mackenzie River Proper

The Mackenzie River supports both freshwater fish populations and anadromous species from the adjacent Beaufort Sea.

The river is a major migration route, a major nutrient source for estuarine and marine communities and a critical overwintering refuge for populations forced to vacate small tributaties because of ice. Tributary mouths and large back eddies in the Mackenzie River are potential nursery areas for whitefish and cisco.

Lower sections of the Mackenzie are characterized by severe ice jams, channel scouring and high turbidity levels. Anadromous and freshwater species must tolerate seasonal high turbidities throughout the system. Less turbid tributaries serve as important spawning and nursery areas for several important species.

Most of the thirty-one species of fish in the Mackenzie Basin utilize the Mackenzie River proper. Significant domestic fisheries occur throughout the river system, usually at the tributary mouths and in the lower delta region. Highest catches usually coincide with major migrations in the spring and fall. Pike, burbot, humpback and broad whitefish, and, to a lesser extent, arctic cisco, comprise the major domestic catches.

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Most of the thirty-one species of fish in the Mackenzie Basin utilize the Mackenzie River proper. Significant domestic fisheries occur throughout the river system, usually at the tributary mouths and in the lower delta region. Highest catches usually coincide with major migrations in the spring and fall. Pike, burbot, humpback and broad whitefish, and, to a lesser extent, arctic cisco, comprise the major domestic catches.

A.6.2 Tributaries of the Mackenzie

Both large and small tributaries in this region are significant spawning, nursery and feeding areas particularly for grayling. Streams also provide access to lakes and marsh systems. Extreme fluctuations in seasonal discharges and severe winter conditions often limit the use of such drainage areas to the spring and early summer. The relatively low turbidities, greater concentrations of suitable spawning substrates, and abundant food sources are conducive to spawning and rearing of many species. Fish using the ephemeral creeks must overwinter in deeper stream pools, hot springs, deep lakes, or the Mackenzie proper. Overwintering areas are limited and therefore of vital importance for maintenance of resident fish populations.

The clearer streams within the study section are important spawning and nursery areas for grayling. Chub, suckers, pike, sculpins, trout-perch and whitefish also utilize more turbid streams in this section. Significant nurseries for whitefish and cisco exist at the mouths of many of the major streams.

A.6.3 Lakes and Marshes

Lakes and marshes provide productive feeding and nursery areas for both resident and transient fish populations. The deeper water bodies provide essential overwintering refuges. Spawning occurs on associated drainages and along lake shores.

Species most common to lake and marsh habitats include: humpback and broad whitefish, those least common include: cisco, grayling, pike, burbot, lake trout, pond smelt, stickleback and longnose sucker.

Species diversities are typically low and it is common to find only one or two species inhabiting isolated lakes.

A.6.4 Utilization of Fisheries Resource

The most significant domestic and commercial fisheries occur on the Mackenzie River, specifically throughout the delta region. While netting occurs anywhere on the river, fishing activities are most intense near native settlements. Fishing occurs throughout the open water season with greatest activity occurring in the fall. Nets are removed prior to freeze-up.

Many lakes within the study area such as Bathing, Jiggle, Travaillant, Yeltea, Manuel, Rorey and Loon Lakes are used in support of trapline activities.

Potential sport fishery areas are becoming increasingly important as resident populations expand and accessibility to formerly remote areas is facilitated by road and air installations. Significant sport fishery concerns occur in major lakes and streams near Inuvik.

The characteristics and information about fish is summarized in Table A.5.

A.6.5 Potential Impacts of Borrow Operations on Aquatic Systems

a. Access Road Development

Poorly designed or extensive access roads could have detrimental effects on aquatic systems. Routes favouring the least number of creek crossings are most desirable. Roads over the ice of large lakes or rivers would have minimal adverse effect. Access routes should be located during the summer, but developed and utilized during the winter.

Table A.5

SENSITIVITY OF FISH TO EXPLOITATION OF DEPOSITS OF GRANULAR SOILS

FAMILY	SPECIES	ROLE	RELATIVE ABUNDANCE	HABITAT PREFERENCE	LIFE HISTORY	SENSITIVE ELEMENTS	RESILIENCE	PROTECTION AND MITIGATION
MOONEYES Family Hiodontidae	GOLDEYE Hiodon alosoides (Rafinesque)	Forage fish for pike, burbot, lake trout. No appreciable domestic use in Area.	Infrequent in streams and lakes in this region.	Large muddy rivers and turbid shallows of lakes.	Overwinters in deep areas of turbid lakes and streams. Spawns soon after break-up (Mid-May - Mid-July) in rivers or tributary streams. Utilizes lakes and streams as feeding and nursery areas.	Deepwater overwintering areas. Invertebrate food sources. Floating larvae.	Minor increases in silt load should not affect this species. Widespread distribution would also aid recolonization of disrupted systems.	Floating eggs of mooneyes would be particularly sensitive to petrochemical spills. Waters should be protected from spillage of stored fuel and from machine operations in or immediately adjacent to water bodies. Curtail operations near overwintering sites.
THE WHITEFISH Family Coregonidae	INCONNU* Stenodus leucichthys nelma (Pallus)	Important domestic fish along the Mackenzie and major tributaries.	Common in Mackenzie River and delta region. Seasonally abundant at the mouths of some streams in this region.	Large, muddy rivers and associated lakes. Prefer clear streams for spawning.	Overwinter in large, muddy tributaries of Mackenzie. Spawns in small clear streams during early fall (September to October). Nursery areas are generally in the lower reaches or mouths of tributary streams.	Major spqwning migrations. Clear spawning tributaries Nursery areas near mouths of tributaries. Unique to Northwestern North America.	Probably able to withstand isolated short term disruptions. Slow growth rate, no feeding during migration and requirements of clear spawning streams may increase any physical impacts.	Excessive siltation of preferred clear spawning streams should be prevented. Sport fishing by construction crews should be regulated to avoid overfishing.
	HUMPBACK WHITEFISH* Coregonus clupeaformes	Domestic catches in lakes and Mackenzie delta region.	Common in many of the larger lakes and Mackenzie River.	Clear to turbid streams and lakes.	Overwinters in deeper lakes or tributaries. Spawning migrations in late summer (August - September). Spawning in associated tributaries in fall (September to November). Eggs overwinter, hatch in spring.	Major spawning migrations. Presence of at least one developmental phase all year round. Predominant invertebrate food source. Overfishing in smaller lakes.	Wide age class distribution, wide range distribution, local abundance and variable habitat use indicate that the species has high resilience.	Avoid excessive water removal during low winter flow periods to protect overwintering. Reduction in zoobenthos by introducting silts and fine sands to lakes or streams would be most serious during the winter and disposal of such material should be in a closed system with settling ponds built into the borrow development.
	BROAD WHITEFISH* Coregonus nasus (Pallus)	Important domestic and commercial species.	Common in major rivers and Mackenzie.	Large muddy rivers. Clear to slightly turbid streams for spawning.	Overwinters in Mackenzie and deep tributaries. Upstream spawning migrations from July to August. Spawning in early autumn (September to October). Eggs and fry in gravel during the winter.	Major spawning migrations. Presence of at least one developmental stage all year round. Predominant invertebrate food source.	Appears relatively resilient to isolated short term disruptions.	Avoid interruption of major migrations by blasting, channel blockage or material spills. Develop borrow sites away from water channels or water bodies.
	LAKE CISCO Coregonus artedii	Potential domestic use. (For dog food).	Infrequent. None sampled by Federal Fisheries surveys of lakes of this region.	Shallow and deep water of lakes.	Overwinter in lakes. Spawn in late autumn Over sandy shoals of lakes.	Overwintering areas. Disruption of invertebrate food sources. Siltation of lake shore spawning areas.	Lack of data negates adequate estimates of species resilience.	Prevent deoxygenation of overwintering lakes by eutrophication or excessive water removal. Avoid disturbance of zoobenthos by material spills.
	LEAST CISCO* Coregonus sardinella	Important domestic catch.	Common in lakes throughout study area.	Clear to turbid lakes and larger muddy rivers.	Overwinter in deep lakes and major rivers. Spawning migrations in late summer and early fall. Spawning occurs in fall under the ice in lower reaches of rivers and deltas.	Overwintering areas. Decreases in plankton and invertebrate food sources.	Occurrence in a wide range of water turbidities would appear to reduce impacts of minimal increments in siltation.	Avoid disturbance of zoobenthos by spills. Schedule operation to prevent interruption of major migrations.
	ARCTIC CISCO* Coregonus autumnalis (Pallus)	Important domestic catch.	Common in larger rivers.	Lower reaches of large muddy rivers and brackish water areas.	This anadromous species feeds in brackish water areas off the Mackenzie delta during the summer. Upstream spawning runs begin in early spring. Spawning occurs in late summer and early autumn in clear tributary streams.	Major migrations. Clear spawning streams.	Tolerance to siltation would appear high due to occurrence in a wide range of water turbidities.	Avoid interruption of major migrations by blasting, channel blockage and material spills.
	ROUND WHITEFISH* Prosopium cylindraceum (Pallus)	Domestic use.	Frequent.	Clear headwater streams and lakes.	Overwinter in lakes or deeper tributaries. Spawning in autumn along shores of lakes and streams. Eggs hatch the following spring.	Clear water habitats. Predominant invertebrate diet. At least one developmental stage present year round.	Possibly low. Extensive distribution throughout the region could facilitate recolonization of disturbed areas.	Extend particular care to avoid an excessive siltation of clear water habitats.
THE GRAYLINGS Family Thymallidae	ARCTIC GRAYLING* Thymallus arcticus (Pallus)	Sport and domestic fishery.	Common.	Clear headwater streams and lakes.	Overwinter in lakes, deeper stream pools and the Mackenzie River. Spawn soon after breakup in mid-May. Eggs hatch May to July. Fry and adults remain in streams during the summer and migrate to overwintering areas prior to freeze-up.	Clear water habitats. Predominant terrestrial invertebrate diet. Clean gravel for spawning.	Possibly least resilient to environmental disruptions. Slow growth rates and few adult age classes indicate long recovery periods if severely disturbed. Predominant terrestrial insect foods make this species particularly vulnerable to toxic chemical disturbances.	Maintain stringent control of petrochemicals stored and in use. Minimize increases in sediment loads in clear headwater streams and lakes.
TROUT, CHAR AND SALMON Family Salmonidae	ARCTIC CHAR Salvelinus alpinus (Linnaeus)	Domestic catch.	Infrequent in the study region.	Clear, swift streams and lakes. Brackish offshore areas.	Spring migrations to summer marine feeding areas in anadromous populations. Fall migration (August to September) to stream spawning areas. Landlocked species remain in clear lakes and associated tributaries. Overwinter in deep pools of clear rivers.	Clear water habitats. Good gravel substrates. At least one developmental stage present year round. Definite migration routes.	Probable low resilience of landlocked populations due to extreme dependence on limited overwintering areas, clear water habitats and good gravel substrates. Migrating stocks are subject to tributary blockages and overfishing.	Protect Mackenzie River populations by providing adequate buffer zones between the Mackenzie shoreline and borrow sites.

