

DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

SUMMARY

FORT SIMPSON TO FORT GOOD HOPE, N.W.T.



PEMCAN SERVICES '72[®]



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FORT SIMPSON TO FORT GOOD HOPE, N.W.T.

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PREFACE

The Government of Canada anticipated the potential need for extensive volumes of granular material for proposed major construction projects in the area of the Mackenzie River Valley and initiated an investigation of granular materials in this region during 1972 and 1973.

In September, 1972 The Department of Indian Affairs and Northern Development engaged PEMCAN Services "72" to conduct Stage 1 of the Territorial Granular Materials Inventory. Stage 1 is defined as the area from Fort Simpson to Fort Good Hope, N.W.T.

The objectives of this investigation were specified as:

Part 1: An investigation of the availability of granular material deposits within a ten mile radius of the communities of Fort Simpson, Wrigley, Fort Norman, Norman Wells and Fort Good Hope.

Part 2: An investigation of the availability of granular material deposits in the intermediate areas between the respective communities.

The Terms of Reference specified the following definitions and procedures:

1. "Granular Material" is defined as all naturally occurring unconsolidated material, and bedrock which can be processed for suitable engineering construction.
2. Compilation and evaluation of the Geological Survey of Canada's surficial geology and granular material maps and all other relevant information prior to the undertaking of the field investigation.
3. Location, testing and classification of all granular and potential bedrock



quarry materials within the specified search area and recommendations for their best use.

The data compiled for each site will include:

- a) The quantity and quality of usable material available, and recommendations as to its suitability as a construction material. Recommendations shall be substantiated by including results of tests on applicable material samples; these tests include:

Grain size distribution

Petrographic analysis

Moisture content

Ice content

Organic content

Hardness test

(In addition to the above tests, PEMCAN Services "72" recommended the use of Los Angeles Abrasion tests on samples from potentially high priority granular material and bedrock quarry sites).

- b) The location of borrow pits, and recommendations for development.
- c) Recommendations on the most efficient sequence of development where several pits can be developed in the same general area.
- d) Evaluate the best access routes from prospective sites to the center of each community or to existing or proposed utilities.
- e) Recommendations for development, exploitation, disposal of overburden and waste, and restoration of proposed borrow pits in such a manner to minimize terrain disturbance.



4. Development of a method of mapping, rating and reporting the deposits within the Study Area.
5. Identification on the plan of granular deposits exposed in, or along banks of streams and rivers adjacent to the communities but exclusion of such deposits in the material availability for the community unless no other sources of granular materials are available.
6. If satisfactory granular materials are not available within the designated Study Area around the communities, then recommendations pertaining to either alternate sources outside of these areas, or bedrock quarry development will be required.

Parts 1 and 2 of the investigation for the granular materials have been carried out by PEMCAN Services "72" in accordance with the Terms of Reference as specified by The Department of Indian Affairs and Northern Development. The results of the investigation pertaining to Part 1 are submitted in five separate reports which cover the respective communities within the Study Area. Part 2 of the investigation includes four separate intercommunity area reports and a summary.

Twelve copies of each community report were presented as an Interim Report to The Department of Indian Affairs and Northern Development in January, 1973.

Excluding the above mentioned reports, the final report pertaining to the Granular Materials Inventory, Part 1 and Part 2 is presented in the following manner:

Part 1

FORT SIMPSON, N.W.T.

COMMUNITY STUDY AREA

WRIGLEY, N.W.T.

COMMUNITY STUDY AREA

FORT NORMAN, N.W.T.

COMMUNITY STUDY AREA

NORMAN WELLS, N.W.T.

COMMUNITY STUDY AREA

FORT GOOD HOPE, N.W.T.

COMMUNITY STUDY AREA



Part 2

INTERCOMMUNITY STUDY AREA	FORT SIMPSON TO WRIGLEY, N.W.T.
INTERCOMMUNITY STUDY AREA	WRIGLEY TO FORT NORMAN, N.W.T. Book I - Wrigley to Blackwater River Book II - Blackwater River to Fort Norman
INTERCOMMUNITY STUDY AREA	FORT NORMAN TO NORMAN WELLS, N.W.T.
INTERCOMMUNITY STUDY AREA	NORMAN WELLS TO FORT GOOD HOPE, N.W.T.
SUMMARY	FORT SIMPSON TO FORT GOOD HOPE, N.W.T.

Each Community Study Area report is discussed in terms of Methodology-Evaluation, Summary, Site Description and Glossary-Bibliography.

The Methodology-Evaluation section includes descriptions of the investigation procedure, geomorphology and environment of each respective community area. The Summary section includes recommendations and conclusions pertaining to various sources and categories of granular deposits and the significance of these with respect to the required quantities and qualities as set forth in the Terms of Reference. This section also includes two maps, namely:

Figure 1 - Surficial Geology

Figure 2 - Site Locations and Wildlife Areas

A tabulated summary of all sites evaluated in each community is presented on Figure 2. The Site Description section of each report presents an airphoto plate of the individual sites followed by a text which includes discussions on environment, development and in some cases, abandonment and rehabilitation. On sites that were drilled and/or test pitted, the text of each site is followed with laboratory data. The Glossary-Bibliography section includes an explanation of terms and symbols and a bibliography.

The Intercommunity Study Area reports correspond in basic format to the Community reports.



The Summary section of the Intercommunity Study Area reports present the sites with respect to quantity and quality of material both in terms of a text and a tabulated summary of all sites evaluated. The tabulated summary is presented in conjunction with a Site Location Map which illustrates both site locations and environmental data. The Site Description section of the report includes individual site airphoto plates and in some cases topographic sections, text and laboratory data on sites which were drilled and/or test pitted. The Glossary-Bibliography section includes an explanation of terms and symbols and a bibliography.

The Summary, Fort Simpson to Fort Good Hope, N.W.T., report includes sections on Methodology-Evaluation, Summary and Glossary-Bibliography. The investigation procedure, geomorphology and environment of the total Study Area is outlined in the Methodology-Evaluation section. The Summary section outlines the salient results of the investigation program in terms of quantity and quality of materials. Maps and tabulated summaries of all sites evaluated in each respective Intercommunity Study Area are included. Areas of material deficiency are also discussed. The Glossary-Bibliography section includes an explanation of terms and symbols used in the various reports and a bibliography.

The successful completion of this study was enhanced by the cooperation and contributions of the respective Territorial Land Use Agents and other Federal and Territorial Government personnel including the Federal Department of Public Works and their respective consultants. In particular, we wish to acknowledge the assistance, guidance and liaison provided by Mr. H. D. Dekker, Chairman, and other members of the Granular Materials Working Group.



INVESTIGATION PROCEDURE

Pertinent geological information was compiled for the study from correlation of previous reports of investigations conducted within the Study Area. These included Geological Survey of Canada reports and open files; pipeline route investigations, previous PEMCAN studies and field investigations, and personal communication with noted authorities of the region.

Airphoto interpretation of prospective sites was undertaken prior to the field work with J.D. Mollard and Associates Ltd. Recent airphotos, scaled at 1"=3,000', provided by The Department of Indian Affairs and Northern Development, were utilized to outline sites, estimate the areal extent of sources and note locations of test holes and required access roads. Pertinent parts of these airphotos have been reproduced and are used as location plans for catalogued sites. Air mosaics scaled at 1"=1,000', showing revised route locations for the Mackenzie Highway were provided by The Federal Department of Public Works or their respective engineering consultants. In accordance with the terms of reference as established for the studies of PEMCAN and the consulting groups under The Federal Department of Public Works, integrated field programs were initiated between the parties in order to facilitate orderly and systematic investigations in the field. Approximate sections of the proposed Mackenzie Highway route which were investigated along the centerline and approximately one mile either side thereof, by consultants working under The Federal Department of Public Works, include:

Mile 346 to 450	Acres Consulting Services Ltd.
Mile 450 to 550	Underwood-McLellan & Associates Ltd.
Mile 550 to 650	R.M. Hardy & Associates
Mile 650 to 725	E.W. Brooker & Associates Ltd.

Airphoto interpretation data and information from the respective programs of both PEMCAN and the respective consultants was exchanged, thus resulting in a minimum duplication of drilling and attendant clearing of access on prospective sites which were common to both



programs. Drill hole data from these common sites is incorporated into the Site Description and Summary sections of the respective reports.

The preliminary field work, carried out by PEMCAN in September and October, 1972, commenced with aerial reconnaissance in order to catalogue and assess sites within the Study Area. Sites were evaluated by means of aerial and ground reconnaissance and, in some cases, by test pits, which were excavated, logged and sampled to depths ranging to eleven feet below the ground surface. Natural outcrops were also catalogued and respective samples secured.

On the basis of the airphoto interpretation and field reconnaissance, 315 sites are catalogued and assessed in the Study Area. Of this total, 94 sites and 221 sites are located, respectively, in Community and Intercommunity Study Areas (Ref. Page 3).

Data from a total of 631 drill holes and 175 test pits was utilized in the evaluation of 184 drilled and/or test pitted sites within the Community and Intercommunity Study Areas.

All sites catalogued and assessed within the Community and Intercommunity Study Area reports are shown on the Site Location Maps in the Summary section of each report. Sites which have been drilled and/or test pitted are shown on the Location Map by means of a solid triangle. Sites within this category which are "Not Recommended" for development are followed by the suffix "X". Drilled and/or test pitted sites are discussed individually in the Site Description section of the report.

All other sites within the respective Community and Intercommunity Study Areas which have been recorded and catalogued are shown on the map by an open triangle symbol. These sites are evaluated in the Site Description section of the report with respect to location, geomorphic characteristics, material type, overburden and vegetation, access, suitability of material and environmental considerations. These sites were not drilled for various reasons including remoteness, anticipated poor quality and/or limited quantity of material, limited and/or severe access requirements and environmental considerations including thermally sensitive terrain conditions.



The following tables summarize the total number of sites in each category within the respective Community and Intercommunity Study Areas:

COMMUNITY STUDY AREAS

Community Study Area	Total Sites Investigated	Sites Drilled and/or Test Pitted	Sites Recommended	Sites Not Recommended	Assessed Sites Not Drilled
Fort Simpson	13	12	8	5	1
Wrigley	20	13	10	10	7
Fort Norman	31	26	15	16	5
Norman Wells	21	14	14	7	7
Fort Good Hope	9	4	8	1	5
TOTALS:	94	69	55	39	25

INTERCOMMUNITY STUDY AREAS

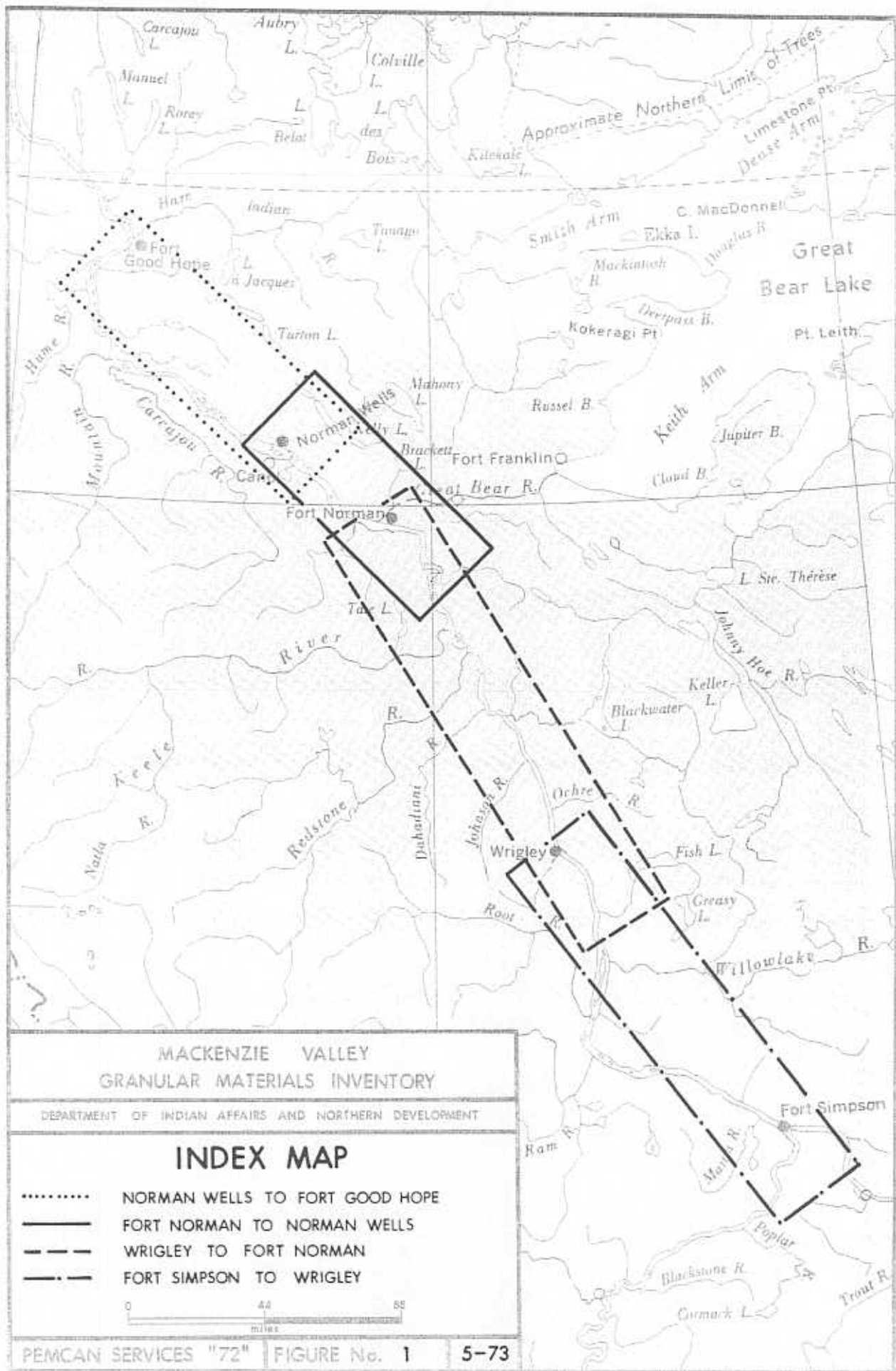
Intercommunity Study Area	Total Sites Investigated	Sites Drilled and/or Test Pitted	Drilled Sites Recommended	Drilled Sites Not Recommended	Assessed Sites Not Drilled
Fort Simpson to Wrigley, N.W.T.	59	32	11	21	27
Wrigley to Fort Norman, N.W.T.	100	45	34	11	55
Fort Norman to Norman Wells, N.W.T.	26	19	9	10	7
Norman Wells to Fort Good Hope, N.W.T.	36	19	16	3	17
TOTALS:	221	115	70	45	106



Material samples secured from outcrops, test pits and drill holes were shipped to Calgary for laboratory analyses which included grain size distribution, petrographic analysis, moisture content determination and hardness tests. In specific cases the samples or combined samples were tested for resistance to mechanical abrasion.

Results of the investigations are summarized in each respective report and detailed information of the studied sites is compiled in the section on Site Description. The areal extent of the individual deposits is based upon airphoto interpretation, field reconnaissance and field drilling records. Except on sites where drill holes penetrated the total depth of the granular deposit the average thickness of individual deposits was generally estimated from morphological and geological features or with respect to thickness indicated by natural outcrops. However, the estimated volumes should be conservative since adjustments were made for variables such as drainage conditions and sloping ground along the outer limits of the deposit.

The respective Intercommunity Study Areas are shown in the Index Map (Figure 1). In addition to the sites in the Intercommunity Study Area, the Location Map included in the Summary section of each Intercommunity report illustrates the sites catalogued and assessed in each of the five communities in the Study Area.





GEOMORPHOLOGY

The Study Area, from Fort Simpson to Fort Good Hope, N.W.T., lies within the Interior Plains physiographic region which is subdivided into secondary plain divisions which are dissected in the central sector of the studied corridor by the crescent shaped northwesterly trending Franklin Mountains unit. Individual physiographic subdivisions of the Interior Plains which are traversed or bordered by the Study Area are:

- Great Slave Plain - which encompasses the Study Area from Fort Simpson, westwards along the Mackenzie River to the vicinity of Willowlake River.
- Mackenzie Plain - which encompasses both sides of the Mackenzie River north of Camsell Bend to Carcajou Ridge. The Plain on the east side of the Mackenzie River is narrow relative to its width west of the river. The eastern margin of the Plain is intercepted by the Mount Gaudet massif north of Wrigley and by the Bear Rock massif west of Fort Norman.
- Anderson Plain - which covers the terrain north of Franklin Mountains and east of the Mackenzie River in the northern sector of the Study Area.
- Peel Plain - which parallels the west side of the Mackenzie River northwest of the Carcajou Ridge.

All physiographic subdivisions of the Interior Plains exhibit, in very general terms, similar basic morphologic character; the terrain is flat, marked with poorly drained zones, thermokarst features and muskeg bogs. Geologic conditions, environment and, consequently, the types and occurrence of granular deposits differ considerably in respective subdivisions and their segments. Since the prevailing overburden cover of both the Great Slave and Mackenzie Plains consists either of glaciolacustrine deposits or morainal till, and since Anderson and Peel Plains are generally covered with a shallow till sheet, the availability



of granular deposits in the Interior Plains is governed by the occurrence of glaciofluvial, ice contact and alluvial landforms. The bedrock in the Plains predominantly consists of weakly cemented sandstones, incompetent siltstones and shales which are, for their most, unsuitable for manufactured construction aggregates. Competent Devonian limestones are indicated only at a few locales, such as the north-south trending band south of the Willowlake River, isolated bedrock ridges paralleling the Franklin Mountains north of Wrigley, shallow and scattered ridges southeast of Norman Wells and in the Ramparts area south of Fort Good Hope. The bedrock in the Plains, with the exception of some walls in deeply incised stream channels and a few ridges, is covered by variably thick layers of unconsolidated materials which would generally curtail extraction of the more competent rock types.

The Franklin Mountains unit is represented within its southern section by the McConnell Range which parallels the east side of the Mackenzie Plain from the Willowlake River to the Big Smith Creek. This Range is rugged; faulting and erosion has resulted in individual bedrock ridges, separated segments and hills. North of Wrigley, the Mount Gaudet massif and the Roche Qui Trempe a l'Eau massif extend to the Mackenzie River and represent an extension of the narrow band of rocky hills west of the river.

The Norman Range represents the Franklin Mountains unit in the northern sector of the Study Area. It begins west of Fort Norman with the prominent Bear Rock massif and continues in a northwesterly direction including major segments such as Discovery Ridge east of Norman Wells, Morrow and Brokenoff Mountains and finally, Carcajou and Gibson Ridges near Sans Sault Rapids.

The Franklin Mountains are basically comprised of Middle Devonian unnamed and undivided carbonate strata with minor shale and anhydrite inclusions and Ordovician and Silurian dolomites, anhydrites and shale. Middle Devonian, Kee Scarp Formation limestone and Hare Indian calcareous shale exists within the northern segment of the Norman Range.

In general, the Franklin Mountains are comprised of rocks which are competent and rep-



resent a good source for manufacturing of construction materials. Rock walls are usually mantled with slope wash materials and talus accumulations at the base while fluvial fans are frequently formed at the mouths of erosional gorges. Rock glaciers are noted along the western flank of the Norman Range south of Sans Sault Rapids. Discontinuous, shallow to moderately thick layers of glacial drift or colluvium topped with several inches of peat and moss is usually encountered outside of rugged or recently eroded areas while poorly drained terrains containing thicker organic sections and scattered muskeg bogs are infrequent.

Three hydrogeologically sensitive areas were noted within the Study Area, all of them geologically related to the Franklin Mountains. These are represented by thermal springs in the Mount Gaudet massif and Roche Qui Trempe a l'Eau massif, at the southern tip of the McConnell Range near the Willowlake River and in the area surrounding Chick Lake.

In individual physiographic subdivisions of the Study Area the following landforms usually contain exploitable granular material deposits:

- A. In the Great Slave Plain granular deposits are scarce because the overburden cover is predominantly of a glaciolacustrine and morainal origin. The following landforms represent prospective sources:
- Ice contact deposits, such as eskers, kames and esker-kame complexes, contain both sand and gravel, with occasional silt and clay pockets. These deposits are sparse within the northern segment of the Plain and discontinued west of Fort Simpson.
 - High terraces on both sides of the Mackenzie River contain mostly unsuitable or poor quality fine grained deposits which cover localized pockets or layers of glaciofluvial gravel.



- Glaciofluvial trains of sandy deposits south of Ebbutt Hills.
 - Dunes and duned ridges, contain poorly graded, fine grained sands. These deposits are widespread south and west from Fort Simpson.
- B. In the Mackenzie Plain, segments covered with glaciolacustrine deposits such as between Camsell Bend and the Willowlake River, between the Big Smith Creek and Bear Rock massif and the strip along the Mackenzie River from Bear Rock to Carajou Ridge are deficient in granular deposits while in remaining segments of the Plain, relatively frequent glaciofluvial and some alluvial deposits represent good prospects for construction materials. These are:
- Ice contact features such as kames, kame fields, kame terraces, eskers and esker-kame complexes, containing variably washed and irregularly stratified sands and gravels, are commonly encountered on slopes adjacent to the western toe of the McConnell and Norman Range. These ice contact deposits vary from poor to good prospects for granular materials.
 - Glaciofluvial outwash plains, terraces and trains usually contain irregularly alternating sand and gravel strata with variable silt content. Large bodies of outwash materials are located on the east side of the Mackenzie River in the region between the River Between Two Mountains and Wrigley, between the Blackwater and Saline rivers and south of Little Smith Creek. Large glaciofluvial deltas are noted in the gaps in the Norman Range north of Norman Wells.
 - High terraces on both sides of the Mackenzie River, encountered at several locales throughout the central sector of the Plain, represent sources of good quality sandy gravel; mostly unsuitable or poor quality fine grained deposits are contained within its remaining portions.

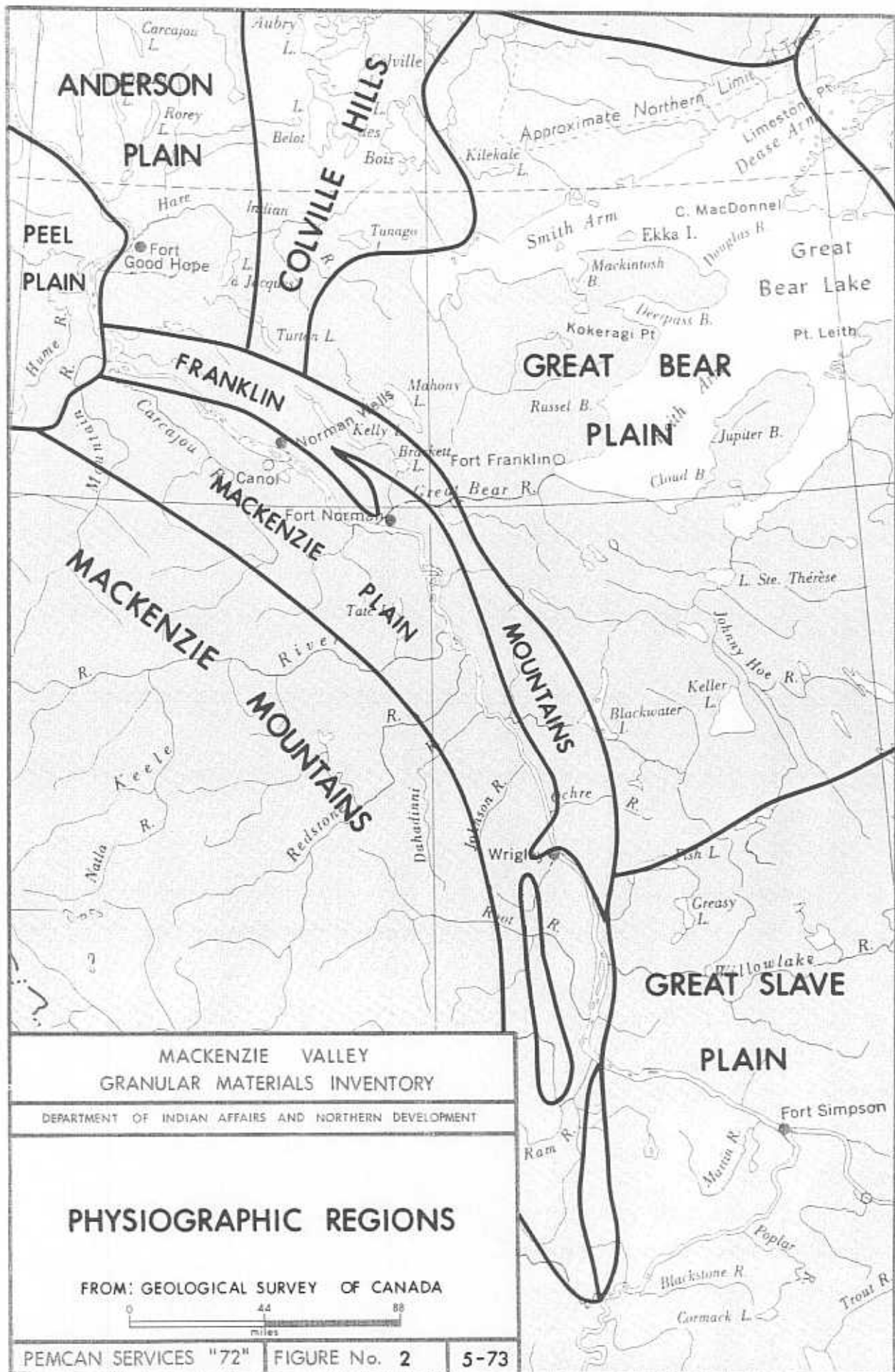


- Alluvial terraces along the Mackenzie River, contain mostly silt and sand deposits while the meandering flood plains and terraces of tributary rivers and streams contain both fine grained and coarse deposits.
 - Alluvial fans, usually deposited at points where stream channels abruptly change their gradient, contain granular deposits ranging from silty sand to coarse gravel.
 - Beach ridges and abandoned strand lines, consisting of silty sands and gravels are widely scattered east of Norman Wells.
 - Dunes and deltaic sand plains containing poorly graded, fine, silty sand are frequently noted in the northern segment of the Plain.
- C. The Anderson and Peel Plains within the Study Area, with exception of the immediate vicinity of Fort Good Hope, are almost entirely covered with morainal deposits and exhibit terrain deficient in naturally occurring granular deposits. The few existing prospective landforms are:
- Ice contact deposits, such as eskers, and esker-kame complexes contain both sand and gravel with occasional silt and till bodies. These deposits are widespread in the immediate vicinity of Fort Good Hope and become infrequent south of the townsite.
 - Glaciofluvial deltas, consisting of outwash plains and channel deposits, overlie the till sheet northeast of Fort Good Hope. These widely separated geomorphologic units contain variable mixtures of sand and gravel.
 - Dunes, consisting of poorly graded, fine grained sand are infrequently scattered in the Ramparts region.



- D. The Franklin Mountains unit contains unconsolidated granular deposits in the following landforms:
- Talus and scree deposits, widespread along steep rock walls, consist of various sized limestone fragments and blocks with silt particles. High ice content in some of the talus slopes within the northern segment of this unit has resulted in rock glaciers.
 - Alluvial cones and shallow fan deposits commonly consist of variously sized, angular to rounded carbonate rock fragments which usually occur in a sand and silt sized matrix.

The Study Area lies within the discontinuous permafrost zone. Permafrost is discontinuous and sporadic in the south and more widespread in the north. In undisturbed areas the active layer generally ranges from four to five feet in the Fort Simpson area and one to two feet at Fort Good Hope.



**MACKENZIE VALLEY
GRANULAR MATERIALS INVENTORY**

DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

PHYSIOGRAPHIC REGIONS

FROM: GEOLOGICAL SURVEY OF CANADA



ENVIRONMENT

The Study Area, from Fort Simpson to Fort Good Hope, traverses a region which possesses abundant and variable water and land environments. For the most part, the respective communities within the Study Area have been geographically located in areas where utilization of natural resources is optimal. Of particular importance to the communities is the Mackenzie River and its tributaries which offer an immense network of transportation for both local and regional utilities.

The Study Area is in the discontinuous permafrost zone. In the southern and central regions of the Study Area, permafrost is more discontinuous and less widespread than in the northern sectors. In undisturbed areas the active layer ranges from four to five feet at Fort Simpson to one to two feet at Fort Good Hope.

Terrain sensitivity is generally less pronounced in southern portions of the Study Area than in regions further to the north because of discontinuous permafrost, lower ground ice content and generally, greater depths to permafrost tables.

The relatively flat, low-profiled and generally fine grained terrain types such as silt-clay plains, beaches, river deposits and organic terrain generally contain moderately high ground ice content. The excess ice content is, however, lower than in similar formations encountered at higher latitudes in the Study Area. Therefore, disturbance because of low strength and high compressibility values is generally less than in similar terrain types to the north. However, vegetated sites are still susceptible to subsidence, slumping and gullyng if the vegetation is removed or highly compressed and disturbed. Thermokarst subsidence, undercutting and channel shifting can also be expected, especially in fine river deposit terrain.

Hummocky and rolling terrain such as till plains generally contain moderate ground ice content. Localized contrasts in material type and ice content is oftentimes evident



between well drained slopes and low depressions. This terrain in general exhibits minor to moderate susceptibility to thermokarst, ground ice slumping and gullying. Usefulness of till material as fill is usually limited by its medium to high ice content.

Upland mountainous terrain, as characterized by rock outcrops or bedrock thinly covered with a veneer of debris, as in the Franklin Mountains, usually contains minimal ice content. Creep, slides and rock falls are common on steep slopes in this terrain as are mudflows and flash floods.

In general, the more favorable granular material sites in the Study Area tend to be located on geomorphic features that contain relatively minor amounts of ground ice. Therefore, properly managed development procedures should minimize the detrimental terrain reaction to acceptable levels. In many cases, the access routes to these sites will traverse areas of low wet terrain that generally will contain higher ice contents and will therefore, be more susceptible to adverse reaction when disturbed. In such cases, terrain reaction can be limited by sound development procedures such as the incorporation of protective measures for retainment of vegetation ground-insulation layers and the selection and utilization of adequate fill materials for access roads.

