

DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

WRIGLEY, N.W.T.

COMMUNITY STUDY AREA



PEMCAN SERVICES "72"





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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 1 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. The surficial geology map shown in Figure 1 has been derived from both the aforementioned information and field observation data.

Airphoto interpretation of potential sources 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 roads. Pertinent parts of these airphotos have been reproduced and used as location plans for catalogued sites. Air mosaics showing revised route locations for the Mackenzie Highway were provided by The Federal Department of Public Works or their respective engineering consultants.

The preliminary field work, carried out in September and October, 1972, commenced with aerial reconnaissance in order to select prospective sites. Selected sites were then investigated by means of test pits which were excavated manually, logged and sampled to depths of eleven 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, Sites W 1, W 2, W 3, W 5, W 6 and W 13, were investigated in further detail during the winter drilling program in February, 1973. Additional field test drilling of Sites W 1, W 2, W 5, W 6 and W 13 was conducted by the engineering consultant for The Federal Department of Public Works, in conjunction with their geotechnical study for the Mackenzie Highway route in this area. The data from their investigation has been incorporated in this report.

The potential quantities of available granular materials, availability of existing access



roads, drainage conditions, wildlife implications and the distance from the community were considered for selecting sites for more detailed investigations. Some of the smaller or more marginal deposits have been recorded but were not studied in detail because of remoteness from the community or planned utilities. These sites as well as those which were ultimately assessed as "Not Recommended" are designated by the suffix "X" after the site number.

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.

A total of twenty sites were catalogued in the ten mile radius of Wrigley (Figure 2). Of these, fourteen sites were investigated to a greater detail by means of test pits and six sites by means of drill holes. Additional sites were investigated by Geological Survey of Canada personnel and partial information from their studies is incorporated in this report. Ten sites that are not recommended for development are identified in Figure 2 by the suffix "X" behind the site number.

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 are based on 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 grounds along the outer limits of the deposit.

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.



GEOMORPHOLOGY

The Wrigley Study Area lies within two physiographic subdivisions, namely:

- Mackenzie Plain - which covers the entire east river bank and a relatively narrow strip on the west side of the Mackenzie River.
- Franklin Mountains - which generally borders the Mackenzie Plain to the east and cuts into the Plain at the Mount Gaudet massif.

The Mackenzie Plain is primarily covered by morainal and glaciofluvial deposits topped by a thin veneer of glaciolacustrine sediments. The glaciation has resulted in a generally flat to gently rolling topography. After the final retreat of the glaciers, melt waters and subsequent development of recent drainage patterns has resulted in numerous channels, gullies and stream courses incised below the glaciated plain.

The bedrock within the Mackenzie Plain region is mostly covered by thick layers of unconsolidated material, except for occasional exposures in walls of deeply incised valleys. The bedrock consists of Devonian calcareous sandstone on the west bank of the Mackenzie River and shale, siltstone and sandstone of the Fort Simpson Formation on the east side of the river.

The Franklin Mountains unit is represented by the rugged and faulted McConnell Range and by the Mount Gaudet massif which extends to the east bank of the Mackenzie River. Numerous exposures of Devonian limestone of the Nahanni Formation, with inclusions of brecciated limestone of the Bear Rock Formation, form steep walls on the western flanks of the McConnell Range and on major parts of Mount Gaudet. The center portion of the McConnell Range is formed primarily by Devonian dolomites of the Mount Kindle and Franklin Formations. Rock walls are usually mantled with talus accumulations at the base and fluvial fans are frequently formed at the mouths



of erosional gorges.

A moderately thick organic soil layer topped with several inches of peat and moss is usually encountered outside of rugged or recently eroded areas. High terraces and sloping grounds are covered with a shallow organic soil layer while low and poorly drained terrain contains a thicker organic section and scattered muskeg bogs.

Main landforms and geologic features, including major faults, are illustrated by Figure 1. A series of highly mineralized, thermal springs is associated with these faults at Mount Gaudet and Roche Qui Trempe a l'Eau.

Glaciolacustrine deposits, consisting primarily of silts and fine grained sands, as well as morainal deposits, consisting of sandy and clayey silts with low gravel contents are poor sources of granular deposits. Silty and sandy materials contained in floodplains along the Mackenzie River and within stream channels in the western half of the Study Area are also of very poor quality with respect to construction requirements. These deposits usually have high water tables or ice content, especially if covered by thick layers of organic soil.

Devonian shales and siltstones, occupying most of the Mackenzie River valley west of the McConnell Range are generally, too soft and incompetent for construction purposes.

In the Study Area there are three main geomorphologic forms in which natural granular materials occur:

- Alluvial floodplains, fans and braided stream channels on the east side of the Mackenzie River which contain coarse, heterogeneous and irregularly stratified material.



- Terraces on both sides of the Mackenzie River which represent major sources of good quality sandy gravel. The townsite and the airport are located on the largest terrace in the Study Area.
- Talus and scree deposits are widespread along the western flanks of the McConnell Range and consist of various sized limestone fragments and blocks with silt particles. Colluvium, which covers shale and sandstone bedrock on the west side of the Mackenzie River is of less desirable quality for granular material requirements.

The bedrock exposed on the western flanks of the McConnell Range is suitable for manufactured aggregates.

The Study Area lies within the discontinuous permafrost zone. Excess ice is fairly common in fine grained, poorly drained glaciolacustrine and glaciofluvial deposits whereas little or no excess ice exists in coarse and well drained deposits. The average depth of the seasonal freezing and thawing cycles is about two to five feet; however, these depth values will vary according to the drainage and type of material at respective sites.

TERRAIN PHOTOGRAPHS



Western slopes of Mount Gaudet and Roche Qui Trempe a l'Eau; area of scree and talus deposits and thermal springs (Ref. Site W 16X).



Typical high terrace deposit extending southward along the Mackenzie River from Wrigley townsite (Ref. Site W 5).



ENVIRONMENT

The ten mile Study Area around the community of Wrigley encompasses all of the lands that are included in the "Proposed Development Control Zone" as shown in Figure 2. It is proposed by the respective Federal and Territorial Governments that management of lands within this Zone will be transferred from Federal to Territorial control. Federal projects such as buildings, highways and airports would be excluded from this transfer.

The Wrigley Study Area is geographically located in an area that offers considerable use and development of both water and land environments. Based upon various components including those of landforms, water, natural vegetation and aesthetics, the Study Area is rated relatively high in terms of recreation and terrain values. This is particularly true on the east side of the Mackenzie River where the terrain and its associated vegetation varies from river floodplains along the Mackenzie to mountainous uplands in the McConnell Range of the Franklin Mountains.

Terrain sensitivity and reaction to modification is less pronounced in the Wrigley Study Area than in regions further to the north because, in general, the occurrence of permafrost is more discontinuous and at greater depths.

Relatively flat, low-profiled and generally fine grained terrain types such as silt-clay plains, beaches, river deposits and organic terrain usually contain the highest ground ice content and can be disturbed because of low strength and high compressibility values. Vegetated sites are susceptible to subsidence, slumping and gullyng if the vegetation is removed or highly compressed and disturbed. Thermokarst subsidence, undercutting and channel shifting can also be expected, especially in fine river deposit terrain.

Hummocky and rolling terrain, as characterized by the till plains in the area, generally contain less ground ice content. Localized contrasts in material type and ice content



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

Upland mountainous terrain, as characterized by rock outcrops or bedrock thinly covered with a veneer of debris, as in the Franklin Mountains, usually contains minimal ice content within the bedrock except for shale where fractures may be ice filled to considerable depth. 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 favorable granular material sites in the Wrigley Study Area tend to be located on geomorphic features that contain relatively minor amounts of ground ice. Therefore, properly managed development procedures should minimize the detrimental terrain reaction to acceptable levels. In many cases, the access routes to these sites will traverse areas of low wet terrain that generally will contain higher ice contents and will therefore, be more susceptible to adverse reaction when disturbed. In these cases, sound development procedures such as the incorporation of protective measures for retainment of vegetation ground-insulation layers and the establishment of adequate fill materials for access roads will limit detrimental terrain reaction to satisfactory levels.

Vegetation

In the Upper Mackenzie Valley the Boreal forest region of Canada is restricted to a narrow band that extends along the Inner Mackenzie Valley. The Wrigley Study Area lies within the southern reaches of this Boreal forest zone.

The dominant tree species in the Study Area are black and white spruce, tamarack, birch, and occasional poplar and pine. Deciduous species in this area are more



pronounced as a vegetation cover than in regions to the north because of the increased occurrence of poplar growth. The vegetation in the Wrigley area is, in general more resilient and therefore, less susceptible to severe damage than regions further north. 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 alder. Permafrost muskegs are generally treeless or support stunted growths of black spruce and tamarack. Well drained sites support white spruce, birch and occasional poplar and pine.

Benchland areas that are underlain by fine-grained materials with shallow permafrost generally support poor growths of spruce and tamarack and in some cases, willow and alder. Well drained benchland areas are generally characterized by well developed growths of birch, poplar and spruce.

Mountain slope vegetation ranges from mixtures of deciduous and evergreen growths near the base to spruce, birch and occasional poplar on the overburden-covered flanks.

In the Wrigley Study Area, natural regrowth of vegetation on existing trails and cut-lines indicates that, for the most part, 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 short and long term seed stocks in order to promote growth cover prior to reestablishment of natural vegetation.



Wildlife

Wildlife species that are characteristic of both Boreal forest and Arctic tundra utilize the Wrigley Study Area and adjacent regions. For the most part the utilization of this area by wildlife, waterfowl and fishery resources is based upon seasonal migration patterns that parallel the Mackenzie River Valley. Except for the extreme southwest portion, the entire Wrigley Study Area is classified as an important wildlife region by the Canadian Wildlife Service. In addition, the western part of the Study Area is designated as a critical wintering range for woodland caribou (Figure 2).

The entire Study Area, except for the extreme western portion, is within the broad flyway that is utilized by various waterfowl species during spring and fall migration. Wildlife resources are hunted and trapped by local residents throughout most of the region west of the Franklin Mountains. Muskrat, marten, mink, beaver and lynx are the most common pelts. The island and bank areas of the Mackenzie River are hunted for moose.

The west central portion of the Study Area on the west side of the Mackenzie River is classified as a critical wintering range for woodland caribou (Figure 2). This area, roughly paralleling the drainage basin of the Wrigley River, is considered to be the eastern extension of the caribou wintering range.

Fishery resources in the Wrigley Study Area are predominantly found in the Mackenzie River and its tributaries and include both resident species and those that seasonally migrate through the respective river systems. A designated domestic fishing area that is utilized by the local residents is located in the Mackenzie River approximately 2½ miles downstream from Wrigley townsite.

Three archeological sites are recorded and located within the Study Area. One site is located immediately south of Wrigley airport on the east bank of the Mackenzie River.



The other two sites are located at the north end of the Study Area on the east and west banks of the Mackenzie River near Roche Qui Trempe a l'Eau (Figure 2).



RECOMMENDATIONS AND CONCLUSIONS

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

The approximate quantities of granular materials required for the Wrigley community as specified in the Terms of Reference received from The Department of Indian Affairs and Northern Development, are outlined as follows:

Fine grained aggregates (Sand)	25,000 cubic yards
Coarse grained aggregates (Gravel)	35,000 cubic yards
Material suitable for building pads, roads, airstrips, etc.	500,000 cubic yards

The results of the completed study indicates that extensive quantities of excellent quality granular materials which are suitable for the requirements of most construction purposes are available in the immediate vicinity of Wrigley. The following sites are recommended for development of granular materials in the Wrigley Community Study Area.

Site W 5: This site which is approximately three miles in length and one-half mile in width encompasses the Wrigley townsite and airport. Therefore, access to future borrow pit areas from the Wrigley townsite for the development of quality granular materials is excellent.

This site has an estimated quantity of 3,000,000 cubic yards of coarse to medium grained, well graded gravels which are suitable for most construction requirements. It is considered that screening, crushing and washing operations may be necessary to process the pit run gravels for production of concrete and surface course aggregates.

Site W 5 has excellent existing access to Wrigley townsite and is considered



to have sufficient quantities of granular materials to supply the current specified requirements for the community. An existing borrow pit is currently operated for granular materials in the southeast portion of the site.

The detailed assessment and recommendations for the proposed development and exploitation of granular materials from Site W 5 are outlined in the Site Description section of the report.

Sites W 1

& W 2:

Located four to five miles southeast of Wrigley, these two sites consist of a large river terrace on the east bank of the Mackenzie River.

Sites W 1 and W 2 are estimated to contain a volume in excess of 45,000,000 cubic yards of medium to coarse grained, well graded gravels which are suitable for most construction requirements and can be developed and exploited for additional granular material requirements if the needs of the Wrigley community and associated facilities become substantially increased.

The existing winter road and the proposed Mackenzie Highway ensures excellent existing and future access to potential borrow pit development areas.

The detailed assessment and recommendations for the proposed development and exploitation of granular materials from Sites W 1 and W 2 are outlined in the Site Description section of the report.

Site W 7:

Located approximately one mile northeast of Wrigley on the south bank of Hodgson Creek, Site W 7 consists of a river terrace.



Site W 7 has an estimated quantity of 250,000 cubic yards of well graded sand which can be utilized in the production of excellent quality fine concrete aggregate. It is considered that concrete sand in the pit run condition can be recovered from this site. However, the production of concrete sand from other sites more accessible to the community in conjunction with the development and exploitation of other types of granular materials may be more economical and equitable.

The detailed assessment and recommendations for the proposed development and exploitation of granular materials from Site W 7 are outlined in the Site Description section of the report.

Site locations and physical and environmental data on each site within the Wrigley Community Study Area are tabulated and presented in map form on Figures 1 and 2 respectively. A synopsis of tabulation of pertinent information for each site is tabulated and noted on Figure 2.

The table in Figure 2 presents a tabulation of pertinent data relative to the sites investigated within the Study Area. Each potential site is 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.

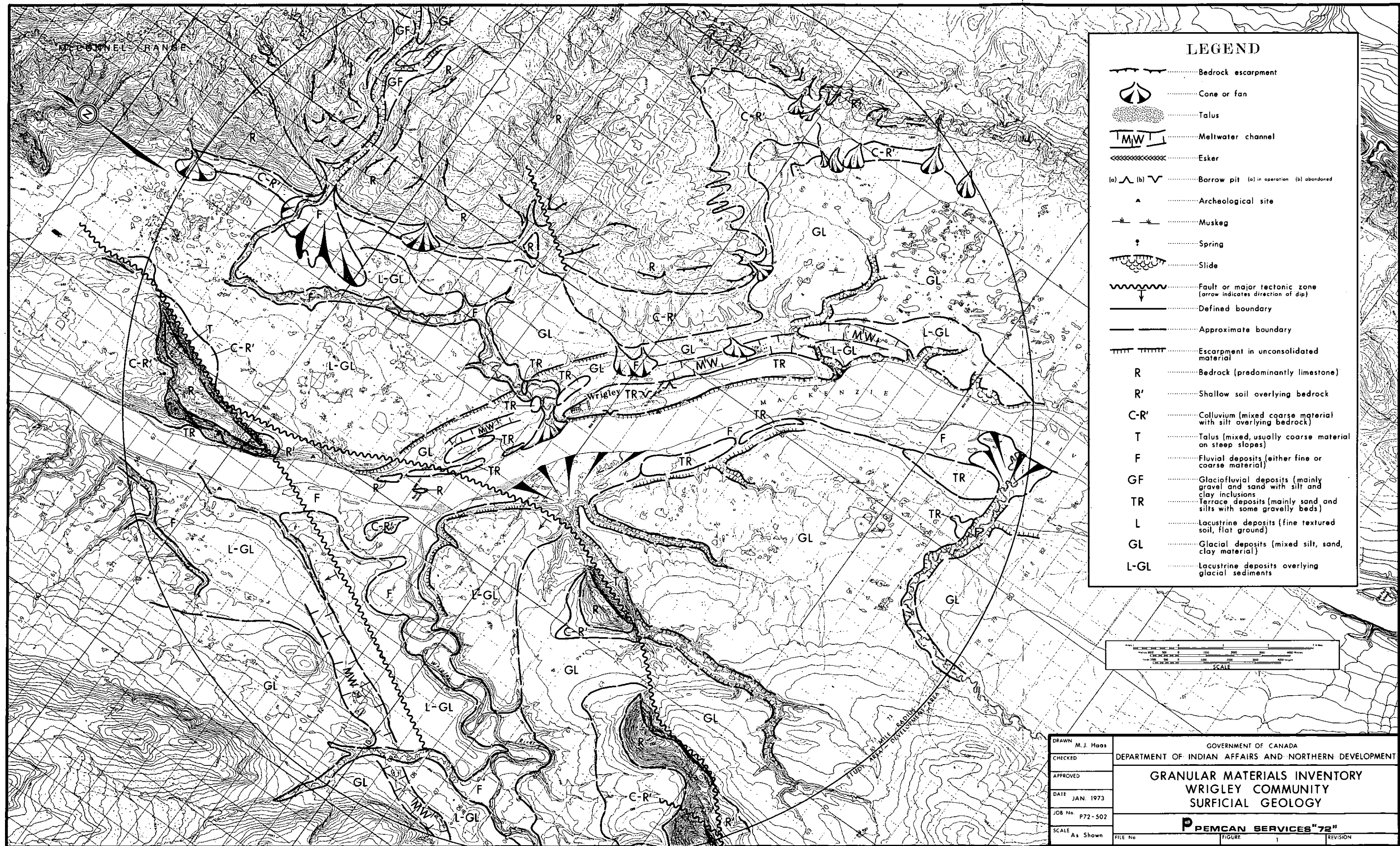
HAUL DISTANCE is the distance along existing and/or proposed access from the site to the community centre.

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 future development of potentially recoverable granular materials at each site investigated in the Study Area.

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 projected granular material requirements for the community.