* Species common to the study area and/or of domestic value.

Table A.5

SENSITIVITY OF FISH TO EXPLOITATION OF DEPOSITS OF GRANULAR SOILS

FAMILY	SPECIES	ROLE	RELATIVE ABUNDANCE	HABITAT PREFERENCE	LIFE HISTORY	SENSITIVE ELEMENTS	RESILIENCE	PROTECTION AND MITIGATION
TROUT, CHAR AND SALMON Family Salmonidae (cont.)	LAKE TROUT* Salvelinus namaycush (Walbaum)	Domestic value potential sport value.	Common in many lakes in the study area.	Clear lakes and streams.	Overwinter in deeper areas of lakes and rivers. Spawning occurs in late summer and early autumn usually in lakes.	Clear water requirements. Clean gravel substrates. Often found in lakes with low species complements (i.e. may be only species present in some tundra lakes). Overfishing.	Very slow growth rates and lengthy maturity rates would probably result in slow recovery rates in localized severe disturbances.	Prevent overfishing by construction personnel. Protect spawning and overwintering areas from siltation.
THE SMELTS Family Osmeridae	POND SMELT* Hypomesus Olidus (Pallus)	Some domestic use.	Common in many lakes in the study area.	Clear lakes and streams.	Overwinter in lakes and Mackenzie River. Spawning occurs in late June in littoral areas over bottoms that are largely covered with organic debris.	Usual, clear water requirements. Plankton food sources.	Insufficient data makes resilience determinations difficult for this species.	Avoid disruption of zoobenthos by increased siltation.
THE PIKES Family Esocidae	NORTHERN PIKE* Exox lucius (Linnaeus)	Human and dog food.	Common in all systems.	Shallow lakes and bays and quiet rivers.	Overwinter in major lakes and rivers. Spawn soon after breakup in marshy or freshly flooded areas.	Siltation of eggs (silt deposition of 1.0 mm/day has been found to produce a mortality rate of 97% in the early embryonic stages.	Considered to have a high resiliency to environmental disturbances because of: wide habitat tolerance, high numbers and widespread distribution.	Sport fishing by construction crews should be controlled. Excessive siltation during spring spawning should be prevented by insuring that spring runoff waters do not carry washed fines from borrow operations.
THE MINNOWS Family Cyprinidae	FLATHEAD CHUB* Platygobio gracilus (Richardson)	Forage fish for commercially or domestically important species.	Common.	Muddy rivers.	Overwinter in deeper rivers or lakes. Spawn in early summer (June to July).	Spawning areas. Zoobenthos.	Expected high resiliency due to side habitat tolerance, large numbers and widespread distribution.	Minimal increments of suspended sediments are not serious to these species since they demonstrate natural tolerances to a wide range of turbidities.
	LAKE CHUB* Couesius plumbeus (Agassiz)		Common.	Clear and muddy lakes and rivers.				
	LONGNOSE DACE Rhinichthys cataractae (Valenciennes)		Frequent.	Clear or muddy running water.				
	FINESCALE DACE Pfrille neogaea (Cope)		Frequent.	Cool boggy lakes or streams.				
	NORTHERN REDBELLY DACE Chrosomus eos (Cope)		Frequent.	Boggy margins of small				
	SPOTTAIL SHINER Notropis hudsonius (Clinton)		Frequent.	Muddy to clear streams and lakes.				
THE SUCKERS Family Catostomidae	LONGNOSE SUCKER* Catostomus catostomus (Forster)	Domestic and commercial use.	Common.	Clear and muddy rivers and lakes.	Overwinter in deeper tributaries. Spawns in early summer (May to July).	Spawning tributaries.	High resilience due to wide habitat tolerance, high numbers and extensive distribution.	Siltation of benthic food sources in clear water areas is of particular concern. Design crossing structures to avoid obstructing migration in in narrow tributaries.
	WHITESUCKER Catostomus commersoni (Lacepede)	Domestic use.	Infrequent.	Warmer shallows of lakes and streams.	Overwinters in deeper lakes and tributaries.	Spawning tributaries.	High resilience due to wide habitat tolerance, high numbers and extensive distribution.	
THE TROUT-PERCHES Family Percopsidae	TROUT-PERCH* Percopsis omiscomaycus (Walbaum)	Forage fish.	Common in major rivers.	Quiet backwaters of large, muddy rivers. Shallow sand beaches of lakes.	Overwinter in major rivers and lakes. Spawning occurs in late spring and early summer.	Benthic food sources.	High resilience due to wide habitat tolerance, high numbers and extensive distribution.	
THE CODS Family Gadidae	BURBOT* Lota lota (Linnaeus)	Domestic catch.	Common.	Muddy to clear streams and lakes.	Overwinter in deeper tributaries and lakes. Spawn under the ice in late winter (November to January). Eggs hatch the following spring.	Winter spawning. Low winter discharge and oxygen levels. At least one developmental stage present all year round.	High resilience. Wide habitat tolerance, high numbers and extensive distribution.	Regulate removal of water from tributaries during periods of low water levels.
STICKLEBACKS Family Gasterostidae	NINESPINE STICKLEBACK* Pungitius pungitius	Forage fish.	Frequent.	Lakes, slow streams and tundra ponds.	Overwinter in deeper pools. Spawn from May to late July.	Clear water habitats. Predominant benthic invertebrate diet.	Possibly low due to low and localized populations.	Prevent increased siltation to benthic food production.
SCULPINS Family Cottidae	SLIMY SCULPIN* Cottus cognatus (Richardson)	Forage fish.	Common.	Cool running streams with a rocky or sandy bottom.	Overwinter in deeper tributaries. Spawn from mid-May to July.	Predominant benthic invertebrate diet.	Possibly high due to apparent tolerance to a wide range of turbidity levels.	
	SPOONHEAD SCULPIN Cottus ricei (Nelson)	Forage fish.	Infrequent.	Large muddy rivers.	Overwinter in deep rivers. Probably spawn in early spring (no data on spawning habits are available).	Predominant benthic invertebrate diet.	Moderate. While this species is tolerant of very high turbidities, numbers in this region are low.	
PERCH Family Percidae	YELLOW WALLEYE Stizostedion vitreum vitreum (Mitchill)	Low domestic use in this area.	Infrequent.	Large, low turbidity rivers. More prevalent in southern areas of the Mackenzie.	Overwinter in deep lakes and rivers. Spawns in the spring soon after breakup (mid-May to July). Feed at river mouths after spawning.	Clear spawning streams with clean gravel substrates.	Considered high due to wide habitat tolerance, high numbers and extensive distribution.	Prevent siltation of spawning streams.

* Species common to the study area and/or of domestic value

Bank failures and inadequate temporary crossings are potential barriers to fish migration.

Winter haul roads across major lakes would be more favourable than roads cut along adjacent shores. Lake routes would decrease erosion impacts on the aquatic systems and maintain the existing integrity and aesthetics of the shorelines. Such natural winter roads could be an obvious economic advantage for removal of borrow materials. Material spills, either granular or petrochemical, during hauling over frozen lakes would be a hazard.

b. Stream Crossings

Temporary crossings often pose serious problems to fish passage. Installation of such crossings should correspond to periods of low fish sensitivity and be removed prior to spring break-up. Permits are required for such installations and migrating fish must be accommodated.

c. Waste Materials

Introduction of wastes or "fines" and removal of excessive volumes of water resulting from gravel washing procedures are major concerns near tributaries and lakes. Introduction of waste borrow materials into aquatic systems should be prevented by utilization of settling pond designs, substantial dykes and extensive buffer zones along adjacent lakes or streams.

d. Water Removal from Lakes and Streams

Removal of large volumes of water for gravel washing procedures could have adverse effects on lake or stream systems. In lakes the oxygen rich upper layer or epilimnion, caused by summer thermal stratification, is the most productive lake zone. Removal of excessive amounts of water from the epilimnion could seriously reduce available water oxygen subsequently decreasing phytoplankton, zooplankton, and fish productivity.

Extensive "drawdowns" in ponds or small lakes result in decreased availability of littoral (shoreline) regions. Suitable littoral spawning substrates may become inaccessible to resident fish.

Reduction in the insulating water layer of the littoral zone can result in increased ice penetration of lake shore substrates causing marked decreases in water plants, zoobenthos, and overwintering fish eggs.

Excessive water removal from streams, already subject to extreme fluctuations in discharge, could cause changes in thermal regimes, decreases in available spawning substrates and disruption of potential overwintering areas.

Detailed field studies of specific lakes and streams are required before recommendations for limits or quotas for water removal could be formulated.

e. Blasting

Blasting in or near lakes or stream beds can cause serious fish mortalities, particularly to eggs in the gravel. Written permission is required from the Fisheries Service prior to blasting operations near lakes or streams.

f. Toxic Materials

The risk of disturbances from material spills should be minimized by effective contingency plans and possible relocation of access routes to bypass particularly sensitive areas.

g. Eutrophication

Introduction of excessive amounts of sewage effluent into small lakes or streams can cause excessive algal blooms, oxygen depletion and subsequent fish mortalities. Adequate sewage disposal at construction camps would be required to minimize impacts of camp installations on local aquatic systems.

h. Overfishing

Lake-trout, grayling and pike are attractive game fish and construction crews often compete with local domestic users of fish at attractive fishing sites, often to the detriment of an essential fishery. Strict fishing regulations may be enforced regarding construction personnel.

