PEMCAN SERVICES #28

DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

# GRANULAR MATERIALS INVENTORY

## INTERCOMMUNITY STUDY AREA
## FORT NORMAN TO NORMAN WELLS, 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.

Part 1 of the investigation for the granular materials has 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 I are submitted in five separate reports which cover the respective communities within the Study Area. Part 2 of the investigation includes four separate inter-community area reports and a summary section.

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.

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 both PEMCAN and the respective 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.

The preliminary field work, carried out 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 eight feet below the ground surface. Natural outcrops were also catalogued and respective samples secured. On the basis of the airphoto interpretation and preliminary field reconnaissance, twenty-six sites were catalogued and assessed in the Fort Norman to Norman Wells Inter-community Study Area.

Of the twenty-six catalogued sites, nineteen were evaluated in detail by means of drill

hole and/or test pit data. These sites were investigated by both PEMCAN and the respective consultants undertaking studies on the proposed Mackenzie Highway by authority of The Federal Department of Public Works. Data from these investigations is incorporated in the Site Description section of this report.

All sites catalogued and assessed within the Fort Norman to Norman Wells Intercommunity Study Area are shown on the location map in the Summary section of this report. Sites which have been drilled and/or test pitted within the Intercommunity Study Area 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 Study Area 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, poor quality and/or limited quantity of material, limited and/or severe access requirements and environmental considerations including thermally sensitive terrain conditions.

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.

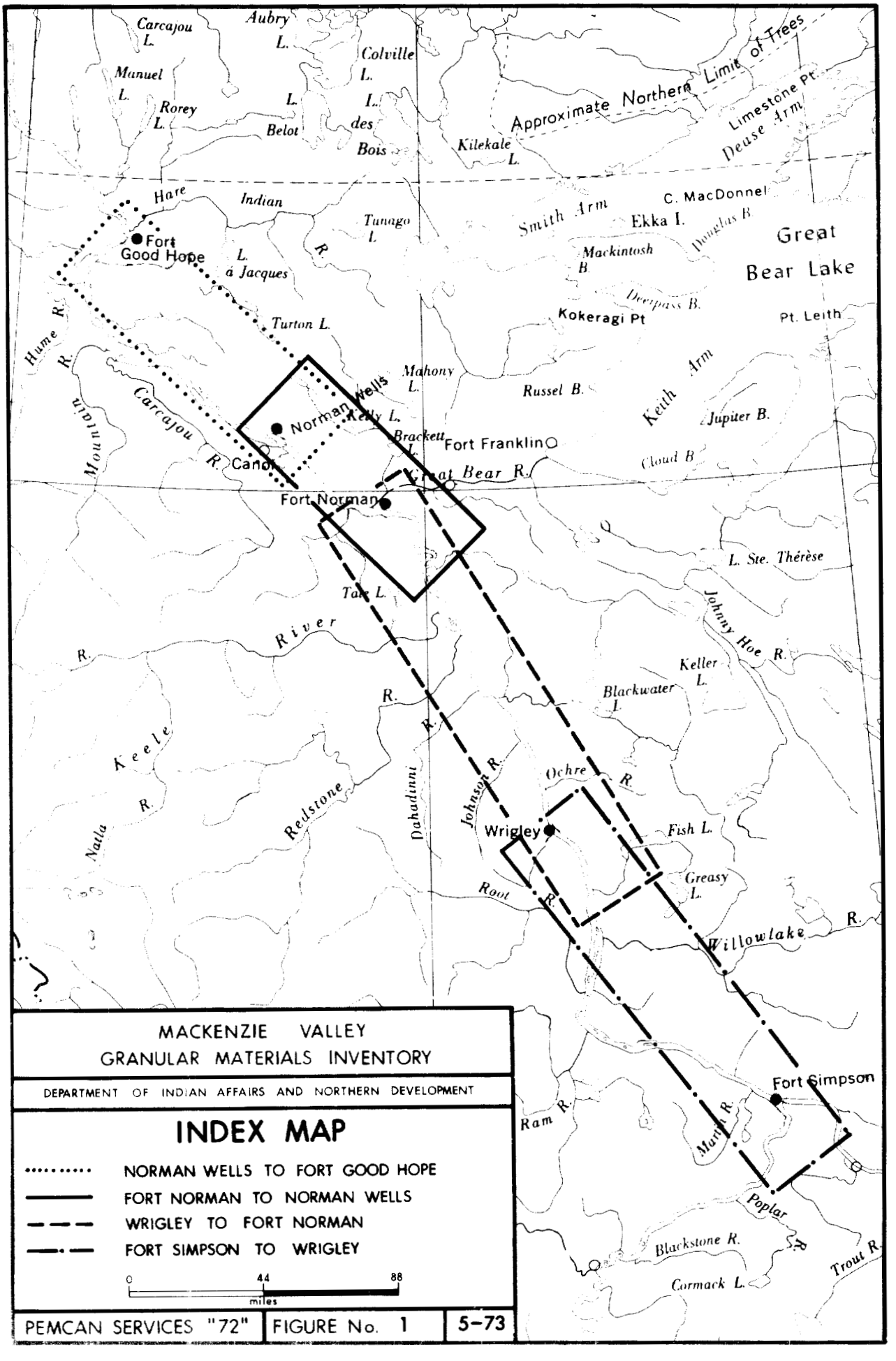
Results of the investigation are summarized in this report and detailed information of the studied sites is compiled in the section on Site Description. The areal extent of the individual deposits is based upon airphoto interpretation, field reconnaissance and field drilling records. Except on sites 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 Fort Norman to Norman Wells Intercommunity Study Area is shown in relation to the other Intercommunity Study Areas on the Index Map (Figure 1).

In addition to the sites in the Intercommunity Study Area, the location map included in the Summary section of the report also illustrates the sites catalogued and assessed in the communities of Fort Norman and Norman Wells. These reports are submitted under separate cover.

Test pit logs, drill hole logs, outcrop descriptions and laboratory test results are attached to the individual Site Descriptions. Symbols, terminology and classification systems used are explained in the glossary.


Carcajou L.
Aubry L.
Colville L.
Manuel L.
Rorey L.
Belot L.
L. des Bois
Approximate Northern Limit of Trees
Limestone Pt.
Dease Arm
Kilekale L.
Hare Indian R.
Tunago L.
Smith Arm
C. MacDonnel
Ekka I.
Douglas B.
Great Bear Lake
Fort Good Hope
L. à Jacques
Mackintosh B.
Deerpass B.
Kokeragi Pt
Pt. Leith
Turton L.
Hume R.
Mahony L.
Russel B.
Keith Arm
Mountain R.
Carcajou R.
Norman Wells
Kelly L.
Jupiter B.
Brackett L.
Fort Franklin
Cloud B.
Great Bear R.
Canol
Fort Norman
L. Ste. Thérèse
Tate L.
Johnny Hoe R.
River R.
Keller L.
Blackwater L.
Keele R.
Natla R.
Redstone R.
Dahadinni R.
Johnson R.
Ochre R.
Wrigley
Fish L.
Root R.
Greasy L.
Willowlake R.
Fort Simpson
Ram R.
Martin R.
Poplar R.
Blackstone R.
Trout R.
Cormack L.
MACKENZIE VALLEY
GRANULAR MATERIALS INVENTORY
DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT
INDEX MAP
NORMAN WELLS TO FORT GOOD HOPE
FORT NORMAN TO NORMAN WELLS
WRIGLEY TO FORT NORMAN
FORT SIMPSON TO WRIGLEY
0 44 88
miles
PEMCAN SERVICES "72"
FIGURE No. 1
5-73

## GEOMORPHOLOGY

The Fort Norman to Norman Wells Intercommunity Study Area, as illustrated by Figure 2, lies within two physiographic subdivisions, namely:

- Mackenzie Plain - which covers both river banks and extends far beyond the Study Area following the river channel.

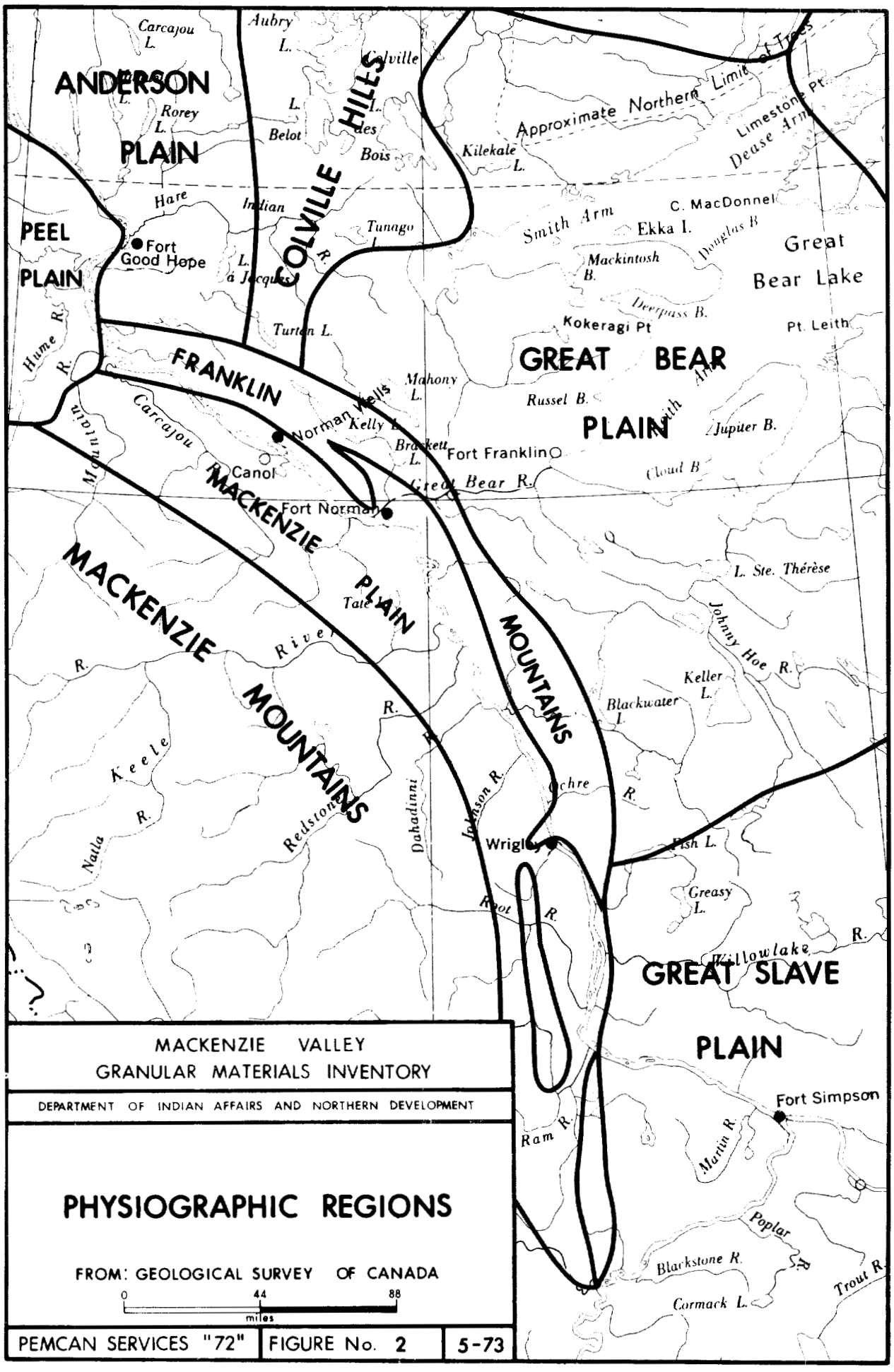
- Franklin Mountains - which borders the Mackenzie Plain along the eastern side of the Study Area.

The Mackenzie Plain is primarily covered by glacial, glaciofluvial and glaciolacustrine deposits. The glaciation has resulted in a generally flat to gently rolling topography.

The bedrock within the Mackenzie Plain consists of greenish grey Devonian and Cretaceous shales, siltstones and mudstone. These strata are locally exposed in the Mackenzie River bank, in its deeply incised tributaries and occasionally along the northeast margin of the Plain. The bedrock is mostly covered with varying thicknesses of glacial drift.

Glaciation has produced morainal till deposits which were surficially reworked by melt waters; these deposits were subsequently covered with glaciofluvial and glaciolacustrine silts, clays and sands. These deposits, which cover the entire southwest Mackenzie River bank, are also encountered along the northeast side of the river. Remnants of beach ridges indicate individual stagnant stages of a former glacial lake basin. The beach ridges on the northeast side of the Mackenzie River are relatively shallow and consist of coarse granular deposits. Fine grained glaciolacustrine sediments, strand lines and beach ridges on the southwest side of the Mackenzie River were reworked by wind action which has resulted in the development of longitudinal dunes.

The transitional zone between the former lake basin and Franklin Mountains exhibits a greater relief as the terrain gradually ascends to the foot of Discovery Ridge. Devonian




MACKENZIE VALLEY
GRANULAR MATERIALS INVENTORY

DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

# PHYSIOGRAPHIC REGIONS

FROM: GEOLOGICAL SURVEY OF CANADA

0 44 88
miles

| PEMCAN SERVICES "72" | FIGURE No. 2 | 5-73 |
|---|---|---|

crystalline and fossiliferous limestones are exposed in localized escarpments while less competent shales usually outcrop only in deeply incised stream channels. In general, the bedrock is covered by a relatively shallow layer of glacial and glaciofluvial material which was reworked to variable depths by surficial erosion. Glaciofluvial outwashes, channel deposits and ice contact deposits, such as eskers and kames, consist predominantly of sandy materials that form thicker layers in a few localized areas.

The Franklin Mountains unit is represented by the rugged Discovery Ridge of the Norman Range and the Bear Rock massif in the southern section of the Study Area.

In the Discovery Ridge, numerous exposures of Devonian limestone form steep walls with talus accumulations of broken and eroded material at the base. The talus generally consists of various sized limestone fragments and blocks. Relatively large fluvial fans, containing coarse grained material, are frequently formed at the mouth of individual erosional gorges.

The Bear Rock massif and its northwesterly extension consists of Devonian, Ordovician and Silurian limestones and dolomites and Cretaceous shales. Karst erosion is common in the carbonate rocks. Rock walls are usually mantled with scree and talus accumulations along the base and alluvial fans have been formed at the mouths of some of the erosional gorges.

Current erosional processes affect both the rock faces in the Discovery Ridge area and the slopes along active stream channels within the Mackenzie Plain. Stream beds contain granular deposits, the gradation of which is inversely proportional to the distance of transport. With the source of the material being in the Discovery Ridge area, the coarse deposits are generally encountered close to the mountain side while the finer materials are carried further downstream towards the Mackenzie River. Fluvial fans exist where stream courses have an abrupt break in slope and at their confluences with the Mackenzie River. The latter fans are generally below the high water mark and contain fine grained material.

A shallow organic soil layer, topped with several inches of peat and moss is usually encountered outside of rugged or recently eroded areas. Low and poorly drained terrain is occasion-

ally covered with a thicker organic section. Fine grained glaciolacustrine deposits in depressional sections of the Mackenzie Plain commonly exhibit thermokarst features as characterized by lakes and deeper muskeg bogs.

Terrain covered by glaciolacustrine deposits, consisting of silts, fine grained sands and occasional clay layers, represent areas deficient in granular materials. Morainal deposits containing heterogeneous mixtures of silt, clay and sand interspersed with some pebbles and cobbles are also very poor sources of granular deposits. Alluvial floodplains and terraces, with the exception of Little Bear River and certain segments of Vermilion, Prohibition, Christina, Francis and Canyon Creeks consist primarily of silty and sandy materials with gravel beds at depth. All of these deposits usually have high water or ice content, especially if covered by thick layers of organic soil. Moreover, potential environmental hazards relative to the exploitation of granular materials may curtail the development of these prospective deposits.

Cretaceous shales, siltstones and mudstones, underlying the major part of the Study Area are, in general, too weak and incompetent for manufactured aggregates for construction purposes.

In the Fort Norman to Norman Wells sector of the Study Area the following landforms usually contain exploitable natural granular materials:

- Ice contact deposits, such as eskers, kames and esker-kame complexes, contain both sand and gravel, with occasional silt and clay pockets. They are widely scattered on the northern side of the Mackenzie River.

- Glaciofluvial outwash plains and channel deposits along the Little Bear River and outwash trains west of Bear Rock contain predominantly sandy gravel of excellent quality with some sand beds.

- Alluvial fans, of both an active and fossil nature, which are usually deposited at

points where stream channels on the east side of the Mackenzie River enter the flats of the glacial lake basin, contain granular deposits ranging from silty sand to coarse gravel. They are irregularly stratified and pocketed.

- Talus and scree deposits as well as cones mantling the base of Bear Rock and Discovery Ridge consist of variously sized limestone fragments and blocks with sand and silt sized particles.

- Beach ridges and abandoned strand lines, consisting of silty sands and gravels do not normally contain large quantities of material. These deposits are relatively common east of Norman Wells.

- Dunes and duned beach ridges containing poorly graded, fine silty sand are frequently noted on the south side of the Mackenzie River.

- Carbonate rocks exposed in the Franklin Mountains, namely in the foreslopes of the Discovery Ridge and in the Bear Rock massif, are generally suitable for manufactured aggregates.

The Study Area lies within the discontinuous permafrost zone. Excess ice is common in fine grained soils and its content may range from thirty to sixty percent. Little or no excess ice exists in coarse and well drained deposits. The average depth of the seasonal freezing and thawing cycles is some three feet, but is apparently as much as twenty feet in clean and well drained sands and gravels.

## TERRAIN PHOTOGRAPHS - FORT NORMAN TO NORMAN WELLS

Flat to gently rolling glacial and glaciolacustrine terrain of the Mackenzie Plain. Bear Rock is on the horizon at left.

Terrace and channel deposits in Vermillion Creek, approximately 25 miles southeast of Norman Wells (Ref. Site 266X).

## ENVIRONMENT

The Fort Norman to Norman Wells Intercommunity Study Area is geographically located in an area that offers considerable use and development of both water and land environments. The area is particularly enhanced by the Mackenzie, Great Bear and Little Bear Rivers, which add aesthetic and recreational values to the region. In the southern section of the Study Area, Bear Rock adds scenic values as it rises some 1,000 feet above the surrounding floodplain and muskeg terrain.

Terrain sensitivity and reaction to modification is generally related to the type of terrain which in turn reflects the material type and ground ice conditions of the various geomorphic features within the Study Area.

Relatively flat, low-profiled and generally fine grained terrain types, such as silt-clay plains, beaches, river deposits and organic terrain usually contain moderate to high ground ice content and can be readily disturbed because of low strength and high compressibility values. Vegetated sites are susceptible to subsidence, slumping and gullying 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 as characterized by the till plains in the Study Area 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 ice content.

Upland mountainous terrain, characterized by rock outcrops or bedrock thinly covered with a veneer of debris, as on Bear Rock and Discovery Ridge, usually contains minimal ice content within the bedrock except for shale where fractures may be ice filled to depths in excess of 100 feet. The overlying debris usually contains low to moderate 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 favourable granular material sites in the Fort Norman to Norman Wells Intercommunity Study Area tend to be located on fairly well drained geomorphic features that contain relatively low 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, detrimental terrain reaction should be limited by sound development procedures such as the incorporation of protective measures for the retainment of vegetation ground-insulation layers and the selection and utilization of adequate fill materials for access roads.

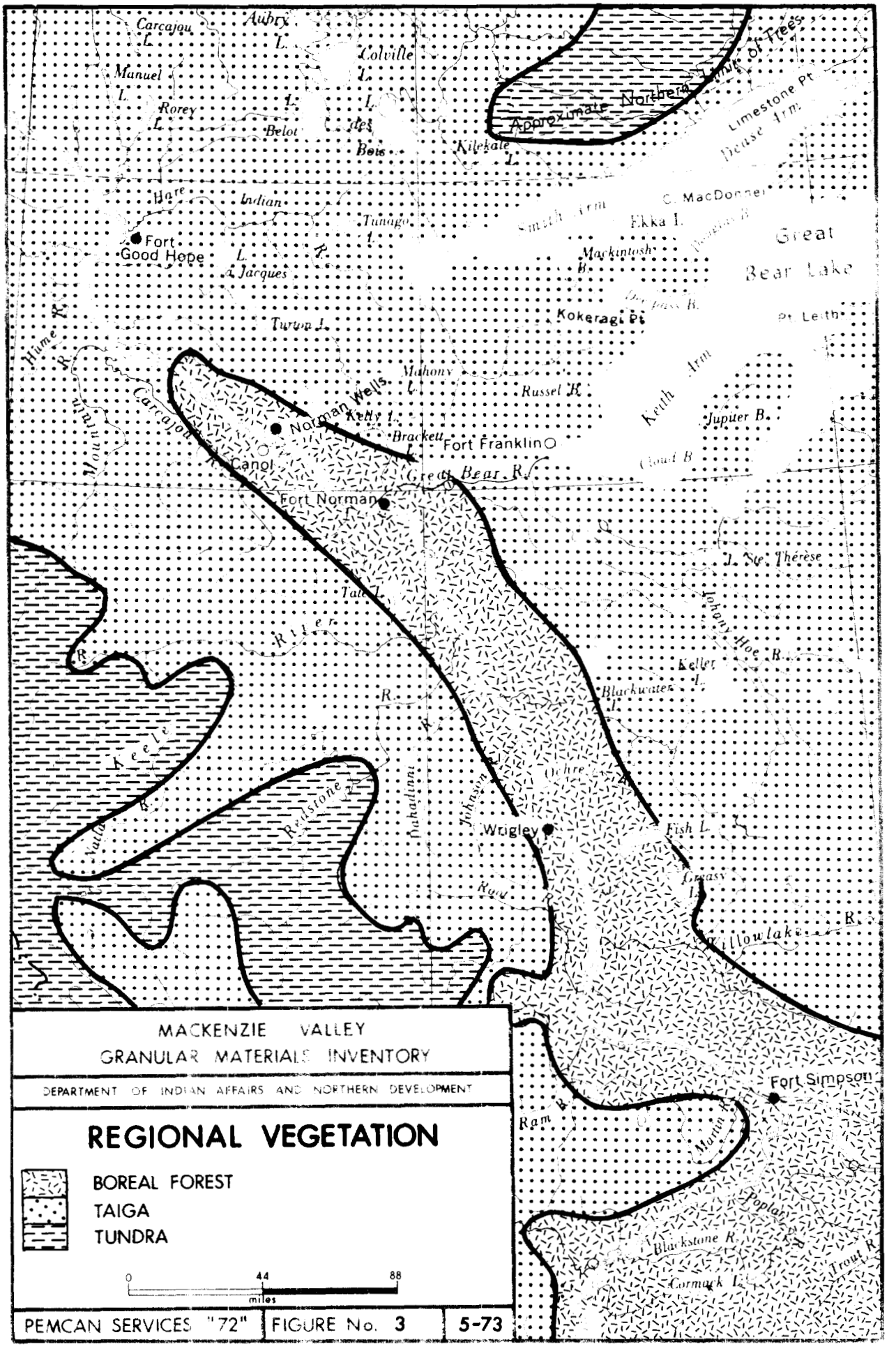
## Vegetation

In the section of the Mackenzie Valley within the Fort Norman to Norman Wells Intercommunity Study Area, the Boreal forest region of Canada is restricted to a narrow extension that parallels the ancient Mackenzie floodplain along the inner valley. As illustrated by Figure 3, the Study Area lies within the northern reaches of this Boreal forest extension.

The dominant tree species in the Fort Norman to Norman Wells Intercommunity Study Area are black and white spruce, tamarack, birch, willows and alder. Poplar is near its northern limit in the Fort Norman area and is only occasionally seen. The ground cover is predominantly mosses, lichens, sedges, herbs and shrubs. The vegetation ranges from commercial growths on river islands and alluvial flats to scrubby growth and treeless muskeg.

Poorly drained alluvial sites commonly support growths of black spruce, tamarack, willows and occasional alder. Permafrost muskegs are generally treeless or support dwarfed growths of black spruce. Well drained sites support black and white spruce, birch and, occasionally, alder.

Benchland areas that are underlain by fine-grained materials with shallow permafrost generally support poor growths of willow, alder and in some cases, black and white spruce.




MACKENZIE VALLEY
GRANULAR MATERIALS INVENTORY

DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

# REGIONAL VEGETATION

BOREAL FOREST
TAIGA
TUNDRA

0 44 88
miles

PEMCAN SERVICES "72" | FIGURE No. 3 | 5-73

Well drained benchland areas generally support well developed growths of birch and spruce.

Mountain slope vegetation ranges from spruce growth near the base to spruce, some birch and occasional poplar on the overburden-covered flanks.

In the Fort Norman to Norman Wells Intercommunity Study Area, natural regrowth of vegetation on existing cutlines and clearings suggests that in general, regeneration of disturbed areas will occur especially if the nutrient zones within the topsoil layer are left undisturbed. In cases where borrow pit developments are abandoned, it may be feasible to artificially reseed and fertilize the area with annual and perennial stocks in order to promote growth cover prior to reestablishment of natural vegetation.

## Wildlife

Wildlife species of both Arctic tundra and Boreal forest utilize the Fort Norman to Norman Wells Intercommunity Study Area and adjacent regions. For the most part the utilization of this area by waterfowl, wildlife and fishery resources is based upon seasonal migration patterns that generally follow the Mackenzie River Valley. There are no known critical wildlife areas in the Study Area; however, the entire region along the Mackenzie Valley is classified as an important wildlife region by the Canadian Wildlife Service.

The Fort Norman to Norman Wells Intercommunity Study Area lies within a broad migration flyway and staging area that is utilized by various waterfowl including swans, geese and ducks during spring and fall migration. The central portion of the Study Area including the Mackenzie River, the sandy islands and both bank areas is utilized as a spring staging area for snow geese, whistling swans, white-fronted geese and various ducks. These areas are shown on the Site Location Map in the Summary section of the report.

Fishery resources in the Study Area are predominantly those found in the Mackenzie, Great Bear, and Little Bear Rivers and include both resident species and those that seasonally

migrate through the respective river systems. The Great Bear River is particularly important to fishery resources as potential spawning gravels occur along the entire length of the river. The area around the mouth of the Great Bear River is noted for its importance as a domestic fishing area to the residents of Fort Norman. The area immediately upstream from the mouth of the Brackett River is reported to contain spawning gravels that are utilized by grayling. Little Bear River is noted as an early summer migration route for chub; Vermilion Creek is tentatively reported to sustain upstream movements of grayling during September and October. A domestic fishing area is located at the mouth of Stewart Creek approximately eight miles southeast of Norman Wells.

Hunting and trapping is periodically undertaken by residents of Norman Wells in the area along and two to four miles inland of the east and west banks of the Mackenzie River from the townsite, southeastwards to the vicinity of Halfway Islands. The area around Three Day Lake is also hunted and trapped for moose, beaver and mink.

| SITE NO. | MATERIAL TYPE: DESCRIPTION | SYM. | SUITABILITY OF MATERIAL | ESTIMATED VOLUME (cu. yds.) | EST'D. RECOV. DEPTH (feet) | OVERBURDEN: TYPE | OVERBURDEN: DEPTH (feet) | OVERBURDEN: DISPOSAL | GROUND ICE (Content) | DRAINAGE | METHOD OF EXTRACTION | HAUL DIST. (miles) | ENVIRONMENTAL CONSIDERATIONS | ASSESSMENT OF SITE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ★259X | Silt, sand & gravel layers | ML | Unsuitable | N/A | — | Topsoil & Peat | 1'± | — | Medium to High | Well Drained to Adjacent Terrain | — | 6'± | 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 | ½ to +14 | Strip & Waste or Stockpile | Low | Good to Southwest | Conventional; Possible Quarry at Depth | ½' | No Critical Wildlife Areas; Adjacent to Stream | Possible Development |
| ★266X | Gravel; silty | GM | General Fill | N/A | +5 | Organic Silt | +½' | — | 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 | — | 1½' | 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 & 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 | ½' | 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 | — | 1½' | 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'± | 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'± | 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'± | 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 | 1½' | 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'± | No Critical Wildlife Areas | Recommended for Development |
| ★282X | Silt, Sand & Gravel | SM-GM | General Fill | N.D. | 2 | Topsoil & Silt | 1½' | — | 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 | 1½' | No Critical Wildlife Areas; Adjacent to two Streams | Fair Prospect |
| ★284X | Silt; clayey | MH | Unsuitable | N/A | — | Topsoil & Peat | 1'± | — | 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

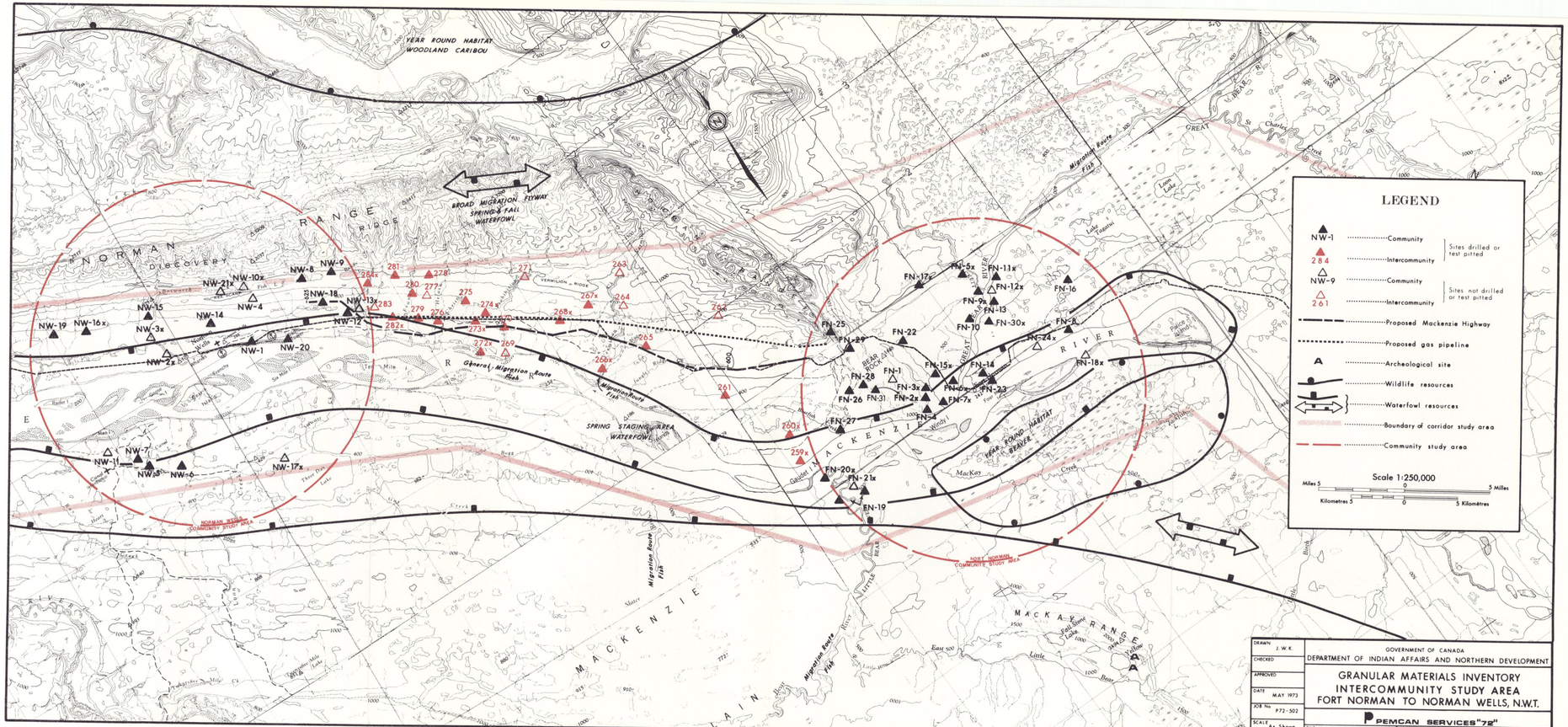
— DRAINAGE:
Rating as shown generally refers to drainage conditions within the site.

— 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.




## LEGEND

- NW-1 ▲ Community — Sites drilled or test pitted
- 284 ▲ Intercommunity
- NW-9 △ Community — Sites not drilled or test pitted
- 261 △ Intercommunity
- 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. |
| CHECKED | |
| APPROVED | |
| DATE | MAY 1973 |
| JOB No. | P72-302 |
| SCALE | As Shown |
| FILE No. | FIGURE / REVISION |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

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

PEMCAN SERVICES "78"

## RECOMMENDATIONS AND CONCLUSIONS

The recommendations and conclusions, which are presented herewith, have been based on airphoto interpretation, office literature studies, preliminary field reconnaissance and detailed field drilling data.

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 or 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 Intercommunity 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.

In addition, all site locations within the Intercommunity Study Area from Fort Norman to Norman Wells, are presented on the Site Location Map in the Summary section of the report. A synopsized 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.

A detailed evaluation of each site investigated in the Study Area is documented in the Site Description section of the report.

# INTERCOMMUNITY STUDY AREA
# FORT NORMAN TO NORMAN WELLS, N.W.T.
# SITE DESCRIPTIONS

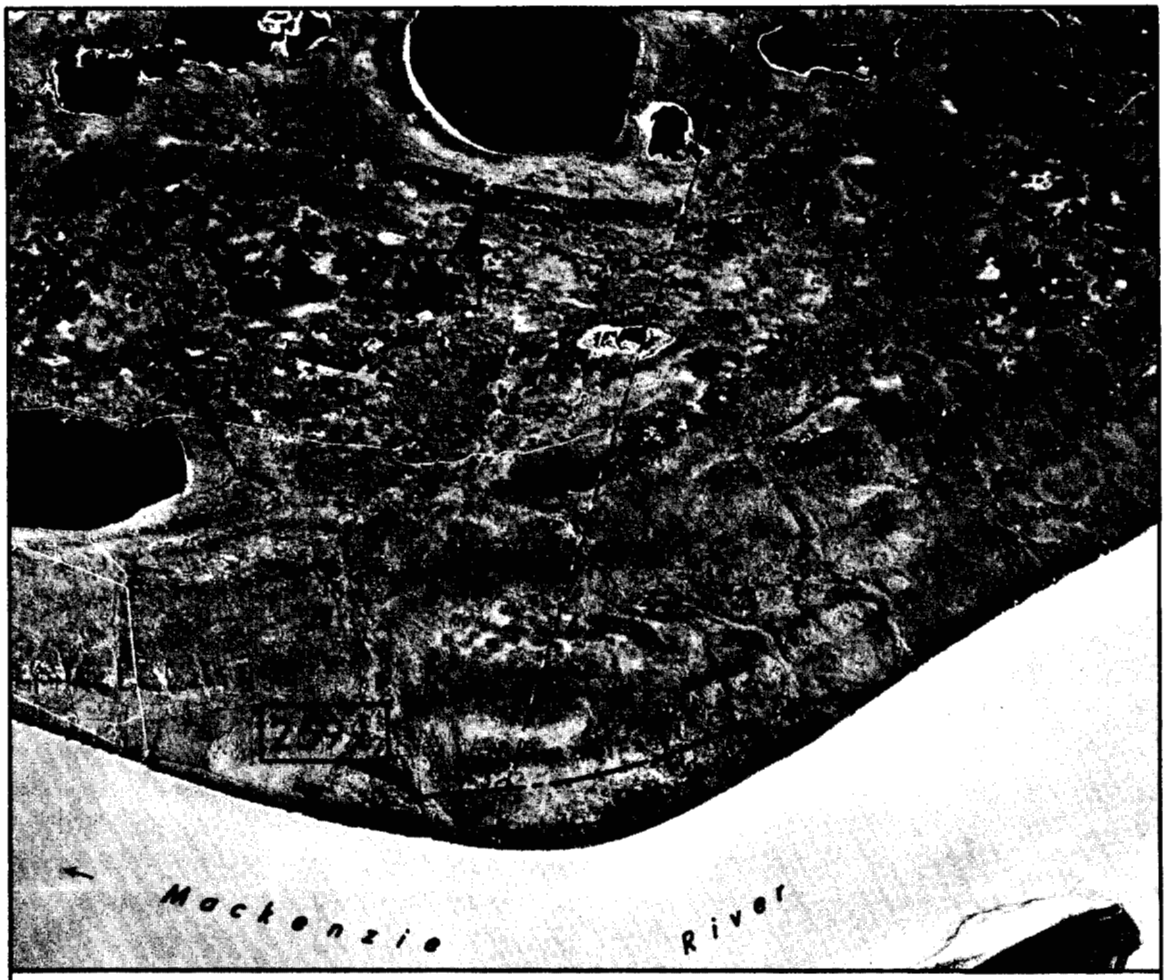
## SITE NO. 259X

Located approximately 32 miles east of Norman Wells and $6\frac{1}{4}$ miles southwest of the proposed Mackenzie Highway, Site 259X consists of a narrow alluvial terrace on the north bank of the Mackenzie River.

Type of Material: Silt; fine grained, thin layers of sand and gravel.

Estimated Volume: Not applicable.

Assessment: Site 259X is not recommended for development because exploitable quantities of granular quality materials were not encountered during the field drilling program.




LEGEND

| | |
|---|---|
| All weather road | Required access |
| Existing trails and cutlines | Site limit |
| Proposed Gas Pipeline | Proposed Mackenzie Highway |
| ⊙ DH Drill Hole | ⊕ TP Test Pit |

Airphoto No. A22862/32 Approximate scale: 1" = 3,000'

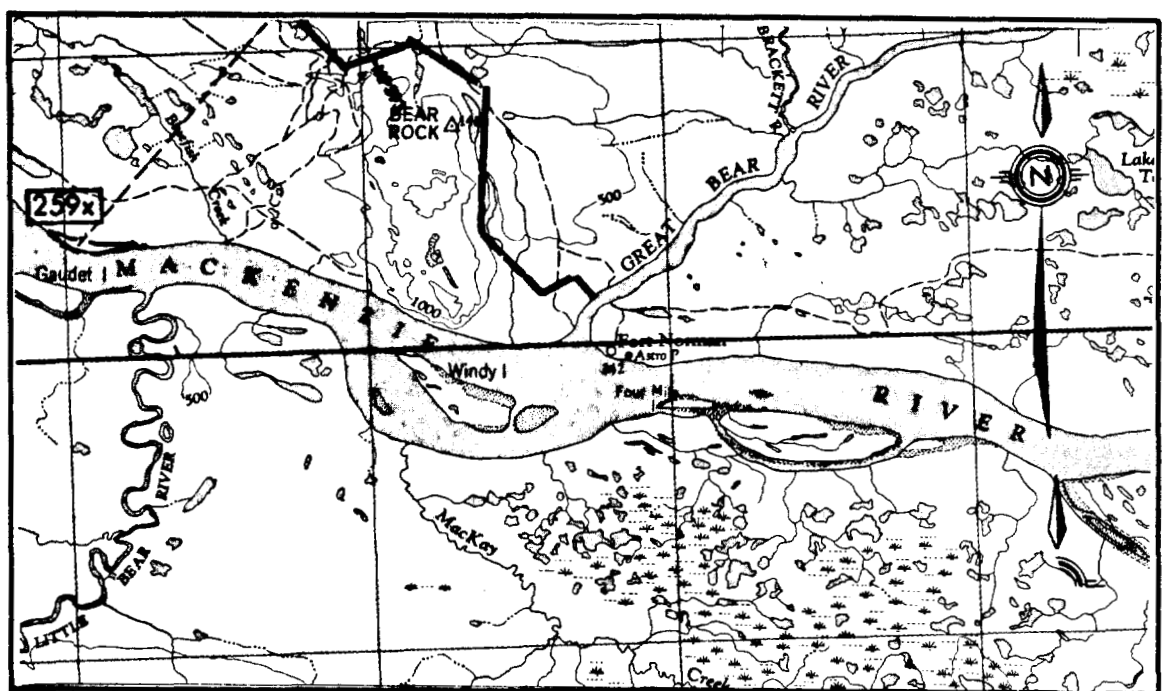
## ENVIRONMENT

Site 259X is located approximately 32 miles east of Norman Wells and 6¼ miles southwest of the proposed Mackenzie Highway right-of-way at Mile 598. The site consists of a prominent narrow, alluvial terrace, approximately 1½ miles in length and 1000 feet in width, which comprises the north bank of the Mackenzie River. The site area exhibits good surficial drainage in all directions, whereas the adjacent terrain immediately to the north is flat, poorly drained and exhibits thermokarst features characterized by numerous lakes, ponds and muskeg bogs.

The material in the alluvial terrace consists of pocketed and stratified silts, sands and gravels exhibiting low to medium ground ice contents. A surficial layer of peat and top-soil, less than 1½ feet in thickness, covers the site area and supports moderately dense growths of spruce.

There are no known critical wildlife areas in the immediate vicinity of Site 259X.

The only existing access to Site 259X from the CNT pole line, proposed gas pipeline or proposed Mackenzie Highway right-of-way consists of seismic cutlines and the access trail




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- Required access
- Site limit
- Proposed Mackenzie Highway

Section of Map No. 96 E

Scale: 1:250,000

which was cleared during the winter drilling program.

## DEVELOPMENT

Site 259X is not recommended for development, because materials of granular quality were not encountered in exploitable quantities in the alluvial terrace. In addition, the in situ ground ice content of the material would make the development of borrow pits quite difficult.

The access to this site involves the traversing of thermally sensitive terrain; upgrading of existing seismic cutlines to facilitate the removal of very poor quality materials would be required.

Site 259X could be considered for exploitation of granular material if a utility was to be constructed in its immediate vicinity.

# DETAILED DRILL HOLE LOG

SITE NO. 259X HOLE NO. DH-1

DATE: JAN. 29, 1973 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: little silt, organic, roots, dark grey | | Vs | H | | 0 |
| 1.5 | | | | | | | | |
| 2 | | ML | SILT: trace sand, occasional pebbles to ¼" size, dark brown | | Vr Vs | M | | 2 |
| 4 | | | | | | | | 4 |
| 6 | | | | | | | | 6 |
| 7.5 | | | | | | | | |
| 8 | | SM-SW | SAND: some gravel and silt, fine to coarse grained, well graded, predominantly rounded and subangular limestone pebbles to 3/4" size, grey | | Vr | L | MC GS O | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 14 | | | | | | | | 14 |
| 15.0 | | | TOTAL DEPTH 15.0' | | | | | |
| 16 | | | | | | | | 16 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 259X HOLE NO. DH-2

DATE: JAN. 29, 1973 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS | | | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| | | | | GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | | |
| 0 | | OL | TOPSOIL: some silt | | Vs | H | | 0 |
| 1.5 | | | | | | | | |
| 2 | | ML | SILT: trace sand, occasional pebbles and cobbles, brown | | Vr | M | | 2 |
| 4 | | | | | | | | 4 |
| 6 | | | | | | | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 12.0 | | | TOTAL DEPTH 12.0' | | | | | |
| 14 | | | | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 259X HOLE NO. DH-3

DATE: JAN. 29, 1973 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS | | | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| | | | | GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | | |
| 0 | | OL | TOPSOIL: some silt, organic, roots, dark grey | | Vr | M | | 0 |
| 1.5 | | | | | | | | |
| 2 | | GM | GRAVEL: little silt, trace sand, predominantly round and subangular limestone and quartzite pebbles to 1" size, grey | | | | | 2 |
| 4 | | | | | | | | 4 |
| 5.0 | | | | | | | | |
| 6 | | SM-ML | SAND AND SILT: occasional rounded and subangular limestone pebbles to $1\frac{1}{2}$", greyish brown | | Vx | L | | 6 |
| 8 | | | | | | | | 8 |
| 8.5 | | | | | | | | |
| 10 | | GW-SP | GRAVEL AND SAND: little silt, medium grained, gravel - well graded, sand - poorly graded, rounded and subangular limestone and dolomite pebbles to 1" size, brown | | | | MC GS | 10 |
| 12 | | | | | | | | 12 |
| 14 | | | | | | | | 14 |
| 14.0 | | | TOTAL DEPTH 14.0' | | | | | |
| 16 | | | | | | | | 16 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

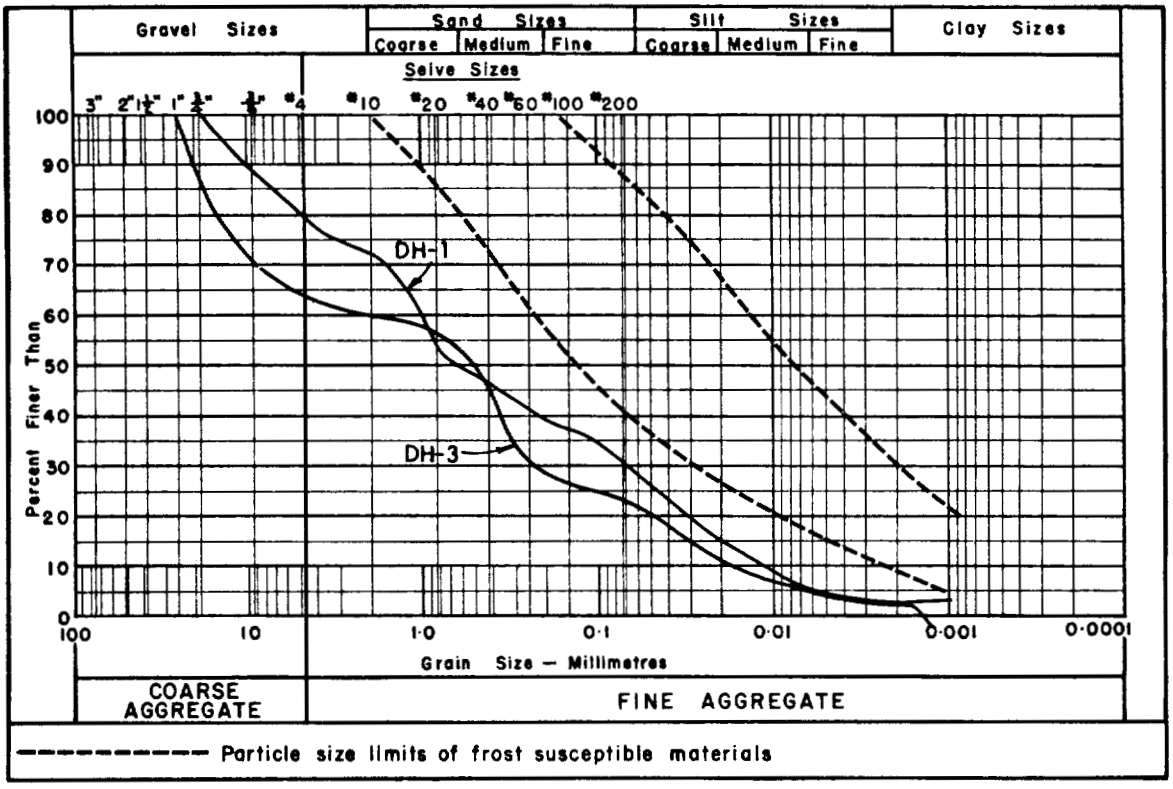
GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

## SUMMARY OF LABORATORY TEST DATA

| | | |
|---|---|---|
| **Sample Location:** | 259X/DH-1 | 259X/DH-3 |
| **Sample Depth (Feet):** | 10.0 | 10.0 - 11.0 |
| **Moisture Content (%):** | 10.3 | 6.1 |
| **Ice Content (%):** | - | - |
| **Organic Content (%):** | 4.1 | - |

### GRAIN SIZE DISTRIBUTION:




### PETROGRAPHIC ANALYSIS:

## SITE NO. 260X

Located approximately 32 miles east of Norman Wells and 5 miles southwest of the proposed Mackenzie Highway at Mile 598, Site 260X consists of a small, narrow sand dune.