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



SITE NO.	MATERIAL TYPE		SUITABILITY OF MATERIAL	ESTIMATED VOLUME (cu. yds.)	EST'D RECOV. DEPTH (feet)	OVERBURDEN			GROUND ICE (Content)	DRAINAGE	METHOD OF EXTRACTION	HAUL DIST (miles)	ENVIRONMENTAL CONSIDERATIONS	ASSESSMENT OF SITE
	DESCRIPTION	SYM.				TYPE	DEPTH (feet)	DISPOSAL						
W 1	Gravel; sandy	GW	All Construction Aggregates	5,000,000	+20	Topsoil	+½	Strip & Stockpile	Low	Good to South	Conventional	5½	No Critical Wildlife Areas	Recommended for Development
W 2	Gravel; sandy	GW	All Construction Aggregates	40,000,000	+25	Topsoil, Peat & Silt	+½	Strip & Stockpile	Low	Good to East and West	Conventional	4	No Critical Wildlife Areas	Recommended for Development
W 3X	Gravel & Silt	GM-ML	Marginal General Fill	1,000,000	3	Topsoil	+½	Strip & Waste	Low	Into Stream Channel	Conventional	6	No Critical Wildlife Areas	Not Recommended
W 4X	Bedrock; Limestone	—	All Construction Aggregates	Unlimited	—	None	—	—	N.D.	Surficially Well Drained	Quarry	2½	No Critical Wildlife Areas	Not Recommended
W 5	Gravel; sandy	GW	All Construction Aggregates	10,000,000	+20	Topsoil & Silt	+1	Strip & Stockpile	Low	Good to West	Conventional	0	Adjacent to Townsite & Airport	Active; Recommended for Development
W 6	Gravel; sandy	GW	All Construction Aggregates	1,000,000	+25	Topsoil & Silt	+1½	Strip, Waste & Stockpile	Low to Medium	Good to North	Conventional with Thawing	¼	No Critical Wildlife Areas; Adjacent to Active Stream	Possible Future Development
W 7	Sand & Gravel	SW-GW	Sand for Concrete Aggregates	250,000	+10	Topsoil & Silt	½	Strip & Stockpile	N.D.	Good	Conventional	1	No Critical Wildlife Areas	Possible Future Development
W 8X	Gravel & Sand	GW-SW	General Fill	N.D.	+5	None	—	—	None	Into Stream Channel	Conventional with Possible Dredging	1	Severe; Within Active Stream Channel	Not Recommended
W 9	Gravel; sandy	GW	All Construction Aggregates	N.D.	—	Topsoil & Silt	+1	Strip, Waste & Stockpile	None	Fair to West	Conventional	9	No Critical Wildlife Areas	Possible Future Development
W 10X	Gravel; sandy	GW	Base & Surface Courses General Fill	300,000	+5	Topsoil & Silt	3	Strip, Waste & Stockpile	N.D.	Fair to South	Conventional	½	No Critical Wildlife Areas; Adjacent to Stream	Not Recommended
W 11	Gravel; sandy	GW	All Construction Aggregates	150,000	+4	Topsoil	+½	Strip & Stockpile	None	Good to West	Conventional	1½	No Critical Wildlife Areas; Domestic Fishing Resources Area	Possible Future Development
W 12	Gravel; sandy	GW	Base, Surface Courses General Fill	600,000	+10	Topsoil & Silt	+½	Strip, Waste & Stockpile	None	Good to West	Conventional	2½	No Critical Wildlife Areas; Domestic Fishing Resources Area	Possible Future Development
W 13	Gravel; sandy	GW	All Construction Aggregates	1,000,000	+5	Topsoil & Silt	1	Strip, Waste & Stockpile	None	Fair to Northwest	Conventional	2½	No Critical Wildlife Areas	Possible Future Development
W 14X	Limestone Fragments	—	General Fill	250,000	+5	Topsoil	+½	Strip & Stockpile	N.D.	Good to South	Conventional	7	Adjacent to Mackenzie River; No Critical Wildlife Areas	Not Recommended
W 15X	Bedrock; Limestone & Dolomite	—	All Construction Aggregates	Unlimited	+100	Colluvium	+1	Strip & Waste	N.D.	Surficially Well Drained	Quarry; Blasting and Crushing	8	Thermal Springs, Fault Zones	Not Recommended
W 16X	Gravel; Limestone Fragments	—	General Fill	1,000,000	+30	Topsoil	+½	Strip & Stockpile	None	Good to West	Conventional	9	No Critical Wildlife Areas; Thermal Springs	Not Recommended
W 17X	Sandstone & Shale Fragments	—	Marginal General Fill	N.D.	—	Colluvium	+1	Strip & Waste	N.D.	Good	Conventional; Possible Blasting	5	Critical Wintering Range for Woodland Caribou	Not Recommended
W 18X	Sand & Silt	SM-ML	Not Suitable	N/A	—	Topsoil	½	—	N.D.	Poor	—	2	Critical Wintering Range for Woodland Caribou	Not Recommended
W 19X	Sand; silty	SP-SM	Not Suitable	N/A	—	Topsoil & Silt	+1	—	None	Good to East	—	2	No Critical Wildlife Areas	Not Recommended
W 20	Gravel; Sand & Silt	GP-ML	Marginal General Fill	200,000	+10	Topsoil	+1	Strip & Stockpile	N.D.	Good to North	Conventional	5	No Critical Wildlife Areas	Possible Future Development

Notes:

— ESTIMATED VOLUME (N/A):

Not applicable because the site does not contain materials of granular quality.

— GROUND ICE (content):

Rating and depth figures are inferred from specific test pits or drill holes.

— 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, light rippers.

— HAUL DISTANCE:

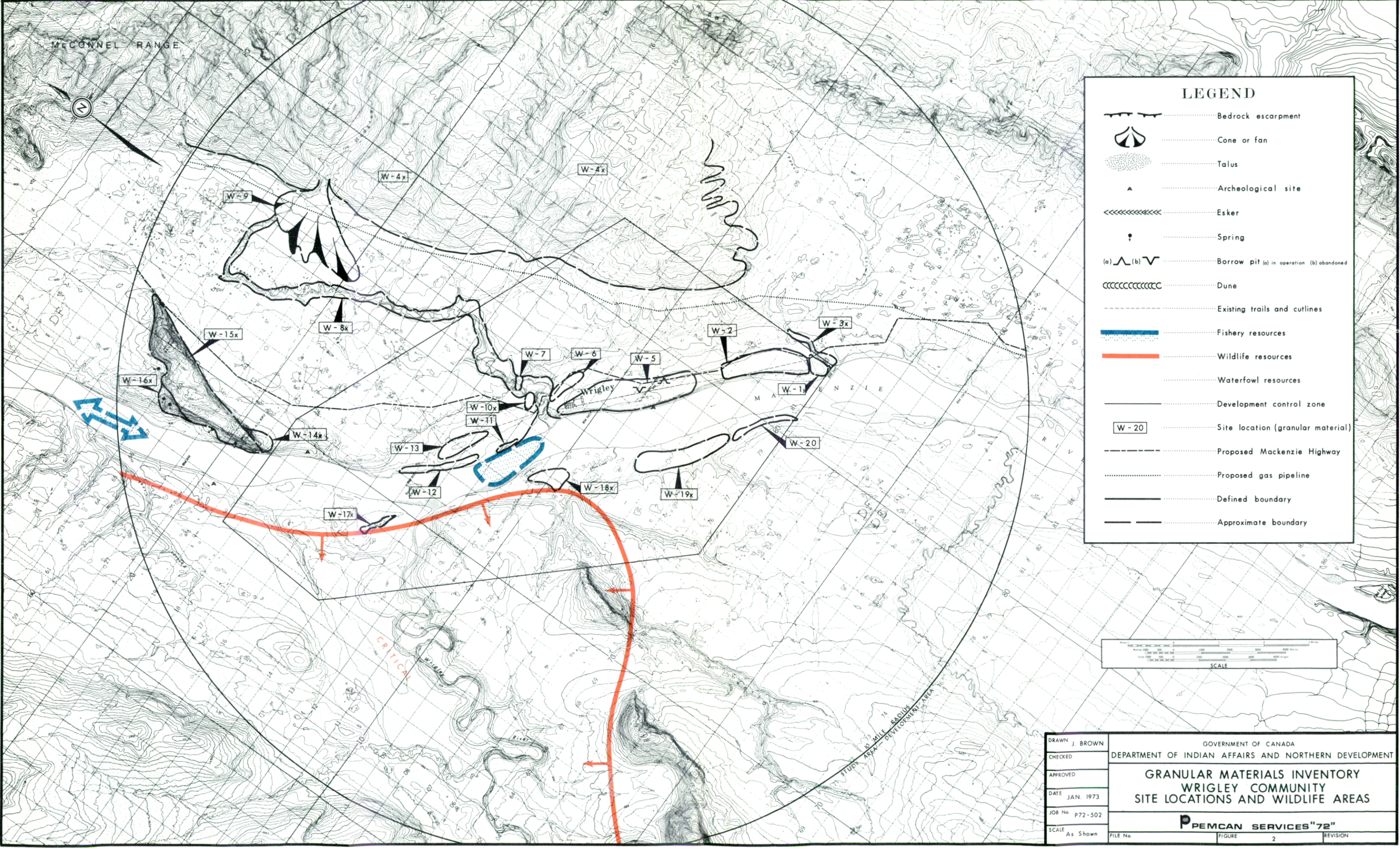
Is distance from site to community along existing or required access.

— SITE ASSESSMENT:

"Active" indicates site is currently or periodically being used.

— N.D.:

Not determined.





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SITE DESCRIPTIONS - WRIGLEY STUDY AREA



<u>SITE NUMBER</u>	<u>PAGE</u>
W 1	1 - 1
W 2	2 - 1
W 3 X	3 - 1
W 4 X	4 - 1
W 5	5 - 1
W 6	6 - 1
W 7	7 - 1
W 8 X	8 - 1
W 9	9 - 1
W 10 X	10 - 1
W 11	11 - 1
W 12	12 - 1
W 13	13 - 1
W 14 X	14 - 1
W 15 X	15 - 1
W 16 X	16 - 1
W 17 X	17 - 1
W 18 X	18 - 1
W 19 X	19 - 1
W 20	20 - 1

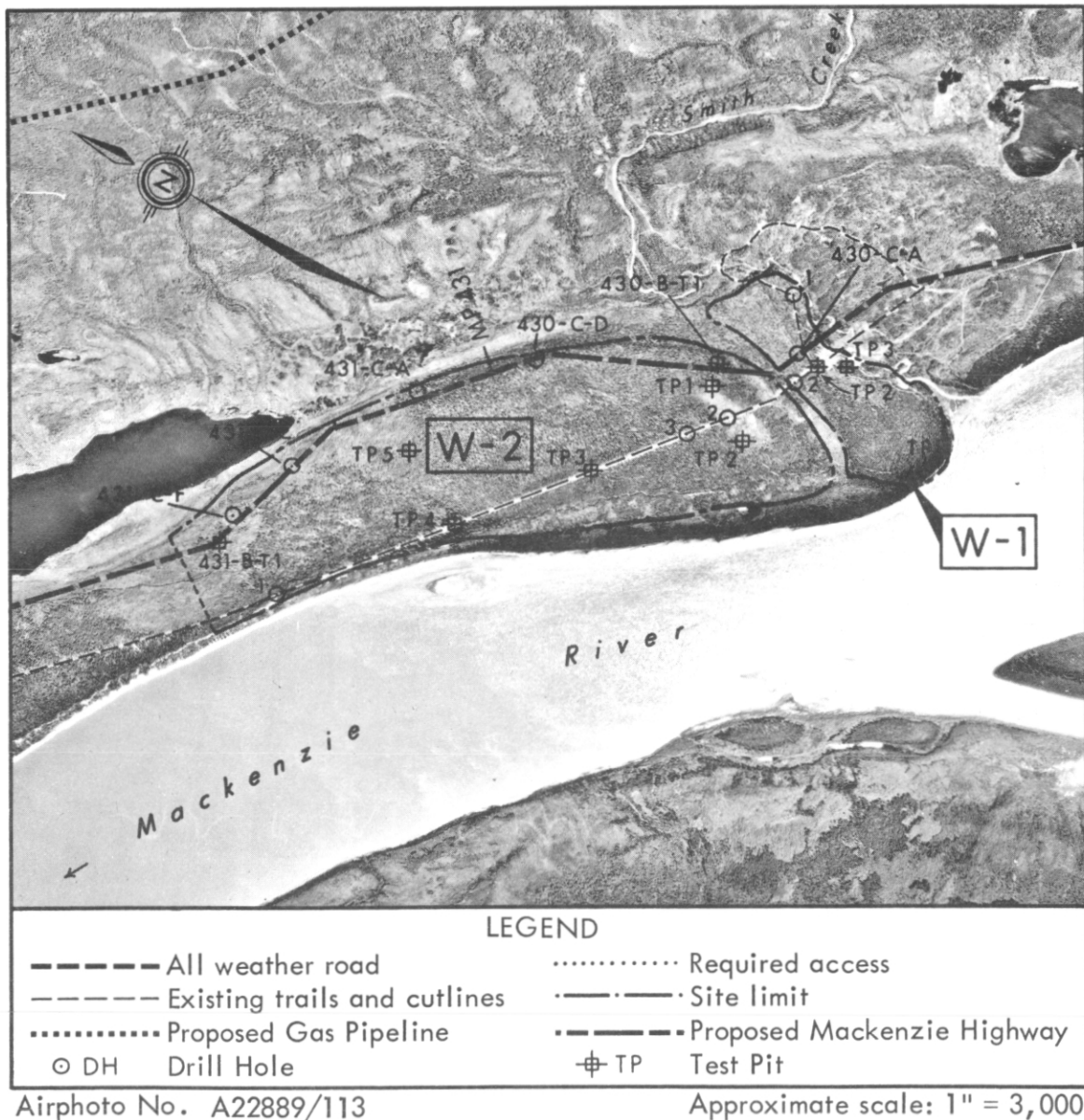
SITE NO. W 1

Located approximately $5\frac{1}{2}$ miles southeast of Wrigley, Site W 1 consists of a partly eroded terrace on the east bank of the Mackenzie River at the confluence of Smith Creek.

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

Estimated Volume: 5,000,000 cubic yards

Assessment: Excellent quality material for production of various categories of aggregates for construction requirements. Site W 1 is recommended for development as a source of granular materials.





ENVIRONMENT

Site W 1 is located approximately $5\frac{1}{2}$ miles southeast of Wrigley on the east bank of the Mackenzie River at the confluence of Smith Creek. The site consists of a partly eroded terrace along the northwestern bank of the deeply incised channel of Smith Creek. Site W 1 encompasses an area of approximately 4,000 by 1,500 feet.

The cliffs along the Mackenzie River and Smith Creek channels, rise 70 to 80 feet above the flowing water level and expose coarse gravel within the upper section of the cliffs. The gravel is well graded with some sand and traces of silt and is considered suitable for the production of most construction aggregates. The gravel from this site is quite resistant to abrasive action. An organic topsoil layer, $1\frac{1}{2}$ to 2 feet thick, mantles the entire site area. This topsoil layer supports dense growths of spruce, poplar, birch and occasional pine ranging in height from 20 to 50 feet and 3 to 15 inches in trunk diameter. The understory growth consists primarily of moss and small brush.

The site is within the broad migration flyway that is utilized by waterfowl during the spring and fall.

The access to the site currently consists of the winter road which flanks the CNT pole line and traverses through the center of the site. This road can be easily upgraded to an all weather status because it runs across another gravel terrace which extends to the town-site. The general drainage of the adjacent terrain is in an easterly direction into the watershed of Smith Creek.

DEVELOPMENT

The exploratory test pits and drill holes carried out on Site W 1 confirmed the following conditions relative to the quality and quantity of granular materials:

- The in situ gravels are well graded, medium to coarse grained and are very low in silt content. In addition, laboratory tests indicate these gravels are quite resistant to mechanical abrasion.
- The gravels are of excellent quality and are considered to be suitable for the production of all aggregate categories for construction requirements.
- The overburden, consisting of topsoil and fibrous peat layers, is relatively shallow, ranging in depth from $\frac{1}{2}$ to 3 feet.
- The drill holes were extended to a maximum depth of 15 feet but did not penetrate through the gravel stratum. The ground ice content in the frozen gravels is very low.

Site W 1 is considered to be an excellent source of granular materials for the community of Wrigley.



The following operational guidelines should be considered if this site is developed for extraction of granular materials:

- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.
- The organic topsoil layer should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.
- Operating procedures during borrow pit development should be maintained whereby surficial waste materials do not drain into the active Smith Creek or Mackenzie River channels.
- Relative to granular deposits immediately adjacent to Smith Creek or Mackenzie River, the development procedures should be commenced at the site area farthest removed from the water course. A vegetation buffer zone of adequate height and breadth should be maintained between the stream and the final limits of the borrow pit.
- A buffer zone of existing tree growth and related vegetation should be retained between borrow pit areas and the winter road or proposed Mackenzie Highway.
- Stands of natural growth should be retained between borrow pit areas in order to promote natural regeneration after abandonment.
- Generally, dozers, overhead loaders and standard ripping equipment should be adequate for the removal of material from this site. The in situ ground ice content is not considered to be a detrimental factor in the development and exploitation of granular materials from this site.
- The production of quality surface course and concrete aggregate material is considered possible by utilization of the granular materials from this site. However, a screening and crushing operation will have to be considered to produce aggregates to meet specific construction requirements for quality aggregates. In addition, a washing operation may be necessary to reduce the silt content for fine concrete aggregates.
- Additional laboratory tests to evaluate specific physical and chemical properties of the granular material is recommended, if material from this source is considered for the production of concrete aggregates.
- If the winter road is considered for the primary access to this site, then necessary upgrading procedures will have to be undertaken.
- The proposed Mackenzie Highway, when completed, would provide excellent all weather access to the community.



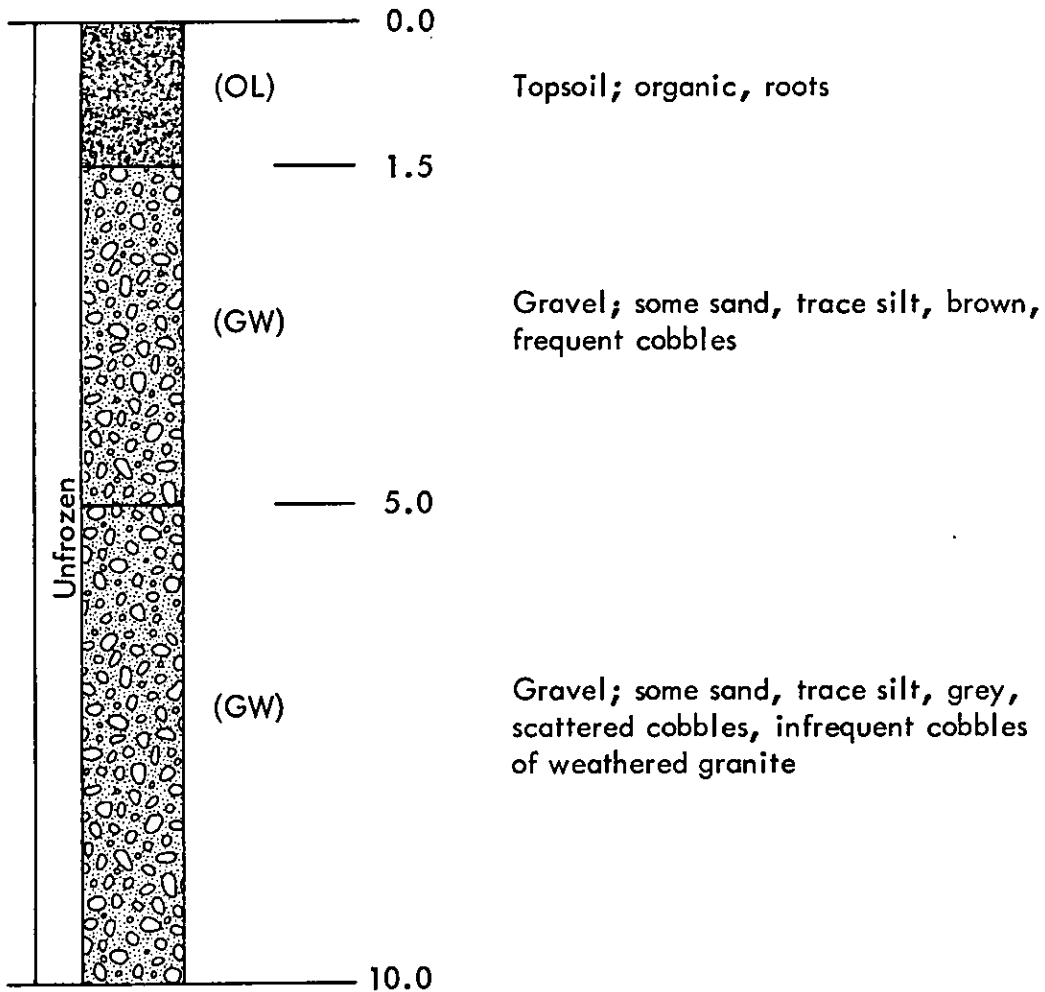
ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include:

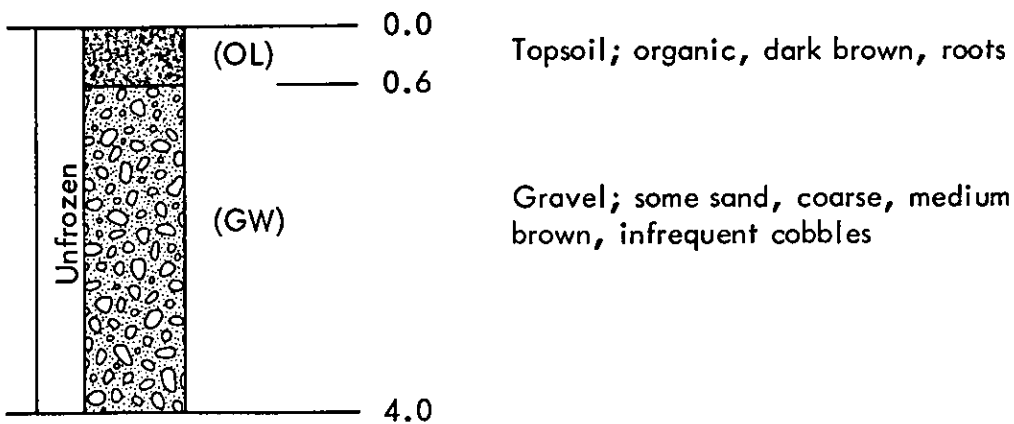
- Recontouring of the pit areas to provide general drainage that is compatible with the natural drainage of the adjacent terrain.
- Replacing stockpiled surficial waste material and organic topsoil on the abandoned recontoured pit areas.
- Reseeding of the recontoured pit areas should be considered in areas that may pose erosional problems. At these locations, the artificial reseeding of annuals and perennials will result in a semi-permanent cover growth prior to reestablishment of native species.