Vegetation

The Study Area between Fort Simpson and Fort Good Hope traverses vegetation types ranging from Boreal forest in the south, central and north central regions to Taiga in the northern sector from the vicinity of Sans Sault Rapids to Fort Good Hope (Figure 3). Each vegetation type is influenced by changing climatic and physiographic conditions along the route; the vegetation varies from relatively resilient Boreal forest to fragile, easily disturbed Taiga systems in delicate balance with their Arctic environment.

In the Study Area the commonly encountered vegetation types serve useful purposes in their individual environmental systems, and to man. Included are provision of food and



cover for many wildlife species, soil stabilization, prevention of erosion and maintenance of water regimes and quality. In permafrost regions the primary function of vegetation is to inhibit erosion by limiting the effect of surface water movement and to establish and maintain thermal equilibrium with the soil.

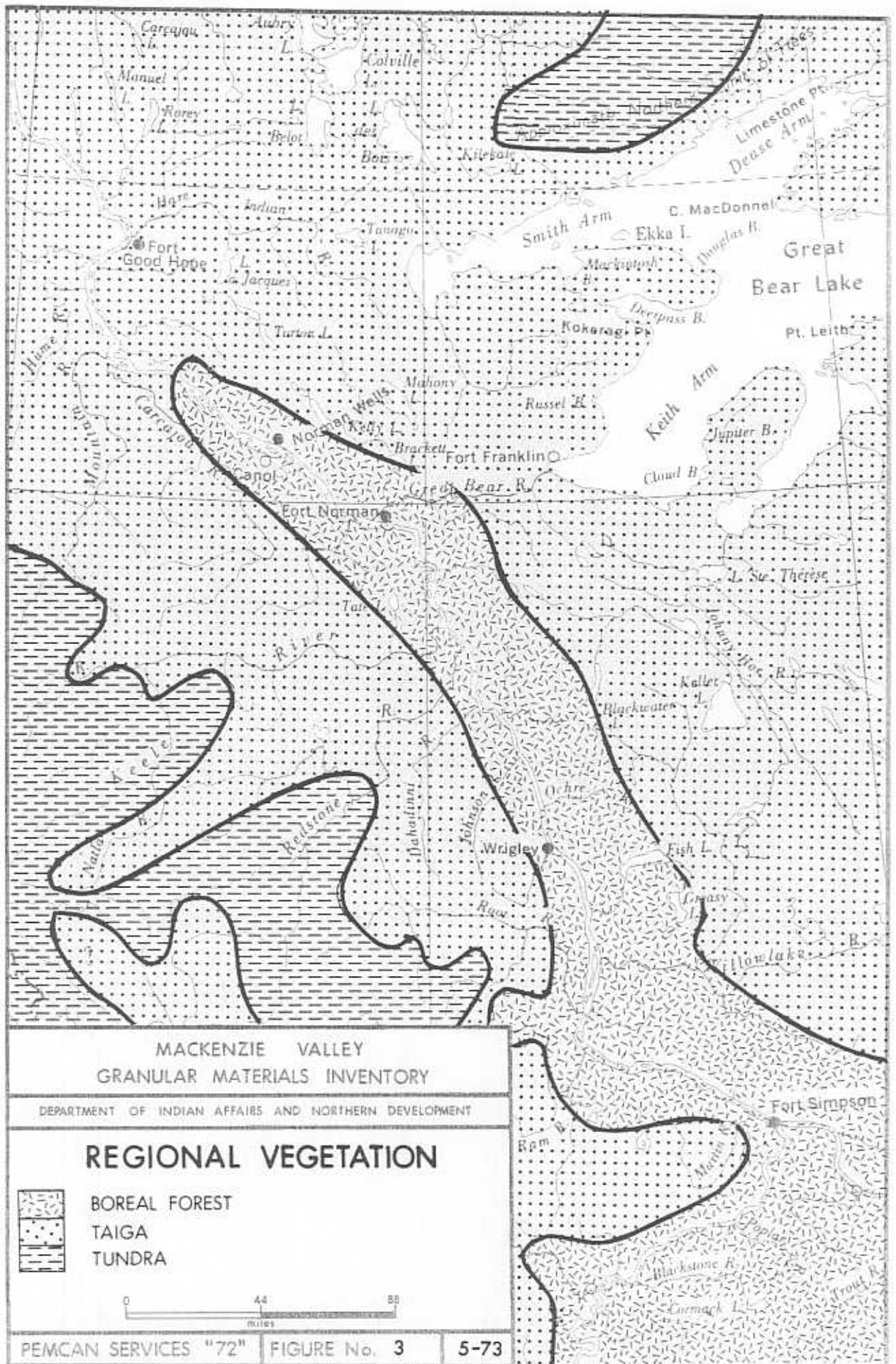
Approximately ninety percent of the Study Area, from Fort Simpson to the vicinity of Sans Sault Rapids, lies within the Boreal forest zone. Forest of this type is primarily coniferous and is comprised of white and black spruce, tamarack and jack and lodgepole pine.

The broadleaf deciduous varieties consist predominantly of poplar, birch, aspen, alder and willow. Ground cover in this forest includes various species of mosses, lichens, sedges, herbs and shrubs including shrubby alders and willows. The Boreal vegetation exhibits discernable variations as it responds to changes in latitude, climate and site conditions from south to north, across the Study Area. In general, the proportion of commercial tree growth decreases in a south to north direction as the occurrence of muskeg terrain increases.

Pine and to a lesser extent poplar and aspen, decrease in frequency or are absent in the forest cover in the region north of Great Bear River.

Taiga vegetation, in the area from the vicinity of Sans Sault Rapids to Fort Good Hope is characterized by open grasslands interspersed with areas of varying size which generally support stunted forest growth. Both Boreal and Tundra forest vegetation are represented within the Taiga zone, although little timber of commercial size and value is produced.

In the Study Area poorly drained alluvial sites commonly support growths of black spruce, tamarack, willow and alder. Muskeg areas generally support black spruce, tamarack and occasionally, birch; relatively shallow permafrost areas may support white spruce, especially if the permafrost acts as a media to maintain relatively high surficial moisture contents. Well drained sites commonly support white spruce and poplar, with lesser growths of birch and pine.





Benchmark areas that are underlain by fine-grained materials with discontinuous permafrost generally support growths of spruce, with occasional tamarack, willow and alder. Well drained benchmark areas are characterized by growths of poplar, with lesser pine and spruce. Mountain slope vegetation ranges from mixtures of deciduous and evergreen growths near the base to spruce, birch and occasional poplar on the overburden-covered flanks.

In the Study Area, natural regrowth of vegetation on existing trails and cutlines indicates that in general, regeneration of disturbed areas will occur, especially if the nutrient levels within the topsoil layer are left undisturbed. However, in areas where permafrost acts as a favourable moisture retention media for vegetation that normally would not grow because of lack of moisture, disturbances such as clearing may sufficiently alter moisture conditions to a point where timber growth is inhibited. It may be feasible to reseed and fertilize abandoned borrow pit areas with short and long term seed stocks in order to promote growth cover prior to reestablishment of natural vegetation. This is particularly true of the northern sector of the Study Area where the Boreal forest is at its extreme northern tolerance levels in this region.

Wildlife

Northwestern North America, from the northern regions of the Provinces to Alaska, is one of the few remaining vast wilderness regions capable of supporting large populations of wildlife and habitats of several rare and endangered species. It is also the breeding habitat for much of the waterfowl in the western half of the continent. The Study Area from Fort Simpson to Fort Good Hope traverses a small segment of this region along the Mackenzie River Valley.

Animal species of both Boreal forest and Arctic tundra inhabit the Study Area. For the most part, the utilization of this area by wildlife, waterfowl and fishery resources is based upon seasonal migration patterns that generally follow the Mackenzie River Valley. Al-



though various wildlife species inhabit the Study Area, and in some cases serve as a means of livelihood for local residents, there are no known critical wildlife habitats within the aerial extent of any granular deposit proposed for development.

Critical and important wildlife areas are assigned to habitats which are considered necessary for the maintenance and/or survival of wildlife populations. These areas, as outlined from data and maps prepared by the Canadian Wildlife Service, represent concentrations of various wildlife species in relation to their total population. Most of the information available on wildlife regions in northern Canada is obtained from the Canadian Wildlife Service, Arctic Ecology Map Series and various published literature.

The more significant wildlife resources in the Study Area range from large concentrations of woodland caribou which seasonally inhabit various segments of the region to high density populations of fur bearing animals such as beaver, mink, muskrat and marten. Other animals commonly found in the Study Area include grizzly and black bear, moose, wolf, wolverine, lynx and fox.

North and northwest of Fort Simpson for about twenty miles, the Study Area traverses near the periphery of an important wildlife area for woodland caribou and marten.

Roughly parallel to and a few miles inland from the west bank of the Mackenzie River, from the vicinity of the mouth of Root River, northwards to a point approximately opposite the mouth of Blackwater River, the Study Area traverses the eastern limits of a critical wintering range for woodland caribou.

The drainage basin area of the Ramparts River immediately to the west of the Study Area is considered a critical habitat for beaver and whooping cranes.

Two locations west and southwest of Fort Good Hope townsite are considered as critical habitats for the rare and endangered peregrine falcon (Ref. Report - Fort Good Hope -



Community Study Area).

The entire Study Area, from the vicinity of McGern Island located north of Camsell Bend, to Fort Good Hope is within the broad and important Mackenzie Valley flyway which is utilized by various waterfowl including swans, geese and ducks during spring and fall migration.

The sandy islands and immediate bank areas of the Mackenzie River are classified as an important spring staging area for waterfowl in the area from Police Island, south of Fort Norman to the vicinity of Sans Sault Rapids.

Fishery resources are those predominantly found in the Mackenzie River and its tributaries and includes both resident species and those that seasonally migrate through the respective river systems. The areas that are of significance to fishery resources are noted on the Site Location Maps in the Summary section of each Community and Intercommunity report.

Hunting and trapping of fur bearing animals is periodically undertaken throughout most of the Study Area, particularly along the Mackenzie River and the drainage basins of its major tributaries. Trapping areas of significance are noted on the Community Study Area maps and are discussed in the Methodology-Evaluation section of each Intercommunity Study Area.



GENERAL DISCUSSION

In accordance with the Terms of Reference received from The Department of Indian Affairs and Northern Development, Stage 1 of the Territorial Granular Materials Inventory has been conducted and completed by PEMCAN Services "72". Stage 1, defined as the total Study Area between Fort Simpson and Fort Good Hope, N.W.T., was investigated and information thereof, prepared in two parts, namely:

Part 1: An investigation of the availability of granular material deposits within a ten mile radius of the communities of Fort Simpson, Wrigley, Fort Norman, Norman Wells and Fort Good Hope, N.W.T. A detailed assessment of the potential granular material deposits within each of the Community Areas is presented in five separate reports for each of the Community Areas within the Study Area.

Part 2: An investigation of the availability of granular materials in the remaining intercommunity areas. The results of the investigation for Part 2 is presented in four separate Intercommunity Study Area reports and a Summary report.

The Summary report is intended to integrate, correlate and assimilate the extensive quantity of data which has been presented in the four Intercommunity Study Area reports. Periodic reference to the data compiled in the Community Area reports has been made in the preparation and finalization of the five reports for Part 2.

The results of the completed study for Stage 1 of the Territorial Granular Materials Inventory indicate that the availability of accessible, naturally occurring, good quality granular materials is localized in the total Study Area. The geomorphic regions which are considered to contain deposits of good quality granular materials has been presented in the preceding section under Geomorphology.



The sites consisting of good quality granular materials with good access to the locations of currently proposed utilities are noted in the Study Area in the following geographical regions:

- North of Willowlake River to Saline River.
- North of Vermilion Creek to Norman Wells, on the east side of the Mackenzie River.
- Immediately adjacent to, and north of the Little Bear River on the west side of the Mackenzie River.
- North of Oscar Creek to the Hanna River on the east side of the Mackenzie River.

In view of the scarcity of granular materials, the remoteness of individual prospects from locations of currently proposed utilities and/or difficult access, the following geographical regions may be classified as "marginal" with respect to the availability of good quality granular materials:

- Northeast of Camsell Bend to the Willowlake River.
- Immediately north of Willowlake River.
- North of Saline River to Big Smith Creek.
- Immediately east of the Bear Rock massif.
- North of Rat Pass to Chick Lake.

The following geographical regions are noted for the scarcity of naturally occurring granular material deposits and/or prospective bedrock exposures for the production of manufactured construction materials:

- Fort Simpson to Camsell Bend on both sides of the Mackenzie River.
- Immediately south of Willowlake River.
- North of Big Smith Creek to Fort Norman on both sides of the Mackenzie River.



- North of the Bear Rock massif to Vermilion Creek on the east side of the Mackenzie River.
- A few miles north of the Little Bear River to the northern extremities of the Study Area on the west side of the Mackenzie River.
- North of Chick Lake to Fort Good Hope, N.W.T.

The required quantities of granular materials as specified in the Terms of Reference have, in general, been established for the respective Community Study Areas. However, the availability of good quality granular materials in the Fort Simpson, Fort Norman and Norman Wells Community Study Areas is very limited while good quality granular materials are available in extensive quantities in the Wrigley and Fort Good Hope Community Study Areas. Therefore, it is anticipated that the large deposits of good quality granular materials in the Wrigley and Fort Good Hope Community Study Areas may be utilized, in part, for the granular material requirements aside from the specified requirements for each respective community.

A total of 315 sites, including the 94 sites investigated for the Community Study Area, were evaluated, assessed and catalogued during the Granular Materials Inventory for Stage 1 and a detailed evaluation of each site investigated in the total Study Area is documented in the Site Description section of each respective Intercommunity or Community Study Area reports. All site locations, including the sites investigated for the Community Study Areas, are shown on each of the four separate Intercommunity Study Area location maps. The Community Study Area sites are noted in "black" open or solid triangles and the Intercommunity Study Area sites are designated in "red" open or solid triangles. In each case, the solid "red" or "black" triangles designate sites which have been test pitted and/or drilled, and sites within this category which are "Not Recommended" for development are followed by the suffix "X".

A total of 221 sites were catalogued and assessed within the four Intercommunity Study Areas of which 115 sites were investigated in detail during the winter drilling program.



A detailed summary of the general assessment of these drilled and/or test pitted sites is presented under the heading of "Recommendations and Conclusions" in this section of the report, together with the Synopsized Tables and Site Location Maps for each of the four Intercommunity Study Areas.

The remaining 106 sites in the Intercommunity Study Areas were evaluated on the basis of airphoto interpretation, office literature studies and partial aerial field reconnaissance, and are designated as open "red" triangles on the Site Location Map for each of the four respective Intercommunity Study Areas. These sites were not investigated in detail during the winter field drilling program nor by test pitting during the summer field reconnaissance because of difficult access, remoteness of the site from currently proposed utility locations, and the minimal anticipated quantity of available granular materials. However, on the basis of detailed airphoto interpretation and known geological data, these secondary sites have been rated to generally designate the anticipated quality of available granular materials and potential exploitability of materials from these sites. The following rating has been utilized in the evaluation of these secondary sites:

1. **Good Prospect:** These sites are anticipated to contain good quality granular materials consisting of well graded, clean sand and gravel deposits which would be suitable for the production of aggregates for most construction requirements. However, these sites generally represent lengthy difficult access across thermally sensitive or rugged terrain and in general, are remotely located from the currently proposed utility locations.

These sites are also represented by areas of bedrock exposures consisting of competent limestone and dolomite which, if quarried, would be suitable for the production of most construction aggregates.

These sites designated as Good Prospects are generally represented



by ice contact features such as eskers or kames and prominent bedrock outcrops.

2. Fair Prospect: These sites are anticipated to contain fair quality granular materials ranging from fine grained sands to silty sand and gravel deposits which would generally be suitable for general fill requirements in the pit run condition. These deposits contain low ground ice and conventional excavation procedures would be suitable for the removal of material.

These sites also represent areas of bedrock exposures consisting of limestone interbedded with shale, which, if quarried, would only be suitable for the production of aggregates for general fill requirements.

3. Poor Prospects: These sites are anticipated to contain fine grained, silty sands which would generally be suitable only for very marginal fill requirements in the construction of subgrades for roads. These materials are also easily erodible if exposed to wind or water action and any embankment constructed from these fine silty sands would have to be surgically protected from erosional agents.

4. Not Suggested for Development: These sites do not contain materials of granular quality or the potential granular material deposits are located within and/or immediately adjacent to an active water course. The proposed exploitation of materials from these deposits adjacent to water courses would have severe detrimental implications on the environmental and ecological framework of the site and adjacent areas.

These secondary sites have all been evaluated and catalogued in the Site Description.



section for each of the four respective Intercommunity Study Area reports. It is considered that the secondary sites designated as "Good" or "Fair" prospects may become very significant sources for granular materials if the routes of currently proposed utilities are re-located or if some local facility, such as drilling pads, are located adjacent to these sites.

All catalogued and assessed sites in the four Intercommunity Study Areas are discussed in the Site Description section of each respective report. In addition, the locations for all sites in the respective Intercommunity Study Areas are presented in the four Site Location Maps.

A synopsis tabulation of pertinent information for each site has been provided. Each potential site has been evaluated in terms of material type, suitability of material, estimated volume, recoverable depth, overburden characteristics, ground ice content, drainage, method of extraction, haul distance, environmental considerations and assessment.

ESTIMATED VOLUME is calculated by means of various parameters including drill hole and test pit data, airphoto interpretation and geomorphology. Adjustments have been made for irregular topography and stream dissection.

RECOVERABLE DEPTH is determined by various methods including drill hole and test pit data, geomorphology and in the case of bedrock, projected stratigraphic thickness.

GROUND ICE CONTENT is reported as high, medium or low by visual inspection of both samples and test pit walls.

METHOD OF EXTRACTION refers to the type of equipment required for development and exploitation of granular materials. "Conventional" as used, indicates the utilization of standard excavation equipment such as bulldozers, overhead loaders, backhoes and light rippers.



HAUL DISTANCE is the distance along existing and/or proposed access from the site to the designated location on the proposed Mackenzie Highway right-of-way.

ENVIRONMENTAL CONSIDERATIONS include any salient factors related to wildlife, waterfowl and fishery resources, archeological sites and potential terrain sensitivity of the site and adjacent areas including proposed access routes. If any environmental implications are considered to exist at a particular site they are synopsized in this column. Further comments on the importance of these conditions as related to potential development are made within the text of the respective sites in the Site Description section of the report.

ASSESSMENT OF SITE relates to the evaluation of each site in terms of recommendations for development, nondevelopment or possible development of potentially recoverable granular materials at each site investigated in the Study Area. The catalogued but not drilled sites are rated as poor, fair and good prospects relative to anticipated availability of granular materials. These sites which apparently do not contain suitable materials or, if their development would entail possible environmental hazards, are not suggested for development.

These recommendations are based upon an assessment of all known data on each respective site including location, access, physical characteristics, environmental considerations, development procedures and quantity, quality and suitability of material as related to currently proposed or future requirements within the Study Area.

The terrain sensitivity relative to the development of borrow pits, quarries and required access roads differs considerably throughout this section of the Study Area and an assessment of local conditions pertinent to prospective sites and access routes is contained in the Site Description section of the report.



Geomorphic landforms containing coarse granular deposits, such as kame fields, large eskers, glaciofluvial outwash plains or bedrock ridges usually represent well drained and stable terrain; therefore, controlled extraction of material should not adversely affect the environment of the site and adjacent terrain. Conversely, the poorly drained areas and landforms formed by fine grained sediments, such as low alluvial terraces, deltaic sand deposits and sand dunes are easily eroded if the vegetation cover is disturbed either because of transportation activity or borrowing of material. In general, any activity within thermally sensitive terrain would require careful planning and supervision in order to restrict and minimize potential adverse effects.

Although detailed specific development procedures relevant to each site investigated and recommended as a potential source of exploitable granular materials has been presented in the Site Description section of each individual Intercommunity Study Area report, the following general guidelines to govern procedures for the removal of gravel, rock or sand from borrow pit or quarry locations are presented herewith for reference. Compliance with these suggested guidelines will result in minimizing or avoiding such factors as stream siltation, unsightly scour, or long-term erosion once the source has been utilized for the exploitation of granular materials:

BORROW PITS (Upland sand and gravel sources)

- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.
- The organic topsoil layer should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.
- Stands of natural growth should be retained between borrow pit locations to facilitate regrowth through natural regeneration.



- In areas adjacent to existing water courses, a vegetation buffer zone of adequate width should be maintained between the outer limits of the borrow pit and the edge of such water courses.
- A similar vegetation buffer zone should be retained between the borrow pit locations and the right-of-ways of proposed utilities such as the Mackenzie Highway or gas pipeline routes.
- Operating procedures should be maintained during the development of borrow pit areas to produce a final excavation which is compatible, as near as possible, with the natural contours of the adjacent terrain.
- Operating procedures should be maintained during borrow pit development whereby surficial waste materials do not drain into adjacent water courses.
- Abandoned borrow pit areas should be recontoured to provide general drainage that is compatible with the natural drainage of the adjacent terrain.
- Stockpiled surficial waste material and organic topsoil should be replaced on the abandoned and recontoured borrow pit backslopes and floor.
- Revegetation of the recontoured borrow pit areas should be considered, especially in areas sensitive to erosion; artificial reseeding of annuals and perennials will result in a semi-permanent cover growth prior to reestablishment by native species.

BORROW PITS (River and Stream Gravel Sources)

- Borrow pit and working areas should be located only on dry bars or other areas removed from existing stream channels.
- Operating procedures should be established whereby the exploitation of borrow



areas can be geographically flexible within the site area in order to allow for the periodic shifting of stream channels.

- Adequate aesthetic buffer zones should be established between the borrow pit areas and the adjacent stream banks.
- Operating procedures should be established to maintain buffer zones and sediment settling ponds that separate the working areas from the active stream channel.
- The borrow pit areas above the water level should be recontoured and/or terraced to provide general drainage which is compatible with the natural drainage of the adjacent terrain.
- The abandoned and restored borrow pit areas should be breached into existing channels in order that high water flows will naturally cleanse and restore such areas.

QUARRY OPERATIONS

In general, the various sites which have been recommended as potential quarry locations for the production of good quality manufactured aggregates are quite unique relative to their geological and topographical settings. Therefore, specific development procedures for proposed quarry operation at these sites have been discussed, individually for each site, in the Site Description section of the respective Intercommunity Study Area reports.



RECOMMENDATIONS AND CONCLUSIONS

The recommendations and conclusions which are presented herewith are based upon air-photo interpretation, office literature studies, preliminary field reconnaissance and detailed field drilling data. The four Intercommunity Study Areas are presented herewith as separate headings and are followed by their respective Site Location Map and tables presenting salient information for each site.

FORT SIMPSON TO WRIGLEY, N.W.T.

The results of the completed study indicate that the availability of quality granular materials in certain segments of the Intercommunity Study Area between Fort Simpson and Wrigley, N.W.T., is quite limited. The scarcity of quality granular materials is especially acute north of Fort Simpson to Willowlake River. In this portion of the Study Area the natural granular deposits are limited to gravel pockets overlain by glaciolacustrine and alluvial sediments. A few ridges containing sand and gravel deposits were noted in the area southwest and west of Ebbutt Hills. Exploitable outcrops of competent crushable bedrock were not encountered between Fort Simpson and Willowlake River, whereas the catalogued bedrock ridges northeast of the Camsell Bend area are mantled by glacial drift. Exploitable quantities of naturally occurring granular materials were established during the winter field drilling program in the northern portion of the Study Area from Willowlake River to Wrigley.

On the basis of the airphoto interpretation and preliminary field reconnaissance data, a total of 32 sites was investigated in detail during the winter drilling program of which eleven sites were confirmed to contain exploitable granular materials. These sites are categorized and grouped as follows:

1. The better quality granular materials were encountered in prominent and larger esker ridge deposits and esker-kame complexes west of Ebbutt Hills, north of Willowlake River and in the area adjacent to the River Between Two Mountains. These esker-kame



sediments consist of well graded, clean, medium to coarse grained gravel deposits which are considered suitable for the production of aggregates for most construction requirements.

These esker-kame deposits are represented by Sites 118, 124, 139, 142, 143 and 146 and are estimated to contain in excess of 10,000,000 cubic yards of good quality granular materials. The location of these sites are noted on the Site Location Map in the Summary section of the report.

2. Fair to good quality granular materials were confirmed in the glaciofluvial outwash deposits immediately adjacent to the east bank of the Mackenzie River in the Study Area from the River Between Two Mountains and Wrigley. These deposits consist of well graded, fine to medium grained sand and gravel with a highly variable silt content.

These glaciofluvial outwash deposits are represented by Sites 140, 151, 153 and 154 and are estimated to contain in excess of 17,000,000 cubic yards of fair quality granular materials suitable for quality embankment fill in the pit run condition. Base and surface course aggregates may be produced if selective harvesting of pockets of better quality gravel is conducted.

3. Site 101 which was investigated during the winter drilling program consists of a high fluvial terrace and is considered to contain sizable, scattered pockets of good quality granular materials. However, before this site is considered for development, a more detailed drilling program would be required to more accurately locate, delineate and assess the material quality of these anticipated gravel pockets.

The detailed assessment and recommendations for Site 101 are outlined in the Site Description section of the report.

In addition to the preceding eleven sites, which contain exploitable quantities of granular



materials suitable for engineering construction materials, 21 sites were drilled during the winter field program which did not contain materials of good granular quality or potential sources of granular materials were located within various active stream and river channels. These sites have been catalogued and recorded in the Site Description section of the report, and have been identified with the suffix "X" after the site number to designate "Not Recommended" as granular material sources.

However, although Sites 104X, 107X, 109X, 110X, 115X, 119X, 134X and 135X do not contain materials of good granular quality, the poorly graded, fine grained, silty sands from these sites may be considered for very marginal fill material in the construction of road subgrades. These fine sands are mostly easily eroded if exposed to wind and rain action; therefore, proper protection measures would have to be implemented to minimize the detrimental effects of erosional agents on any embankments constructed from these fine sands.

On the basis of detailed airphoto interpretation and known geological data, good quality naturally occurring granular materials are considered available in exploitable quantities from Sites 141, 143A, 148, 157 and 158 which generally consist of glaciofluvial outwash, esker ridge or kame terrace and hillock deposits. Also, Site 199 can be considered for the production of manufactured aggregates from competent limestone formations.

All catalogued and assessed sites in the Fort Simpson to Fort Good Hope, N.W.T. Intercommunity Study Area, including the eleven sites which were confirmed to contain granular type materials are discussed in detail in the Site Description section of the report.