A.6.6 Site Assessment Rationale

Sites within one mile of the Mackenzie River, major tributaries and large lakes were rated as having generally high potential for impacts on aquatic systems. Potential excavations near ephemeral drainages, small, isolated lakes or areas devoid of conspicuous aquatic systems were rated from minimal to moderate potential impacts.

Steep terrains adjacent streams, lakes or rivers; presence of valuable or abundant fish species and proximity to local settlements contributed to higher impact ratings. Increased distances of borrow areas from aquatic systems decreased potential impact rating of the respective sites.

A.7 Archaeology

A.7.1 General

The study area is a potentially important archaeological region. Studies of the evolution of settlement patterns and cultural developments along the Mackenzie Corridor indicate that the large lake and river complexes inland from the Mackenzie River were favoured sites for early man.

A.7.2 Archaeological Sites Within the Study Area

Two known prehistoric fishing camps have been located at the whirl Lake inlet and Travaillant Lake outlet. The Whirl Lake site is identified as Kutchin fishing camp, circa 1400 A.D.

Two historic sites are found in old trading posts along the Mackenzie River; one at Gillis River and one at Travaillant River.

An unspecified site has been reported on the east side of Yeltea Lake.

A.7.3 Archaeological Potential Within the Study Area

Scarps and terraces parallel to the Mackenzie are areas of moderate discovery potential, particularly where associated with major tributaries.

The major inland lake systems have high archaeological potential. Travaillant, Yeltea, Manuel, and Loon Lakes and the major tributary connection to the Mackenzie are of very high potential. The Sunny Lake-Sandy Lake complex is considered as a high discovery potential area.

The potential ethnohistoric value of archaeological sites in this area is high. The dearth of existing knowledge is great. Detailed site surveys prior to actual granular borrow operations is warranted at all sites. Identified sites should be fully investigated and evaluated before operations are permitted. Requirements to salvage some sites may require minor modifications of excavation plans. Most archaeological sites are relatively small.

A.7.4 Site Assessment Rationale

The archaeological site potential of uplands was considered low. Confluences of streams, or of streams and lakes, or borders of major lakes were considered to have high archaeological site potential. Presence of known sites in the region or important animal abundance raised archaeological potential ratings. Sites adjacent to large lakes or the Mackenzie generally were considered to have high paleontoligocal potential.

GLOSSARY

ALLUVIUM	-	Stream deposits of comparatively recent time, does not include subaqueous deposits of seas and lakes.
ANADROMOUS	-	Fish species which travel from the sea up rivers to spawn.
ANHYDRITE	-	A mineral, anhydrous calcium sulphate, $CaSO_4$. Orthorhomibic, commonly massive in evaporite beds.
ANNUALS	-	A plant that lives only one year or season.
AQUATIC	-	Living in or near the water.
AUTHIGENIC	-	Pertaining to minerals formed on the spot where they are now found, before burial and consolidation of the sediment. They are products of chemical and biochemical action.
AVIFAUNA	-	The birds of a region.
BERM	-	A horizontal portion of an earth embankment to ensure greater stability of a long slope.
BENTHIC, BENTHOS	-	The entire assemblage of plants and animals inhabiting the lake or river bottom.
BENTONITE	-	Clay largely composed of the clay minerals montmorillonite and beidellite.
BIOLOGICALLY SENSITIVE	-	Subject to disturbance of plant and animal communities.
BIOTIC	-	Of or pertaining to life or mode of living.
BITUMINOUS	-	Containing much organic or at least carbonaceous matter, mostly in the form of tarry hydrocarbous.
BOREAL	-	Pertaining to the North.
BOULDER	-	A rock fragment larger than 8" in diameter.
CALCITE	-	A mineral, $CaCO_3$.
CARNIVORE	-	A flesh-eating mammal.
CARRION	-	Feeding on dead and decaying animal flesh.
CLAY	-	Soil particles smaller than 0.002 mm. in diameter.

COBBLE	-	A rock fragment between 3" and 8" in diameter.
COLLUVIUM	-	A general term applied to loose and incoherent deposits, usually at the foot of a slope or cliff and brought there chiefly by gravity.
CONCRETION	-	A nodular or irregular concentration of certain authigenic constituents of sedimentary rocks.
CONGLOMERATE	-	Rounded water-worn fragments of rocks or pebbles, cemented together by another mineral substance which may be of a siliceous or argillaceous nature.
CONIFEROUS	-	Evergreen trees and shrubs characterized by needle-shaped leaves, resinous wood and cones.
CRETACEOUS	-	The third and latest of the periods included in Mesozoic era; also the system of strata deposited in the Cretaceous period.
CREVASSE FILLING	-	A relatively straight ridge of stratified sand and gravel or till and other sediments, formed by the filling of a crevasse in a stagnant glacier that later melted. Crevasse fillings are similar in form to eskers but are not as winding or branching and are often much wider with nearly level tops.
CRYSTALLINE	-	Of or pertaining to the nature of a crystal; having regular molecular structure.
CYCLIC	-	Populations of animals which fluctuate in numbers over a period of years. The changes in numbers recur in cycles.
DECIDUOUS	-	Broad-leaved shrubs and trees which shed their leaves in winter.
DELTA DEPOSITS	-	An alluvial deposit, usually triangular, at the mouth of a river.
DENNING AREA	-	Region known to be used by animals for caves or burrows for the purpose of shelter and rearing their young.

DEVONIAN - In the ordinarily accepted classification, the fourth in order of age of periods, comprised in the Paleozoic era, following the Silurian and succeeded by the Mississippian. Also the system of strata deposited at that time.

DISINTEGRATION MORAINE - (also DEAD - ICE MORAINE) Collapsed superglacial till (ablation till), which accumulated by ablation concentration of sub-glacial drift thrust up into the glacier along compressive flow shear planes.

DIURNAL - More active during the day than at night. Daily occurrences.

DOLOMITE - A mineral, CaMg (CO3)2, commonly with some iron replacing magnesium; a common rock-forming mineral. The name is commonly applied to rocks composed chiefly of the mineral dolomite.

DRUMLIN - Streamlined hill or ridge of glacial drift with long axis paralleling direction of flow of former glacier.

ECOLOGY - The study of the mutual relationships between organisms and their environments.

EOLIAN - Deposits which are due to the transporting action of the wind.

EPHEMERAL CREEK - Watercourse which carries water only during the spring melt.

ERICACEOUS - Plants of the heather family.

ESCARPMENT - The steep face of a ridge of high land.

ESKER - A narrow sinuous ridge of gravelly or sandy drift, deposited by a stream in association with glacier ice.

EUTROPHICATION - Excessive discharge of organic matter and nutrients such as sewage effluent into small lakes or streams will result in increased growth of algae and oxygen depletion and subsequent fish mortality. Such oxygen-deficient water bodies are termed <u>eutrophic</u> <u>eutrophication</u>.

EXCESS ICE - Ice in excess of the fraction that would be retained as water in the soil voids upon thawing.

FAUNA - The animals collectively of any given age or region.

FISSILE BEDDING - Term commonly applied to bedding consisting of laminae less than 2 mm. in thickness. Also refers to the tendency of such rocks to easily split along closely spaced parallel planes.

FLOOD PLAIN - That portion of a river valley, adjacent to the river channel, which is built of sediments during the present regime of the stream and which is covered with water when the river overflows its banks at flood stages.

FLORA - The plants collectively of any given formation, age or region.

FLOW SLIDE - (or EARTH FLOW or MUDFLOW)
A slide of liquified loose sand or silt that spreads out on a flat slope downslope of the failure crater.

FORBS - Edible plants, commonly used as a source of food by herbivores.

FOSSILIFEROUS - Containing organic remains.

FLUVIAL GEOMORPHOLOGY - The study of landscape and of the geologic forces that produce it. It is the dynamic geology of the face of the earth. It concerns that branch of physical geography dealing with the origin and development of the earth's surface; features (landforms) and the history of geologic changes through the interpretation of topographic forms.

GLACIAL TILL - Nonsorted, nonstratified sediment carried or deposited by a glacier.

GLACIOFLUVIAL - ~~FLUVIOGLACIAL~~. Pertaining to streams flowing from glaciers or to the deposits made by such streams.

GLACIO-LACUSTRINE - Pertaining to glacial-lake conditions, as in glaciolacustrine deposits.

GRAVEL - Soil particles smaller than 3" in diameter and larger that which will pass a #4 sieve.

GROUND MORAINE - A moraine with low relief, devoid of transverse linear elements.

GYPSUM - Alabaster. Selenite. Satin Spar. A mineral, $CaSO_4 \cdot 2H_2O$. Monoclinic. A common mineral of evaporites.

HABITAT - The place in which an organism lives and its surroundings both living and non-living.

HERBIVORE - A plant-eating animal.

HETEROGENEOUS - Differing in kind; having unlike qualities; possessed of different characteristics; opposite of homogeneous.

HIBERNATION - The winter dormant state of animals characterized by reduced body temperature, pulse rate and breathing.

HIGH TERRACE - Terraces which may be either erosional benches cut in lacustrine or eolian silt or depositional (alluvial, fluvial) terraces and contain variable portions of silt, sand, and gravel.

HUMMOCK - A mound or knoll.

~~ICING~~ - Mass of surface ice formed during winter by successive freezing of sheets of water seeping from the ground, a river or spring.

INSECTIVORE - Feeding on insects.

KAMES - A mound composed chiefly of gravel or sand, whose form is the result of original deposition modified by settling during the melting of glacier ice against or upon which the sediment is accumulated.

LACUSTRINE - Produced or belonging to lakes.