DETAILED TEST PIT LOG

W 1/TP 1

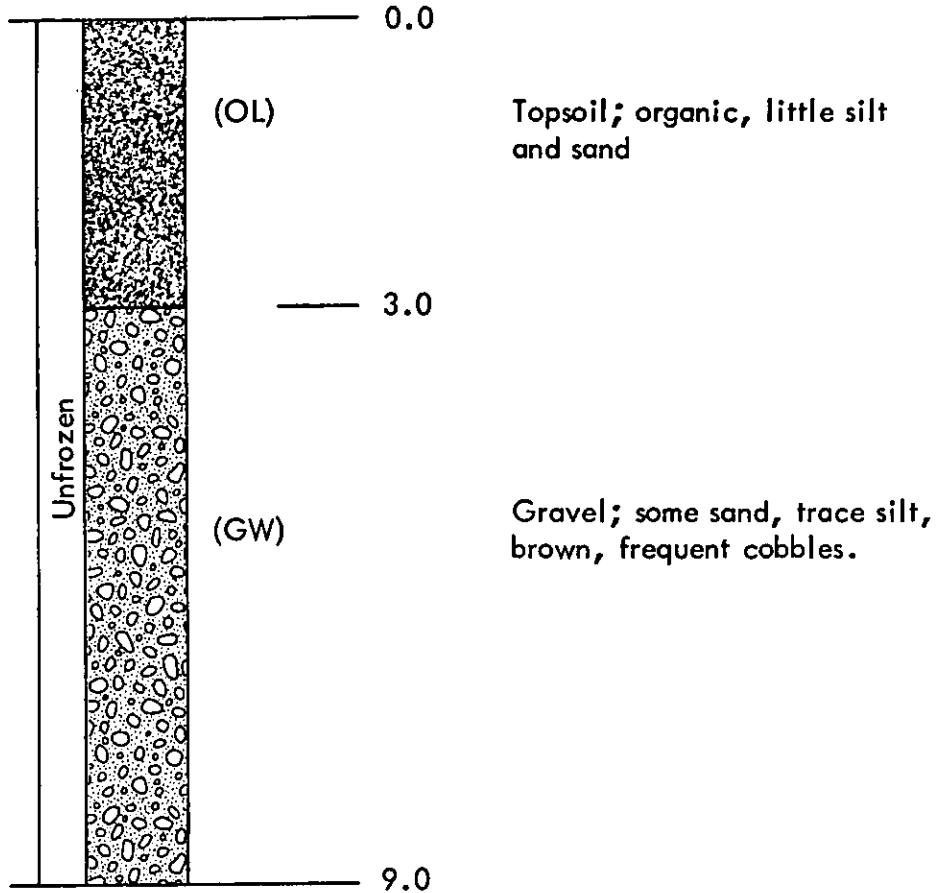


W 1/TP 2



DETAILED TEST PIT LOG

W 1/TP 3



DETAILED DRILL HOLE LOG



SITE NO. W 1

HOLE NO. DH-1

DATE: FEB. 11, 1973

LOGGED BY: ☒ PEMCAN ☐

DRILLING METHOD: ☐ 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		GW	GRAVEL: some sand, medium to coarse grained, well graded, frequent boulders, rust brown. (Approx. 55% of the pebbles were crushed or broken during drilling)		Nf	VL		0
2								2
4								4
6								6
8								8
10							G.S. O. P.	10
12								12
14								14
15.0								
16								16

15.0

TOTAL DEPTH 15.0'

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

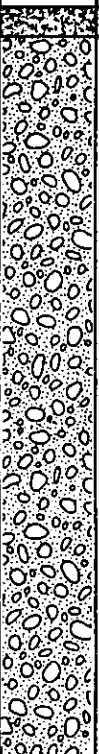

DETAILED DRILL HOLE LOG

SITE NO. W 1

HOLE NO. DH-2

DATE: FEB. 11, 1973 LOGGED BY: ☒ PEMCAN ☐

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

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE EST'D CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS				
0		Pt	PEAT: organic, fibrous, muskeg		Vx	M			0
2		GW	0.5		NF	VL			2
4			GRAVEL: some sand, well graded, medium to coarse grained, frequent boulders, rust brown						4
6									6
8			- becoming predominantly sandy with pebbles to 1/2" at 8.0' to 10.0'					MC	8
10									10
12			12.0						12
14			TOTAL DEPTH 12.0'						14

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG


SITE NO. W 1

HOLE NO. C A

DATE: FEB. 17, 1973		LOGGED BY:		<input type="checkbox"/> PEMCAN	<input checked="" type="checkbox"/> ACRES CONSULTING			
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR CIRCULATION <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:								
DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0								0
1		SW	Brown silty Sand and Gravel		Nf			1
2								2
3								3
4								4
5			5.0					5
			END OF HOLE 5.0'					
			Material kept caving and hole would not remain open to use casing					

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

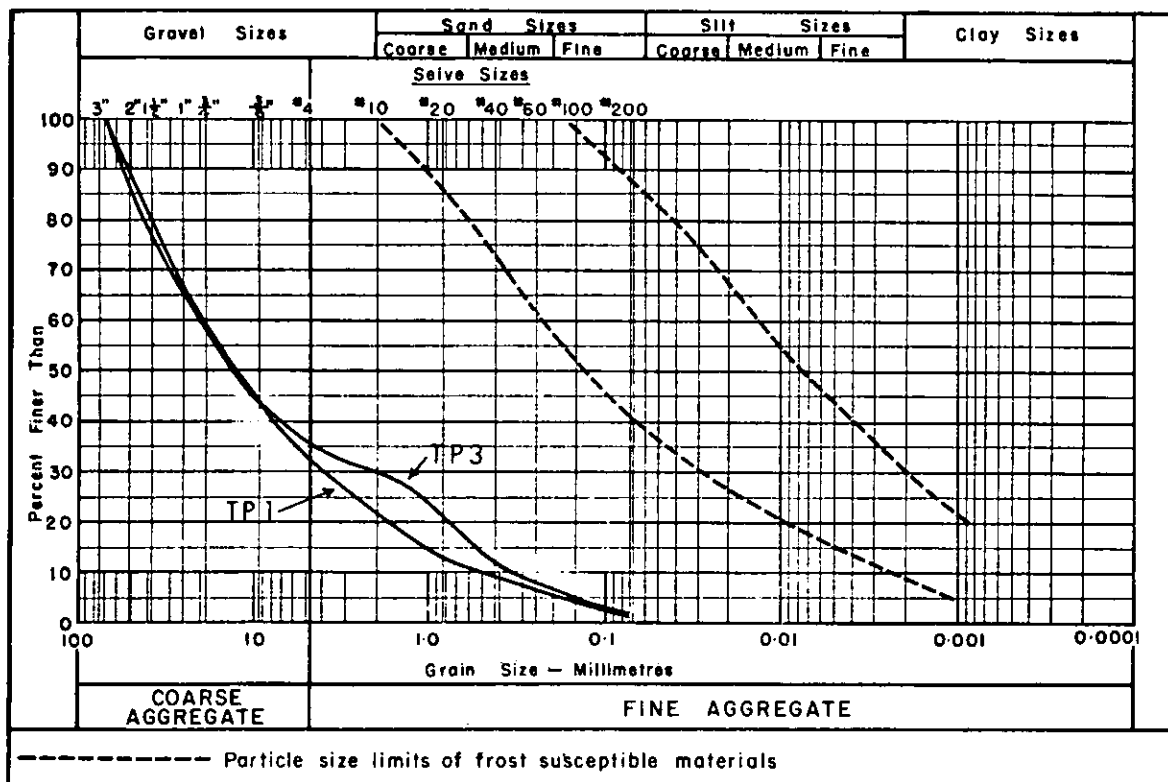


PEMCAN SERVICES "72"

SUMMARY OF LABORATORY TEST DATA

Sample Location:	W 1/TP 1	W 1/TP 3
Sample Depth (Feet):	10.0	4.0
Moisture Content (%):	-	-
Ice Content (%):	-	-
Organic Content (%):	-	-

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS:

Dolostone	48.5 %	Limestone	4.2 %
Granite, syenite	18.7 %	Chert	1.5 %
Quartzite	18.1 %		
Deleterious ferruginous material	6.0 %		
Deleterious marlstone	3.1 %		

L.A. ABRASION TEST:

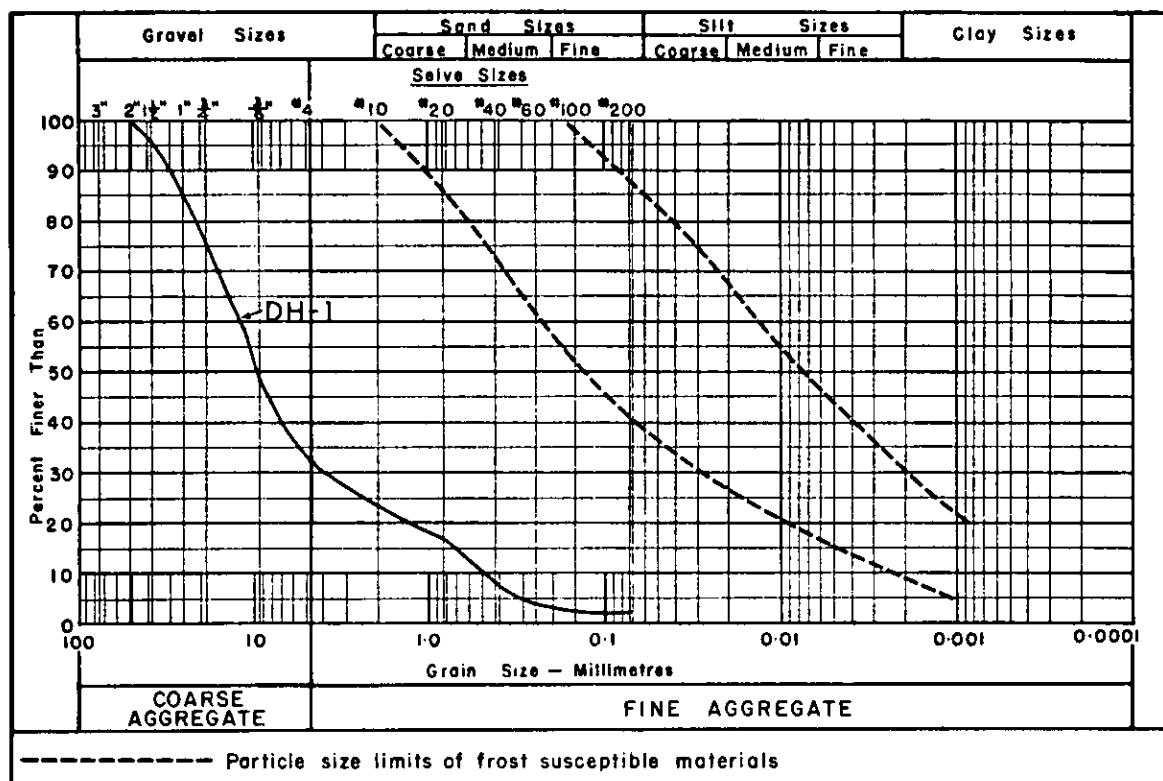
Percent loss	18.2 %
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1-10

SUMMARY OF LABORATORY TEST DATA

Sample Location:	W 1/DH 1	W 1/DH 2
Sample Depth (Feet):	6.0 - 9.0	8.0 - 10.0
Moisture Content (%):	-	1.9
Ice Content (%):	-	-
Organic Content (%):	1.94	-

GRAIN SIZE DISTRIBUTION:



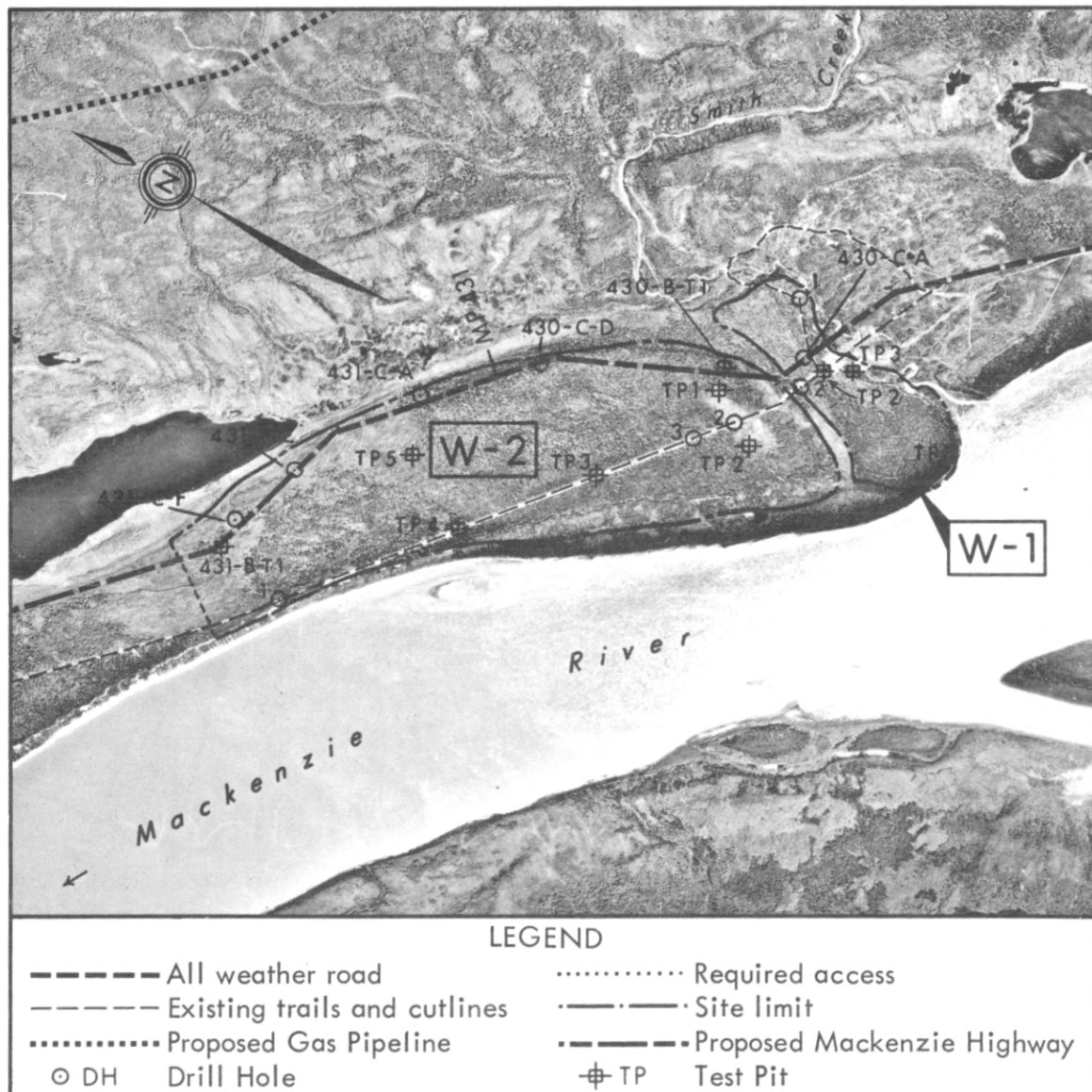
SITE NO. W 2

Located approximately 4 miles southeast of Wrigley, Site W 2 is a large river terrace located immediately adjacent and parallel to the east bank of the Mackenzie River.

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

Estimated Volume: 40,000,000 cubic yards.

Assessment: Excellent quality material for the production of all types of construction aggregates. Good access to Wrigley. This site is recommended as a major source of granular materials for the community.



Airphoto No. A22889/112

Approximate scale: 1" = 3,000'



ENVIRONMENT

Site W 2 is located approximately 4 miles southeast of Wrigley immediately adjacent and parallel to the east bank of the Mackenzie River. This site is immediately downstream from Site W 1 and consists of a large river terrace. The site encompasses an area approximately 9000 by 2500 feet. An infilled glacial melt water channel flanks the eastern boundary of Site W 2.

The granular material encountered at this site consists of well graded, coarse gravels with some sand and a trace of silt. The gravels are relatively resistant to abrasive action.

An organic silty topsoil horizon, 1 to 2 feet in depth, overlies the entire site area and supports a dense growth of spruce with occasional clusters of birch, poplar and pine. The tree growth ranges from 30 to 50 feet in height and 4 to 15 inches in trunk diameter. The understory growth consists primarily of moss with some sedge grass and small bushes.

There are no known critical wildlife areas in the vicinity of the site; however, the site is within the broad migration flyway that is utilized by waterfowl during the spring and fall seasons (Figure 2).

The winter road which flanks the CNT pole line traverses the western length of the entire site area. In addition, the proposed Mackenzie Highway is routed along the eastern flank of the site area, paralleling the melt water channel and existing lake shorelines.

DEVELOPMENT

The information obtained from the exploratory test pits and drill holes, carried out on Site W 2, has confirmed the following conditions relative to the quality and quantity of granular materials encountered:

- The available granular materials consist of well graded, medium to coarse grained, clean gravels which are relatively resistant to mechanical abrasion. These gravels are considered suitable for the production of aggregates for most categories of construction.
- The overburden, consisting of topsoil, fibrous peat and organic silts is relatively shallow, ranging in depth from $\frac{1}{2}$ to $2\frac{1}{2}$ feet.
- The drill holes were extended to a maximum depth of 12 feet but did not penetrate the in situ gravel stratum. Field observations indicate that the ground ice content is very low.

Site W 2 is considered as a major source of granular materials for the community of Wrigley. The following operational guidelines should be considered during the development of this site for granular materials.