SITE NO.	MATERIAL TYPE		SUITABILITY OF MATERIAL	ESTIMATED VOLUME (cu. yds.)	ESTD. RECOV DEPTH (feet)	OVERBURDEN			GROUND ICE (Content)	DRAINAGE	METHOD OF EXTRACTION	HAUL DIST (mi/ha)	ENVIRONMENTAL CONSIDERATIONS	ASSESSMENT OF SITE
	DESCRIPTION	SYM.				TYPE	DEPTH (feet)	DISPOSAL						
*101	Gravel; sandy	GW-GP	General Fill	N.D.	--	Topsoil, Peat & Till	+6	Strip, Waste & Stockpile	Low to Medium	Fair to South	Conventional	+12	No Critical Wildlife Areas	Possible Development Based on Additional Studies
102	Gravel; sandy	GW	General Fill	N.D.	--	Topsoil & Silt	--	Strip & Stockpile	N.D.	Good to South	Conventional	3%	No Critical Wildlife Areas	Poor Prospect
*103X	Gravel; sandy	GW	General Fill, Base & Surface Courses	N.D.	--	Silt & Topsoil	+1%	--	Low	Into Adjacent Stream	Conventional with Dredging	0	No Critical Wildlife Areas	Not Recommended
*104X	Sand; fine	SP	Unsuitable	N/A	--	Peat & Topsoil	2	--	Low to Medium	--	--	+10	No Critical Wildlife Areas; Sensitive Terrain	Not Recommended
105	Sand; fine	SP	Marginal General Fill	N.D.	--	Topsoil	--	Strip & Stockpile	N.D.	Fair into Adjacent Terrain	Conventional	5	No Critical Wildlife Areas; Sensitive Terrain	Fair Prospect; Difficult Access
106	Sand; fine	SP	Marginal General Fill	N.D.	--	Topsoil	--	Strip & Stockpile	N.D.	Fair into Adjacent Terrain	Conventional	4%	No Critical Wildlife Areas; Sensitive Terrain	Poor Prospect; Difficult Access
*107X	Sand; silty	SP-SM	Unsuitable	N.D.	--	Topsoil	1	--	Low to Medium	Good to South	--	+5	No Critical Wildlife Areas	Not Recommended
*108X	Till; silty, clayey	MH-GI	Unsuitable	N/A	--	Topsoil	1	--	Low to Medium	Good to North	--	-5	No Critical Wildlife Areas	Not Recommended
*109X	Sand; silty, fine	SM-ML	Very Marginal Fill	N/A	--	Topsoil	1	--	Low to Medium	Good to North & West	--	0	No Critical Wildlife Areas	Not Recommended
*110X	Sand; silty, fine	SM-ML	Unsuitable	N/A	--	Topsoil	1	--	Low	Good to South	--	-4	No Critical Wildlife Areas	Not Recommended
111	Sand & Silt; Gravel Pockets	SM-ML, GM	Very Marginal Fill	N.D.	--	Topsoil & Silt	--	Strip & Stockpile	N.D.	Fair to South	Conventional	5	Adjacent to River Channel; No Critical Wildlife Areas	Poor Prospect
112	Sand; silty	SM-ML	Very Marginal Fill	N.D.	--	Topsoil & Silt	--	Strip & Stockpile	N.D.	Good to Northwest	Conventional	7	Adjacent to Stream Channel; No Critical Wildlife Areas	Poor Prospect
*113X	Sand; silty	SM-ML	Unsuitable	N/A	--	Topsoil & Silt	2 to +10	--	Low to Medium	Good to South	--	10	No Critical Wildlife Areas	Not Recommended
114	Till; silty, sandy & clayey	--	Not Granular; Very Marginal Fill	N.D.	--	Topsoil	--	Strip & Stockpile	N.D.	Fair into Adjacent Terrain	Conventional	3%	No Critical Wildlife Areas; Sensitive Terrain	Poor Prospect
*115X	Sand; silty	SM-SC	Very Marginal Fill	N.D.	--	Topsoil	1	--	N.D.	Fair to Southwest	--	0	No Critical Wildlife Areas	Not Recommended
*116X	Glacial Till; silty	CI	Unsuitable	N/A	--	Topsoil	1%	--	Low to Medium	Good to West	--	4	No Critical Wildlife Areas	Not Recommended
117	Sand; gravelly & silty	SM-GM	Marginal General Fill	N.D.	--	Topsoil	--	--	N.D.	Fair into Adjacent Terrain	--	3	No Critical Wildlife Areas; Sensitive Terrain	Not Suggested for Development
*118	Sand & Gravel	SW-GW	Most Construction Aggregates	2,000,000	4 to +15	Topsoil & Silt	1 to 6	Strip & Waste or Stockpile	Low	Good to West	Conventional	0	No Critical Wildlife Areas	Recommended for Development
*118X	Sand; silty	SM-SP	Marginal General Fill	N.D.	--	Topsoil & Peat	+1	--	N.D.	Fair to Southwest	--	0	No Critical Wildlife Areas	Not Recommended
120	Sand; silty & clayey	SM-SW	Marginal General Fill	N.D.	--	Topsoil	--	Strip & Stockpile	N.D.	Fair into Adjacent Terrain	Conventional	2%	No Critical Wildlife Areas	Poor Prospect
121	Sand; silty	SM-ML	Very Marginal Fill	N.D.	--	Topsoil	--	Strip & Stockpile	N.D.	Poor into Adjacent Terrain	Conventional	10	No Critical Wildlife Areas; Sensitive Terrain	Poor Prospect
122	Bedrock; Shale	--	Marginal General Fill	Unlimited	--	Topsoil & Silt	--	Strip & Waste	N.D.	Good into Adjacent Terrain	Quarry; ripping & blasting	12	No Critical Wildlife Areas; Sensitive Terrain	Poor Prospect
*123X	Glacial Till	ML-CI	Unsuitable	N/A	--	Topsoil & Peat	+1	--	Low to Medium	Good to West	--	3	No Critical Wildlife Areas	Not Recommended
*124	Sand & Gravel	SW-GW	Most Construction Aggregates	4,000,000	5 to +19	Topsoil & Silt	1 to 6	Strip & Waste or Stockpile	Low	Good to West	Conventional	0	No Critical Wildlife Areas	Recommended for Development
125	Bedrock; Limestone	--	Most Construction Aggregates	N.D.	--	Topsoil & Silt	--	Strip, Stockpile & Waste	N.D.	Fair to Poor into Adjacent Terrain	Quarry; Blast & crushing	5%	No Critical Wildlife Areas; Sensitive Terrain	Fair Prospect; Difficult Access
126	Bedrock; Limestone & Shale	--	Most Construction Aggregates	Unlimited	--	Topsoil & Silt	--	Strip, Stockpile & Waste	N.D.	Good to Fair into Adjacent Terrain	Quarry; Blast & crushing	5	No Critical Wildlife Areas; Sensitive Terrain	Fair Prospect; Difficult Access
127	Bedrock; Limestone & Shale	--	Most Construction Aggregates	N.D.	--	Topsoil & Silt	--	Strip, Stockpile & Waste	N.D.	Fair to Good into Adjacent Terrain	Quarry; Blast & crushing	4%	No Critical Wildlife Areas; Sensitive Terrain	Fair Prospect; Difficult Access
*128X	Glacial Till	ML-CI	Unsuitable	N/A	--	Topsoil	1	--	Low to Medium	Poorly Drained to West	--	-1	No Critical Wildlife Areas	Not Recommended
129	Gravel & Sand; silty; Washed Till	GM	Marginal General Fill	N.D.	--	Topsoil & Silt	--	--	N.D.	Into Adjacent River Arms	--	5	Within River Channel; No Critical Wildlife Areas; Sensitive Terrain	Not Suggested for Development
*130X	Glacial Till	ML-CI	Unsuitable	N/A	--	Topsoil	1%	--	Very Low	Fair to Adjacent Terrain	--	5	No Critical Wildlife Areas	Not Recommended
*131X	Glacial Till; silty	ML-CI	Unsuitable	N/A	--	Topsoil	1	--	Low	Well Drained to Adjacent Terrain	--	4	No Critical Wildlife Areas	Not Recommended
*132X	Sand; silty, fine	SP-SM	Unsuitable	N/A	--	Topsoil	1	--	None	Fair to Adjacent River	--	1%	No Critical Wildlife Areas; In River Channel	Not Recommended
133	Gravel & sand; silty; Washed Till	GM	Marginal General Fill	N.D.	--	Topsoil & Silt	--	--	N.D.	Into Adjacent River Arms	--	1	Within River Channel; No Critical Wildlife Areas	Not Suggested for Development

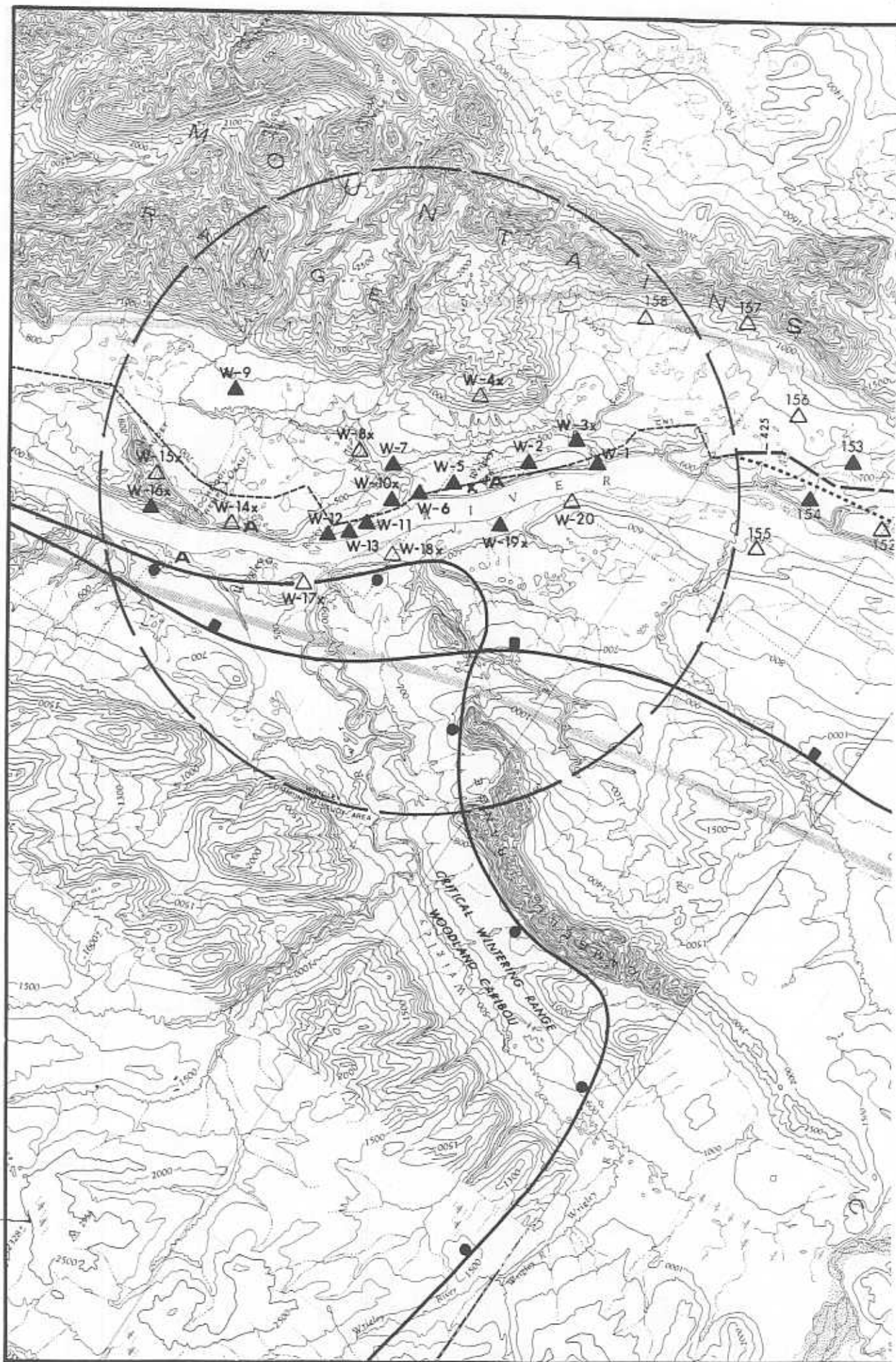
SITE NO.	MATERIAL TYPE		SUITABILITY OF MATERIAL	ESTIMATED VOLUME (cu. yds.)	ESTD. RECOV. DEPTH (feet)	OVERBURDEN			GROUND ICE (Content)	DRAINAGE	METHOD OF EXTRACTION	HAUL DIST. (miles)	ENVIRONMENTAL CONSIDERATIONS	ASSESSMENT OF SITE
	DESCRIPTION	SYM.				TYPE	DEPTH (feet)	DISPOSAL						
*134 X	Sand; silty, fine	SM-SP	Very Marginal Fill	N/A	—	Topsoil	1	—	Low to Medium	Good to North & East	—	0	No Critical Wildlife Areas Adjacent to River	Not Recommended
*135 X	Sand; silty, fine	SP-SM	Very Marginal Fill	N/A	—	Topsoil	1	—	Low to Medium	Good to North & East	—	1	No Critical Wildlife Areas	Not Recommended
*136 X	Gravel; silty	GM-GP	General Fill	N.D.	—	Silt	+1	—	None	Into Stream Channel	—	0	Within Active Stream Channel	Not Recommended
*137 X	Glacial Till; Sand & Gravel Pockets	ML-CI	Unsuitable	N/A	—	Topsoil & Peat	+2	—	Low to Medium	Poor to South	—	3	No Critical Wildlife Areas	Not Recommended
*138 X	Glacial Till	ML-CI	Unsuitable	N/A	—	Topsoil & Peat	+1	—	Low to Medium	Poorly Drained	—	3	No Critical Wildlife Areas	Not Recommended
*139	Sand & Gravel	SW-GW	Various Construction Aggregates	500,000	+20	Topsoil & Silt	1	Strip & Stockpile	Low	Fair to Northwest	Conventional	3	No Critical Wildlife Areas; Adjacent to Lake	Recommended for Development
*140	Sand, fine	SW-SP	Marginal General Fill	3,000,000	—	Topsoil	1	Strip & Stockpile	N.D.	Fair to Southwest	Conventional	0	No Critical Wildlife Areas	Possible Development
141	Gravel & Sand	GW-SW	Most Construction Aggregates	N.D.	—	Topsoil	—	Strip & Stockpile	—	Fair to Good to Adjacent Terrain	Conventional	+9	No Critical Wildlife Areas; Adjacent to Lake	Good Prospect
*142	Sand & Gravel	SW-GW	Most Construction Aggregates	+ several million	+10	Topsoil & Silt	1 to +5	Strip & Waste or Stockpile	Low	Well Drained to Adjacent Terrain	Conventional	1/2	No Critical Wildlife Areas; Sensitive Terrain	Recommended for Development
*143	Gravel; sandy	GW	Most Construction Aggregates	1,000,000	+10	Topsoil & Silt	2 to +5	Strip & Waste or Stockpile	Low	Fair to North & South	Conventional	3%	No Critical Wildlife Areas; Local Trapping	Recommended for Development
143A	Sand & Gravel	SW-GW	Most Construction Aggregates	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to Good to Adjacent Terrain & Streams	Conventional	8	No Critical Wildlife Areas; Local Trapping; Adjacent to Stream Channels	Good Prospect
144	Sand & Gravel; silty	SM-GM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good to Northeast	Conventional	1 1/2	No Critical Wildlife Areas	Poor Prospect, Low Volume
*145 X	Silt; sand & clay	ML-CI	Unsuitable	N/A	—	Topsoil & Peat	+1	—	High	Good to Adjacent Stream	—	0	Within Stream Channel; Domestic Fishing	Not Recommended
*146	Sand & Gravel	SW-GW	Most Construction Aggregates	600,000	+10	Topsoil & Silt	2	Strip & Stockpile	Low	Good to West	Conventional	2 1/2	No Critical Wildlife Areas; Local Trapping	Recommended for Development
147	Sand, Gravel & Silt	SM-GW	General Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	—	Good to West	Conventional	1/2	No Critical Wildlife Areas	Fair Prospect
148	Gravel & Sand	GW-SM	Most Construction Aggregates	N.D.	—	Topsoil	—	Strip & Stockpile	—	Fair to Good to Adjacent Terrain	Conventional	4	No Critical Wildlife Areas	Good Prospect
149	Bedrock; Limestone	—	Various Construction Aggregates	Unlimited	—	Drill & Screens	—	Strip & Waste	—	Well Drained	Quarry; Blasting & Crushing	2	No Critical Wildlife Areas	Good Prospect; Possible Development
150	Sand & Gravel; silty	SM-GM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	—	Good to West	Conventional	3	No Critical Wildlife Areas	Fair Prospect; Difficult Access
*151	Gravel & Sand	GW-SW	General Fill	1,500,000	+10	Topsoil & Peat	1	Strip & Stockpile	N.D.	Fair to West	Conventional	0	No Critical Wildlife Areas	Recommended for Development
152	Sand & Sand, silt gravel mixture	SP-SM; SM-GM	Marginal and Very Marginal Fill	N.D.	—	Topsoil	—	Strip & Stockpile	—	Fair to Adjacent Terrain & River	Conventional	1/2	No Critical Wildlife Areas; Adjacent to River	Poor to Fair Prospect
*153	Gravel	GW-GP	Most Construction Aggregates	3,000,000	+15	Topsoil & Silt	+1 1/2	Strip & Stockpile	Very Low	Fair to West	Conventional	1 1/2	No Critical Wildlife Areas; Local Trapping	Recommended for Development
*154	Gravel & Sand	GW-SW	General Fill; Base & Surface Courses	10,000,000	+10	Topsoil & Silt	+1	Strip & Stockpile	Low	Fair to West	Conventional	0	No Critical Wildlife Areas	Recommended for Development
155	Sand & Gravel; silty	SM-GM	Marginal General Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Fair to Good into Adjacent Terrain & Stream	Conventional	+4	Adjacent to Stream Channel & River	Poor to Fair Prospect
156	Sand & Gravel; silty	SM-GM	Marginal General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good to West	Conventional	2 1/2	No Critical Wildlife Areas; Sensitive Terrain	Poor Prospect
157	Gravel & Sand; some silt	GW-GM	General Fill	N.D.	—	Discontinuous Topsoil	—	Strip & Waste	N.D.	Good to West	Conventional	+4	No Critical Wildlife Areas; Sensitive Terrain	Good Prospect; Difficult Access
158	Gravel & Sand; some silt	GW-GM	General Fill	N.D.	—	Discontinuous Topsoil	—	Strip & Waste or Stockpile	N.D.	Good to West	Conventional	+5	No Critical Wildlife Areas; Sensitive Terrain	Good Prospect; Difficult Access

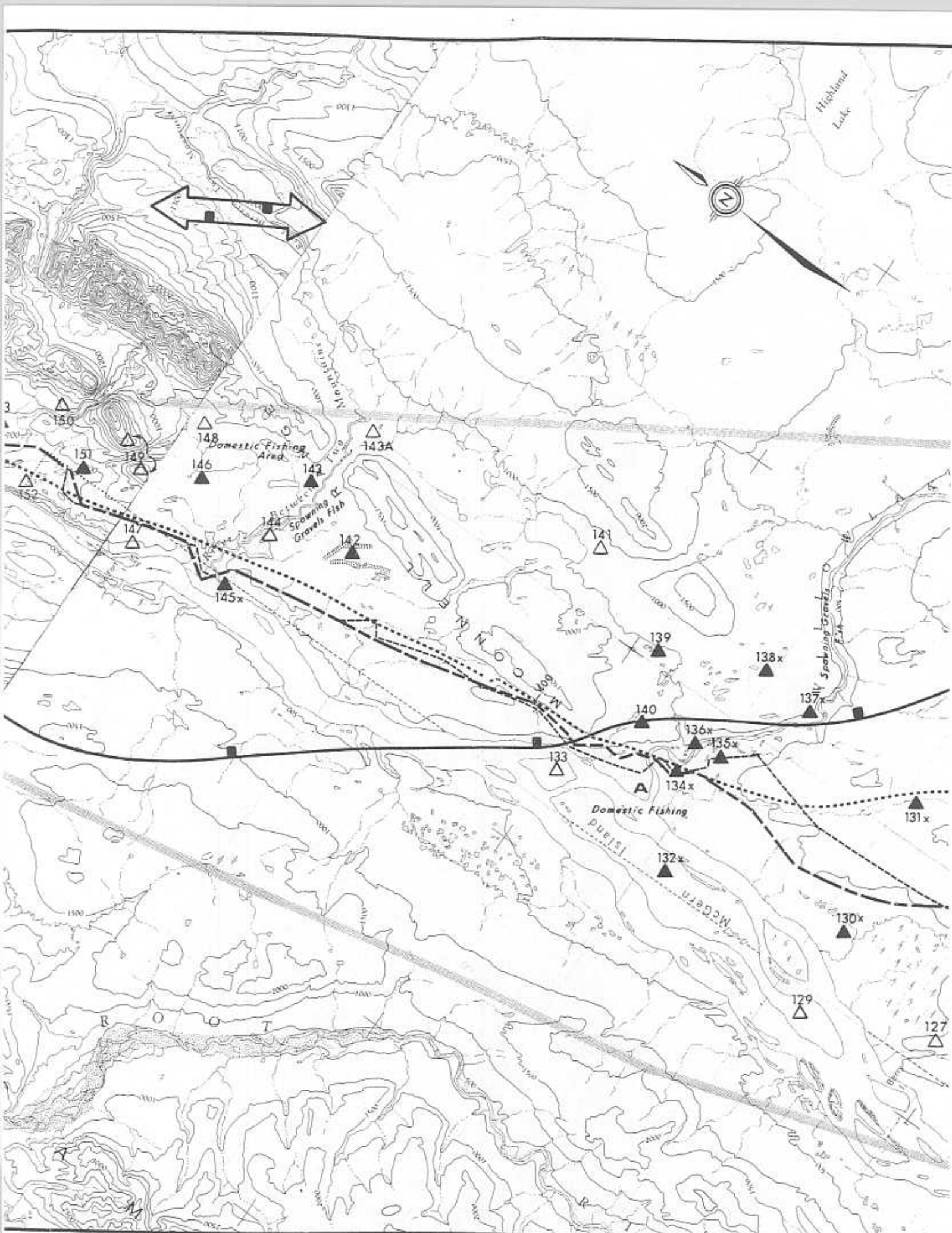
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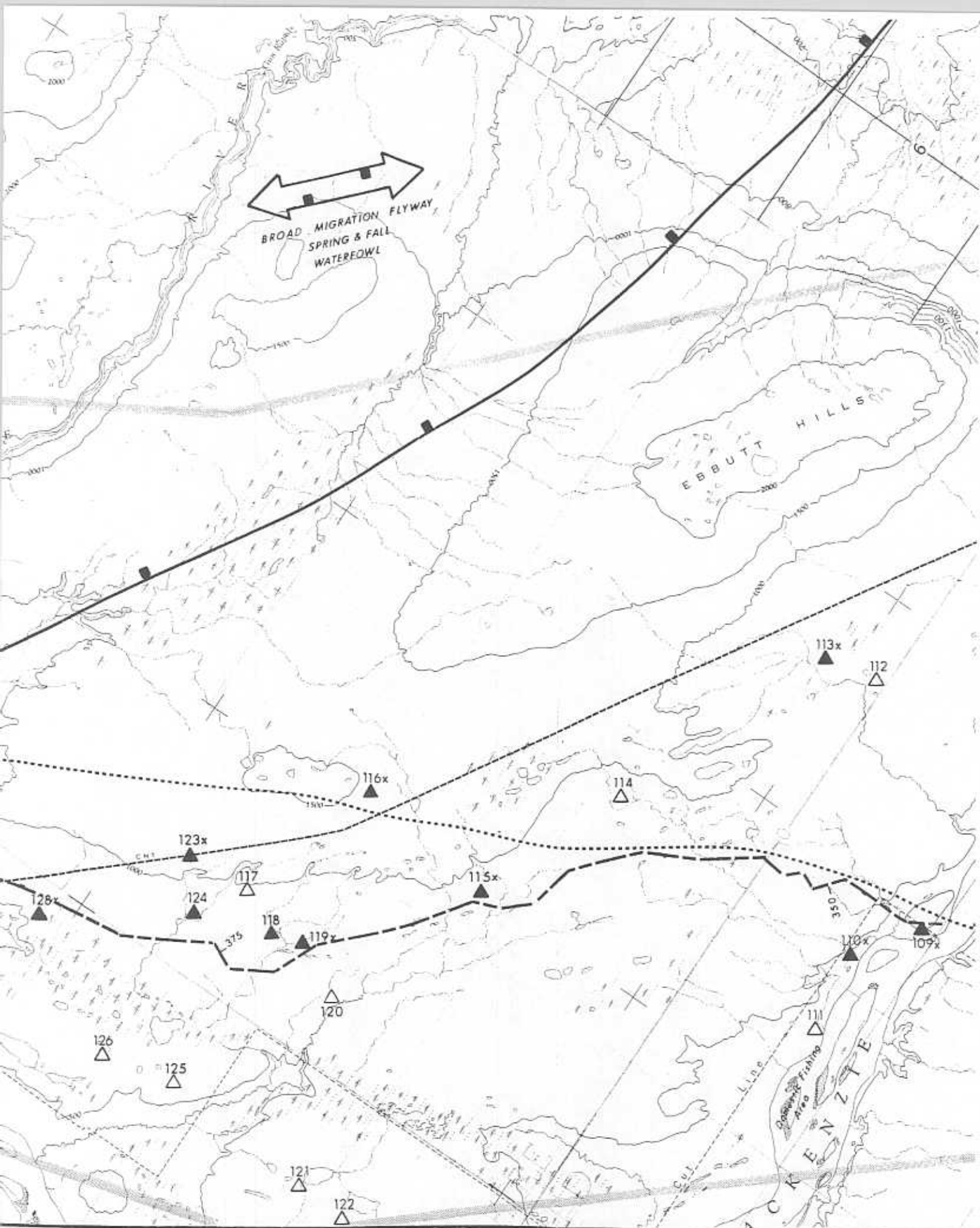
- SITE NUMBER: * Represents sites that have been drilled and/or test pitted; these sites are shown as solid triangles on the topographic strip maps.
X Drilled and/or test pitted sites "Not Recommended" for development.
- ESTIMATED VOLUME: N/A Not Applicable because the site does not contain materials of granular quality.
N.D. Not Determined.
- DRAINAGE: Rating as shown generally refers to drainage conditions within the site.
- METHOD OF EXTRACTION: "Conventional" indicates use of standard excavation equipment such as dozers, overhead loaders, backhoes and light rippers.
- HAUL DISTANCE: Is distance along existing and/or required access from the site to the nearest Mile Post on the proposed Mackenzie Highway (Ref. Text). "0" Haul Distance indicates site is on or immediately adjacent to the proposed Highway location.
- ENVIRONMENTAL CONSIDERATIONS: "Sensitive Terrain" refers to thermal and/or erosional sensitivity at, or adjacent to the site (Ref. Text).
- ASSESSMENT OF SITE: Ref. Text "Recommendations and Conclusions" and "Site Description" sections.

Fig 1-1

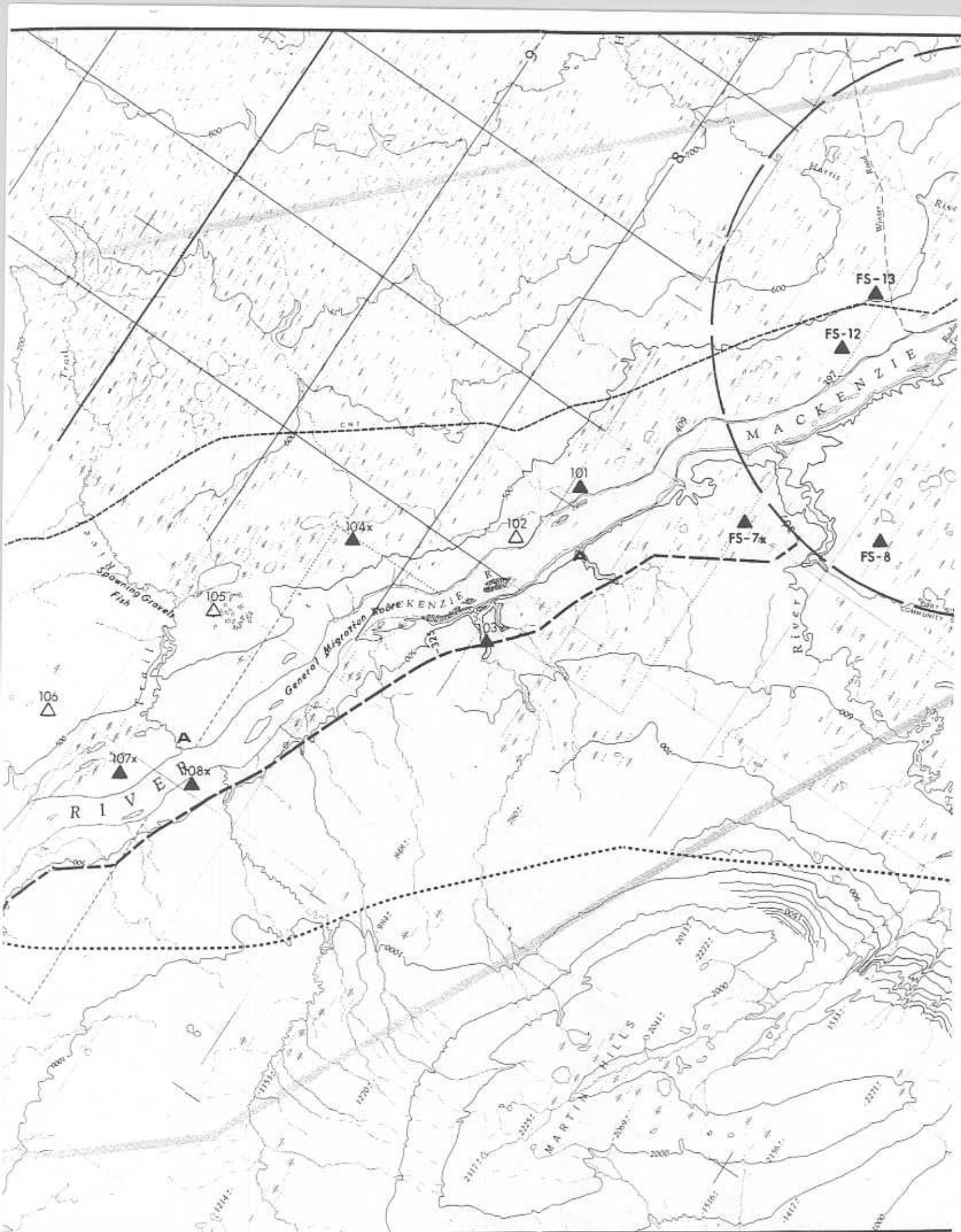
F16 1.2



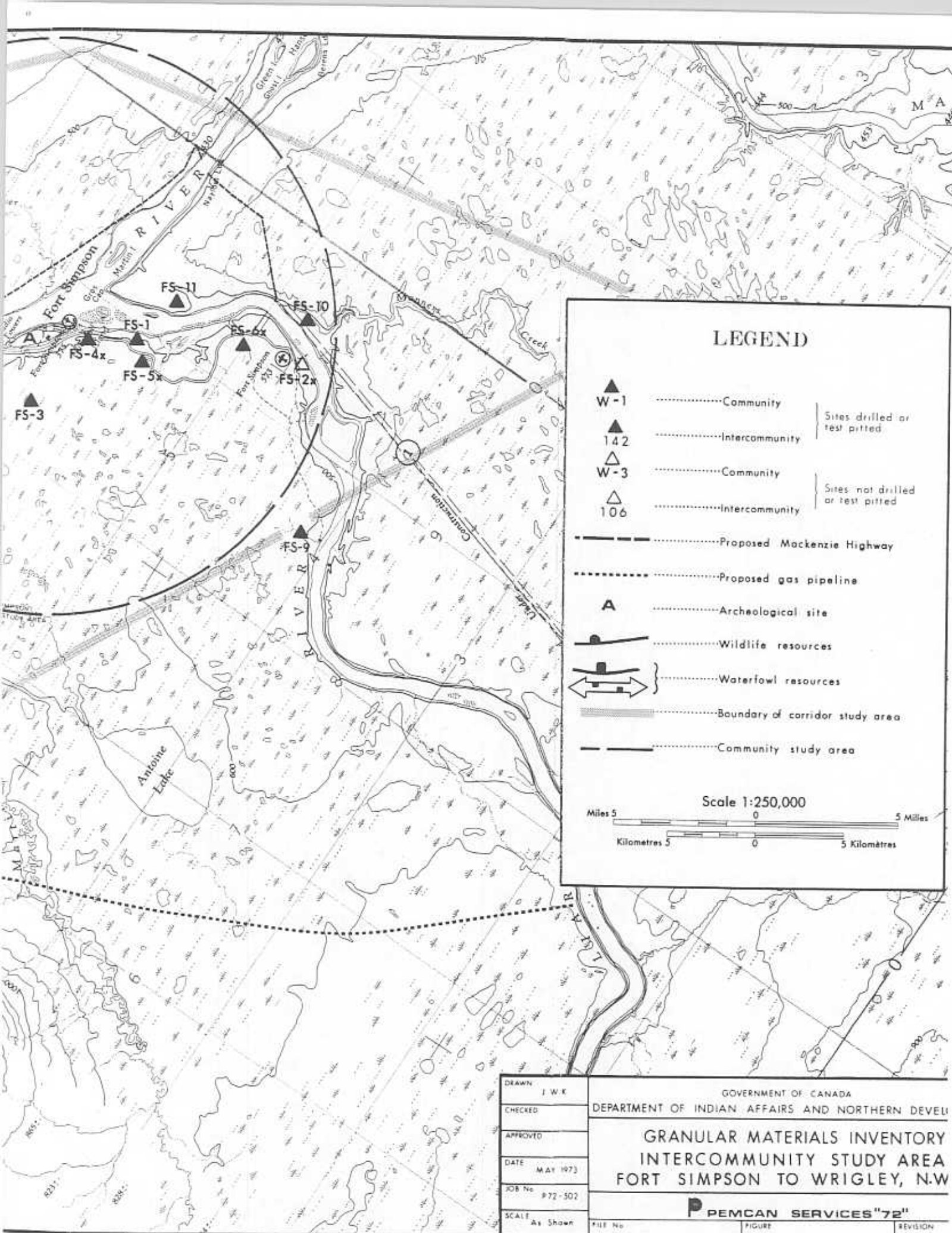




B ← C → D



C ← D → E



LEGEND

- ▲ W-1Community
 - ▲ 142Intercommunity
 - △ W-3Community
 - △ 106Intercommunity
- } Sites drilled or test pitted
- } Sites not drilled or test pitted
- Proposed Mackenzie Highway
 - - - Proposed gas pipeline
 - AArcheological site
 - ▲ Wildlife resources
 - ↔ Waterfowl resources
 - ▬ Boundary of corridor study area
 - ▬ Community study area

Scale 1:250,000



DRAWN	J W K	GOVERNMENT OF CANADA DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT GRANULAR MATERIALS INVENTORY INTERCOMMUNITY STUDY AREA FORT SIMPSON TO WRIGLEY, N.W.	
CHECKED			
APPROVED			
DATE	MAY 1973		
JOB No.	P72-502		
SCALE	As Shown		
	FILE No.	FIGURE	REVISION



WRIGLEY TO FORT NORMAN, N.W.T.