LICHEN	-	Low growing flowerless plant communities composed of a union of fungi and algae. Abundant in the north as flat grey, brown or yellowish patches on rocks and trees.
LIMESTONE	-	A bedded sedimentary rock composed chiefly of calcium carbonate ($CaCO_3$).
LITTORAL ZONE	-	The shore or coastal region of a water body.
MEANDERING	-	Condition of river that follows a winding path owing to natural physical causes not imposed by external restraint. Characterized by alternating shoals and bank erosion.
MIGRATION BARRIER	-	Any obstruction in a stream or river which prevents normal fish passage.
MIGRATION ROUTE	-	The route followed regularly by birds, animals or fish in their seasonal movement from one region to another.
MITIGATE	-	To reduce or lessen effects of disturbance by appropriate means.
MORAINE	-	Drift, deposited chiefly by direct glacial action, and having constructional topography independent of control by the surface on which the drift lies.
MORPHOLOGICAL	-	The scientific study of form. Used in various connections, e.g. landforms (geomorphology).
MOULT	-	Process of loss and subsequent replacement of feathers. Waterfowl experience a period of flightlessness during this process.
MULCH	-	Any loose material placed about the base of a plant or over the ground surface to retain moisture and protect the soil surface from erosion.
MUSKEG	-	The term designating organic terrain, the physical condition of which is governed by the structure of peat it contains and its related mineral sublayer, considered in relation to topographic features and the surface vegetation with which the peat co-exists.

NOCTURNAL - More active during the night than in the daytime - nightly occurrence.

NOMADIC - Animal groups which move frequently from place to place.

ORGANIC MAT - The layer of vegetation living and decayed, which covers the mineral soil of northern regions. This layer forms an insulating mat between frozen ground and the warming effects of the sun's rays.

ORGANIC SOIL - A soil which contains a high percentage (>20%) of organic matter throughout the A and B horizons.

OUTWASH - Bodies of stratified drift that are washed out and deposited by meltwater streams issuing from and discharging beyond active glacier ice.

OUTWASH PLAIN - A body of outwash that forms a broad plain. Varieties are called outwash terraces, fans, aprons, trains or sandur.

PASSERINE - A large order of birds including all song birds.

PEAT - A dark brown or black residuum produced by the partial decomposition and disintegration of mosses, sedges, trees and other plants that grow in marshes and like wet places.

PERCHING AREA - A region known to be used by birds for resting, frequently a high rock face overlooking a water body.

PERENNIAL - Lasting through the year.

PERMAFROST - The thermal condition under which earth materials exist at a temperature below 32 degrees F continuously for a number of years.

PETROGRAPHY - The branch of science treating of the systematic description and classification of rocks.

PHYTOPLANKTON - Minute plants suspended in the upper water levels of lakes and streams. Includes the diatoms, desmids and green algae which form the base on which the rest of aquatic life depends.

PREDATOR - An animal which utilizes other animals for food.

PREY SPECIES - Animals which serve as a food resource for other animal species.

PROGLACIAL - Pertaining to features of glacial origin beyond the limits of the glacier itself, as...streams,... deposits,...sand.

RAPTOR - Predator bird species such as the hawks, owls, falcons and eagles.

RESTORATION - The reconstruction or repair of an area to return it to its undisturbed state.

RIPARIAN - Vegetation along the banks of watercourses.

SAND - Soil particles smaller than #4 Sieve and larger than #200 Sieve.

SANDSTONE - A cemented or otherwise compacted detrital sediment composed predominantly of quartz grains, the grades of the latter being those of sand.

SCARP - See ESCARPMENT.

SCREES - A heap of rock waste at the base of a cliff or a sheet of coarse debris mantling a mountain slope.

SENSITIVE AREA - Easily disturbed or affected by construction procedures.

SHALE - A laminated sediment in which the constituent particles are predominantly of the clay grade.

SILT - Soil particles smaller than the #200 sieve and larger than 0.002 mm.

SILTSTONE - A very fine grained consolidated clastic rock composed predominantly of particles of silt grade.

SINUOUS - Winding or curving in and out.

SLOPE WASH - Soil and rock material that is being or has moved down a slope predominantly by the action of gravity assisted by running water that is not concentrated into channels.

SMALL MAMMAL - Includes mice, voles, shrews and squirrels.

SOLIFLUCTION - The slow downhill flow of surface deposits saturated with water released by thawing. The solifluction layer overlies frozen ground.

SPAWNING - The seasonal deposition of fish eggs and rearing of young fish. The time of year at which spawning takes place varies with species.

SPRING AND FALL STAGING AREAS - Migratory bird species congregate in large flocks to rest and feed during their spring and fall migration periods. Areas known to be used regularly be migrating flocks are termed "staging areas".

TALUS - Coarse angular fragments of rock and subordinate soil material dislodged by weathering (temperature and moisture changes) and collected at the foot of cliffs and other steep slopes and moved downslope primarily by the pull of gravity.

TAIGA - A Russian word applied to the old, swampy, forested region of the north...that region between the Tundra in the north and the Boreal in the south.

TERRACE - A relatively flat elongate stairstepped surface bounded by a steeper ascending slope on one side and a steep descending slope on the other.

TERRACED SLOPE - A narrow step or several steps cut into the face of the slope.

TERRESTRIAL - Living or growing on land.

THERMAL REGRESSION - The thawing of frozen ground due to surface disturbance, increasing temperature, etc.

THERMALLY SENSITIVE - Subject to disturbance by thawing of permafrost zone.

THERMOKARST LAKE - (Cave-in Lake), lakes which occupy depressions resulting from subsidence caused by thawing of ground ice.

TILL - A nonsorted and nonstratified mixed grained sediment carried or deposited by a glacier.

TUNDRA	-	Any of the vast, nearly level, treeless plains of the Arctic Regions.
TURBID	-	Having the sediment stirred up hence muddy, impure.
WATERFOWL	-	Collectively, the birds which live on or near watercourses, particularly the large game birds such as ducks, geese and swans.
WEATHERING	-	The group of processes, such as the chemical action of air, rain and water and of plants and bacteria and the mechanical action of changes of temperature, whereby rocks on exposure to the weather change in character, decay and finally crumble into soil.
ZOOBENTHOS	-	The animal portion of living organisms which inhabit a lake or river bottom.
ZOOPLANKTON	-	The minute suspended animal organisms in water bodies. They graze on phytoplankton and form an important link in the aquatic food chain.

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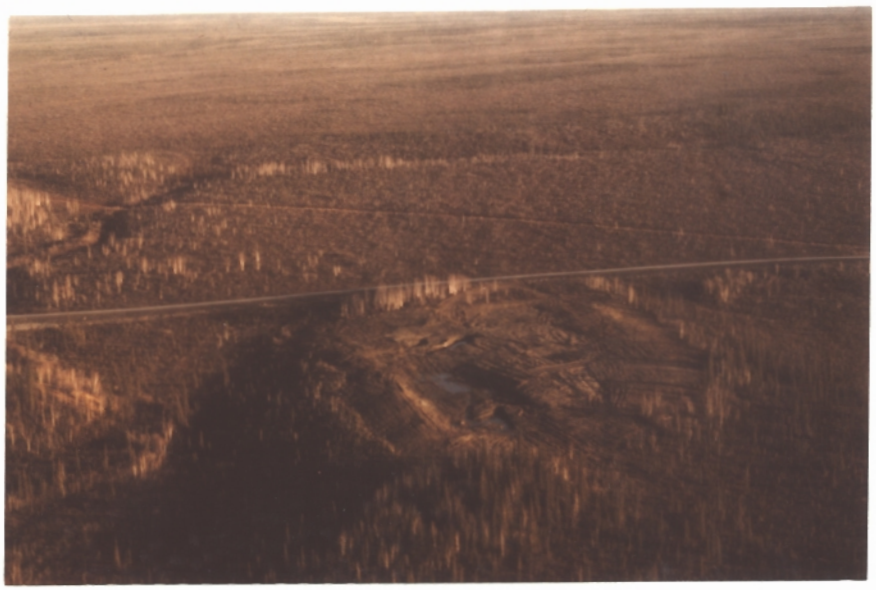
SITE 1153

Mobile Arctic Auger in flight.

SITE 1153

Mobile Arctic Auger drilling with air.



Borrow Source, Inuvik to Arctic Red River Highway C155E151-19

Removing borrow from knolls or knobs causes little visual disturbance. North and east facing slopes are preferred for excavation while south and west exposures should be avoided to conserve wildlife habitat and minimize erosion.

Bedrock Quarry, Inuvik to Arctic Red River Highway C155E151-14

Large Rectangular bedrock quarries create major visual scars and are difficult to reclaim. If the borrow had been removed in an irregular pattern, the pit walls could be reshaped, using the stockpiled overburden, to form more natural land contours.

Borrow Source, Inuvik to Arctic Red River Highway C155E151-19

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SITE 1002 - Confluence Loon and Mackenzie Rivers B87K105-2A

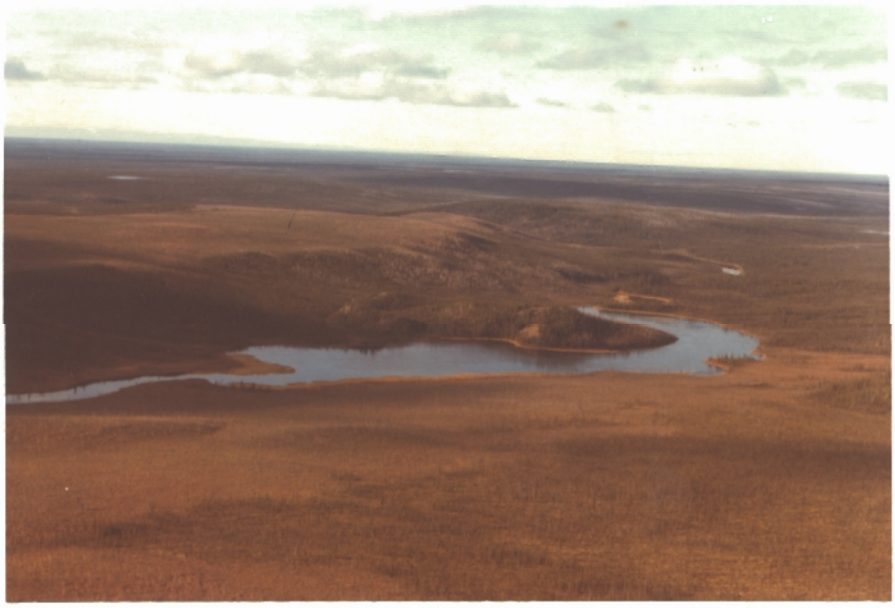
The confluences of the major tributaries with the Mackenzie River provide important habitat for many fish and wildlife species and focal areas for human activities. Material spills and blasting near the river could affect fish populations directly. Slumping banks and channel scouring could degrade land and aquatic habitats and create visual scars. Borrow operations should be located to maintain the integrity of river banks.