- The development of borrow pit areas for the granular material needs of Wrigley should be commenced at the extreme northwestern extremities of the site area.
- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.
- The organic topsoil layer should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.
- Operating procedures during borrow pit development should be maintained whereby surficial waste materials do not drain into the active Mackenzie River channel.
- A vegetation buffer zone of adequate height and breadth should be maintained between the outer limits of the borrow pit and the east shoreline of the Mackenzie River. A similar buffer zone should be retained between the borrow pit locations and the winter road or proposed Mackenzie Highway route.
- Stands of natural growth should be retained between pit areas in order to facilitate regrowth through natural regeneration.
- The use of dozers, overhead loaders and conventional ripping equipment should adequately remove the material from this site. The in situ ground ice content is not considered to be a detrimental factor in the development and extraction of granular materials.
- The production of quality surface course and concrete aggregate material is anticipated. The production of higher quality aggregates will dictate the need of screening or crushing plants to ensure aggregate properties for specified construction requirements.
- Additional laboratory tests to evaluate specific physical and chemical properties of the granular materials will be required, if the material is to be considered for the production of concrete aggregates. In addition, a washing operation may be required to reduce the silt content to within acceptable limits for fine concrete aggregates.
- The existing winter road and the proposed Mackenzie Highway provides excellent current and future access to this site.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include the following:

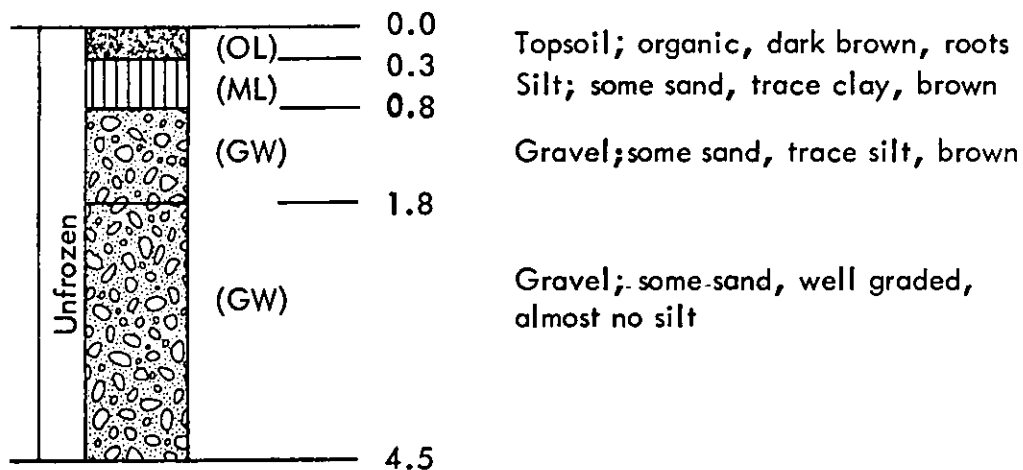
- Recontouring of abandoned pit areas to provide general drainage that is compatible with the natural drainage of the adjacent terrain.
- Replacing stockpiled surficial waste material and organic topsoil on the abandoned and recontoured pit areas.



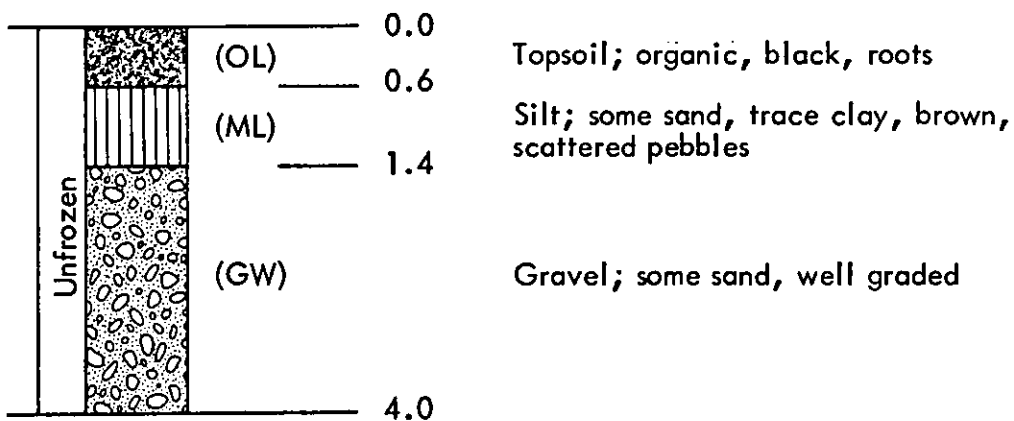
- Revegetation of the recontoured areas should be considered, especially in potential erosion cases where the artificial reseeding of annuals and perennials will result in a semi-permanent cover growth prior to reestablishment by native species.

DETAILED TEST PIT LOG

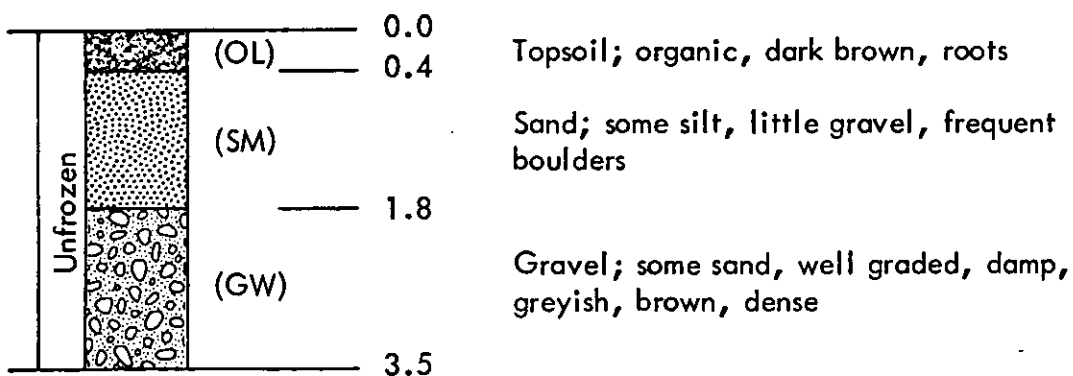
W 2/TP 1



W 2/TP 2

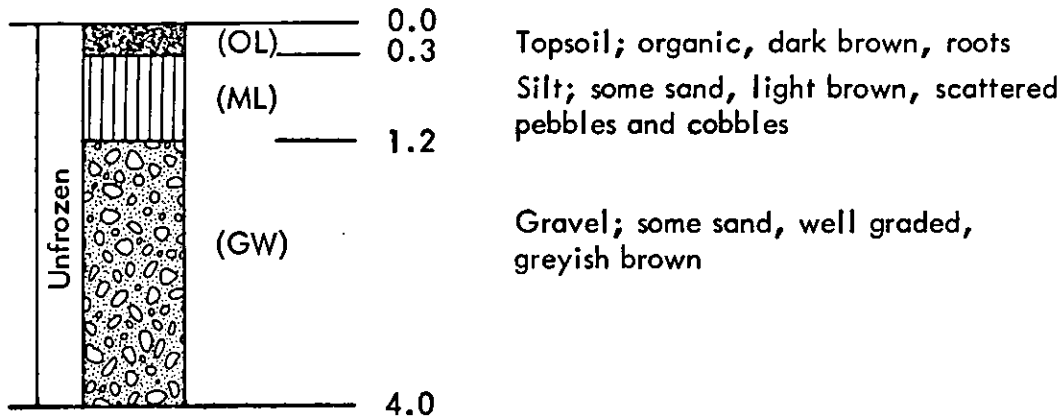


W 2/TP 3

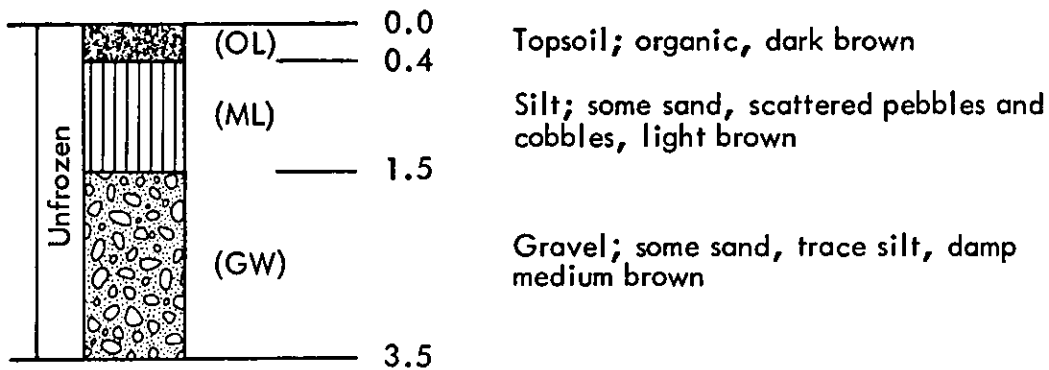


DETAILED TEST PIT LOG

W 2/TP 4



W 2/TP 5



DETAILED DRILL HOLE LOG

SITE NO. W 2

HOLE NO. DH-1

DATE: FEB. 11, 1973 LOGGED BY: ☒ PEMCAN ☐

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

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE EST'D CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS				
0		OL	TOPSOIL: some silt and organic, medium brown		Vr		M		0
1									1
2		GP	GRAVEL: some sand, little silt, poorly graded, frequent large boulders, brown		Nf		VL		2
3									3
4									4
5									5
6									6
7									7
8									8
9									9

1.5

8.0

TOTAL DEPTH 8.0'

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY









PEMCAN SERVICES "72"


DETAILED DRILL HOLE LOG

SITE NO. W 2

HOLE NO. DH-2

DATE: FEB. 11, 1973		LOGGED BY: <input checked="" type="checkbox"/> PEMCAN <input type="checkbox"/>	
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:			

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt	PEAT: organic, fibrous, muskeg					0
0.5					Nbn	L		2
2		ML	SILT: some sand, light brown		Nf	VL		4
4		SM-SP	SAND: little silt, few large boulders					6
4.5				Nbn	L		8	
6		MC-ML	SILT: some clay and sand, frequent pebbles to 1/2", medium brown becoming medium grey (TILL)				10	
8							12	
10							14	
12			TOTAL DEPTH 12.0'					
14								

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



DETAILED DRILL HOLE LOG

SITE NO. W 2

HOLE NO. DH-3

DATE: FEB. 11, 1973 LOGGED BY: ☒ PEMCAN ☐

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

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)		
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.				
0		Pt	0.5 PEAT: organic, fibrous, muskeg		N	L		0		
1		GW	GRAVEL: some sand, little silt, well graded, frequent boulders, brown		Nf	VL		1		
2								2		
3								3		
4								4		
5								5		
6								6		
7								7		
8								8		
9								9		
10								10		

- becoming sandier at 6.0'

9.0 TOTAL DEPTH 9.0'
HOLE CAVES IN

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"



DETAILED DRILL HOLE LOG

SITE NO. W 2

HOLE NO. C A

DATE: FEB. 17, 1973 LOGGED BY: ☐ PEMCAN ☒ ACRES CONSULTING

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

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		GP	Brown Sand and Gravel with some cobbles		Nf		MC	0
1								1
2								2
3								3
4								4
5								5
6								6
7								7
8								8
9								9
10			10.0 — END OF HOLE 10.0'					10

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

DETAILED DRILL HOLE LOG

SITE NO. W 2

HOLE NO. C C

DATE: FEB. 17, 1973 LOGGED BY: ☐ PEMCAN ☒ ACRES CONSULTING

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

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			ICE CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.			
0		GP	Brown sandy Gravel with some cobbles		Nf			MC	0
2									2
4									4
6									6
8									8
10									10
12									12
14									14
15.0									15.0
16									16
			END OF HOLE 15.0'						

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



DETAILED DRILL HOLE LOG

SITE NO. W 2

HOLE NO. C D

DATE: FEB. 17, 1973 LOGGED BY: ☐ PEMCAN ☒ ACRES CONSULTING

DRILLING METHOD: ☒ 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		GP	Brown Sand and Gravel		Nf			0
2								2
4								4
6								6
8								8
10								10
11.0								11.0
12								12
			END OF HOLE 11.0'					

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"



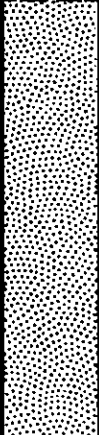

DETAILED DRILL HOLE LOG

SITE NO. W 2

HOLE NO. C F

DATE: FEB. 18, 1973 LOGGED BY: ☐ PEMCAN ☒ ACRES CONSULTING

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

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE CONT.		
0		ML	Brown Sand and Silt with some Clay and a trace of Gravel		Nbn			0
2							MC	2
4								4
6								6
8		SM	Brown Sand with some Silt and a trace of Clay		Nbn		MC	8
10								10
12							MC GS	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

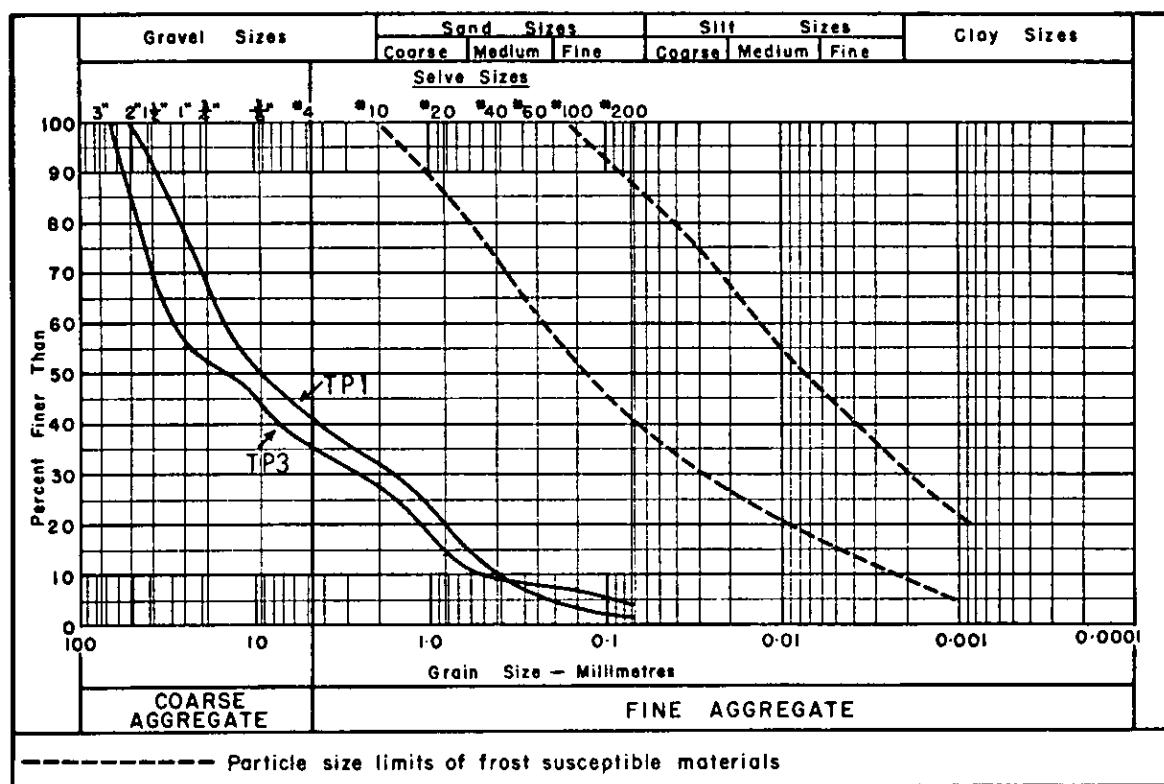


PEMCAN SERVICES "72"

SUMMARY OF LABORATORY TEST DATA

Sample Location:	W 2/TP 1	W 2/TP 3	W 1/TP 4
Sample Depth (Feet):	2.5	2.5	3.0
Moisture Content (%):	-	-	8.7
Ice Content (%):	-	-	-
Organic Content (%):	-	-	-

GRAIN SIZE DISTRIBUTION:



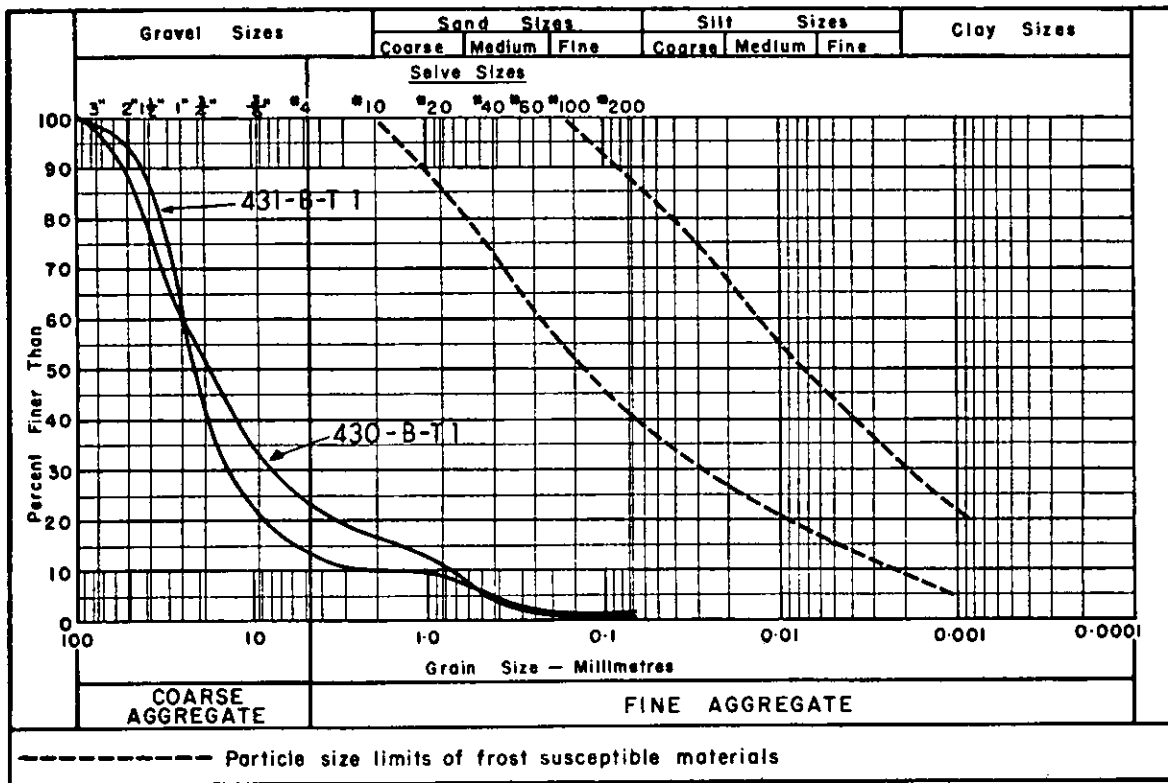
PETROGRAPHIC ANALYSIS:

Syenite, granite	43.7 %	Dolostone	11.3 %
Quartzite	16.9 %	Chert	6.9 %
Limestone	15.9 %		
Deleterious marlstone	4.3 %		
Deleterious mica schist	0.8 %		

SUMMARY OF LABORATORY TEST DATA

Sample Location:	W 2/430-BT 1	W 2/431-BT 1
Sample Depth (Feet):	-	-
Moisture Content (%):	-	-
Ice Content (%):	-	-
Organic Content (%):	-	-

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS:

SUMMARY OF MOISTURE CONTENT DETERMINATIONS

<u>Sample Location</u>	<u>Sample Depth (Ft.)</u>	<u>Moisture Content (%)</u>
W 2/430-C-D	2.5-7.5	2.0
W 2/431-C-A	2.5	3.0
W 2/431-C-A	7.5	1.5
W 2/431-C-C	2.5	2.0
W 2/431-C-C	7.5-12.5	3.0
W 2/431-C-F	2.5	14.0
W 2/431-C-F	7.5	19.5
W 2/431-C-F	12.5	9.0