Type of Material: Sand; fine grained, poorly graded.

Estimated Volume: 250,000 cubic yards.

Assessment: Site 260X is not recommended for development because of the poor quality of available materials and the difficult access to the site area across thermally sensitive terrain.


LEGEND

| | |
|---|---|
| All weather road | Required access |
| Existing trails and cutlines | Site limit |
| Proposed Gas Pipeline | Proposed Mackenzie Highway |
| ⊙ DH Drill Hole | ⊕ TP Test Pit |

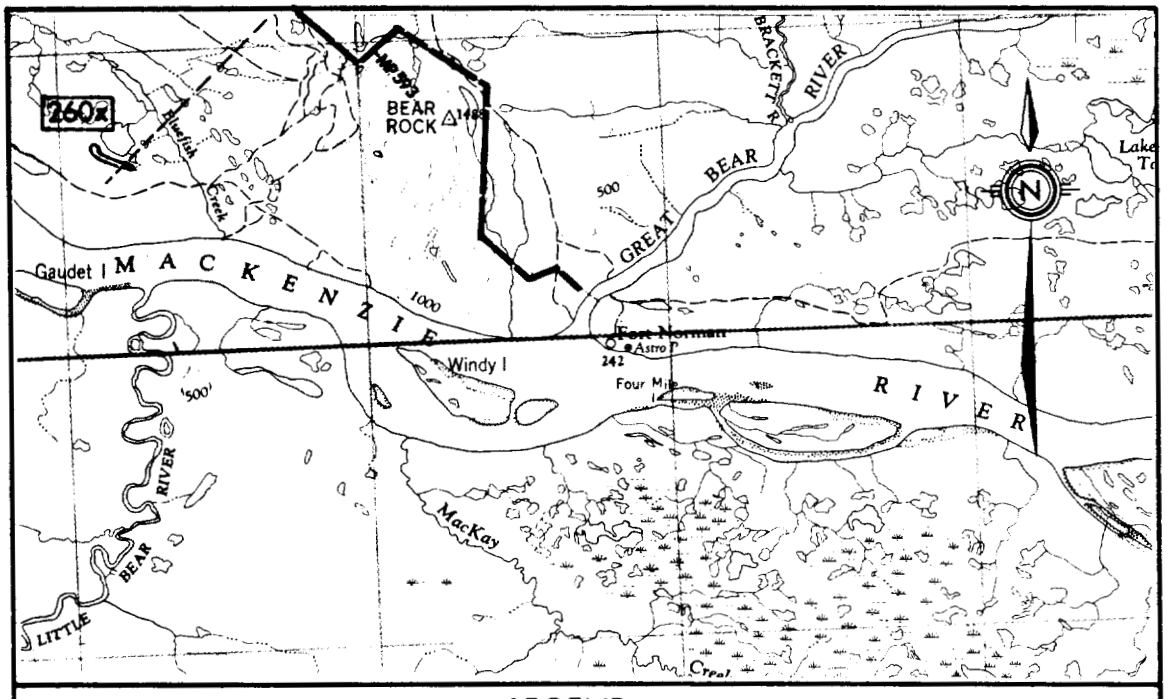
Airphoto No. A22862/32 Approximate scale: 1" = 3,000'

## ENVIRONMENT

Site 260X is located approximately 32 miles east of Norman Wells and approximately 5 miles southwest of the proposed Mackenzie Highway right-of-way at Mile 598. The site consists of a small, narrow sand dune approximately 3500 feet in length and 150 feet in width with a relief of 30 to 40 feet above the adjacent flat, poorly drained glaciolacustrine terrain. The adjacent terrain exhibits thermally sensitive conditions characterized by numerous lakes, ponds and muskeg bogs.

The dune material consists of fine grained, poorly graded eolian sand with a trace of silt which may be suitable for very marginal fill material. A layer of organic topsoil, less than 1 foot in depth, supports moderately dense growths of spruce, birch and poplar which attain heights in excess of 30 feet and trunk diameters to 12 inches. The adjacent poorly drained glaciolacustrine plain supports light to moderate growths of stunted spruce and tamarack. The understory growth on the site area is relatively dense and consists primarily of small bushes and some grass.

There are no known critical wildlife areas in the immediate vicinity of Site 260X.




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- Required access
- Site limit
- Proposed Mackenzie Highway

Section of Map No. 96 E

Scale: 1:250,000

The only existing access to the site area from the CNT pole line or the proposed Mackenzie Highway right-of-way consists of the seismic cutline and the short access trail which was cleared on to the sand dune during the winter drilling program.

## DEVELOPMENT

Site 260X is not recommended for development because of its general remoteness from current locations of proposed utilities, poor quality of material and difficult access to the site area. However, for reference, an estimated quantity of 250,000 cubic yards of fine eolian sands are available from the dune structure.

# DETAILED DRILL HOLE LOG

SITE NO. 260 X

HOLE NO. DH-1

DATE: JAN. 29, 1973 | LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: some silt, little organic, roots, dark grey | | | | | 0 |
| 1.0 | | | | | | | | |
| 2 | | | | | Vx | L | | 2 |
| 4 | | | SAND: trace silt, fine grained, poorly graded, grey | | | | | 4 |
| 6 | | | | UF | | | MC GS O | 6 |
| 8 | | SP | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | Vx | L | | 12 |
| 14 | | | | | | | | 14 |
| 14.0 | | | TOTAL DEPTH 14.0' | | | | | |
| 16 | | | | | | | | 16 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

## SUMMARY OF LABORATORY TEST DATA

**Sample Location:** 260X/DH-1

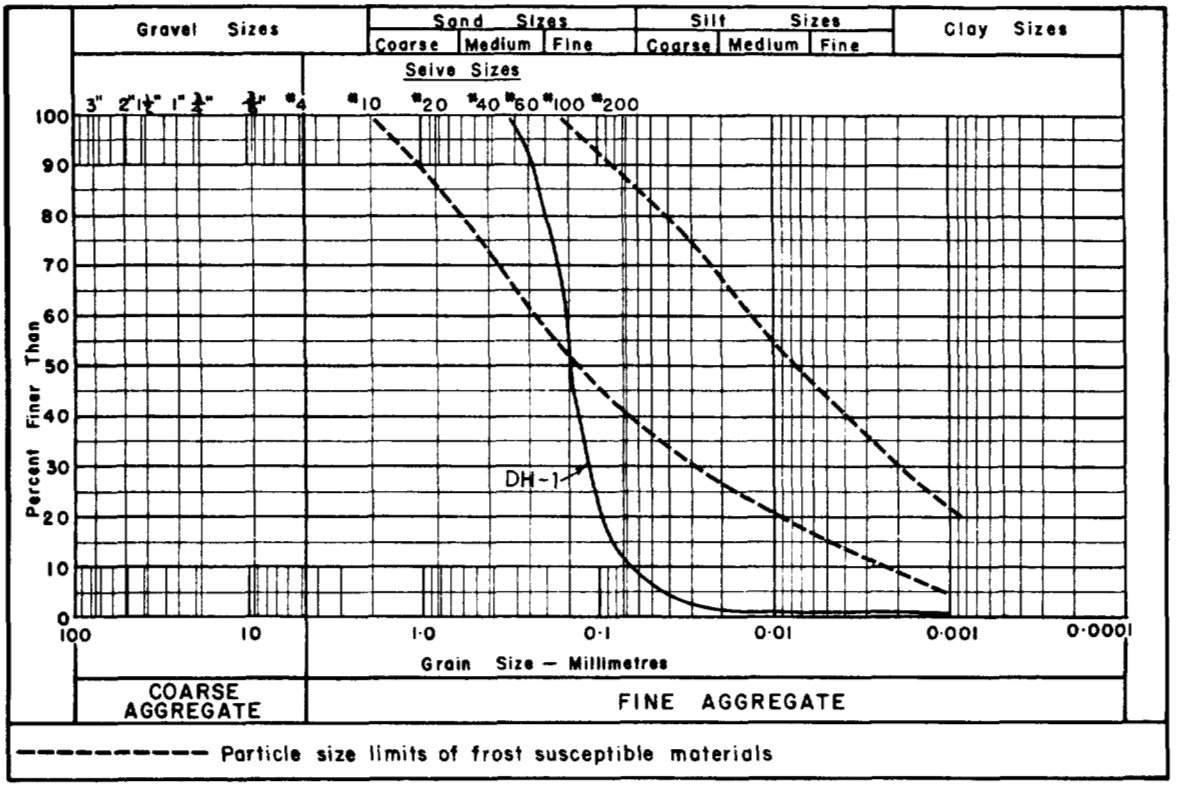
**Sample Depth (Feet):** 6.0

**Moisture Content (%):** 3.1

**Ice Content (%):** -

**Organic Content (%):** 1.5

### GRAIN SIZE DISTRIBUTION:




### PETROGRAPHIC ANALYSIS:

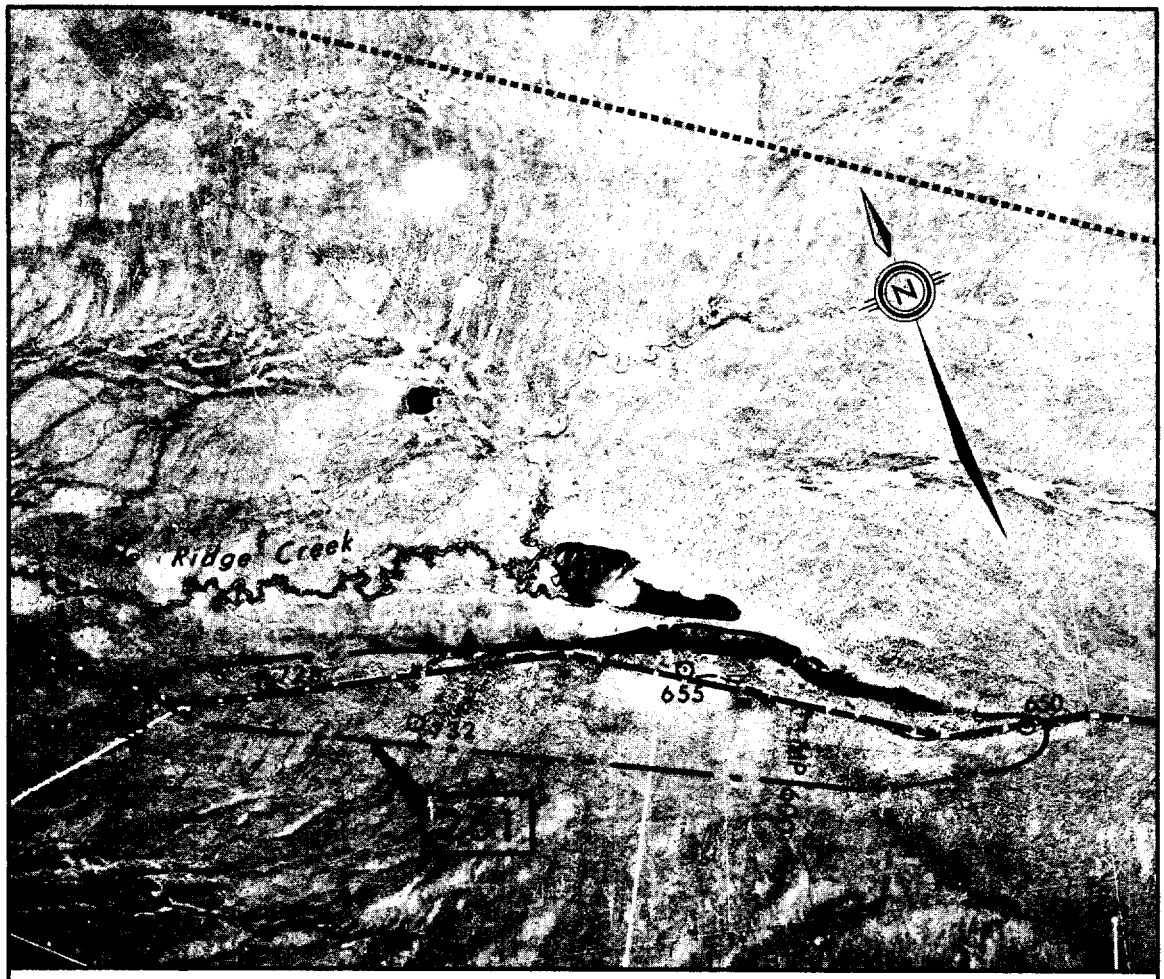
## SITE NO. 261

Located approximately 30 miles east of Norman Wells, Site 261 consists of a prominent bedrock ridge which encompasses the proposed Mackenzie Highway from Mile 599 to Mile 602.

Type of Material: Limestone Bedrock.

Estimated Volume: Unlimited.

Assessment: Good quality granular materials can be quarried for most construction requirements from the bedrock formation; Site 261 is recommended for development.




LEGEND

| | |
|---|---|
| All weather road | Required access |
| Existing trails and cutlines | Site limit |
| Proposed Gas Pipeline | Proposed Mackenzie Highway |
| ⊙ DH Drill Hole | ⊕ TP Test Pit |

Airphoto No. A22934/152 Approximate scale: 1" = 3,000'

## ENVIRONMENT

Site 261 is located approximately 30 miles east of Norman Wells and is generally within the proposed Mackenzie Highway right-of-way from Mile 599 to Mile 602. The site consists of a prominent bedrock ridge which is approximately 3 miles in length and averages $\frac{1}{4}$ mile in width. The site is covered with a layer of glacial till which increases in depth to the southwest. The northeastern periphery of the site area consists of a steep escarpment with exposed faces of limestone. The site area and the adjacent terrain to the southwest is well drained and supports moderately dense growths of birch with occasional clusters of spruce and tamarack. The meandering Jungle Ridge Creek flows parallel to the northern escarpment.

There are no known critical wildlife areas in the immediate vicinity of Site 261.

The CNT pole line and the proposed Mackenzie Highway right-of-way are coincident within this site area and provide excellent future and existing access to potential quarry locations. The gas pipeline route is located approximately $1\frac{1}{2}$ miles north of Site 261.

## DEVELOPMENT

The information from the drill holes conducted on Site 261 by the engineering consultant for The Federal Department of Public Works has confirmed the presence of competent limestone bedrock at a shallow depth below existing ground surface and their drill hole data has been incorporated into this report.

In view of the general shortage of naturally occurring granular materials in this portion of the Study Area, Site 261 is recommended for the possible development of quarries for the production of manufactured aggregates for various construction requirements. The following operational guidelines should be considered if development of quarries are anticipated at Site 261.

- The best quarry locations would be in the site area adjacent to the steep northern escarpment where the overburden material is relatively shallow.

- The existing tree growth and vegetation in required areas should be cleared and removed in accordance with current land use guidelines.

- Quarry operations including blasting and crushing of the limestone bedrock will be required for the manufacturing of granular materials.

- The fibrous peat, organic topsoil and glacial till overburden should be stripped, removed and stockpiled adjacent to quarry locations.

- Selective excavation can be anticipated. The weathered and friable surficial bedrock material may be extracted by standard ripping, dozing and loading techniques

and this material should be suitable in its pit run condition for use in general fill requirements. Better quality aggregates can be produced from fresher and more competent limestone beds at greater depths but extensive blasting and crushing operations would be necessary.

- Staged development of quarry operations should be considered to allow summer thawing of the frozen bedrock in order to minimize the efforts required for the removal of the limestone bedrock material.

- If staged quarry operations are considered then the access road to the proposed Mackenzie Highway or gas pipeline routes from the site area should be upgraded to all weather standards.

- Access from the site area to the existing CNT pole line, proposed Mackenzie Highway and the proposed gas pipeline is excellent and in general does not exceed $\frac{1}{2}$ mile.

## ABANDONMENT AND REHABILITATION

In general, if a well organized and controlled quarry operation is maintained during the development and extraction of material, then the problems related to abandonment and rehabilitation would, for the most part, be inherently managed.

# DETAILED DRILL HOLE LOG

SITE NO. 261 HOLE NO. C 650

DATE: MAR. 1, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | CL | CLAY (TILL): silty, sandy, medium plastic, pebbles & cobbles | | Nbn | | | 0 |
| 3.5 | | GM | GRAVEL: silty-clayey | | | | | |
| 4.5 | | CL | CLAY (TILL): - silty-sandy - medium plastic - cobbles - small boulders - brown | | | | | |
| 9.3 | | | BEDROCK (LIMESTONE) - weathered - grey | | | | | |
| 12.0 | | | END OF HOLE 12.0' | | | | | |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 261 HOLE NO. C 655

DATE: MAR. 1, 1973 | LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS | | | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| | | | | GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | | |
| 0 | | CL | CLAY (TILL): silty sandy, medium plastic pebbles, brown | | Vx | L | | 0 |
| 2 | | | | | | | | 2 |
| 3.0 | | | shale inclusions | | Nbn | | | |
| 4 | | | | | | | | 4 |
| 6 | | | | | | | | 6 |
| 7.0 | | | BEDROCK (LIMESTONE): - weathered - grey | | | | | |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 14 | | | | | | | | 14 |
| 14.0 | | | END OF HOLE 14.0' | | | | | |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 261 HOLE NO. 728

DATE: MAR. 1, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | PT | PEAT | | Vx | M | | 0 |
| 1.0 | | | | | | | | |
| 2 | | OH | CLAY: organic, high plastic dark brown | | Vx | H | | 2 |
| 3.0 | | | | | | | | |
| 4 | | CI | CLAY (TILL): - sandy silty - stones - rust & coal specs - medium plastic - brown | | | | | 4 |
| 6 | | | | | Vx | L | | 6 |
| 7.0 | | | | | | | | |
| 8 | | | - less sand cobbles | | Nbn | | | 8 |
| 10 | | | | | | | | 10 |
| 10.5 | | | | | | | | |
| 12 | | CH | - grey - high plastic | | | | | 12 |
| 14 | | | | | | | | 14 |
| 16 | | | | | | | | 16 |
| 18 | | | | | | | | 18 |
| 18.0 | | | | | | | | |
| 20 | | CH | CLAY (SHALE): high plastic, grey | | | | | |
| 20.0 | | | END OF HOLE 20.0' | | | | | |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 261 HOLE NO. 732

DATE: MAR. 1, 1973 | LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | PT | PEAT | | Vx | M | | 0 |
| 1.0 | | OH | CLAY: organic, high plastic dark brown | | Vx | H | | |
| 3.0 | | CI | CLAY (TILL): silty sandy, stones, medium plastic, brown | | Vs | M | | |
| 5.0 | | | | | Vs | L | | |
| | | | - very sandy<br>- rust & coal specs | | Nbn | | | |
| 7.5 | | | - less sandy<br>- boulders | | | | | |
| 16.0 | | | - grey | | | | | |
| 20.0 | | | END OF HOLE 20.0' | | | | | 20 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

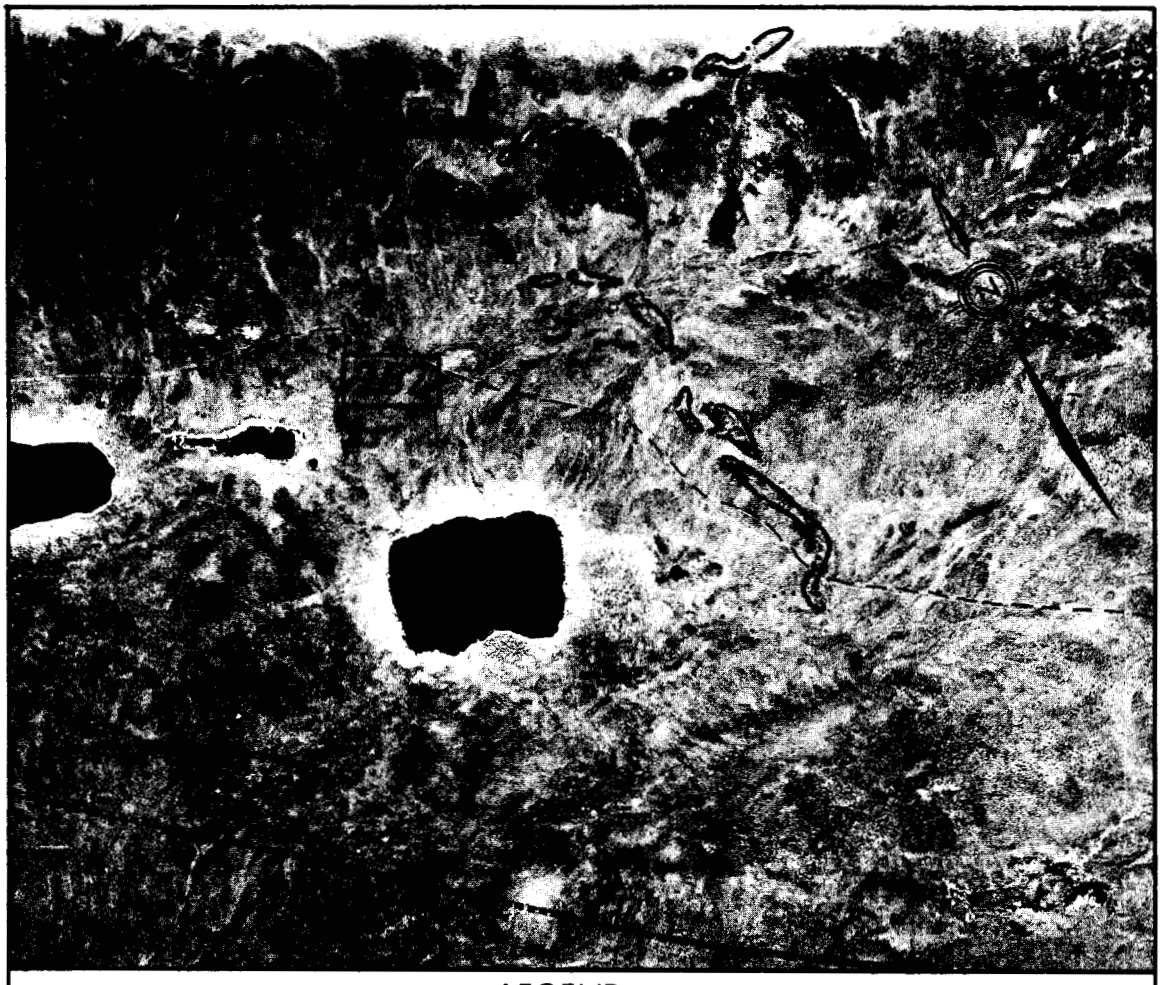
PEMCAN SERVICES "72"

## SITE NO. 262

### LOCATION

Located on the sloping grounds adjacent to the western toe of the Norman Range and east of the upstream section of Nota Creek, Site 262 consists of a series of small esker ridges, including a kame field. It is anticipated the materials, consisting of silty sand with little gravel, are available at Site 262.

The proposed Mackenzie Highway right-of-way at Mile 598 is located approximately $3\frac{1}{2}$ miles south of Site 262. The proposed gas pipeline route runs southwest of the site area at a distance of 1 mile.




Airphoto No. A22934/153

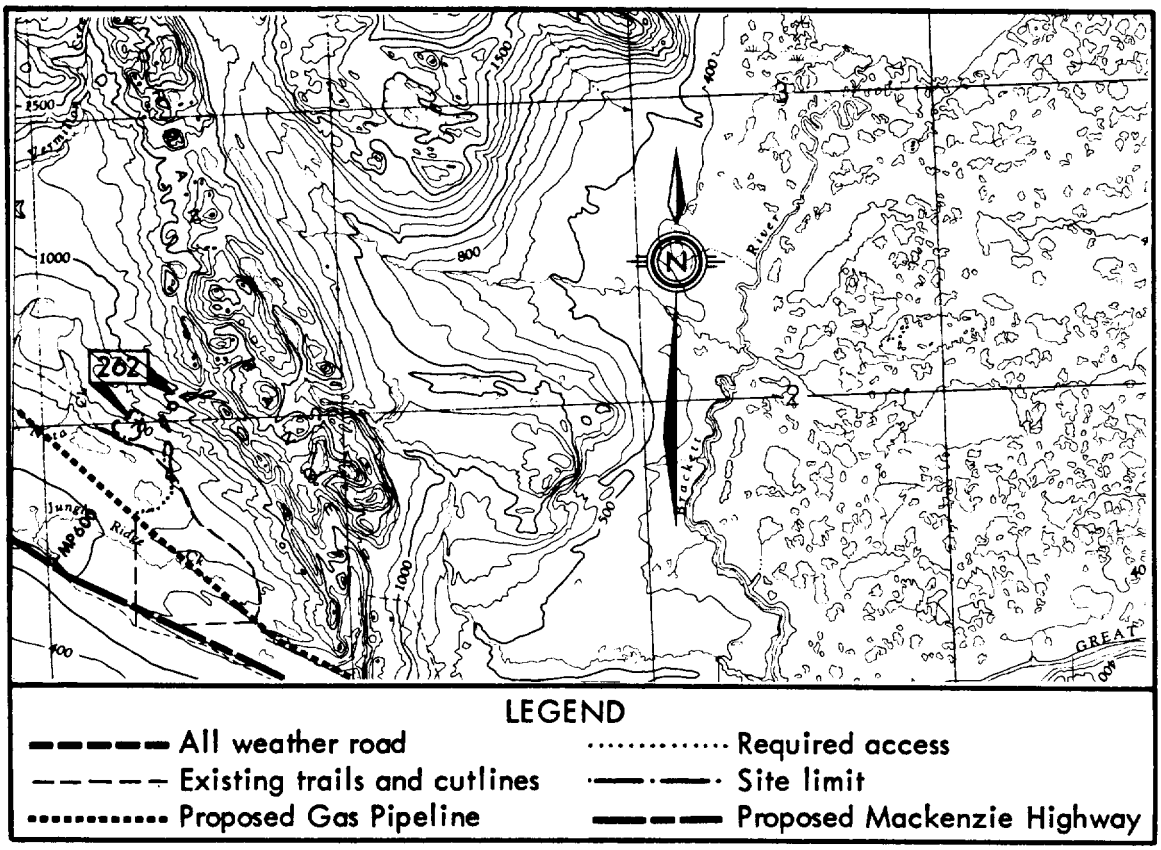
Approximate scale: 1" = 3,000'

## GENERAL

Site 262 is comprised of a narrow discontinuous train of shallow esker ridges spaced over an area more than $2\frac{1}{2}$ miles in length. These ridges range in length from 300 to 3000 feet and in width from 200 to 300 feet. West of the esker train, a separate small kame field, some 1000 by 700 feet in aerial extent, is indicated. The surficial drainage of the site area is fair to the southwest into a depressional terrain marked by several lakes. Spruce interspersed with poplar stands constitutes the primary vegetation cover on the site. There are no known critical wildlife areas in the immediate vicinity of Site 262.

Irregularly bedded and variably washed sands with little gravel are probably the most common constituents of these ice contact deposits. Silt beds and till lenses may be, however, also encountered within the main sand body. It is expected that these deposits may be suitable as marginal to fair quality general fill material. Site 262 is, however, rated as a poor prospect because the development would entail a comparatively large degree of surficial area being cleared relative to the volume of material available.

The access to the site area from both proposed utility routes can be readily achieved through existing seismic cutlines.




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- Required access
- Site limit
- Proposed Mackenzie Highway

Section of Map No. 96 F

Scale: 1:250,000

## SITE NO. 263

### LOCATION

Paralleling the upstream section of Vermilion Creek and approximately 6 miles northeast of the east Mackenzie River bank on the slopes adjacent to the southwestern toe of the Norman Range, Site 263 consists of one esker-kame train and a discontinuous esker-kame complex.

The proposed Mackenzie Highway right-of-way at Mile 608 and the gas pipeline route are located some $3\frac{1}{2}$ and $2\frac{1}{2}$ miles southwest of Site 263, respectively.

The access to Site 263 from either of the proposed utilities is difficult because of deeply incised stream channels surrounding the site area.


LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- Required access
- Site limit
- Proposed Mackenzie Highway

Airphoto No. A22934/90

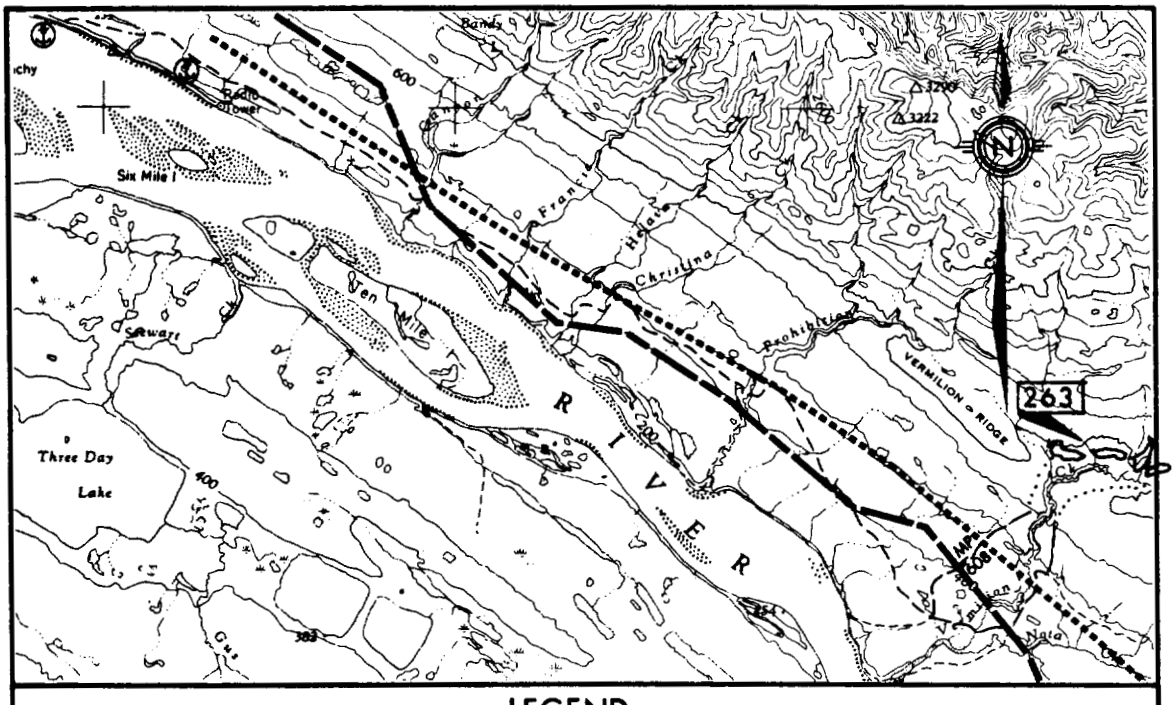
Approximate scale: 1" = 3,000'

## GENERAL

Site 263 consists of one esker-kame train, approximately 3 miles long, located north of Vermilion Creek, and a discontinuous esker-kame complex on the southern side of the stream channel, which totals 3/4 of a mile in length. These ice contact deposits parallel the sloping and glaciated terrain at the toe of the Norman Range. The site area is separated from the terrain to the west by deeply incised stream channels of the Vermilion Creek drainage system.

Three different land forms, possibly containing granular materials, can be distinguished within the site area. The esker-kame complex is denoted as "a"; the narrow esker ridges as "b", and the kame hillocks as "c" on the airphoto. It is anticipated, that these land forms are comprised of variably washed sand and gravel deposits with silt and till pockets. Geomorphic features indicate the possibility of high fine grained material content. The site area is well drained and supports relatively dense growths of spruce and poplar. There are no known critical wildlife areas in the vicinity of Site 263.

The deposits in Site 263 may be suitable for fair quality general fill material; therefore, the site area is rated as a fair prospect. The access to Site 263 can be achieved by extending the existing seismic cutlines paralleling the downstream section of Vermilion Creek. This would, however, entail the crossing of a rugged terrain.




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- Required access
- Site limit
- Proposed Mackenzie Highway

Section of Map No. 96 E

Scale: 1:250,000

## SITE NO. 264

### LOCATION

Located immediately southeast of Vermilion Creek and approximately 6 miles east of the Mackenzie River, Site 264 encompasses a shallow bedrock ridge representing the eastern flank of the Vermilion Ridge. Competent carbonate rocks are indicated within the site area.

The proposed Mackenzie Highway right-of-way at Mile 606.5 is located approximately 3 miles southwest of Site 264. The proposed gas pipeline route parallels the site to the west at a distance of about 2 miles.

LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- Required access
- Site limit
- Proposed Mackenzie Highway

Airphoto No. A22934/89

Approximate scale: 1" = 3,000'

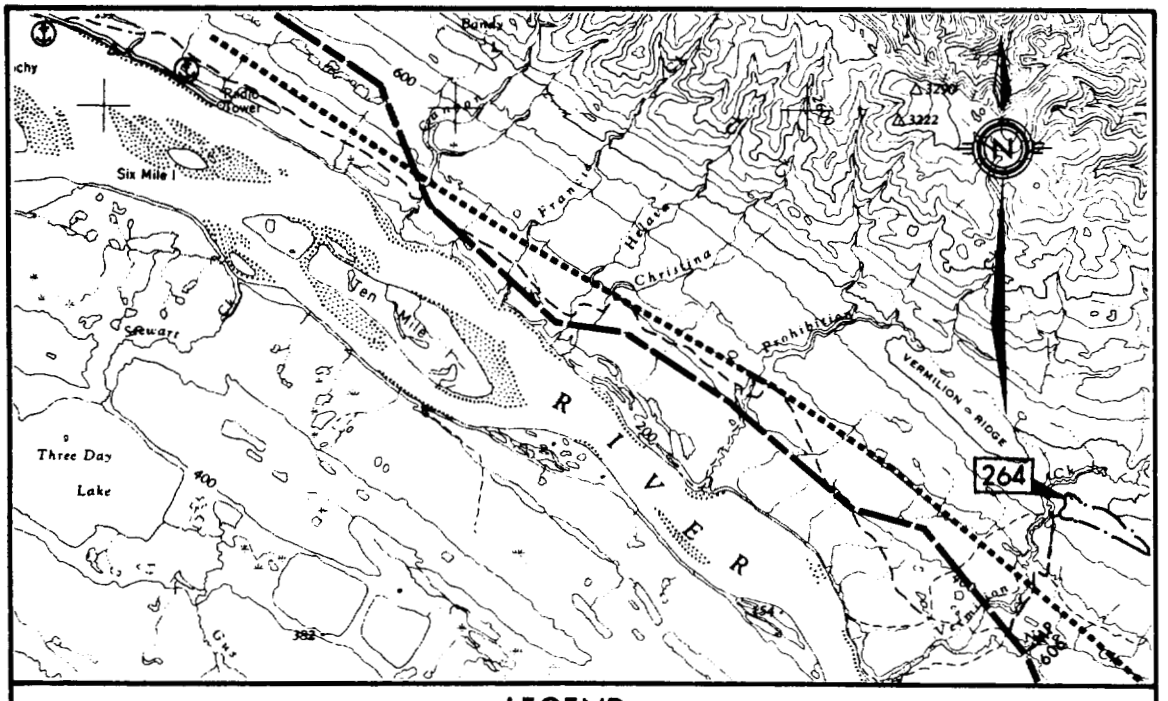
## GENERAL

Site 264 consists of a shallow bedrock ridge which encompasses an area about 2 miles long and more than $\frac{1}{4}$ of a mile wide. The terrain south of the ridge is rugged and rolling before descending onto the flat glaciolacustrine basin which parallels the Mackenzie River. Terrain on the north side of the site ascends towards the Norman Range. A discontinuous layer of glacial drift covers most of the ridge surface. These deposits support moderate growths of spruce and irregular stands of birch. The site area is surficially drained to the west and south.

There are no known critical wildlife areas in the vicinity of Site 264.

Several small exposures of fractured and blocky limestone, as well as sinkholes, denoted as "a" on the airphoto, indicate the presence of material probably suitable for manufacturing of various types of construction aggregates. The site area, however, lies within a Middle Devonian formation noted for predominantly shale bedrock.

The development of Site 264 would require a quarry operation and stripping of the overburden layer. Because of the unknown extent of limestone beds the site is rated as a fair prospect.




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- Required access
- Site limit
- Proposed Mackenzie Highway

Section of Map No. 96 E

Scale: 1:250,000

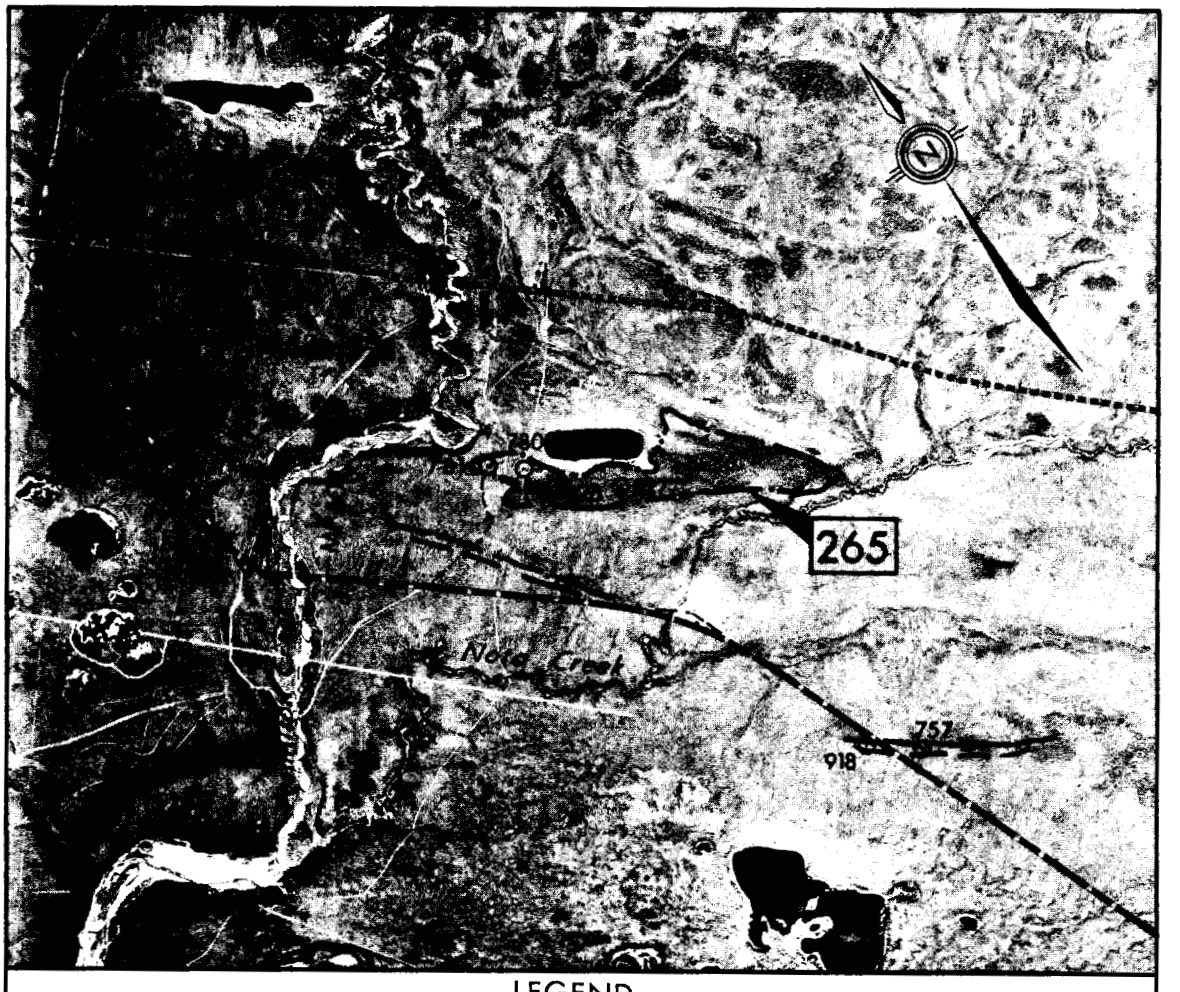
## SITE NO. 265

Located approximately 26 miles east of Norman Wells and less than $\frac{1}{2}$ mile northeast of the proposed Mackenzie Highway at Mile 606, Site 265 consists of a shallow bedrock ridge overlain by a thin veneer of glacial till.

Type of Material: Bedrock; shale, surficially weathered and friable.

Estimated Volume: Not determined.

Assessment: Fair quality general fill material suitable for use in the construction of subgrades for roads may be recovered; therefore, Site 265 is recommended for possible future development.




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- ⊙ DH Drill Hole
- Required access
- Site limit
- Proposed Mackenzie Highway
- ⊕ TP Test Pit

Airphoto No., A22934/150

Approximate scale: 1" = 3,000'

## ENVIRONMENT

Site 265 is located approximately 26 miles east of Norman Wells and less than $\frac{1}{2}$ mile northeast of the proposed Mackenzie Highway right-of-way at Mile 606. The site area, which extends east from Vermilion Creek to Nota Creek, is approximately 6000 feet in length and 400 to 800 feet in width. The site, consisting of a shallow bedrock ridge which has been glaciated to a drumlinoid appearance, is covered with remnants of glacial till. The adjacent terrain consists of a gently rolling ground moraine and exhibits fair surficial drainage into the water sheds of Nota and Vermilion Creeks. Short segments of strand lines were noted to the southwest of Site 265 in the immediate vicinity of the proposed Mackenzie Highway right-of-way.

The bedrock ridge is comprised of shale and siltstone beds with the occasional inclusion of sandstone. The top 3 to 5 feet of the shale bedrock is weathered and calcareous and exhibits random ice lenses. The more competent and massive shale and siltstone beds are frozen but exhibit no visible ice; therefore, the material contains very little ground ice. The site area is covered with peat and organic topsoil, generally less than 6 inches thick which supports sparse growths of spruce.

There are no known critical wildlife areas in the immediate vicinity of Site 265.

The only existing access to the site area from the CNT pole line or proposed Mackenzie Highway right-of-way consists of existing seismic cutlines. The proposed gas pipeline route parallels the site area to the north at a distance of less than $\frac{1}{2}$ mile.

## DEVELOPMENT

The information from the drill holes conducted on Site 265 by the engineering consultant for The Federal Department of Public Works has been assessed and incorporated in this report. The following conditions have been established relative to the subsurface soil profiles at Site 265:

- The bedrock formation consisting of shale and siltstone was encountered at very shallow depths. Some localized areas are covered with a thin veneer of glacial till whereas other portions of the bedrock ridge is only covered with a thin moss carpet.