The results of the completed study indicate that the availability of quality granular materials in certain segments of the Intercommunity Study Area between Wrigley and Fort Norman is relatively limited. The scarcity of quality granular materials is especially acute in the area between Little Smith Creek and Fort Norman on the east side of the Mackenzie River.

On the basis of the airphoto interpretation and preliminary field reconnaissance data, a total of 45 sites was investigated in detail during the winter drilling program, of which 34 sites were confirmed to contain exploitable granular materials. These sites are categorized and grouped as follows:

1. The better quality granular materials were generally encountered in glaciofluvial outwash plains, terraces and trains containing irregularly stratified sand and gravel deposits with a low silt content. Large bodies of outwash materials are located on the east side of the Mackenzie River in the region between the Blackwater and Saline Rivers and south of Little Smith Creek. These deposits are represented by Sites 190, 191, 195, 196, 197, 213, 227 and 228 and are located as noted on the Site Location map in the Summary section of this report.

These sites contain an estimated quantity in excess of 130,000,000 cubic yards of good quality granular materials which are considered suitable for most construction requirements.

2. The kame-esker complexes, represented by Sites 224 and 232, contain variably washed, irregularly stratified and pocketed sand and gravel deposits along the western slopes of the McConnell Range in the region bordered by the Blackwater River and Big Smith Creek.

These two sites are estimated to contain approximately 2,500,000 cubic yards of good quality granular materials which are suitable for the production of base and surface course aggregates and good quality general fill in the pit run condition.



The general remoteness of these two sites from the location of the proposed utilities as well as the difficult access required across rugged terrain may limit the exploitation of granular materials from these sites.

3. The alluvial terraces on the east side of the Mackenzie River between the Ochre and Saline Rivers, which were investigated by drill holes, showed fair quality granular materials consisting of stratified sands and gravels with a highly variable silt content. These sand and gravel deposits are considered as good potential sources of general fill material in the pit run condition for the construction of road bases, pipeline berms and utility backfill.

These deposits are represented by Sites 164, 168, 169, 170, 176, 177, 178, 183, 184 and 185, and are estimated to contain in excess of 25,000,000 cubic yards of fair quality granular materials.

4. The alluvial cones and fans which are located at the mouths of various erosional gullies along the western flanks of the McConnell Range represent additional potential sources of poorer quality granular materials which may be suitable for marginal general fill requirements. The majority of these deposits could not be evaluated in detail because of difficult access; however, access to Site 159 was attained and drill holes were carried out during the winter field program.

Site 159 contains fair quality granular materials consisting of well graded, silty sand and gravel. An estimated quantity of approximately 1,000,000 cubic yards of gravel suitable for general fill is considered recoverable from this site.

5. Dunes, strand lines and deltaic deposits consisting of poorly graded, fine grained sand with a variable silt content which are represented by Sites 209, 244, 249, 251, 252, 253, 254, 255, 256 and 257 were investigated and catalogued in detail during the winter drilling program. These deltaic and eolian sand deposits are considered suitable only for very marginal fill material in the construction of subgrades for roads.



These sites were catalogued and recorded because of the acute deficiency of good quality construction materials in this portion of the Study Area, extending south from Fort Norman to Little Smith Creek.

6. Sites 162, 166, 220 and 226 which were investigated by drilling during the winter program, represent potential areas for quarry operations for the production of good quality manufactured aggregates for various construction requirements.

If these sites are developed as sources of granular materials, then extensive quantities of material are potentially available. The detailed assessment and recommendations for development of quarry operations at these sites are outlined in the Site Description section of the report.

7. Site FN 19, which is located within the Fort Norman Community Study Area, consists of a large glaciofluvial outwash plain, several square miles in area, containing good quality granular materials suitable for most construction requirements. It is considered that the available quantities of granular materials in this deposit are well in excess of the currently specified requirements for the Fort Norman community. Therefore, in view of the scarcity of granular materials on the west side of the Mackenzie River in this portion of the Intercommunity Study Area, the exploitation of granular materials from Site FN 19 should be considered for requirements apart from the needs of the Fort Norman community.

In addition to the preceding 34 sites, which contain exploitable granular materials or bedrock formations for use as engineering construction materials, eleven sites were drilled during the winter field program which did not contain granular type materials. These sites have been catalogued and recorded in the Site Description section of the report, but have been identified with the suffix "X" after the site number.

On the basis of detailed airphoto interpretation and known geological data, Sites 160, 161, 173, 175, 181, 182, 192, 199, 206 and 207 may be considered for the production



of manufactured aggregates by developing quarry operations in the competent limestone bedrock formations. In addition, sand and gravel deposits of varying quality may be exploited from the ice contact features along the western slopes of the McConnell Range represented by Sites 163, 186, 187, 204, 233 and 235. However, these sites are remotely located from the location of the currently proposed utilities and require difficult access across very rugged terrain.

All catalogued and assessed sites in the Wrigley to Fort Norman, N.W.T. Intercommunity Study Area, including the 34 which were confirmed to contain granular type materials are discussed in detail in the Site Description section of the report.

SITE No.	MATERIAL TYPE		SUITABILITY OF MATERIAL	ESTIMATED VOLUME (cu. yds.)	ESTD. RECOV. DEPTH (feet)	OVERBURDEN			GROUND ICE (Consist)	DRAINAGE	METHOD OF EXTRACTION	HAUL DIST. (miles)	ENVIRONMENTAL CONSIDERATIONS	ASSESSMENT OF SITE
	DESCRIPTION	SYM.				TYPE	DEPTH (feet)	DISPOSAL						
* 159	Gravel & Sand	GW-SM	General Fill	1,000,000	8-15	Topsoil	½	Strip & Stockpile	Low	Good to West	Conventional	3	No Critical Wildlife Areas	Recommended for Development
160	Bedrock; Limestone	—	Various Construction Aggregates	N.D.	—	Discontinuous Screens	—	Strip & Waste	Very low or none	Good to West and East	Quarry; Blasting & Crushing	0	No Critical Wildlife Areas	Good Prospect; Possible Development
161	Bedrock; Limestone	—	Various Construction Aggregates	Unlimited	—	Discontinuous Screens	—	Strip & Waste	Very low or none	Good	Quarry; Blasting & Crushing	3	No Critical Wildlife Areas	Good Prospect
* 162	Bedrock; Limestone	—	Various Construction Aggregates	Unlimited	—	Topsoil & Till	+1	Strip & Waste or Stockpile	Very Low	Good to West	Quarry; Blasting & Crushing	1½	No Critical Wildlife Areas	Possible Development
163	Gravel & Sand	GW-SM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good into River Channel	Conventional	2½	Adjacent to River Channel	Good Prospect
* 164	Sand & Gravel; silty	SM-GM	General Fill	1,500,000	+20	Topsoil	1	Strip & Stockpile	Low	Fair to West	Conventional	0	No Critical Wildlife Areas; Local Trapping	Recommended for Development
165	Sand & Gravel; Pockets; silty	SM-GM	Marginal Fill	N.D.	—	Topsoil & Silt	—	—	N.D.	Good into Stream Channel	—	0	Adjacent to Stream Channel	Not Suggested for Development
* 166	Bedrock; Limestone	—	General Fill; Base and Surface Courses	Unlimited	—	Fill	—	—	None	Good to Northwest	Quarry; Blasting & Crushing	3	No Critical Wildlife Areas; Sensitive Terrain	Recommended for Development
* 167 X	Silt; clayey, sandy	ML-MH	Unsuitable	N/A	—	Topsoil	1	—	High	Good to West	—	2	No Critical Wildlife Areas	Not Recommended
* 168	Sand & Gravel; silty	SM-GM	General Fill	3,000,000	+20	Topsoil	1	Strip & Stockpile	Low	Fair to West	Conventional	0	No Critical Wildlife Areas; Local Trapping	Recommended for Development
* 169	Sand & Gravel; silty	SM-GM	General Fill	1,000,000	+20	Topsoil	1	Strip & Stockpile	Low	Fair to West	Conventional	0	No Critical Wildlife Areas; Local Trapping	Recommended for Development
* 170	Sand & Gravel; silty	SM-GM	General Fill	2,000,000	+20	Topsoil	1 to +12	Strip & Waste or Stockpile	Low	Fair to West	Conventional	0	No Critical Wildlife Areas; Local Trapping	Recommended for Development
171	Sand & Gravel; silty	SM-GM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good into Adjacent River	Conventional	1½	Adjacent to Stream Channel	Fair Prospect
172	Sand & Gravel	SW-GW	Various Construction Aggregates	N.D.	—	Topsoil & Silt	—	—	N.D.	Good into Stream Channel	—	4	Adjacent to Active Stream Channel	Not Suggested for Development
173	Bedrock; Limestone	—	Various Construction Aggregates	Unlimited	—	Screens & Drift	—	Strip & Waste	N.D.	Good to West	Quarry; Blasting & Crushing	5	No Critical Wildlife Areas; Sensitive Terrain	Good Prospect; Difficult Access
174	Gravel & Sand	GW-SW	Various Construction Aggregates	N.D.	—	None	—	—	N.D.	Within the Active Stream	—	5	Within the Active Stream Channel	Not Suggested for Development
175	Bedrock; Limestone	—	Various Construction Aggregates	Unlimited	—	Screens	—	Strip & Waste	N.D.	Well Drained	Quarry; Blasting & Crushing	6½	No Critical Wildlife Areas	Good Prospect; Difficult Access
* 176	Sand & Gravel; silty	GM-SM	General Fill	10,000,000	+15	Topsoil & Silt	1 to +10'	Strip & Waste or Stockpile	Low	Fair to West	Conventional	0	No Critical Wildlife Areas	Recommended for Development
* 177	Gravel & Sand; silty	GM-SM	General Fill	750,000	+10	Topsoil & Silt	+3	Strip & Waste or Stockpile	Low	Fair to West	Conventional	0	No Critical Wildlife Areas	Recommended for Development
* 178	Sand & Gravel	SM-GW	General Fill	2,000,000	+10	Topsoil & Silt	1 to +8	Strip & Waste or Stockpile	Low	Fair to West	Conventional	0	No Critical Wildlife Areas	Recommended for Development
179	Silt & Sand; Gravel Pockets	ML-SM-GM	Probably Unsuitable	N.D.	—	Topsoil & Silt	—	—	N.D.	Fair into Stream Channel	—	1½	Adjacent to Stream Channel	Not Suggested for Development
180	Sand & Gravel; silty	SM-GM	General Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Fair to Good to East & South	Conventional	2	No Critical Wildlife Areas	Fair to Good Prospect
181	Bedrock; Limestone	—	Various Construction Aggregates	Unlimited	—	Screens & Drift	—	Strip & Waste	N.D.	Good to West	Quarry; Blasting & Crushing	2	No Critical Wildlife Areas	Good Prospect; Possible Development
182	Bedrock; Limestone	—	Various Construction Aggregates	Unlimited	—	Discont. Screens & Drift	—	Strip & Waste	N.D.	Good to West	Quarry; Blasting & Crushing	1½	No Critical Wildlife Areas	Good Prospect; Possible Development
* 183	Gravel; silty & clayey	GM-GC	General Fill	1,000,000	+20	Topsoil	½	Strip & Stockpile	Low	Fair to West	Conventional	0	No Critical Wildlife Areas	Recommended for Development
* 184	Gravel; sandy, silty	GW-GM	General Fill	1,500,000	+20	Topsoil	½	Strip & Stockpile	Low	Good to West	Conventional	0	No Critical Wildlife Areas	Recommended for Development
* 185	Gravel; sandy, silty	GW-GM	General Fill	2,500,000	+20	Topsoil	½	Strip & Stockpile	Low	Fair to West and East	Conventional	0	No Critical Wildlife Areas	Recommended for Development
186	Gravel & Sand; silty	GW-GM	General Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Good into Adjacent River	Conventional	1½	Adjacent to Stream Channel	Good Prospect
187	Gravel & Sand; silty	GW-GM	General Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Good into Adjacent River	Conventional	1½	Adjacent to Stream Channel	Good Prospect; Possible Development
* 188 X	Sand & Gravel; silty	SM-GM	Various Construction Aggregates	N.D.	—	Silt	½	—	—	into Stream Channel	—	—	Within Active Stream Channel	Not Recommended
* 189 X	Gravel; sandy	GW	Various Construction Aggregates	50,000	8	Topsoil	1	—	Low	Well Drained	—	0	No Critical Wildlife Areas	Not Recommended
* 190	Gravel & Sand	GW-SW	Various Construction Aggregates	10,000,000	+20	Topsoil	1	Strip & Stockpile	Low	Good to East, West & North	Conventional	½	No Critical Wildlife Areas	Recommended for Development
* 191	Sand & Gravel	SW-GW	Various Construction Aggregates	30,000,000	+20	Topsoil	1	Strip & Stockpile	Low	Fair to South	Conventional	2	No Critical Wildlife Areas; Sensitive Terrain	Possible Development
192	Bedrock; Limestone	—	Various Construction Aggregates	N.D.	—	Topsoil & Drift	—	Strip & Waste	N.D.	Good to West	Quarry; Blasting & Crushing	8	No Critical Wildlife Areas; Sensitive Terrain	Good Prospect; Possible Development
193	Silt & Sand; like gravel	ML-GM	Very Marginal Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to West	Conventional	5	No Critical Wildlife Areas; Sensitive Terrain	Poor Prospect
194	Gravel & Sand	GW-SW	Various Construction Aggregates	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to Adjacent Terrain	Conventional	1	No Critical Wildlife Areas	Good Prospect

SITE NO.	MATERIAL TYPE		SUITABILITY OF MATERIAL	ESTIMATED VOLUME (cu yds.)	EST'D RECOV DEPTH (feet)	OVERBURDEN			GROUND ICE (Content)	DRAINAGE	METHOD OF EXTRACTION	HAUL DIST. (miles)	ENVIRONMENTAL CONSIDERATIONS	ASSESSMENT OF SITE
	DESCRIPTION	SYM.				TYPE	DEPTH (feet)	DISPOSAL						
* 195	Gravel & Sand	GW-SW	Various Construction Aggregates	10,000,000	+20	Topsoil	1	Strip & Stockpile	Low	Fair to Adjacent Terrain	Conventional	0	No Critical Wildlife Areas	Recommended for Development
* 196	Gravel & Sand	GW-SW	Various Construction Aggregates	40,000,000	+20	Topsoil	1	Strip & Stockpile	Low	Fair to Adjacent Terrain	Conventional	2	No Critical Wildlife Areas; Sensitive Terrain	Recommended for Development
* 197	Gravel & Sand	GW-SW	Various Construction Aggregates	15,000,000	+20	Topsoil	1	Strip & Stockpile	Low	Fair to Adjacent Terrain	Conventional	0	No Critical Wildlife Areas	Recommended for Development
* 198 X	Silt & Sand	ML	Unsuitable	N/A	—	Topsoil	1	—	High	Good to West	—	2½	No Critical Wildlife Areas; Sensitive Terrain	Not Recommended
199	Bedrock; Limestone	—	Various Construction Aggregates	Unlimited	—	Drift & Screes	—	Strip & Waste	N.D.	Good to West	Quarry; Blasting & Crushing	1½	No Critical Wildlife Areas	Good Prospect; Possible Development
200	Sand & Gravel; silty	SM-GM	Marginal General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to Southwest	Conventional	0½	No Critical Wildlife Areas	Fair to Poor Prospect
201	Sand & Gravel; silty	SM-GM	Marginal General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to West	Conventional	+7	No Critical Wildlife Areas	Poor Prospect; Difficult Access
202	Sand & Gravel; silty	SM-GM	Marginal General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to Northwest & West	Conventional	2½	No Critical Wildlife Areas	Fair to Poor Prospect; Difficult Access
203	Sand & Gravel; silty	SM-GM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Well Drained	Conventional	6	No Critical Wildlife Areas	Fair to Good Prospect; Difficult Access
204	Sand & Gravel; silty	SM-GM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good to South & West	Conventional	7	No Critical Wildlife Areas	Good Prospect; Difficult Access
205	Sand; silty, gravelly	SM-SW	Very Marginal Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to Southwest	Conventional	3½	No Critical Wildlife Areas	Poor Prospect
206	Bedrock; Limestone	—	General Fill; Base & Surface Courses	N.D.	—	Topsoil & Drift	—	Strip & Waste	N.D.	Good to West	Quarry; Blasting & Crushing	1½	No Critical Wildlife Areas	Good Prospect; Possible Development
* 207 X	Glacial Till	ML-CI	Unsuitable	N/A	—	Topsoil	1	—	Medium	Good to West	—	1½	No Critical Wildlife Areas	Not Recommended
* 208 X	Sand & Gravel; silty	SM-GM	General Fill	N.D.	+5	Silt; organic	+½	—	None to Low	Into Adjacent Stream Channel	—	0	Within Active Stream Channel; No Critical Wildlife Areas	Not Recommended
* 209	Sand; fine	SP	Very Marginal Fill	3,000,000	+10	Topsoil	½	Strip & Stockpile	Low	Fair to North & West	Conventional	0	No Critical Wildlife Areas	Possible Development
210	Sand; silty	SM	Very Marginal Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Fair to West & East	Conventional	3	No Critical Wildlife Areas	Poor Prospect
211	Sand & Gravel; silty	SM-GM	Marginal General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to West	Conventional	2	No Critical Wildlife Areas	Fair to Poor Prospect
212	Sand & Gravel; silty	SM-GM	General to Marginal Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good	Conventional	6	No Critical Wildlife Areas	Fair to Good Prospect
* 213	Sand; fine to coarse; silty	SW-SM	General Fill	5,000,000	+15	Topsoil	+1	Strip & Stockpile	Low	Good into Adjacent River	Conventional	½	No Critical Wildlife Areas	Recommended for Development
214	Sand; Gravel pockets	SM-GM	General Fill	N.D.	N.D.	Topsoil & Silt	—	—	N.D.	Good into Adjacent River	—	0	Within and Adjacent to Active Stream Channel	Not Suggested for Development
* 215 X	Silt & Sand; clayey	SM-ML	Unsuitable	N/A	—	Peat & Organic Silt	2	—	Medium to High	Good to South & West	—	½	No Critical Wildlife Areas	Not Recommended
216	Silt & Sand; gravel bars	ML-SM, SM-GW	Unsuitable	N/A	—	Topsoil & Silt	—	—	N.D.	Fair into Adjacent Stream Channel	—	+3	Within and Adjacent to Active Stream Channel	Not Suggested for Development
217	Sand & Gravel; silty	SM-GM	General to Marginal Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Good to South	Conventional	½	Adjacent to Stream Channel	Fair Prospect
218	Bedrock; Limestone	—	General Fill; Base & Surface Courses	N.D.	—	Topsoil & Drift	—	Strip & Waste	N.D.	Good to West	Quarry; Blasting & Crushing	1½	No Critical Wildlife Areas	Fair Prospect; Possible Development
219	Sand & Gravel; silty	SM-GM	Probable Marginal Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good to Southwest	Conventional	8	No Critical Wildlife Areas	Poor to Fair Prospect
* 220	Bedrock; Limestone	—	All Construction Aggregates	Unlimited	—	Topsoil & Till	0 to +10	Strip & Waste or Stockpile	Very low	Good to West	Quarry; Blasting & Crushing	0	No Critical Wildlife Areas	Recommended for Development
* 221 X	Bedrock; Limestone	—	N.D.	N/A	—	Peat, Topsoil & Silt	+8	—	High	Good to Southwest	—	1½	No Critical Wildlife Areas	Not Recommended
222	Sand; silty	SM	Very Marginal Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Fair to Good to Northeast	Conventional	8	Adjacent to Stream Channel	Poor Prospect
223	Sand; silty	SM	Very Marginal Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Fair to Good to East	Conventional	4	No Critical Wildlife Areas	Poor Prospect
* 224	Gravel & Sand	GW-SW	General Fill	+2,000,000	+20	Topsoil	+½	Strip & Stockpile	Very Low	Good to West	Conventional	5	No Critical Wildlife Areas	Possible Development
225	Sand & Gravel; silty	SM-GM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good to North	Conventional	5½	No Critical Wildlife Areas	Fair Prospect
* 226	Bedrock; Limestone	—	General Fill; Base Surface Courses	Unlimited	—	Topsoil; Colluvium & Till	+1	Strip, Waste & Stockpile	Very Low	Good to West & South	Quarry; Blasting & Crushing	7	No Critical Wildlife Areas	Possible Development
* 227	Sand & Gravel	SW-GW	General Fill	25,000,000	+10	Topsoil	1	Strip & Stockpile	Low	Good to North & West	Conventional	3	No Critical Wildlife Areas	Recommended for Development
* 228	Sand & Gravel	SW-GW	Most Construction Aggregates	8,000,000	+15	Topsoil	1	Strip & Stockpile	Low	Good to Adjacent Streams	Conventional	0	No Critical Wildlife Areas	Recommended for Development
229	Silt & Sand; gravel bars	ML-SM, GW	N.D.	N/A	—	Topsoil & Silt	—	—	N.D.	Into Adjacent Stream Channel	—	5	Adjacent and within Stream Channel	Not Suggested for Development

SITE NO.	MATERIAL TYPE		SUITABILITY OF MATERIAL	ESTIMATED VOLUME (cu. yds.)	EST'D. RECOV. DEPTH (feet)	OVERBURDEN			GROUND ICE (Content)	DRAINAGE	METHOD OF EXTRACTION	HAUL DIST. (miles)	ENVIRONMENTAL CONSIDERATIONS	ASSESSMENT OF SITE
	DESCRIPTION	SYM.				TYPE	DEPTH (feet)	DISPOSAL						
230	Sand & Silt	ML-SM	Very Marginal Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Fair to Northeast	—	6	No Critical Wildlife Areas	Poor Prospect
231	Sand	SW	Marginal General Fill	N.D.	—	Topsoil & Silt	—	—	N.D.	Fair into Stream Channel	—	—	Adjacent to Active Stream Channel	Not Suggested for Development
* 232	Sand & Gravel	SW-GP	General Fill	500,000	+10	Topsoil	+1/2	Strip & Stockpile	Low	Well Drained to Southwest	Conventional	4	No Critical Wildlife Areas	Recommended for Development
233	Sand & Gravel, silty	SM-GM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good to Southeast	Conventional	8	No Critical Wildlife Areas	Good Prospect
234	Bedrock, shale & dolomite	—	General Fill; Base & Surface Courses	Unlimited	—	Topsoil, Screen & drift	—	Strip & Waste	N.D.	Well Drained	Quarry, Blasting & Crushing	3 1/2	No Critical Wildlife Areas	Good Prospect; Possible Development
235	Sand & Gravel, silty	SM-GM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to Good	Conventional	0	No Critical Wildlife Areas	Good Prospect
236	Sand & Gravel, silty	SM-GW	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good into Stream Channel	Conventional	0	No Critical Wildlife Areas	Fair to Good Prospect
237	Silt & Sand	ML-SM	Probably Unsuitable	N.D.	—	Topsoil	—	—	N.D.	Fair to Poor to South	—	4	No Critical Wildlife Areas	Not Suggested for Development
238	Silt & Sand	ML-SM	N.D.	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Poor to Northwest	Conventional	5	No Critical Wildlife Areas	Poor Prospect
239	Silt & Sand	ML-SM	Probably Unsuitable	N/A	—	Topsoil	—	—	N.D.	Into Stream Channel	—	5	No Critical Wildlife Areas	Not Suggested for Development
240	Silt & Sand	ML-SM	Probably Unsuitable	N/A	—	Topsoil	—	—	N.D.	Poor	—	3	No Critical Wildlife Areas	Not Suggested for Development
241	Silt & Sand, some gravel	ML-SM	Very Marginal Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Poor	Conventional	5 1/2	No Critical Wildlife Areas	Poor Prospect
242	Sand & Gravel, silty	SM-GW	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to West	Conventional	5	No Critical Wildlife Areas	Fair to Good Prospect
243	Silt, sand, clay mixture	—	Very Marginal Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to West	Conventional	3 1/2	No Critical Wildlife Areas	Not Suggested for Development
* 244	Sand, silty	SP-SM	Very Marginal Fill	N.D.	+15	Topsoil	1	Strip & Stockpile	Low	Fair to North & South	Conventional	1 1/2	No Critical Wildlife Areas	No Granular Materials
245	Sand, silty	SM	Very Marginal Fill	N.D.	—	Topsoil & Silt	—	—	N.D.	Into Adjacent Stream Channel	—	0	Adjacent to Stream Channel	Not Suggested for Development
246	Sand, silty	SM	Very Marginal Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Fair to Good to East & West	Conventional	0	Adjacent to Stream Channel	Poor Prospect
247	Sand, silty	ML-SM	Very Marginal Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Fair to North & South	Conventional	0	Adjacent to Stream Channel	Poor Prospect
* 248 X	Sand & Silt	SM-ML	Unsuitable	N/A	—	Topsoil	+1/2	—	High	Poor to South	—	1 1/2	No Critical Wildlife Areas; Sensitive Terrain	Not Recommended
* 249	Sand, fine	SP	Very Marginal Fill	700,000	+15	Topsoil	1/2	Strip & Stockpile	Low	Well Drained	Conventional	0	No Critical Wildlife Areas	Possible Development
* 250 X	Sand, silty	SM	Unsuitable	N/A	—	Topsoil & Peat	1	—	Medium to High	Fair to Southwest	—	0	No Critical Wildlife Areas	Not Recommended
251	Sand, fine	SP	Very Marginal Fill	+5,000,000	+15	Topsoil	1/2	Strip & Stockpile	Low	Well Drained	Conventional	4	No Critical Wildlife Areas; Sensitive Terrain	Possible Development
* 252	Sand, fine	SP	Very Marginal Fill	1,000,000	+15	Topsoil	1/2	Strip & Stockpile	Low	Well Drained	Conventional	4	No Critical Wildlife Areas; Sensitive Terrain	Possible Development
* 253	Sand, fine	SP	Very Marginal Fill	2,000,000	+15	Topsoil	1/2	Strip & Stockpile	Low	Well Drained	Conventional	4	No Critical Wildlife Areas; Sensitive Terrain	Possible Development
* 254	Sand, fine	SP	Very Marginal Fill	1,000,000	+15	Topsoil	1/2	Strip & Stockpile	Low	Well Drained	Conventional	1 1/2	No Critical Wildlife Areas; Sensitive Terrain	Possible Development
* 255	Sand, fine	SP	Very Marginal Fill	7,000,000	+15	Topsoil	1/2	Strip & Stockpile	Low	Well Drained	Conventional	0	No Critical Wildlife Areas	Possible Development
* 256	Sand, fine	SP	Very Marginal Fill	1,500,000	+15	Topsoil	1/2	Strip & Stockpile	Low	Well Drained	Conventional	1/2	No Critical Wildlife Areas	Possible Development
* 257	Sand, fine	SP	Very Marginal Fill	250,000	+15	Topsoil	1/2	Strip & Stockpile	Low	Well Drained	Conventional	0	No Critical Wildlife Areas	Possible Development
* 258 X	Sand, some silt	SM	Unsuitable	N/A	—	Topsoil & Peat	1	—	High	Fair to Southwest	—	0	No Critical Wildlife Areas	Not Recommended

Notes:

— SITE NUMBER:

* Represents sites that have been drilled and/or test pilled; these sites are shown as solid triangles on the topographic strip maps.

— ESTIMATED VOLUME:

X Drilled and/or test pilled sites "Not Recommended" for development.

N/A Not Applicable because the site does not contain materials of granular quality.

N.D. Not Determined.

— DRAINAGE:

Rating as shown generally refers to drainage conditions within the site.

— METHOD OF EXTRACTION:

"Conventional" indicates use of standard excavation equipment such as dozers, overhead loaders, backhoes and light rippers.

— HAUL DISTANCE:

Is distance along existing and/or required access from the site to the nearest Mile Post on the proposed Mackenzie Highway (Ref. Text). "0" Haul Distance indicates site is on or immediately adjacent to the proposed Highway location.