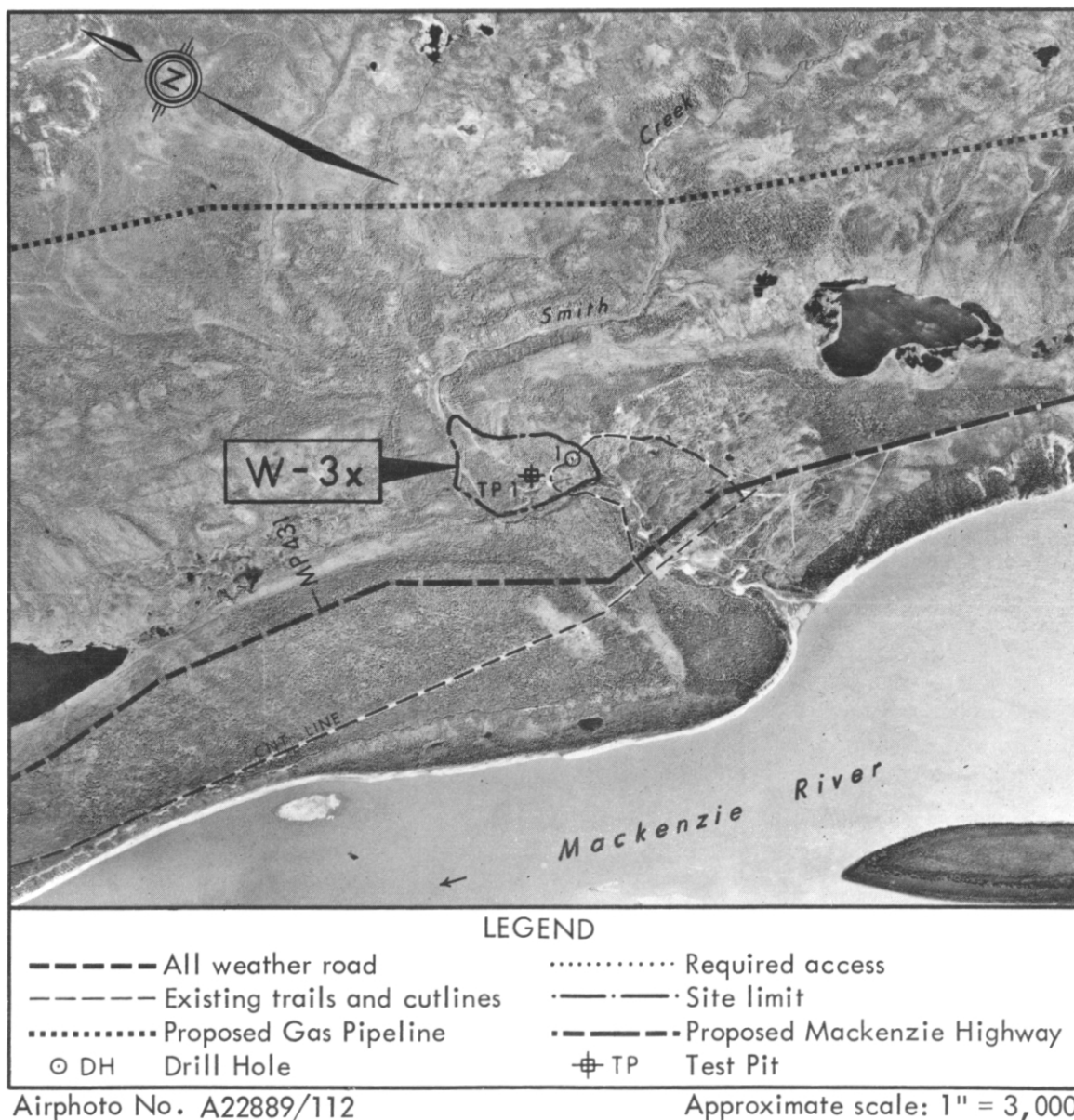
SITE NO. W 3X

Located approximately 6 miles southeast of Wrigley, Site W 3X consists of a low alluvial terrace along the south shoreline of Smith Creek.

Type of Material: Gravel and Silt; poorly graded, stratified.

Estimated Volume: 1,000,000 cubic yards.

Assessment: This site is not recommended for development because other sites with better quality granular material and better access are available in the Study Area.





ENVIRONMENT

Site W 3X is located approximately 6 miles southeast of Wrigley along the south bank of Smith Creek and approximately 1 mile upstream from the mouth of Smith Creek. The site is situated above the present water channel and consists of an alluvial terrace. The site encompasses an area of approximately 3000 feet by 400 feet.

The material at this site consists of shallow layers of poorly graded gravel interspersed with silt, clay and sand beds. An overlying organic topsoil layer, $1\frac{1}{2}$ feet thick, supports clustered growths of spruce, birch and poplar in the site area. The tree growth ranges in height from 20 to 50 feet and 3 to 10 inches in trunk diameter. The understory growth consists primarily of moss, sedge grass and small bushes.

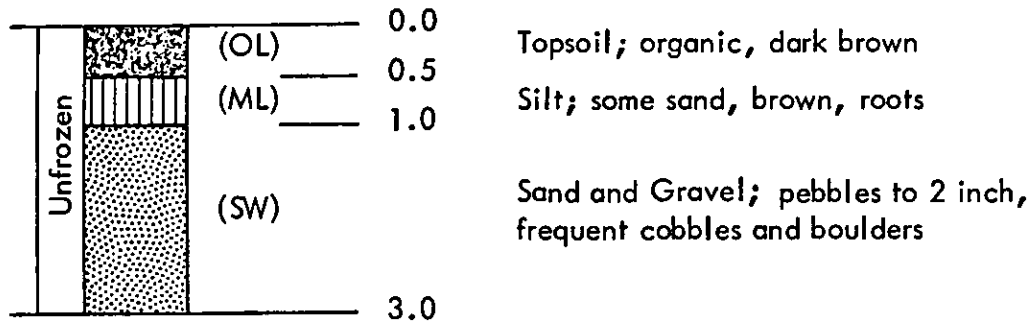
The surficial and underground flow from adjacent slopes and slide areas are partly directed into this terrace and because of stratified material a relatively high ground water table can be expected. The site itself is drained into the stream channel.

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

The winter road traverses through the western extremity of the site area. However, since the site is located on the southern side of Smith Creek, a stream crossing is required to transport any material from this site to the community of Wrigley.

DETAILED TEST PIT LOG

W 3/TP 1



DETAILED DRILL HOLE LOG

SITE NO. W3X

HOLE NO. DH-1

DATE: FEB. 11, 1973 LOGGED BY: ☒ PEMCAN ☐

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

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		Pt	TOPSOIL: organic, fibrous		Vx	L		0
2		GP-GW	GRAVEL: some sand, medium to coarse grained, frequent boulders, rust brown		Nf	VL		2
4		ML-CL	SILT: some clay, frequent pebbles to 1" size, medium grey (TILL LIKE)		Vs	M		4
6								6
8								8
10								10
12								12
14								14
16								16
		GM-GP	GRAVEL: some silt, poorly graded, medium grey, wet	UF				
			TOTAL DEPTH 15.0'					

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

SUMMARY OF LABORATORY TEST DATA

Sample Location: W 3X/TP 1

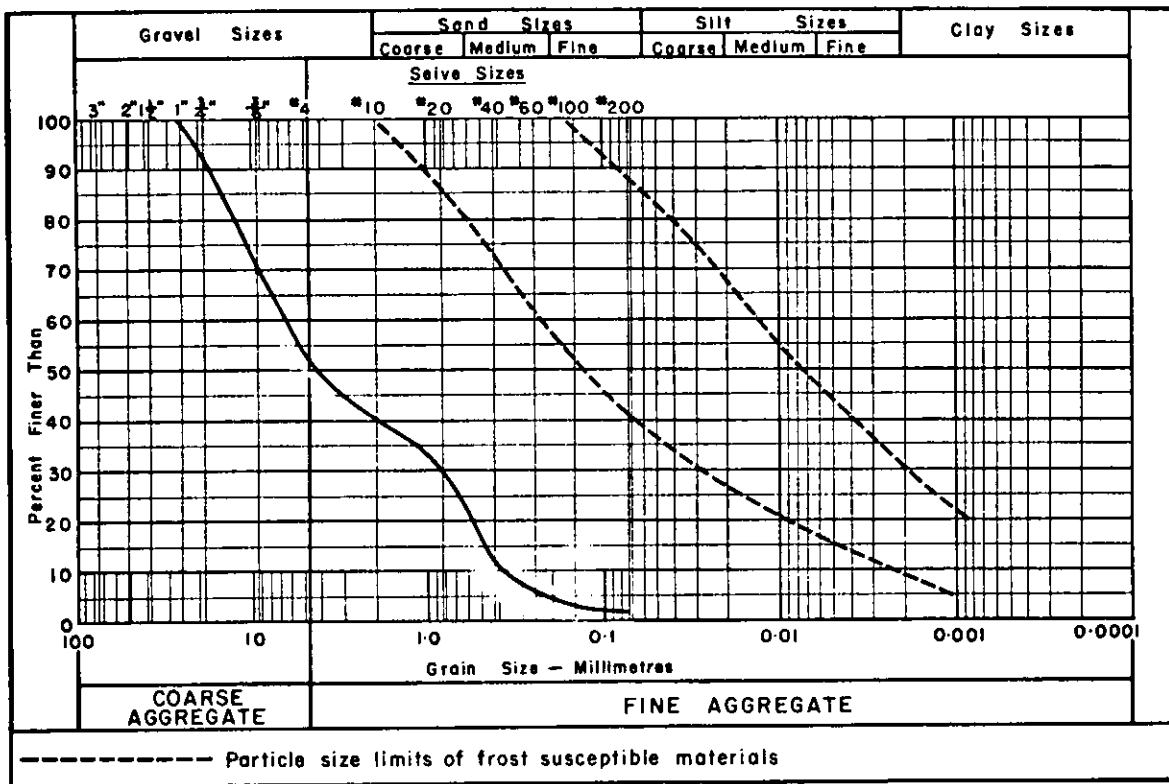
Sample Depth (Feet): 2.0

Moisture Content (%): 6.7

Ice Content (%): -

Organic Content (%): -

GRAIN SIZE DISTRIBUTION:

**PETROGRAPHIC ANALYSIS:**

Limestone and dolomite	41.1 %	Cherts	3.5 %
Igneous Material	27.6 %	Sandstone,	
Quartzites	22.7 %	siltstone	4.8 %

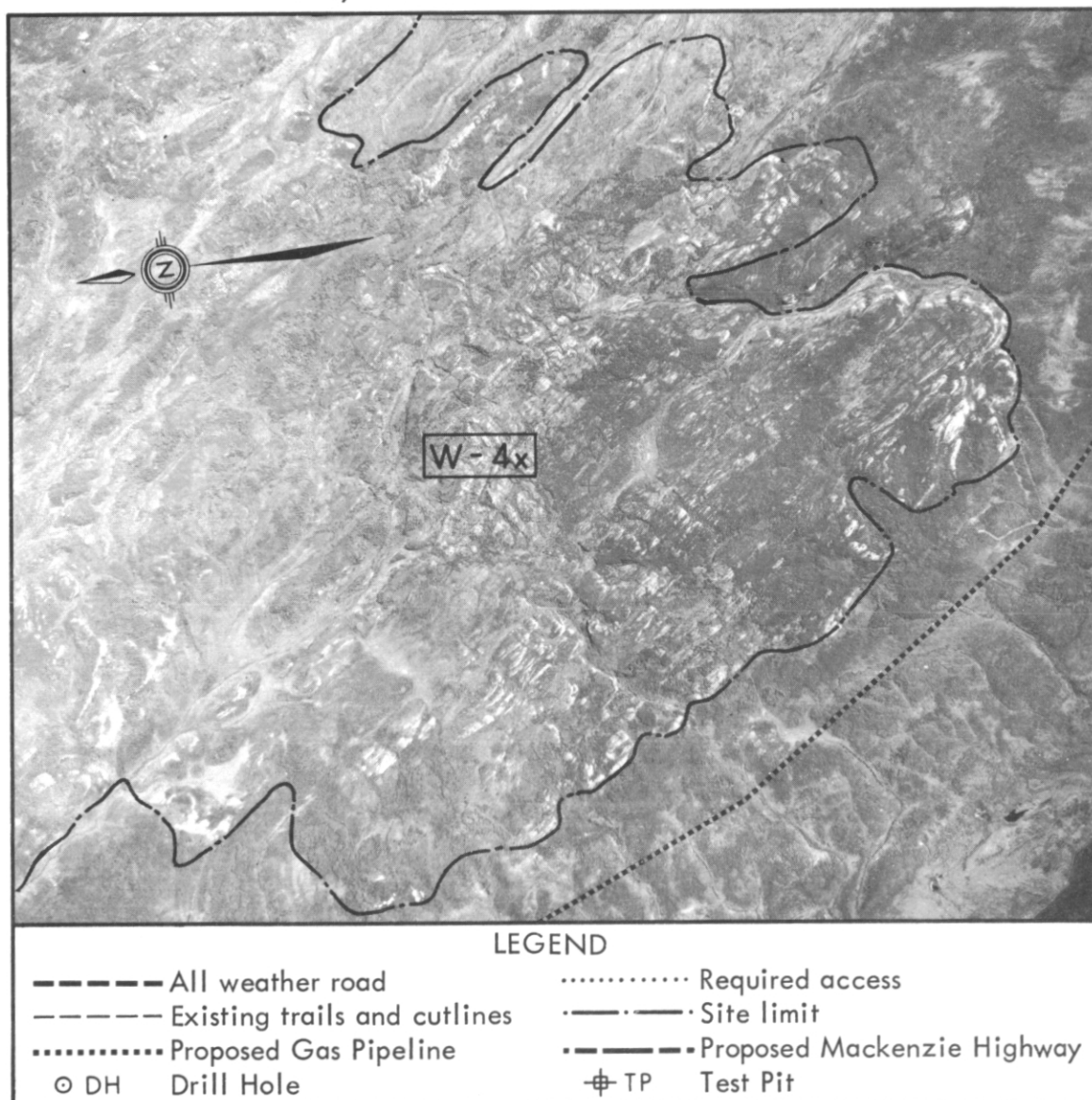
SITE NO. W 4X

Located approximately $2\frac{1}{2}$ miles east of Wrigley, Site W 4X encompasses the southern and western portions of the McConnell Range. Quarries can be located and developed at numerous bluffs along the base of the mountain range.

Type of Material: Limestone; brecciated dolomite

Estimated Volume: Unlimited

Assessment: This site is not recommended for development because quarry operations would be required. Other sources of excellent quality granular materials are available at more accessible sites in the Study Area.



Airphoto No. A13290/113

Approximate scale: 1" = 3,800'



ENVIRONMENT

Site W 4X is located approximately $2\frac{1}{2}$ miles east of Wrigley and consists of the western flank of the McConnell Range. The site encompasses the entire eastern quarter of the community Study Area. Hodgson Creek which discharges into the Mackenzie River immediately adjacent to the north side of Wrigley, has its head waters located in the McConnell Range.

The bedrock material in Site W 4X consists of:

- Devonian Limestone of the Nahanni Formation located at the southwestern toe of the McConnell Range.
- Devonian Limestone breccia of the Bear Rock Formation noted in numerous exposures in the Hodgson Creek valley.
- Dolomite of the Mount Kindle and Franklin Formations forming the central portion of the McConnell Range.

The bedrock formations are extensively faulted and the rock massif is rugged with frequent gullies. Scree and talus slopes mantle the downslope portions of the rock exposures. Spruce and occasional birch are the most common types of ground cover.

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

The existing access to the base of Site W 4X consists of the winter road and seismic cutlines or trails. The proposed gas pipeline and Mackenzie Highway routes are located at the base of the rock massif and generally parallel the McConnell Range in the vicinity of the Wrigley Study Area.

DEVELOPMENT

Site W 4X is not recommended for development because extensive quantities of excellent quality granular materials are available in the Wrigley Study Area at closer and more accessible sites. Any development of aggregates from Site W 4X would entail a quarry operation with extensive blasting and crushing. The access from the community would involve the crossing of localized zones of thermally sensitive terrain, northeast of Wrigley, or steeply sloping terrain bordering the southern section of the McConnell Range.

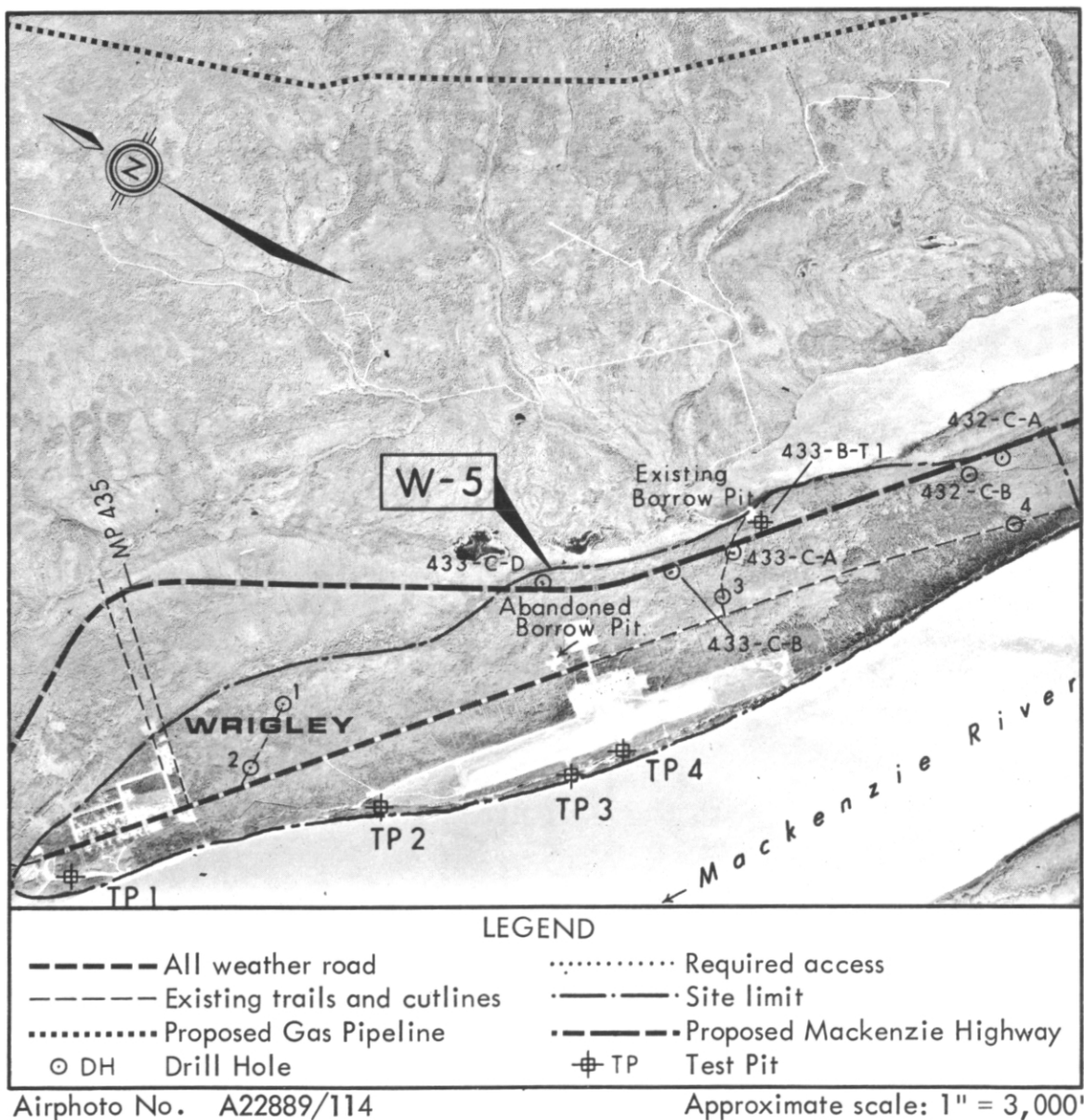
SITE NO. W 5

Located in the immediate vicinity of Wrigley, along the eastern bank of the Mackenzie River, Site W 5 consists of a large high river terrace.