- The overburden material consisting of moss, glacial till and lacustrine clays varies from 0 to 14 feet near the base of the shallow bedrock ridge in the immediate vicinity of the small lake.

- The initial 3 to 5 feet of the shale bedrock is weathered, calcareous and generally very friable.

Site 265 is not recommended as a source for granular materials; however, in view of the scarcity of good quality construction materials in this portion of the Study Area, these

shale and siltstone formations may be utilized for embankment fill material in the construction of road grades. The following guidelines should be considered if borrow pits or quarries are developed on Site 265:

- Borrow pit or quarry operations should be initiated in the elevated portions of the ridge where the overburden material is very shallow.

- Conventional excavation equipment supplemented by heavy rippers may be adequate to remove the in place shales and sandstone. However, blasting may be required at depth in order to loosen and extract the bedrock material.

- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.

- The thin veneer of organic topsoil and peat should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.

- Relative to granular deposits immediately adjacent to the active stream channels of Vermilion and Nota Creeks, the development procedures should be commenced at the source area farthest removed from the water course. A buffer zone of adequate width should be maintained between the stream and the final limits of the borrow pit.

- Operating procedures during borrow pit development should be maintained whereby surficial waste materials do not drain to the adjacent active stream channels.

## ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the pit area to provide general drainage compatible with the natural drainage of the adjacent terrain.

- Replacing stockpiled surficial waste material on the abandoned borrow pit areas.

- Reseeding of the recontoured pit areas may be considered although existing cutlines in the area indicate that understory growth and eventually spruce will be naturally reestablished.

# DETAILED DRILL HOLE LOG

**SITE NO.** 265 **HOLE NO.** 757

**DATE:** MAR. 2, 1973 **LOGGED BY:** ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

**DRILLING METHOD:** ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | MOSS | | | | | 0 |
| 0.3 | | Pt | PEAT: Category #3 | | Vx | H | | |
| 1.0 | | OH | CLAY: organic | | | H | | |
| 2.0 | | CH | CLAY: silty, high plastic, brown | | Vs | M | | 2 |
| 4.0 | | SP | SAND: medium grained, gravelly, silty, grey brown | | Vs | M | | 4 |
| 6 | | | - finer<br>- less stones | | Nf | | | 6 |
| 8.0 | | Cl | CLAY (TILL): silty, sandy, rust and coal, medium plastic, brown | | Nbn | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 14.0 | | CH | CLAY (SHALE): high plastic, grey | | | | | 14 |
| 20.0 | | | END OF HOLE 20.0' | | | | | |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 265 HOLE NO. 780

DATE: MAR. 2, 1973 | LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | CI | CLAY:<br>- silty<br>- medium plastic<br>- brown | | Nbn<br>Nf | | | 0 |
| 4 | | CI | 4.0<br>CLAY (TILL):<br>- silty sandy<br>- medium plastic<br>- rust & coal specs<br>- stones<br>- brown<br>- pockets of sand | | Nbn<br>Nf<br>Nbn | | | 4 |
| 10 | | | 10.0<br>- shale inclusions<br>- silt stone inclusions | | Nf | | | 10 |
| 14 | | CH | 14.0<br>CLAY (SHALE):<br>- silty<br>- high plastic<br>- grey | | | | | 14 |
| 20 | | | 20.0 END OF HOLE 20.0' | | | | | 20 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 265 HOLE NO. 781

DATE: MAR. 2, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES LTD.

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | Moss | | | | | 0 |
| 0.3 | | CH | CLAY (SHALE): silty, high plastic, interbedded with sandstone brown, hard | | Nbn | | | 2 |
| 4.0 | | | - rust stains | | | | | 4 |
| 16.0 | | | - grey | | | | | 16 |
| 20.0 | | | END OF HOLE 20.0' | | | | | 20 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 265 HOLE NO. 826

DATE: MAR. 9, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | CI | CLAY (TILL): silty, sandy, medium plastic brown, pebbles, rust stains, calcareous | | Vs | M | | 0 |
| 2 | | | | | | | | 2 |
| 4 | | | | | | | | 4 |
| 5.0 | | | | | | | | |
| 6 | | | SILTSTONE; HORIZONTAL - stratification - fissured, rusted - brown color | | Nbn | | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 14 | | | - shale beddings | | | | | 14 |
| 16 | | | - grey | | | | | 16 |
| 18 | | | | | | | | 18 |
| 20 | | | END OF HOLE 20.0' | | | | | 20 |
| 20.0 | | | | | | | | |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 265 HOLE NO. 827

DATE: MAR. 9, 1973 | LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | CI | CLAY (SHALE): weathered, medium plastic rusted, calcareous brown | | Vr | L | | 0 |
| 3.0 | | CI | CLAY (SHALE): - brown - sandstone inclusions | | Nbn | | | 3.0 |
| 13.0 | | | | | | | | 13.0 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

**SITE NO.** 265 **HOLE NO.** C 918

**DATE:** MAR. 9, 1973 **LOGGED BY:** ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

**DRILLING METHOD:** ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | PEAT: Category #4, dark brown color | | Vs | M | | 0 |
| 2 | | | | | | | | 2 |
| 3.0 | | | | | | | | |
| 4 | | SC | SAND: silty, clayey, low plastic, brown, (dirty), medium grained, poorly graded | | Vx | M | | 4 |
| 6 | | | | | | | | 6 |
| 6.0 | | | | | | | | |
| 8 | | Cl | CLAY (TILL): silty, sandy, medium plastic, brown, pebbles to cobbles, rust and coal specks, calcareous | | Vx | M | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | - - - - - - boulders | | | | | 12 |
| | | | - - - - - - grey | | Vx | L | | |
| 14 | | | | | | | | 14 |
| 14.0 | | | END OF HOLE 14.0' | | | | | |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

## SITE NO. 266X

Located approximately 25 miles east of Norman Wells in the vicinity of Mile 607 on the proposed Mackenzie Highway, Site 266X consists of inactive terraces and fans, gravel bars and active fans within the braided stream channel of Vermilion Creek.

Type of Material: Gravel; some silt, variable gradation, coarse grained.

Estimated Volume: Not determined.

Assessment: Site 266X is not recommended for development because the granular deposits are located within the active stream channel of Vermilion Creek.


LEGEND

| | |
|---|---|
| All weather road | Required access |
| Existing trails and cutlines | Site limit |
| Proposed Gas Pipeline | Proposed Mackenzie Highway |
| ⊙ DH Drill Hole | ⊕ TP Test Pit |

Airphoto No. A22934/149 Approximate scale: 1" = 3,000'

## ENVIRONMENT

Site 266X is located approximately 25 miles east of Norman Wells and encompasses the area immediately adjacent to and within the active stream channel of Vermilion Creek downstream from the proposed Mackenzie Highway right-of-way at Mile 607. The site area encompasses the active and inactive portions of the Vermilion Creek stream channel and extends upstream for a distance in excess of 4 miles. The site consists of the following distinct geological features:

Area "a" : Inactive alluvial terraces and fans containing stratified organic silts, sandy silts and pockets of silty gravels. The ground ice content in these deposits varies from medium to high.

Area "b" : The braided active stream channel of Vermilion Creek consisting of shallow exposed coarse, silty gravel bars underlain by clayey glacial till and shale bedrock.

Area "c" : Active alluvial fan at the mouth of Vermilion Creek which extends into the Mackenzie River channel.

The terrain adjacent to the Vermilion Creek stream channel exhibits fair surficial drainage and supports light to moderate growths of spruce and birch attaining heights to 20 feet and trunk diameters to 6 inches. The understory growth consisting primarily of willow and small bush is moderately dense.

There are no known critical wildlife areas in the immediate vicinity of Site 266X.

The only existing access to the various portions of the site area along Vermilion Creek from the CNT pole line or the proposed Mackenzie Highway right-of-way consists of seismic cut-lines and various narrow trails.

## DEVELOPMENT

Site 266X is not recommended for development and exploitation of granular materials for the following reasons:

- The majority of available granular materials are located in the shallow gravel bars within the active stream channel of Vermilion Creek.

- Although initial airphoto interpretation and field reconnaissance of the inactive alluvial fans and terraces indicated good possibilities of granular materials, the results of the winter drilling program only showed small pockets of poorly graded, silty gravels. In addition, the in situ ground ice content of these alluvial deposits is relatively high and deters the excavation of these small gravel pockets.

# DETAILED DRILL HOLE LOG

SITE NO. 266X

HOLE NO. DH 1

DATE: JAN. 28, 1973 | LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | PEAT: organic, fibrous | | | | | 0 |
| 1.0 | | | | | | | | |
| 2 | | OL | TOPSOIL: some silt, organic, roots, dark brown | | | | | 2 |
| 3.0 | | | | | | | | |
| 4 | | | | | | | | 4 |
| 6 | | | SILT: little sand, thin laminations, bluish grey to light brown | | Vs | M-H | | 6 |
| 8 | | ML | | | | | | 8 |
| 10 | | | - becoming medium brown from 10.0' | | Vx | H | | 10 |
| 12 | | | | | Vx | | | 12 |
| 13.0 | | | | | | | | |
| 14 | | | TOTAL DEPTH 13.0' | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 266 X

HOLE NO. DH-2

DATE: JAN. 28, 1973 | LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: some silt, organic, dark brown | | | | | 0 |
| 2 | | | 2.0 | | | | | 2 |
| | | OL-ML | SILT: trace organic, dark brown | | | | | |
| 4 | | | | | | | | 4 |
| | | | 5.0 | | | | | |
| 6 | | GM-GP | GRAVEL: some silt, little sand, medium brown | | Vs | L-M | | 6 |
| 8 | | | | | | | | 8 |
| | | | 9.0 | | | | | |
| 10 | | ML-SM | SILT: little sand, occasional pebbles to ½" size, light brown | | | | | 10 |
| 12 | | | | | | | | 12 |
| | | | 13.0 | | | | | |
| 14 | | | TOTAL DEPTH 13.0' | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

**SITE NO.** 266 X **HOLE NO.** C,S 854

**DATE:** MAR. 9, 1973 **LOGGED BY:** ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

**DRILLING METHOD:** ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | GC | GRAVEL: silty, clayey, coarse sand, siltstone inclusions | | Vx | M | | 0 |
| 2 | | | | | | | | 2 |
| 4 | | NP | 4.0 SANDSTONE-SILTSTONE: - gravelly (Till like) | | | | | 4 |
| 6 | | CI | 6.0 CLAY (TILL): sandy, silty, medium plastic, grey, cobbles | UF | | | | 6 |
| 8 | | | | | | | | 8 |
| | | | - shale inclusions, calcareous | | | | | |
| 10 | | | | | | | | 10 |
| 12 | | CH | 12.0 CLAY (SHALE): hard, high plastic, laminated, grey color | | | | | 12 |
| 14 | | | 14.0 END OF HOLE 14.0' | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

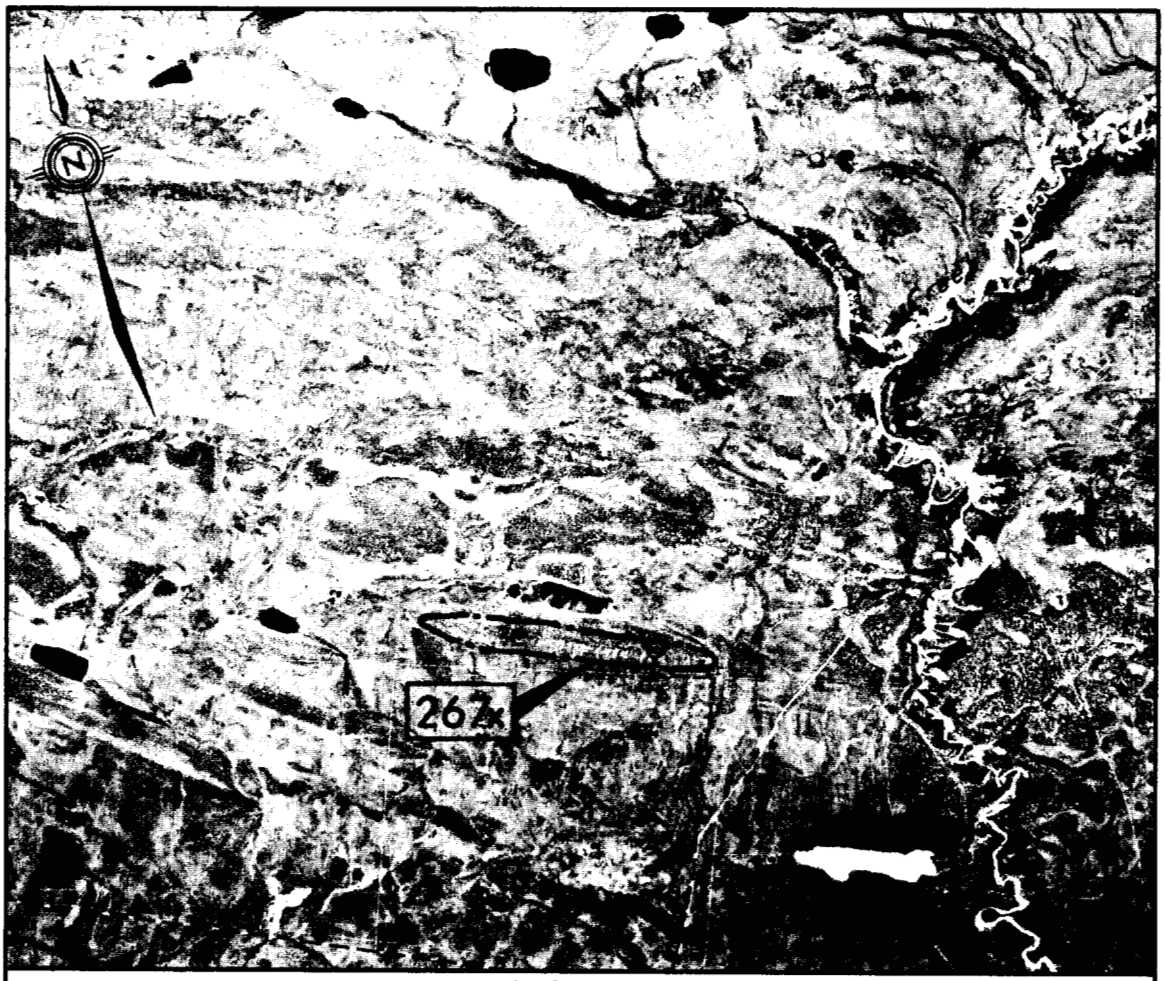
## SITE NO. 267X

Located approximately $\frac{1}{2}$ mile west of Vermilion Creek and $1\frac{1}{2}$ miles north of the proposed Mackenzie Highway at Mile 608, Site 267X consists of an esker-like ridge deposit.

Type of Material: Silt and Sand; fine grained.

Estimated Volume: Not determined.

Assessment: Site 267X is not recommended for development because materials of granular quality were not established during the field drilling program.




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- ⊙ DH Drill Hole
- Required access
- Site limit
- Proposed Mackenzie Highway
- ⊕ TP Test Pit

Airphoto No. A22934/91

Approximate scale: 1" = 3,000'

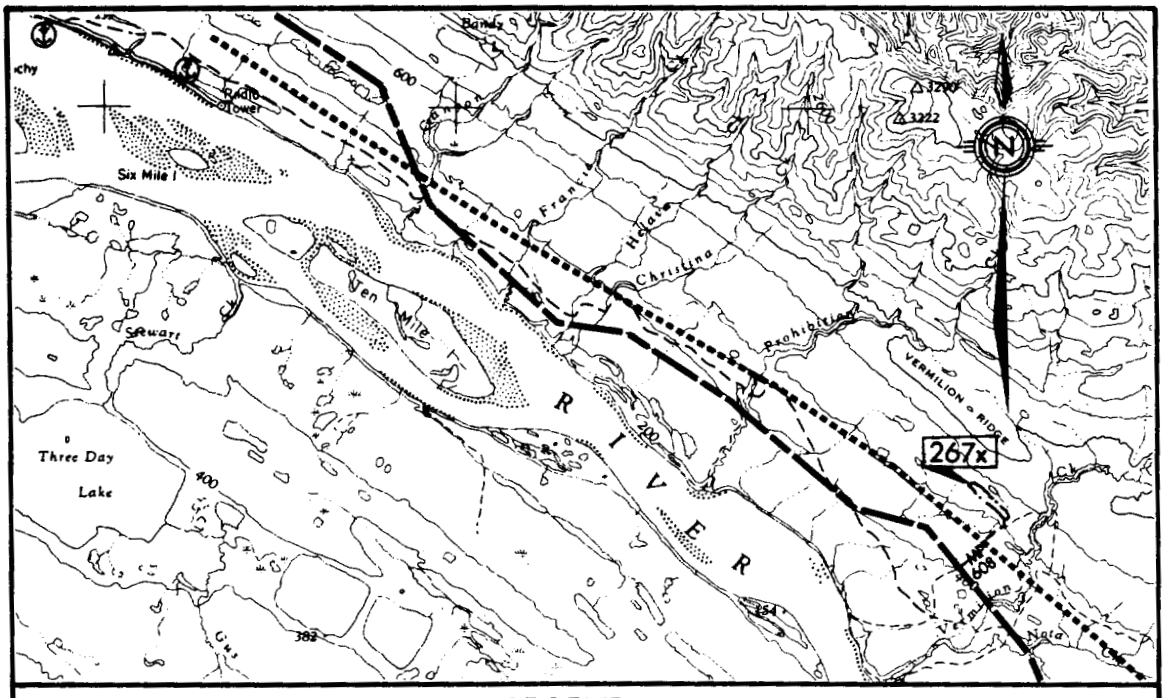
## ENVIRONMENT

Site 267X is located $\frac{1}{2}$ mile west of Vermilion Creek and $1\frac{1}{2}$ miles north of the proposed Mackenzie Highway right-of-way at Mile 608. The site consists of an esker-like ridge deposit, approximately 4500 feet in length, 300 feet in width at its base with an elevation rise of 50 to 60 feet above the adjacent flat terrain. The esker-like ridge is well drained whereas the adjacent terrain exhibits poor to fair surficial drainage and is characterized by a few small lakes.

The material in the ridge consists of fine grained, poorly graded sands with some silt. The overburden consists of shallow topsoil and inorganic silt. The ridge is covered with sparse growths of spruce attaining heights to 20 feet and trunk diameters to 6 inches. The understory growth is moderately dense and consists primarily of grasses and small bush.

There are no known critical wildlife areas in the immediate vicinity of Site 267X.

The only existing access to the site area from the CNT pole line and proposed Mackenzie Highway right-of-way consists of an old, partly overgrown seismic cutline.




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- Required access
- Site limit
- Proposed Mackenzie Highway

Section of Map No. 96 E

Scale: 1:250,000

## DEVELOPMENT

Site 267X is not recommended for development because the potentially available granular materials consisting of fine grained sands are only suitable for very marginal fill material and the presence of extensive thicknesses of overburden material negates the exploitation of these deposits.

# DETAILED DRILL HOLE LOG

SITE NO. 267X

HOLE NO. DH-1

DATE: JAN. 29, 1973 | LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | | | | | | 0 |
| 1.0 | | | TOPSOIL: some silt and organic, roots, brown | | | | | |
| 2 | | | | | | | | 2 |
| 4 | | ML | SILT: some sand, fine grained, occasional pebbles and fragments to 1" size, greyish brown | | Vx | L | | 4 |
| 6 | | | | | | | | 6 |
| 8 | | | | | | | MC | 8 |
| 8.0 | | | | | | | | |
| 10 | | SM | SAND: some silt, fine grained, occasional round and subangular pebbles to $\frac{1}{2}$" size, brown | UF | | | | 10 |
| 12 | | | | | | | | 12 |
| 13.0 | | | TOTAL DEPTH 13.0' | | | | | |
| 14 | | | | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

## SUMMARY OF LABORATORY TEST DATA

**Sample Location:** 267X/DH-1

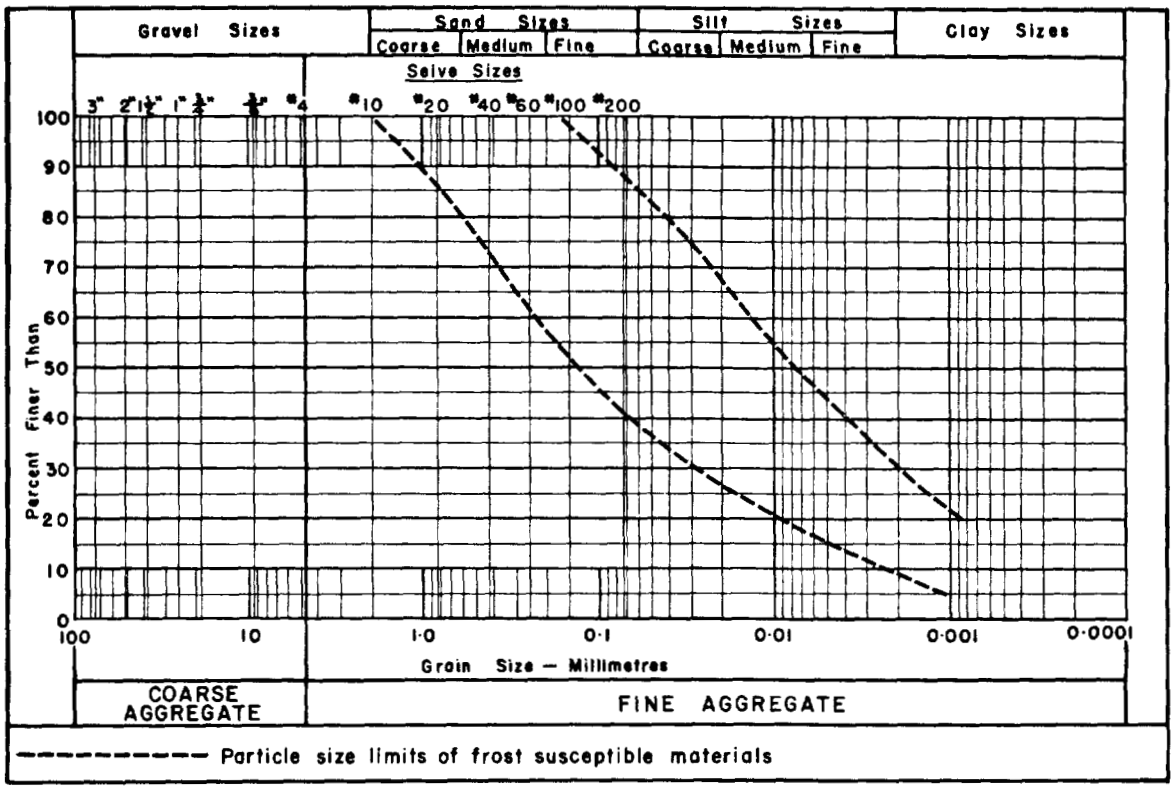
**Sample Depth (Feet):** 7.0

**Moisture Content (%):** 14.1

**Ice Content (%):** -

**Organic Content (%):** -

**GRAIN SIZE DISTRIBUTION:** (Test not conducted.)




**PETROGRAPHIC ANALYSIS:**

## SITE NO. 268X

Located approximately 22 miles east of Norman Wells, Site 268X consists of segmented narrow strand lines across which the proposed Mackenzie Highway is located between Mile 609 and Mile 611.

Type of Material: Gravel; some sand, poorly graded, medium grained.

Estimated Volume: Not determined.

Assessment: Site 268X is not recommended for development because only very minimal quantities of gravel suitable for construction requirements are available.

LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- ⊙ DH Drill Hole
- Required access
- Site limit
- Proposed Mackenzie Highway
- ⊕ TP Test Pit

Airphoto No. A22934/148

Approximate scale: 1" = 3,000'

## ENVIRONMENT

Site 268X is located approximately 22 miles east of Norman Wells and is coincident with the proposed Mackenzie Highway location from Mile 609 to Mile 611. The site consists of segments of narrow strand lines, approximately 2 miles in length and less than a few hundred feet in width. The site area and the adjacent terrain exhibit fair to poor surficial drainage into the Mackenzie River which is located 2 miles to the southwest.

The material in the strand lines consists of poorly graded, medium grained, sandy gravels which are suitable for good quality embankment fill material. However, the surficial layers of sandy gravels are very thin and are underlain by glacial till and shale bedrock. The organic peat and organic topsoil layer, less than 1 foot in depth, which overlies the site area supports light to moderate growths of spruce and birch.

There are no known critical wildlife areas in the immediate vicinity of Site 268X.

The CNT pole line, proposed gas pipeline and the proposed Mackenzie Highway right-of-way are located in the immediate vicinity of Site 268X. Therefore, existing or future access to the site area is not a problem.

## DEVELOPMENT

The information from the drill holes conducted by the engineering consultant for The Federal Department of Public Works has been assessed and incorporated in this report. The following conditions relative to the quality and quantity of available granular materials has been established:

- The strand lines contain very shallow surficial deposits of clean, poorly graded, medium grained gravels which may be suitable for good quality fill in the construction of subgrades for roads. Glacial till-like clayey silts underlie the shallow surficial gravel stratum.

- The depth of gravels varies from 2 to 5 feet and is overlain by 1 foot of organic topsoil.

Site 268X is not recommended for development and exploitation of granular materials because of the very minimal quantities of gravels available for construction requirements.

In addition, the relatively thin layer of sand available for exploitation would require an extensive surficial area being cleared if foraging for material is undertaken. These surficial deposits of gravels can be utilized as common fill material in the construction of local utilities if they are encountered during the preparation of right-of-ways.

# DETAILED DRILL HOLE LOG

SITE NO. 268 X HOLE NO. C 803

DATE: MAR. 4, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | MOSS: | | | | | 0 |
| 0.5 | | | | | Vx | M | | |
| | | OH | CLAY: organic | | | | | |
| 1.0 | | | | | | | | |
| 2 | | Cl | CLAY (TILL): silty, sandy gravelly, rust and coal specks, medium plastic, brown | | Vx | L | | 2 |
| 4 | | | | | | | | 4 |
| 4.5 | | | - less gravel | | Vx | M | | |
| 6 | | | | | | | | 6 |
| 7.5 | | | - shale inclusions, grey | | Nbn | | | |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 14 | | | | | | | | 14 |
| 15.0 | | | END OF HOLE 15.0' | | | | | |
| 16 | | | | | | | | 16 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

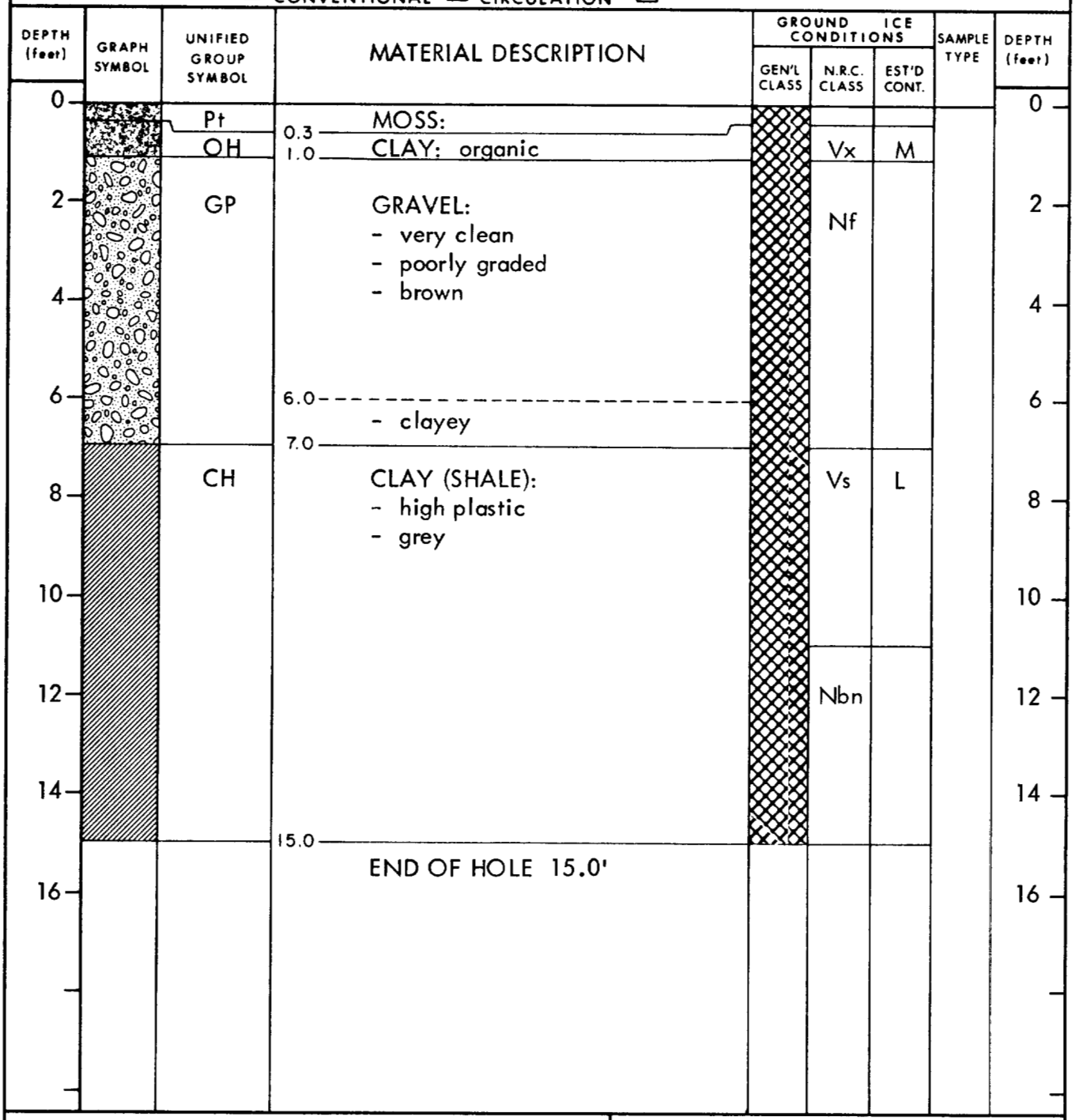
PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 268X HOLE NO. C 805

DATE: MAR. 4, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:




GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 268 X HOLE NO. C 807

DATE: MAR. 4, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | MOSS: | | | | | 0 |
| 0.3 | | OH | CLAY: organic | | Vx | M | | |
| 1.0 | | | | | | | | |
| 2 | | GW | GRAVEL:<br>- very clean<br>- brown | | Nf | | | 2 |
| 3.0 | | | | | | | | |
| 4 | | Cl | CLAY (TILL):<br>- silty, sandy<br>- gravelly<br>- cobbles<br>- medium plastic<br>- brown | | Vr | M | | 4 |
| 6 | | | | | | | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 11.0 | | | - less gravel<br>- shale inclusions<br>- grey | | Vr | L | | |
| 12 | | | | | | | | 12 |
| 14 | | | | | | | | 14 |
| 14.0 | | | END OF HOLE 14.0' | | | | | |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 268X HOLE NO. C 810

DATE: MAR. 4, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | MOSS: | | | | | 0 |
| 0.3 | | OH | CLAY: organic | | Vx | M | | |
| 1.0 | | | | | Vx | M | | |
| 2 | | CI | CLAY (TILL): | | | | | 2 |
| | | | - silty, sandy | | Vr | L | | |
| | | | - medium plastic | | | | | |
| 4 | | | - pebbles | | | | | 4 |
| | | | - rust | | | | | |
| 5.0 | | | | | | | | |
| | | CI-SM | - sandier | | Vx | L | | |
| 6 | | | | | | | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 10.0 | | CH | CLAY (SHALE): | | | | | |
| | | | - high plastic | | | | | |
| 12 | | | - grey | | | | | 12 |
| 14 | | | | | | | | 14 |
| 15.0 | | | END OF HOLE 15.0' | | | | | |
| 16 | | | | | | | | 16 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 268X HOLE NO. C 812

DATE: MAR. 4, 1973 | LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | PEAT: | | Vx | M | | 0 |
| 1.5 | | | | | | | | |
| 2 | | SP | SAND (TILL): silty, gravelly | | Nf | | | 2 |
| 3.0 | | | | | | | | |
| 4 | | CI | CLAY (TILL):<br>- sandy, silty<br>- rust and coal specks<br>- stones<br>- medium plastic<br>- brown | | Nbn | | | 4 |
| 6 | | | | | | | | 6 |
| 8 | | | | | | | | 8 |
| 9.0 | | | | | | | | |
| 10 | | CH | CLAY (SHALE):<br>- high plastic<br>- grey | | | | | 10 |
| 12 | | | | | | | | 12 |
| 14 | | | | | | | | 14 |
| 14.0 | | | END OF HOLE 14.0' | | | | | |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

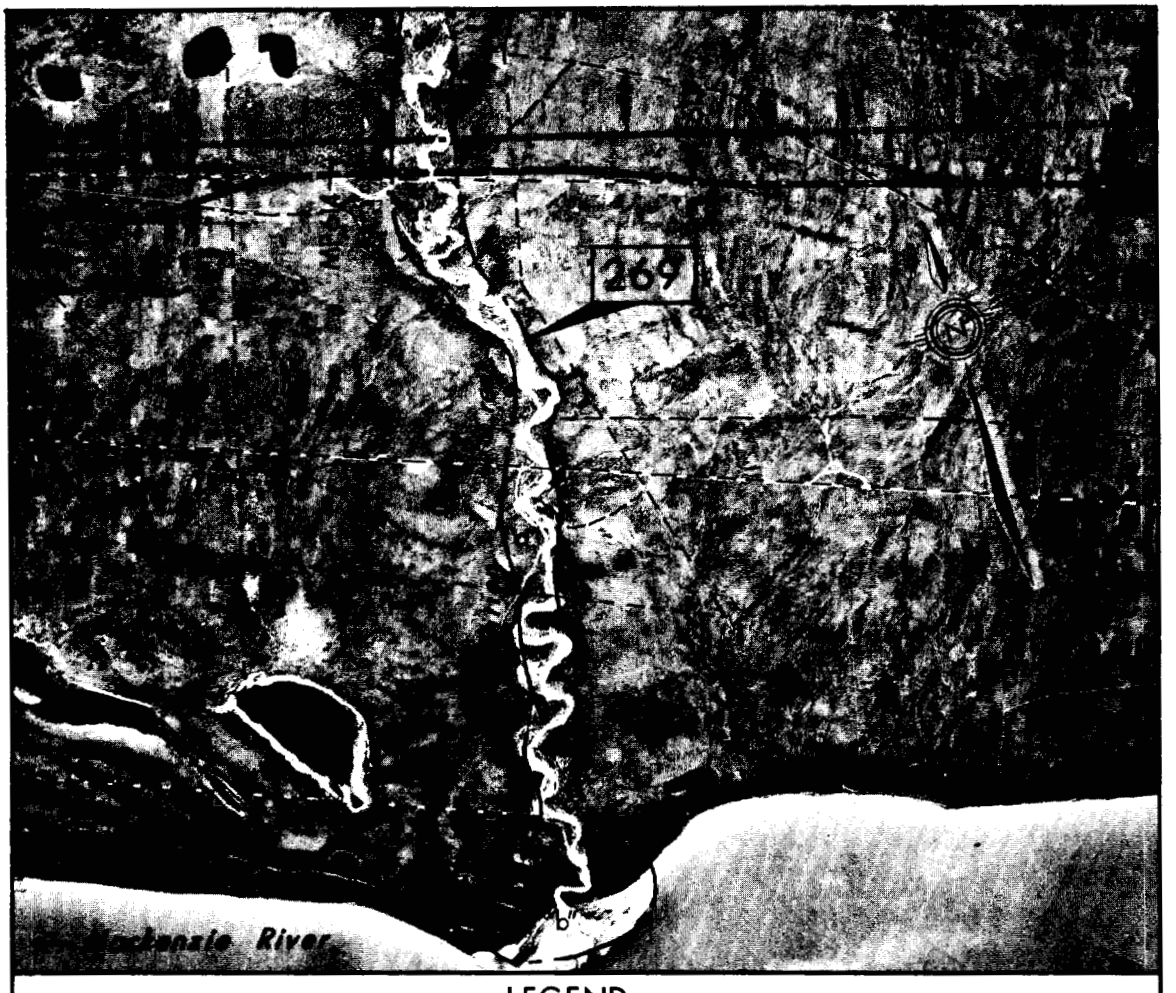
PEMCAN SERVICES "72"

## SITE NO. 269

### LOCATION

Located approximately 18 miles southeast of Norman Wells on the east side of the Mackenzie River, Site 269 encompasses the active stream channel of Prohibition Creek from its mouth and extends 3½ miles upstream. The stream channel in its downstream section is 300 to 800 feet wide and contains variably washed sand, gravel and silt deposits.

The proposed Mackenzie Highway and gas pipeline routes, both cross the Prohibition Creek valley approximately 2 miles upstream from its confluence with the Mackenzie River.




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- Required access
- Site limit
- Proposed Mackenzie Highway

Airphoto No. A22934/146

Approximate scale: 1" = 3,000'

## GENERAL

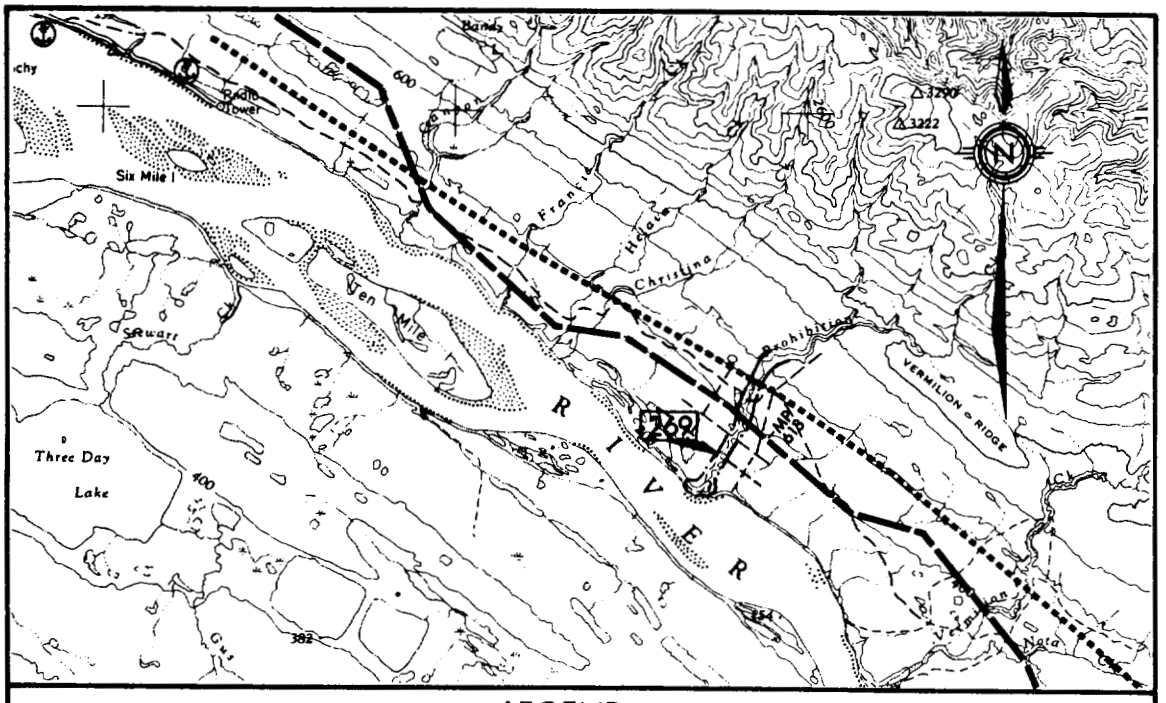
Site 269 consists of alluvial deposits exposed in gravel bars and low terraces which are mostly below or at the high water level of the creek. The drainage area of Prohibition Creek is approximately 20 miles.

Coarser deposits form terraces and gravel bars within the braided stream channel and are denoted as "a" on the site airphoto. The material becomes finer toward the stream mouth which is marked by a relatively wide and flat fan denoted as "b" on the airphoto. Fine grained, silty and sandy material with some clay can be expected to prevail along the downstream creek segment.

The terraces are covered with organic silt supporting sparse growths of small bushes. Most areas adjacent to the creek channel support growths of spruce. Wet and poorly drained sites are characterized by tamarack. There are no known critical wildlife areas in the immediate vicinity of Site 269. The use of this creek by fishery resources is primarily seasonal as it generally dries up by early to mid-summer.

Access to this site can be achieved from the existing winter road which traverses the site area at the southern extremities of this source.

Site 269 is not suggested for development since the granular materials are located within the stream channel of an active water course.




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- Required access
- Site limit
- Proposed Mackenzie Highway

Section of Map No. 96 E

Scale: 1:250,000

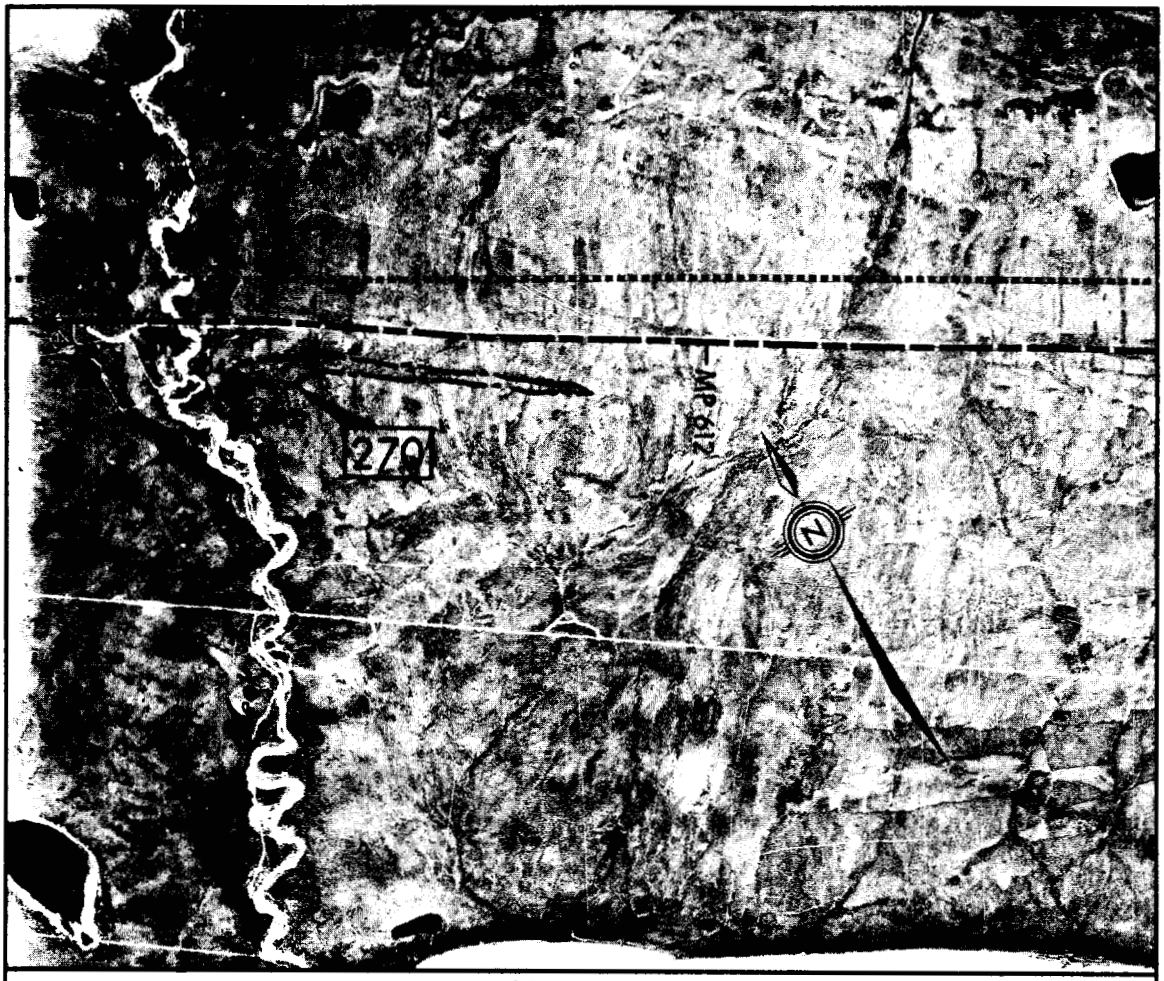
## SITE NO. 270

Located approximately 19 miles east of Norman Wells and adjacent to the southside of the proposed Mackenzie Highway at Mile 613, Site 270 consists of a localized glaciofluvial outwash plain.

Type of Material: Gravel; some sand, medium grained, well graded.

Estimated Volume: 200,000 cubic yards.

Assessment: Good quality granular materials suitable for embankment fill, base and surface courses; Site 270 is recommended for development.