Hare Indian River C155E149-25

The Hare Indian River supports a significant domestic fishery for Fort Good Hope residents during the summer and, to a limited degree, during winter months. The riparian zone along the river banks is utilized by willow ptarmigan and moose in winter. Buffer zones should be maintained between borrow areas or access routes and major tributaries to minimize disturbance.

SITE 1124 - Near Sandy Lake B87K102-15

Many lakes within the study region support trapline activities. Fishing potential is limited but catches are important to local trappers. Major fish species are lake trout, pike, humpback whitefish and burbot. Waterfowl use the lakes for spring moulting by non-breeders, staging, and fall migration. Shoreline habitat is important for birds, fish and mammals and, where possible, it should be protected from disturbance and siltation.



SITE 1110 B87K102-28

Introduction of "fines" from gravel washing or crushing processes could have adverse effects on resident lake fish populations. Waste "wash" water should be channeled through settling ponds before release to natural waters. Dry slopes on the exposed knobs overlooking lakes are favoured denning habitat for bear and fox and burrow habitat for ground squirrels.

SITE 1138 B87K101-1-14

Open muskeg areas characterized by dense shrub cover and sparse spruce are lightly used by moose and hare for browse. Open areas with lichens provide caribou winter range. The dense black spruce stand in the background would contain sparse shrub component and receive minor wildlife use.

SITE 1022

The mosaic terrain and drainage patterns create microhabitats favourable to many species of animals and birds. Vegetation types include mixed conifers and deciduous stands with many heights and densities. The marshy lakeshore is an attractive feeding area for moose and muskrat and nesting habitat for ducks.

SITE 1071

Large areas of open muskeg and marsh, common in the northern part of the study area, receive little use by mammals. Rough-legged hawks and marsh hawks favour open habitats for hunting small mammals and birds. Lakes are summer habitat for waterfowl.

SITE 1121

Most creek banks have a dense cover of shrubs, grasses and forbs. This riparian habitat is favoured by most mammals. In winter, moose and hare concentrate in riparian habitat and willow ptarmigan feed on willow buds.

SITE 1027

Well-drained sites support dense stands of white spruce. Carnivores favour such sites in their search for prey. Raptors (falcons) nest on the ledges of scarp faces which overlook water.

SITE 1022

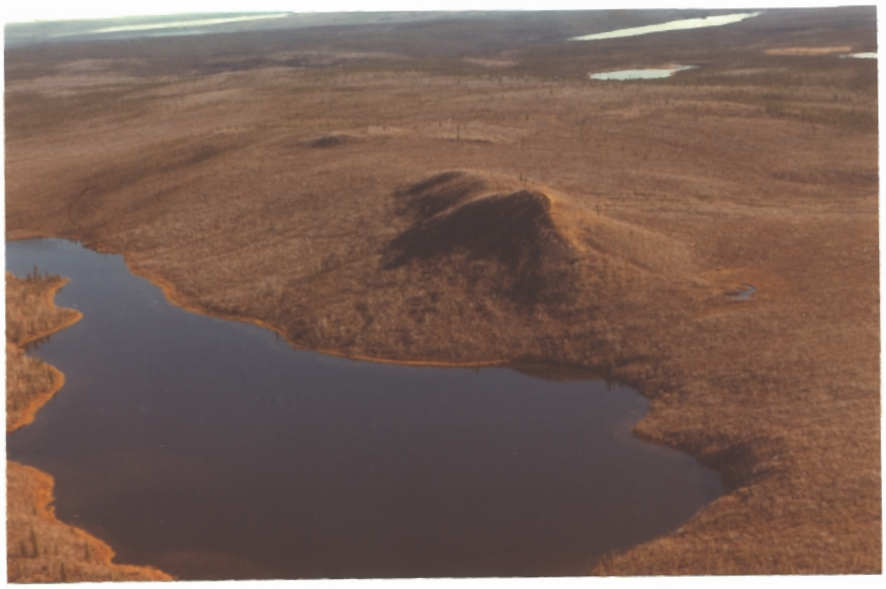
Eskers are characterized by dry slopes covered with lichens and grasses. They are favoured travel routes and habitat for ground squirrels and small mammals, thus raptors frequently hunt the open slopes for prey. Prominent esker ridges have high potential for archaeological discoveries.

SITE 1131 B87K101-8

Birch tends to grow in clumps and has a dense understory of alder while aspen usually grows in uniform dense stands. Deciduous habitats are heavily used by hares and their associated predators. Upland game birds utilize such habitats for nesting and rearing their young.

B87K102-18

This dry grassy slope in a recent burn is pockmarked by fox burrows. Ground squirrel dens may be present also. Borrow operations should avoid known denning areas where possible, by utilizing northern aspects of the source.



SITE 1119

Old burn areas covered with dense shrub growth are used as winter moose range, especially near the edge of spruce stands. Sharp-tailed grouse favour this habitat in the early stages of sucession. The removal of isolated knobs or outcrops for borrow would cause minimal visual disturbance if the sites are reshaped to blend with adjacent landforms.