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

Estimated Volume: 10,000,000 cubic yards

Assessment: Excellent quality material for the production of various types of construction aggregates. This source is recommended as the primary source for granular materials for the community of Wrigley.





ENVIRONMENT

Site W 5 encompasses the existing Wrigley townsite and airstrip and incorporates an area approximately 3 miles in length and $\frac{1}{2}$ mile in width. The site represents the northern half of a high fluvial terrace some 6 miles in length. The southern segment of this terrace forms Site W 2. The Mackenzie River and a large lake at the end of a glacial melt water channel form the western and eastern boundaries of Site W 5, respectively.

The in situ material at Site W 5 consists of fluvial sand and gravels of possible early post glacial age. The sand and gravels are partially stratified, medium to coarse grained, well graded and contain occasional cobbles and boulders. A thin organic topsoil layer, 6 inches in depth, is underlain by approximately $1\frac{1}{2}$ feet of lacustrine silts and supports moderately dense growths of spruce with occasional pine.

There are no known critical wildlife areas in the immediate vicinity of the site. The proximity of the site to the townsite and airport negates any severe wildlife implications.

The site area is well drained with drainage into the Mackenzie River on the west and into the melt water channel on the east. A borrow pit is currently being operated on the southwest shore of the large lake (ref.: Site Airphoto, Page 5-1). This borrow pit has existing access roads to the Wrigley townsite.

The existing winter road which traverses the entire south to north length of the site area, provides excellent access for any future development of borrow pits.

DEVELOPMENT

The data obtained from the test pits and drill holes indicates the following features relative to the quality and quantity of granular materials available at Site W 5:

- The granular materials consist of well graded, medium to coarse grained, clean gravels which are relatively resistant to mechanical abrasion. These gravels are considered suitable for the production of aggregates for most construction requirements.
- The overburden consisting of topsoil varies from 1 to 2 feet in depth.
- The drill holes, which were extended to a maximum depth of 15.0 feet, did not penetrate the in situ gravel stratum. Field observations indicate that the ground ice content is very low.

Site W 5 represents a major source and possibly the primary source of granular materials for the community of Wrigley because of the excellent quality of available materials and its immediate accessibility. The following guidelines should be considered for the development of granular materials from this site:

- The development of borrow pit areas for granular materials should be commenced at the



extreme southeastern extremities of the site area.

- The regional community planning guidelines relative to the future development of the Wrigley townsite should be considered prior to the selection of future borrow pit areas.
- The existing tree growth and related vegetation should be cleared and removed in accordance with current land use guidelines.
- The organic topsoil layer should be stripped, removed and stockpiled adjacent to the borrow pit areas in designated locations.
- Operating procedures during borrow pit development should be maintained whereby surficial waste materials do not drain into the active Mackenzie River channel or adjacent lakes.
- An adequate vegetation buffer zone should be maintained between the outer limits of the borrow pits and the east shoreline of the Mackenzie River. A similar buffer zone should be retained between the borrow pit locations and any utility such as the existing winter road or proposed Mackenzie Highway.
- Stands of natural growth should be retained between pit areas in order to facilitate regrowth through natural regeneration.
- The use of dozers, overhead loaders and conventional ripping equipment should adequately remove the material from this site. However, the extent of ground ice in this granular source appears to be quite minimal and will not adversely affect the borrow pit operations.
- The production of quality surface course and concrete aggregate material is anticipated. The production of higher quality aggregates will dictate the need of screening or crushing plants to ensure aggregate properties for specified construction requirements.
- Additional laboratory tests to evaluate specific physical and chemical properties of the granular materials will be required, if the material is to be considered for the production of concrete aggregates. In addition, a washing operation may be required to reduce the silt content to within acceptable limits for fine concrete aggregates.
- The existing winter road provides excellent current access to this site.

ABANDONMENT AND REHABILITATION

Abandonment and rehabilitation procedures should include the following:

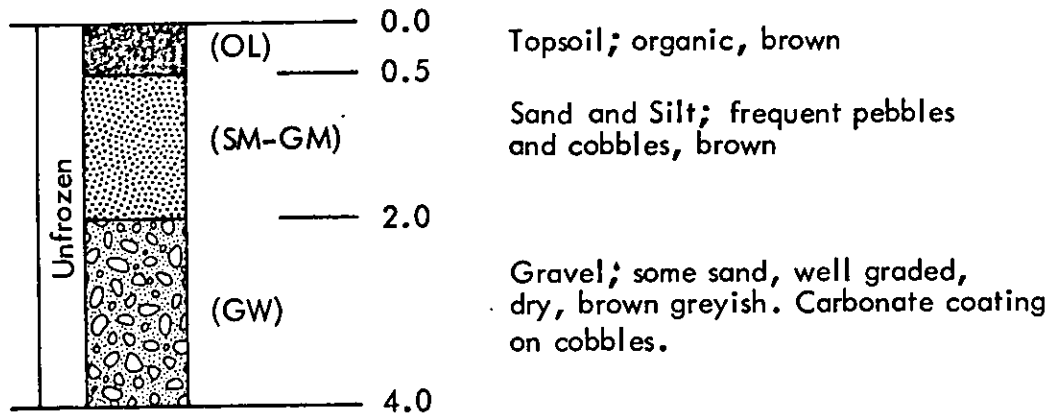
- Recontouring of abandoned pit areas to provide general drainage that is compatible with the natural drainage of the adjacent terrain.



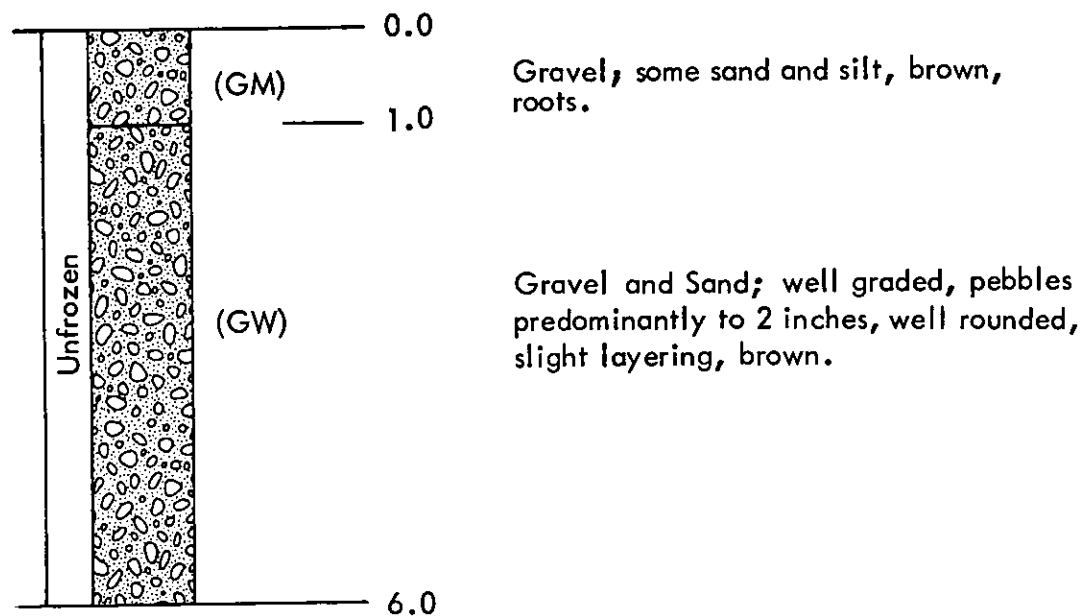
- Replacing stockpiled surficial waste material and organic topsoil on the abandoned and recontoured pit areas.
- Revegetation of the recontoured areas should be considered, especially in potential erosion cases where the artificial reseeding of annuals and perennials will result in a semi-permanent cover growth prior to reestablishment by native species.

DETAILED TEST PIT LOG

W 5/TP 1

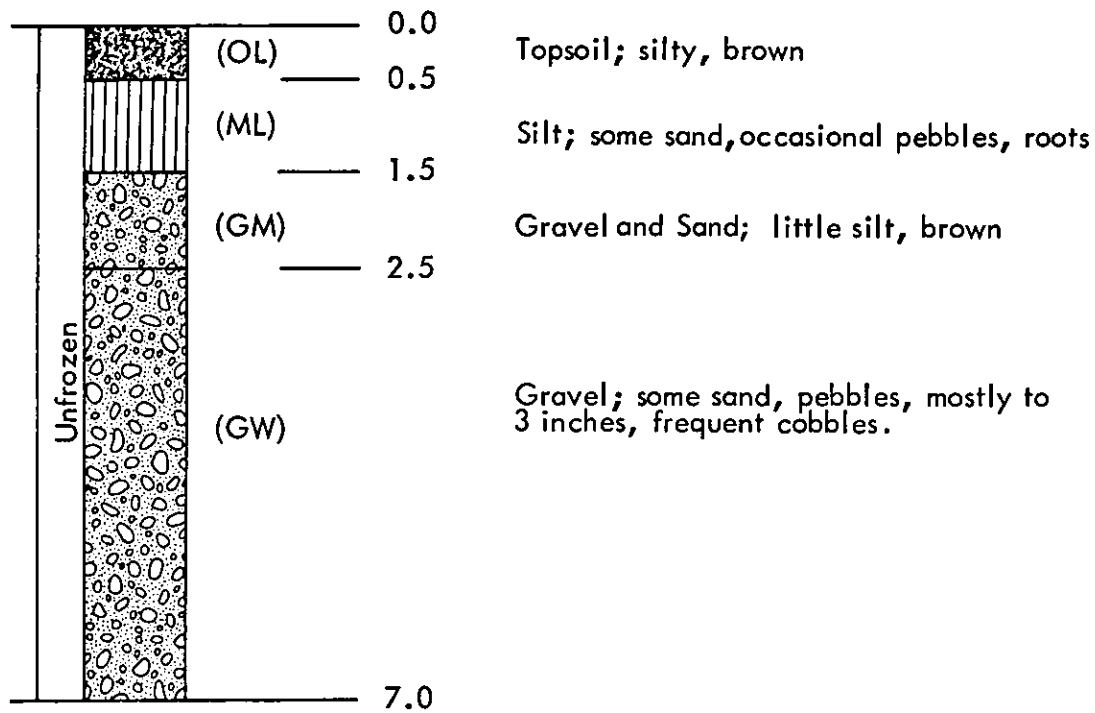


W 5/TP 2

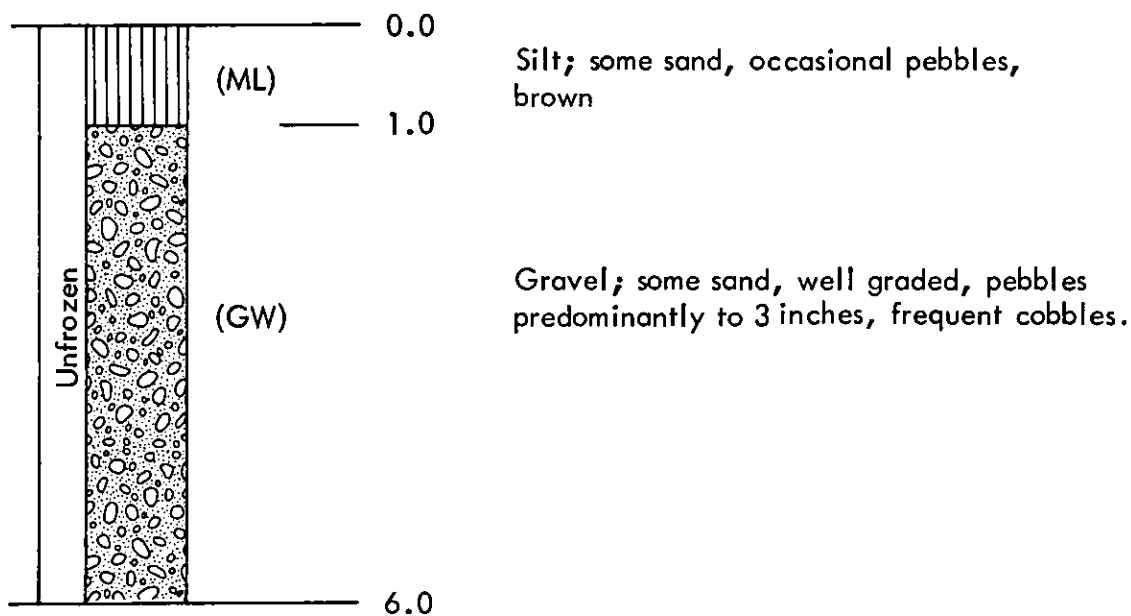


DETAILED TEST PIT LOG

W 5/TP 3

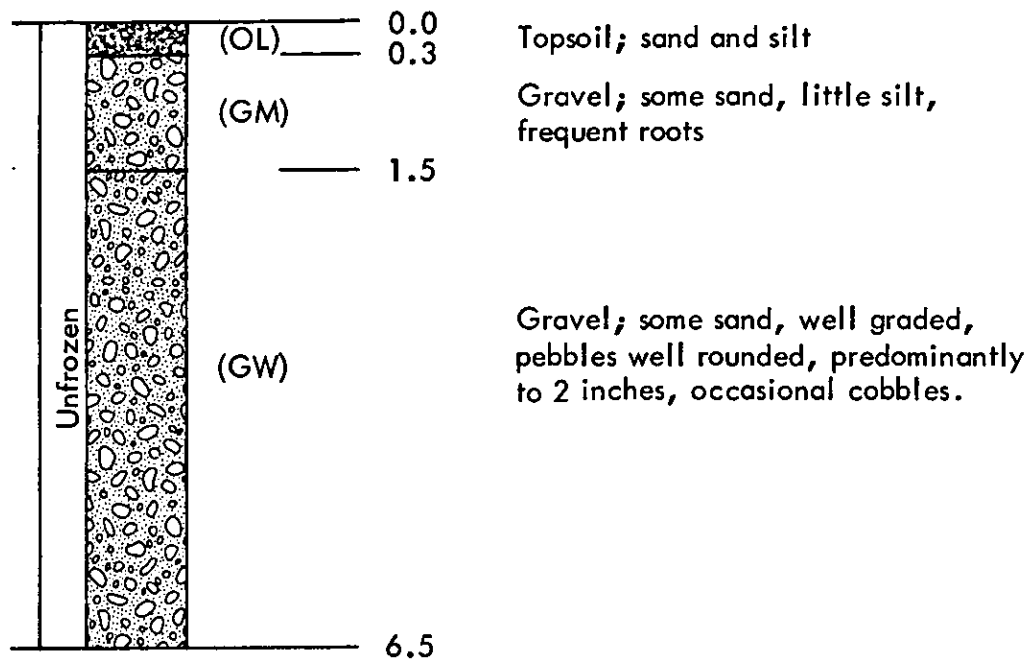


W 5/TP 4



DETAILED TEST PIT LOG

W 5/TP 5





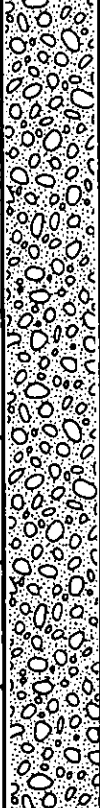
DETAILED DRILL HOLE LOG

SITE NO. W 5

HOLE NO. DH-1

DATE: FEB. 11, 1973 LOGGED BY: ☒ PEMCAN ☐

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

CONVENTIONAL — CIRCULATION —								
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		ML	TOPSOIL: some silt, little sand, roots, brown		Vx	M		0
1								1
2		GW	GRAVEL: little sand, well graded, predominantly rounded to subrounded, pebbles ¼" to 3", quartzites, granite and limestone, greyish brown					2
3								3
4								4
5								5
6								6
7								7
8								8
9			TOTAL DEPTH 8.0'					9

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY







PEMCAN SERVICES "72"


DETAILED DRILL HOLE LOG

SITE NO. W 5

HOLE NO. DH-2

DATE: FEB. 11, 1973		LOGGED BY: <input checked="" type="checkbox"/> PEMCAN <input type="checkbox"/>	
DRILLING METHOD: <input type="checkbox"/> CONVENTIONAL		<input checked="" type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:	

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)			
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.					
0		OL	1.0 TOPSOIL: some silt, little sand, trace organic, roots, brown		Vr			0			
2		GW	GRAVEL: little sand, well graded, predominantly rounded to sub-angular; limestone and frequent quartzite pebbles to 3" size, greyish brown			Vx		M		2	
4										4	
6										MC	6
8											
10			- trace sand, medium brown, at depths greater than 7.0'		NF	VL		10			
12									12		
14			14.0 TOTAL DEPTH 14.0'							14	
15										15	




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

DETAILED DRILL HOLE LOG

SITE NO. W 5


HOLE NO. DH-3

DATE: FEB. 11, 1973		LOGGED BY: <input checked="" type="checkbox"/> PEMCAN <input type="checkbox"/>	
DRILLING METHOD: <input type="checkbox"/> AIR CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:			

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		OL	TOPSOIL: some silt, little sand, light brown		Vx	M		0
2		SM	SAND: trace silt, poorly graded, fine grained, brown		Nf	VL		2
4	4							
6	6							
8		GW	GRAVEL: little sand, well graded, predominantly rounded and sub-angular pebbles, limestone, frequent quartzite and granite pebbles to 3" size, grey		Vx	M		8
10								10
12								12
14								14
15.0			TOTAL DEPTH 15.0'	UF				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. W 5

HOLE NO. DH-4

DATE: FEB. 11, 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, little sand, light brown		Vr	M		0
1		GW	GRAVEL: little sand, well graded, predominantly limestone, quartz- ite and granite pebbles and cobbles to 5" size, occasional boulders, greyish brown		Vx	M		1
2	2							
3	MC						3	
4	4							
5	5							
6	6							
7	7							
8			TOTAL DEPTH 7.0'					8

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. W 5

HOLE NO. 432-C-A

DATE: FEB. 18, 1973 LOGGED BY: ☐ PEMCAN ☒ ACRES CONSULTING

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

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0								0
1								1
2		ML	Brown Silt with Sand and some Gravel		Nbn		MC	2
3								3
4								4
5								5
6								6
7								7
8		SW	- brown Sand with some Gravel and Silt		Nf		MC GS	8
9								9
10			10.0 — END OF HOLE 10.0'					10

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"


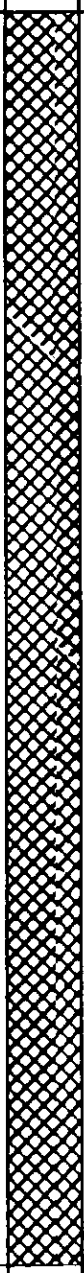
DETAILED DRILL HOLE LOG

SITE NO. W 5

HOLE NO. 432-C-B

DATE: FEB. 18, 1973 LOGGED BY: ☐ PEMCAN ☒ ACRES CONSULTING

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

CONVENTIONAL CIRCULATION								
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		GP	Brown Sand and Gravel with some cobbles and a few small boulders		Nf			0
1								1
2								2
3								MC
4								4
5								5
6								6
7								7
8	GP	GP					MC	8
9								9
10								10
10.0 — END OF HOLE 10.0'								

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. W 5

HOLE NO. 433-C-A

DATE: FEB. 17, 1973		LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> ACRES CONSULTING						
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:								
DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.		
0		GM	Brown silty Sand and Gravel		Nf			0
1								1
2								2
3								3
4								4
5								5
6								6
7								7
8								8
9								9
10			10.0 — END OF HOLE 10.0'					10