LEGEND

| | |
|---|---|
| All weather road | Required access |
| Existing trails and cutlines | Site limit |
| Proposed Gas Pipeline | Proposed Mackenzie Highway |
| ⊙ DH Drill Hole | ⊕ TP Test Pit |

Airphoto No. A22934/147

Approximate scale: 1" = 3,000'

## ENVIRONMENT

Site 270 is located 19 miles east of Norman Wells immediately adjacent to the southside of the proposed Mackenzie Highway right-of-way at Mile 613. The site consists of a localized glaciofluvial outwash deposit which encompasses an area 4000 feet in length and 300 feet in average width. The site extends southeastwards from the east bank of Prohibition Creek. The site area and adjacent terrain exhibit fair to good surficial drainage conditions to the west into the watershed of Prohibition Creek.

The material in the outwash deposits consists of well graded, medium grained gravels overlying coarse grained sands with a little silt. These gravels and sands are considered suitable for good quality embankment fill and for the production of base course and surface course aggregates. A layer of peat and organic topsoil, less than 6 inches in depth, overlies the site area and supports light to moderate growths of spruce, birch and poplar attaining heights to 30 feet and trunk diameters to 10 inches. The sparse understory growth consists primarily of grasses and small shrubs.

There are no known critical wildlife areas in the immediate vicinity of Site 270. Potential spawning gravels exist in the gravel bottomed channel of Prohibition Creek; however, the utilization of these gravels by fishery resources is likely limited by the fact that the Creek normally dries up by mid-summer.

The only existing access to the site area from the CNT pole line and proposed Mackenzie Highway right-of-way, which are coincident in the immediate vicinity of Site 270, consists of the short access trail which was cleared by the consultant for The Federal Department of Public Works during their winter drilling program.

## DEVELOPMENT

The exploratory test pits and drill holes which were carried out on Site 270 by PEMCAN and the engineering consultant for The Federal Department of Public Works showed the following conditions relative to the quality and quantity of available granular materials:

- Good quality granular materials consisting of well graded, medium grained, clean gravels were encountered to depths varying from 3 to 15 feet below the existing ground surface. The gravels are underlain by coarse grained sands with a little silt to the bottom of the drill holes. The gravels are considered suitable for good quality embankment fill material and for production of base course and surface course aggregates.

- The overburden material consisting of peat and organic topsoil is less than 6 inches in depth.

- The southeast finger of the site area, away from Prohibition Creek, is considered to contain only shallow layers of gravel near the surface.

- The estimated quantity of available granular materials is considered to be in the order of 200,000 cubic yards.

Site 270 is recommended for development and exploitation of granular materials to supply the requirements for the construction of local utilities. The following guidelines should be considered in the development of borrow pits:

- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.

- The thin veneer of organic topsoil and peat should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.

- Relative to granular deposits immediately adjacent to the east side of Prohibition Creek, the development procedures should be commenced at the source area farthest removed from the water course. A buffer zone of adequate width should be maintained between the stream and the final limits of the borrow pit.

- Operating procedures during borrow pit development should be maintained whereby surficial waste materials do not drain to the active Prohibition Creek stream channel.

- Adequate buffer zones should be retained around the site of the waterfall and along the hiking trail that provides access to this feature.

## ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

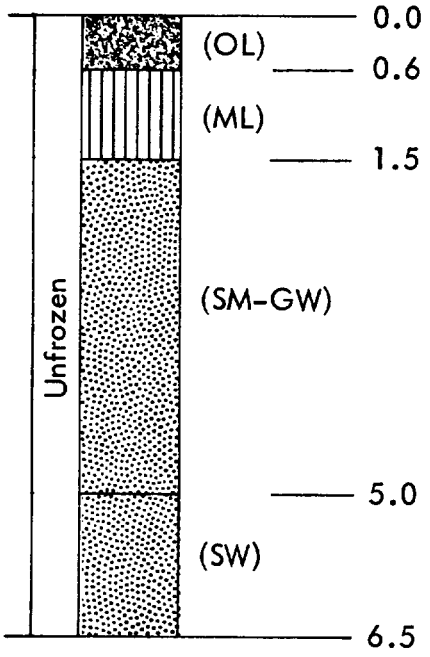
- Recontouring of the pit area to provide general drainage compatible with the natural drainage of the adjacent terrain.

- Replacing stockpiled surficial waste material on the abandoned borrow pit areas.

- Reseeding of the recontoured pit areas may be considered although existing cutlines in the area indicate that understory growth and eventually spruce will be naturally reestablished.

## DETAILED TEST PIT LOG

270/TP 1




Topsoil

Silt; some sand, light brown, roots

Sand and Gravel; some silt, stratified, grey, pebbles to 2 inch size

Sand; medium to coarse grained, few pebbles, grey

# DETAILED DRILL HOLE LOG

SITE NO. 270 HOLE NO. 902

DATE: MAR. 9, 1973 | LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OH | ORGANIC CLAY: silty, medium plastic | | | | | 0 |
| 0.3 | | | | | | | | |
| 2 | | GC | GRAVEL: organic, sandy, silty, clayey, non to low plastic | | Nbn | | | 2 |
| 3.0 | | | | | | | | |
| 4 | | SM | SAND: coarse, silty, sharp, non plastic, brown | UF | | | | 4 |
| 6 | | | | | | | | 6 |
| 6.5 | | | | | | | | |
| 8 | | SC | SAND: silty, clayey, medium grained, low plastic, brown | | | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 14 | | | | | | | | 14 |
| 14.0 | | | | | | | | |
| 16 | | SM | SAND (TILL): silty, non-plastic, clay (TILL) inclusions, shale inclusions | | | | | 16 |
| 18 | | | | | | | | 18 |
| 20 | | | | | | | | 20 |
| 20.0 | | | END OF HOLE 20.0' | | | | | |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

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PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 270 HOLE NO. 904

DATE: MAR. 9, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | O | MOSS | | | H | | 0 |
| 0.3 | | GW | GRAVEL: - well graded - sand - clean | | Vc | L | | 2 |
| 4 | | | | | | | | 4 |
| 6 | | | - boulders - sandier | | Nf | | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 14 | | | | | | | | 14 |
| 15.0 | | SM | SAND: silty - coarse grained - sharp - non-plastic - finer | | Vx | M | | 16 |
| 18 | | | | | | | | 18 |
| 20 | | | 20.0 — END OF HOLE 20.0' | | | | | 20 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# SITE NO. 271

## LOCATION

Located on both sides of the upstream section of Prohibition Creek, Site 271 consists of a series of bedrock ridges which possibly contain competent, crushable limestone beds.

The proposed Mackenzie Highway right-of-way at Mile 610.5 is located approximately 3 miles southwest of Site 271. The proposed gas pipeline route parallels the site to the southwest at a distance of less than 2 miles.


LEGEND

| | |
|---|---|
| ▬▬▬ All weather road | ····· Required access |
| – – – – – – Existing trails and cutlines | ·—·—· Site limit |
| ▪▪▪▪▪▪▪▪▪▪ Proposed Gas Pipeline | ▬ ▬ ▬ Proposed Mackenzie Highway |

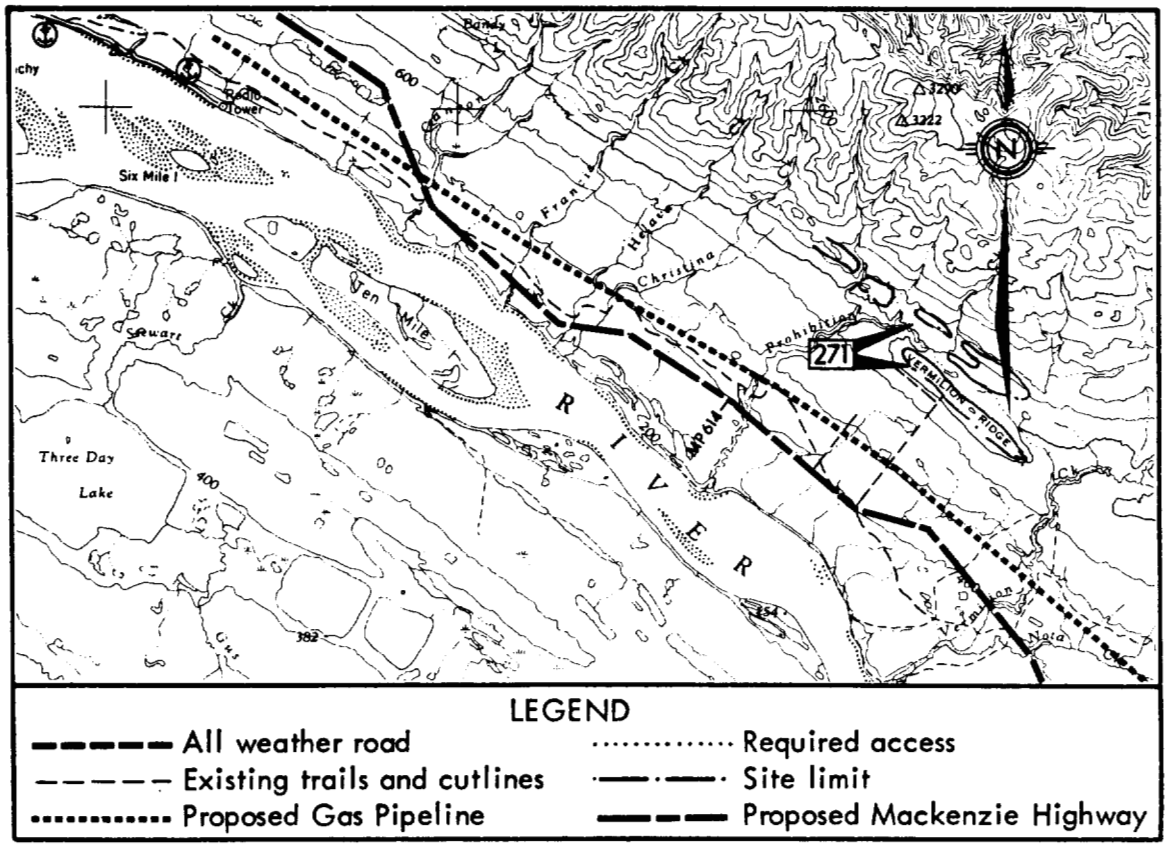
Airphoto No. A22934/93 Approximate scale: 1" = 3,000'

## GENERAL

Site 271 consists of a series of bedrock ridges paralleling the southwestern toe of Norman Range. The terrain surface is rugged and well drained because of deeply incised channels of Prohibition Creek and its tributary streams. The most southerly located ridge, known as Vermilion Ridge, borders the flat Mackenzie Plain. This ridge is readily accessible along existing seismic cutlines while access to other ridges is difficult because of eroded gullies and rugged terrain.

Numerous exposures of blocky and fractured limestone are noted within the site area. The exposures, marked as "a" on the site airphoto, form prominent escarpments. According to geological evidence, the ridges also contain frequent shale beds. Discontinuous layers of glacial drift cover major ridge segments and support moderate growths of spruce and irregular stands of poplar. There are no known critical wildlife areas in the immediate vicinity of Site 271.

It is considered that the thick Middle Devonian limestone beds are suitable for a quarry location. The bedrock will very likely require blasting to be extracted. Good quality general fill material can be obtained and aggregates for base and surface courses can possibly be produced by crushing and screening of fresh limestone from this site area.




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- Required access
- Site limit
- Proposed Mackenzie Highway

Section of Map No. 96 E

Scale: 1:250,000

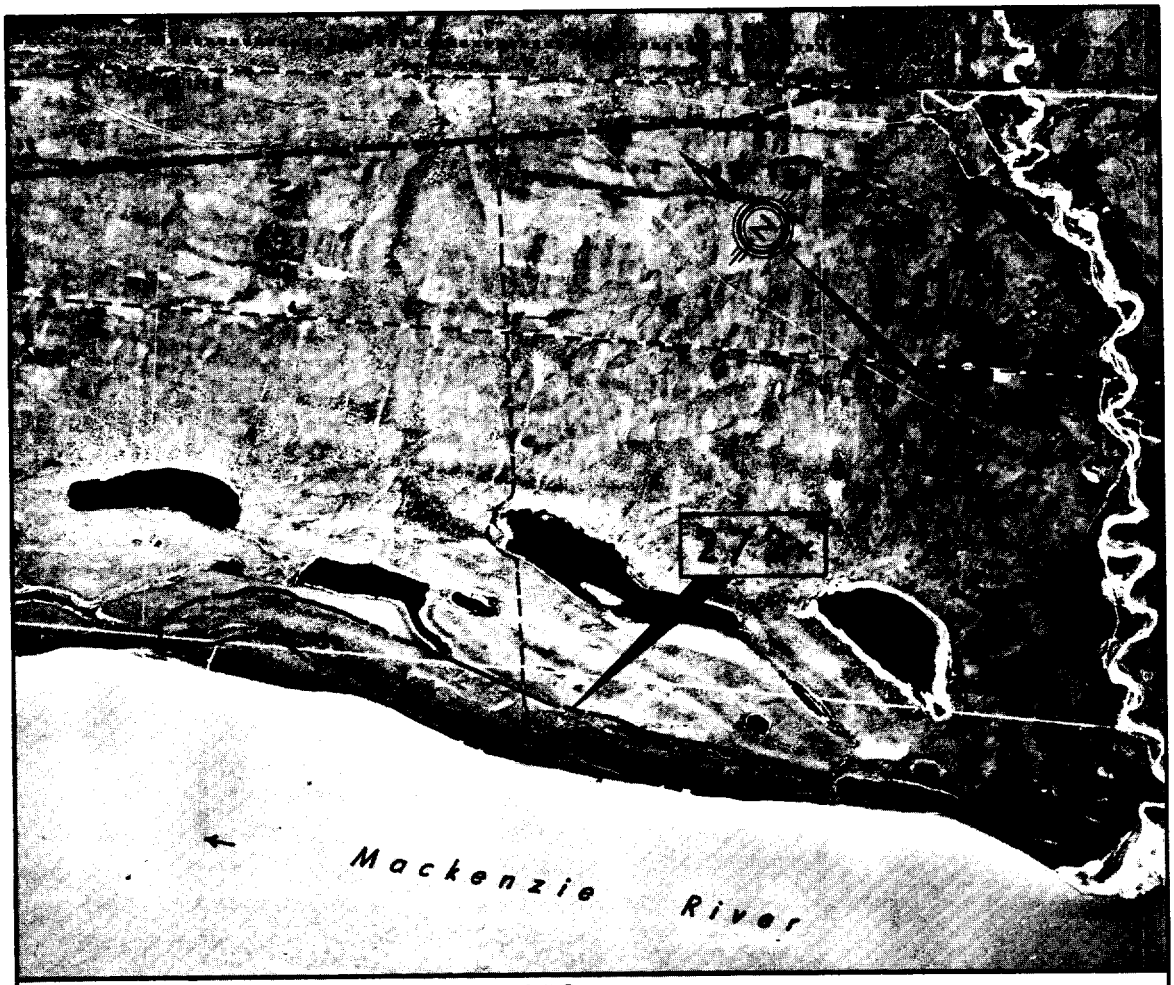
## SITE NO. 272X

Located approximately 17 miles east of Norman Wells and $1\frac{1}{4}$ miles southwest of the proposed Mackenzie Highway at Mile 616, Site 272X consists of a prominent narrow alluvial terrace on the north bank of the Mackenzie River.

Type of Material: Silt; some sand and clay, stratified.

Estimated Volume: Not applicable.

Assessment: Site 272X is not recommended for development because materials of granular quality were not encountered during the field drilling program.




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- ⊙ DH Drill Hole
- Required access
- Site limit
- Proposed Mackenzie Highway
- ⊕ TP Test Pit

Airphoto No. A22934/145

Approximate scale: 1" = 3,000'

## ENVIRONMENT

Site 272X is located approximately 17 miles east of Norman Wells and $1\frac{1}{4}$ miles southwest of the proposed Mackenzie Highway right-of-way at Mile 616. The site consists of a prominent narrow, alluvial terrace, approximately 2 miles in length and 700 to 1000 feet in width, along the northeast bank of the Mackenzie River. The site area exhibits good surficial drainage in all directions, whereas the adjacent terrain immediately to the northeast is flat, poorly drained and contains several lakes.

The material in the alluvial terrace, consisting of silt with a little sand and clay, exhibits high ground ice content. A surficial layer of peat and topsoil, less than 1 foot in thickness, covers the site area and supports moderately dense growths of spruce.

There are no known critical wildlife areas in the immediate vicinity of Site 272X.

The only existing access to Site 272X from the CNT pole line, proposed gas pipeline or proposed Mackenzie Highway right-of-way consists of seismic cutlines and the access trail which was cleared during the winter drilling program.

## DEVELOPMENT

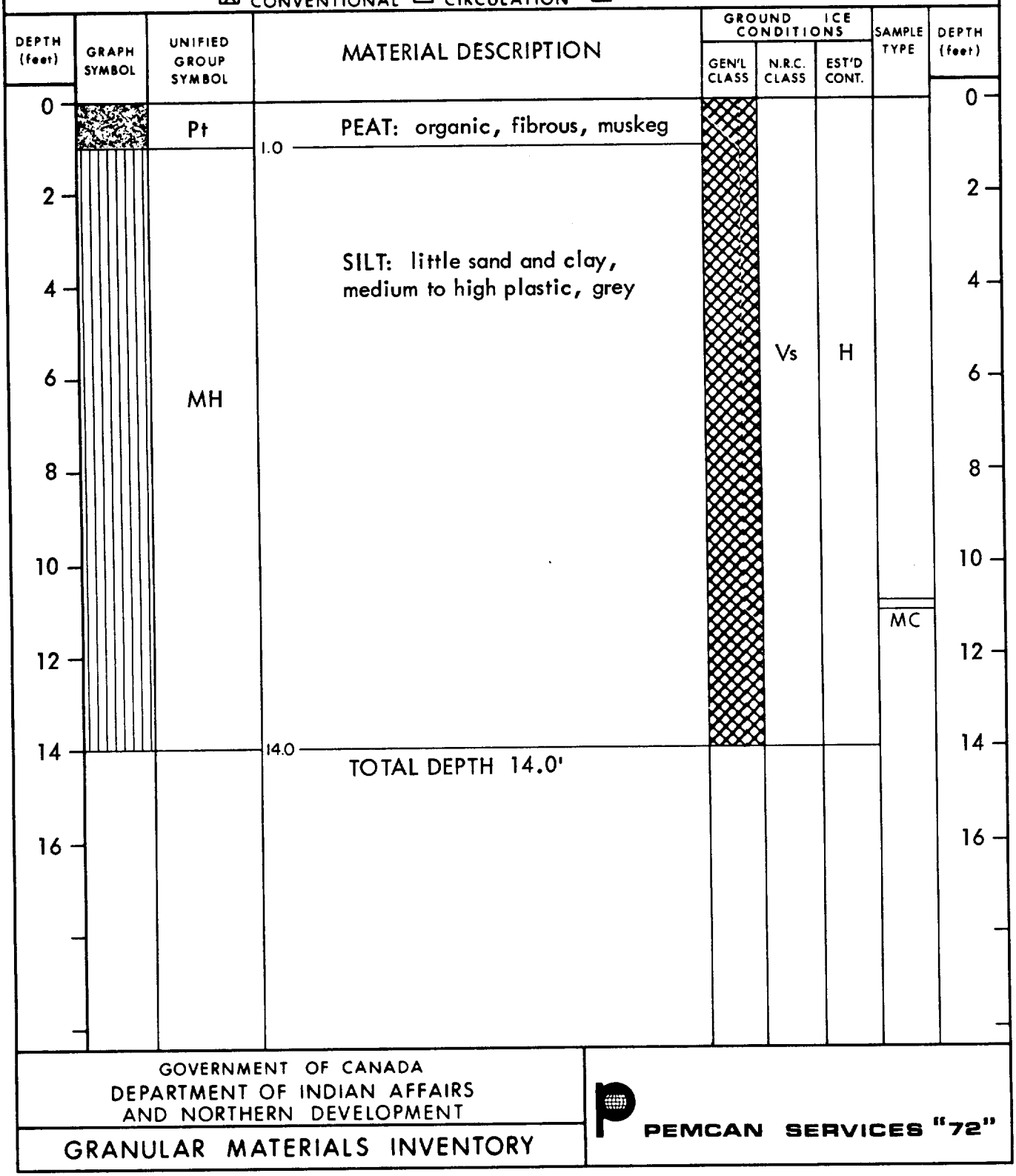
Site 272X is not recommended for development, because materials of granular quality were not encountered in the alluvial terrace. Although the initial airphoto interpretation and field reconnaissance observations indicated a good possibility of locating granular materials, the field drilling program did not prove up any granular type materials.

# DETAILED DRILL HOLE LOG

SITE NO. 272X HOLE NO. DH-1

DATE: DEC. 16, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:




GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 272X HOLE NO. DH-2

DATE: DEC. 16, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | PEAT: organic, fibrous | | | | | 0 |
| 1.0 | | | | | | | | |
| 2 | | | SILT: little sand and clay, medium to high plastic, grey | | | | | 2 |
| 4 | | | | | | | | 4 |
| 6 | | MH | | | Vs Vx | H | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 13.0 | | | TOTAL DEPTH 13.0' | | | | | |
| 14 | | | | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 272X HOLE NO. DH-3

DATE: DEC. 16, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | PEAT: organic, muskeg | | | | | 0 |
| 1.0 | | | | | | | | |
| 2 | | | SILT: little sand and clay, medium to high plastic, grey | | | | | 2 |
| 4 | | | | | | | | 4 |
| 6 | | MH | | | Vs | H | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | MC | 12 |
| 13.0 | | | TOTAL DEPTH 13.0' | | | | | |
| 14 | | | | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

## SUMMARY OF MOISTURE CONTENT DETERMINATIONS

| Sample Location | Sample Depth (Ft.) | Moisture Content (%) |
|---|---|---|
| 272X/DH-1 | 11.0 | 83.5 |
| 272X/DH-3 | 12.0 | 109.4 |

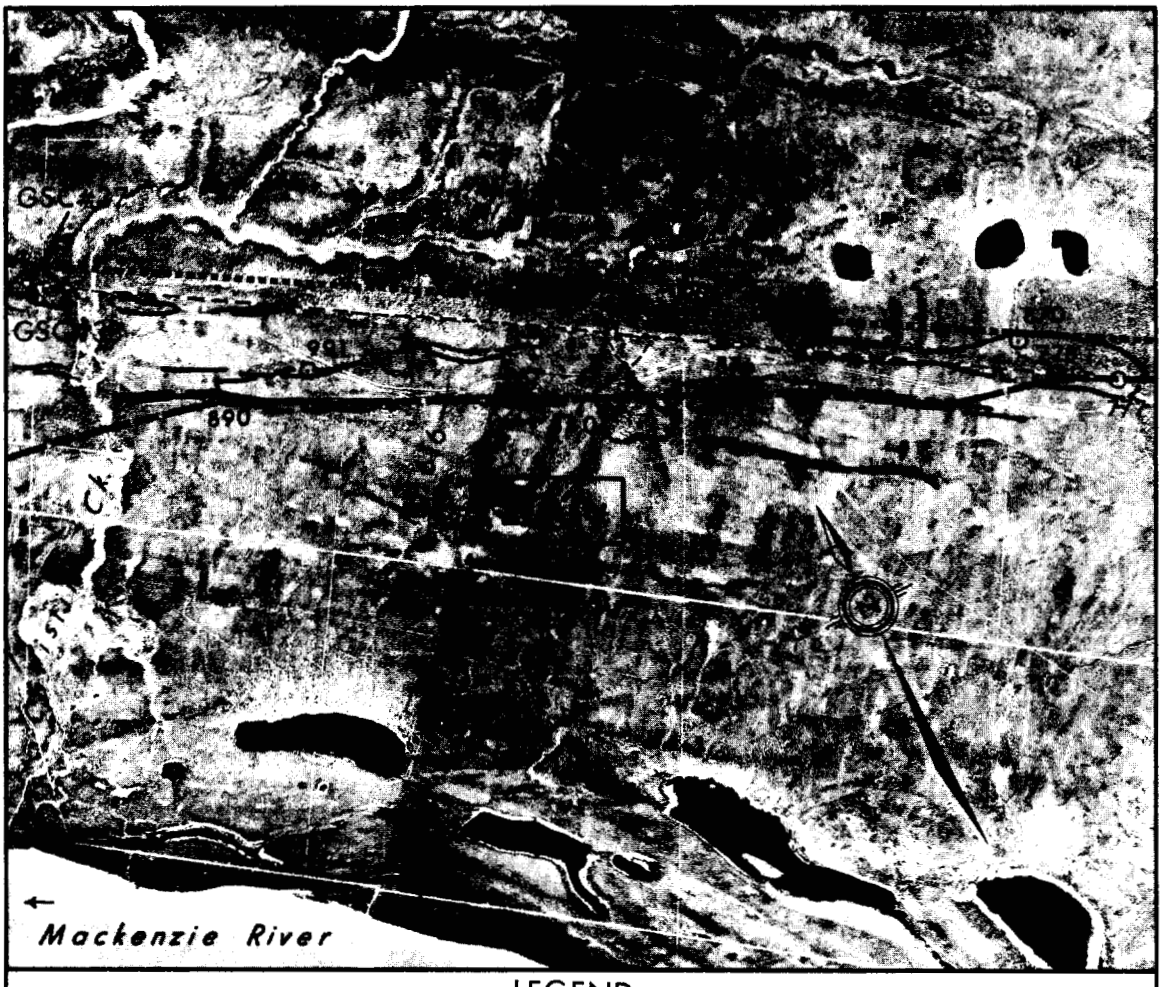
## SITE NO. 273X

Located approximately 17 miles east of Norman Wells in the immediate vicinity of the proposed Mackenzie Highway from Mile 614 to Mile 618, Site 273X consists of beach ridge deposits, abandoned strand lines and a small alluvial fan.

Type of Material: Sand and Gravel; some silt, variable gradation.

Estimated Volume: Not determined.

Assessment: Site 273X is not recommended for development because the available granular material deposits are very thin and the potentially recoverable volumes are quite minimal. In addition, the foraging for material in these widely scattered deposits could result in extensive surficial disturbance.




LEGEND

| | |
|---|---|
| All weather road | Required access |
| Existing trails and cutlines | Site limit |
| Proposed Gas Pipeline | Proposed Mackenzie Highway |
| ⊙ DH Drill Hole | ⊕ TP Test Pit |

Airphoto No. A22934/144 and 146 Approximate scale: 1" = 3,000'

## ENVIRONMENT

Site 273X is located approximately 17 miles east of Norman Wells in the immediate vicinity of the proposed Mackenzie Highway right-of-way from Mile 614 to Mile 618. The total site area consists of beach ridge deposits, abandoned segments of strand lines and one small alluvial fan which encompasses an aggregate area approximately $3\frac{1}{2}$ miles in length and $\frac{1}{2}$ mile in width extending north from Prohibition Creek to Christina Creek. The site and adjacent terrain exhibits fair surficial drainage to the southwest.

The material in the beach ridges, strand line segments and the small alluvial fan consists of very shallow surficial layers of sand and gravel which are high in silt content and exhibit variable gradation. The sand and gravel layers, generally, less than 2 to 4 feet in thickness are underlain by glacial till. Pockets of gravelly till were noted in a few drill hole locations. An organic topsoil layer, less than 1 foot in thickness, overlies these deposits in the site area and supports light to moderate growths of spruce and birch.

There are no known critical wildlife areas in the immediate vicinity of Site 273X.

The access to the site area is quite good because the CNT pole line and the proposed gas pipeline route parallel the northern periphery of the site and the proposed Mackenzie Highway right-of-way is located along the southern perimeter.

## DEVELOPMENT

The information from the drill holes conducted on Site 273X by the engineering consultant for The Federal Department of Public Works has been assessed and incorporated in this report. The following conditions relative to the quality and quantity of available granular materials has been established:

- The beach ridges, segments of strand lines and the alluvial fan contain very shallow, surface layers of sand and gravel which are high in silt content and extremely variable in gradation. Occasional pockets of sand or gravel to depths of 7 to 12 feet below existing ground surface were noted. These sands and gravels are considered to be only suitable for use as fill material in the construction of building pads, road subgrades and berms for pipelines.

- The average thickness of recoverable sand and gravel, based upon drilling information, is considered to be less than 3 feet.

- The average overburden depth consisting of topsoil and organic silt is generally less than 1 foot.

Site 273X is not recommended for development and exploitation of granular materials because the quantity of potentially recoverable sands and gravels is quite minimal. In addition, these pockets and layers of sand and gravel are widely scattered and the foraging

for materials could result in extensive surficial disturbance to the site area.

However, if the utility right-of-ways are located, as proposed, across these various deposits, then these pockets of sand and gravel which would be encountered during the construction of such facilities could be utilized as fill material.

# DETAILED DRILL HOLE LOG

SITE NO. 273X HOLE NO. C 777

DATE: MAR. 10, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | SP | SAND: coarse, gravelly | | Nf | | | 0 |
| 4.0 | | | | | | | | |
| 5 | | SW | - fine gravelly | | | | | 5 |
| 6.0 | | | | | | | | |
| | | | CLAY (TILL): | | Vx | M | | |
| | | CI | silty, sandy, gravelly, | | Vs | M | | |
| 10 | | | medium plastic, brown, calcareous | | | | | 10 |
| | | | | UF | | | | |
| 14.0 | | | | | | | | |
| 15 | | | - grey | | | | | 15 |
| 18.0 | | | | | | | | |
| 20 | | CH | CLAY (Shale): | | | | | 20 |
| | | | - high plastic | | | | | |
| | | | - grey | | | | | |
| 25 | | | | UF | | | | 25 |
| 30 | | | | | | | | 30 |
| 35 | | | | | | | | 35 |
| 40 | | | | | | | | 40 |
| 45 | | | | | | | | 45 |
| 50 | | | | | | | | 50 |
| 50.0 | | | END OF HOLE 50.0' | | | | | |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 273X HOLE NO. C 778

DATE: MAR. 10, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS | | | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| | | | | GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | | |
| 0 | | OH | ORGANIC SILT: clayey, medium plastic, yellow-brown color | | Nbn | | | 0 |
| 2 | | GP | 2.0 GRAVEL: slightly sandy | | Vx | L | | 2 |
| | | | ------ - boulders | | | | | |
| 4 | | CI-CL | 4.0 CLAY (TILL): silty, sandy, gravelly, low-medium plastic, brown, rust and coal specks calcareous | | | | | 4 |
| 6 | | | | | | | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | CH | 10.0 CLAY (SHALE): silty, high plastic, brown | | Vx | M | | 10 |
| 12 | | | ----- - grey | | | | | 12 |
| 14 | | | 14.0 END OF HOLE 14.0' | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 273X HOLE NO. 870

DATE: MAR. 10, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | O | 0.3 MOSS: | | | | | 0 |
| | | OH-OL | ORGANIC CLAY: silty, medium plastic, dark brown | | Vx | H | | |
| 2 | | | 2.0 | | | | | 2 |
| | | GC | GRAVEL (TILL): silty, sandy, clayey, calcareous | | | | | |
| 4 | | | 4.0 | | | | | 4 |
| 6 | | CI | CLAY (TILL): silty, slightly sandy, non-plastic, brown, occasional shale inclusion some gravel | | Vx | L | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| | | | Transition Zone | | | | | |
| 14 | | | 14.0 | | | | | 14 |
| 16 | | | CLAY (SHALE): silty, medium to high plastic, grey, fissured, Till inclusions | | | | | 16 |
| | | | - laminated inclusions | | | | | |
| 18 | | | - rust fissures<br>- siltstone beddings | | | | | 18 |
| 20 | | | 20.0 END OF HOLE 20.0' | | | | | 20 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 273X HOLE NO. C 876

DATE: MAR. 10, 1973 | LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | ORGANIC SILT: clayey, medium plastic, organic inclusions | | Vx | M | | 0 |
| 2 | | | 2.0 | | | | | 2 |
| 4 | | GM-GC | GRAVEL: coarse, sandy, clayey, silty, brown, pebbles, calcareous shale inclusions | | Vs | M | | 4 |
| 6 | | | | | | | | 6 |
| 8 | | | | | Vx | L | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | Nbn | | | 12 |
| | | CH | 12.0 CLAY (Shale): firm, high plastic, grey, laminated | | | | | |
| 14 | | | | | | | | 14 |
| | | | 15.0 END OF HOLE 15.0' | | | | | |
| 16 | | | | | | | | 16 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 273X HOLE NO. C 880

DATE: MAR. 11, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | O | MOSS: | | Vs | H | | 0 |
| 0.3 | | | | | | | | |
| 2 | | GM-GC | GRAVEL: sandy, silty, clayey, non to low plastic, brown | | Vx | M | | 2 |
| 4 | | | | | | | | 4 |
| 6 | | | | | | | | 6 |
| 7.0 | | | | | | | | |
| 8 | | CH | CLAY (Shale): silty, high plastic, calcareous, grey | | Vr | M | | 8 |
| 10 | | | | | | | | 10 |
| | | | | | Vr | L | | |
| 14.0 | | | END OF HOLE 14.0' | | | | | |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 273X HOLE NO. C 887

DATE: MAR. 11, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | 0.3 MOSS | | Vs | H | | 0 |
| 2 | | OH | ORGANIC CLAY: silty, medium high plastic, dark brown | | Vs | H | | 2 |
| | | | 2.5 | | | | | |
| 4 | | CL | CLAY (TILL): sandy, gravelly, silty, low plastic, brown, rust and coal specks, shale inclusions, calcareous | | Vx | M | | 4 |
| 6 | | | | | | | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | Vr | L | | 10 |
| 12 | | | - grey | | | | | 12 |
| 14 | | | 14.0 END OF HOLE 14.0' | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 273X HOLE NO. SN 905

DATE: MAR. 10, 1973 | LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | 0 |
| | | CI | CLAY (SHALE): medium plastic, weathered, rust specks, organic clay, organics, rust fissured, dark brown | | Vx | M | | |
| 4 | | | 4.0 | | | | | 4 |
| | | CH | CLAY (SHALE): firm, high plastic, brown | | Nbn | | | |
| 14 | | | 14.0 - grey | | | | | 14 |
| 20 | | | 20.0 END OF HOLE 20.0' | | | | | 20 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

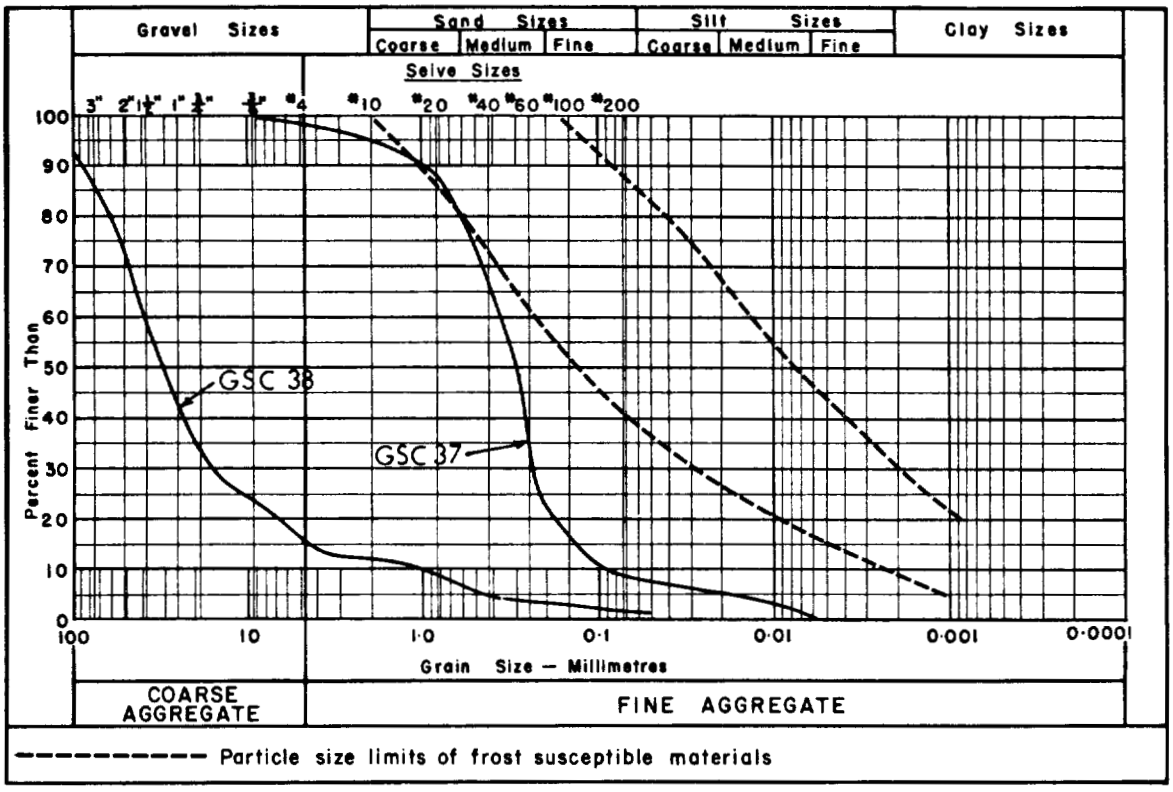
GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

## SUMMARY OF LABORATORY TEST DATA

| | | |
|---|---|---|
| Sample Location: | 273X/GSC 37 | 273X/GSC 38 |
| Sample Depth (Feet): | - | - |
| Moisture Content (%): | 4.4 | 6.1 |
| Ice Content (%): | - | - |
| Organic Content (%): | - | - |

GRAIN SIZE DISTRIBUTION:




PETROGRAPHIC ANALYSIS:

## SITE NO. 274X

Located approximately 17 miles east of Norman Wells and parallel to the northside of the proposed Mackenzie Highway from Mile 614 to Mile 619, Site 274X consists of a narrow, discontinuous beach ridge deposit.

Type of Material: Sand; little silt, fine grained, poorly graded.

Estimated Volume: Not determined.

Assessment: Site 274X is not recommended for development because only a minimal volume from a thin layer of very poor quality sand is available for construction purposes.

LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- ⊙ DH Drill Hole
- Required access
- Site limit
- Proposed Mackenzie Highway
- ⊕ TP Test Pit

Airphoto No. A22934/94

Approximate scale: 1" = 3,000'

## ENVIRONMENT

Site 274X is located approximately 17 miles east of Norman Wells and parallel to the north-side of the proposed Mackenzie Highway right-of-way from Mile 614 to Mile 619. The site consists of a discontinuous, narrow beach ridge formation which is approximately 5 miles in length and extends from Prohibition Creek northwest to Francis Creek. The active stream channels of Christina Creek and Helava Creek are incised through the site area. The beach ridge rises only slightly above the adjacent terrain and exhibits fair surficial drainage to the southwest into the general watershed of the various creek channels.

The material in the beach ridge, consisting of fine grained, poorly graded sands with a little silt, may be suitable as fill material in very marginal construction requirements for road sub-grades. The sand stratum is very shallow and is underlain by glacial till. An organic top-soil layer less than 1 foot in depth, overlies the site area and supports light to moderate growths of spruce and birch.

There are no critical wildlife areas in the immediate vicinity of Site 274X.

The only existing access to the site area from the CNT pole line, proposed gas pipeline or the proposed Mackenzie Highway consists of various seismic cutlines which, in part, traverse thermally sensitive terrain at various locations.

## DEVELOPMENT

The exploratory drilling which was carried out on Site 274X, showed the following conditions relative to the quality of subsurface material:

- The beach ridge consists of fine grained, poorly graded sands with a little silt which may be suitable for very marginal fill in the construction of subgrades for roads. Glacial till-like clayey silts underlie the shallow surficial sand stratum.

- The sand is approximately 4 feet thick and is overlain by a 1 foot thick layer of organic topsoil.

Site 274X is not recommended for development and exploitation of granular materials because of the very poor quality of sand available for construction requirements.

In addition, the relatively thin layer of sand will require an extensive surficial area being cleared if foraging for material is undertaken.

# DETAILED DRILL HOLE LOG

SITE NO. 274X HOLE NO. DH-1

DATE: DEC. 15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | PEAT: organic, fibrous, muskeg | | | | | 0 |
| 1.0 | | | | | | | | |
| 2 | | SM-SP | SAND: some silt, fine grained, poorly graded, pebbles to 3/4" size, medium brown | | | | | 2 |
| 4 | | | | | | | | 4 |
| 5.0 | | | | | | | | |
| 6 | | MH | SILT: some sand, pebbles to 3/4" size, light to medium brown (TILL-LIKE) | | Vs | M | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | TOTAL DEPTH 12.0' | | | | | 12 |
| 12.0 | | | | | | | | |
| 14 | | | | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

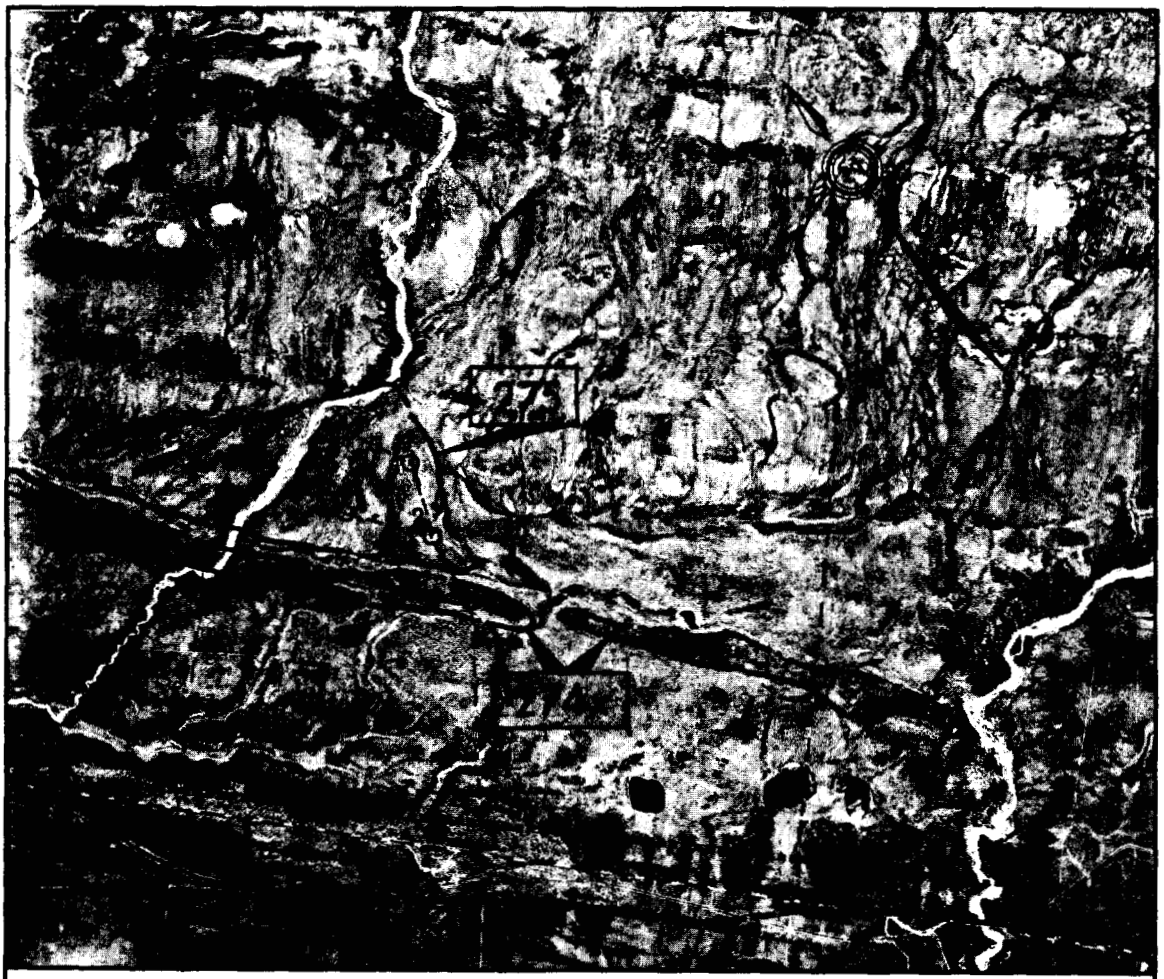
## SITE NO. 275

Located approximately 17 miles east of Norman Wells and $1\frac{1}{4}$ miles northeast of the proposed Mackenzie Highway at Mile 617, Site 275 consists of an alluvial fan deposit which has been incised by the Christina Creek stream channel.

Type of Material: Sand and Gravel; little to some silt, poorly graded, fine to medium grained.

Estimated Volume: 2,000,000 cubic yards.

Assessment: Fair to good quality granular materials which are suitable for embankment fill in the construction of road grades and utility backfill; Site 275 is recommended for development.



LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- ⊙ DH Drill Hole
- Required access
- Site limit
- Proposed Mackenzie Highway
- ⊕ TP Test Pit

Airphoto No. A22934/94

Approximate scale: 1" = 3,000'

## ENVIRONMENT

Site 275 is located approximately 17 miles east of Norman Wells and $1\frac{1}{4}$ miles northeast of the proposed Mackenzie Highway right-of-way at Mile 617. The site consists of an alluvial fan deposit which has been incised by the current stream channel of Christina Creek and encompasses an area 6000 feet in length by 1500 feet in width. The site area and immediately adjacent terrain exhibits good surficial drainage to the southwest into the watershed of Christina Creek. The rugged McConnell Range rises steeply immediately to the north of Site 275.