Site No.	Material Type: Description	Material Type: Sym.	Suitability of Material	Estimated Volume (cu. yd.)	Est'd Recov. Depth (feet)	Overburden: Type	Overburden: Depth (feet)	Overburden: Disposal	Ground Ice (content)	Drainage	Method of Extraction	Min. Haul. Dist. (mi.)	Relative Environmental Sensitivity	Assessment
1001a	Limestone, Bedrock	--	Most Construction Aggregates	N.D.	--	N.D.	N.D.	--	--	Good	Quarry and Blasting	6-7	High - 390	Not Recommended
1002	Sand, trace Silt	SM	Marginal General Fill	8,300,000	+26.5	--	--	--	None	Good	Conventional	3½-4½	Moderate - 280	Recommended
1003	Gravel and Sand, trace Silt	GP-GW	General Fill	>1,900,000	N.D.	Peat and Silt	4	Strip and Stockpile	Low	Good	Conventional	1	Moderate - 320	Excellent Prospect
1004a	Fine sand, some silt	SP-SM	Unsuitable	N/A	--	--	--	--	N.D.	Good	N/A	3	N.D.	Not Recommended
1005a	N.D.	--	N.D.	N.D.	--	--	--	--	--	--	--	0	N.D.	Poor Prospect
1006a	Fine sand, some silt	SW-SM	Unsuitable	N.D.	--	--	--	--	Low	Good	N/A	3-4	Moderate - 255	Not Recommended
1007a	Limestone Bedrock	--	Most Construction Aggregates	N.D.	--	N.D.	N.D.	--	--	Good	Quarry and Blasting	7-8	Low - 215	Not Recommended
1008a	Silty sand, some gravel	GM	General Fill	800,000	8	--	--	--	None	Good	Conventional	12	High - 345	Not Recommended
1009a	Silt and fine sand	ND	Unsuitable	N/A	--	--	--	--	N.D.	Good	N/A	16	High - 370	Not Recommended
1010a	Limestone Bedrock	ND	Most Construction Aggregates	N.D.	--	Silt	4	Strip and Stockpile	--	Good	Quarry and Blasting	21	High - 345	Not Recommended
1011	Sand and Gravel, trace Silt	SP & GP-GW	Most Construction Aggregates	N.D.	8	--	--	--	None	Good	Conventional	26	High - 340	Poor Prospect
1012	Sand and Gravel, some Silt	GP GM	General Fill	N.D.	25	Silt	7-14	Strip and Stockpile	Low	Good	Conventional	22	N.D.	Poor Prospect
1013	Sandy gravel, trace Silt	GW SM	General Fill	N.D.	+14	Peat	1	--	None	Good	Conventional	14½	High - 325	Poor Prospect
1014a	Silt	--	Unsuitable	N/A	--	--	--	--	--	Good	--	16	N.D.	Not Recommended
1015a	Limestone Bedrock	--	Most Construction Aggregates	N.D.	--	N.D.	--	Strip and Stockpile		Good	Quarry and Blasting	11	Moderate - 300	Not Recommended
1016	Sand and Gravel	GW-GP	General Fill	N.D.	20	--	--	--	None	Good	Conventional	9	Low - 235	Not Recommended
1017a	Sand and silt, trace Gravel	SM	Unsuitable	N/A	--	--	--	--	--	Good	--	6	High - 370	Not Recommended
1018	Limestone Bedrock	--	Most Construction Aggregates	N.D.	--	Clay	N.D.	--	N.D.	Good	Quarry and Blasting	3	Low - 175	Recommended
1019a	Sand	--	Marginal General Fill	N.D.	--	--	--	--	--	Good	Conventional	3	N.D.	Not Recommended
1020	Gravel with fine to Coarse Sand	GW	General Fill	800,000	21	Clayey Silt and Fine Sand	12	--	High	Good	--	4½	Low - 225	Fair Prospect
1021	Gravel and Sand	GW SP-SW	General Fill	8,500,000	20+	Sand and Silt	5	Strip and Stockpile	Low	Good	Conventional	5	Low - 225	Excellent Prospect
1022	Gravel and Gravelly Sand	GW-GP SM	General Fill	4,500,000	15+	--	--	--	None	Good	Conventional	2½	Low - 235	Excellent Prospect
1023	Limestone Bedrock	--	Most Construction Aggregates	Unlimited	--	N.D.	N.D.	--	--	Good	Quarry and Blasting	1	Moderate - 300	Excellent Prospect
1024a	Limestone Bedrock	--	Most Construction Aggregates	N.D.	--	Silt	20	Strip and Stockpile	N.D.	Good	Quarry and Blasting	5	High - 380	Not Recommended
1025	Gravelly Silt	ND	Marginal General Fill	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	Good	Conventional	1	N.D.	Fair to Good Prospect
1026a	Limestone Bedrock	--	Most Construction Aggregates	N.D.	N.D.	N.D.	N.D.	--	N.D.	Good	Quarry and Blasting	4-5	High - 365	Not Recommended
1027	Silty sand and Limestone	--	Most Construction Aggregates	Unlimited	N.D.	N.D.	N.D.	--	N.D.	Good	Quarry and Blasting	1-2	High - 385	Fair to Good Prospect
1028	Shale Bedrock	--	General Fill	N.D.	N.D.	Clay Till	12	Strip and Stockpile	N.D.	Fair	Quarry and Blasting	1	Low - 185	Fair to Good Prospect
1029a	Silty sand	--	General Fill	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	Good	Conventional	4½-6	Moderate - 275	Not Recommended
1030a	Limestone	--	Most Construction Requirements	N.D.	N.D.	Peat/Clay	5-10	--	N.D.	Good	Quarry and Blasting	13	Moderate - 265	Not Recommended
1031a	Limestone	--	Most Construction Requirements	N.D.	N.D.	--	--	--	--	Good	Quarry and Blasting	16	Moderate - 310	Not Recommended
1032	Sand and Gravel	GP	General Fill	350,000	N.D.	--	--	--	None	Good	Conventional	9½	Low - 240	Not Recommended
1033	Limestone, Sand and Gravel	--	General Fill	N.D.	N.D.	N.D.	10+	--	N.D.	Good	Conventional to Blasting	2	Moderate - 320	Good Source
1034a	Glacial till	--	Unsuitable	--	--	--	--	--	N.D.	--	--		Moderate - 295	Not Recommended
1035	Gravel, some Sand	GW-GM	General Aggregate	11,000,000	20+	N.D.	--	Strip and Stockpile	None	Fair to Good	Conventional	2	Moderate - 260	Excellent Source
1036	Gravel and Sand	GW	Construction Aggregate	2,200,000	N.D.	N.D.	1-2	N.D.	N.D.	Fair	Conventional	½	Low - 195	Good Deposit
1037a	Clay, silt	--	Unsuitable	--	--	N.D.	N.D.	N.D.	N.D.	Good	Conventional	2	N.D.	Not Recommended
1038	Sandy Gravel	--	General Fill	3,500,000	N.D.	N.D.	N.D.	N.D.	N.D.	Good	Conventional	8	Low - 205	Fair Prospect
1039a	Sandy Silt	SM-ML	Poor	--	N.D.	None	--	--	Low	Good to Fair	Conventional	21	Moderate - 295	Not Recommended
1040a	Limestone	--	General Aggregate	--	--	--	Thick	N.D.	N.D.	Good	--	21	High - 365	Not Recommended
1041a	Gravel, Sand	GP-GM	General Aggregate	3,500,000	N.D.	None	--	--	High	Fair to Poor	Stock Piling Required	19	Moderate - 260	Not Recommended
1042a	Clayey Silt	--	Unsuitable	--	--	--	--	--	--	--	--	20	N.D.	Not Recommended
1043a	N.D.	ND	N.D.	--	--	N.D.	--	--	N.D.	Good	N.D.	14	Low - 235	Not Recommended
1044	Sandy Gravel	GM	General Construction Use	1,000,000	--	Silt	1.0	--	N.D.	Fair	Conventional	13	Moderate - 275	Not Recommended
1045	Gravel and Sand	GW-GM	General Aggregate	5,650,000	14	Peat/Silt	< 1	Strip and Stockpile	14' to Permafrost	Good	Conventional	7	Low - 175	Fair Prospect
1046	Gravelly Sand and Silt	GM	General Fill	1,000,000	N.D.	Organic Soil	< 1	Strip and Stockpile	7' to Permafrost	Good	Conventional	7	Low - 190	Fair Prospect
1047	Sand and Gravel	SM	Construction Aggregate	42,000,000	15	Silt	1	Strip and Stockpile	15' to Permafrost	Excellent	Conventional	0-1	Low - 215	Excellent Prospect
1048	Sand and Gravel	SM	General Fill	N.D.	14	N.D.	--	--	14' to Permafrost	Good	Conventional	3	N.D.	Fair Prospect
1049	Gravelly Sand	SM	General Fill	175,000	N.D.	None	--	--	Not frozen	Fair	Conventional	½-1	Low - 190	Fair Prospect
1050	Gravel and Sand	GM	General Fill	1,500,000	N.D.	Silt	1-5	Strip and Stockpile	--	Good	Conventional	2-3	Low - 200	Fair Prospect
1051a	Silt	--	Unsuitable	--	--	--	--	--	--	--	--	8	N.D.	Not Recommended
1052	Sand and Gravel	GP-GM	Construction Aggregates	120,000	--	Negligible	--	--	Unfrozen	Good	Conventional	3	Low - 230	Good Prospect
1053a	Silt and Clay	SC	Unsuitable	--	--	Peat	--	--	--	--	--	10	N.D.	Not Recommended
1056	Shale	--	General Fill	--	--	Peat	½-7	Strip and Stockpile	Low to Moderate	Good	Striping and Blasting	1	Moderate - 295	Fair to Poor Prospect
1057	Sand and Gravel	GC	Construction Aggregate	10,500,000	24	--	Thin	Strip	Unfrozen	Good	Conventional	1½	Low - 210	Excellent Prospect
1058	Shale	--	General Fill	--	--	Clay	4-6	Strip and Stockpile	Unfrozen	Good	Blast and Quarry	4	Low - 190	Fair Prospect
1059a	Clay	CL	Unsuitable	--	--	--	--	--	--	--	--	8½	N.D.	Not Recommended
1060	Sand and Gravel	GM	Construction Aggregate and Fill	80,000,000	--	Peat	Thin	Strip and Stockpile	Irregular	Good	Conventional	7	Low - 245	Good Prospect

Notes:

- N.D. — Not determined.
- N/A — Not applicable.
- SITE NUMBER: — The site number, followed by an "a", codes sites which are not recommended for development.
- METHOD OF EXCAVATION: — "Conventional" indicates use of such standard equipment as dozers, overhead loaders, backhoes, light rippers and trucks.
- MINIMUM HAULAGE DISTANCE: — The minimum haulage distance is an air mileage from proposed pipeline and highway routes to the site.
- RELATIVE ENVIRONMENTAL SENSITIVITY: — The relative environmental sensitivity is based on an environmental sensitivity index as established by F.F. Slaney and Co. Ltd.
- ASSESSMENT: — Refer to site descriptions section.

Site No.	Material Type		Suitability of Material	Estimated Volume (cu. yd.)	Est'd Recov. Depth (feet)	Overburden			Ground Ice (content)	Drainage	Method of Extraction	Min. Haul. Dist. (mi.)	Relative Environmental Sensitivity	Assessment
	Description	Sym.				Type	Depth (feet)	Disposal						
1054	Gravelly, sand and silt	GP-GM	General Fill to Aggregate	2,000,000	--	Peat	1	Strip and Stockpile	Irregular	Good	Conventional and Stock-pile	9	Low - 225	Good Prospect
1055	Gravel and Sand	GP-GM	General Fill	525,000	--	--	Thin	Strip	--	Good	Conventional	9	Low - 205	Fair to Good Prospect
1061	Sand and Gravel	GW-GM	Construction Aggregate	Great	--	--	Thin	Strip	Unfrozen	Variable	Conventional	10	Moderate - 295	Good Prospect
1062	Sand and Gravel	GM	General Fill	Great	--	--	Thin	Strip	Unfrozen	Variable	Conventional	7-12	Moderate - 285	Good Prospect
1063a	Sand	SM	Poor	4,500,000	--	--	Thin	--	Frozen	Good	Conventional	9-5	High - 365	Not Recommended
1064a	Silt	--	Unsuitable	--	--	--	--	--	--	--	--	9	N.D.	Not Recommended
1065	Sand and Gravel	--	General Fill	6,000,000	--	--	Thin	--	Unfrozen	Good	Conventional	12	Moderate - 250	Fair Prospect
1066a	Silt	--	Unsuitable	--	--	--	--	--	--	--	--	11-16	N.D.	Not Recommended
1067a	Silt	--	Unsuitable	--	--	--	--	--	--	--	--	20	N.D.	Not Recommended
1068a	Silt	--	Unsuitable	--	--	--	--	--	--	--	--	18	N.D.	Not Recommended
1069a	Silt and Sand	--	Unsuitable	--	--	--	--	--	--	--	--	13	N.D.	Not Recommended
1070	Gravel and Sand	SC	General Fill	N.D.	N.D.	Clay and Peat	½-1½	Strip and Stockpile	Irregular	Fair	Conventional	9	N.D.	Poor to Fair Prospect
1071a	Silt	--	Unsuitable	--	--	--	--	--	--	--	--	13½	N.D.	Not Recommended
1072a	Silt	--	Unsuitable	--	--	--	--	--	--	--	--	6-7	N.D.	Not Recommended
1073	Silty sand some Gravel	SM	General Fill	4,500,000	10½	Negligible	--	--	Frozen under 10½	Good	Conventional	7-8	Low - 200	Fair Prospect
1074	Sandy silt	--	Unsuitable	N.D.	--	Negligible	--	--	--	Good	Conventional	2-3	N.D.	Poor Prospect
1075a	Silt	--	Unsuitable	--	--	--	--	--	--	--	--	4-5	N.D.	Not Recommended
1076	Sand and Gravel	--	Some Aggregate to General Fill	2,500,000	--	Peat	1½	Strip and Stockpile	Frozen	Good	Conventional	1	Moderate - 270	Good Prospect
1077a	Shale	--	Poor	--	--	Clay	28	--	Frozen	Good	--	4-6	N.D.	Not Recommended
1078	Shale	--	General Fill	N.D.	N.D.	N.D.	Thick	Strip and Stockpile	N.D.	Good	Blast and Quarry	1	Moderate - 255	Fair Prospect
1079	Shale	--	General Fill	N.D.	N.D.	Clay	14	Strip and Stockpile	Not Frozen	Good	Blast and Quarry	2	N.D.	Fair Prospect
1080	Shale	--	General Fill	N.D.	N.D.	Clay and Shale	14	Strip and Stockpile	N.D.	Good	Blast and Quarry	½	Low - 225	Good Prospect
1081	Shale	--	General Fill	N.D.	N.D.	Clay and Shale	11	Strip and Stockpile	N.D.	Good	Blast and Quarry	0	Low - 220	Fair to Good
1082	Sand and Gravel	GW	General Fill	2,200,000	12	Negligible	--	--	Irregular to very High	Fair	Conventional with Stock-piling	½	Moderate - 260	Poor Prospect
1083a	Sandy Silt	SM-ML	Unsuitable	N.D.	N.D.	Negligible	--	--	Unfrozen	Fair to Good	--	2-3½	N.D.	Not Recommended
1084	Sand and Gravel	SM	General Fill	2,000,000	7	Topsoil	Thin	Strip and Stockpile	Frozen	Poor to Fair	Rip and Doze	1½-4½	High - 335	Poor Prospect
1085	Sand, Gravelly	GW-GM	General Fill	1,200,000	5	Peat and Silt	1	Strip and Stockpile	Unfrozen	Good	Conventional	1½-3	High - 385	Poor to Fair Prospect
1086	Sand	SP-SM	General Fill	1,300,000	12-15	Negligible	--	--	Frozen at 8 feet	Good	Conventional & Stockpile	0-1½	N.D.	Fair Prospect
1087	Silt, sand and Gravel	GM	General Fill	1,800,000	N.D.	Negligible	Thin	--	Frozen at 8 feet	Good	Conventional & Stockpile	4	Low - 190	Good to Fair Prospect
1088	Sand	SM	General Fill	13,800,000	8	Negligible	Thin	--	Frozen at 8½ feet	Good	Conventional & Stockpile	10	Moderate - 255	Fair Prospect
1089	Sand	SP-SM	General Fill	7,500,000	7	Negligible	Thin	--	Frozen at 7½ feet	Good	Conventional & Stockpile	0	High - 335	Fair to Poor Prospect
1090	Shale	--	General Fill	N.D.	N.D.	Clay and Shale	7-15	Strip and Stockpile	Frozen	Fair	Blast and Quarry	1½-6	Moderate - 275	Good to Fair Prospect
1091	Shale	--	General Fill	N.D.	N.D.	Clay and Shale	7-15	Strip and Stockpile	N.D.	Fair to Good	Blast and Quarry	0	Low - 205	Good to Fair Prospect
1092	Shale	--	General Fill	N.D.	N.D.	Clay and Shale	7-15	Strip and Stockpile	Frozen	Good	Blast and Quarry	3	Low - 195	Fair to Poor Prospect
1093	Shale	--	General Fill	N.D.	N.D.	Weathered Shale	4	Strip and Stockpile	N.D.	Fair to Good	Blast and Quarry	½	Low - 225	Good to Fair Prospect
1094	Shale	--	Subgrade Construction	N.D.	N.D.	Clay and Shale	15	Strip and Stockpile	N.D.	Fair	Blast and Quarry	4	Low - 210	Fair to Poor Prospect
1095	Sand	GW-SM	General Fill	N.D.	N.D.	Clay	4	Strip and Stockpile	Unfrozen to 11 ft.	Good	Conventional & Stockpile	3½	Moderate - 265	Fair Prospect
1096	Gravel and Sand	GW-GM	General Fill	1,250,000	N.D.	Peat	0-3	Stockpiled	Unfrozen to 11 ft.	Fair	Conventional	5	Moderate - 260	Fair Prospect
1097a	Clay and Sand	SC	Unsuitable	N.D.	N.D.	N.D.	--	--	N.D.	N.D.	--	6	N.D.	Not Recommended