— ENVIRONMENTAL CONSIDERATIONS:

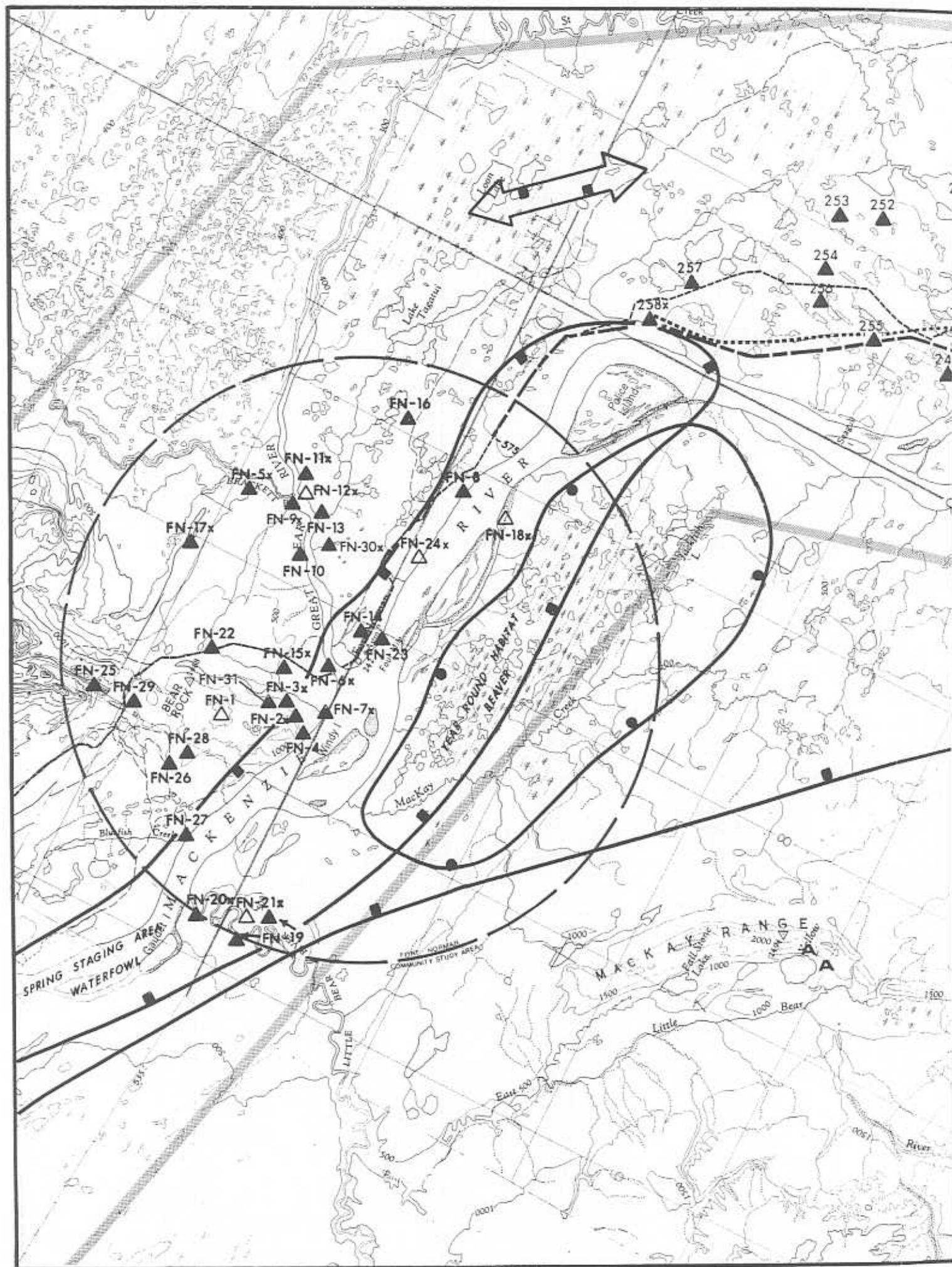
"Sensitive Terrain" refers to thermal and/or erosional sensitivity of, or adjacent to the site (Ref. Text).

— ASSESSMENT OF SITE:

Ref. Text "Recommendations and Conclusions" and "Site Description" sections.

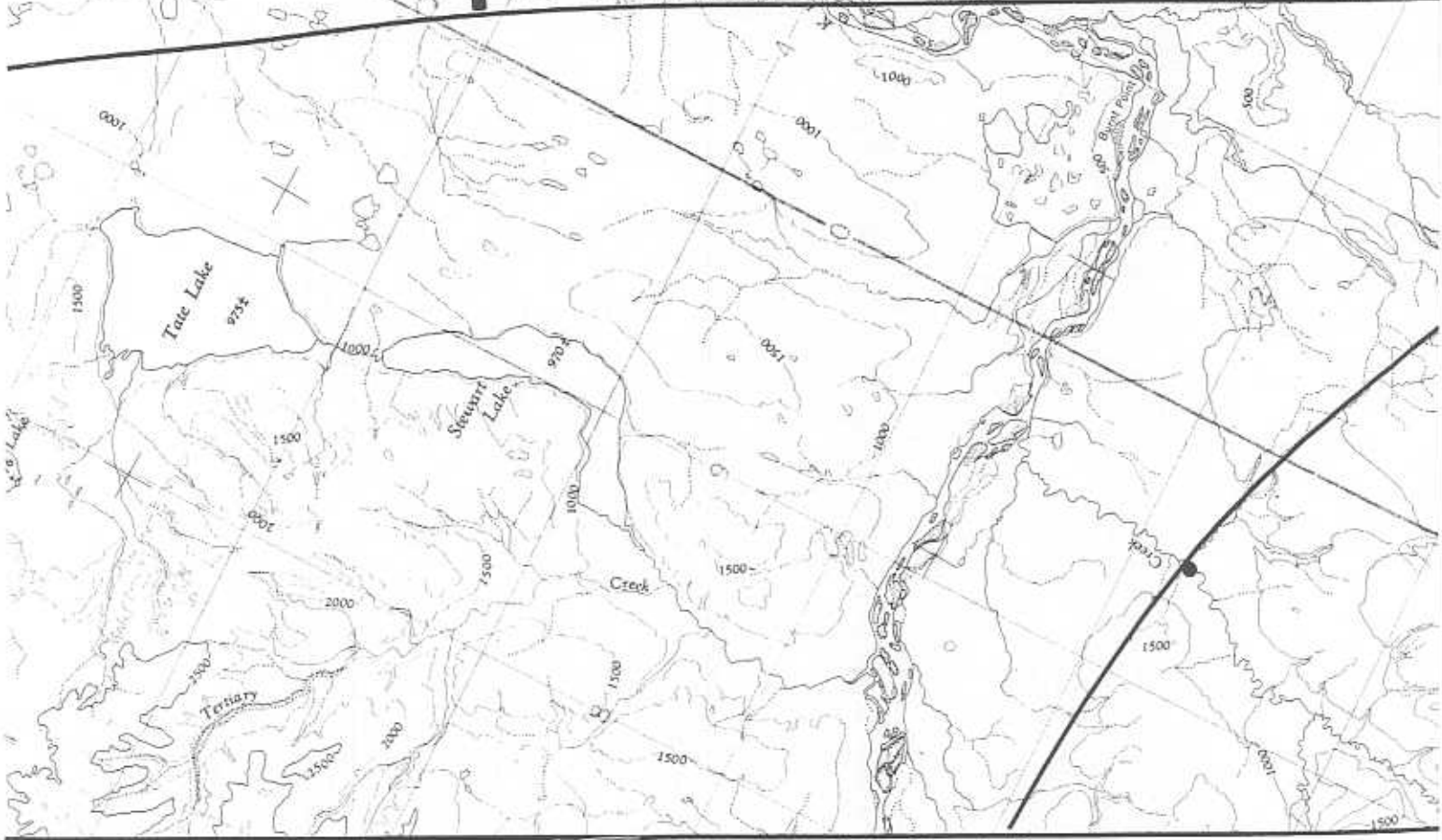
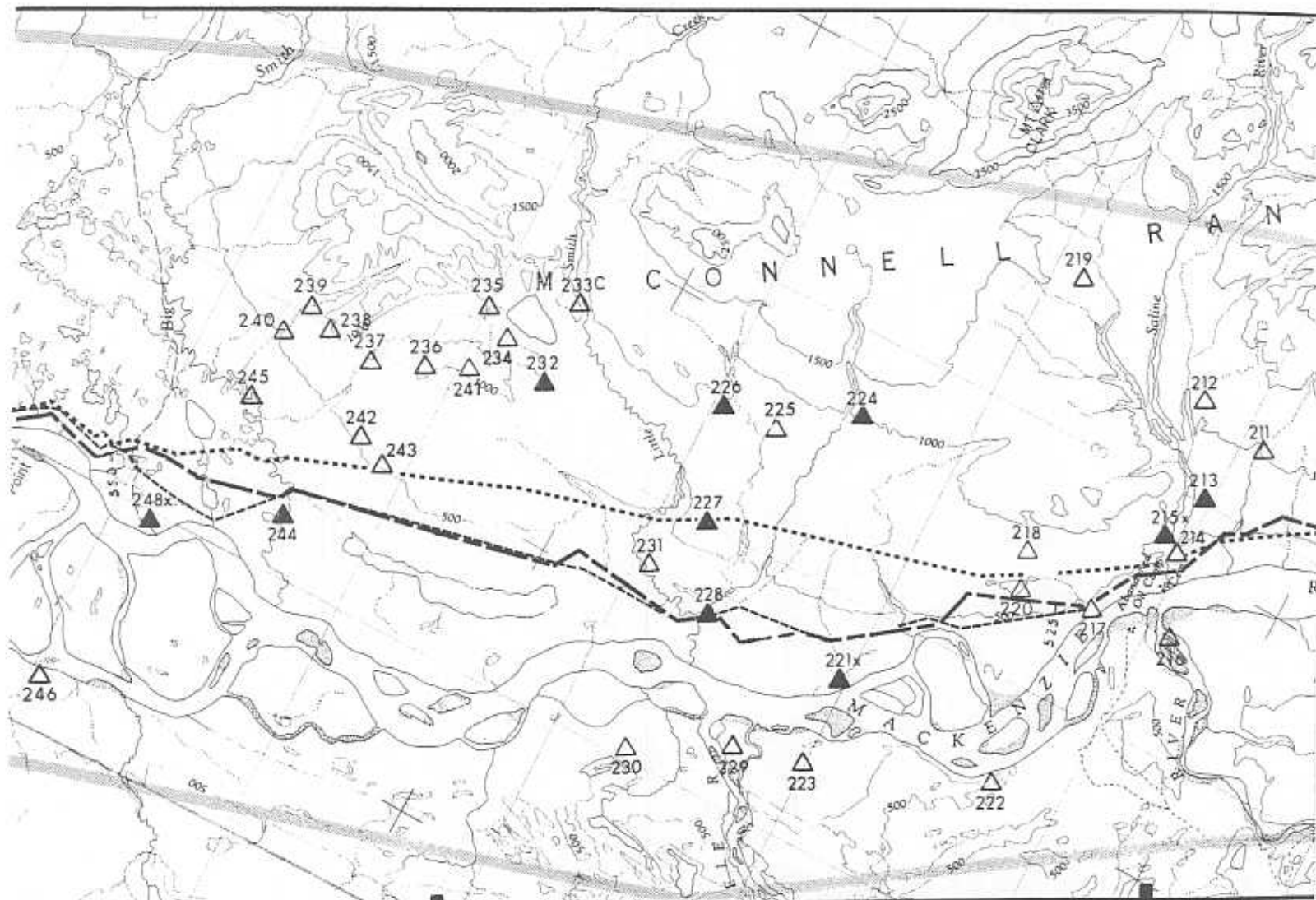
761.2

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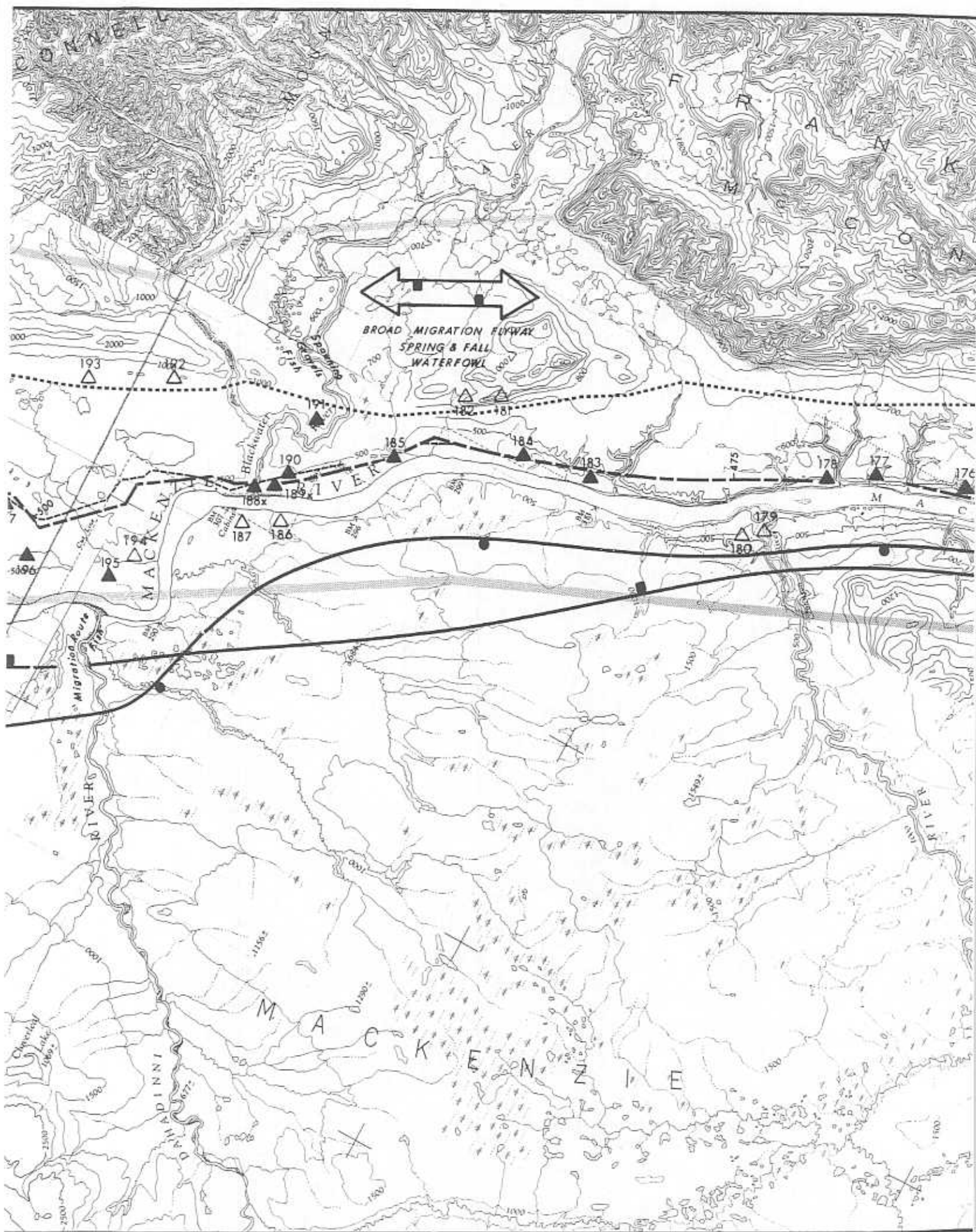
A > B



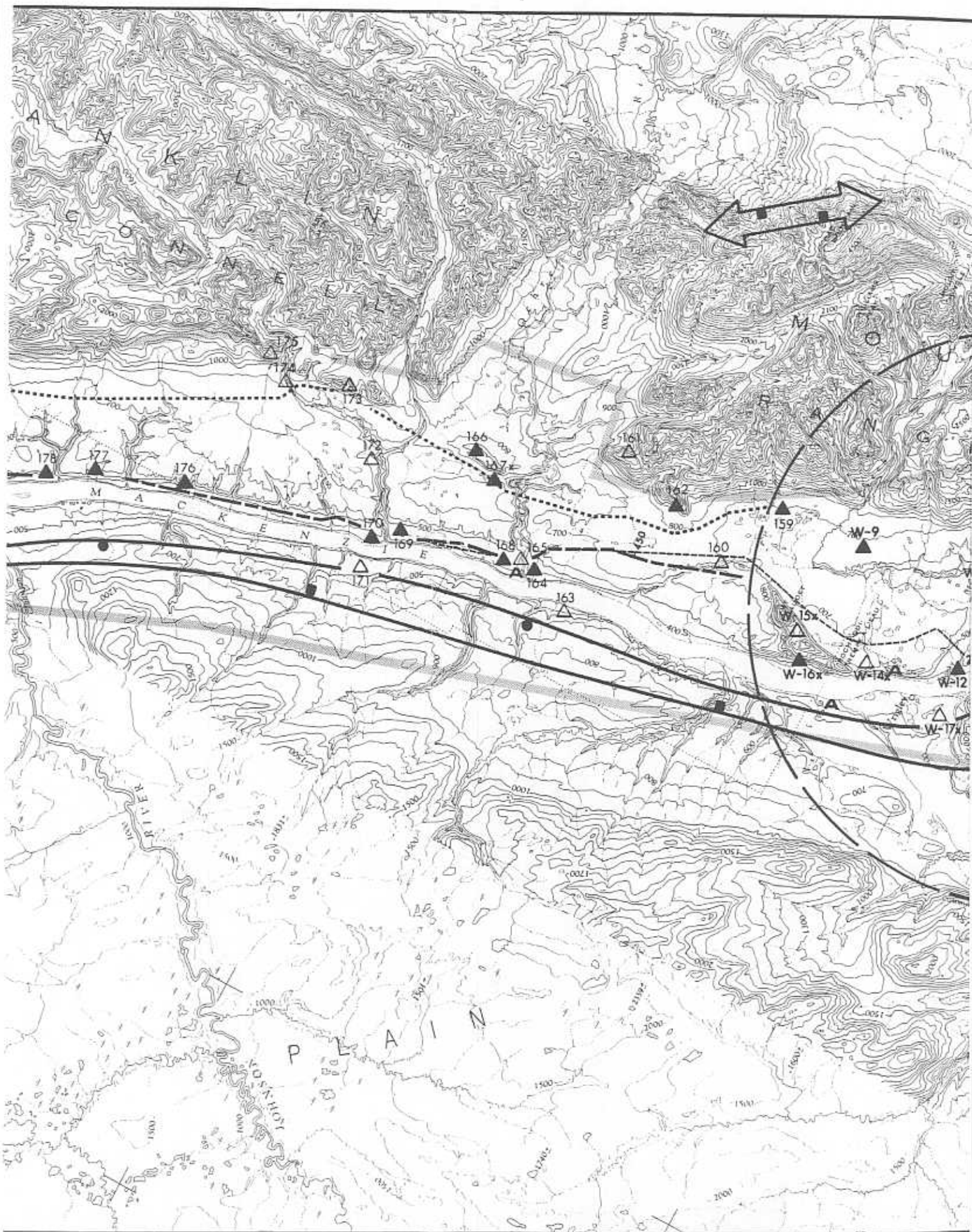


B ← C → D

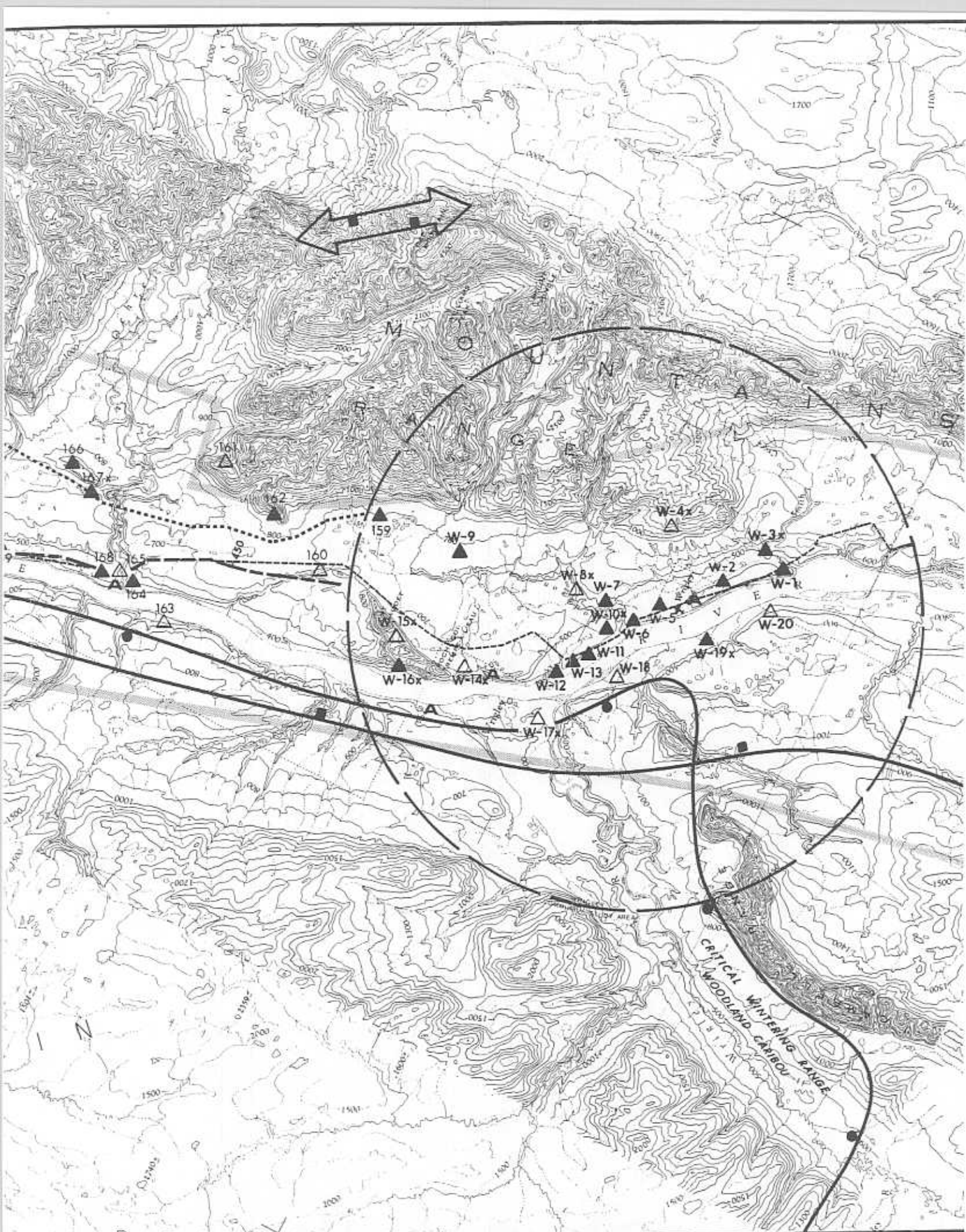




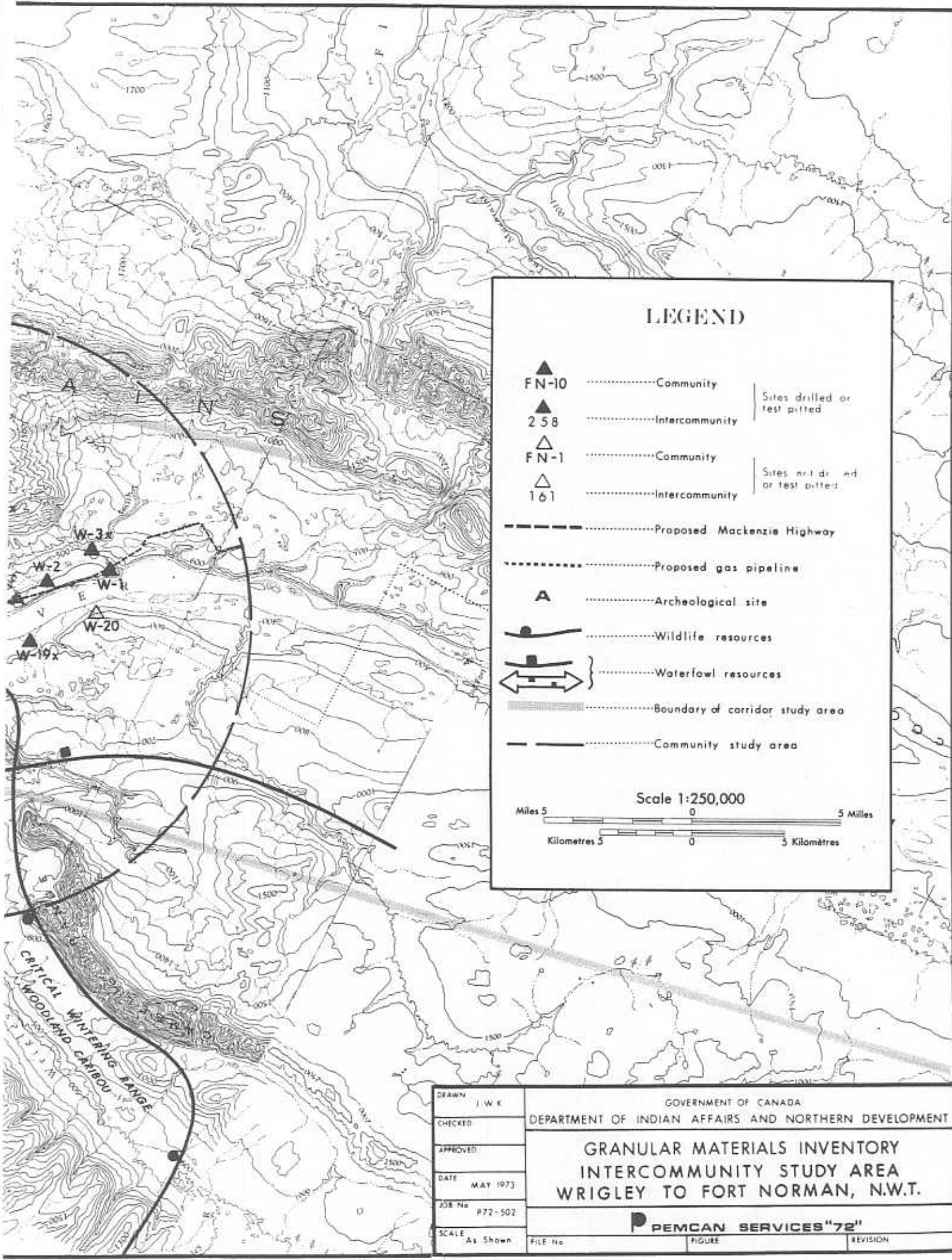
D ← E → F



E ← F → G

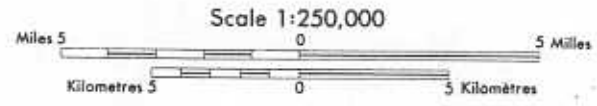


F < G > H



LEGEND

- ▲ FN-10Community
- ▲ 258Intercommunity
- △ FN-1Community
- △ 161Intercommunity
- Proposed Mackenzie Highway
- Proposed gas pipeline
- AArcheological site
- Wildlife resources
- Waterfowl resources
- Boundary of corridor study area
- Community study area



DRAWN	J. W. K.
CHECKED	
APPROVED	
DATE	MAY 1973
JOB No	P77-502
SCALE	As Shown

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY INTERCOMMUNITY STUDY AREA WRIGLEY TO FORT NORMAN, N.W.T.

PEMCAN SERVICES '72'

FILE No	FIGURE	REVISION
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G ← H



FORT NORMAN TO NORMAN WELLS, N.W.T.

The results of the completed study indicate that the availability of quality granular materials in certain segments of the Intercommunity Study Area between Fort Norman and Norman Wells, N.W.T. is relatively limited. The scarcity of quality granular materials is especially acute north of the Bear Rock massif to Vermilion Creek on the east side of the Mackenzie River and north of Little Bear River to the north boundaries of this Study Area on the west side of the Mackenzie River.

On the basis of the airphoto interpretation and preliminary field reconnaissance data, a total of nineteen sites was investigated in detail during the winter drilling program, of which nine sites were confirmed to contain exploitable granular materials. These sites are categorized and grouped as follows:

1. The better quality granular materials were generally encountered in the ice contact deposits, located along the western slopes of the McConnell Range between Prohibition Creek and Canyon Creek. These features generally consist of kames, kame fields, kame terraces, eskers and esker-kame complexes which contain variably washed, stratified and pocketed sand and gravel deposits.

These deposits are represented by Sites 278 and 281 and are estimated to contain in excess of 4,000,000 cubic yards of fair to good quality granular materials which are considered suitable for quality embankment fill and production of base and surface course aggregates. The location of these two sites is noted on the Site Location Map in the Summary section of the report.

2. A localized glaciofluvial outwash deposit was established on the southwest bank of Prohibition Creek and is represented by Site 270. Good quality granular materials consisting of well graded, medium grained, sandy gravel suitable for various construction requirements are available from this site.

However, since only 200,000 cubic yards of gravels are considered recoverable from



Site 270, the exploitation of granular materials from this site may be limited for the construction of a local utility.

3. The alluvial fossil fans and cones adjacent to the active stream channels of Francis, Christina and Helava Creeks showed fair quality granular materials which are suitable for good quality general fill in the pit run condition. These alluvial deposits generally contain sand and gravel of variable gradation and silt content and are represented by Sites 275, 276, 279 and 280.

These deposits are estimated to contain in excess of 4,700,000 cubic yards of fair quality granular materials.

As discussed in the Site Description text for each site, careful development procedures should be exercised because of the close proximity of these alluvial fan deposits to currently active stream channels.

4. Sites 261 and 265 which were investigated during the winter drilling program, represent potential areas for quarry operations.

Site 261 which consists of limestone bedrock at shallow depths below existing ground surface, may be developed for the production of good quality manufactured aggregates for various construction requirements. However, Site 265 which consists of surficially weathered and friable shale bedrock may be suitable only for the exploitation of fair quality general fill material for use in the construction of subgrades for roads.

In general, an unlimited quantity of material is available from Sites 261 and 265 if major quarry operations are initiated. The detailed assessment and recommendations for development of quarry operations at these two sites is outlined in the Site Description section of the report.