The material in the alluvial fan deposit consists of fine to medium grained, poorly graded sands and medium grained, well graded gravels with variable silt contents. These sands and gravels are suitable for good quality embankment fill material in the construction of road grades. The surficial layer of topsoil and organic silt is generally less than 2 feet in depth and supports light to moderate growths of spruce and birch. The understory growth is sparse.

There are no known critical wildlife areas in the immediate vicinity of Site 275. Although Christina Creek is reported to contain potential spawning gravels, the usage of this watercourse by fishery resources is limited because the Creek normally dries up by mid-summer.

The only existing access to the site area from the CNT pole line or proposed Mackenzie Highway right-of-way consists of a seismic cutline and the access trails which were cleared to the site area during the winter drilling program.

## DEVELOPMENT

The detailed exploratory drilling conducted on Site 275 has shown the following conditions relative to the quality and quantity of available granular materials:

- Fair to good quality granular materials which can be utilized for embankment fill in the construction of road grades, building pads and pipeline berms can be recovered from Site 275. These granular materials consist of fine to medium grained sands and medium grained, well to poorly graded gravels with a variable silt content.

- Sands and gravels were encountered to the depths of drill holes conducted which ranged from 12 to 28 feet below the existing ground surface. An average depth of 15 feet was utilized for estimating the volume of available granular materials.

- The overburden material consisting primarily of topsoil and organic silt is less than 2 feet in depth.

- An estimated volume in excess of 2,000,000 cubic yards of sand and gravel is considered recoverable from Site 275.

- The ground ice content of the frozen gravels are very low and the in situ gravels are generally in a friable condition.

Site 275 is recommended for the development and exploitation of granular materials and the following guidelines should be considered in the development of borrow pit areas:

- In view of the stratified nature of the in situ sands and gravels, vertical excavation of borrow pit areas should be considered for recovery of better sorted pit run aggregates. In addition, if careful and selective excavating procedures are utilized in the development of borrow pits, then the pockets or layers of better quality gravels could be exploited for the production of base and surface course aggregates.

- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.

- The thin veneer or organic topsoil and peat should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.

- Relative to granular deposits immediately adjacent to the east and west sides of Christina Creek, the development procedures should be commenced at the source area farthest removed from the water course. A buffer zone of adequate width should be maintained between the stream and the final limits of the borrow pit.

- Operating procedures during borrow pit development should be maintained whereby surficial waste materials do not drain to the active Christina Creek stream channel.

## ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the pit area to provide general drainage compatible with the natural drainage of the adjacent terrain.

- Replacing stockpiled surficial waste material on the abandoned borrow pit areas.

- Reseeding of the recontoured pit areas may be considered although existing cutlines in the area indicate that understory growth and eventually spruce will be naturally reestablished.

# DETAILED DRILL HOLE LOG

SITE NO. 275 HOLE NO. DH 1

DATE: DEC. 16, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | PEAT: organic, fibrous, muskeg | | | | | 0 |
| 1.0 | | | | | | | | |
| 2 | | SP-SM | SAND: some silt, little gravel, predominantly fine and medium grained, poorly graded, frequent pebbles with shale fragments to 3/4" size, medium brown | | Vs | L | | 2 |
| 4 | | | | | | | | 4 |
| 6 | | | | | | | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 13.0 | | | TOTAL DEPTH 13.0' | | | | | |
| 14 | | | | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

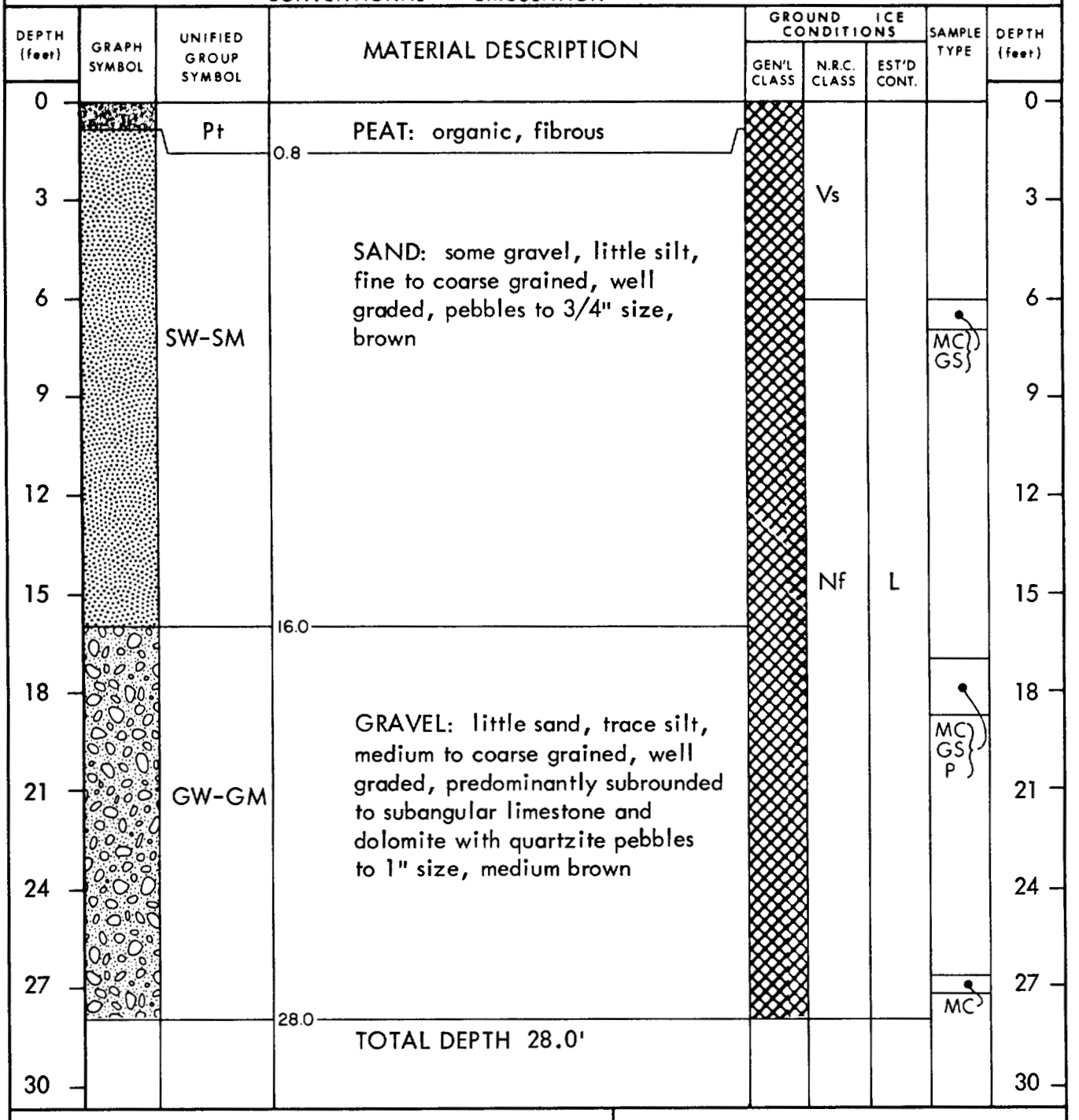
PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 275 HOLE NO. DH-2

DATE: DEC. 15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:




GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 275 HOLE NO. DH-3

DATE: DEC. 15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: some silt, organic, roots, dark brown | | Vs | | | 0 |
| 1.5 | | | | | | | | |
| 2 | | ML | SILT AND SAND: pebbles to 3/4", light brown | | | | | 2 |
| 4 | | | | | | | | 4 |
| 4.0 | | | | | | | | |
| 6 | | GW | GRAVEL: some sand, pebbles to 1" size, medium brown | | Vx Vc | L | | 6 |
| 8 | | | - becoming high in silt content from 8.0' | | | | | 8 |
| 10 | | GM-GP | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 12.0 | | | TOTAL DEPTH 12.0' | | | | | |
| 14 | | | | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 275 HOLE NO. DH-4

DATE: DEC. 15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | 0 |
| 2 | | GP-GM | GRAVEL: some sand, little silt, poorly graded, frequent pebbles and cobbles, brown | | Vx | | | 2 |
| 4 | | | | | | | | 4 |
| 6 | | | | | | L | | 6 |
| | | | 6.5 | | | | | |
| 8 | | SP | SAND: fine grained, poorly graded, brown | | Vx Vs | | GS MC | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | 12.0 | | | | | 12 |
| | | | TOTAL DEPTH 12.0' | | | | | |
| | | | Note: Hole caving in at 12.0', discontinued drilling | | | | | |
| 14 | | | | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

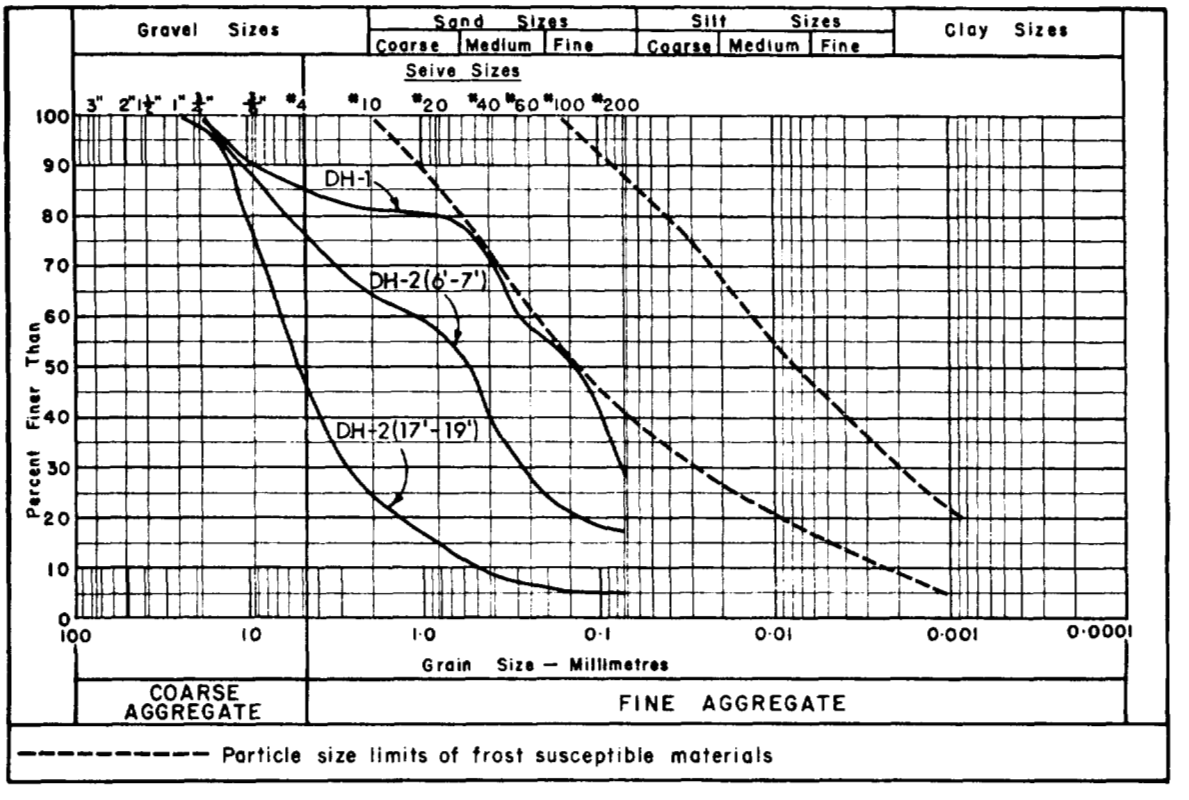
GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

## SUMMARY OF LABORATORY TEST DATA

| Sample Location: | 275/DH-1 | 275/DH-2 | 275/DH-2 |
|---|---|---|---|
| Sample Depth (Feet): | 1.0 - 3.0 | 17.0 - 19.0 | 6.0 - 7.0 |
| Moisture Content (%): | - | 5.2 | 6.7 |
| Ice Content (%): | - | - | - |
| Organic Content (%): | - | - | - |

GRAIN SIZE DISTRIBUTION:



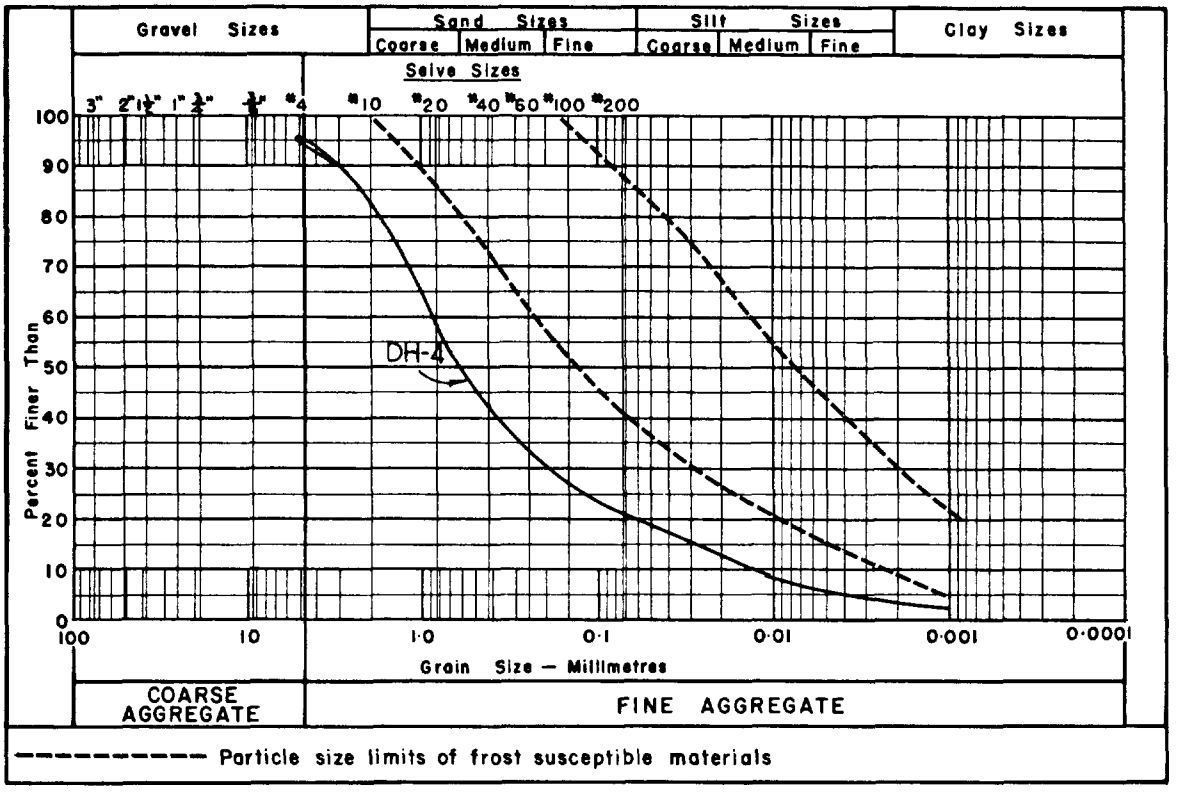

PETROGRAPHIC ANALYSIS: (275/DH-2 @ 17.0' - 19.0')

| | | | |
|---|---|---|---|
| Limestone and dolomite | 47.7% | Deteterious | |
| Quartizite (Sound) | 19.4% | Shale and Silty shale | 11.8% |
| Igneous | 13.9% | Ironstone | 2.2% |
| Chert | 4.8% | | |

## SUMMARY OF LABORATORY TEST DATA

| | | |
|---|---|---|
| Sample Location: | 275/DH-2 | 275/DH-4 |
| Sample Depth (Feet): | 27.0 | 9.0 - 10.0 |
| Moisture Content (%): | 7.7 | 4.4 |
| Ice Content (%): | - | - |
| Organic Content (%): | - | - |

GRAIN SIZE DISTRIBUTION:




PETROGRAPHIC ANALYSIS:

## SITE NO. 276

Located approximately 15 to 16 miles east of Norman Wells and adjacent to the proposed Mackenzie Highway from Mile 617 to Mile 618, Site 276 consists of a group of four fluvial fans which have been developed adjacent to the channels of Helava Creek and Christina Creek.

Type of Material: Sand and Gravel; little to some silt, fine grained, variable gradation.

Estimated Volume: 200,000 cubic yards.

Assessment: Fair to good quality granular materials can be recovered from the fans designated as "a", "b" and "c"; Site 276 is recommended for possible future development.


LEGEND

| | |
|---|---|
| ▬▬▬ All weather road | ····· Required access |
| ▬ ▬ ▬ Existing trails and cutlines | ·—·—· Site limit |
| ····· Proposed Gas Pipeline | ·▬▬▬· Proposed Mackenzie Highway |
| ⊙ DH Drill Hole | ⊕ TP Test Pit |

Airphoto No. A22934/145 Approximate scale: 1" = 3,000'

## ENVIRONMENT

Site 276 is located approximately 15 to 16 miles east of Norman Wells and immediately adjacent to the proposed Mackenzie Highway right-of-way between Mile 617 and Mile 618. The site consists of a group of four fluvial fans which have been developed immediately adjacent to or within the current stream channels of Helava Creek and Christina Creek. The four distinct fluvial fans are designated as "a", "b", "c" and "d" on the preceding site airphoto, page 276-1, and are briefly described as follows:

Fans "a" and "b" : These two fans located immediately adjacent to the east and west banks of Helava Creek and Christina Creek, respectively, represent the oldest fan formations and contain coarser deposits of sands and gravels. The fans are well drained into the existing stream channels of their respective creek channels.

Fan "c" : This fan formation encompasses the current stream channel of Christina Creek and is a relatively recent deposit in terms of geological time. This deposit consists primarily of fine sands and silts although pockets of medium grained, silty gravels were noted at the apex of the fan, adjacent to the current active stream channel of Christina Creek.

Fan "d" : This fan is the youngest of the four fan deposits and consists primarily of silts. This deposit which is poorly drained, experiences seasonal flooding and is in an active stage of growth.

The fluvial fan deposits vary in size from 900 to 2000 feet in length and 500 to 1500 feet in width. The organic silt and topsoil layer is generally less than $1\frac{1}{2}$ feet in thickness and supports light to moderate growths of spruce, birch and tamarack and sparse understory growth.

There are no known critical wildlife areas in the immediate vicinity of Site 276.

The proposed Mackenzie Highway right-of-way traverses immediately adjacent to the southern perimeter of fans "a" and "b" and through the apex of fan "d". The CNT pole line and the proposed gas pipeline routes are located less than $\frac{1}{4}$ mile northeast of the northern extremities of the fan complex.

## DEVELOPMENT

The information from the drill holes carried out on Site 276 by the engineering consultant for The Federal Department of Public Works has been assessed and incorporated into this report. The following conditions are relative to the quality and quantity of available granular materials from this group of fluvial fans:

- The fans "a" and "b" and the apex of fan "c" contain fair to good quality granular

materials suitable for use in the construction of road grades, building pads, berms for pipelines and miscellaneous backfill. These granular materials consist of fine grained, well to poorly graded sand and gravel with a relatively high silt content.

- The depth of sand and gravel suitable for construction requirements varies from less than 5 feet to 10 feet in depth and is generally underlain by glacial till.

- The overburden material consisting of topsoil, silt and clay, varies from 1 to 4 feet.

- The volume of recoverable granular materials is difficult to assess; however, it is considered that volumes of sands and gravels in the order of 100,000 to 200,000 cubic yards can be recovered from Site 276.

Therefore, Site 276 is recommended as a possible source of granular materials and the development of borrow pits should be directed to fans "a", "b" and "c". The following guidelines should be considered in the development of borrow pit areas:

- In view of the stratified and scattered nature of the in situ sands and gravels, vertical excavation of borrow pit areas should be considered for recovery of better sorted pit run aggregates. In addition, if careful and selective excavating procedures are utilized in the development of borrow pits, then the pockets or layers of better quality gravels could be exploited for the production of base and surface course aggregates.

- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.

- The thin veneer of organic topsoil and peat should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.

- Relative to granular deposits immediately adjacent to the east and west sides of Heleva Creek and Christina Creek, the development procedures should be commenced at the source area farthest removed from the water course. A buffer zone of adequate width should be maintained between the stream and the final limits of the borrow pit.

- Operating procedures during borrow pit development should be maintained whereby surficial waste materials do not drain to the active stream channels of Helava and Christina Creeks.

## ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the pit area to provide general drainage compatible with the natural drainage of the adjacent terrain.

- Replacing stockpiled surficial waste material on the abandoned borrow pit areas.

- Reseeding of the recontoured pit areas may be considered although existing cutlines in the area indicate that understory growth and eventually spruce will be naturally reestablished.

# DETAILED DRILL HOLE LOG

SITE NO. 276 HOLE NO. S 892

DATE: MAR. 11, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | GC | GRAVEL:<br>- silty, sandy<br>- clayey, low plastic<br>- brown, calcareous<br>- rootlets | | Vx | L | | 0 |
| 2 | | | | | | | | 2 |
| 4 | | | - coarse sand, less fines | | | | | 4 |
| 6 | | | | | | | | 6 |
| 8 | | | 8.0 | | | | | 8 |
| | | CL | CLAY (TILL): gravelly,<br>- silty, sandy<br>- low plastic<br>- light brown<br>- rust spots | UF | | | | |
| 10 | | | | | | | | 10 |
| 12 | | | - grey<br>- higher plastic | | | | | 12 |
| 14 | | | | | | | | 14 |
| | | | 15.0 | | | | | |
| 16 | | | END OF HOLE 15.0' | | | | | 16 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 276 HOLE NO. 947

DATE: MAR. 13, 1973 | LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | PEAT: | | Vx | H | | 0 |
| 1.0 | | | | | | | | |
| 2 | | SC | SAND (TILL): coarse grained, silty clayey, brown, medium plastic, traces of shale and rootlets, calcareous | | Nbn | | | 2 |
| 4 | | | - less silt and clay<br>- finer sand | | Vs | M | | 4 |
| 6 | | | | | | | | 6 |
| 6.0 | | CH | CLAY: traces of sand, high plastic, brown, occasional pebbles | | Vs | M | | |
| 8 | | | - grey, no sand | | Vs | M | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 14 | | | | | Vs | L | | 14 |
| 16 | | | - slight trace of silt | | Vs | M | | 16 |
| 18 | | | | | | | | 18 |
| 20 | | | | | | | | 20 |
| 20.0 | | | END OF HOLE 20.0' | | | | | |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 276 HOLE NO. 948

DATE: MAR. 13, 1973 | LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | PEAT: | | Vx | H | | 0 |
| 0.5 | | | | | | | | |
| 2 | | Cl | CLAY (TILL): silty, medium plastic, brown, occasional pebbles | | Nbn | | | 2 |
| 4 | | | 4.0 | | | | | 4 |
| 6 | | SC | SAND: fine gravelly, silty, trace of clay, poorly graded, shale and siltstone inclusions, brown | | | | | 6 |
| 8 | | | - sandy - gravelly | | | | | 8 |
| 10 | | | - gravelly - sandy | | | | | 10 |
| 12 | | | 12.0 | | | | | 12 |
| 12 | | Cl | CLAY (TILL): very silty, quite sandy, low to medium plastic, brown siltstone and shale inclusions | | | | | 12 |
| 14 | | | | | | | | 14 |
| 16 | | | - grey | | | | | 16 |
| 18 | | | - less sandy | | | | | 18 |
| 20 | | | 20.0 END OF HOLE 20.0' | | | | | 20 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 276 HOLE NO. 949

DATE: MAR. 13, 1973 LOGGED BY: ☐ PEMCAN ☒

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | 0 |
| | | CI | CLAY: silty, sandy, low plastic, brown, rootlets, shale inclusions | | Nbn | | | |
| 2 | | | | | | | | 2 |
| 3.5 | | | | | | | | |
| 4 | | GW | GRAVEL (Fine): sandy, well graded, clean | | Nf | | | 4 |
| 6 | | GM | - shalestone inclusions, sandier | | | | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 12.0 | | | | | | | | |
| | | SM | - silty, sand | | | | | |
| 14 | | | | | | | | 14 |
| 16 | | | | | | | | 16 |
| | | | - siltier | | Vx | M | | |
| 18 | | | | | | | | 18 |
| 18.0 | | | | | | | | |
| | | CI | CLAY (TILL): gravelly, grey, medium plastic | | Nf | | | |
| 20 | | | | | | | | 20 |
| 20.0 | | | END OF HOLE 20.0' | | | | | |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 276 HOLE NO. 950

DATE: MAR. 13, 1973 | LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | ML | SILT: clayey, sandy, low plastic, brown, root inclusions | | Nbn | | | 0 |
| 2 | | | | | | | | 2 |
| | | | 3.0 | | | | | |
| 4 | | GP | GRAVEL (TILL): fine, shalestone inclusions, calcareous | | Nf | | | 4 |
| 6 | | | - clean, sandier | | | | | 6 |
| 8 | | | - siltstone and hard shale | | | | | 8 |
| 10 | | | - coarse sand, fine gravel, shalestone inclusions | | | | | 10 |
| 12 | | | 12.0 | | | | | 12 |
| | | CI | CLAY (TILL): silty, sandy, medium plastic, grey, pebbles, coal specks | | Vx | M | | |
| 14 | | | | | | | | 14 |
| | | | 15.0 | | | | | |
| 16 | | GC | GRAVEL: silty, trace of clay, siltstones inclusions | | | | | 16 |
| | | | 17.0 | | | | | |
| 18 | | CI | CLAY (TILL): silty, sandy, medium plastic, grey | | Vx | M | | 18 |
| 20 | | | 20.0 END OF HOLE 20.0' | | | | | 20 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

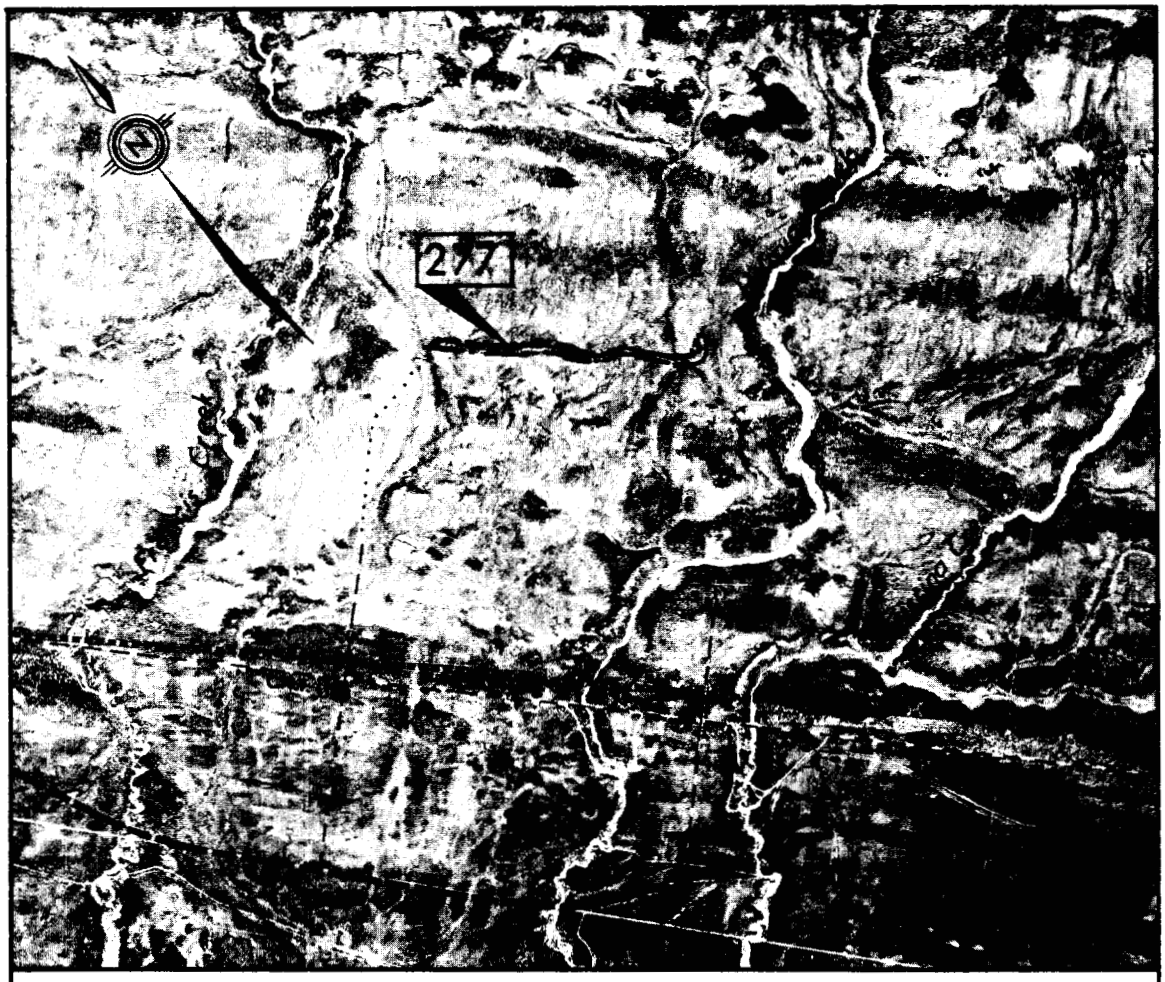
PEMCAN SERVICES "72"

## SITE NO. 277

### LOCATION

Located between Francis and Helava Creeks, approximately 13 miles east of Norman Wells, Site 277 consists of a shallow esker ridge. The esker material likely consists of silty sand with some gravel.

The proposed Mackenzie Highway right-of-way at Mile 618.5 is located approximately $2\frac{1}{2}$ miles southwest of Site 277. The proposed gas pipeline route parallels the esker ridge to the southwest at a distance of $1\frac{1}{2}$ miles.




LEGEND

| | |
|---|---|
| ▬▬▬▬ All weather road | ..... Required access |
| ------ Existing trails and cutlines | ·—·—· Site limit |
| ..... Proposed Gas Pipeline | ▬▬▬ Proposed Mackenzie Highway |

Airphoto No. A22934/96 Approximate scale: 1" = 3,000'

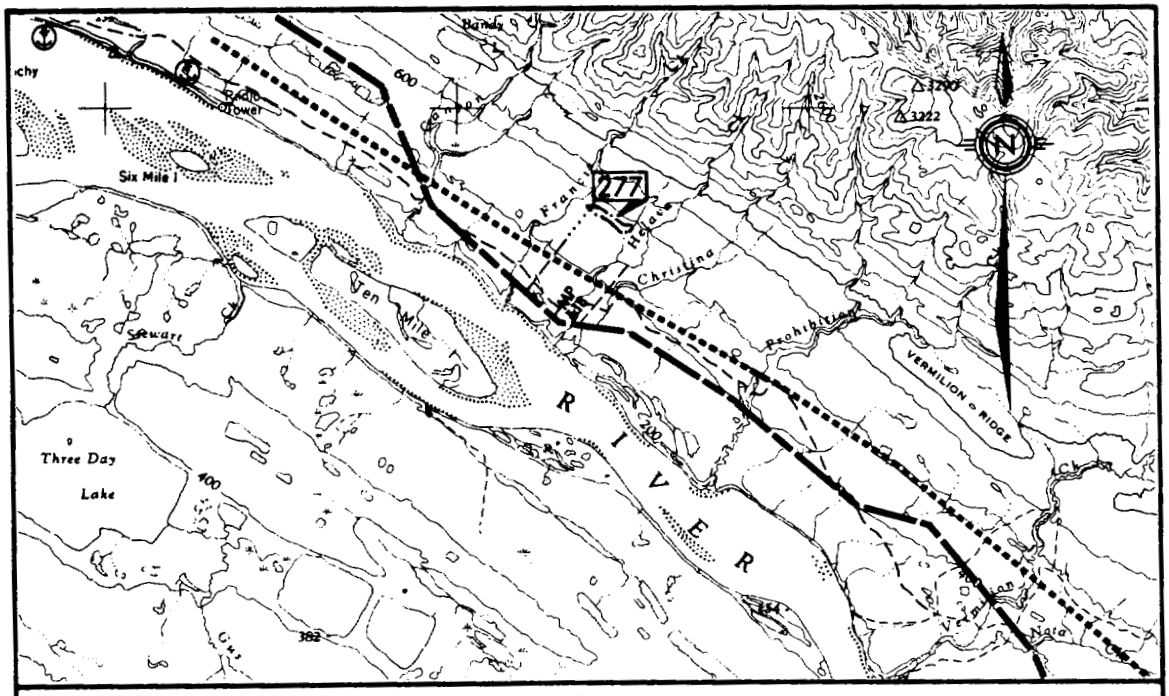
## GENERAL

Site 277 consists of a narrow and sinuous esker ridge which is approximately 3/4 of a mile long and varies in height from several feet to a maximum height of about 20 feet. It is expected that material in the esker ridge is composed mainly of silty sands with traces of gravel thus providing low quality general fill material. A relatively shallow layer of organic topsoil covers the esker ridge.

The esker ridge is well drained and supports mixed growths of birch and spruce. The adjacent terrain is poorly drained and is covered with muskeg characterized by growths of tamarack and stunted black spruce. There are no known critical wildlife areas in the immediate vicinity of Site 277.

Site 277 is rated as a poor prospect because of possibly fine grained and silty materials in the esker ridge. Moreover, the extraction of relatively small volumes of material would entail clearing of large tracks of land.

The site area is readily accessible along the existing seismic cutline and trails located immediately north of the site.




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- Required access
- Site limit
- Proposed Mackenzie Highway

Section of Map No. 96 E

Scale: 1:250,000

## SITE NO. 278

Located approximately 15 to 16 miles east of Norman Wells and $2\frac{1}{4}$ miles northwest of the proposed Mackenzie Highway at Mile 618, Site 278 consists of a series of partially effaced kame hillocks and terraces.

Type of Material: Sand and Gravel; little to some silt, variable gradation

Estimated Volume: 2,000,000 cubic yards.

Assessment: Good quality granular materials suitable for quality embankment fill and production of base and surface course aggregates; Site 278 is recommended for development.

LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- ⊙ DH Drill Hole
- Required access
- Site limit
- Proposed Mackenzie Highway
- ⊕ TP Test Pit

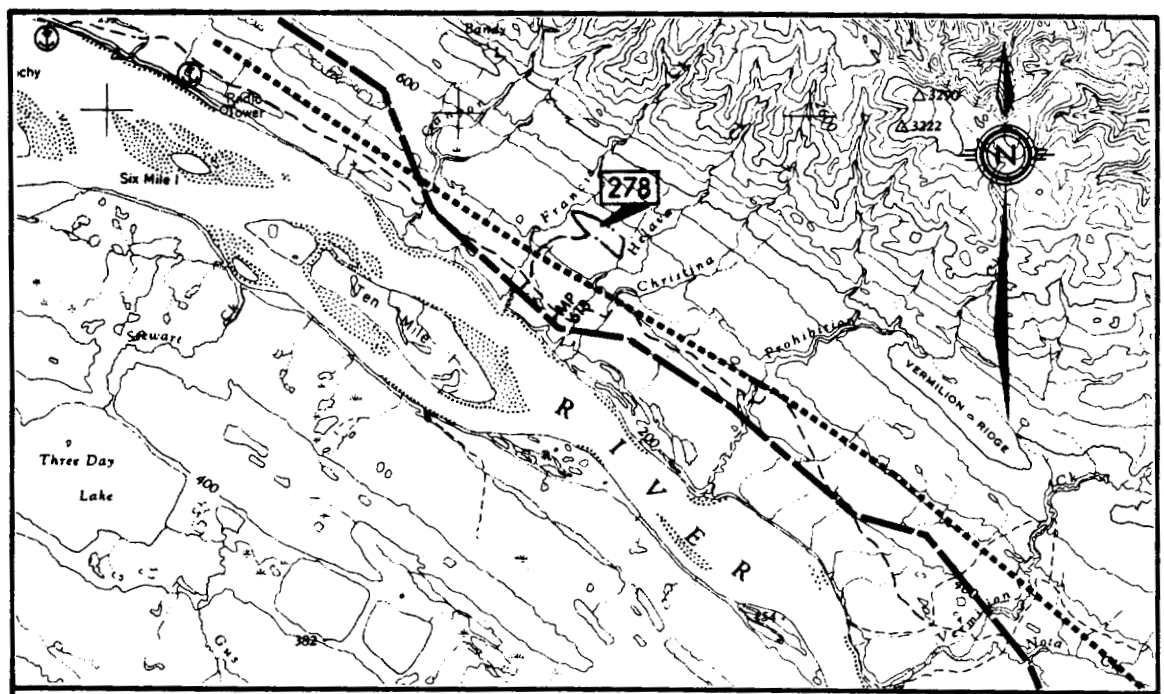
Airphoto No. A22934/95

Approximate scale: 1" = 3,000'

## ENVIRONMENT

Site 278 is located 15 to 16 miles east of Norman Wells and 2¼ miles northeast of the proposed Mackenzie Highway right-of-way at Mile 618. The site is situated on a terrace or bench which is orientated parallel to the rugged McConnell Range to the northeast; to the southwest, the site is slightly elevated above the adjacent glaciolacustrine plain. Site 278 is an easterly extension of Site 281 and consists of a series of kame hillocks and partially effaced kame terraces which encompass an area extending from the northwest bank of Francis Creek to the southwest bank of Helava Creek. The site area which is approximately 2 miles in length and a ¼ mile in width, exhibits good surficial drainage to the southwest.

The material in the kame hillocks and terraces is highly variable but, generally, consists of stratified and pocketed deposits of sand and gravel of varying gradation and relatively high silt content. The presence of deleterious shale fragments in these gravel deposits is quite significant. Grey shale bedrock underlies these gravel deposits at depth. An organic topsoil layer, generally less than 1 foot in depth overlies the entire site area, and supports moderately dense growths of spruce, birch and poplar. The understory growth is relatively sparse. The terrain immediately adjacent to the southwest exhibits partial thermokarst features characterized by a series of small shallow ponds and muskeg bogs which parallel




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- Required access
- Site limit
- Proposed Mackenzie Highway

Section of Map No. 96 E

Scale: 1:250,000

the southwest perimeter of Site 278 at the base of the ridge.

There are no known critical wildlife areas in the immediate vicinity of Site 281.

The only existing access to the site area from the CNT pole line and the proposed Mackenzie Highway right-of-way consists of a seismic cutline and the access trails which were cleared to and across the site area during the winter drilling program. In part, any future access to Site 278 will traverse terrain conditions which are sensitive to thermal erosion if the vegetation cover is excessively disturbed.

## DEVELOPMENT

The exploratory drilling which was conducted during the winter field program showed the following conditions relative to the quality and quantity of available granular materials in Site 278.

- Good quality granular materials consisting of stratified and pocketed deposits of fine to medium grained gravels and coarse sands of highly variable gradation and varying silt content. These sands and gravels are suitable for use as good quality embankment fill material, production of base course aggregates. The relatively high content of deleterious shale fragments, generally, negates the use of these gravels and sands for the production of concrete aggregates.

- The depth of the in situ gravel deposits varies from 9 to 17 feet; therefore, an average depth of 15 feet has been utilized in evaluating the volume of available granular materials.

- Soft shale bedrock was encountered in drill hole DH-4 at a depth of 11 feet below existing ground surface.

- The overburden material consisting of topsoil and organic silts is generally less than 1 foot in depth.

- An estimated volume in excess of 2,000,000 cubic yards of sands and gravels are considered recoverable from Site 278.

Site 278 is recommended for the development and exploitation of granular materials and the following operational guidelines should be considered in the development of borrow pit areas:

- In view of the relatively variable quality and scattered nature of the available granular materials, Site 278 should be considered essentially for pit run aggregates to be utilized in building pads, roads and airstrip subbase construction. However, if careful and selective excavating procedures are utilized during the development of borrow pits, then the pockets or layers of better quality gravels may be exploited for use in

production of base and surface course aggregates.

- The various kame hillocks and terraces should be further investigated by probing at closer intervals with shallow test pits or drill holes to more specifically delineate and assess the quantity of available granular materials.

- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use regulations.

- The thin veneer of organic topsoil and silt should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.

- Relative to granular deposits immediately adjacent to the northeast side of Francis Creek or to the southwest side of Helava Creek, the development procedures should be commenced at the source area farthest removed from the water courses. A buffer zone of adequate width should be maintained between the stream channels and the final limits of the borrow pit areas.

- Operating procedures during borrow pit development should be maintained whereby surficial waste materials do not drain into the active Helava Creek or Francis Creek stream channels.

- The construction of access roads of adequate standards to sufficiently traverse the thermally sensitive terrain conditions to the southwest of the site area will have to be undertaken if extensive quantities of granular materials are to be exploited.

## ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the borrow pit areas to provide general drainage compatible with the natural drainage of the adjacent terrain.

- Replacing stockpiled surficial waste material on the abandoned borrow pit areas.

- Reseeding of the recontoured borrow pit areas may be considered although existing seismic cutlines in the area indicate that the understory growth and eventually spruce will be naturally reestablished.