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. W 5

HOLE NO. 433-C-B

DATE: FEB. 17, 1973 LOGGED BY: ☐ PEMCAN ☒ ACRES CONSULTING

DRILLING METHOD: ☒ 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		SM	1' of brown Sand					0
2		SM	- grey Sand with some Silt and a trace of Gravel		Nbn		MC GS	2
4		SM						4
6		SM						6
8		SM					MC	8
10		SM						10
12		SM						12
14		SM						14
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. W 5

HOLE NO. C D

DATE: FEB. 17, 1973 LOGGED BY: ☐ PEMCAN ☒ ACRES CONSULTING

DRILLING METHOD: ☒ 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		SM	Silty Sand		Nbn			0
2		SW	Gravelly Sand with a trace of Silt		Nf		MC GS	2
4								4
6		CL	Grey clayey Silt and Sand with a trace of Gravel		Nbn		MC GS	6
8								8
10								10
12		CL			Vx		MC	12
14								14
16			END OF HOLE 15.0'					16

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

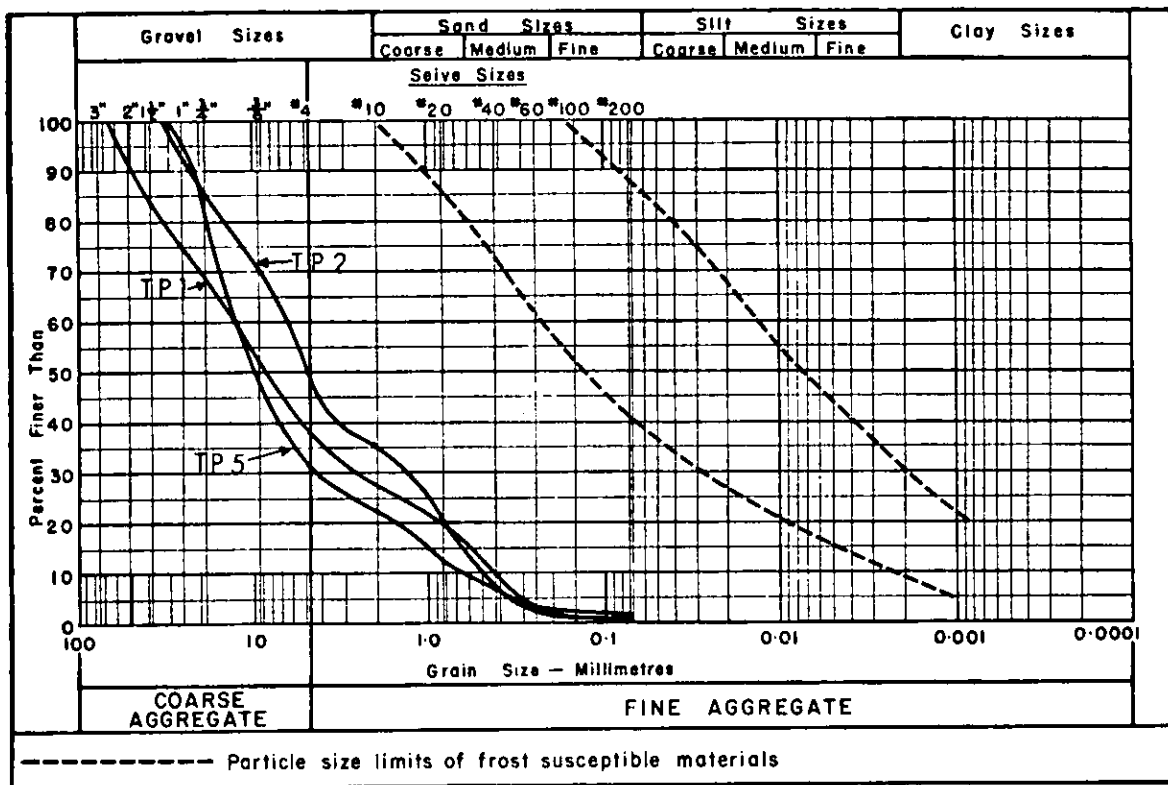


PEMCAN SERVICES "72"

SUMMARY OF LABORATORY TEST DATA

Sample Location:	W 5/TP 1	W 5/TP 2	W 5/TP 5
Sample Depth (Feet):	3.0 - 4.0	2.0 - 4.0	3.0
Moisture Content (%):	-	-	1.1
Ice Content (%):	-	-	-
Organic Content (%):	-	-	-

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS:

Limestone and dolomite	44.4 %	Cherts	3.3 %
Quartzites	36.3 %	Siltstone, sandstone	0.6 %
Igneous material	15.2 %		

SUMMARY OF LABORATORY TEST DATA

Sample Location: W 5/TP 2

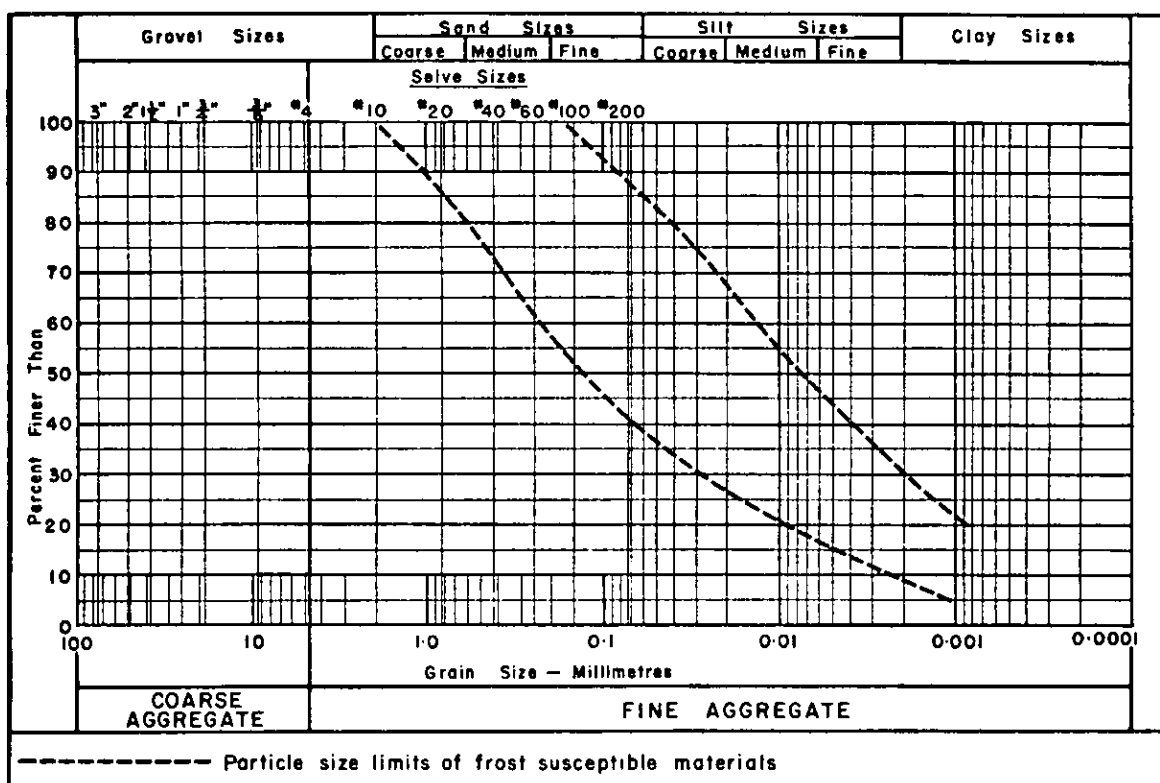
Sample Depth (Feet): -

Moisture Content (%): -

Ice Content (%): -

Organic Content (%): -

GRAIN SIZE DISTRIBUTION:



SUMMARY OF LABORATORY TEST DATA

Sample Location: W 5/BT 1

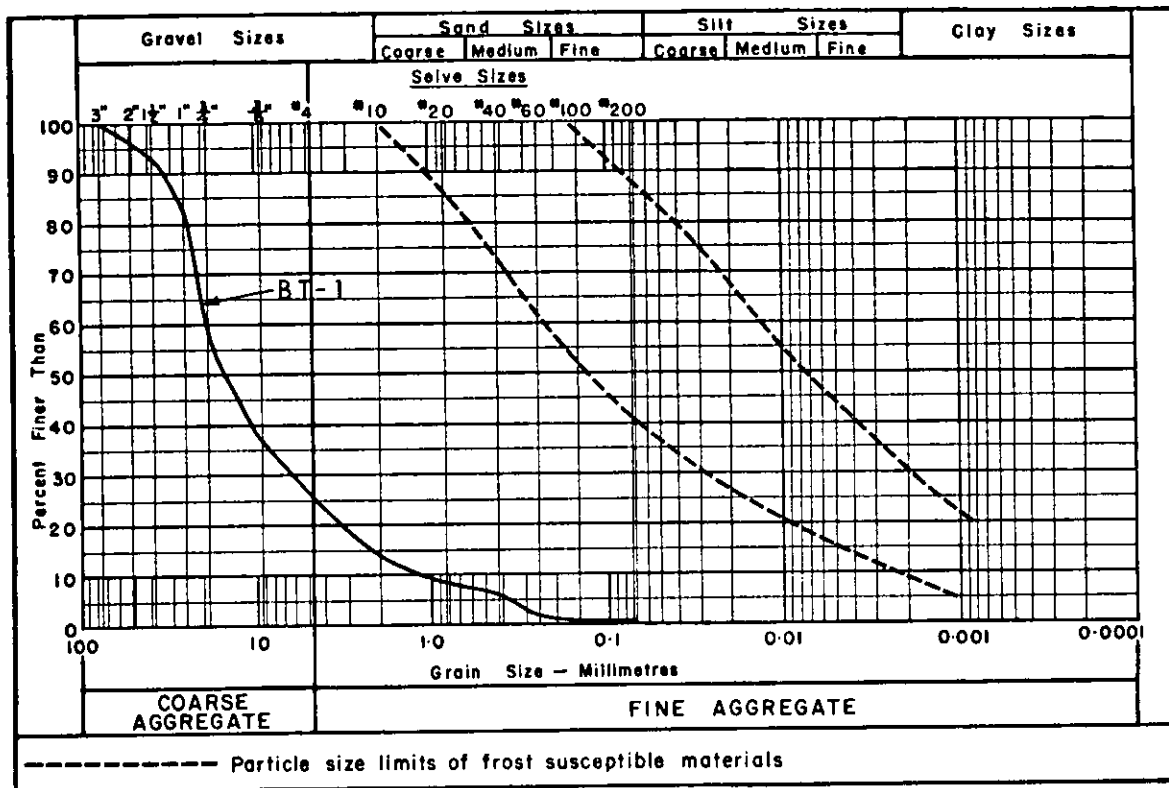
Sample Depth (Feet): 4.0 - 9.0

Moisture Content (%): -

Ice Content (%): -

Organic Content (%): -

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS:

SUMMARY OF MOISTURE CONTENT DETERMINATIONS

<u>Sample Location</u>	<u>Sample Depth (Ft.)</u>	<u>Moisture Content (%)</u>
W 5/432-C-A	2.5	24.0
W 5/432-C-A	7.5	3.5
W 5/432-C-B	2.5	8.0
W 5/432-C-B	7.0	9.5
W 5/433-C-B	2.5	8.5
W 5/433-C-B	7.5	6.5
W 5/433-C-D	3.0	3.5
W 5/433-C-D	7.5	12.5
W 5/433-C-D	12.5	17.0

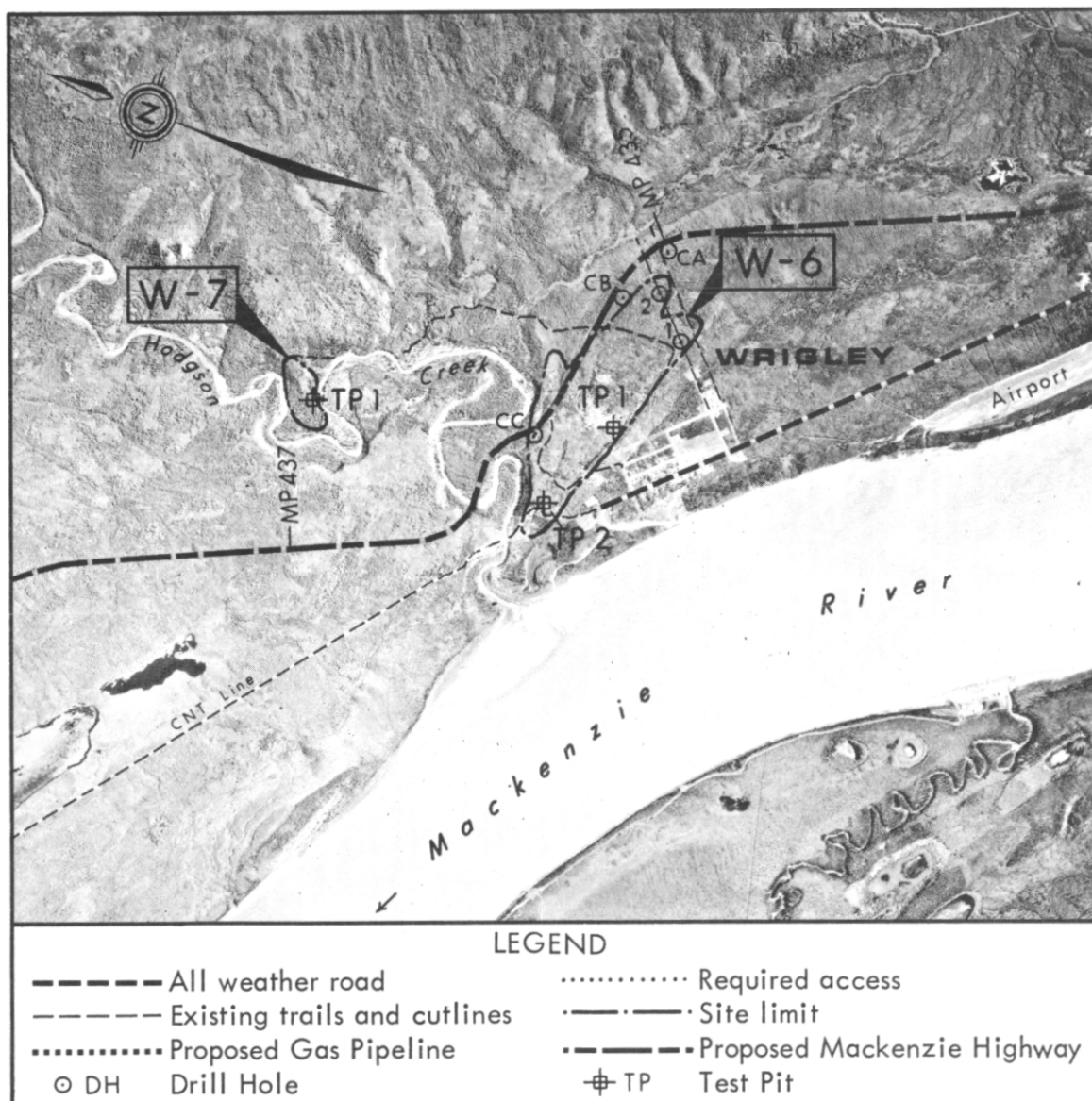
SITE NO. W 6

Located approximately $\frac{1}{4}$ mile north of Wrigley, Site W 6 consists of an elevated terrace deposited within the wide glacial melt water channel paralleling the Mackenzie River.

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

Estimated Volume: 1,000,000 cubic yards.

Assessment: This site is not currently recommended for development because similar quality materials in extensive quantities are available at other sites.



Airphoto No. A22304/19

Approximate scale: 1" = 3,000'



ENVIRONMENT

Site W 6 is located approximately $\frac{1}{4}$ mile north of the Wrigley townsite and consists of an elevated glacial terrace deposited within the northwestern end of the melt water channel. The site encompasses an area approximately 4000 feet in length and 1500 feet in width. The active stream channel of the Hodgson Creek forms the northeast boundary of the site.

The in situ material at Site W 6 consists of stratified, fluvial sands and gravels of a post glacial origin. The material is generally well graded and consists of medium to coarse grained gravel with occasional cobbles and boulders. A thin organic topsoil layer, 8 to 10 inches in depth, is underlain by approximately 1 to 2 feet of sandy, lacustrine silt. The site area is densely wooded with spruce, birch, poplar and occasional pine.

The existing winter road passes through the northwestern portion of Site W 6 and provides for a direct access to the western end of the terrace.

DEVELOPMENT

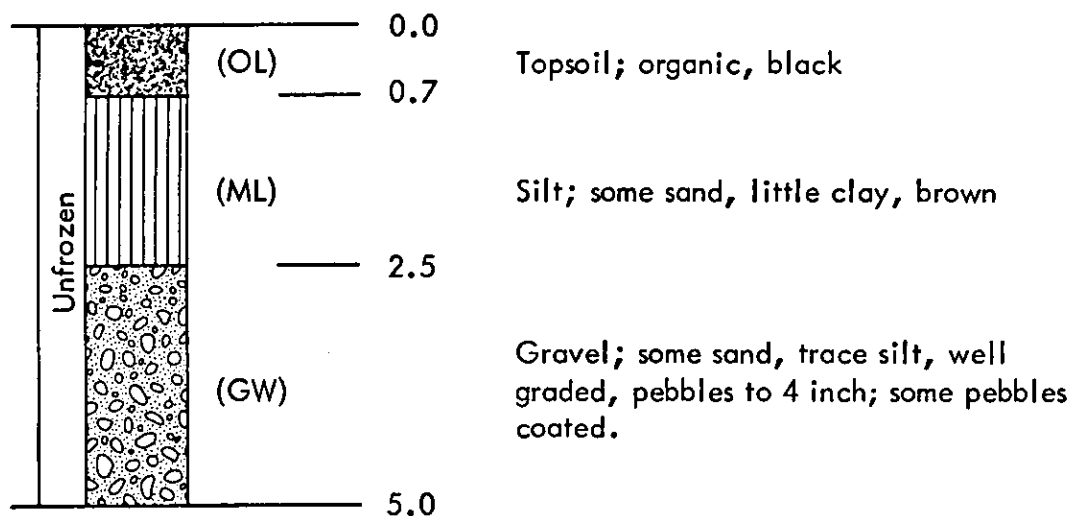
Although the quality of granular material is excellent, Site W 6 is not recommended for immediate development because of the following reasons:

- The availability of similar material in extensive quantities at Site W 5.
- The greater depth of overburden, approximately 2 to $2\frac{1}{2}$ feet, which has to be removed.
- The area of the site adjacent to the community may be considered for future expansion of the townsite. Also, the location of the proposed Mackenzie Highway along the northern extremities of this site would limit development of borrow areas.