In addition to the preceding nine sites, which contain exploitable quantities of granular



materials or bedrock formations suitable for engineering construction materials, four sites consisting of beach ridges and strand lines contain scattered and thin layers of silty sand and gravel deposits. These areas, represented by Sites 268X, 273X, 274X and 282X, were not recommended for development because of the minimal quantities of available granular materials and the scattered nature of these deposits. Therefore, these four sites were designated with the suffix "X" as "Not Recommended" granular material sources. Six additional sites were drilled during the winter field program which did not contain granular type materials. These sites have been catalogued and recorded in the Site Description section of the report and have also been identified with the suffix "X" after the site number.

All catalogued and assessed sites in the Fort Norman to Norman Wells, N.W.T. Inter-community Study Area, including the nine sites which were confirmed to contain granular type materials are discussed in detail in the Site Description section of the report.

SITE NO	MATERIAL TYPE		SUITABILITY OF MATERIAL	ESTIMATED VOLUME (cu. yds.)	ESTD. RECOV. DEPTH (feet)	OVERBURDEN			GROUND ICE (Content)	DRAINAGE	METHOD OF EXTRACTION	HAUL DIST (miles)	ENVIRONMENTAL CONSIDERATIONS	ASSESSMENT OF SITE
	DESCRIPTION	SYM				TYPE	DEPTH (feet)	DISPOSAL						
*259X	Silt, sand & gravel layers	ML	Unsuitable	N/A	—	Topsoil & Peat	1 1/2	—	Medium to High	Well Drained to Adjacent Terrain	—	5 1/2	No Critical Wildlife Areas	Not Recommended
*260X	Sand, fine	SP	Very Marginal Fill	250,000	+20	Topsoil	1	—	Low	Well Drained to Adjacent Terrain	—	5	No Critical Wildlife Areas; Sensitive Terrain	Not Recommended
*261	Bedrock: Limestone	—	Most Construction Aggregates	Unlimited	+50	Topsoil & Till	+1	Strip & Waste or Stockpile	Very Low	Good to Southwest	Quarry: Blasting & Crushing	0	No Critical Wildlife Areas	Recommended for Development
262	Sand; little gravel & silt	SM-GM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to Adjacent Terrain	Conventional	3	No Critical Wildlife Areas	Poor Prospect
263	Sand & Gravel; silty	SM-GM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to Good to Adjacent Terrain	Conventional	+3	No Critical Wildlife Areas	Fair Prospect; Difficult Access
264	Bedrock: Limestone	—	Most Construction Aggregates	N.D.	—	Topsoil & Drift	—	Strip & Stockpile	N.D.	Good to West	Quarry: Blasting & Crushing	3	No Critical Wildlife Areas	Good Prospect
*265	Bedrock: shale	—	General Fill	N.D.	+20	Topsoil & Till	1 to 14	Strip & Waste or Stockpile	Low	Good to Southwest	Conventional; Possible Quarry at Depth	1/2	No Critical Wildlife Areas; Adjacent to Stream	Possible Development
*266X	Gravel; silty	GM	General Fill	N/A	+5	Organic Silt	+1/2	—	None	Into Stream Channel	—	0	Within Active Stream Channel	Not Recommended
*267X	Silt & Sand; fine	ML-SM	Unsuitable	N/A	—	Topsoil	1	—	Low to Medium	Well Drained	—	1 1/2	No Critical Wildlife Areas	Not Recommended
*268X	Gravel; sandy	GP-GM	General Fill	N.D.	+2	Topsoil & Peat	1	—	Low	Fair to Poor to South	Conventional	0	No Critical Wildlife Areas	Not Recommended
269	Sand & Gravel; silt layers	SM-GW	Various Construction Aggregates	N.D.	—	Topsoil & Silt	—	—	N.D.	Into Stream Channel	Conventional with Dredging	0	Within Active Stream Channel	Not Suggested for Development
*270	Gravel; sandy	GW	General Fill; Base & Surface Courses	200,000	3 to 15	Topsoil & Peat	1/2	Strip & Stockpile	Low	Good to West	Conventional	0	No Critical Wildlife Areas	Recommended for Development
271	Bedrock: Limestone & Shale	—	Various Construction Aggregates	N.D.	—	Topsoil & Drift	—	Strip & Stockpile	N.D.	Well Drained	Quarry: Blasting & Crushing	+3	No Critical Wildlife Areas; Adjacent to Stream	Fair & Good Prospects
*272X	Silt; sandy & clayey	ML-MH	Unsuitable	N/A	—	Topsoil & Peat	1	—	High	Good in all Directions	—	1 1/2	No Critical Wildlife Areas	Not Recommended
*273X	Sand & Gravel; silty	SM-GM	General Fill	N/A	—	Topsoil	1	—	Low	Fair to Southwest	Conventional	0	No Critical Wildlife Areas	Not Recommended
*274X	Sand; silty; fine	SM-SP	Very Marginal Fill	N.D.	—	Topsoil	1	—	Low to Medium	Fair to Southwest	Conventional	0	No Critical Wildlife Areas	Not Recommended
*275	Sand & Gravel; silty	SM-GM	General Fill	2,000,000	+15	Topsoil & Silt	2	Strip & Waste or Stockpile	Very Low	Good to Southwest	Conventional	1 1/2	No Critical Wildlife Areas	Recommended for Development
*276	Sand & Gravel; silty	SM-GM	General Fill	200,000	+5	Topsoil; Silt & Clay	1 to 4	Strip & Waste or Stockpile	Low	Good to Adjacent Streams	Conventional	0	No Critical Wildlife Areas; Adjacent to Stream	Possible Development
277	Sand; some gravel & silt	SM-GM	General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to Adjacent Terrain	Conventional	2 1/2	No Critical Wildlife Areas	Poor Prospect
*278	Sand & Gravel; silty	SM-GM	General Fill; Base & Surface Courses	2,000,000	+15	Topsoil & Silt	1	Strip & Stockpile	Low	Good to Southwest	Conventional	2 1/2	No Critical Wildlife Areas	Recommended for Development
*279	Sand & Gravel; silty	SM-GM	General Fill	1,000,000	+12	Topsoil & Silt	2	Strip & Stockpile	Low	Good to Adjacent Stream	Conventional	0	No Critical Wildlife Areas; Adjacent to Stream	Recommended for Development
*280	Sand & Gravel	GW-SW	General Fill; Base Course	1,500,000	+10	Topsoil & Peat	1	Strip & Stockpile	Low	Good to Adjacent Stream	Conventional	1 1/2	No Critical Wildlife Areas; Adjacent to Stream	Recommended for Development
*281	Sand & Gravel; silty	SM-GM	General Fill; Base Course	2,000,000	+10	Topsoil & Silt	1	Strip & Stockpile	Low	Good to Southwest	Conventional	2 1/2	No Critical Wildlife Areas	Recommended for Development
*282X	Silt, Sand & Gravel	SM-GM	General Fill	N.D.	2	Topsoil & Silt	1 1/2	—	Low	Poor to Fair to Adjacent Stream	—	0	No Critical Wildlife Areas	Not Recommended
283	Sand & Gravel; silt pockets	SM-GW	General Fill	N.D.	—	Topsoil & Silt	—	Strip & Stockpile	N.D.	Fair to Poor to Adjacent Streams	Conventional	1 1/2	No Critical Wildlife Areas; Adjacent to two Streams	Fair Prospect
*284X	Silt; clayey	MH	Unsuitable	N/A	—	Topsoil & Peat	1 1/2	—	Medium	Good to Southwest	—	2	No Critical Wildlife Areas	Not Recommended

Notes:

— SITE NUMBER:

* Represents sites that have been drilled and/or test pitted; these sites are shown as solid triangles on the topographic strip maps.
X Drilled and/or test pitted sites "Not Recommended" for development.

— ESTIMATED VOLUME

N/A Not Applicable because the site does not contain materials of granular quality.
N.D. Not Determined.

— DRAINAGE

Rating as shown generally refers to drainage conditions within the site.

— METHOD OF EXTRACTION

"Conventional" indicates use of standard excavation equipment such as dozers, overhead loaders, backhoes and light rippers.

— HAUL DISTANCE

is distance along existing and/or required access from the site to the nearest Mile Post on the proposed Mackenzie Highway (Ref. Text). "0" Haul Distance indicates site is on or immediately adjacent to the proposed Highway location.

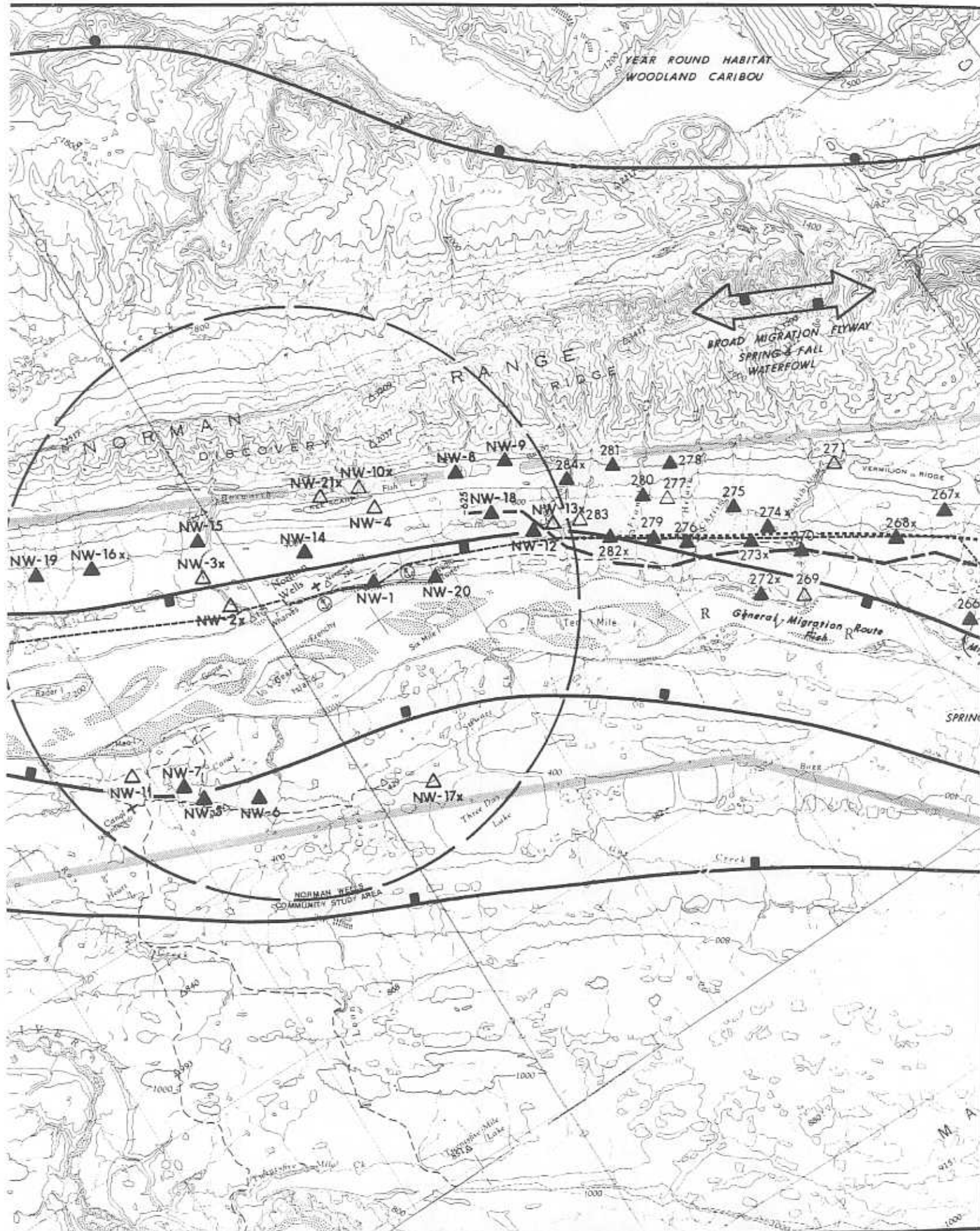
— ENVIRONMENTAL CONSIDERATIONS:

"Sensitive Terrain" refers to thermal and/or erosional sensitivity at, or adjacent to the site (Ref. Text).

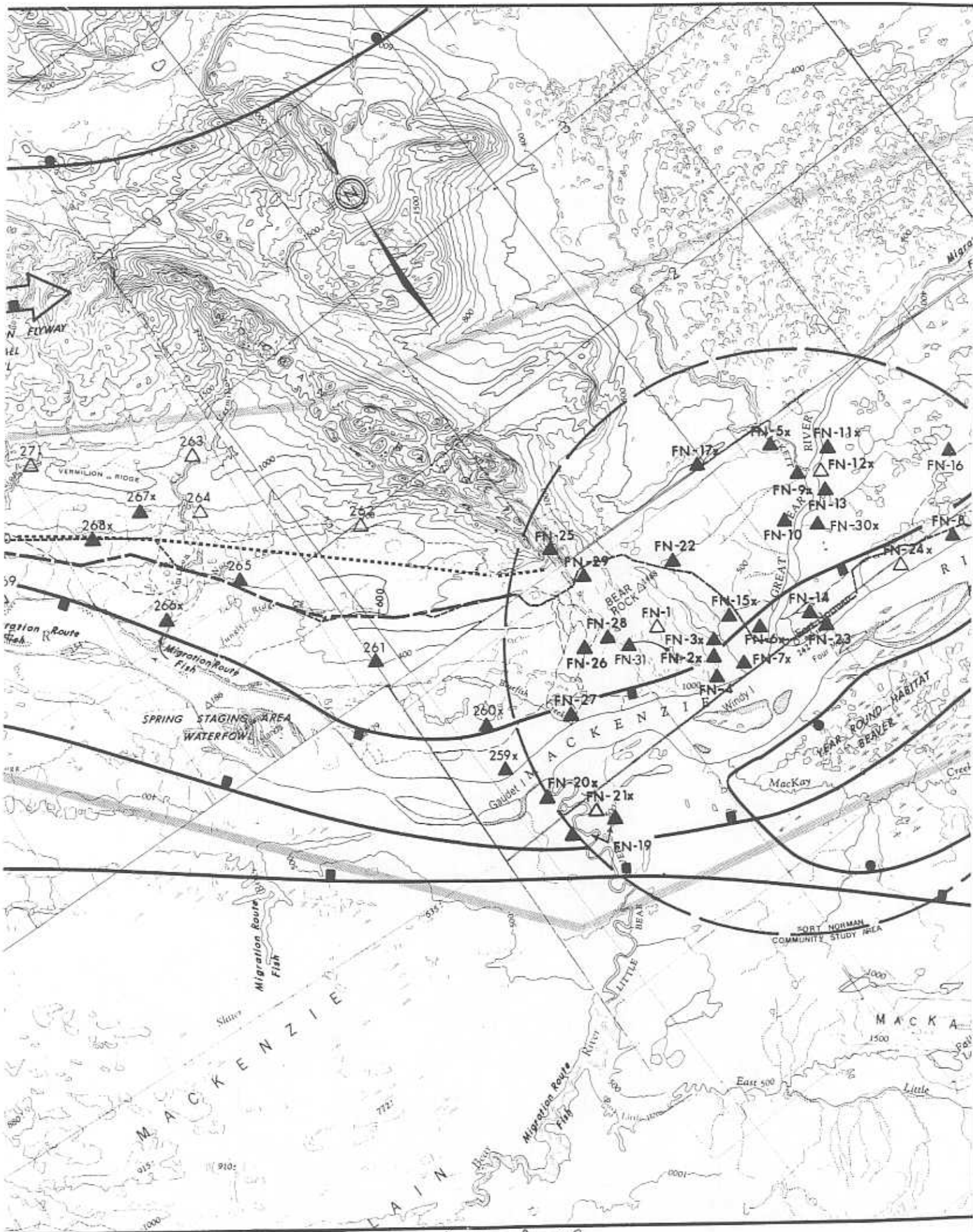
— ASSESSMENT OF SITE:

Ref. Text "Recommendations and Conclusions" and "Site Description" sections.

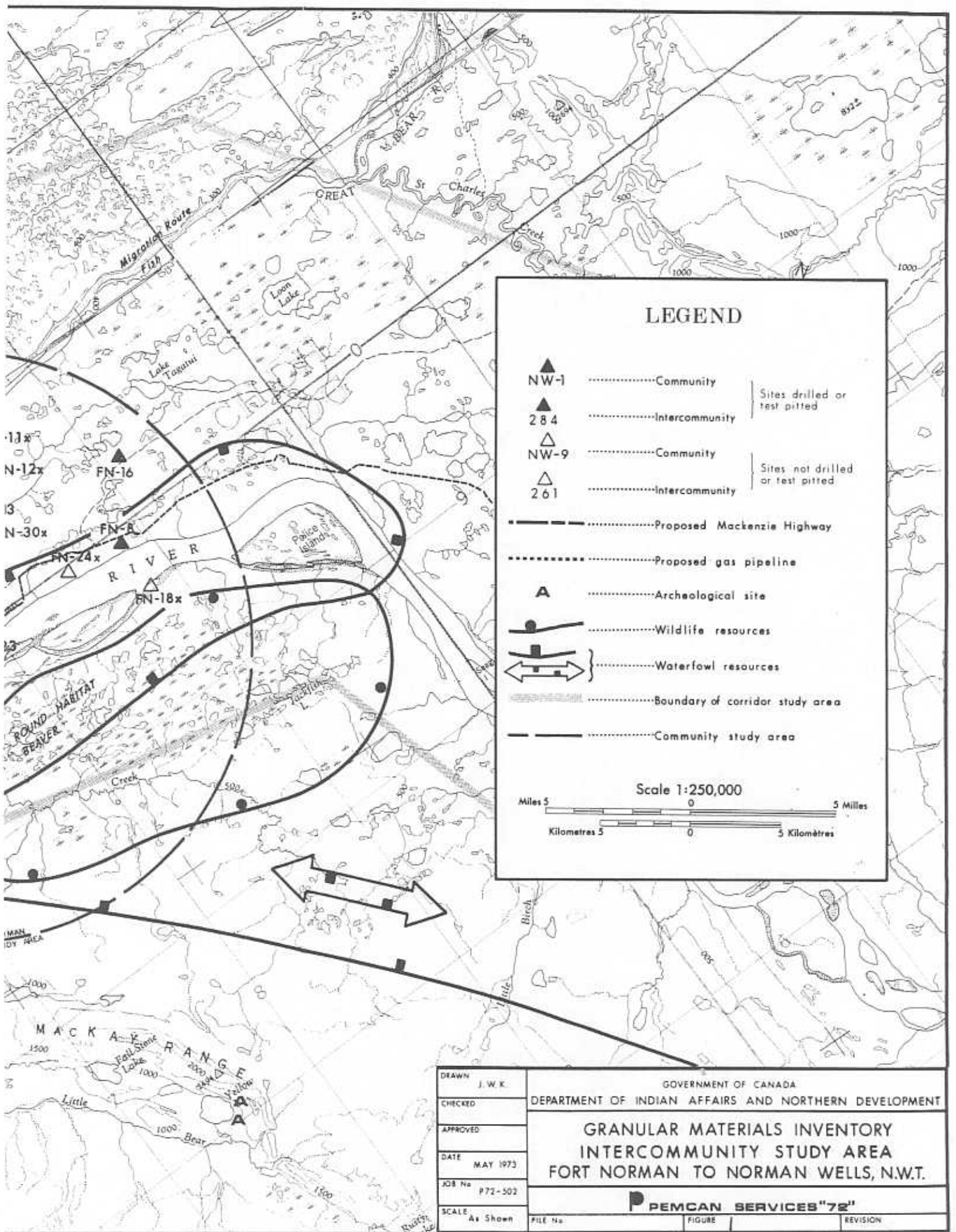
YEAR ROUND HABITAT
WOODLAND CARIBOU



A > B



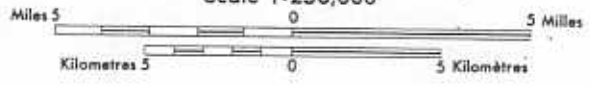
A ← B → C



LEGEND

- ▲ NW-1Community
 - ▲ 284Intercommunity
 - △ NW-9Community
 - △ 261Intercommunity
- } Sites drilled or test pitted
- } Sites not drilled or test pitted
- Proposed Mackenzie Highway
 - Proposed gas pipeline
 - A Archeological site
 - Wildlife resources
 - ← → Waterfowl resources
 - Boundary of corridor study area
 - Community study area

Scale 1:250,000



DRAWN	J. W. K.	GOVERNMENT OF CANADA		
CHECKED		DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT		
APPROVED		GRANULAR MATERIALS INVENTORY		
DATE	MAY 1973	INTERCOMMUNITY STUDY AREA		
JOB No	P71-502	FORT NORMAN TO NORMAN WELLS, N.W.T.		
SCALE	As Shown	PEMCAN SERVICES "72"		
		FILE No	FIGURE	REVISION

B ← C



NORMAN WELLS TO FORT GOOD HOPE, N.W.T.

The results of the completed study indicate that the availability of quality granular materials in the Intercommunity Study Area between Norman Wells and Fort Good Hope, N.W.T. is very scarce in the area from north of Rat Pass to Fort Good Hope. Exploitable quantities of naturally occurring granular materials in the southern portion of the Study Area from Norman Wells to the Rat Pass were established during the winter field drilling program.

On the basis of the airphoto interpretation and preliminary field reconnaissance data, a total of nineteen sites was investigated in detail during the winter drilling program, of which fifteen sites were confirmed to contain exploitable granular materials. These sites are categorized and grouped as follows:

1. The better quality granular materials were encountered in glaciofluvial delta deposits adjacent to the upstream portions of the Oscar Creek and Elliot Creek stream channels. These deposits consist of well graded, fine to medium grained sand and gravel which are considered suitable for quality general fill material in the pit run condition and production of base and surface course aggregates.

These glaciofluvial delta deposits are represented by Sites 288, 289 and 296 and are estimated to contain in excess of 20,000,000 cubic yards of good quality granular materials. The locations of these sites are noted on the Site Location Map in the Summary section of the report.

2. Fair to good quality granular materials were confirmed in the ice contact deposits consisting of kame hillocks and terraces adjacent to the upstream section of the Hanna River and a discontinuous chain of esker ridges immediately east of Snafu Lake.

These ice contact features generally consist of variably washed, stratified and pocketed sand and gravel deposits which are suitable for quality embankment fill in the pit run condition and for the production of base and surface course aggregates.



These deposits are represented by Sites 302, 303 and 315 and are estimated to contain in excess of one million cubic yards of fair to good quality granular materials.

3. The talus slopes, alluvial cones, collapsed cones and rock glaciers which are located along the various exposed escarpments of the Norman and Gibson Ranges represent additional sources of poor to fair quality granular materials. These deposits generally consist of limestone and dolomite fragments and blocks with a silt and sand matrix. Several of the exposed talus slopes exhibit localized rock glaciers which may be indicative of a highly variable ice content in these deposits.

These deposits are represented by Sites 293, 304, 305 and 309 and are estimated to contain a relatively unlimited quantity of fair quality granular materials which are considered suitable for quality embankment fill. As discussed in the Site Description text for each site, the access to these sites entails the traversing of thermally sensitive terrain which may restrict the extensive exploitation of granular materials from these sites.

4. Sites 311 and 319 which were investigated during the winter drilling program, represent potential areas for quarry operations. These two sites, consisting of limestone and dolomite bedrock at shallow depths below existing ground surface, may be developed for the production of good quality manufactured aggregates for various construction requirements.

In general, an unlimited quantity of material is available from Sites 311 or 319 if major quarry operations are initiated. The detailed assessment and recommendations for development of quarry operations at these two sites is outlined in the Site Description section of the report.

5. Sand dune deposits consisting of poorly graded, fine grained sand with a variable silt content which are represented by Sites 287, 292 and 299 were investigated and catalogued in detail during the winter drilling program. These eolian sand deposits are



considered suitable only for very marginal fill material in the construction of subgrades for roads.

These dune deposits are estimated to contain in excess of 15,000,000 cubic yards of poorly graded fine sands. These sites were investigated and catalogued because of their close proximity to the location of the currently proposed route of the Mackenzie Highway and the suitability of these fine sands as low quality material in the construction of road subgrades.

6. Sites FGH 1 and FGH 2, which are located in the Fort Good Hope Community Study Area, consist of large esker-kame complexes containing extensive quantities of good quality granular materials well in excess of the currently specified requirements for the Fort Good Hope community. Therefore, in view of the acute scarcity of available granular materials immediately south of Fort Good Hope, the exploitation of granular materials from Sites FGH 1 and FGH 2 should be considered for the requirements apart from the needs of the community.

In addition to the preceding fifteen sites, which contain exploitable quantities of granular materials or bedrock formations suitable for engineering construction materials, four sites consisting of slope wash materials overlying glacial till were drilled during the winter field program. These sites are represented by Sites 306X, 308X, 312 and 313X and do not contain materials of granular quality.

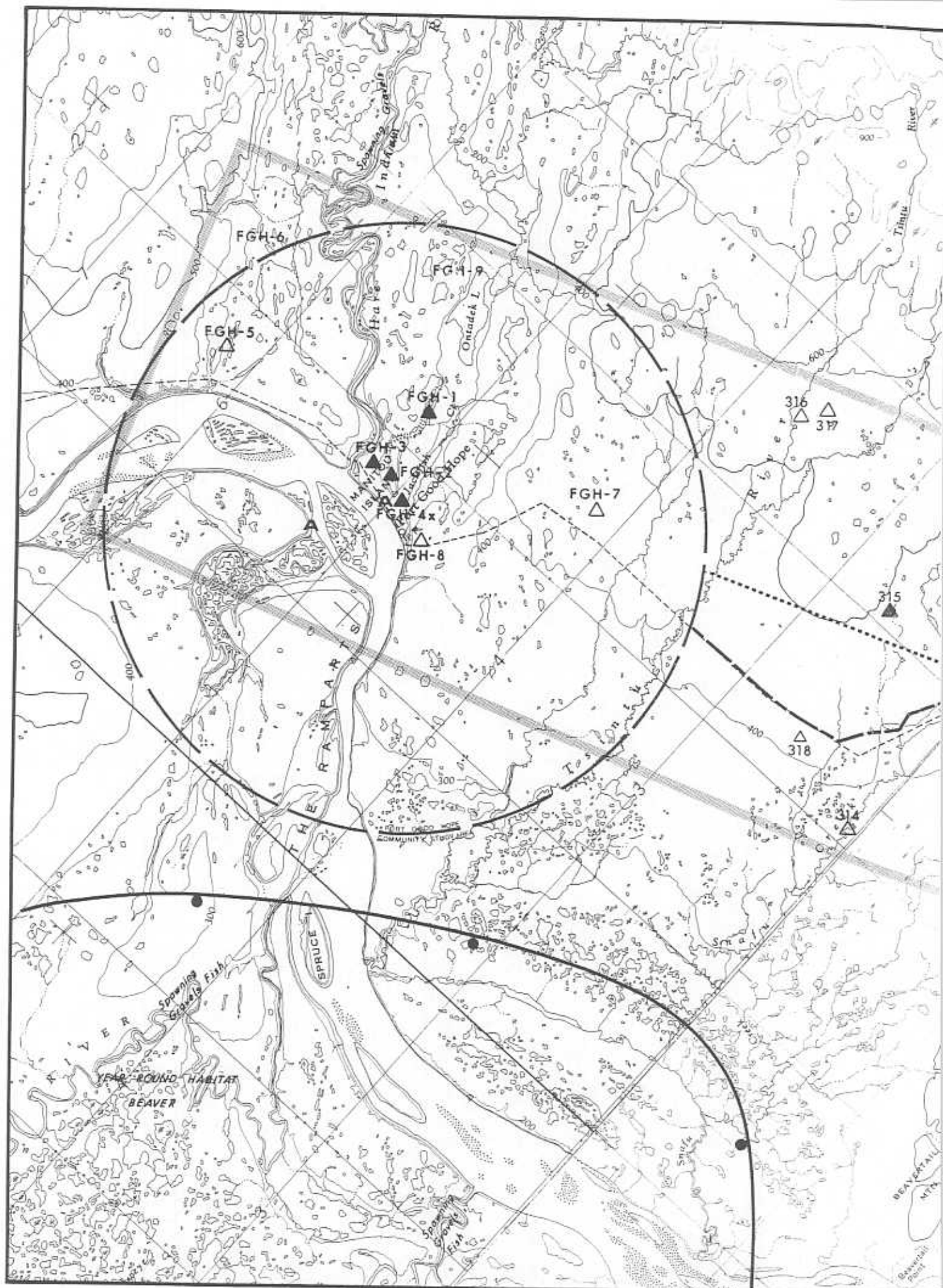
Site 312 was not designated with an "X" denoting "Not Recommended for Development" because the slope wash material in this site exhibits relatively low ground ice contents and may be utilized as very marginal fill material in the construction of subgrades for roads. The remaining three sites have been catalogued and recorded in the Site Description section of the report and have been identified with the suffix "X" after the site number which designates a "Not Recommended" granular material source.