Site No.	Material Type		Suitability of Material	Estimated Volume (cu. yd.)	Est'd Recov. Depth (feet)	Overburden			Ground Ice (content)	Drainage	Method of Extraction	Min. Haul. Dist. (mi.)	Relative Environmental Sensitivity	Assessment
	Description	Sym.				Type	Depth (feet)	Disposal						
1058	Sandy Gravel	GW-GM	Concrete Aggregate	13,000,000	N.D.	Negligible	--	--	Unfrozen	Good	Conventional	7	Moderate - 255	Excellent Prospect
1059	Siltstone	--	General Fill	N.D.	N.D.	Silt	5	Strip and Stockpile	Frozen	Good	Blast and Quarry	10	N.D.	Fair to Good Prospect
1060	Shale	--	General Fill	Very Great	N.D.	Clay and Shale	9	Strip and Stockpile	N.D.	Good	Blast and Quarry	5	Moderate - 290	Good Prospect
1101	Sandy Gravel	GM	General Fill & Aggregate	1,700,000	N.D.	Negligible	Thin	--	N.D.	Good	Conventional	6	Moderate - 270	Good Prospect
1102	Gravel and Sand	GM-SM	General Fill	650,000	N.D.	Topsoil and Till	1-4	Strip and Stockpile	Frozen at 5' - 10'	Good	Conventional	5	Moderate - 280	Fair to Good Prospect
1103a	Shale	--	General Fill	N.D.	N.D.	Clay and Weathered Shale	25	--	Frozen	Fair	--	0	Low - 245	Not Recommended
1104	Sand and Gravel	GM-SM	General Fill Some Aggregate	14,300,000	N.D.	Peat and Clay	0-4	Strip and Stockpile	Frozen	Good	Blasting or Ripping	3	Moderate - 315	Good Prospect
1105	Gravel and Sand	GP-GM	General Fill Some Aggregate	286,000	N.D.	Negligible	Thin	--	Unfrozen	Good	Conventional	6	High - 350	Poor Site
1106a	Silt	--	Unsuitable	--	--	N.D.	--	--	Frozen	Good	--	--	N.D.	Not Recommended
1107	Gravel	GM	General Fill	1,000,000	N.D.	Topsoil	Thin	Strip and Stockpile	N.D.	Good	Conventional	6	Moderate - 310	Fair to Good Prospect
1108a	Gravel and Clay	--	Unsuitable	N.D.	N.D.	N.D.	--	--	N.D.	Good	--	1½	Moderate - 315	Not Recommended
1109a	Silt	--	Unsuitable	N.D.	N.D.	N.D.	--	--	N.D.	--	--	5	N.D.	Not Recommended
1110a	Sand and Silt	--	Unsuitable	N.D.	--	N.D.	--	--	Frozen	Good	--	4	Moderate - 260	Not Recommended
1111a	Silt	--	Unsuitable	N.D.	--	N.D.	--	--	N.D.	Fair	--	2	N.D.	Not Recommended
1112a	Shale	--	Unsuitable	N.D.	--	Peat and Till	20	--	N.D.	Fair	--	1½	Low - 180	Not Recommended
1113a	Shale	--	Unsuitable	N.D.	--	Till and wet shale	25	--	High	--	--	0	Low - 210	Not Recommended
1114a	Shale and Siltstone	--	Unsuitable	N.D.	--	Till and wet shale	--	--	N.D.	--	--	½	Low - 235	Not Recommended
1115	Sand and Sandstone	--	General Fill	N.D.	N.D.	Clayey Sand	6	Strip and Stockpile	Not Frozen	Poor	Conventional & Quarry	4½	Low - 205	Fair to Good Prospect
1116a	Gravelly Sand	GW-SM	General Fill	65,000	--	Peat	Thin	Strip and Stockpile	Not Frozen	Good	--	12	High - 350	Not Recommended
1117	Shale	--	General Fill	N.D.	N.D.	Silt till	4-10	Strip and Stockpile	N.D.	Fair	Blast and Quarry	0	Low - 195	Good Prospect
1118	Shale	--	General Fill	N.D.	N.D.	Topsoil and Till	8-14	Strip and Stockpile	Frozen	Fair	Blast and Quarry	2½	Low - 180	Fair to Good Prospect
1119a	Clay	--	Unsuitable	N.D.	N.D.	N.D.	--	--	N.D.	Good	--	8	N.D.	Not Recommended
1120	Sand and Gravel	GM	Aggregate and Fill	1,500,000	N.D.	Peat, silt and clay	2	Strip and Stockpile	Frozen at 7'	Good	Conventional	8½	High - 340	Good Prospect
1121	Sand and Gravel	GM	Aggregate and Fill	26,500,000	N.D.	Negligible	--	--	Unfrozen to 16'	Good	Conventional	14	High - 340	Good Prospect
1122a	Silt	--	Unsuitable	N.D.	N.D.	N.D.	--	--	Frozen	Fair	--	--	Moderate - 305	Not Recommended
1123	Gravel	GM	Aggregated General Fill	2,200,000	12	Negligible	--	--	Frozen at 9 - 12'	Good	Conventional	13	High - 350	Good Prospect
1124a	Sand and Gravel	GW-SM	General Fill	10,600,000	N.D.	Peat and Silt	3	Strip and Stockpile	Frozen	Poor	Conventional & Stockpile	13	High - 355	Not Recommended
1125	Gravel and Sand	GM	General Fill	N.D.	N.D.	Topsoil	Thin	--	N.D.	Good	Conventional	13	High - 350	Fair Prospect
1126a	Sand and Gravel	GW-GM	General Fill	Small	N.D.	Negligible	Thin	Strip and Stockpile	N.D.	Good	Conventional	13	High - 325	Not Recommended
1127	Sand and Gravel	GM	General Fill	5,700,000	N.D.	Negligible	--	--	Unfrozen to 21'	Good	Conventional	18	High - 365	Fair to Good Prospect
1128	Shale	--	General Fill	Great	N.D.	Clayey Silt	12	Strip and Stockpile	Frozen	Good	Blast and Quarry	20	Moderate - 285	Fair Prospect
1129a	Clay	CL	Unsuitable	N.D.	--	N.D.	--	--	Frozen	Fair	--	15	N.D.	Not Recommended
1130a	Clay	CL	Unsuitable	N.D.	--	N.D.	--	--	--	--	--	18	N.D.	Not Recommended
1131a	Clay (till)	--	Unsuitable	10,000,000	N.D.	N.D.	--	--	Frozen 20K	Good	--	15	High - 380	Not Recommended
1132a	Clayey Sand	SC	Unsuitable	N.D.	N.D.	N.D.	--	--	--	Good	--	14	N.D.	Not Recommended
1133	Sand and Gravel	SW-SM	General Fill	675,000	N.D.	Silt and Peat	Thin	Strip and Stockpile	N.D.	Good	Conventional	8½	Low - 210	Fair Prospect
1134a	Clay	--	Unsuitable	--	--	--	--	--	--	Good	--	7	N.D.	Not Recommended
1135	Sand and Gravel	GM	Concrete Aggregate	15,125,000	6-10	Negligible	Thin	--	Frozen at 8½'	Fair	Conventional	9½	Low - 230	Fair to Good Prospect
1136	Sand and Gravel	SM	General Fill	12,000,000	N.D.	Peat and Silt	Thin	--	Frozen	Poor	Conventional & Stockpile	12	Moderate - 270	Fair to Poor Prospect
1137	Gravel and Sand	SM	General Fill	N.D.	N.D.	Negligible	Thin	--	Unfrozen	Good	Conventional	21	Low - 225	Fair Prospect