# DETAILED DRILL HOLE LOG

SITE NO. 278 HOLE NO. DH-1

DATE: DEC. 15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS | | | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| | | | | GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | | |
| 0 | | OL | TOPSOIL: some silt, organic, occasional pebbles, dark brown | | Vx | | | 0 |
| 1 | | | 1.0 | | | | | 1 |
| 2 | | GW | GRAVEL AND SAND: trace silt, coarse grained, well graded, flat shale fragments, brown | | | | GS | 2 |
| 3 | | | 3.0 | | | | | 3 |
| 4 | | SW | SAND: some gravel, medium to coarse grained, well graded, brown | | Nf | L | GS | 4 |
| 5 | | | | | | | | 5 |
| 6 | | | | | | | | 6 |
| 7 | | | 7.0 | | | | | 7 |
| | | | TOTAL DEPTH 7.0' | | | | | |
| 8 | | | Note: Hole caving in at 7.0', discontinued drilling | | | | | 8 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 278 HOLE NO. DH-2

DATE: DEC. 15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: some silt, organic, roots, dark brown | | Vr | M | | 0 |
| 0.5 | | | | | | | | |
| 2 | | GM | GRAVEL: some silt, little sand, occasional shale and limestone fragments, pebbles to maximum 1½" size, calcareous coating on pebbles | | Vx | L | GS | 2 |
| 4 | | | | | | | | 4 |
| 6 | | | | | | | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | - higher sand content from 10.0' | | | | | 10 |
| 12 | | | | | | | | 12 |
| 14 | | SW | SAND: little gravel, trace silt, fine to coarse grained, well graded, few pebbles to ½" size | | Vx | VL | GS MC | 14 |
| 14.0 | | | | | | | | |
| 16 | | | | | | | | 16 |
| 17.0 | | | TOTAL DEPTH 17.0' | | | | | |
| 18 | | | Note: hole caved in at 17.0', discontinued drilling | | | | | 18 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 278 HOLE NO. DH-3

DATE: DEC. 15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: some silt, organic, brown | | | | | 0 |
| 0.7 | | | | | | | | |
| 2 | | | SILT: trace sand and gravel, rounded pebbles to $\frac{1}{4}$" size, brown | | | | | 2 |
| 4 | | | | | | | | 4 |
| 6 | | ML | - some clay, occasional pebbles to $\frac{1}{2}$" size from 6.0' | | Vx | L | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 11.0 | | | TOTAL DEPTH 11.0' | | | | | |
| 12 | | | | | | | | 12 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 278 HOLE NO. DH-4

DATE: DEC. 15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: some silt, organic, brown | | | | | 0 |
| 0.6 | | | | | | | | |
| 2 | | | | | | | | 2 |
| 4 | | GM-GP | GRAVEL: little sand and silt, poorly graded, occasional pebbles, cobbles, rounded, predominantly limestone and quartzite, few shale fragments, brown | | Vx | L | MC | 4 |
| 6 | | | | | | | | 6 |
| 8 | | | - some silt from 8.0' | | | | | 8 |
| 10 | | | | | | | | 10 |
| 11.0 | | | | | | | | |
| 12 | | | BEDROCK: shale, weathered, soft | | | | | 12 |
| 12.0 | | | TOTAL DEPTH 12.0' | | | | | |
| 14 | | | | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 278 HOLE NO. DH-5

DATE: DEC. 15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS | | | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| | | | | GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | | |
| 0 | | OL | 0.8 TOPSOIL: some silt, organic, dark brown | | | | | 0 |
| 2 | | | | | | | | 2 |
| 4 | | | SILT: some sand, occasional rounded pebbles to 1", and shale fragments, brown | | | | | 4 |
| 6 | | | | | Vx | L | | 6 |
| 8 | | ML-GM | | | | | | 8 |
| 10 | | | | | | | | 10 |
| | | | 11.0 TOTAL DEPTH 11.0' | | | | | |
| 12 | | | | | | | | 12 |

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DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 278 HOLE NO. DH-6

DATE: DEC. 15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|
| 0 | OL | | | | | | 0 |
| | | 1.0 TOPSOIL: some silt, organic, brown | | | | | |
| 2 | | | | | | | 2 |
| 4 | GM | GRAVEL: some silt, little sand, predominantly quartzite and limestone pebbles to 2" size, occasional shale fragments, grey | | | | | 4 |
| | | | | | | MC | |
| 6 | | | | | | | 6 |
| 8 | | | | Vx | L | | 8 |
| | | 9.0 | | | | | |
| 10 | ML | SILT: little sand, occasional pebbles, greyish brown | | | | | 10 |
| 12 | | 12.0 | | | | | 12 |
| | | TOTAL DEPTH 12.0' | | | | | |
| 14 | | | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 278 HOLE NO. DH-7

DATE: DEC. 15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: some silt, organic, brown | | Vr | M | | 0 |
| 0.5 | | | | | | | | |
| 2 | | | GRAVEL AND SILT: trace sand, occasional cobbles and shale fragments, light grey | | | | | 2 |
| 4 | | | | | | | | 4 |
| 6 | | | | | | | | 6 |
| 8 | | GM-ML | | | Vx | L | MC GS | 8 |
| 10 | | | | | | | | 10 |
| 11.0 | | | TOTAL DEPTH 11.0' | | | | | |
| 12 | | | | | | | | 12 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

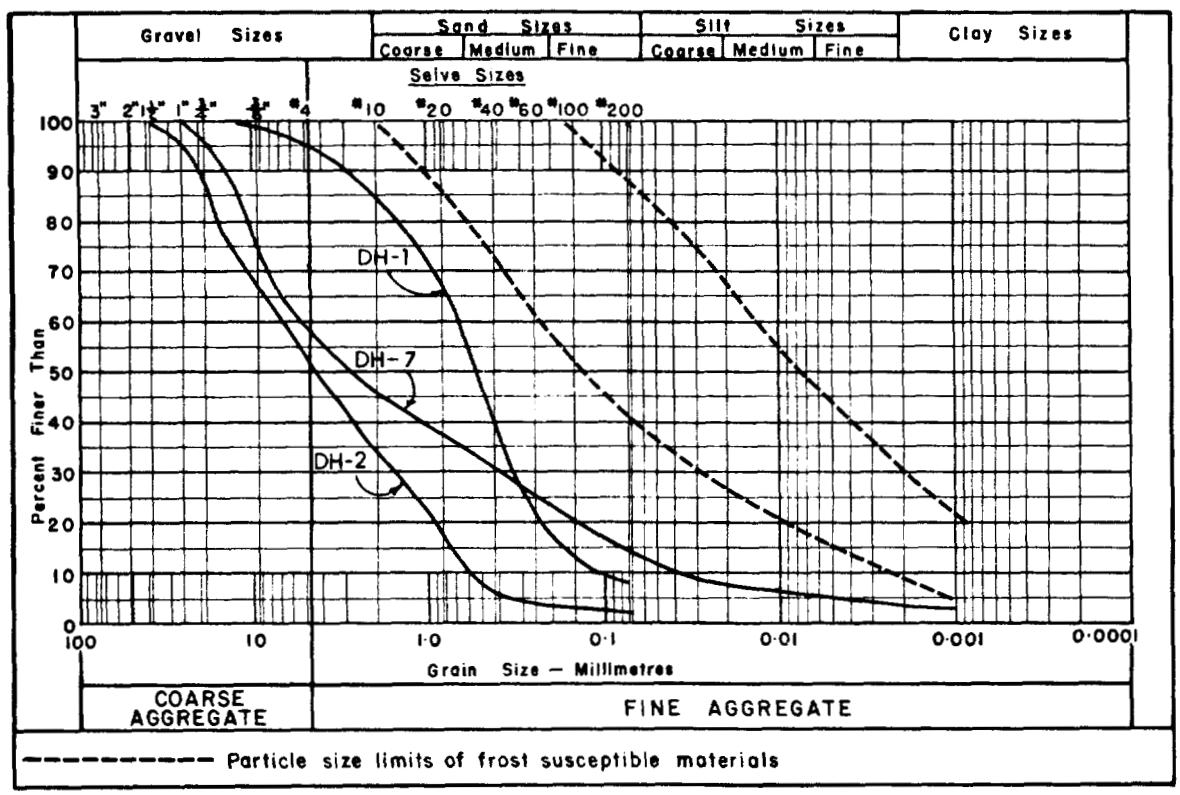
GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

## SUMMARY OF LABORATORY TEST DATA

| Sample Location: | 278/DH-1 | 278/DH-2 | 278/DH-7 |
|---|---|---|---|
| Sample Depth (Feet): | 4.0 - 5.0 | 3.0 - 4.0 | 7.0 - 9.0 |
| Moisture Content (%): | - | - | 10.8 |
| Ice Content (%): | - | - | - |
| Organic Content (%): | - | - | - |

GRAIN SIZE DISTRIBUTION:




PETROGRAPHIC ANALYSIS: (278/DH-2 @ 3.0' - 4.0')

| | | | |
|---|---|---|---|
| Limestone and dolomite | 44.5% | Chert | 1.6% |
| Quartzite (Sound) | 3.8% | Deteterious | |
| Igneous | 1.8% | Shale | 41.9% |
| | | Sandstone and breccia | 2.6% |

## SUMMARY OF MOISTURE CONTENT DETERMINATIONS

| Sample Location | Sample Depth (Ft.) | Moisture Content (%) |
|---|---|---|
| 278/DH-4 | 5.0 | 5.2 |
| 278/DH-6 | 5.0 | 10.9 |

## SITE NO. 279

Located approximately 14 miles east of Norman Wells on the proposed Mackenzie Highway in the vicinity of Mile 619, Site 279 consists of an alluvial fan deposit which has been incised by Francis Creek.

Type of Material: Sand and Gravel; variable gradation and silt content.

Estimated Volume: 1,000,000 cubic yards.

Assessment: Fair to good quality granular materials which can be used as quality embankment fill in the construction of road bases, pipeline berms and utility backfill; Site 279 is recommended for development.


LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- ⊙ DH Drill Hole
- Required access
- Site limit
- Proposed Mackenzie Highway
- ⊕ TP Test Pit

Airphoto No. A22934/144

Approximate scale: 1" = 3,000'

## ENVIRONMENT

Site 279 is located approximately 14 miles east of Norman Wells on the proposed Mackenzie Highway right-of-way in the immediate vicinity of Mile 619. The site consists of an alluvial fan deposit which has been incised by the current stream channel of Francis Creek and encompasses an area 3000 feet in length by 1500 feet in width. The site area and immediately adjacent terrain exhibits good surficial drainage to the southwest into the watershed of Francis Creek. The north bank of the Mackenzie River is located approximately 1 mile downstream of the site area on Francis Creek.

The material in the alluvial fan deposit consists of fine to medium grained sands and medium grained, well graded gravels with variable silt contents. These sands and gravels are suitable for good quality embankment fill material in the construction of road grades. The surficial layer of topsoil and organic silt is generally less than 2 feet in depth and supports light to moderate growths of spruce and birch.

There are no known critical wildlife areas in the immediate vicinity of Site 279.

The proposed Mackenzie Highway right-of-way traverses the entire length of Site 279. The CNT pole line and the proposed gas pipeline routes are located less than $\frac{1}{4}$ mile northeast of the site area. Therefore, the existing and future access to Site 279 is good.

## DEVELOPMENT

The information from drill holes conducted on Site 279 by the engineering consultant for The Federal Department of Public Works has been assessed and incorporated into this report. The following conditions relative to the quality and quantity of available granular materials have been established:

- Fair to good quality granular materials which can be utilized for embankment fill in the construction of road grades, building pads and pipeline berms can be recovered from Site 279. These granular materials consist of fine to medium grained sands and medium grained, well to poorly graded gravels with a highly variable silt content.

- Sands and gravels were encountered to the depths of drill holes conducted which ranged from 10 to 20 feet below existing ground surface. An average depth of 12 feet was utilized for estimating the volume of available granular materials.

- The overburden material consisting primarily of topsoil and organic silt is less than 2 feet in depth.

- An estimated volume in excess of 1,000,000 cubic yards of sand and gravel is considered recoverable from Site 279.

Site 279 is recommended for the development and exploitation of granular materials and the

following guidelines should be considered in the development of borrow pit areas:

- In view of the stratified nature of the in situ sands and gravels, vertical excavation of borrow pit areas should be considered for recovery of better sorted pit run aggregates. In addition, if careful and selective excavating procedures are utilized in the development of borrow pits, then the pockets or layers of better quality gravels could be exploited for the production of base and surface course aggregates.

- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.

- The thin veneer of organic topsoil and peat should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.

- Relative to granular deposits immediately adjacent to the east and west sides of Francis Creek, the development procedures should be commenced at the source area farthest removed from the water course. A buffer zone of adequate width should be maintained between the stream and the final limits of the borrow pit.

- Operating procedures during borrow pit development should be maintained whereby surficial waste materials do not drain to the active Francis Creek stream channel.

## ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the pit area to provide general drainage compatible with the natural drainage of the adjacent terrain.

- Replacing stockpiled surficial waste material on the abandoned borrow pit areas.

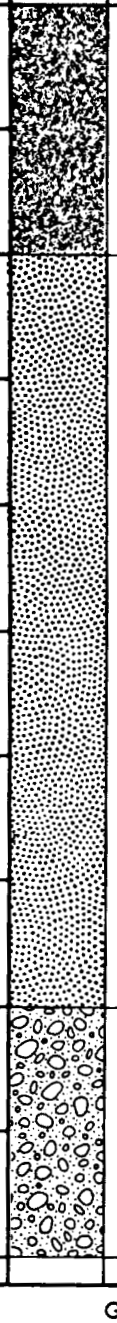
- Reseeding of the recontoured pit areas may be considered although existing cutlines in the area indicate that understory growth and eventually spruce will be naturally reestablished.

# DETAILED DRILL HOLE LOG

SITE NO. 279 HOLE NO. C 920

DATE: MAR. 12, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:



| DEPTH (feet) | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | 0 |
| 1 | OL | ORGANIC SILT: clayey, low plastic, brown, pebbles | | Vx | L | | 1 |
| 2 | | 2.0 | | | | | 2 |
| 3 | SM | SAND: fine grained, silty, pebbles, organics, brown | | Nbn | | | 3 |
| 4 | | | | | | | 4 |
| 5 | | | | | | | 5 |
| 6 | | | | | | | 6 |
| 7 | | | | | | | 7 |
| 8 | | 8.0 | | | | | 8 |
| 9 | GM | GRAVEL: sandy, silty, brown, calcareous | | | | | 9 |
| 10 | | 10.0 END OF HOLE 10.0' (Sluffing) | | | | | 10 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 279 HOLE NO. C 921

DATE: MAR. 12, 1973 | LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | 0 |
| 1 | | SW | SAND: gravelly (fine), silty, rootlets, brown, calcareous, shalestone inclusions | | Nbn | | | 1 |
| 2 | | | 2.0 | | | | | 2 |
| 3 | | GP | GRAVEL: sandy, trace of silt, brown | | | | | 3 |
| 4 | | | | | | | | 4 |
| 5 | | | 5.0 END OF HOLE 5.0' | | | | | 5 |
| 6 | | | | | | | | 6 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

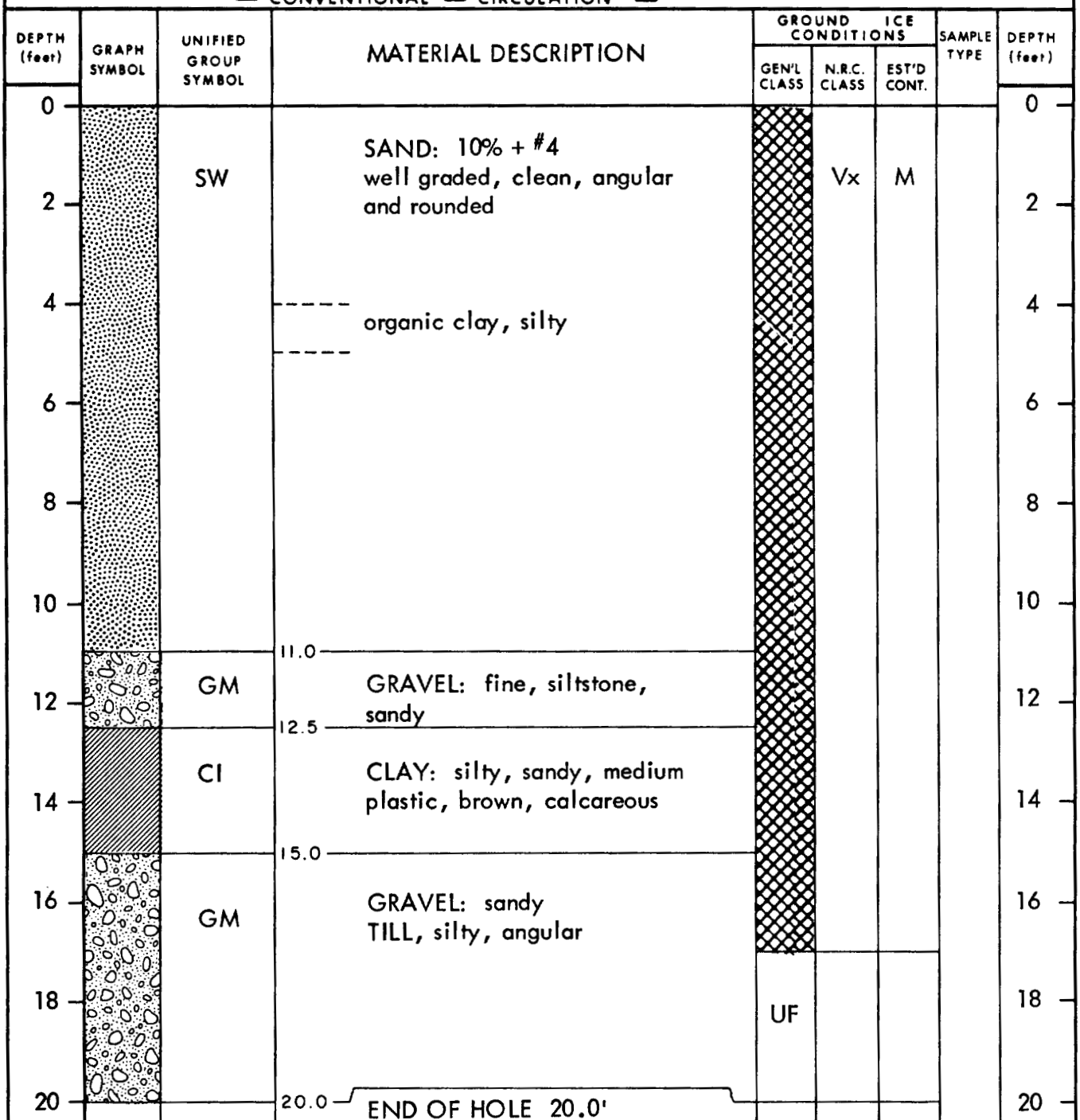
PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 279 HOLE NO. C 922

DATE: MAR. 12, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:




GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 279 HOLE NO. C 923

DATE: MAR. 12, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | GW | GRAVEL: well graded, slightly silty, angular and rounded | | Vx | M | | 0 |
| 2 | | | | | | | | 2 |
| 4 | | | - siltier | | | | | 4 |
| 6 | | SM | 6.0 SAND: silty, gravelly, organics, siltstones, low to medium plastic | | | | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | SM | 10.0 SAND: angular, silty | | | | | 10 |
| 12 | | | | | | | | 12 |
| 14 | | | | | | | | 14 |
| 16 | | | 15.0 END OF HOLE 15.0' | | | | | 16 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 279 HOLE NO. C 924

DATE: MAR. 12, 1973 | LOGGED BY: ☐ PEMCAN ☒ R. M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | 0 |
| | | CL | CLAY: silty, yellow brown, low to medium plastic | | Nbn | | | |
| 2 | | | | | | | | 2 |
| | | | 2.5 | | | | | |
| 4 | | GP | GRAVEL: angular and sub-rounded, poorly graded, 60% flat siltstone, black | | Vc | L | | 4 |
| 6 | | | | | | | | 6 |
| 8 | | | 8.0 | | | | | 8 |
| | | GC | GRAVEL: angular, sandy, slightly plastic, occasional interbedding of silt with trace of clay, mottled brown-black | | | | | |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 14 | | | | | | | | 14 |
| | | | 15.0 | | | | | |
| 16 | | | END OF HOLE 15.0' | | | | | 16 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

## SITE NO. 280

Located approximately 14 miles east of Norman Wells and 1¼ miles northeast of the proposed Mackenzie Highway at Mile 619, Site 280 consists of an alluvial fan deposit incised by the Francis Creek stream channel.

Type of Material: Sand and Gravel; little silt, well graded, medium grained.

Estimated Volume: 1,500,000 cubic yards.

Assessment: Good quality granular materials which are suitable for quality embankment fill and production of base course aggregates; Site 280 is recommended for development.


LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- ⊙ DH Drill Hole
- Required access
- Site limit
- Proposed Mackenzie Highway
- TP Test Pit

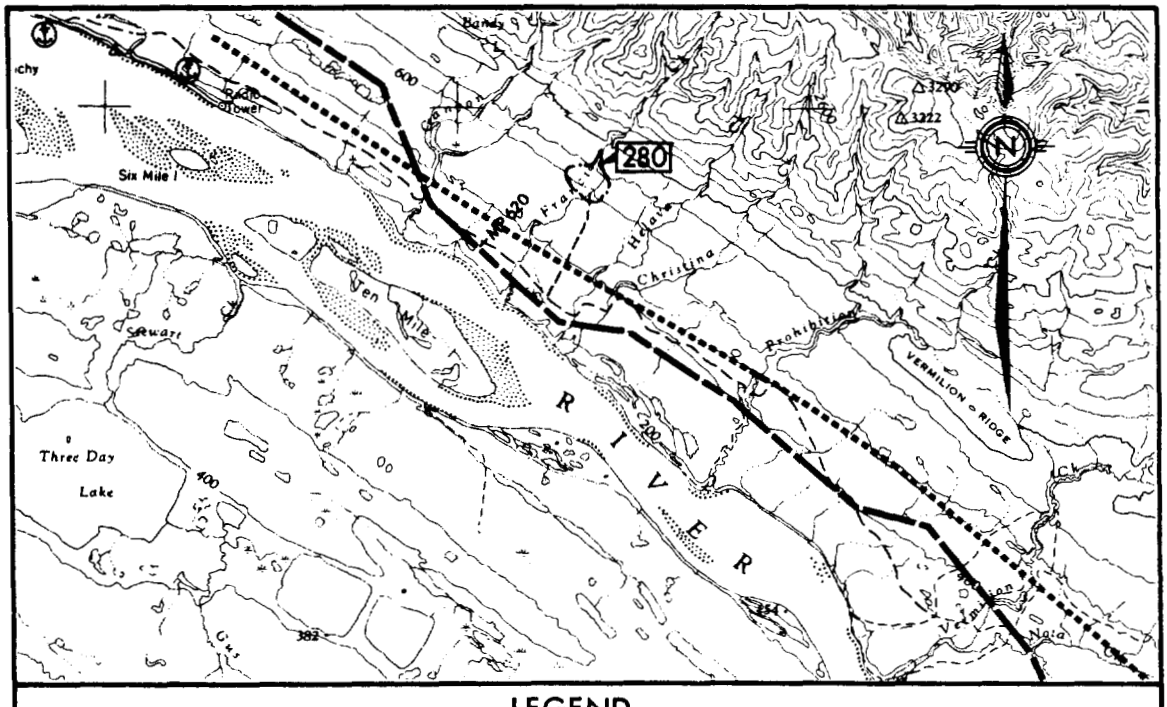
Airphoto No. A22934/96

Approximate scale: 1" = 3,000'

## ENVIRONMENT

Site 280 is located 14 miles east of Norman Wells and $1\frac{1}{4}$ miles northeast of the proposed Mackenzie Highway right-of-way at Mile 619. The site consists of an alluvial fan deposit which has been incised by the current stream channel of Francis Creek. The total fan area is approximately 5000 feet in length and 4500 feet in width, however, the apex of the fan which is currently in an active stage growth contains the coarser granular materials and is designated as zone "A" on the preceding site airphoto, Page 280-1. Zone "B" consists of the inactive peripheral downslope portion of the alluvial fan and is composed of fine grained soils. The site area and the immediately adjacent terrain exhibits good surficial drainage to the southwest into the active stream channel of Francis Creek.

The material in the active apex of the alluvial fan, designated as zone "A", consists of stratified, medium grained sand and gravel with a little silt which is suitable for good quality embankment fill material. The material in zone "B" consists of fine grained silts with a few small pockets of sand and gravel which is not considered suitable as granular fill material. The surficial layer of organic topsoil and peat in the apex of the fan which is generally less than 1 foot in depth, supports light to moderate growths of spruce, birch and poplar.




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- Required access
- Site limit
- Proposed Mackenzie Highway

Section of Map No. 96 E

Scale: 1:250,000

There are no known critical wildlife areas in the immediate vicinity of Site 280. Although potential spawning gravels exist in Francis Creek, the utilization of these gravels by fishery resources is likely minimized by the fact that the Creek normally dries up by mid-summer.

The only existing access to Site 280, on either side of the Francis Creek stream channel, from the CNT pole line or proposed Mackenzie Highway right-of-way consists of seismic cutlines and the access trails which were cleared during the winter drilling program.

## DEVELOPMENT

The exploratory test holes which were drilled on Site 280 during the winter field program showed the following conditions relative to the quality and quantity of available granular materials:

- Good quality granular materials were encountered only in the active apex of the alluvial fan which is designated as zone "A". These granular materials consist of stratified, medium grained, well graded sands and gravels with a little silt content. These sands and gravels are suitable for use as good quality embankment fill material, pit run aggregates and in the production of fair quality base course aggregates.

- The depth of the in situ gravel and sand strata may vary from a few feet to in excess of 20 feet. An average depth of 10 feet was utilized for estimating the volume of available granular materials.

- Soft shale bedrock was encountered only in drill hole DH-9, at a depth of 6 feet below existing ground surface.

- Ground water was encountered in drill hole DH-4 at a depth of 24 feet below the existing ground surface. This drill hole is located immediately adjacent to the southwest shoreline of Francis Creek.

- An estimated volume of 1,500,000 cubic yards of sand and gravel are considered available from zone "A" of Site 280. An area, approximately 3000 feet in length and 1500 feet in width, for zone "A" was utilized in estimating the quantity of available granular materials.

Site 280 is recommended for the development and exploitation of granular materials and the following guidelines should be considered in the development of borrow pit areas:

- Granular materials suitable for construction requirements are available only from zone "A" of the alluvial fan deposit in Site 280. Zone "B" does not contain materials suitable for granular material requirements.

- In view of the stratified nature of the in situ sands and gravels, vertical excavation of borrow pit areas should be considered for recovery of better sorted pit run aggregates. In addition, if careful and selective excavating procedures are utilized in the

development of borrow pits, then the pockets or layers of better quality gravels could be exploited for the production of base and surface course aggregates.

- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.

- The thin veneer of organic topsoil and peat should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.

- Relative to granular deposits immediately adjacent to the east and west sides of Francis Creek, the development procedures should be commenced at the source area farthest removed from the water course. A buffer zone of adequate width should be maintained between the stream and the final limits of the borrow pit.

- Operating procedures during borrow pit development should be maintained whereby surficial waste materials do not drain to the active Francis Creek stream channel.

## ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the pit area to provide general drainage compatible with the natural drainage of the adjacent terrain.

- Replacing stockpiled surficial waste material on the abandoned borrow pit areas.

- Reseeding of the recontoured pit areas may be considered although existing cutlines in the area indicate that understory growth and eventually spruce will be naturally reestablished.

# DETAILED DRILL HOLE LOG

SITE NO. 280 HOLE NO. DH-1

DATE: DEC. 15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | PEAT: organic, fibrous, muskeg | | | | | 0 |
| 1.0 | | | | | | | | |
| 2 | | ML-CL | SILT: some clay, light brown | | Vs | L | | 2 |
| 4 | | | | | | | MC GS | 4 |
| 4.0 | | | | | | | | |
| 6 | | GW-SW | GRAVEL AND SAND: trace silt, medium to coarse grained, well graded, frequent pebbles of limestone and quartzite with angular shale fragments, maximum size 1", brown | | N | | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 10.0 | | | | | | | | |
| 12 | | MH | SILT: trace sand, frequent shale fragments, occasional limestone pebbles to $\frac{1}{2}$" size, grey | | Vx Vs | M | MC | 12 |
| 14 | | | | | | | | 14 |
| 14.0 | | | TOTAL DEPTH 14.0' | | | | | |
| 16 | | | | | | | | 16 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 280 HOLE NO. DH-2

DATE: DEC. 15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: some silt, organic, roots, light brown | | | | | 0 |
| 0.2 | | | | | | | | |
| 1 | | | | | | | | 1 |
| 2 | | GM | GRAVEL: little silt, trace sand, angular to subangular fragments of shale, rounded pebbles of limestone and quartzite to 1" size, greyish brown | | | | | 2 |
| 3 | | | | | | | | 3 |
| 4 | | | | | | | | 4 |
| 5 | | | | | | | | 5 |
| 6 | | | | UF | | | | 6 |
| 6.0 | | | | | | | | |
| 7 | | SM | SAND: little silt, medium to coarse grained, few rounded pebbles to $\frac{1}{4}$" size, dry, medium brown | | | | | 7 |
| 8 | | | | | | | | 8 |
| 9 | | | | | | | | 9 |
| 9.8 | | | | | | | | |
| 10 | | | TOTAL DEPTH 9.8' | | | | | 10 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 280 HOLE NO. DH-3

DATE: DEC. 14, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS | | | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| | | | | GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | | |
| 0 | | Pt | PEAT: organic, fibrous, muskeg | | N | M | | 0 |
| 0.5 | | | | | | | | |
| 2 | | GW | GRAVEL: some sand, trace silt, medium to coarse grained, well graded, frequent shale fragments, pebbles to 1" size, occasional cobbles and boulders, medium brown | UF | | | GS | 2 |
| 4 | | | - water seepage at 5.0' | | | | | 4 |
| 6 | | | | | | | | 6 |
| 8 | | | | | | | GS | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 13.0 | | | TOTAL DEPTH 13.0' | | | | | |
| 14 | | | | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 280 HOLE NO. DH-4

DATE: DEC. 14, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | PEAT: organic, fibrous, muskeg | | | | | 0 |
| 0.5 | | | | | | | | |
| 3 | | GW-GM | GRAVEL, SAND AND SILT: fine to coarse grained, well graded, pebbles to 3/4" size, predominantly limestone and dolomite with shale fragments, frequent cobbles and boulders | | Vx | M | | 3 |
| 6 | | | | | | | MC GS P | 6 |
| 8.0 | | | | | | | | |
| 9 | | SW-SM | SAND: some silt, well graded, pebbles to 3/4" size, medium brown | | | | | 9 |
| 12 | | | | | | | MC | 12 |
| 15 | | | - pockets of coarse gravel at 15.0' | | N | L | | 15 |
| 18 | | | | | | | MC | 18 |
| 19.0 | | | | | | | | |
| 21 | | GM | GRAVEL: some silt, little sand, pebbles to 1" size, medium brown | UF | | | | 21 |
| 24 | | | ▼ | | | | | 24 |
| 25.0 | | | | | | | GS | |
| 27 | | | TOTAL DEPTH 25.0' | | | | | 27 |

GOVERNMENT OF CANADA
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AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 280 HOLE NO. DH-5

DATE: DEC. 16, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS | | | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| | | | | GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | | |
| 0 | | OL | TOPSOIL: some silt, organic, roots, dark brown | | Vx | M | | 0 |
| 0.6 | | | | | | | | |
| 2 | | GM | GRAVEL: little silt, trace sand, flat-flaky shale fragments, few limestone and quartzite pebbles, subangular and subrounded, to 1½" size, medium brown | | | | | 2 |
| 4 | | | | | | | | 4 |
| 6 | | | | UF | | | | 6 |
| 6.0 | | | | | | | | |
| 8 | | SM | SAND: some silt, medium grained, few pebbles to 1" size, cobbles and boulders from 10.0', high silt content, fine to medium grained, occasional pebbles to ¼", greyish brown, dry | | | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 14 | | | | | | | | 14 |
| 14.0 | | | TOTAL DEPTH 14.0' | | | | | |
| 16 | | | | | | | | 16 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 280 HOLE NO. DH-6

DATE: DEC. 15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: some silt, organic, roots, brown | | | | | 0 |
| 1.5 | | | | | | | | |
| 2 | | ML | SILT: trace sand, brown | | | | | 2 |
| 4 | | | | | | | | 4 |
| 6 | | ML-GM | - some gravel, little sand, occasional clay pockets, pebbles to 1½" size, predominantly limestone, occasional shale fragments, brown | | Vx | L | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | ML | - little sand, rounded limestone and quartzite pebbles to 1½" size, brown | | | | | 10 |
| 12 | | | | | | | | 12 |
| 12.0 | | | TOTAL DEPTH 12.0' | | | | | |
| 14 | | | | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 280 HOLE NO. DH-7

DATE: DEC. 15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | PEAT: organic, roots, fibrous, black | | Vr | M | | 0 |
| 1.5 | | | | | | | | |
| 2 | | | SILT: trace sand, few pebbles to ½" size, brown | | | | | 2 |
| 4 | | | | | | | | 4 |
| 6 | | ML | - more pebbles and frequent angular shale fragments from 6.0' | | Vx | L | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | MH | - some clay, dark grey | | | | | 10 |
| 11.0 | | | TOTAL DEPTH 11.0' | | | | | |
| 12 | | | | | | | | 12 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 280 HOLE NO. DH-8

DATE: DEC.15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: some silt, organic, dark brown | | | | | 0 |
| 1.5 | | | | | | | | |
| 2 | | | SILT: some sand, trace gravel, fine grained, few angular shale fragments to 1" size, rounded, light brown | | | | | 2 |
| 4 | | | | | | | | 4 |
| 6 | | ML-GM | | | | | | 6 |
| 8 | | | | | Vx | L | | 8 |
| 10 | | ML | little sand, occasional clay pockets few pebbles to $\frac{1}{4}$" size, brown | | | | | 10 |
| 12 | | | | | | | | 12 |
| 12.0 | | | TOTAL DEPTH 12.0' | | | | | |
| 14 | | | | | | | | 14 |

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AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 280 HOLE NO. DH-9

DATE: DEC.15,1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: some silt, organic | | Vr | M | | 0 |
| 1 | | | 1.0 | | | | | 1 |
| 2 | | GW-GM | GRAVEL: little sand, trace silt, fine to coarse grained, predominantly flat angular shale fragments, some limestone and quartzite pebbles to 2" size, grey | | | L | GS | 2 |
| 3 | | | | | | | | 3 |
| 4 | | | becoming high in silt content from 5.0' | | | | | 4 |
| 5 | | | | | | | | 5 |
| 6 | | | 6.0 BEDROCK: shale, weathered, soft grey | | | | MC | 6 |
| 7 | | | 6.5 TOTAL DEPTH 6.5' | | | | | 7 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 280 HOLE NO. DH-10

DATE: DEC.15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: some silt, organic, roots, dark brown | | | | | 0 |
| 0.8 | | | | | | | | |
| 2 | | | GRAVEL AND SAND: little silt, fine to coarse grained, predominantly angular to subangular shale fragments with limestone pebbles to 1" size, grey | | | | MC | 2 |
| 4 | | | | | Vx | M | | 4 |
| 6 | | GW-GM | | | | | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | GS | 10 |
| 12 | | | ---- few clay pockets from 12' | UF | | | | 12 |
| 14 | | | | | | | | 14 |
| 16 | | | | | | | | 16 |
| 16.0 | | | | | | | | |
| | | ML | SILT: some clay, few rounded pebbles to $\frac{1}{2}$" size | | | | | |
| 16.5 | | | TOTAL DEPTH 16.5' | | | | | |
| 18 | | | | | | | | 18 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 280 HOLE NO. DH-11

DATE: DEC. 15, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | 0 |
| 3 | | GW-GM | GRAVEL: some sand, little silt, fine to coarse grained, well graded, frequent pebbles to 3/4" size, numerous cobbles and boulders, few shale fragments | | | L | | 3 |
| 6 | | | | | | | MC GS | 6 |
| 7.0 | | | | | | | | |
| 9 | | ML | SILT: some sand, frequent pebbles to ½" size, medium brown | | Vs | | | 9 |
| 10.0 | | | | | | | | |
| 12 | | | GRAVEL: some sand, little silt, well graded, frequent pebbles, with shale fragments to 3/4" size, cobbles and boulders, medium brown | | N | M | MC | 12 |
| 15 | | | | | | | | 15 |
| 18 | | GW-GM | | | | | | 18 |
| 21 | | | | | | L-M | MC | 21 |
| 24 | | | | | | | | 24 |
| 27 | | | | | | | MC | 27 |
| 27.0 | | | TOTAL DEPTH 27.0' | | | | | |
| 30 | | | | | | | | 30 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

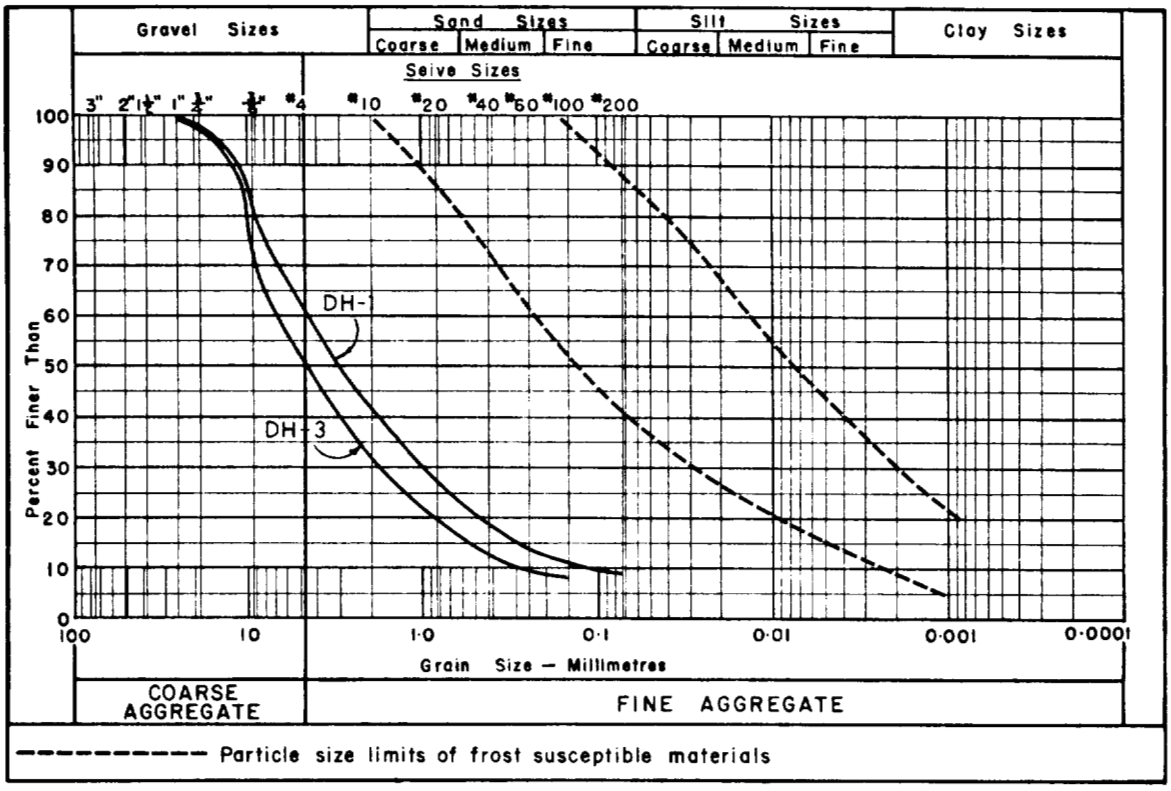
GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

## SUMMARY OF LABORATORY TEST DATA

| Sample Location: | 280/DH-1 | 280/DH-3 |
|---|---|---|
| Sample Depth (Feet): | 4 | 1 - 4 |
| Moisture Content (%): | 9.2% | - |
| Ice Content (%): | - | - |
| Organic Content (%): | - | - |

GRAIN SIZE DISTRIBUTION:

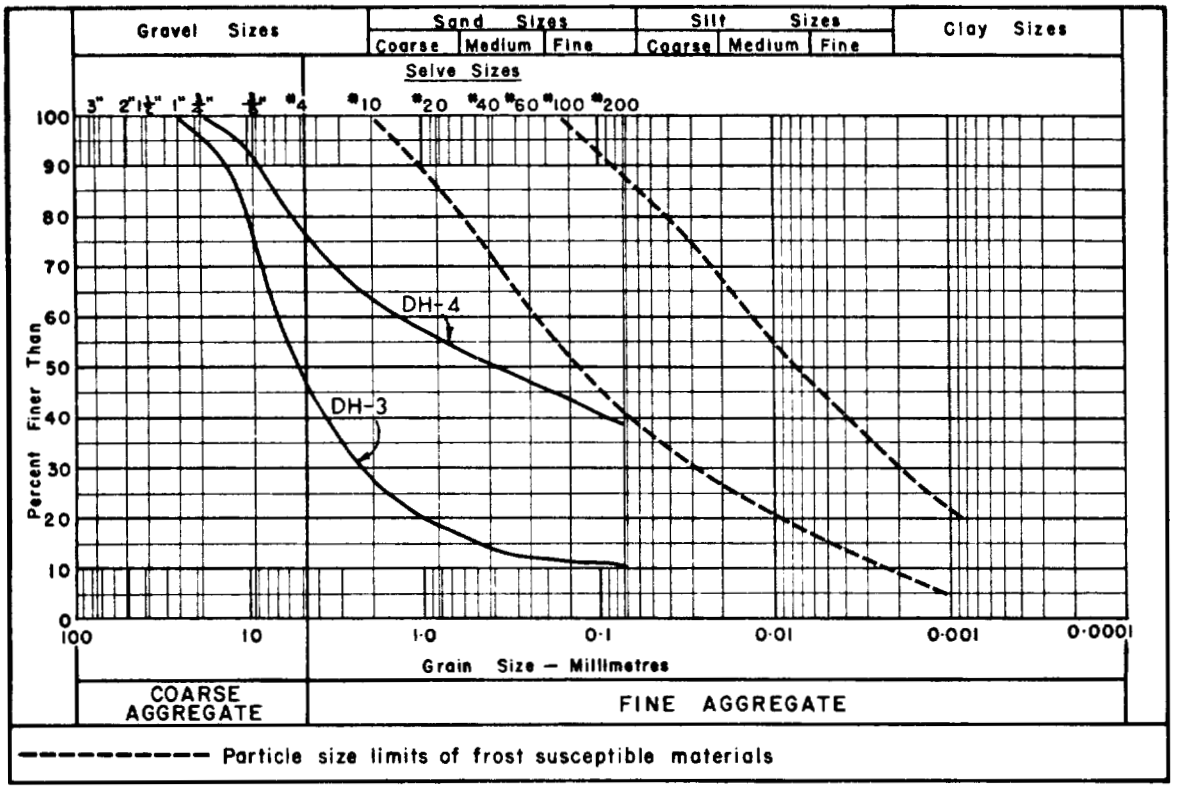



PETROGRAPHIC ANALYSIS:

## SUMMARY OF LABORATORY TEST DATA

| Sample Location: | 280/DH-3 | 280/DH-4 |
|---|---|---|
| Sample Depth (Feet): | 8 - 10 | 6.0 |
| Moisture Content (%): | - | 17.7 |
| Ice Content (%): | - | - |
| Organic Content (%): | - | - |

GRAIN SIZE DISTRIBUTION:



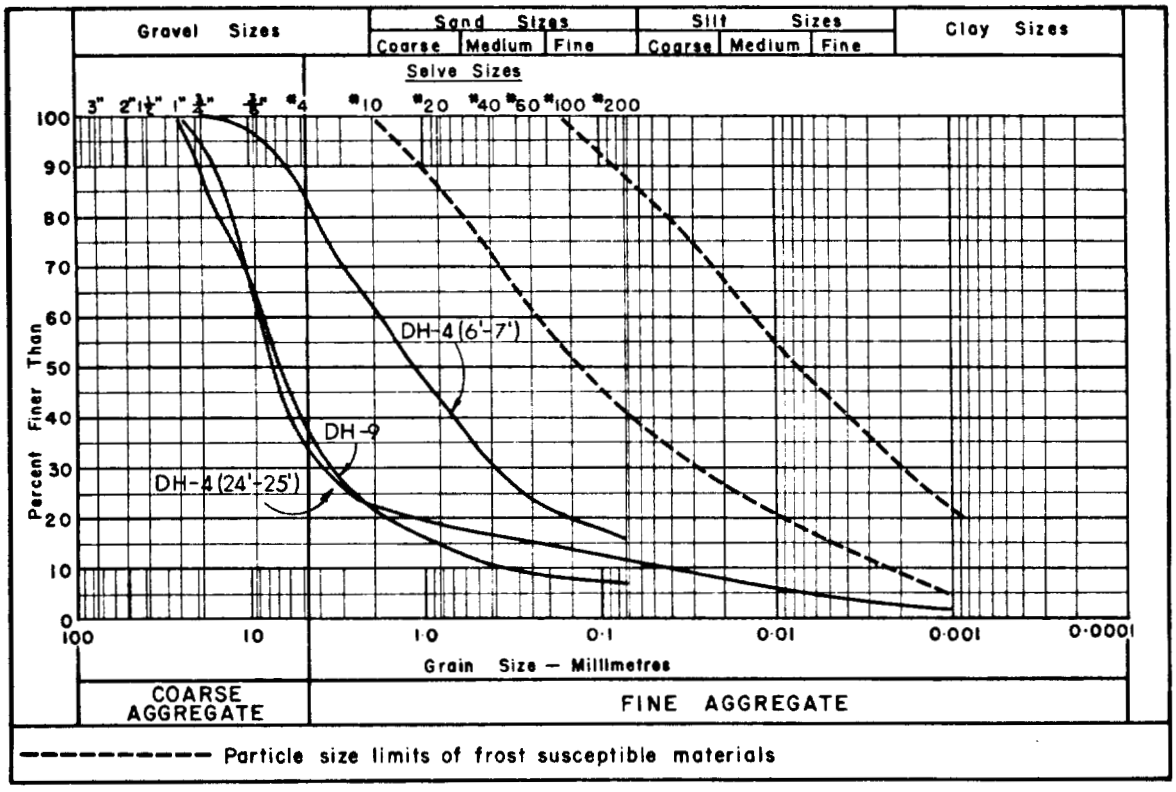

PETROGRAPHIC ANALYSIS: (280/DH-4 @ 6.0')

| | | Deteterious | |
|---|---|---|---|
| Limestone and dolomite | 50.4% | Shale | 34.8% |
| Quartzite (Sound) | 3.3% | Ferruginous Sandstone and Ironstone | 8.7% |
| Igneous | 2.2% | | |
| Chert | 0.6% | | |

## SUMMARY OF LABORATORY TEST DATA

| Sample Location: | 280/DH-4 | 280/DH 4 | 280/DH 9 |
|---|---|---|---|
| Sample Depth (Feet): | 6 - 7 | 24.0 - 25.0 | 3.0 |
| Moisture Content (%): | - | - | - |
| Ice Content (%): | - | - | - |
| Organic Content (%): | - | - | - |

GRAIN SIZE DISTRIBUTION:

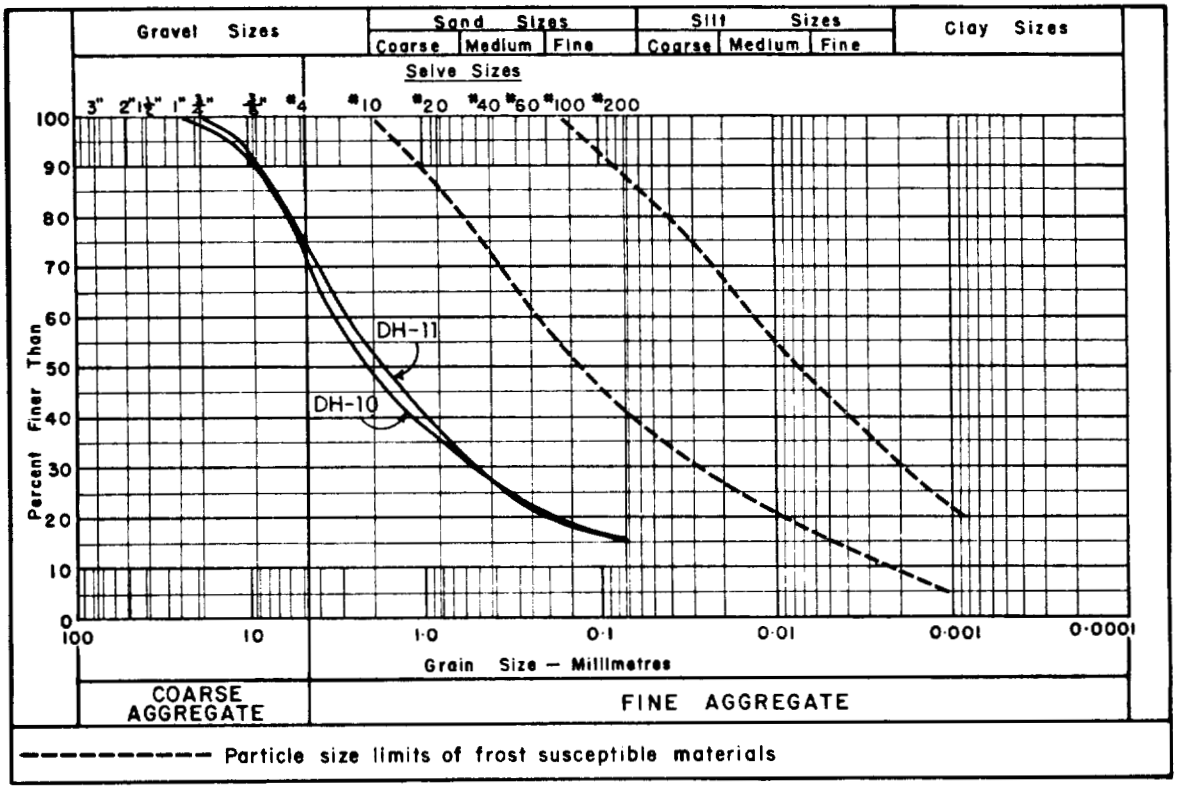



PETROGRAPHIC ANALYSIS:

## SUMMARY OF LABORATORY TEST DATA

| | | |
|---|---|---|
| Sample Location: | 280/DH-10 | 280/DH-11 |
| Sample Depth (Feet): | 10 | 5 - 6 |
| Moisture Content (%): | - | 6.4 |
| Ice Content (%): | - | -- |
| Organic Content (%): | - | -- |

GRAIN SIZE DISTRIBUTION:




PETROGRAPHIC ANALYSIS:

## SUMMARY OF MOISTURE CONTENT DETERMINATIONS

| Sample Location | Sample Depth (Ft.) | Moisture Content (%) |
|---|---|---|
| 280/DH-1 | 12.0 | 27.7 |
| 280/DH-4 | 11.0 | 8.0 |
| 280/DH-4 | 17.0 | 10.4 |
| 280/DH-9 | 5.5 | 6.9 |
| 280/DH-10 | 2.5 | 13.4 |
| 280/DH-11 | 10.0 - 12.0 | 14.1 |
| 280/DH-11 | 19.0 - 21.0 | 8.9 |
| 280/DH-11 | 27.0 | 12.2 |

## SITE NO. 281

Located approximately 12 to 14 miles east of Norman Wells and $2\frac{1}{4}$ miles northeast of the proposed Mackenzie Highway at Mile 620, Site 281 consists of a series of partially effaced kame hillocks and terraces.