On the basis of detailed airphoto interpretation and known geological data, Sites 286, 295, 298, 301 and 307 which consist of competent limestone bedrock formations may be con-

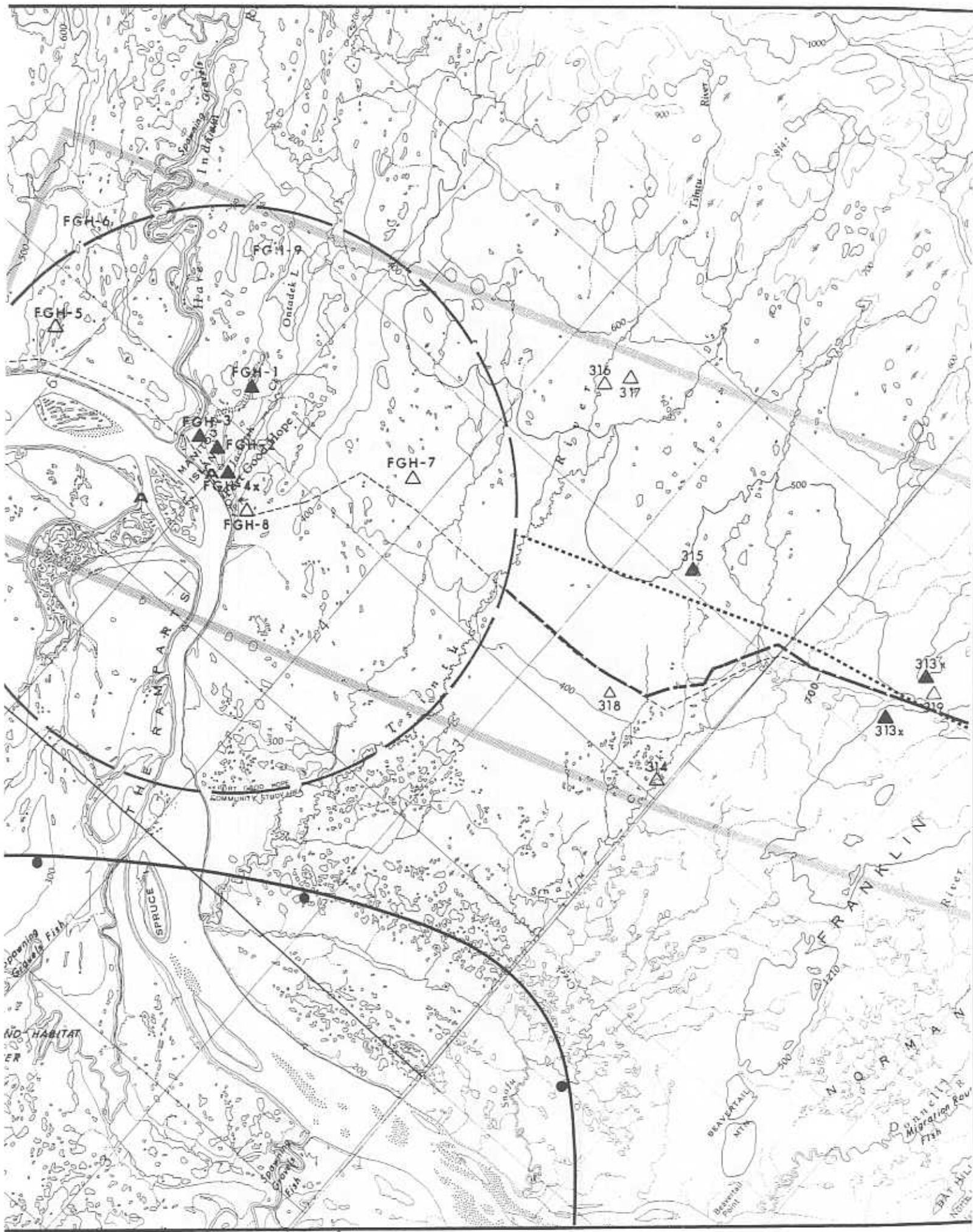


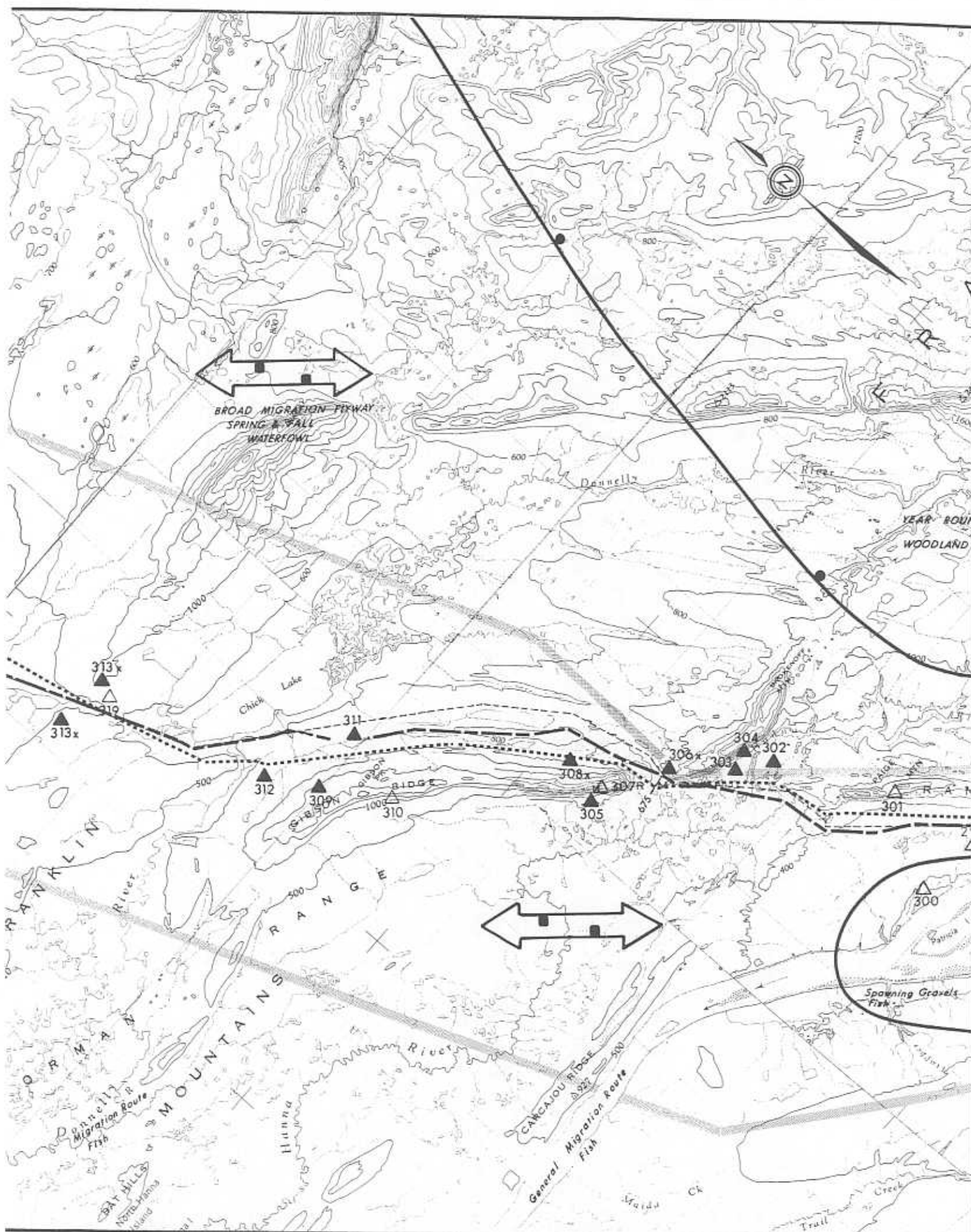
sidered for the production of manufactured aggregates by the development of quarry operations. In general, the proposed future access to these bedrock exposures requires the traversing of thermally sensitive and surficially wet terrain.

All catalogued and assessed sites in the Norman Wells to Fort Good Hope, N.W.T. Intercommunity Study Area, including the fifteen sites which were confirmed to contain granular materials are discussed in detail in the Site Description section of the report.

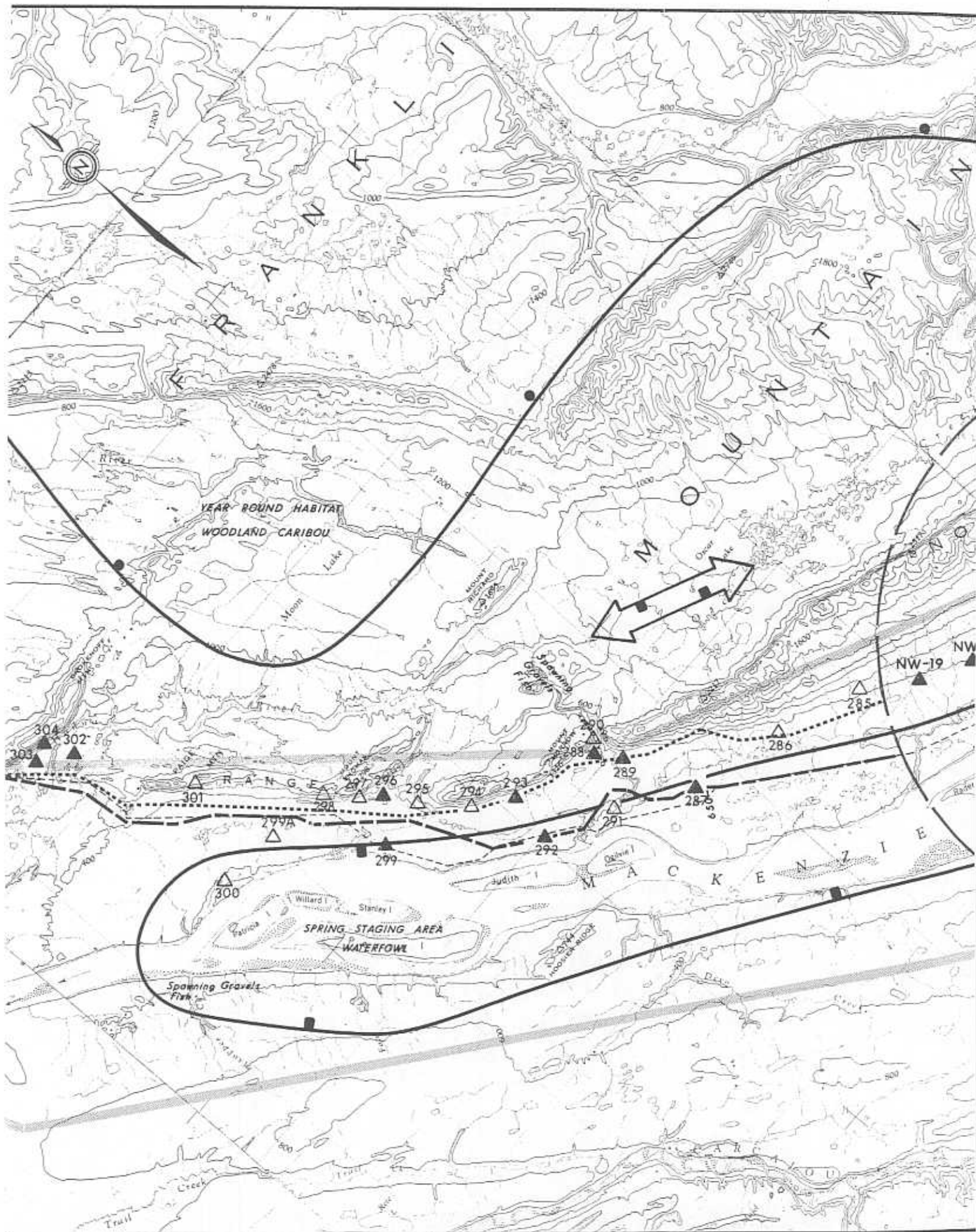


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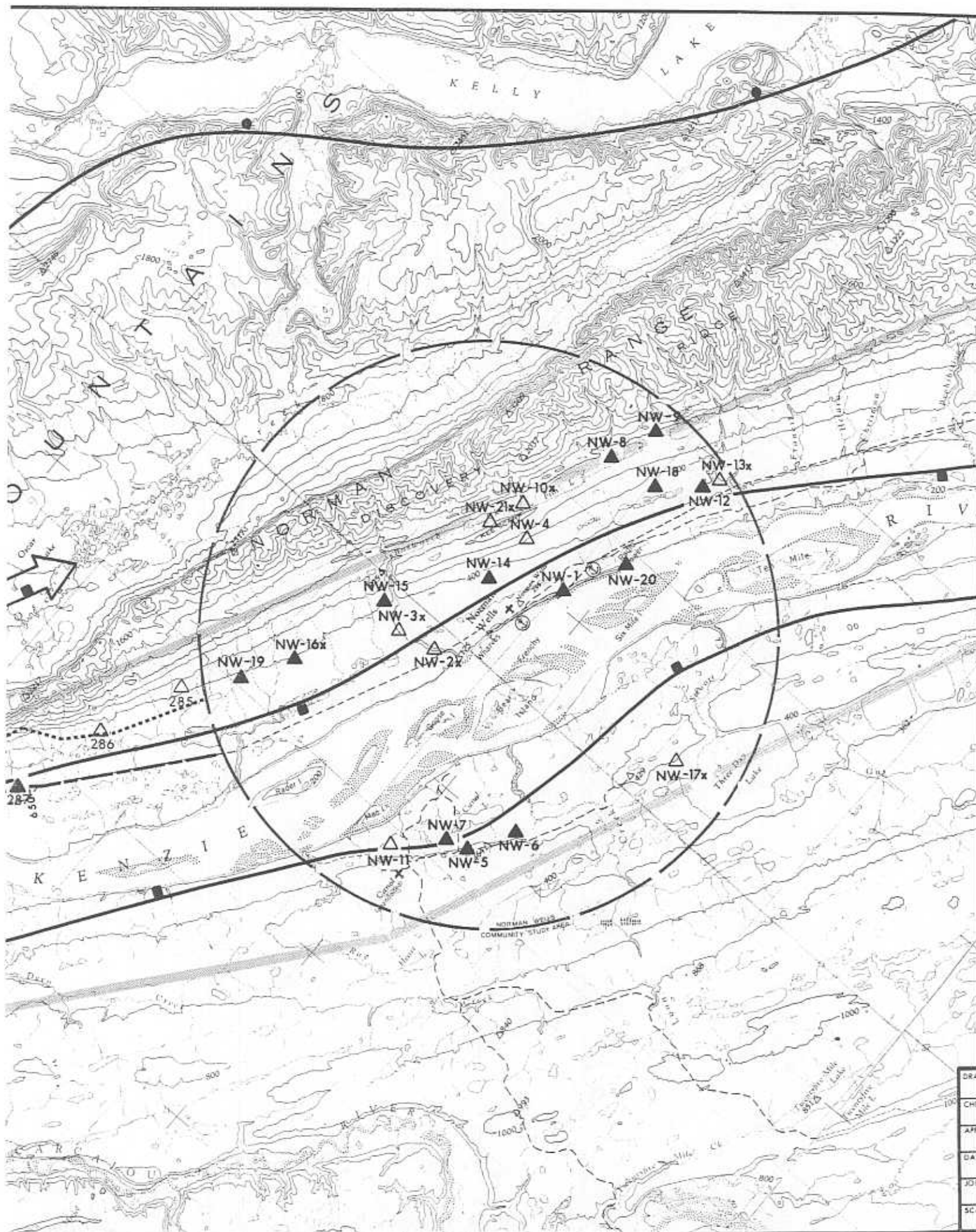




B ← C → D

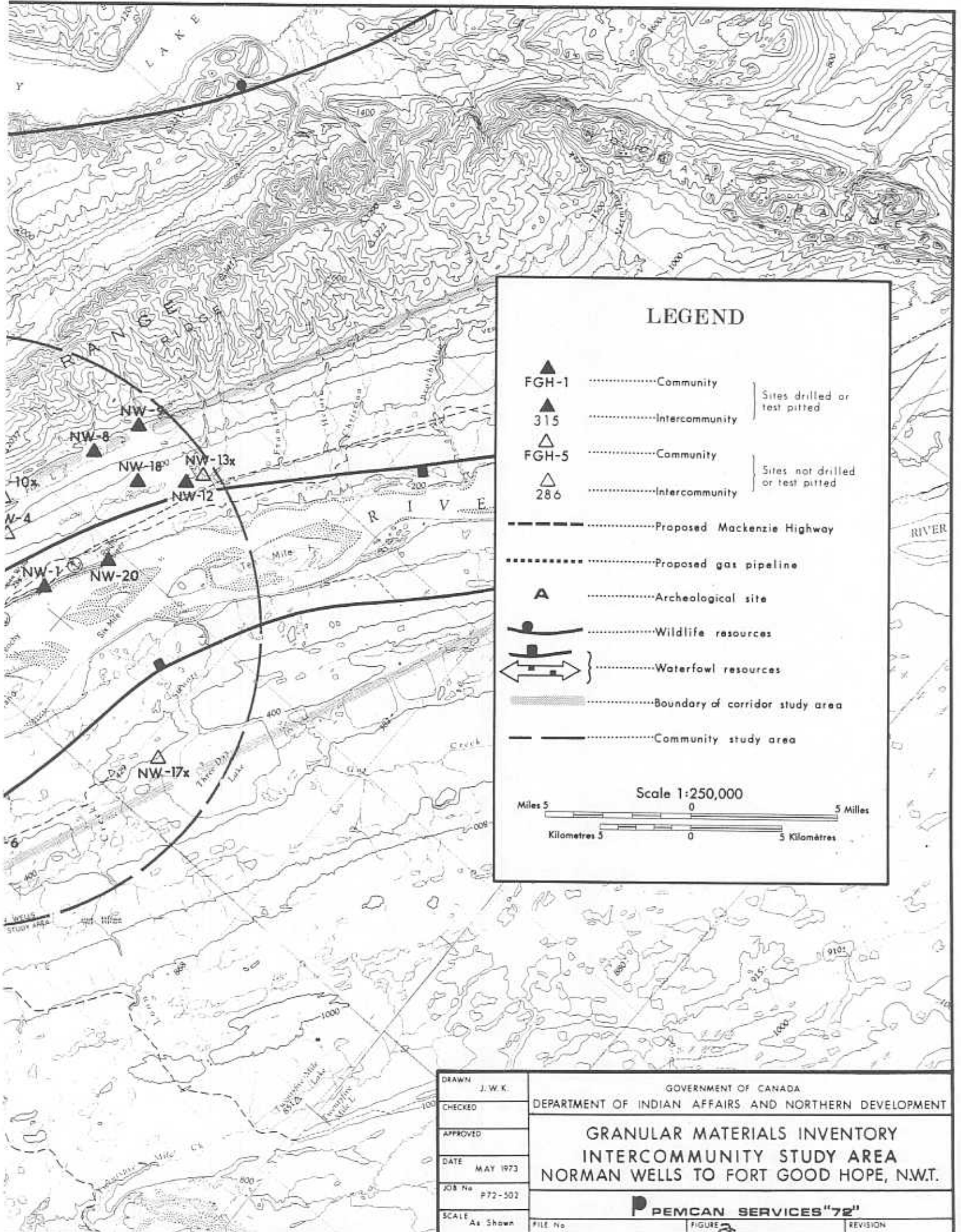


C < D > E



D ← E → F

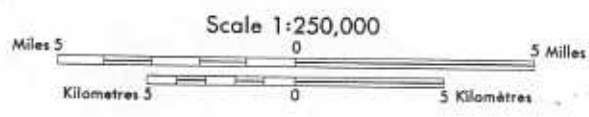
DRG
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LEGEND

- ▲ FGH-1Community
 - ▲ 315Intercommunity
 - △ FGH-5Community
 - △ 286Intercommunity
- } Sites drilled or test pitted
- } Sites not drilled or test pitted

- Proposed Mackenzie Highway
- Proposed gas pipeline
- A Archeological site
- Wildlife resources
- Waterfowl resources
- Boundary of corridor study area
- Community study area



DRAWN	J. W. K.	GOVERNMENT OF CANADA
CHECKED		DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT
APPROVED		GRANULAR MATERIALS INVENTORY
DATE	MAY 1973	INTERCOMMUNITY STUDY AREA
JOB No	P72-502	NORMAN WELLS TO FORT GOOD HOPE, N.W.T.
SCALE	As Shown	PEMCAN SERVICES "72"
	FILE No	FIGURE 3
		REVISION

E ← F

SITE NO.	MATERIAL TYPE		SUITABILITY OF MATERIAL	ESTIMATED VOLUME (cu. yds.)	EST'D. RECOV. DEPTH (feet)	OVERBURDEN			GROUND ICE (Content)	DRAINAGE	METHOD OF EXTRACTION	HAUL DIST. (miles)	ENVIRONMENTAL CONSIDERATIONS	ASSESSMENT OF SITE
	DESCRIPTION	SYM.				TYPE	DEPTH (feet)	DISPOSAL						
285	Sand; silty; some gravel	SM-SW	Marginal General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to Southwest	Conventional	+2	No Critical Wildlife Areas	Poor Prospect
286	Limestone Bedrock	—	Various Construction Aggregates	N.D.	—	Topsoil & Drift	—	Strip & Waste	N.D.	Good to Southwest	Quarry; Blasting & Crushing	1%	No Critical Wildlife Areas; Sensitive Terrain	Possible Development
* 287	Sand; fine	SP	Marginal General Fill	3,500,000	+20	Topsoil	1	Strip & Stockpile	Very Low	Good to Adjacent Lakes	Conventional	1%	Water fowl Migration & Staging Area	Possible Development
* 288	Gravel & Sand	GW-SW	General Fill; Base & Surface Course	10,000,000	+10	Topsoil	1	Strip & Stockpile	Low	Good to South & East	Conventional	1%	No Critical Wildlife Areas	Future Development Recommended
* 289	Gravel & Sand	GW-SW	All Construction Aggregates	1,500,000	+10	Topsoil	1	Strip & Stockpile	Low	Good to Southwest	Conventional	1%	No Critical Wildlife Areas	Recommended for Development
290	Limestone & Dolomite Fragments	—	Marginal General Fill	N.D.	—	Nil	—	—	N.D.	Good to South	—	1%	No Critical Wildlife Areas	Not Suggested for Development
291	Sand & Gravel	SM-GW	General Fill	N.D.	—	Topsoil & Silt	—	—	N.D.	into the Stream Channel	—	0	Within or Immediately Adjacent to Stream Channel	Not Suggested for Development
* 292	Sand; fine	SP	Marginal General Fill	10,000,000	+20	Topsoil	1	Strip & Stockpile	— (Not Frozen)	Good to Southwest	Conventional	0	Water fowl Migration & Staging Area	Possible Development
* 293	Limestone & Dolomite Fragments	—	General Fill	N.D.	+10	Nil	—	—	Low	Good to South	Conventional	2	No Critical Wildlife Areas; Sensitive Terrain	Possible Development
294	Limestone & Dolomite Blocks	—	Various Construction Aggregates	N.D.	—	Nil	—	—	N.D.	Good to Southwest	—	1%	No Critical Wildlife Areas; Sensitive Terrain	Not Suggested for Development
295	Limestone Bedrock	—	Various Construction Aggregates	N.D.	—	Topsoil & Drift	—	Strip & Waste	N.D.	Well Drained	Quarry; Blasting & Crushing	-1%	No Critical Wildlife Areas; Sensitive Terrain	Good Prospect
* 296	Gravel; well graded	GW	All Construction Aggregates	10,000,000	+10	Topsoil	1	Strip & Stockpile	Low	Well Drained	Conventional	1%	No Critical Wildlife Areas	Recommended for Development
297	Limestone & Dolomite Fragments	—	Marginal General Fill	N.D.	—	Nil	—	—	N.D.	Good to South	—	1%	No Critical Wildlife Areas; Sensitive Terrain	Not Suggested for Development
298	Limestone & Shale Bedrock	—	Various Construction Aggregates	N.D.	—	Drift & Scree	—	Strip & Waste	N.D.	Well Drained	Quarry; Blasting & Crushing	1	No Critical Wildlife Areas	Good Prospect
* 299	Sand; fine	SP	Marginal General Fill	2,000,000	+10	Topsoil	+1%	Strip & Stockpile	None	Fair to Adjacent Terrain	Conventional	1%	Water fowl Migration & Staging Area	Possible Development
299A	Sand; fine	SP	Marginal General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Well Drained	Conventional	1%	No Critical Wildlife Areas; Sensitive Terrain	Fair Prospect
300	Sand; fine	SP	Marginal General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Good to Adjacent Terrain	Conventional	1%	Water fowl Migration & Staging Area; Sensitive Terrain	Fair Prospect
301	Limestone Bedrock; Slope Debris	—	Various Construction Materials	N.D.	—	Glacial Drift	—	Strip & Waste	N.D.	Well Drained	Quarry; Blasting & Crushing	-1%	No Critical Wildlife Areas	Good Prospect
* 302	Sand & Gravel; some silt	SM-GM	General Fill	N.D.	2-10	Topsoil & Silt	2-7	Strip & Waste or Stockpile	Low	Well Drained into Adjacent Rivers	Conventional	1	No Critical Wildlife Areas	Possible Development
* 303	Sand & Gravel; some silt	SM-GM	General Fill	N.D.	2-10	Topsoil & Silt	2-6	Strip, Waste & Stockpile	Low	Good to Southwest	Conventional	1%	No Critical Wildlife Areas	Possible Development
* 304	Limestone & Dolomite Fragments	—	Marginal General Fill	N.D.	—	Nil	—	—	Variable	Good to Southwest	Conventional	1%	No Critical Wildlife Areas	Possible Development
* 305	Limestone & Dolomite Fragments	—	Marginal General Fill	N.D.	—	Nil	—	—	Variable	Good to Southwest	Conventional	1%	No Critical Wildlife Areas; Sensitive Terrain	Possible Development
* 306 X	Slope Wash & Glacial Till	—	Unsuitable	N.A.	—	Topsoil & Peat	1	—	N.D.	Good to Southeast	N.A.	0	No Critical Wildlife Areas	Not Recommended
307	Limestone Bedrock	—	Various Construction Aggregates	N.D.	—	Glacial Drift	—	Strip & Waste	N.D.	Well Drained	Quarry; Blasting & Crushing	1%	No Critical Wildlife Areas	Fair to Good Prospect
* 308 X	Silt; fine	ML	Unsuitable	N.A.	—	Peat	+1%	—	High	Good to East	N.A.	1%	Water fowl Staging Area	Not Recommended
* 309	Limestone Fragments	—	General Fill	500,000	10	Nil	—	—	Medium	Good to North	Conventional	1%	No Critical Wildlife Areas; Sensitive Terrain	Future Development
310	Limestone Fragments	—	Marginal General Fill	N.D.	—	Nil	—	—	N.D.	Good to Fair to South	—	9	No Critical Wildlife Areas; Sensitive Terrain	Not Suggested for Development
* 311	Limestone Bedrock	—	Various Construction Aggregates	5,000,000	+10	Nil	—	—	Low	Good to South & North	Quarry; Blasting & Crushing	1%	Water fowl Staging Area	Recommended for Development
* 312	Sand; Silts; Limestone & Shale Fragments	—	Very Marginal General Fill	N.D.	—	Topsoil & Peat	1%	Strip & Stockpile	Low	Good to North	Conventional with Thawing	1%	Water fowl Staging Area	Possible Development
* 313 X	Sand; Silt; Shale & Limestone Fragments	—	Unsuitable	N.A.	—	Topsoil & Peat	+1	—	Low to High	Poorly drained	N.A.	0	Water fowl Staging Area; Sensitive Terrain	Not Recommended
314	Silt; sandy & clayey; some sand	ML-SM	Possibly Unsuitable	N.A.	—	Topsoil & Peat	—	—	N.D.	Poor to Fair into Stream Channel	—	6	Adjacent to Stream Channel; Sensitive Terrain	Not Suggested for Development

SITE NO.	MATERIAL TYPE		SUITABILITY OF MATERIAL	ESTIMATED VOLUME (cu. yds.)	EST'D. RECOV. DEPTH (feet)	OVERBURDEN			GROUND ICE (Content)	DRAINAGE	METHOD OF EXTRACTION	HAUL DIST. (miles)	ENVIRONMENTAL CONSIDERATIONS	ASSESSMENT OF SITE
	DESCRIPTION	SYM.				TYPE	DEPTH (feet)	DISPOSAL						
* 315	Gravel; sandy	GW	Base & Surface Course; General Fill	600,000	+10	Peat & Silt	+2%	Strip, Waste & Stockpile	Low	Well Drained	Conventional	3	No Critical Wildlife Areas; Sensitive Terrain	Recommended for Development
316	Sand; silty, some gravel	SM-GM	Marginal to Very Marginal Fill	N.D.	—	Topsoil	—	—	N.D.	Fair to Adjacent Terrain	—	7½	No Critical Wildlife Areas; Sensitive Terrain	Not Suggested for Development
317	Sand; silty, some gravel	SM-GM	Marginal to Very Marginal Fill	N.D.	—	Topsoil	—	—	N.D.	Fair to Adjacent Stream	—	9	Adjacent to Stream Channel; Sensitive Terrain	Not Suggested for Development
318	Sand; silty & gravelly	SM-GM	Marginal General Fill	N.D.	—	Topsoil	—	Strip & Stockpile	N.D.	Fair to Adjacent Terrain	Conventional	½	No Critical Wildlife Areas	Poor Prospect
* 319	Limestone Bedrock	—	All Construction Aggregates	Unlimited	—	—	—	—	—	Fair to Adjacent Terrain	Quarry; Blasting & Crushing	0	No Critical Wildlife Areas	Recommended for Development

Notes:

- SITE NUMBER: * Represents sites that have been drilled and/or test pitted; these sites are shown as solid triangles on the topographic strip maps.
X Drilled and/or test pitted sites "Not Recommended" for development.
- ESTIMATED VOLUME: N/A Not Applicable because the site does not contain materials of granular quality.
N.D. Not Determined.
- DRAINAGE: Rating as shown generally refers to drainage conditions within the site.
- METHOD OF EXTRACTION: "Conventional" indicates use of standard excavation equipment such as dozers, overhead loaders, backhoes and light rippers.
- HAUL DISTANCE: Is distance along existing and/or required access from the site to the nearest Mile Post on the proposed Mackenzie Highway (Ref. Text).
"0" Haul Distance indicates site is on or immediately adjacent to the proposed Highway location.
- ENVIRONMENTAL CONSIDERATIONS: "Sensitive Terrain" refers to thermal and/or erosional sensitivity at, or adjacent to the site (Ref. Text).
- ASSESSMENT OF SITE: Ref. Text "Recommendations and Conclusions" and "Site Description" sections.



PEMCAN SERVICES

GLOSSARY



GLOSSARY

Alluvium	Stream deposits of comparatively recent time, does not include subaqueous deposits of seas and lakes.
Anhydrite	A mineral, anhydrous calcium sulfate, CaSO_4 . Orthorhombic, commonly massive in evaporite beds.
Annuals	A plant that lives only one year or season.
Autoclave Expansion	Laboratory test procedure as designated by ASTM-C151-63 for determination of expansive qualities for all types of Portland Cement and aggregate reactions.
Berm	A horizontal portion of an earth embankment to ensure greater stability of a long slope.
Biotic	Of or pertaining to life or mode of living.
Boreal	Pertaining to the North.
Boulder	A rock fragment larger than 8" in diameter.
Cartographic	Pertaining to a map. In geology a cartographic unit is a rock or group of rocks that is shown on a geologic map by a single color or pattern.
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.
Conglomerate	Rounded water-worn fragments of rocks or pebbles, cemented together by another mineral substance which may be of a siliceous or argillaceous nature.
Cretaceous	The third and latest of the periods included in the Mesozoic era; also the system of strata deposited in the Cretaceous period.
Crystalline	Of or pertaining to the nature of a crystal; having regular molecular structure.
Delta Deposits	An alluvial deposit, usually triangular, at the mouth of a river.