Site No.	Material Type		Suitability of Material	Estimated Volume (cu. yd.)	Est'd Recov. Depth (feet)	Overburden			Ground Ice (content)	Drainage	Method of Extraction	Min. Haul. Dist. (mi.)	Relative Environmental Sensitivity	Assessment
	Description	Sym.				Type	Depth (feet)	Disposal						
1138	Sand and Gravel	GW-GM	Aggregate and General Fill	35,000,000	--	Peat, Silt	0-2	Strip and Stockpile	Frozen at 8½'	Good	Conventional & Stockpile	22	High - 355	Fair to Good Prospect
1139a	Shale	--	General Fill	N.D.	N.D.	N.D.	Deep	--	N.D.	Good	--	21	N.D.	Not Recommended
1140a	Clay	ND	Unsuitable	N.D.	N.D.	N.D.	--	--	N.D.	Fair	--	24	Low - 230	Not Recommended
1141	Sand and Gravel	GW-GM	General Fill	N.D.	N.D.	N.D.	Thin	--	N.D.	Poor	Conventional	24	Moderate - 260	Fair Prospect
1142a	Silt and Sand	--	Unsuitable	N.D.	N.D.	--	--	--	N.D.	--	--	25	Moderate - 295	Not Recommended
1143a	Sand and Gravel	GP-GM	General Fill	Small	N.D.	Negligible	Thin	--	N.D.	Good	Conventional	20	N.D.	Not Recommended
1144	Sand and Gravel	GM	General Fill	N.D.	N.D.	Clay	2	Strip and Stockpile	N.D.	Poor	Conventional & Stockpile	19	Moderate - 310	Fair Prospect
1145a	Sand and Gravel	--	Unsuitable	N.D.	N.D.	Peat and Silt	2	--	N.D.	N.D.	--	24	N.D.	Not Recommended
1146	Sand and Gravel	SM	General Fill	13,500,000	18	Negligible	Thin	--	Frozen	Good	Blasting or Rip	26	Moderate - 270	Fair Prospect
1147	Gravel and Sand	GP-SM	General Fill	16,000,000	--	Peat and Silt	2	Strip and Stockpile	Frozen at 6'	Good	Blast Stockpile	29	Low - 210	Fair Prospect
1148	Gravel and Sand	GP-GM	General Fill	N.D.	N.D.	Topsoil	Thin	--	N.D.	Fair	Conventional	29	Moderate - 265	Fair to Good Prospect
1149a	Clay	--	Unsuitable	N.D.	N.D.	--	--	--	N.D.	N.D.	--	32	N.D.	Not Recommended
1150a	Sand	SP-SM	General Fill	N.D.	N.D.	--	Thin	--	Frozen at 6'	Good	Conventional	25	Low - 205	Not Recommended
1151a	Shale	--	General Fill	N.D.	N.D.	Silt	19	--	Frozen	Poor	--	22	Moderate - 280	Not Recommended
1152a	Sand and Gravel	GP-GM	General Fill	4,200,000	N.D.	Peat and Silt	10	--	Frozen	Fair	--	18	High - 325	Not Recommended
1153a	Sand	GM	General Fill	N.D.	N.D.	Irregular	--	--	N.D.	Poor	--	18	Moderate - 315	Not Recommended
1154a	Sand and Gravel	GC	Unsuitable	N.D.	N.D.	--	--	--	Frozen	Poor	--	15	Moderate - 315	Not Recommended
1155	Shale and Siltstone	--	General Fill	N.D.	N.D.	Silt	8½	Strip and Stockpile	Frozen	Fair	Blast and Quarry	9	Moderate - 280	Fair to Poor Prospect
1156a	Silt	--	Unsuitable	N.D.	N.D.	--	--	--	N.D.	--	--	5	Moderate - 250	Not Recommended

Notes:

- N.D. — Not determined.
- N/A — Not applicable.
- SITE NUMBER: — The site number, followed by an "a", codes sites which are not recommended for development.
- METHOD OF EXCAVATION: — "Conventional" indicates use of such standard equipment as dozers, overhead loaders, backhoes, light rippers and trucks.
- MINIMUM HAULAGE DISTANCE: — The minimum haulage distance is an air mileage from proposed pipeline and highway routes to the site.
- RELATIVE ENVIRONMENTAL SENSITIVITY: — The relative environmental sensitivity is based on an environmental sensitivity index as established by F.F. Slaney and Co. Ltd.
- ASSESSMENT: — Refer to site descriptions section.

NORTH HALF

LEGEND

- GOOD BEAVER HABITAT
- GOOD MUSKRAT HABITAT
- GOOD MOOSE WINTER HABITAT
- CARIBOU WINTER CONCENTRATION
- GRIZZLY BEAR RANGE
- WATERFOWL – SPRING STAGING AND MOULTING AREAS
- PEREGRINE FALCON - NESTING
- PROPOSED MACKENZIE HIGHWAY
- PROPOSED PIPELINE ROUTE
- SITE LIMITS

Scale 1:250,000

MILES 5 0 5 MILES

KILOMETERS 5 0 5 KILOMETERS

WILDLIFE ABUNDANCE AREAS

EBA Engineering Consultants Ltd.

Project No: B87 | Date: February 1974

F.F. SLANEY AND COMPANY LIMITED
Vancouver - Canada

SOUTH HALF

LEGEND

- GOOD BEAVER HABITAT
- GOOD MUSKRAT HABITAT
- GOOD MOOSE WINTER HABITAT
- CARIBOU WINTER CONCENTRATION
- GRIZZLY BEAR RANGE
- WATERFOWL – SPRING STAGING AND MOULTING AREAS
- PEREGRINE FALCON - NESTING
- PROPOSED MACKENZIE HIGHWAY
- PROPOSED PIPELINE ROUTE
- SITE LIMITS

Scale 1:250,000

MILES 5 0 5 MILES

KILOMETERS 5 0 5 KILOMETERS

WILDLIFE ABUNDANCE AREAS

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Vancouver - Canada

NORTH HALF

Inuvik Native
Occasionally trapped for martin, lynx and fox
Some winter moose hunting.

Yearly trapping for marten, lynx and mink by Artic Red River Natives.

Permanent family camp at trading post
Trapping for mink, beaver, lynx and marten (Artic Red River) Local lakes hunted for muskrat and beaver in spring.

Big Lake area hunted for muskrat and beaver, April – June 15 by Artic Red River Natives.

BIRDS

Waterfowl and upland game birds are utilized by residents and native people of the area, particulary those residing at Fort Good Hope and Little Chicago. Hunting of waterfowl is subject the Migratory Bird Regulations which are set out yearly. Upland game species are hunted from September to April. Willow Ptarmigan is the most common upland species hunted in the area. Hunting for game birds is limited, usually associated with trapline activites. Overall utilization of birds in the area is unknown but probably light.

Trapped for beaver, mink, lynx, fox, muskrat and marten by Artic Red River Natives. One or two permanent traplines – best around Clearwater and Beaver Lakes

Marten, lynx, mink and beaver from permanent camp at Tree River (West side Mackenzie River) Rabbit Hay River to Rat Lake – hunted for muskrat and beaver in spring. Artic Red River Natives.

LEGEND

- PROPOSED MACKENZIE HIGHWAY
- PROPOSED PIPELINE ROUTE
- SITE LIMITS
- HUMAN UTILIZATION
- WATERSHED BOUNDARY
- A ARCHAEOLOGICAL SITE
- H HISTORIC SITE (Trading Post)

Scale 1:250,000

MILES 5 0 5 MILES

KILOMETES 5 0 5 KILOMETERS

AREAS OF NATIVE UTILIZATION OF WILDLIFE RESOURCES

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Vancouver - Canada

SOUTH HALF

Caribou hunting area in December specifically North East of Carcajou Lake by Artic Red River and Fort Good Hope Natives.

Fort Good Hope trappers take many marten and some beaver, muskrat and mink, November to December.

Day lines for marten and beaver from Little Chicago. (Fort Good Hope Natives)

Marten are trapped in Bluefish River in November, beaver, muskrat and mink are taken November-December. Beaver, muskrat hunting in spring near Fort Good Hope.

BIRDS

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LEGEND

- PROPOSED MACKENZIE HIGHWAY
- PROPOSED PIPELINE ROUTE
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Scale 1:250,000

MILES 5 0 5 MILES

KILOMETES 5 0 5 KILOMETERS

AREAS OF NATIVE UTILIZATION OF WILDLIFE RESOURCES

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Vancouver - Canada

SOUTH HALF

LEGEND

PROPOSED MACKENZIE HIGHWAY

PROPOSED PIPELINE ROUTE

SITE LIMITS

Scale 1:250,000

MILES 5 0 5 MILES

KILOMETERS 5 0 5 KILOMETERS

GRANULAR MATERIALS INVENTORY
STAGE III
SITE LOCATIONS
FORT GOOD HOPE TO ARCTIC RED RIVER NWT.

DRAWN : A.L.B.	DATE : MARCH 1974
CHECKED : E.M.F.	JOB NO.: E666
APPROVED : D.W.H.	SCALE : AS SHOWN

EBA Engineering Consultants Ltd.

NORTH HALF

LEGEND

PROPOSED MACKENZIE HIGHWAY
PROPOSED PIPELINE ROUTE
SITE LIMITS

Scale 1:250,000

MILES 5 0 5 MILES

KILOMETERS 5 0 5 KILOMETERS

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STAGE III
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