Type of Material: Sand and Gravel; some silt, variable gradation, stratified.

Estimated Volume: 2,000,000 cubic yards.

Assessment: Good quality granular materials which are suitable in the pit run condition for quality general fill and in the production of base course aggregates; Site 281 is recommended for development.

LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- ⊙ DH Drill Hole
- Required access
- Site limit
- Proposed Mackenzie Highway
- ⊕ TP Test Pit

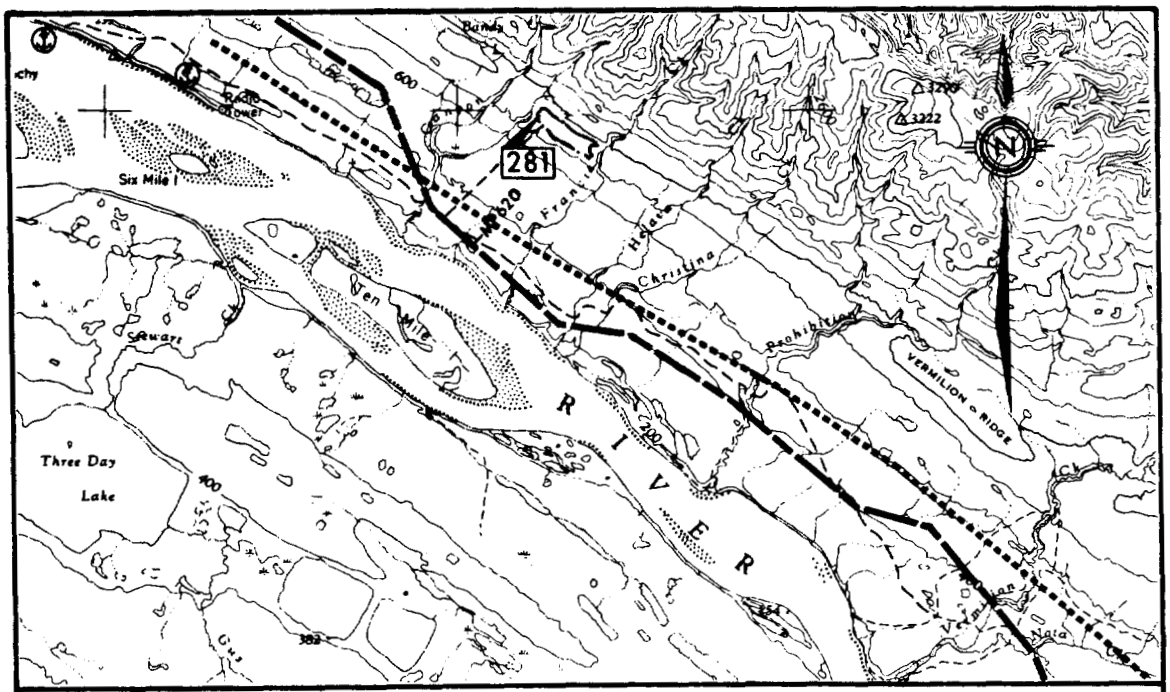
Airphoto No. A22934/96

Approximate scale: 1" = 3,000'

## ENVIRONMENT

Site 281 is located 12 to 14 miles east of Norman Wells and $2\frac{1}{4}$ miles northeast of the proposed Mackenzie Highway right-of-way at Mile 620. The site is situated on a terrace or bench which is orientated parallel to the rugged McConnell Range to the northeast and is slightly elevated above the adjacent glaciolacustrine plain to the southwest. Site 281 consists of a series of partially effaced kame hillocks and terraces which encompass an area extending from the southwest bank of Francis Creek to the northeast bank of Canyon Creek. The site area which is approximately $1\frac{1}{2}$ miles in length and a $\frac{1}{4}$ mile in width, exhibits good surficial drainage to the southwest.

The material in the kame and terrace deposits is highly variable but, generally, consists of stratified and pocketed deposits of sand and gravel of varying gradation and relatively high silt content. The presence of deleterious shale fragments in these gravel deposits is quite significant. Grey shale bedrock underlies these gravel deposits at depth; an organic topsoil layer, generally less than 1 foot in depth, overlies the entire site area and supports moderately dense growths of spruce, birch and poplar. The understory growth is relatively sparse. The terrain immediately adjacent to the southwest exhibits partial thermo-




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- Required access
- Site limit
- Proposed Mackenzie Highway

Section of Map No. 96 E

Scale: 1:250,000

karst features characterized by a series of small shallow ponds and muskeg bogs which parallel the southwest perimeter of Site 281 at the base of the ridge.

There are no known critical wildlife areas in the immediate vicinity of Site 281. Both Canyon Creek and Francis Creek contain considerable volumes of potential spawning gravels; however, these are likely not utilized by fishery resources since both streams dry up during the summer.

The only existing access to the site area from the CNT pole line and the proposed Mackenzie Highway right-of-way consists of a seismic cutline and the access trails which were cleared to and across the site area during the winter drilling program. In part, any future access to Site 281 will traverse terrain conditions which are sensitive to thermal erosion if the insulative vegetation cover is excessively disturbed.

## DEVELOPMENT

The exploratory drilling which was conducted during the winter field program showed the following conditions relative to the quality and quantity of available granular materials in Site 281:

- Good quality granular materials consisting of stratified and pocketed deposits of fine to medium grained gravels and coarse sands of highly variable gradation and varying silt content. These sands and gravels are suitable for use as good quality embankment fill material, production of base course aggregates and pit run aggregates. The relatively high content of deleterious shale fragments, generally negates the use of these gravels and sands for the production of concrete aggregates.

- The depth of the in situ gravel deposit varies from 5 to 15 feet; therefore, an average depth of 10 feet has been utilized in evaluating the volume of available granular materials.

- The overburden material consisting of topsoil and organic silt is generally less than 1 foot in depth.

- An estimated volume of 2,000,000 cubic yards of sand and gravel is considered recoverable from Site 281.

Site 281 is recommended for the development and exploitation of granular materials and the following operational guidelines should be considered in the development of borrow pit areas:

- In view of the relatively variable quality and scattered nature of the available granular materials, Site 281 should be considered essentially for pit run aggregates to be utilized in building pads, roads and airstrip subbase construction. However, if careful and selective excavating procedures are utilized during the development of borrow pits, then the pockets or layers of better quality gravels may be exploited for use

in production of base and surface course aggregates.

- The various kame hillocks and terraces should be further investigated, prior to development, by probing at closer intervals with shallow test pits or drill holes to more specifically delineate and assess the quantity of available granular materials.

- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use regulations.

- The thin veneer of organic topsoil and silt should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.

- Relative to granular deposits immediately adjacent to the northeast side of Canyon Creek or the southwest side of Francis Creek, the development procedures should be commenced at the source area farthest removed from the water courses. A buffer zone of adequate width should be maintained between the stream channels and the final limits of the borrow pit areas.

- Operating procedures during borrow pit development should be maintained whereby surficial waste materials do not drain into the active Canyon Creek or Francis Creek stream channels.

- The construction of adequate access roads of sufficient standards to traverse the thermally sensitive terrain conditions to the southwest of the site area will have to be undertaken if extensive quantities of granular materials are to be exploited.

## ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

- Recontouring of the borrow pit areas to provide general drainage compatible with the natural drainage of the adjacent terrain.

- Replacing stockpiled surficial waste material on the abandoned borrow pit areas.

- Reseeding of the recontoured borrow pit areas may be considered although existing seismic cutlines in the area indicate that the understory growth and eventually spruce will be naturally reestablished.

# DETAILED DRILL HOLE LOG

SITE NO. 281 HOLE NO. DH-1

DATE: DEC. 14, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: some silt, organic, roots, medium brown | | | | | 0 |
| 0.7 | | ML | SILT: trace sand, light to medium brown | | | | | |
| 1.5 | | GW | GRAVEL: trace sand and silt, well graded, medium to coarse grained, predominantly angular fragments of flaky shale, limestone and dolomite, maximum size 1½", few subangular and rounded pebbles, grey | | Vx | L | MC GS | 3, 6, 9, 12, 15 |
| 18 | | GM | - 4' thick layer with high silt content | | | | | 18 |
| 21 | | GW | | | | | MC | 21, 24 |
| 27.0 | | | BEDROCK: shale, fresh, hard | | N | | | 27 |
| 28.0 | | | TOTAL DEPTH 28.0' | | | | | 30 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

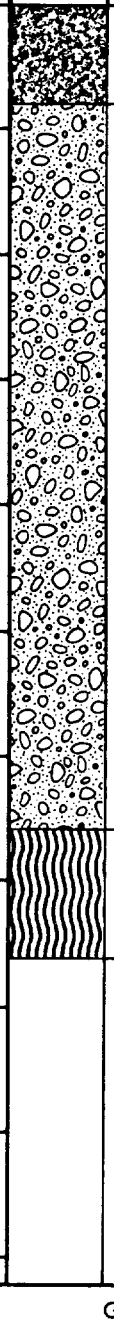
PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 281 HOLE NO. DH-2

DATE: DEC. 14, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:



| DEPTH (feet) | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|
| 0 | OL | TOPSOIL: some silt, organic, roots, dark brown | | Vx | M | | 0 |
| 0.8 | | | | | | | |
| 1 | GM-GW | GRAVEL: some silt, little sand, fine to coarse grained, well graded, pebbles subangular to subrounded, basically limestone and dolomite, angular, flaky fragments of shale, maximum size 1½", grey | | N | L | GS | 1 |
| 2 | | | | | | | 2 |
| 3 | | | | | | MC | 3 |
| 4 | | | | | | | 4 |
| 5 | | | | | | | 5 |
| 6 | | | | | | | 6 |
| 6.6 | | | | | | | |
| 7 | | BEDROCK: shale, fresh, hard, grey | | Nbn | L | | 7 |
| 7.6 | | TOTAL DEPTH 7.6' | | | | | |
| 8 | | | | | | | 8 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

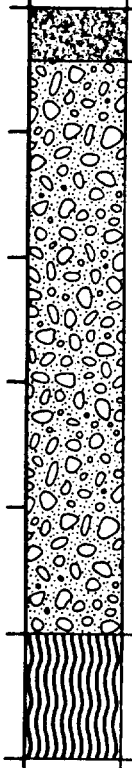
PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 281 HOLE NO. DH-3

DATE: DEC. 14, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:



| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: some silt, organic, fibrous, dark brown | | | | | 0 |
| 0.4 | | | | | | | | |
| 1 | | GM-GW | GRAVEL: little sand and silt, fine to coarse, well graded, predominantly limestone, and angular shale fragments, maximum $1\frac{1}{2}$" size, occasional granodiorite, quartzite and dolomite pebbles | | Vx | L | | 1 |
| 2 | | | | | | | | 2 |
| 3 | | | | | | | GS MC | 3 |
| 4 | | | | | | | | 4 |
| 5 | | | | | | | | 5 |
| 5.0 | | | BEDROCK: shale, hard, grey, recovered | | N | | | |
| 6 | | | | | | | | 6 |
| 6.0 | | | TOTAL DEPTH 6.0' | | | | | |
| 7 | | | | | | | | 7 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 281 HOLE NO. DH-4

DATE: DEC. 14, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: some silt, organic, root roots, fibrous, dark brown | | Vr / Vx | M | | 0 |
| 0.4 | | | | | | | | |
| 2 | | ML | SILT: some sand, few pebbles and cobbles, low plastic, medium brown | | | | | 2 |
| 1.5 | | | | | | | | |
| 4 | | | | | | | | 4 |
| 6 | | | BEDROCK: shale, finely laminated, soft, weathered, dark grey | | Nbn | L | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | MC | 10 |
| 11.0 | | | TOTAL DEPTH 11.0' | | | | | |
| 12 | | | | | | | | 12 |

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AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 281 HOLE NO. DH-5

DATE: DEC. 14, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: some silt, organic, fibrous, rootlets, black | | Vr | M | | 0 |
| 1.0 | | | | | Vx | | | |
| 2 | | GM | SILT AND GRAVEL: little sand, frequent shale, limestone and dolomite fragments, predominantly angular, few subangular to round | | | | | 2 |
| 3.0 | | | | | | | | |
| 4 | | | | | | | MC | 4 |
| 6 | | SW-GM | GRAVEL AND SAND: little silt, fine to coarse grained, well graded, few angular to subangular shale and limestone fragments to 1" size, occasional pebbles to 2" size, medium brown | | N | L | GS | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 12.0 | | | | | | | | |
| 14 | | SW-SM | SAND: some silt, little gravel, medium to coarse grained, well graded, pebbles to ½" size, medium brown, wet | UF | | | MC | 14 |
| 16 | | | | | | | | 16 |
| 17.0 | | | BEDROCK: shale, fresh, hard, grey | | | | | |
| 17.5 | | | TOTAL DEPTH 17.5' | | | | | 18 |
| 18 | | | | | | | | |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 281 HOLE NO. DH-6

DATE: DEC. 14, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS | | | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| | | | | GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | | |
| 0 | | OL | TOPSOIL: some silt, organic, fibrous, black | | Vr | M | | 0 |
| 1.5 | | | | | | | | |
| 2 | | ML | SILT: some sand, medium grained, few pebbles to 3/4" size, sub-angular | | Vx | L | | 2 |
| 4 | | | | | | | | 4 |
| 6 | | | | | | | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 13.0 | | | | | | | | |
| 14 | | GW-SW | GRAVEL AND SAND: medium to coarse grained, well graded, frequent pebbles to 3/4" size, medium brown | UF | | | MC GS | 14 |
| 16 | | | ▼ | | | | | 16 |
| 18 | | | | | | | MC | 18 |
| 20 | | | 20.0 TOTAL DEPTH 20.0' | | | | | 20 |

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AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 281 HOLE NO. DH-7

DATE: DEC. 14, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | 0 |
| 1 | | OL | TOPSOIL: some silt, organic, roots, dark brown | | Vr Vx | M | | 1 |
| 1.3 | | | | | | | | |
| 2 | | | SILT: some sand, medium grained, few pebbles to ½" size, low plastic | | | | | 2 |
| 3 | | ML | | | Vx | L | | 3 |
| 4 | | | | | | | | 4 |
| 5 | | | | | | | | 5 |
| 6 | | | | | | | | 6 |
| 6.0 | | | BEDROCK: shale, hard, grey | | N | | | |
| 7 | | | | | | | | 7 |
| 7.0 | | | TOTAL DEPTH 7.0' | | | | | |
| 8 | | | | | | | | 8 |

GOVERNMENT OF CANADA
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GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 281 HOLE NO. DH-8

DATE: DEC. 14, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS | | | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| | | | | GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | | |
| 0 | | OL | TOPSOIL: some silt, fibrous, roots, black | | Vr | M | | 0 |
| 1 | | | 1.0 | | | | | 1 |
| 2 | | GM | GRAVEL: little silt and sand, angular pebbles of shale, limestone and dolomite, few subangular to subrounded, maximum size 1½" | | Vx | L | | 2 |
| 3 | | | | | | | | 3 |
| 4 | | | | | | | | 4 |
| 5 | | | | | | | | 5 |
| 6 | | | 6.2 | | | | | 6 |
| | | | BEDROCK: shale, hard, light grey | | N | | | |
| 7 | | | 7.0 | | | | | 7 |
| | | | TOTAL DEPTH 7.0' | | | | | |
| 8 | | | | | | | | 8 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

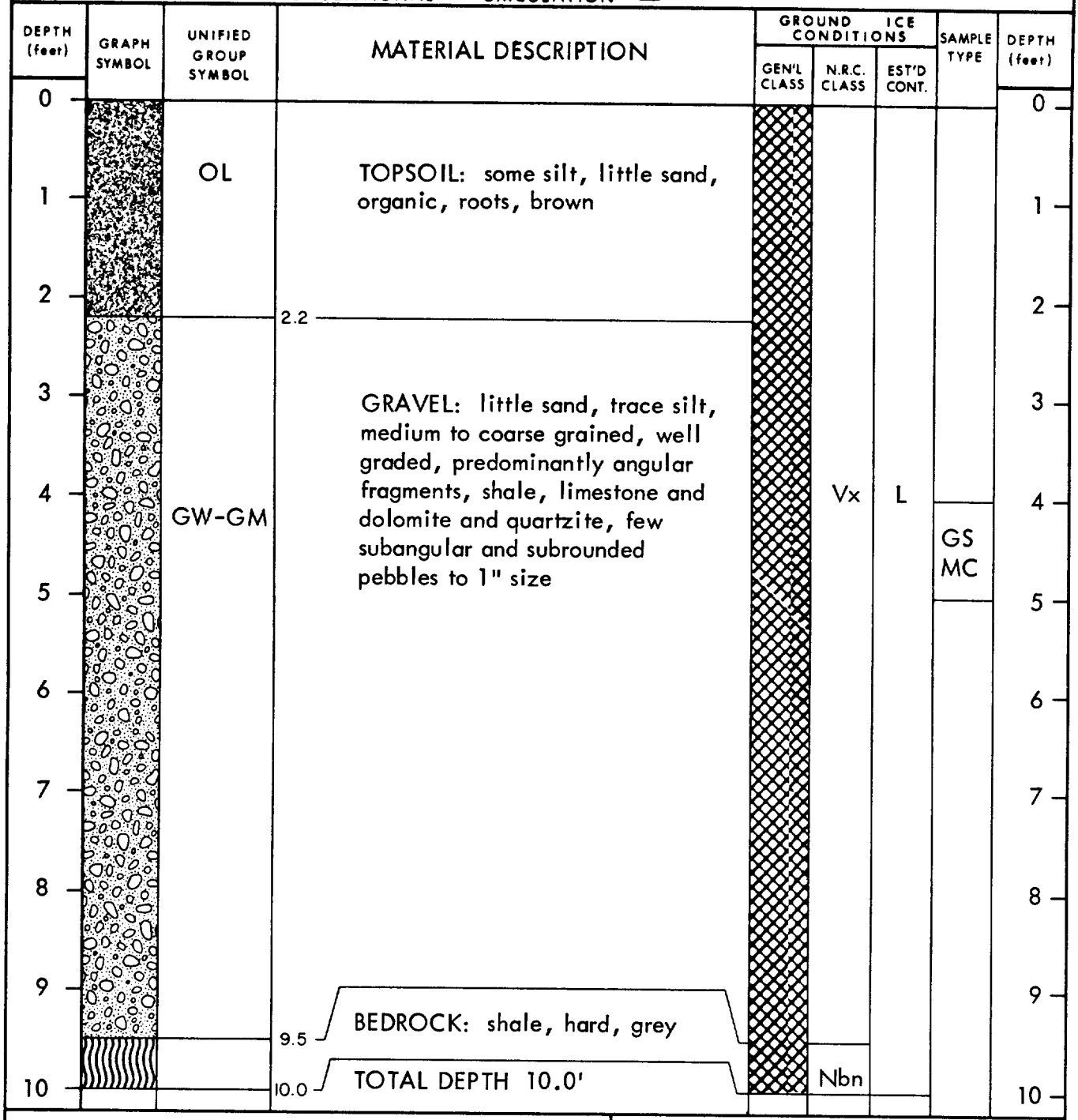
PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 281 HOLE NO. DH-9

DATE: DEC. 14, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

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DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

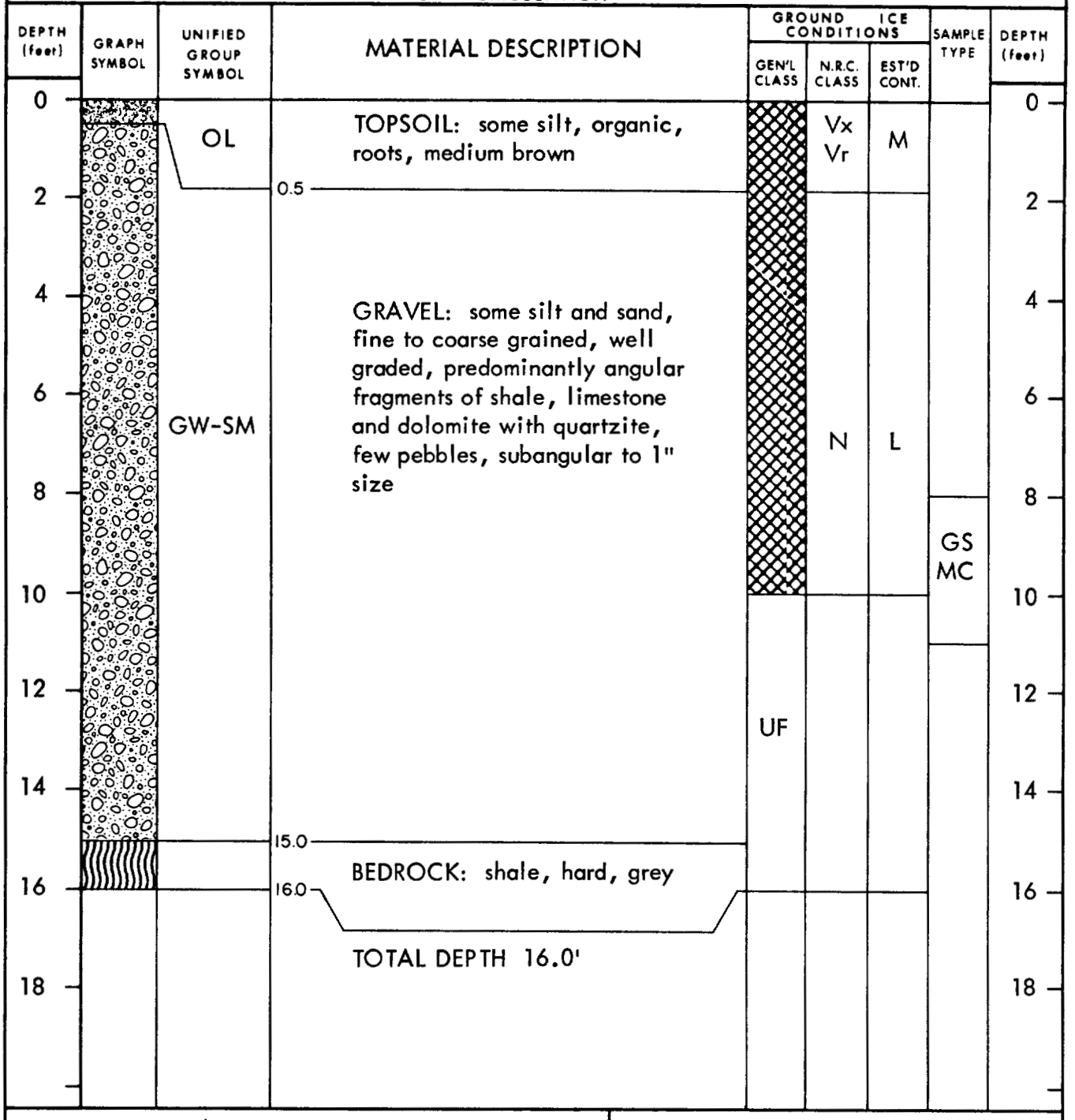
PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 281 HOLE NO. DH-10

DATE: DEC. 14, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:




GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

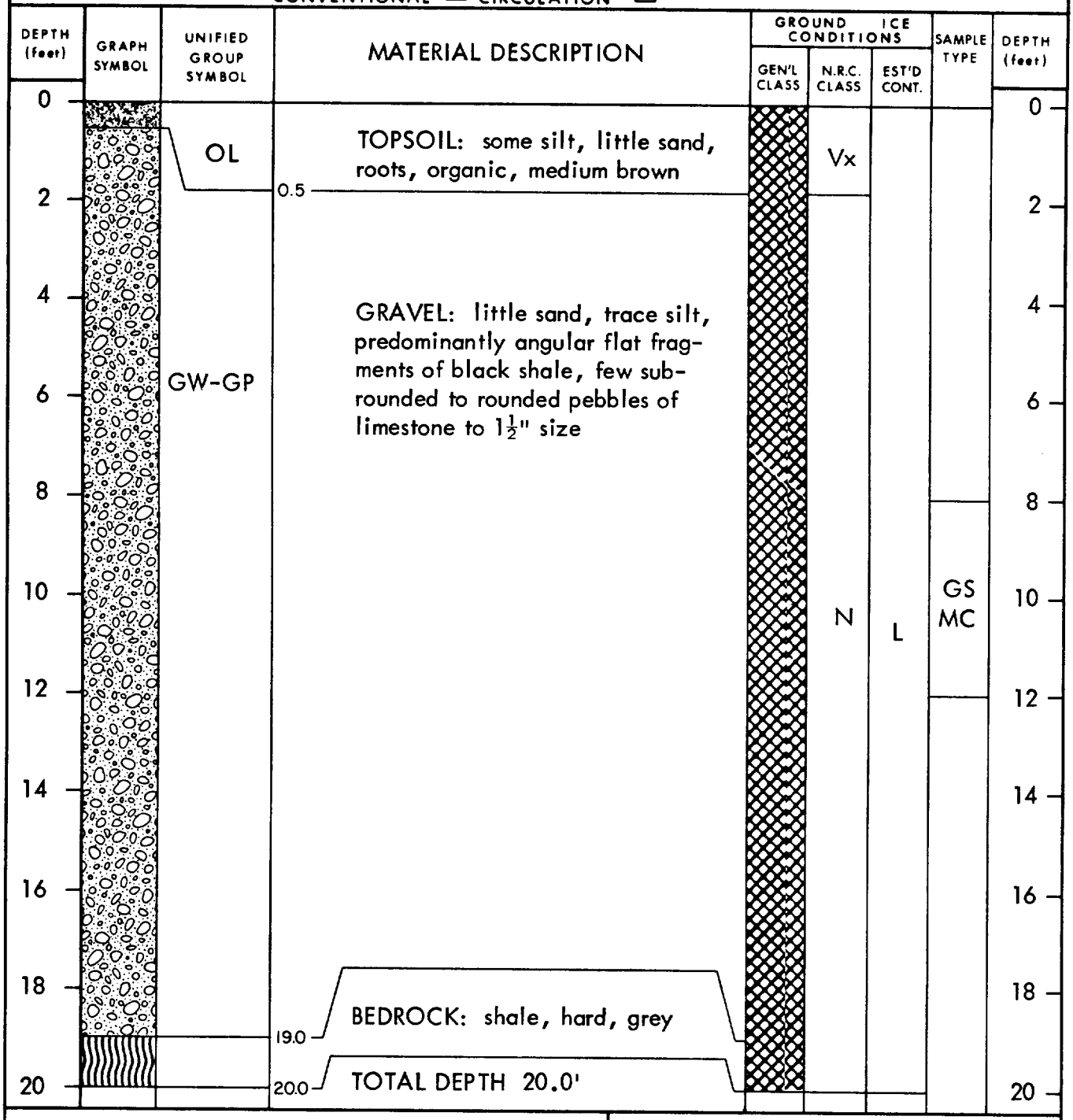
PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 281 HOLE NO. DH-11

DATE: DEC. 14, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:




GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

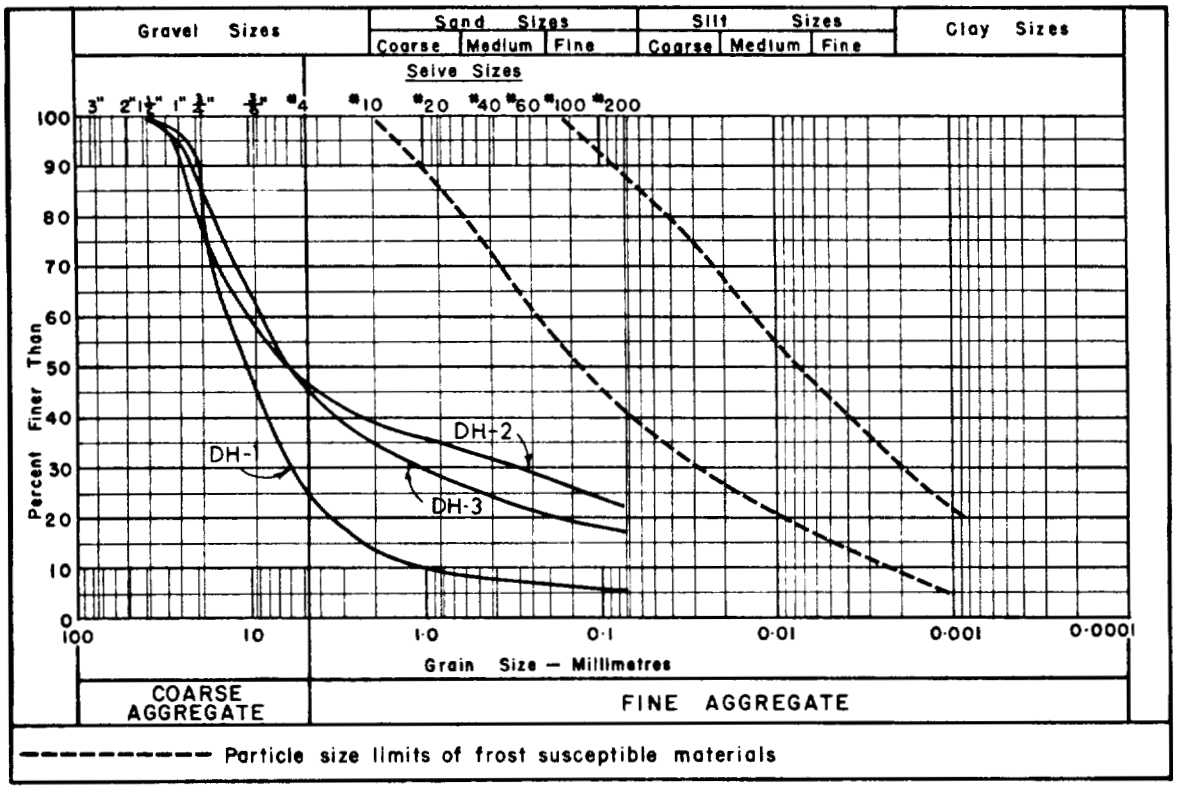
GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

## SUMMARY OF LABORATORY TEST DATA

| Sample Location: | 281/DH-1 | 281/DH-2 | 281/DH-3 |
|---|---|---|---|
| Sample Depth (Feet): | 8 - 11 | 1 - 3 | 2 - 5 |
| Moisture Content (%): | 8.4% | 11.6% | 10.2% |
| Ice Content (%): | - | - | - |
| Organic Content (%): | - | - | - |

GRAIN SIZE DISTRIBUTION:

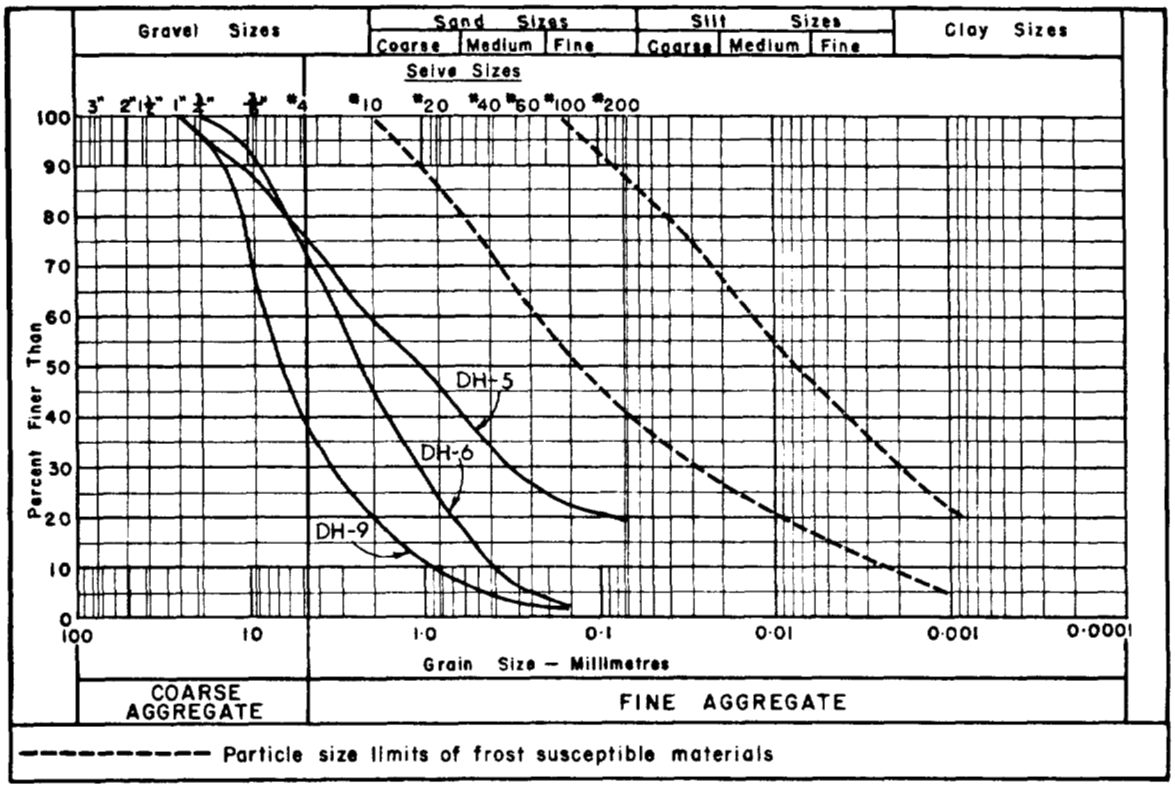



PETROGRAPHIC ANALYSIS:

## SUMMARY OF LABORATORY TEST DATA

| Sample Location: | 281/DH-5 | 281/DH-6 | 281/DH-9 |
|---|---|---|---|
| Sample Depth (Feet): | 3 - 8 | 13 - 16 | 4 - 5 |
| Moisture Content (%): | 9.6% | 6.1% | 6.9% |
| Ice Content (%): | - | - | - |
| Organic Content (%): | - | - | - |

GRAIN SIZE DISTRIBUTION:



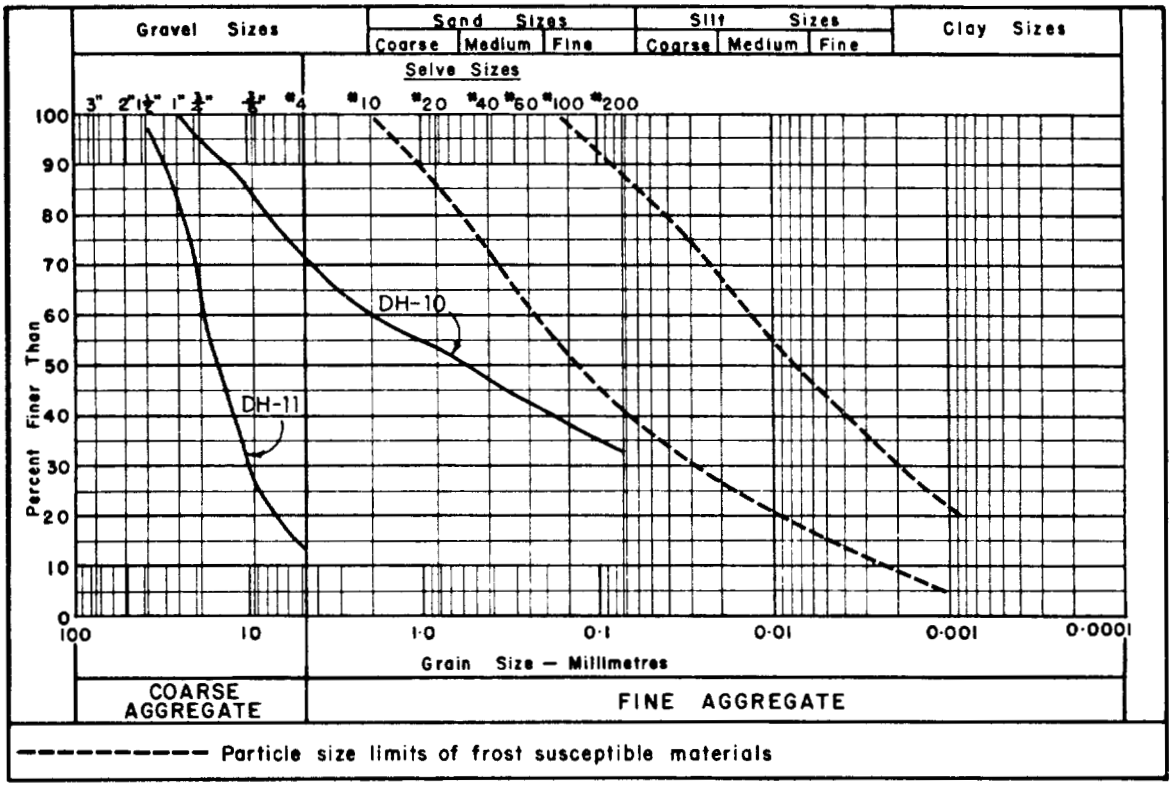

PETROGRAPHIC ANALYSIS: (281/DH-9 @ 4.0' - 5.0')

| | | | |
|---|---|---|---|
| Limestone and dolomite | 38.6% | Deteterious | |
| Quartzite (Sound) | 12.6% | Shale | 41.3% |
| Igneous | 5.1% | Siltstone and clay lumps | 1.0% |
| Cherts | 1.4% | | |

## SUMMARY OF LABORATORY TEST DATA

| | | |
|---|---|---|
| Sample Location: | 281/DH-10 | 281/DH-11 |
| Sample Depth (Feet): | 8.0 - 11.0 | 8.0 - 12.0 |
| Moisture Content (%): | 12.3 | 7.1 |
| Ice Content (%): | - | - |
| Organic Content (%): | - | |

GRAIN SIZE DISTRIBUTION:




PETROGRAPHIC ANALYSIS: (281/DH-11 @ 8.0' - 12.0')

| | | | |
|---|---|---|---|
| Limestone and dolomite | 23.4% | Deteterious | |
| Quartzite (Sound) | 6.0% | Shale | 59.7% |
| Igneous | 3.2% | Sandstone | 4.0% |
| Metamorphic (gneiss) | 2.6% | | |

## SUMMARY OF MOISTURE CONTENT DETERMINATIONS

| Sample Location | Sample Depth (Ft.) | Moisture Content (%) |
|---|---|---|
| 281/DH-1 | 24.0 - 25.0 | 8.8 |
| 281/DH-4 | 10.0 | 12.9 |
| 281/DH-5 | 13.0 | 20.9 |
| 281/DH-6 | 18.0 | 7.1 |

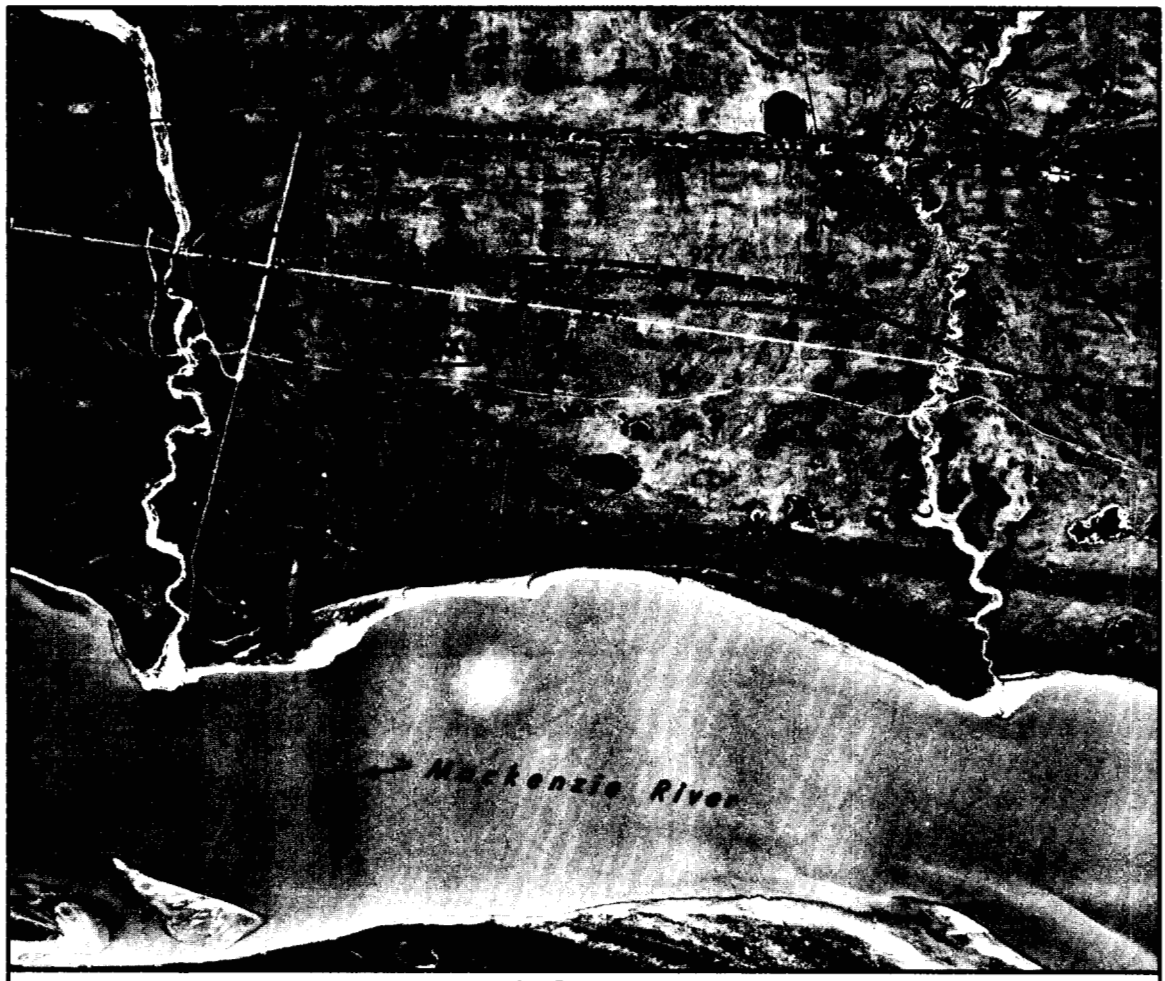
## SITE NO. 282X

Located 12 to 14 miles southeast of Norman Wells and adjacent to the proposed Mackenzie Highway from Mile 619 to Mile 621, Site 282X consists of two longitudinal and narrow beach ridge deposits.