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.
Dolomite	A mineral, $\text{CaMg}(\text{CO}_3)_2$, commonly with some iron replacing magnesium; a common rock-forming mineral.
Ecology	The study of the mutual relationships between organisms and their environments.
Eolian	Deposits which are due to the transporting action of the wind.
Escarpment	The steep face of a ridge of high land.
Esker	A narrow ridge of gravelly or sandy drift, deposited by a stream in association with glacier ice.
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.
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.
Fossiliferous	Containing organic remains.
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	Non sorted, non stratified sediment carried or deposited by a glacier.
Glaciofluvial	Fluvioglacial. Pertaining to streams flowing from glaciers or to the deposits made by such streams.



Glaciolacustrine	Pertaining to glacial-lake conditions, as in glaciolacustrine deposits.
Gravel	Soil particles smaller than 3" in diameter and larger than 2.0 mm in diameter.
Ground Moraine	A moraine with low relief, devoid of transverse linear elements.
Gypsum	Alabaster. Selenite. Satin Spar. A mineral, $\text{CaSO}_4, 2\text{H}_2\text{O}$. Monoclinic. A common mineral of evaporites.
Heterogeneous	Differing in kind; having unlike qualities; possessed of different characteristics; opposed to homogeneous.
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.
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.
Karst	A limestone plateau marked by sinkholes and underlain by cavernous carbonate rocks having subterranean drainage channelways that largely follow solution-widened joints, faults, and bedding planes.
Lacustrine	Produced or belonging to lakes.
Lichen	Any of a group of low growing plant formations composed of a certain fungi growing close together with certain algae.
Massif	A French term adopted in geology and physical geography for a mountainous mass or group of connected heights, whether isolated or forming a part of a larger mountain system.
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.
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).
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.
Ordovician	The second of the periods comprised in the Paleozoic era, in the geological classification now generally used. Also the system of strata deposited during that period.
Perennial	Lasting through the year.
Permafrost	The thermal condition under which earth materials exist at a temperature below 32°F continuously for a number of years.
Petrography	The branch of science treating of the systematic description and classification of rocks.
Proglacial	Pertaining to features of glacial origin beyond the limits of the glacier itself, as...streams, ...deposits, ...sand.
Sand	Soil particles smaller than 2.0 mm. in diameter and larger than 0.06 mm. in diameter.
Screens	A heap of rock waste at the base of a cliff or a sheet of coarse debris mantling a mountain slope.
Silurian	The third in order of age of the geologic periods comprised in the Paleozoic era, in the nomenclature in general use. Also the system of strata deposited during that period.
Sinuuous	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.
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.



PEMCAN SERVICES

EXPLANATION OF TERMS AND SYMBOLS



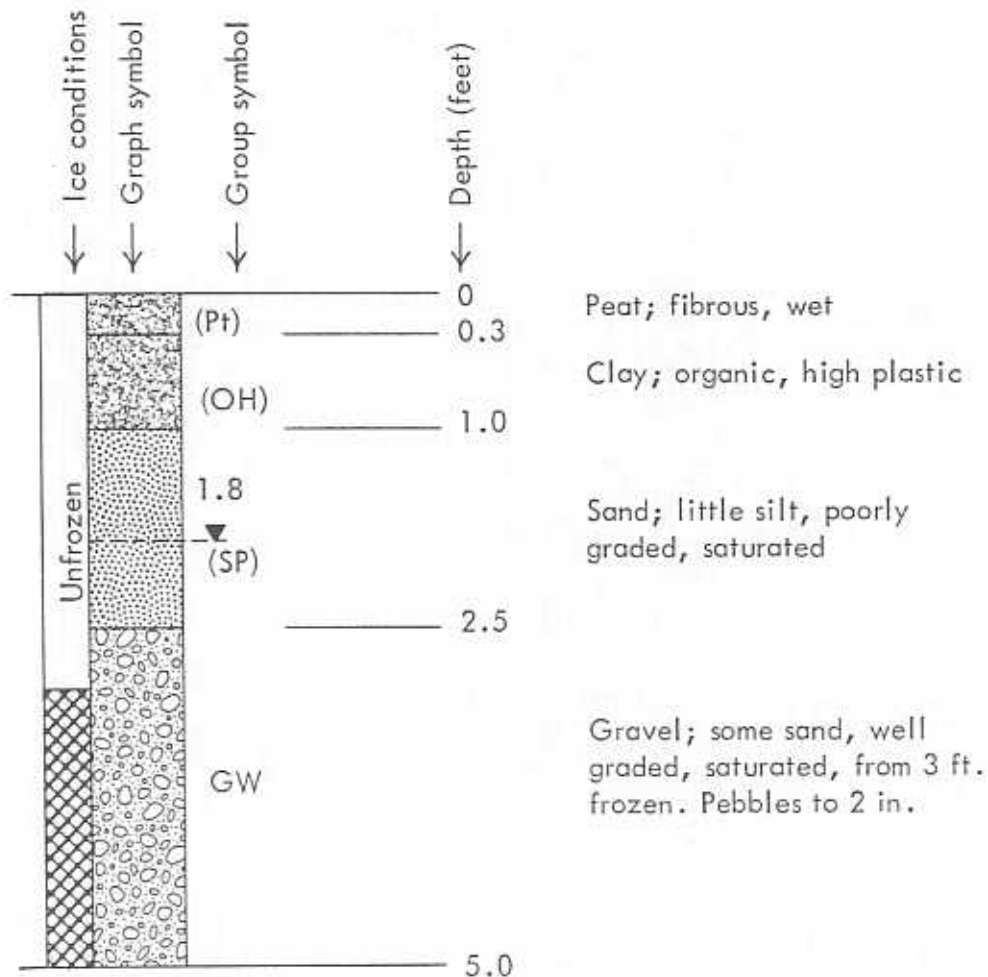
EXPLANATION OF TERMS AND SYMBOLS

DRILL HOLES AND TEST PITS

These pages present an explanation of the terms and symbols used in summarizing the results of field investigations as presented under Site Descriptions. Specifically, the explanations refer to the sheets entitled "Log Description and Laboratory Test Data". The materials, boundaries, and conditions have been established only at the test locations and could differ elsewhere on the site.

TEST PIT LOG DESCRIPTION

Soils of different engineering classification are commonly grouped generically for ease of reference. Seepage and the water level are indicated beside the graphical representation. They are followed by group symbols (according to the Unified Soil Classification System) and depths at individual soil type boundaries. Frost penetration is indicated to the left of the graph symbol as illustrated below:





DRILL HOLE LOG DESCRIPTION

The general information, indicating Site No., Hole No., Date drilled, Drilling Method and the firm responsible for the acquisition of the drill hole data designated under "Logged By", is noted in the upper portion of the standard "Detailed Drill Hole Log" form.

The detailed sub-surface information at each drill hole location has been presented in a columnar form as noted on the "exhibit" drill hole log data sheet on the following page. A description of each column used is outlined herewith:

- Column 1 and 9: Depth scale outlining increasing depth of drill hole below existing ground surface.
- Column 2: Graph Symbol to pictorially illustrate major soil divisions encountered in the drill hole. A detailed definition of each graph symbol is explained in the Materials Classification section of the Terms and Symbols.
- Column 3: Unified Group Symbol indicating the abbreviated material classification in accordance with the Unified Soil Classification system. A detailed definition of each Unified Group Symbol is explained under the Materials Classification heading in the Terms and Symbols section of the glossary.
- Column 4: Materials Description contains the engineering classification of each soil strata encountered in accordance with the criteria outlined in the Materials Classification heading in the Terms and Symbols section of the Glossary.
- The depths of ground water level and the interface between different soil strata are indicated on the extreme left of this column.
- Column 5: General Classification of Ground Ice Conditions indicates whether the material was frozen or unfrozen at the time of drilling.
- Column 6: N.R.C. Classification of Ground Ice Conditions contains abbreviated symbols for ground ice in accordance with the National Research Council of Canada's "Guide to a Field Description of Permafrost for Engineering Purposes", Technical Memorandum 79. A detailed outline of the N.R.C. classification is contained in the "Ground Ice Classification" heading in the Terms and Symbols Section of the Glossary.
- Column 7: Estimated Content of Ground Ice Conditions refers, generally, to the visual estimate of ice content in the soil formations encountered during the drilling program. The following abbreviations have been utilized for estimated ice content:



"L":- indicates Low ice content with generally less than 10% ice.

"M":- indicates Medium ice content with generally 10% to 50% ice.

"H":- indicates High ice content with generally in excess of 50% ice.

Column 8:

Sample Type indicates the depth intervals where field samples were secured during the drilling program and the subsequent types of laboratory tests conducted on each respective sample. The following abbreviations have been utilized for the various types of laboratory tests conducted:

MC:- designates moisture content determinations.

GS:- designates grain size analyses including hydrometer tests.

P:- designates Petrographic analyses.

H:- designates Hardness Tests in accordance with the standard "Morr" classification for rocks and minerals.

O:- designates Organic Content determinations.







DETAILED DRILL HOLE LOG

SITE NO. 131


HOLE NO. DH-1

DATE: FEB. 15, 1973 LOGGED BY: PEMCAN

DRILLING METHOD: AIR CONVENTIONAL AIR REVERSE CIRCULATION OTHER:

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)	
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.			
0		OL	1.0 — TOPSOIL: organic, dark brown		Nf	L		0	
2		GM-GP	GRAVEL: some silt, little sand, frequent pebbles to 2" size, occasional boulders, medium brown		Vs	L-M		2	
4	4							6	6
8		ML	7.0 — SILT: some clay, trace of rust and coal specks, frequent pebbles to 1" size, occasional boulders, medium brown					8	
10								10	
12			12.0 — TOTAL DEPTH 12.0'					12	
	①	②	③	④	⑤	⑥	⑦	⑧	⑨

EXHIBIT

GOVERNMENT OF CANADA DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT	 PEMCAN SERVICES "72"
GRANULAR MATERIALS INVENTORY	



MATERIAL CLASSIFICATION

Soil types are designated by a modified version of the Unified Soil Classification System ("The Unified Soil Classification System", Technical Memorandum No. 3-357, Vol.1, 1953, the Waterways Research Station, U.S.A.). The following page defines these terms and symbols. Letters appearing in parentheses denote visual identification which have not been verified in the laboratory. If the soil falls close to the boundaries established between the various groups a double symbol (for example GW-GP) is used.

Since the Unified Soil Classification System does not contain detailed subdivisions of granular soils according to percentage proportions of secondary components, the ASTM suggested method for identification of granular soils ("Suggested Methods of Test for Identification of Soils", ASTM Procedures for Testing of Soils, 4th edition, December, 1964) is adopted for soil description as defined below:

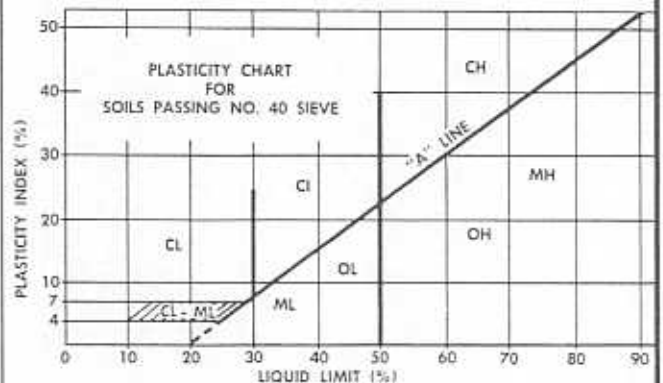
Composite Sand-Gravel Soils		Composite Sand-Silt Soils	
Percentages	Identification	Percentages	Identification
90 to 10	Gravel; trace Sand	95 to 5	Sand; trace - Silt
80 to 20	Gravel; little Sand	90 to 10	Sand; trace + Silt
65 to 35	Gravel; some Sand	80 to 20	Sand; little Silt
50 to 50	Gravel and Sand	65 to 35	Sand; some Silt
35 to 65	Sand and Gravel	50 to 50	Sand and Silt
20 to 80	Sand; some Gravel	35 to 65	Silt and Sand
10 to 90	Sand; little Gravel	20 to 80	Silt; some Sand
	Sand; trace Gravel	10 to 90	Silt; little Sand
			Silt; trace Sand

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION		GROUP SYMBOL	GRAPH SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA				
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 200 SIEVE)	GRAVELS MORE THAN HALF COARSE GRAINS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	GW		WELL GRADED GRAVELS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 6$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$			
		GP		POORLY GRADED GRAVELS, AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS				
		DIRTY GRAVELS (WITH SOME FINES)	GM		SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE P.I. LESS THAN 4		
			GC		CLAYEY GRAVELS, GRAVEL-SAND-SILT CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7		
	SANDS MORE THAN HALF FINE GRAINS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	SW		WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 4$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$			
			SP		POORLY GRADED SANDS, LITTLE OR NO FINES		NOT MEETING ABOVE REQUIREMENTS		
		DIRTY SANDS (WITH SOME FINES)	SM		SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE P.I. LESS THAN 4		
			SC		CLAYEY SANDS, SAND-SILT CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7		
							CLASSIFICATION IS BASED UPON PLASTICITY CHART (see below)		
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES 200 SIEVE)	SILTS BELOW "A" LINE NEGLECTIBLE ORGANIC CONTENT	$W_L < 50\%$	ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	WHENEVER THE NATURE OF THE FINE CONTENT HAS NOT BEEN DETERMINED, IT IS DESIGNATED BY THE LETTER "F", E.G. SF IS A MIXTURE OF SAND WITH SILT OR CLAY			
		$W_L > 50\%$	MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS				
	CLAYS ABOVE "A" LINE ON PLASTICITY CHART NEGLECTIBLE ORGANIC CONTENT	$W_L < 30\%$	CL		INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS				
		$30\% < W_L < 50\%$	CI		INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS				
		$W_L > 50\%$	CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS				
	ORGANIC SILTS & CLAYS BELOW "A" LINE ON CHART	$W_L < 50\%$	OL		ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY				
		$W_L > 50\%$	OH		ORGANIC CLAYS OF HIGH PLASTICITY				
	HIGHLY ORGANIC SOILS		Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS		STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE		

SPECIAL SYMBOLS

BEDROCK (UNDIFFERENTIATED)	OVERBURDEN (UNDIFFERENTIATED)
SANDSTONE	LIMESTONE (fragments & blocks)
SHALE	
LIMESTONE	
TALUS (angular rock fragments)	
TILL (mixed silty sand & clay)	



1. ALL SIEVE SIZES MENTIONED ON THIS CHART ARE U.S. STANDARD, A.S.T.M. E.11.
2. BOUNDARY CLASSIFICATIONS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE GIVEN COMBINED GROUP SYMBOLS, E.G. GW-GC IS A WELL GRADED GRAVEL SAND MIXTURE WITH CLAY BINDER BETWEEN 5% AND 12%.

GROUND ICE CLASSIFICATION

TABLE I
ICE DESCRIPTIONS
A. ICE NOT VISIBLE^(a)

Group Symbol	Subgroup		Field Identification
	Description	Symbol	
N	Poorly bonded or friable	Nf	Identify by visual examination. To determine presence of excess ice, use procedure under note ^(b) and hand magnifying lens as necessary. For soils not fully saturated, estimate degree of ice saturation: medium, low. Note presence of crystals or of ice coatings around larger particles.
	No excess ice	Nbn	
	Well-bonded Excess ice	Nbe	

^(a) Frozen soils in the N group may, on close examination, indicate presence of ice within the voids of the material by crystalline reflections or by a sheen on fractured or trimmed surfaces. The impression received by the unaided eye, however, is that none of the frozen water occupies space in excess of the original voids in the soil. The opposite is true of frozen soils in the V group (see p. 14).

^(b) When visual methods may be inadequate, a simple field test to aid evaluation of volume of excess ice can be made by placing some frozen soil in a small jar, allowing it to melt, and observing the quantity of supernatant water as a percentage of total volume.

FIG A. ICE NOT VISIBLE

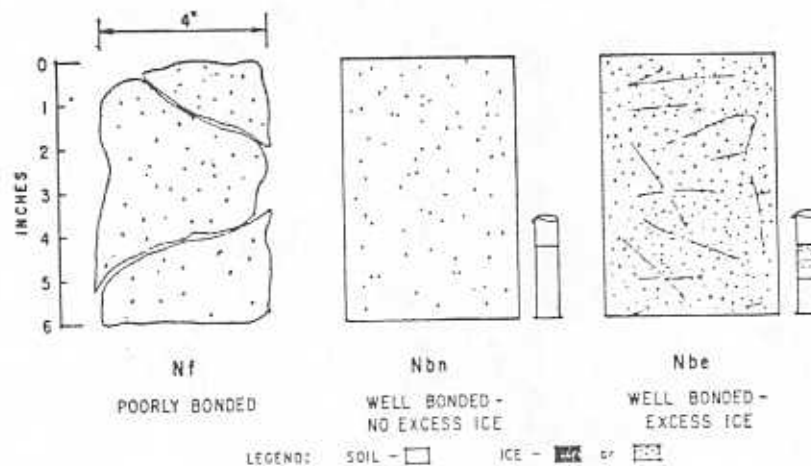




TABLE I (cont'd)
ICE DESCRIPTIONS
B. VISIBLE ICE—LESS THAN 1 INCH THICK^(*)

Group Symbol	Subgroup		Field Identification
	Description	Symbol	
V	Individual ice crystal or inclusions	V _x	For ice phase, record the following when applicable: Location Size Orientation Shape Thickness Pattern of arrangement Length Spacing Hardness Structure } per Group C (see p. 16) Colour Estimate volume of visible segregated ice present as percentage of total sample volume.
	Ice coatings on particles	V _c	
	Random or irregularly oriented ice formations	V _r	
	Stratified or distinctly oriented ice formations	V _s	

^(*) Frozen soils in the N group may, on close examination, indicate presence of ice within the voids of the material by crystalline reflections or by a sheen on fractured or trimmed surfaces. The impression received by the unaided eye, however, is that none of the frozen water occupies space in excess of the original voids in the soil. The opposite is true of frozen soils in the V group.

FIG B. VISIBLE ICE LESS THAN ONE INCH THICK

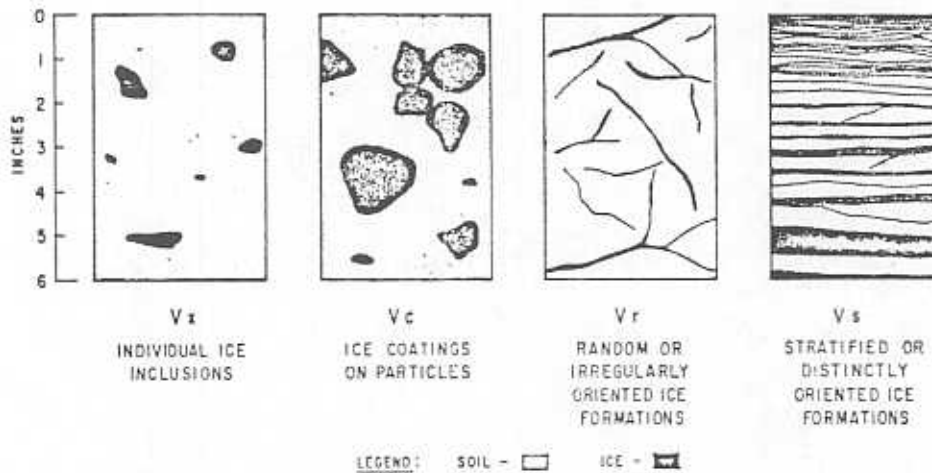




TABLE I (cont'd)
ICE DESCRIPTIONS
C. VISIBLE ICE—GREATER THAN 1 INCH THICK

Group Symbol	Subgroup		Field Identification
	Description	Symbol	
ICE	Ice with soil inclusions	ICE + soil type	Designate material as ICE ^(a) and use descriptive terms as follows, usually one item from each group, when applicable: <u>Hardness</u> HARD SOFT (of mass, not individual crystals) <u>Colour</u> (Examples): COLOURLESS GRAY BLUE <u>Structure^(b)</u> CLEAR CLOUDY POROUS CANDLED GRANULAR STRATIFIED <u>Admixtures</u> (Examples): CONTAINS FEW THIN SILT INCLUSIONS
	Ice without soil inclusions	ICE	

^(a) Where special forms of ice such as hoarfrost can be distinguished, more explicit description should be given.

^(b) Observer should be careful to avoid being misled by surface scratches or frost coating on the ice.

FIG C. VISIBLE ICE GREATER THAN ONE INCH THICK

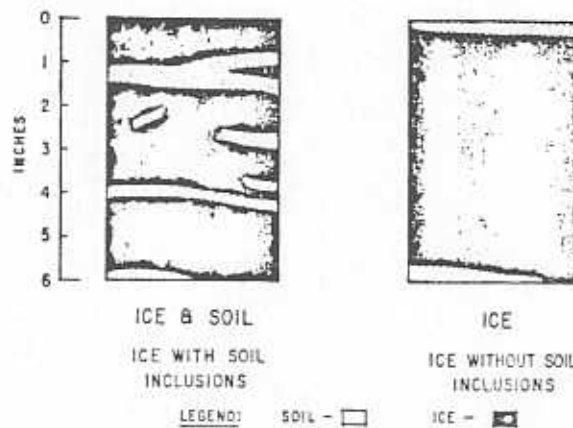




TABLE II

TERMINOLOGY

Ice Coatings on Particles are discernible layers of ice found on or below the larger soil particles in a frozen soil mass. They are sometimes associated with hoarfrost crystals, which have grown into voids produced by the freezing action.

Ice Crystal is a very small individual ice particle visible in the face of a soil mass. Crystals may be present alone or in combination with other ice formations.

Clear Ice is transparent and contains only a moderate number of air bubbles.

Cloudy Ice is relatively opaque due to entrained air bubbles or other reasons, but which is essentially sound and non-pervious.

Porous Ice contains numerous voids, usually interconnected and usually resulting from melting at air bubbles or along crystal interfaces from presence of salt or other materials in the water, or from the freezing of saturated snow. Though porous, the mass retains its structural unity.

Candled Ice is ice that has rotted or otherwise formed into long columnar crystals, very loosely bonded together.

Granular Ice is composed of coarse, more or less equidimensional, ice crystals weakly bonded together.

Ice Lenses are lenticular ice formations in soil occurring essentially parallel to each other, generally normal to the direction of heat loss and commonly in repeated layers.

Ice Segregation is the growth of ice as distinct lenses, layers, veins, and masses in soils commonly but not always, oriented normal to direction of heat loss.

Well-bonded signifies that the soil particles are strongly held together by the ice and that the frozen soil possesses relatively high resistance to chipping or breaking.

Poorly-bonded signifies that the soil particles are weakly held together by the ice and that the frozen soil consequently has poor resistance to chipping or breaking.

Friable denotes extremely weak bond between soil particles. Material is easily broken up.

Excess Ice signifies ice in excess of the fraction that would be retained as water in the soil voids upon thawing.

For a more complete list of terms generally accepted and used in current literature on Frost and Permafrost see Hennion, F. "FROST AND PERMAFROST DEFINITIONS", Highway Research Board, Bulletin 111, 1955.



EXPLANATION OF TERMS AND SYMBOLS

WILDLIFE AREAS

Wildlife boundaries and information presented in the Community and Intercommunity reports has been extracted for the most part from publications prepared by the Canadian Wildlife Service, Government of Canada.

The terms "critical" and "important" as used to designate certain wildlife areas can be generally defined as habitat areas which are critical and/or important to the subsistence and survival of various wildlife species.

COMMUNITY REPORTS

In each Community Study Area, known "critical" and "important" wildlife, waterfowl and fishery resource areas are outlined on the respective map presentations. Any wildlife, waterfowl or fishery resource area which is acknowledged as being "critical" is outlined in red and is noted with the word "critical" within the boundary of the respective area. Non-critical areas are outlined as follows:

- Wildlife areas are outlined in red.
- Waterfowl areas and, in the case of Fort Simpson, hunting locales, are outlined in yellow.
- Fishery resource areas are outlined in blue.

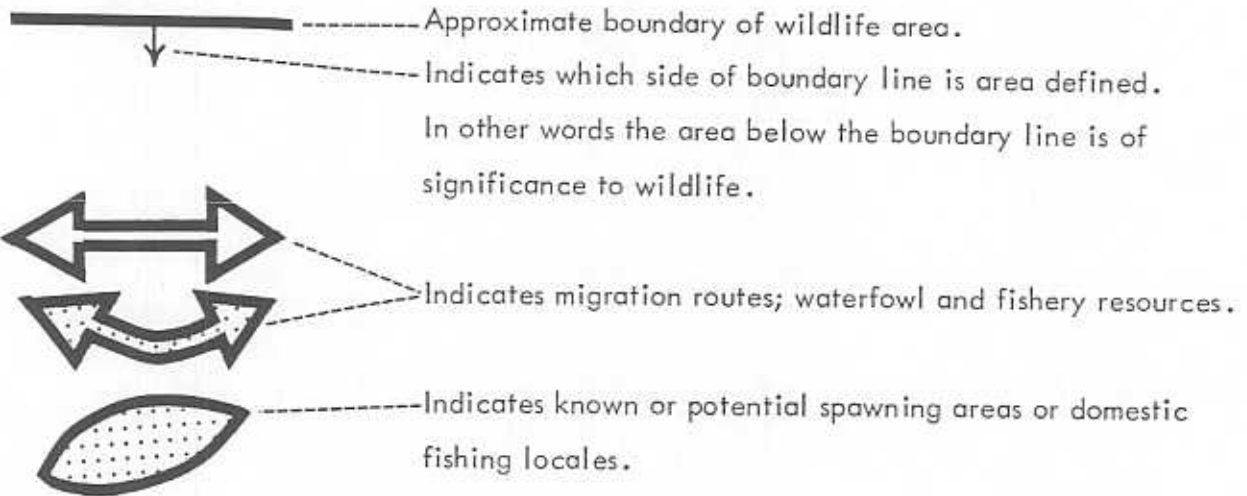
Outlined wildlife areas include both regions of known wildlife habitation and regions which have been historically trapped by northern residents.

Waterfowl areas include migration, staging, molting and nesting locales which are of significance in the respective Study Areas.



Fishery resource areas include migration, spawning and domestic fishing locales which are of significance in the respective Study Areas.

Symbols used on the maps are illustrated and explained as follows:

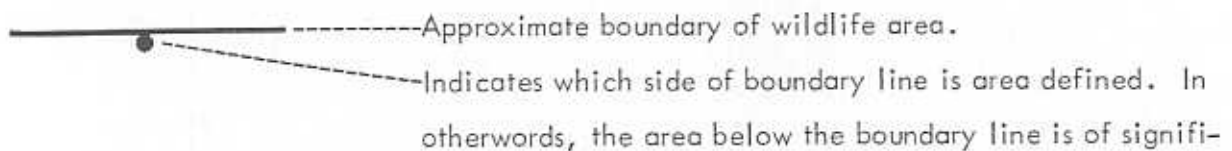


Pertinent wildlife areas are discussed in the Methodology-Evaluation section of the text in each community report. Similar documentation is also presented for sites which occur in significant wildlife areas in the Site Description section of the report.

INTERCOMMUNITY REPORTS

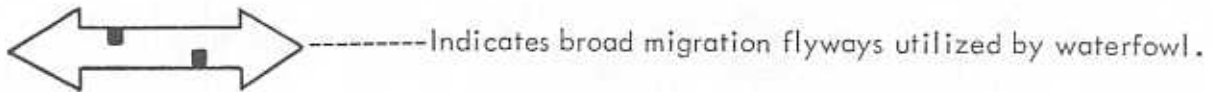
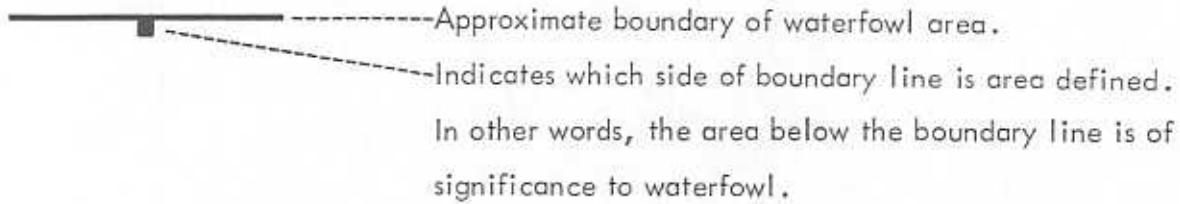
In each Intercommunity Study Area, known "critical" and "important" wildlife, waterfowl and fishery resource areas are outlined on the respective map presentations. A brief description relating to the significance of each area is included within the outlined boundary. Areas that are classified as "critical" are so noted on the maps.

Symbols used on the maps are illustrated and explained as follows:





cance to wildlife.



Significant fishery resource information such as migration routes and potential spawning areas is noted directly on the maps.

Pertinent wildlife areas are discussed in the Methodology-Evaluation section of the text in each Intercommunity report. Similar documentation is also presented for sites which occur in significant wildlife areas in the Site Description section of the report.



PEMCAN SERVICES

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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.
Terrace	A relatively flat elongate stairstepped surface bounded by a steeper ascending slope on one side and a steep descending slope on the other.
Tertiary	The earlier of the two geologic periods comprised in the Cenozoic era, in the classification generally used. Also the system of strata deposited during that period.
Thermal Regression	The thawing of frozen ground due to surface disturbance, increasing temperature, etc.
Thermokarst Lake	(Cave-in Lake), lakes which occupy depressions resulting from subsidence caused by thawing of ground ice.
Tundra	Any of the vast, nearly level, treeless plains of the Arctic Regions.
Turbid.	Having the sediment stirred up hence muddy, impure.