Type of Material: Gravel, Sand and Silt; stratified, scattered.

Estimated Volume: Not determined.

Assessment: Site 282X is not recommended for development because the potential quantity of recoverable sand and gravel is very minimal and the foraging for these scattered pockets of shallow granular materials could result in extensive surficial disturbance to the site area.




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- ⊙ DH Drill Hole
- Required access
- Site limit
- Proposed Mackenzie Highway
- ⊕ TP Test Pit

Airphoto No. A22934/143

Approximate scale: 1" = 3,000'

## ENVIRONMENT

Site 282X is located 12 to 14 miles southeast of Norman Wells and is generally in the immediate vicinity of the proposed Mackenzie Highway right-of-way between Mile 619 and Mile 621. The site consists of two series of longitudinal and narrow beach ridges situated between the southwest bank of Francis Creek and the northeast bank of Canyon Creek. The beach ridge formations are approximately 1½ miles in length, 500 feet in width and are only slightly elevated above the adjacent flat terrain. The site area and adjacent terrain exhibit poor to fair surficial drainage into the adjacent stream channels.

The material in the beach ridges consists of stratified sands, silts and gravels. The layers of sand and gravel are generally less than 2 feet in thickness and are widely scattered. Glacial till is encountered beneath the beach ridge materials at a depth ranging from 2 to 10 feet below existing ground surface. The organic topsoil layer, generally less than 1 foot in depth, supports light to moderate growths of spruce and birch attaining heights to 30 feet and trunk diameters to 8 inches. The understory growth is relatively light and consists mainly of grasses and small bush.

There are no known critical wildlife areas in the immediate vicinity of Site 282X.

The existing and future access to the beach ridge deposits is good as both the CNT pole line and the proposed gas pipeline route traverse the entire length of the northern beach ridge; the southern ridge is traversed by the proposed Mackenzie Highway right-of-way.

## DEVELOPMENT

The exploratory test pits and drill holes which were carried out on Site 282X by PEMCAN and the consultant for The Federal Department of Public Works showed the following conditions relative to the quality and quantity of available granular materials:

- The beach ridge consists of stratified sand, silt and gravel in very thin layers. Glacial till underlies the beach ridge materials at a very shallow depth, ranging from 2 to 20 feet below existing ground surface.

- The layers and pockets of sand and gravel are widely scattered and represent a very minimal quantity of granular materials. The concentration of sand and gravel pockets are in the beach ridge areas immediately adjacent to the Francis Creek and Canyon Creek stream channels.

- The overburden material, consisting primarily of topsoil and inorganic silt, is less than 2½ feet in thickness in areas where the stratified sands and gravels were encountered.

- The depth of recoverable sand and gravel is generally less than 2 feet.

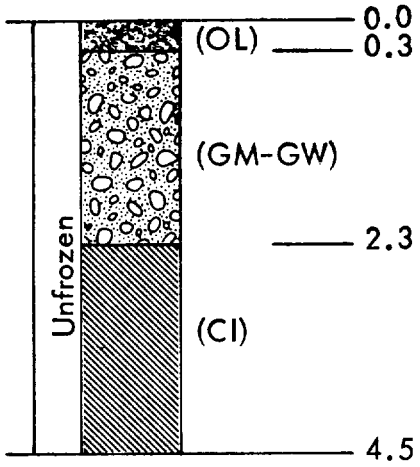
Site 282X is not recommended for development and exploitation of granular materials

because the potential quantity of recoverable sand and gravel is very minimal. In addition, the pocketed and stratified sand and gravel deposits are widely scattered and the foraging for these materials could result in rather extensive disturbance to the site area.

If utility right-of-ways are located as proposed, across these beach ridges on Site 282X, then these pockets of sand and gravel can be utilized as embankment fill material obtained from the cleared right-of-way as common excavation.

## DETAILED TEST PIT LOG

282X/TP 1

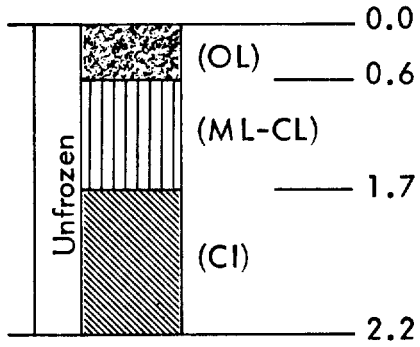



TOPSOIL; organic, roots, black

GRAVEL; coarse, cobbles, well graded

CLAY (TILL); pebbles

282X/TP 2

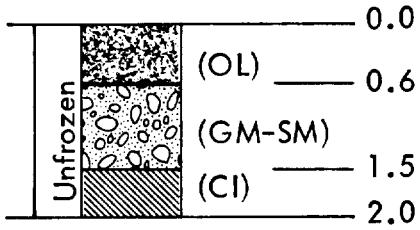



TOPSOIL; organic, roots, black

SILT; some clay and sand, occasional cobbles

CLAY (TILL);

282X/TP 3

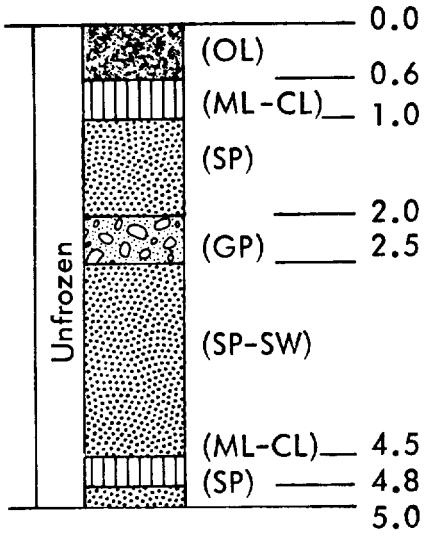



TOPSOIL; organic, black

GRAVEL and SAND;
CLAY (TILL);

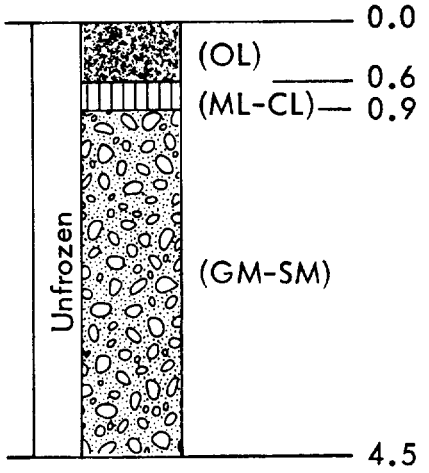
## DETAILED TEST PIT LOG

282X/TP 4




TOPSOIL; organic, black
SILT; some clay, yellow
SAND; coarse grained
GRAVEL; fine
SAND; medium to fine grained
SILT; some clay, laminated
SAND; medium grained

282X/TP 5




TOPSOIL; organic, black
SILT; some clay
GRAVEL and SAND

# DETAILED DRILL HOLE LOG

SITE NO. 282X HOLE NO. C 925

DATE: MAR. 12, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | 0.3 MOSS: | | Vx | H | | 0 |
| 2 | | (CL-CI) | CLAY: silty, low to medium plastic, brown | | Vs | M | | 2 |
| 4 | | | | | | | | 4 |
| 6 | | | | | | | | 6 |
| 8 | | (ML) | 7.5 SILT: sandy, fine lensed | | | | | 8 |
| | | (CL) | 8.0 CLAY (TILL): silty, sandy, low plastic, brown | | | | | |
| 10 | | (SM-SC) | 10.0 SAND (TILL): low plastic, very silty, trace of clay | | Nbn | | | 10 |
| 12 | | (CI) | 12.0 CLAY (TILL): medium plastic, brown | | | | | 12 |
| 14 | | | | | | | | 14 |
| | | | 15.0 END OF HOLE 15.0' | | | | | |
| 16 | | | | | | | | 16 |
| 18 | | | | | | | | 18 |
| 20 | | | | | | | | 20 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 282 X HOLE NO. C 929

DATE: MAR. 12, 1973 | LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | (ML) | SILT: clayey, brown, organics | | Nbn | | | 0 |
| 2 | | | 2.0 | | | | | 2 |
| 4 | | (CI) | CLAY (TILL): silty, sandy, medium plastic, grey, calcareous | | Vx & Vs | M | | 4 |
| 6 | | (CI-CL) | 5.5 - coarse sand | | | | | 6 |
| 8 | | | | | | | | 8 |
| 10 | | (CL) | 9.0 - silty, sandy, low plastic, grey brown | | Vx | M | | 10 |
| 12 | | (SM) | 11.0 SAND (TILL): fine silty, brown, slightly plastic clay; Till inclusions | | Nbn | | | 12 |
| 14 | | | | | | | | 14 |
| 16 | | | 15.0 END OF HOLE 15.0' | | | | | 16 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 282 X HOLE NO. C 927

DATE: MAR. 12, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | 0 |
| | | (CL-CI) | CLAY: silty, low to medium plastic, brown, rootlets | | Vx | M | | |
| 2 | | | 2.0 | | | | | 2 |
| | | (ML) | SILT: clayey, trace of fine sand, occasional siltstone and cobbles, low plastic | | Vx | M | | |
| 4 | | | | | | | | 4 |
| | | | | | Vx | M | | |
| 6 | | | | | | | | 6 |
| 8 | | | 8.0 | | | | | 8 |
| | | (SM) | SAND: fine grained, brown occasional stone | | Vx | M | | |
| 10 | | | 10.0 | | | | | 10 |
| | | (CL) | CLAY (TILL): silty, sandy, low plastic | | | | | |
| 12 | | | 12.0 | | | | | 12 |
| | | (ML) | SILT (TILL): trace of fine sand and clay, pebbles and cobbles | | | | | |
| 14 | | | 14.0 | | | | | 14 |
| | | | END OF HOLE 14.0' | | | | | |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 282X HOLE NO. C 931

DATE: MAR. 12, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | (ML) | SILT: fine sandy, low plastic brown, organic | | Vs | M | | 0 |
| 2 | | | 2.0 | | | | | 2 |
| | | (CI) | CLAY (TILL): silty, sandy, medium plastic, brown | | | | | |
| 4 | | (CL) | - siltier | | | | | 4 |
| 6 | | (CI) | - less silty | | Vx | L | | 6 |
| 8 | | | - pebbles, fairly sandy | | | | | 8 |
| | | | - siltier and sandier low to medium plastic | | | | | |
| 10 | | (CL-CI) | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 14 | | | 14.0 | | | | | 14 |
| | | | END OF HOLE 14.0' | | | | | |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 282X HOLE NO. C 936

DATE: MAR. 12, 1973 LOGGED BY: ☐ PEMCAN ☒ R.M. HARDY & ASSOCIATES

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | (GM) | GRAVEL: sandy, silty, non-plastic, brown | | Vx | M | | 0 |
| 2 | | | | | | | | 2 |
| 4 | | | ----- - finer | | | | | 4 |
| 6 | | | ----- - coarser | | | | | 6 |
| 8 | | | ----- - very silty, fine, sandy | | | | | 8 |
| 10 | | (SW-SM) | 10.0 SAND: coarse, fine gravelly, very fine grained sand | | | | | 10 |
| 12 | | | 12.0 | | | | | 12 |
| 14 | | (CL) | CLAY (TILL): silty, sandy, low plastic, grey, pebbles | | | | | 14 |
| 16 | | | 15.0 END OF HOLE 15.0' | | | | | 16 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

## SUMMARY OF LABORATORY TEST DATA

Sample Location: 282X/TP-1

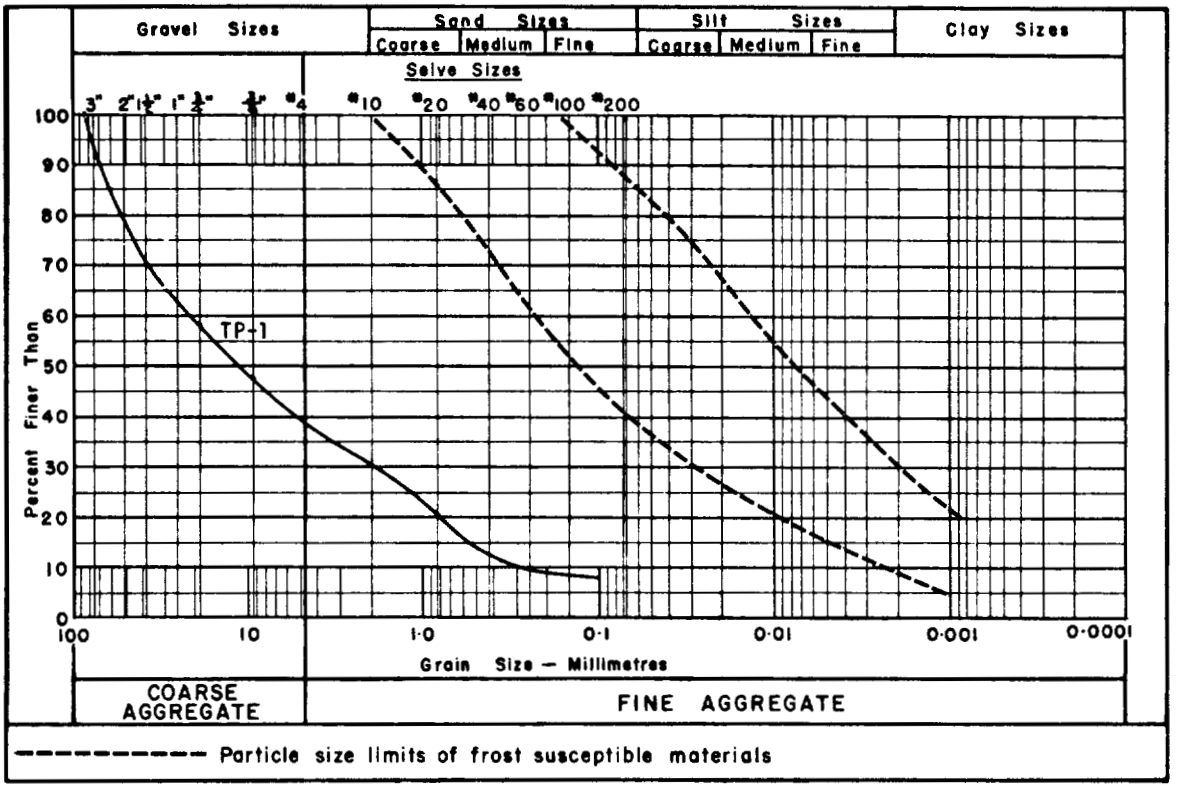
Sample Depth (Feet): 1.5

Moisture Content (%): -

Ice Content (%): -

Organic Content (%): -

GRAIN SIZE DISTRIBUTION:



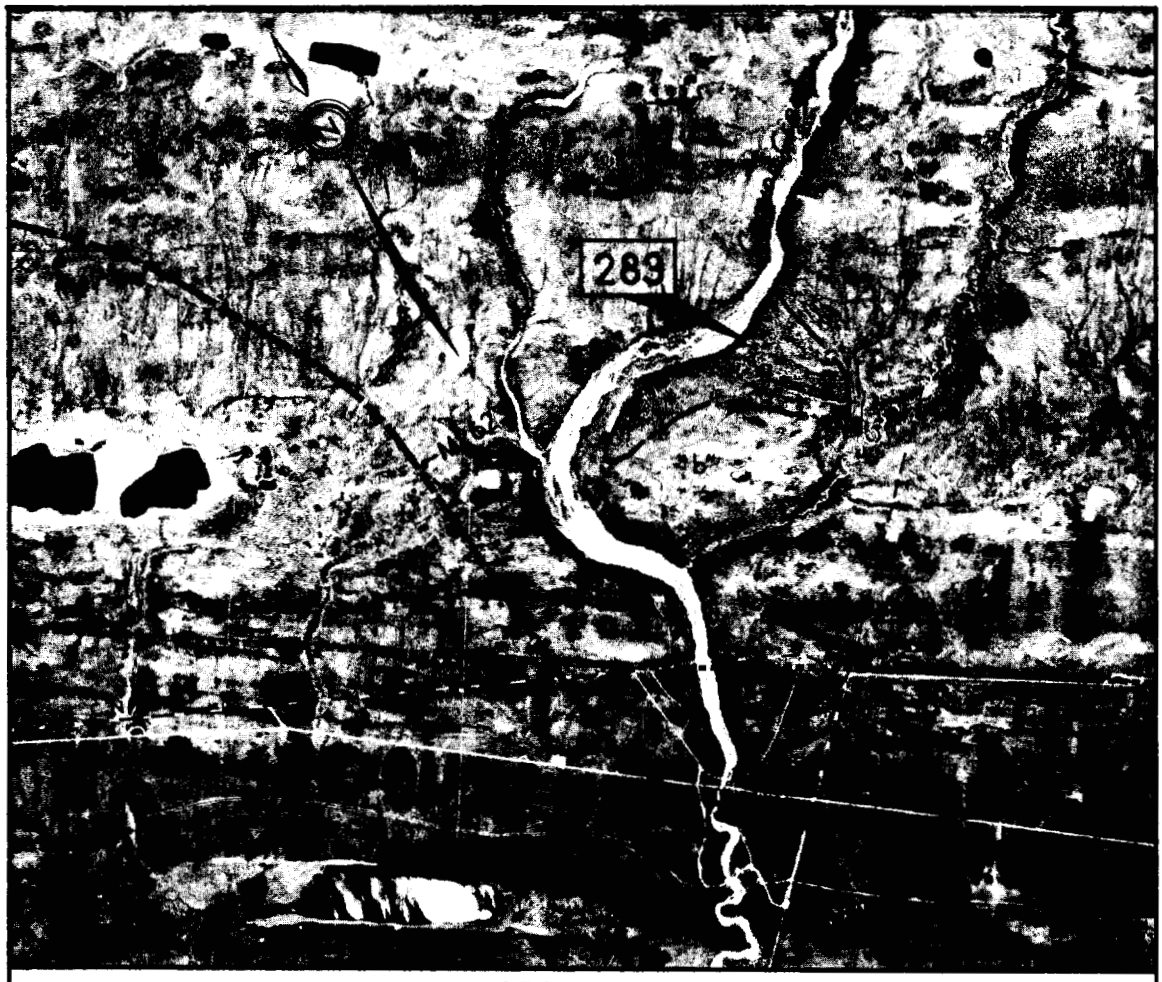

PETROGRAPHIC ANALYSIS:

## SITE NO. 283

### LOCATION

Located approximately 11 miles east of Norman Wells and immediately adjacent to the current stream channel of Canyon Creek, Site 283 consists of a fossil alluvial fan. It is expected that materials in the fan consist of silty sand and gravel.

The proposed Mackenzie Highway right-of-way at Mile 621 is located approximately $1\frac{1}{4}$ miles southwest of Site 283. The proposed gas pipeline route runs approximately 3/4 of a mile southwest of the site area.




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- Required access
- Site limit
- Proposed Mackenzie Highway

Airphoto No. A22934/98

Approximate scale: 1" = 3,000'

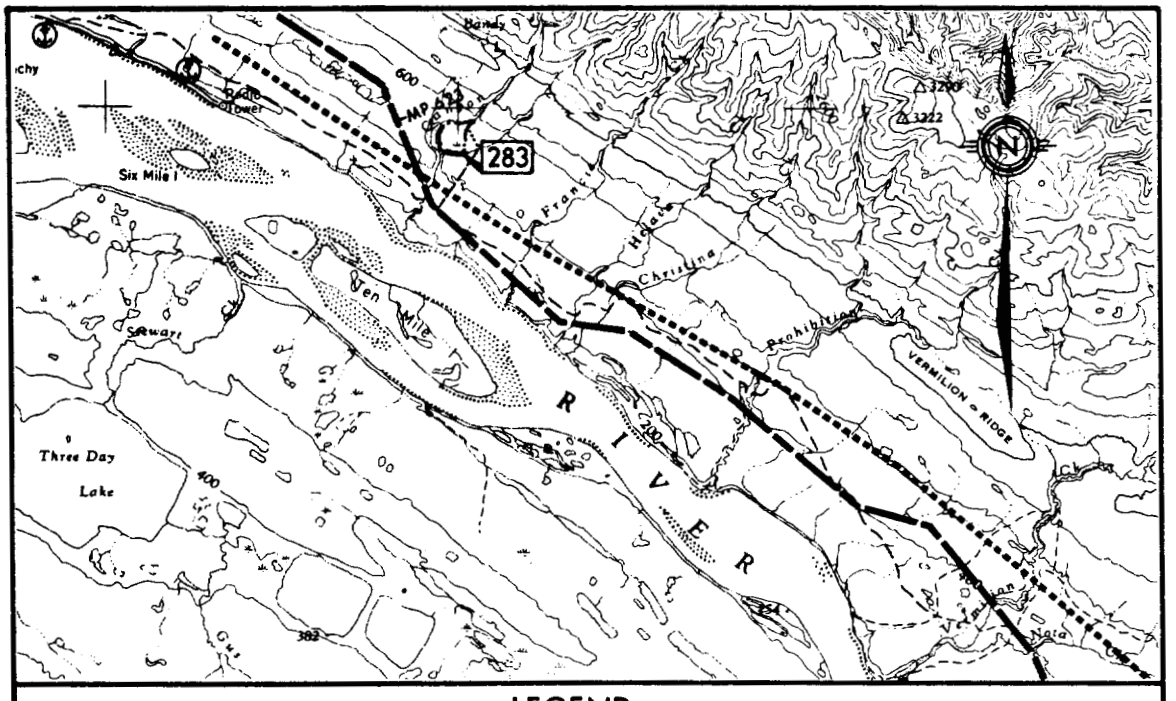
## GENERAL

Site 283 encompasses a fossil alluvial fan which has been deposited approximately at a point where the stream channel of Canyon Creek enters the Mackenzie Plain. The total fan area is approximately 4000 feet in length and 3500 feet in width. Based on inferred data from a similar fan, denoted as Site 280 and drilled during the winter program, the apex of the fan, designated as zone "a" on the site airphoto, contains the coarser granular materials while zone "b", forming the peripherial downslope portion of the alluvial fan is probably composed of fine grained soils. The site area and the immediately adjacent terrain exhibits fair to poor surficial drainage into the active stream channel of Canyon Creek.

The surficial layer of topsoil and organic silt supports moderate growths of spruce with irregular stands of poplar and birch.

There are no known critical wildlife areas in the immediate vicinity of Site 283.

It is anticipated that good quality granular materials are available in zone "a" while zone "b" likely contains less suitable deposits. Therefore, on this basis, Site 283 is rated as a fair prospect. The access to the site can be achieved by a short extension of the existing seismic cutline; but will require the crossing of a small creek.




Section of Map No. 96 E

Scale: 1:250,000

## SITE NO. 284X

Located approximately 11 miles east of Norman Wells and 2 miles northeast of the proposed Mackenzie Highway at Mile 622, Site 284X consists of shallow slope wash and reworked glacial till materials on the west bank of Canyon Creek.

Type of Material: Silt; some clay, little gravel and sand.

Estimated Volume: Not applicable.

Assessment: Site 284X is not recommended for development because materials of granular quality were not established during the field drilling program.


LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- ⊙ DH Drill Hole
- Required access
- Site limit
- Proposed Mackenzie Highway
- ⊕ TP Test Pit

Airphoto No. A22934/97

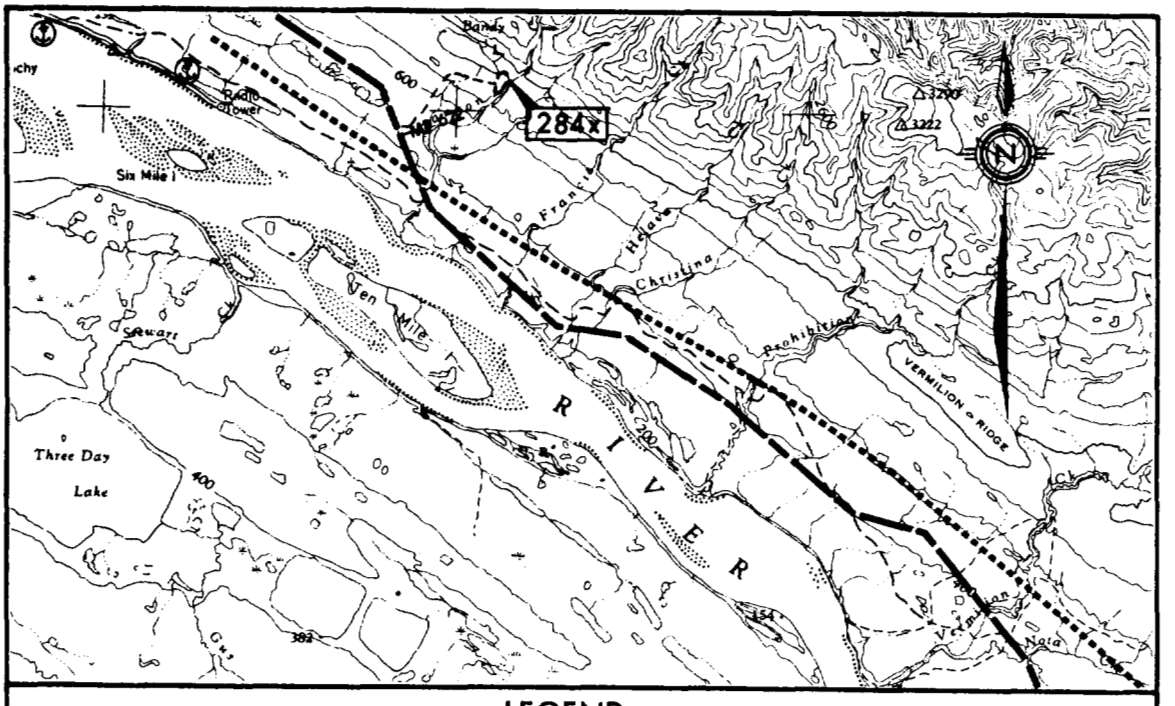
Approximate scale: 1" = 3,000'

## ENVIRONMENT

Site 284X is located approximately 11 miles east of Norman Wells immediately adjacent to the west bank of Canyon Creek and 2 miles northeast of the proposed Mackenzie Highway right-of-way at Mile 622. The site, consisting of shallow slope wash material and reworked glacial till overlying shale bedrock, encompasses an area approximately 1500 feet in length and 1000 feet in width. The site area and adjacent terrain slopes gently to the southwest and exhibits good surficial drainage into the watershed of Canyon and Snowshoe Creeks. The steep west bank of Canyon Creek, which is deeply incised into shallow bedrock, forms the eastern perimeter of Site 284X.

The material in Site 284X consists of inorganic, clayey silts with some small pebbles interspersed throughout. Shale bedrock was encountered at depths generally less than 11 feet below the existing ground surface. An organic topsoil and peat layer, which is less than $1\frac{1}{2}$ feet in depth, overlies the site area and supports light to moderate growths of spruce. The understory growth is relatively sparse and consists primarily of grasses and shrubs.

There are no known critical wildlife areas in the immediate vicinity of Site 284X. Canyon Creek contains considerable potential spawning gravels along its course; however, these




LEGEND

- All weather road
- Existing trails and cutlines
- Proposed Gas Pipeline
- Required access
- Site limit
- Proposed Mackenzie Highway

Section of Map No. 96 E

Scale: 1:250,000

gravels are not likely to be used by fishery resources since the Creek normally dries up during the summer.

The existing access to the site area from the CNT pole line, proposed Mackenzie Highway and gas pipeline right-of-way consists of seismic cutlines and the new access trails which were cleared to the site during the winter drilling program.

## DEVELOPMENT

The exploratory drill holes which were carried out on Site 284X did not show any subsurface materials of granular quality although the initial airphoto interpretation and field reconnaissance of the site indicated the possibility of encountering granular materials.

# DETAILED DRILL HOLE LOG

SITE NO. 284X HOLE NO. DH-1

DATE: DEC. 14, 1972 | LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | 0.8 PEAT: organic, fibrous, muskeg | | Vx | M | | 0 |
| 2 | | | | | | L | | 2 |
| 4 | | | SILT: some clay, trace sand, frequent pebbles to $\frac{1}{2}$" size, brown | | | | | 4 |
| 6 | | MH | | | Vs | M-H | | 6 |
| 8 | | | | | Vx | | | 8 |
| 10 | | | 10.0 | | | | | 10 |
| 12 | | | BEDROCK: shale, dark grey to black | | Nf | L | | 12 |
| | | | 13.0 | | | | | |
| 14 | | | TOTAL DEPTH 13.0' | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 284X

HOLE NO. DH-2

DATE: DEC. 14, 1972

LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | PEAT: organic, fibrous, muskeg | | | M | | 0 |
| 1.0 | | | | | Vx | L | | |
| 2 | | MH | SILT: some clay, some pebbles to ½" size, light brown | | | | | 2 |
| 4 | | ML | - little sand, larger pebbles to 1" size, shale fragments to 3/8" size, from 3.0' | | Vs | M-H | | 4 |
| 6 | | | | | | | | 6 |
| 8 | | | | | | | | 8 |
| 8.0 | | | BEDROCK: shale, black | | Nf | L | | |
| 10 | | | | | | | | 10 |
| 11.0 | | | TOTAL DEPTH 11.0' | | | | | |
| 12 | | | | | | | | 12 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 284 X HOLE NO. DH-3

DATE: DEC. 14, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | N.R.C. CLASS | EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | PEAT: organic, fibrous, muskeg | | Vs | M-H | | 0 |
| 1.5 | | | | | | | | |
| 2 | | MH-CL | SILT: some clay, trace sand, frequent pebbles to ½" size, medium brown | | | | | 2 |
| 4 | | | - occasional larger pebbles to 1" size from 3.0' | | Vs | | | 4 |
| 6 | | | | | Vx | | | 6 |
| 8 | | | | | | | | 8 |
| 9.0 | | | | | | | | |
| 10 | | SM | SAND: some silt, friable sandstone fragments to 1/8" size, medium brown | | Nf | L | | 10 |
| 12 | | | | | | | | 12 |
| 13.0 | | | TOTAL DEPTH 13.0' | | | | | |
| 14 | | | | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# DETAILED DRILL HOLE LOG

SITE NO. 284X HOLE NO. DH-4

DATE: DEC. 14, 1972 LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☒ AIR CONVENTIONAL ☐ AIR REVERSE CIRCULATION ☐ OTHER:

| DEPTH (feet) | GRAPH SYMBOL | UNIFIED GROUP SYMBOL | MATERIAL DESCRIPTION | GROUND ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | Pt | PEAT: organic, fibrous, muskeg | | Vx | M-H | | 0 |
| | | OL | - some silt, dark brown | | Vs | | | |
| 1.5 | | | from 0.8' | | Vx | | | |
| 2 | | | | | | | | 2 |
| 4 | | | SILT: some clay, trace sand, some pebbles to $\frac{1}{2}$" size, brown | | | | | 4 |
| 6 | | ML | | | | M | | 6 |
| 8 | | | - frequent pebbles from 7.0' | | Vx | | | 8 |
| 9.0 | | | | | | | | |
| 10 | | CL | CLAY: some silt, occasional pebbles to 3/4" size, shale fragments, brown | | | L | | 10 |
| 11.0 | | | | | | | | |
| 12 | | | BEDROCK: shale, black | | Nf | | | 12 |
| 13.0 | | | | | | | | |
| | | | TOTAL DEPTH 13.0' | | | | | |
| 14 | | | | | | | | 14 |

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
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GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

# 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, $CaMg(CO_3)_2$, 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, $CaSO_4$, $2H_20$. 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 a 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. |
| Screes | 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. |
| Sinuous | Winding or curving in and out. |
| Slope Wash | Soil and rock material that is being or has moved down a slope predominantly by the action of gravity assisted by running water that is not concentrated into channels. |
| 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. |

| | |
|---|---|
| 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. |

# EXPLANATION OF TERMS AND SYMBOLS

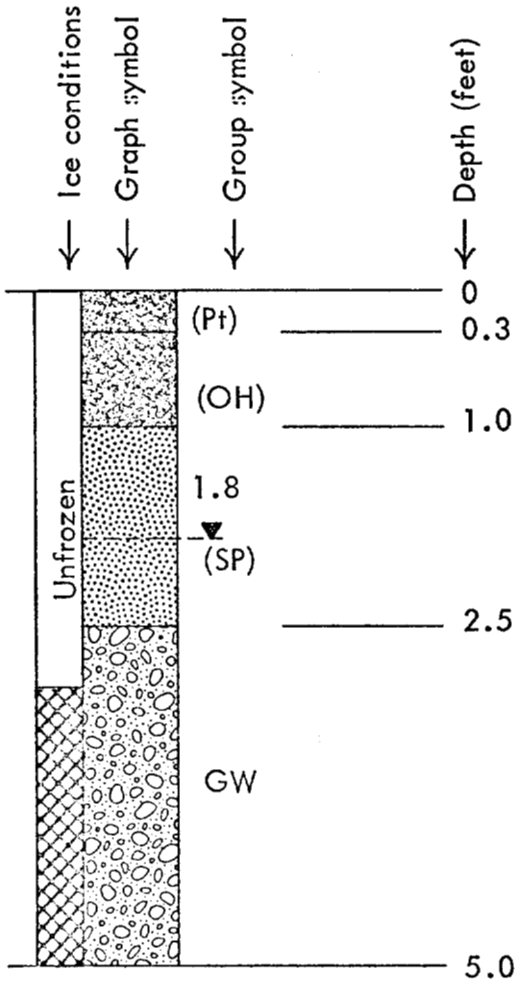
# EXPLANATION OF TERMS AND SYMBOLS

## 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 ICE CONDITIONS: GEN'L CLASS | GROUND ICE CONDITIONS: N.R.C. CLASS | GROUND ICE CONDITIONS: EST'D CONT. | SAMPLE TYPE | DEPTH (feet) |
|---|---|---|---|---|---|---|---|---|
| 0 | | OL | TOPSOIL: organic, dark brown | | Nf | L | | 0 |
| 1.0 | | | | | | | | |
| 2 | | GM-GP | GRAVEL: some silt, little sand, frequent pebbles to 2½" size, occasional boulders, medium brown | | Vs | L-M | | 2 |
| 4 | | | | | | | | 4 |
| 6 | | | | | | | | 6 |
| 7.0 | | | | | | | | |
| 8 | | ML | SILT: some clay, trace of rust and coal specks, frequent pebbles to 1" size, occasional boulders, medium brown | | | | | 8 |
| 10 | | | | | | | | 10 |
| 12 | | | | | | | | 12 |
| 12.0 | | | TOTAL DEPTH 12.0' | | | | | |
| | ① | ② | ③ | ④ | ⑤ | ⑥ | ⑦ | ⑧ | ⑨ |



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## 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.I, 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.

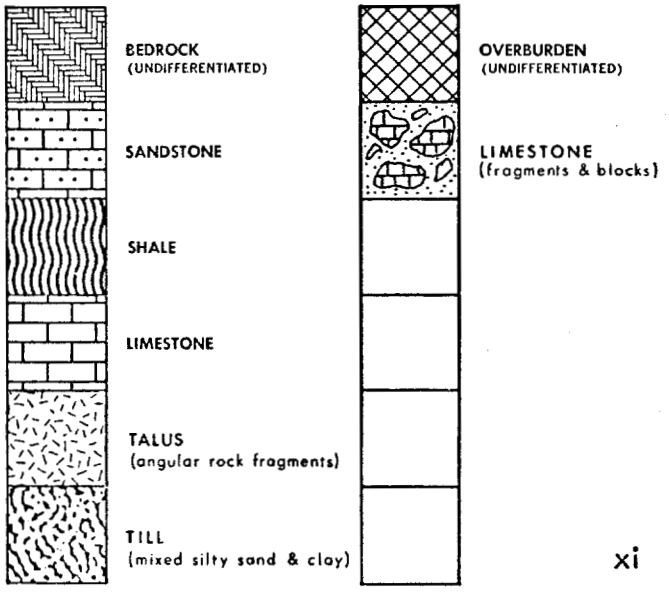
Since the Unified Soil Classification System does not contain detailed subdivisions of granular soils according to percentage proportions of secondary components, the ASTM suggested method for identification of granular soils ("Suggested Methods of Test for Identification of Soils", ASTM Procedures for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

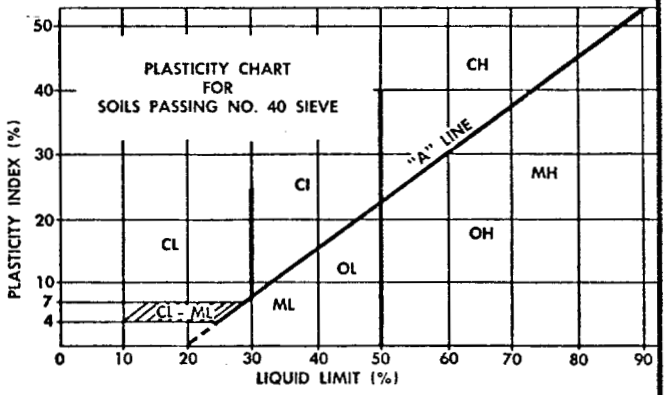
| Composite Sand-Gravel Soils | | Composite Sand-Silt Soils | |
|---|---|---|---|
| Percentages | Identification | Percentages | Identification |
| | Gravel; trace Sand | | Sand; trace - Silt |
| 90 to 10 | | 95 to 5 | |
| | Gravel; little Sand | | Sand; trace + Silt |
| 80 to 20 | | 90 to 10 | |
| | Gravel; some Sand | | Sand; little Silt |
| 65 to 35 | | 80 to 20 | |
| | Gravel and Sand | | Sand; some Silt |
| 50 to 50 | | 65 to 35 | |
| | Sand and Gravel | | Sand and Silt |
| 35 to 65 | | 50 to 50 | |
| | Sand; some Gravel | | Silt and Sand |
| 20 to 80 | | 35 to 65 | |
| | Sand; little Gravel | | Silt; some Sand |
| 10 to 90 | | 20 to 80 | |
| | Sand; trace Gravel | | Silt; little Sand |
| | | 10 to 90 | |
| | | | 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 | $C_U = \frac{D_{60}}{D_{10}} > 6$ $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ 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 | $C_U = \frac{D_{60}}{D_{10}} > 4$ $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ 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 |
| FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES 200 SIEVE) | SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT | $W_L < 50\%$ | ML | | INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY | CLASSIFICATION IS BASED UPON PLASTICITY CHART (see below) | |
| | | $W_L > 50\%$ | MH | | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS | | |
| | CLAYS ABOVE "A" LINE ON PLASTICITY CHART NEGLIGIBLE 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 | 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 | |
| | | $W_L > 50\%$ | 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




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 Well-bonded | Nb | Nbn | |
| | 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

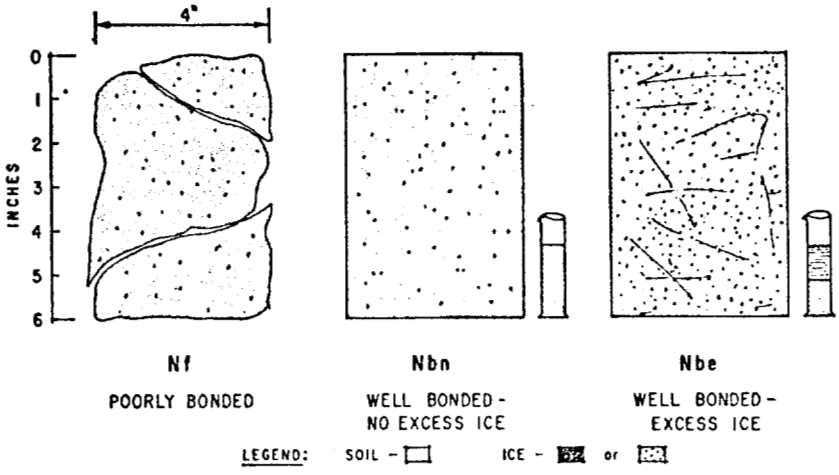


TABLE I (cont'd)

ICE DESCRIPTIONS

B. VISIBLE ICE—LESS THAN 1 INCH THICK[a]

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

[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.*

FIG B. VISIBLE ICE LESS THAN ONE INCH THICK

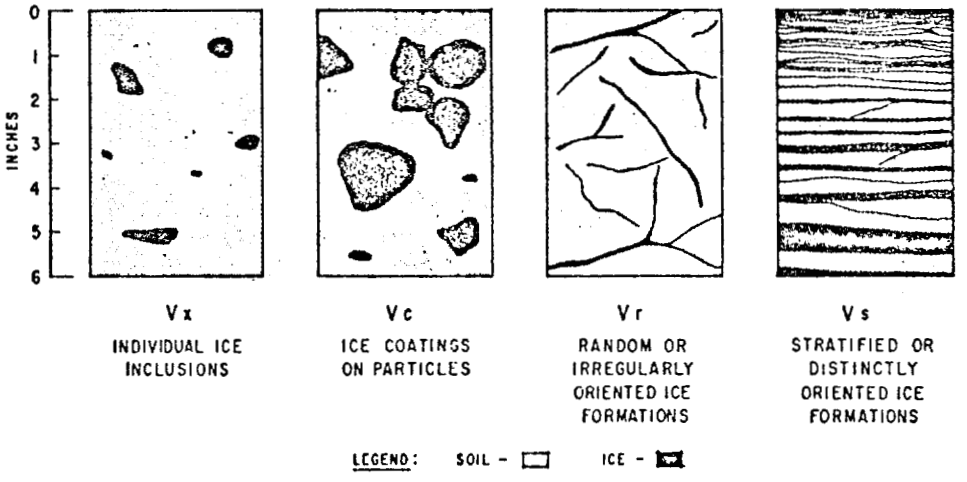


TABLE I (cont'd)

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: |
| | Ice without soil inclusions | ICE | Hardness: HARD, SOFT (of mass, not individual crystals). Colour (Examples): COLOURLESS, GRAY, BLUE. Structure[b]: CLEAR, CLOUDY, POROUS, CANDLED, GRANULAR, STRATIFIED. Admixtures (Examples): CONTAINS FEW THIN SILT INCLUSIONS |

[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

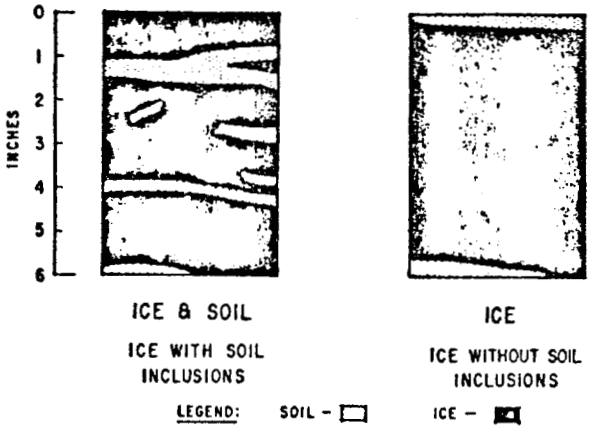


TABLE II

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.

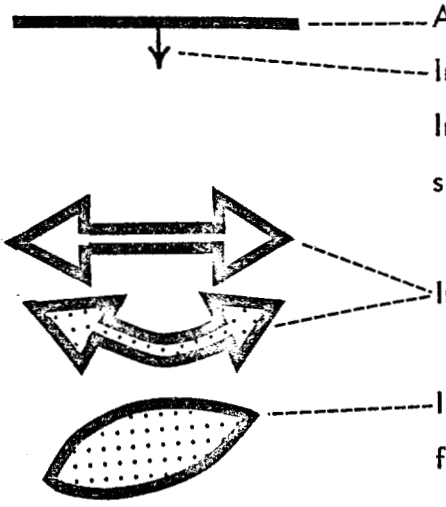
- Fishery resource areas are outlined in blue.

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:



---------Approximate boundary of wildlife area.

----------Indicates which side of boundary line is area defined. In other words the area below the boundary line is of significance to wildlife.

Indicates migration routes; waterfowl and fishery resources.

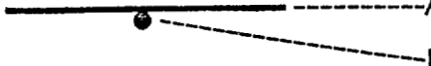
----------Indicates known or potential spawning areas or domestic fishing locales.

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.

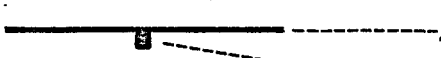
Symbols used on the maps are illustrated and explained as follows:



----------Approximate boundary of wildlife area.

----------Indicates which side of boundary line is area defined. In otherwords, the area below the boundary line is of signifi-

cance to wildlife.



----------Approximate boundary of waterfowl area.

----------Indicates which side of boundary line is area defined. In other words, the area below the boundary line is of significance to waterfowl.

---------Indicates broad migration flyways utilized by waterfowl.

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.

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