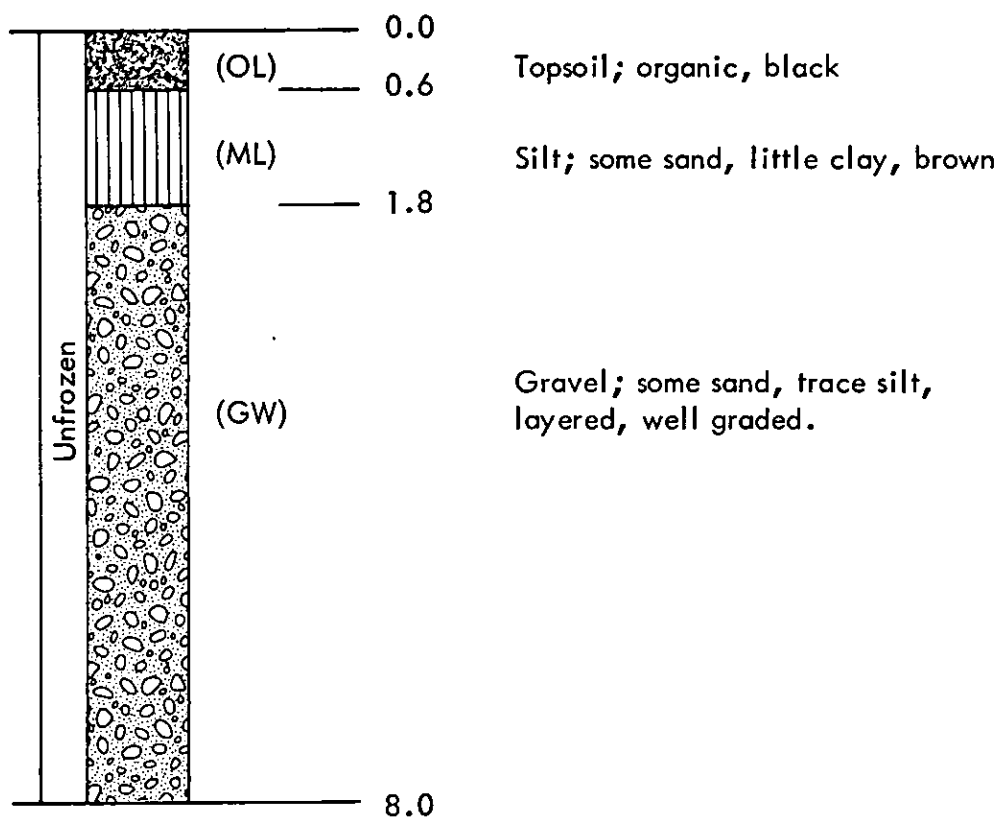
However, if this site is considered for development at a future date in order to meet increased demands for granular materials, then an assessment of development procedures coupled with environmentally acceptable restoration guidelines should be established in accordance with the land use regulations that are in effect at that time.

DETAILED TEST PIT LOG

W 6/TP 1



W 6/TP 2



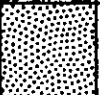



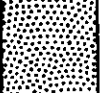

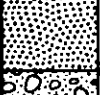

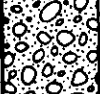







DETAILED DRILL HOLE LOG

SITE NO. W 6


HOLE NO. DH-1

DATE: FEB. 11, 1973		LOGGED BY: <input checked="" type="checkbox"/> PEMCAN <input type="checkbox"/>	
DRILLING METHOD: <input type="checkbox"/> CONVENTIONAL <input checked="" type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:			

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS		ICE EST'D CONT.	SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS			
0		OL	TOPSOIL: some silt, little sand, trace organic		Vx	M		0
2		SM	SAND: trace silt, fine grained, poorly graded, brown		Vx			2
4								4
6							GS	6
8		GW	GRAVEL: little sand, well graded, rounded to subangular limestone, quartzite and few granite pebbles, greyish brown		Vx			8
10								10
12								12
14							MC	14
16			TOTAL DEPTH 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. W 6

HOLE NO. DH-2

DATE: FEB. 11, 1973

LOGGED BY: ☒ PEMCAN ☐

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

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0								0
3		OL	TOPSOIL: silt, little organic, trace sand, roots, brown		Vr			3
6		ML	SILT: little sand, medium brown					6
9								9
12								12
15								15
18								18
21								21
24								24
27								27

1.0

3.0

25.0

TOTAL DEPTH 25.0'

GW

GRAVEL: little sand, well graded,
predominantly rounded to sub-
angular limestone, and frequent
quartzites from 1/8" to 5" size,
greyish brown

M

MC

MC

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

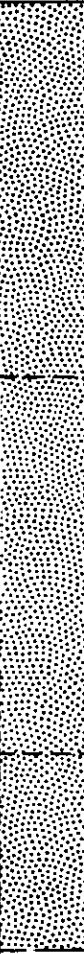

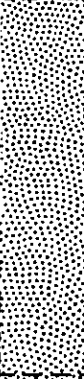


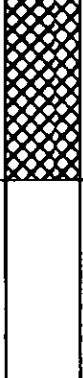
DETAILED DRILL HOLE LOG

SITE NO. W 6

HOLE NO. C A


DATE: FEB. 17, 1973 LOGGED BY: ☐ PEMCAN ☒ ACRES CONSULTING

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

CONVENTIONAL CIRCULATION										
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		SM	Brownish grey silty Sand		Nbn			0		
2									MC	2
4										4
6		SW	- fine to coarse sand		Nf			6		
8										8
10										10
12		SW	- well graded sand with fine gravel					12		
14									MC GS	14
16										16
			END OF HOLE 15.0'							

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY

 **PEMcan SERVICES "72"**

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. W 6

HOLE NO. C B

DATE: FEB. 17, 1973 LOGGED BY: ☐ PEMCAN ☒ ACRES CONSULTING

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

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)			
				GEN'L CLASS	N.R.C. CLASS	EST'D CONT.					
0		SM	Sand with some Gravel and a trace of Silt		Nf			0			
2							MC	2			
4		SW	- brown - grey					4			
6								6			
8							MC GS	8			
10								10			
12		SW					MC	12			
14								14			
16								16			
			16.0				END OF HOLE 16.0'				

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. W 6

HOLE NO. C C

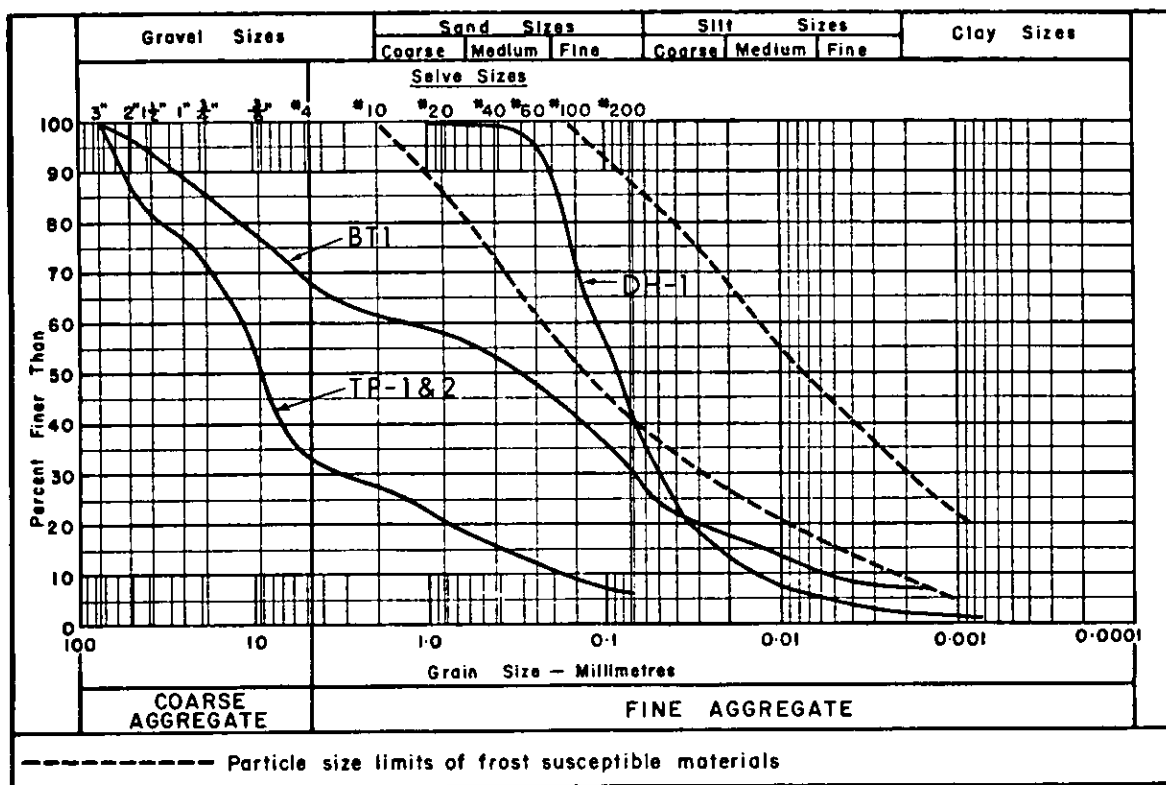
DATE: FEB. 18, 1973		LOGGED BY: <input type="checkbox"/> PEMCAN <input checked="" type="checkbox"/> ACRES CONSULTING	
DRILLING METHOD: <input checked="" type="checkbox"/> CONVENTIONAL <input type="checkbox"/> AIR REVERSE CIRCULATION <input type="checkbox"/> OTHER:			

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		SM	Silty Sand with some Gravel		Nbn		MC	0
2								2
4								4
6								6
8								8
10								10
12								12
14								14
15.0								15.0
16								16
<div style="display: flex; justify-content: space-between;"> <div> <p>GOVERNMENT OF CANADA DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT</p> <p>GRANULAR MATERIALS INVENTORY</p> </div> <div> <p>PEMCAN SERVICES "72"</p> </div> </div>								

SUMMARY OF LABORATORY TEST DATA

Sample Location:	W 6/TP 1 & 2	W 6/DH 1	W 6/BT 1
Sample Depth (Feet):	3.0 - 5.0	5.0'	3.0 - 7.0
Moisture Content (%):	-	-	-
Ice Content (%):	-	-	-
Organic Content (%):	-	-	-

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS: (W 6/TP 1 and TP 2 at 3.0' - 5.0')

Igneous material	35.3 %	Chert	5.6 %
Quartzite	24.5 %	Limestone	5.2 %
Dolostone	24.2 %		
Deleterious marlstone, mica schist and concretions			5.1 %

SUMMARY OF MOISTURE CONTENT DETERMINATIONS

<u>Sample Location</u>	<u>Sample Depth (Ft.)</u>	<u>Moisture Content (%)</u>
W 6/DH 1	13.0	0.1
W 6/DH 2	8.0	2.3
W 6/DH 2	20.0	0.7
W 6/435-C-A	2.5	20.0
W 6/435-C-B	2.5-7.5	3.0
W 6/435-C-B	13.0	2.0
W 6/435-C-C	2.5	7.0
W 6/435-C-C	7.5	7.5
W 6/435-C-C	12.8	5.0

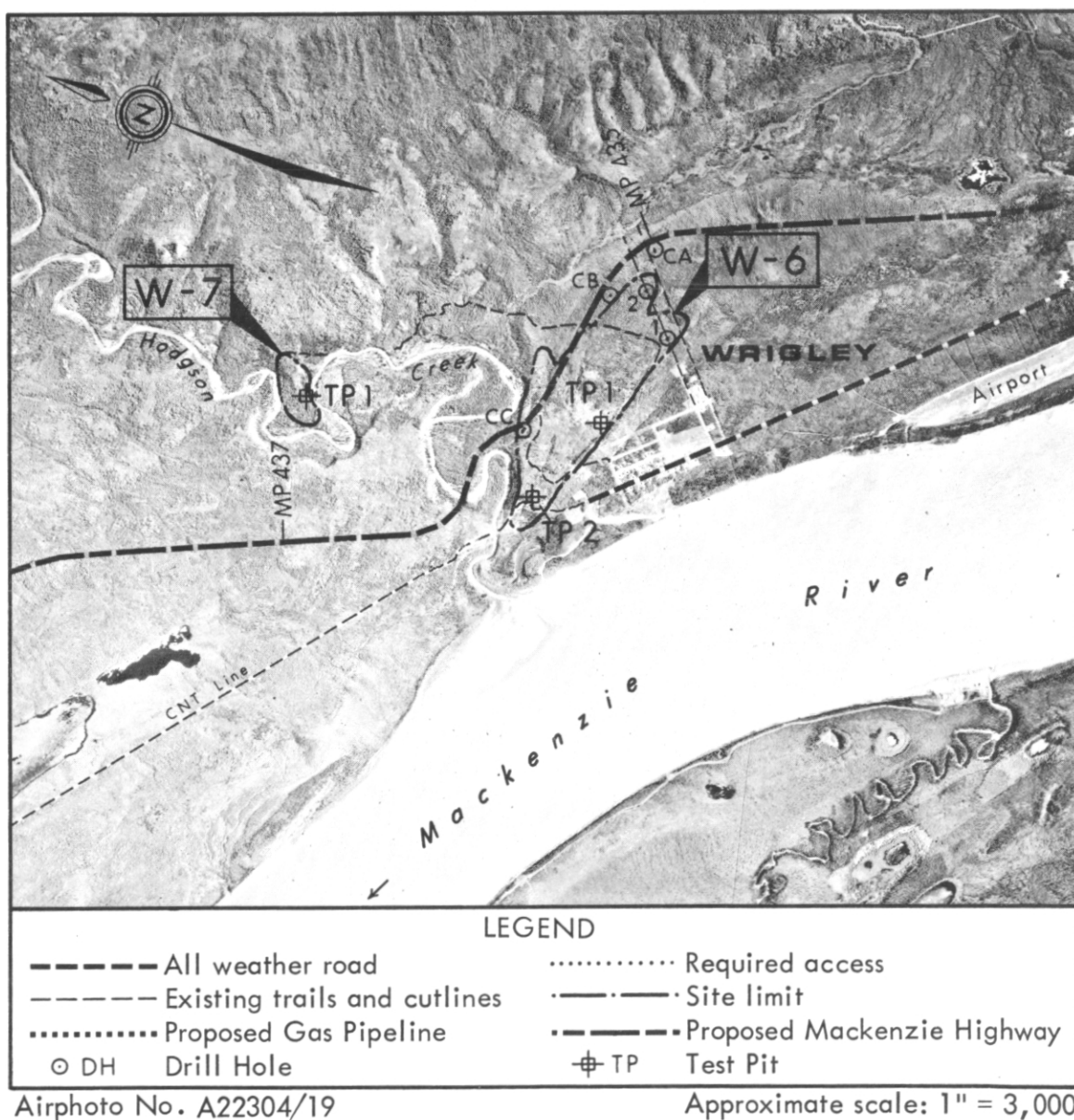
SITE NO. W 7

Located approximately 1 mile northeast of Wrigley on the south bank of Hodgson Creek, Site W 7 consists of a river terrace.

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

Estimated Volume: 250,000 cubic yards.

Assessment: Excellent quality sand for concrete production. This site is not recommended for development at this time because of the difficult access and the availability of similar quality material at other sites.





ENVIRONMENT

Site W 7 is located approximately 1 mile northeast of Wrigley, and consists of a river terrace within the fluvial plain of Hodgson Creek. The top of the terrace is elevated approximately 20 feet above the Hodgson Creek stream channel and the northern and southern site limits are bordered by the steep valley walls incised by Hodgson Creek. The site encompasses an area 1000 feet in length by 500 feet in width.

The site material consists of stratified sands and gravels in the initial 14 feet below ground surface and is predominantly clean, well graded sand at greater depths. This site is the only identified source of good quality sand which could be utilized for concrete aggregates in the pit run condition. A thin mantle of organic topsoil, 6 inches in depth, overlies the site area and supports moderately dense growths of spruce and pine. The site area is well drained into the adjacent Hodgson Creek valley.

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

The nearest access road to the site is the winter road at a distance of $1\frac{1}{2}$ miles.

DEVELOPMENT

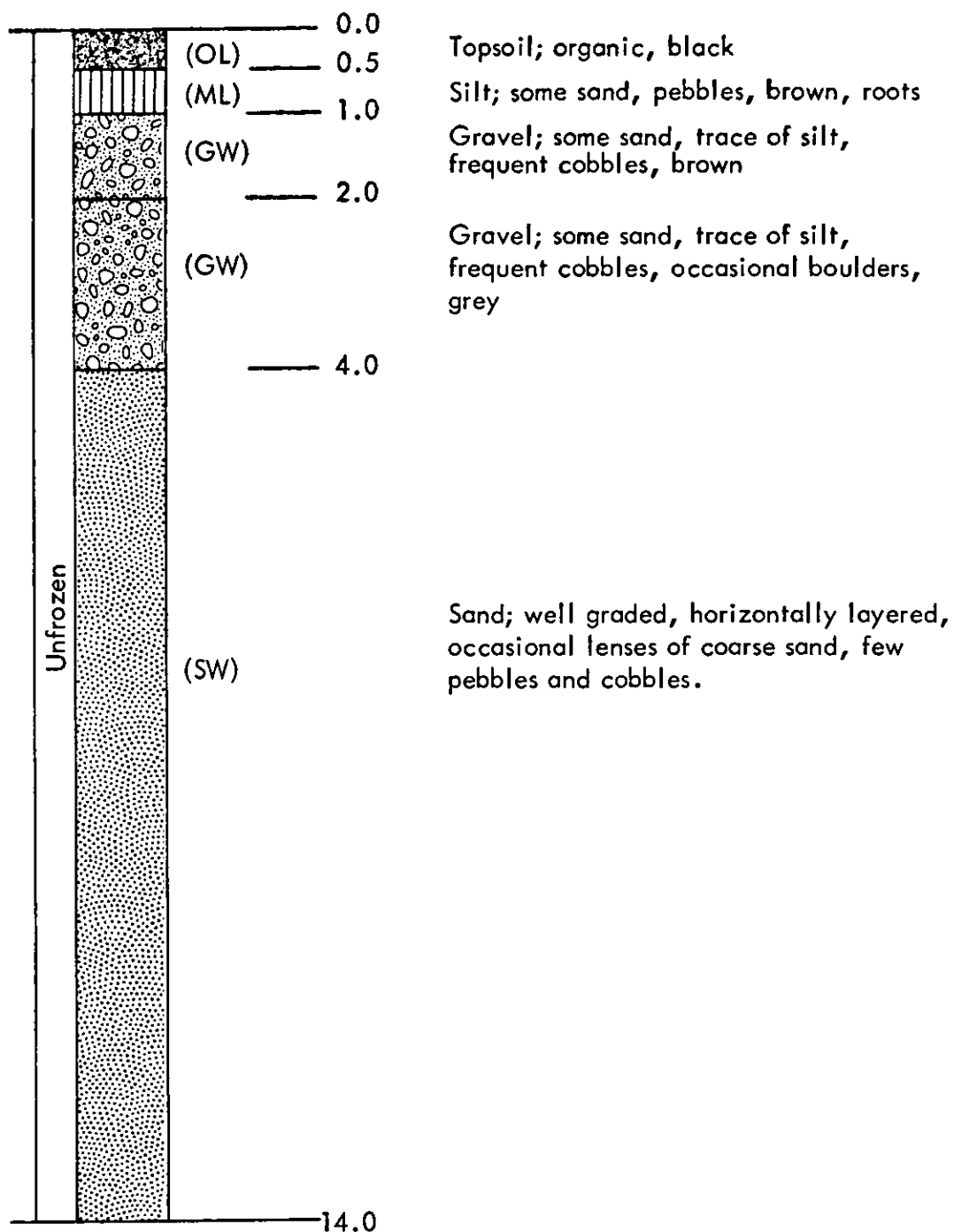
Site W 7 is not recommended for development at this time because of the following reasons:

- The access to this site is very difficult and would entail the construction of an access road along the top of the southern bank of Hodgson Creek.
- Although excellent quality sand is available at this source for concrete production, the screening of granular materials at other sites more easily accessible to Wrigley may be more economical.
- The site would be difficult to develop because of the steep valley walls.
- The close proximity of the active stream channel of Hodgson Creek may have serious environmental implications on any proposed development in this area.

However, if this site is considered for development at a later date for the exploitation of good quality sand, then an assessment of development procedures coupled with environmentally acceptable restoration guidelines should be established in accordance with the land use regulations that are in effect at that time.

DETAILED TEST PIT LOG

W 7/TP 1



SUMMARY OF LABORATORY TEST DATA

Sample Location: W 7/TP 1

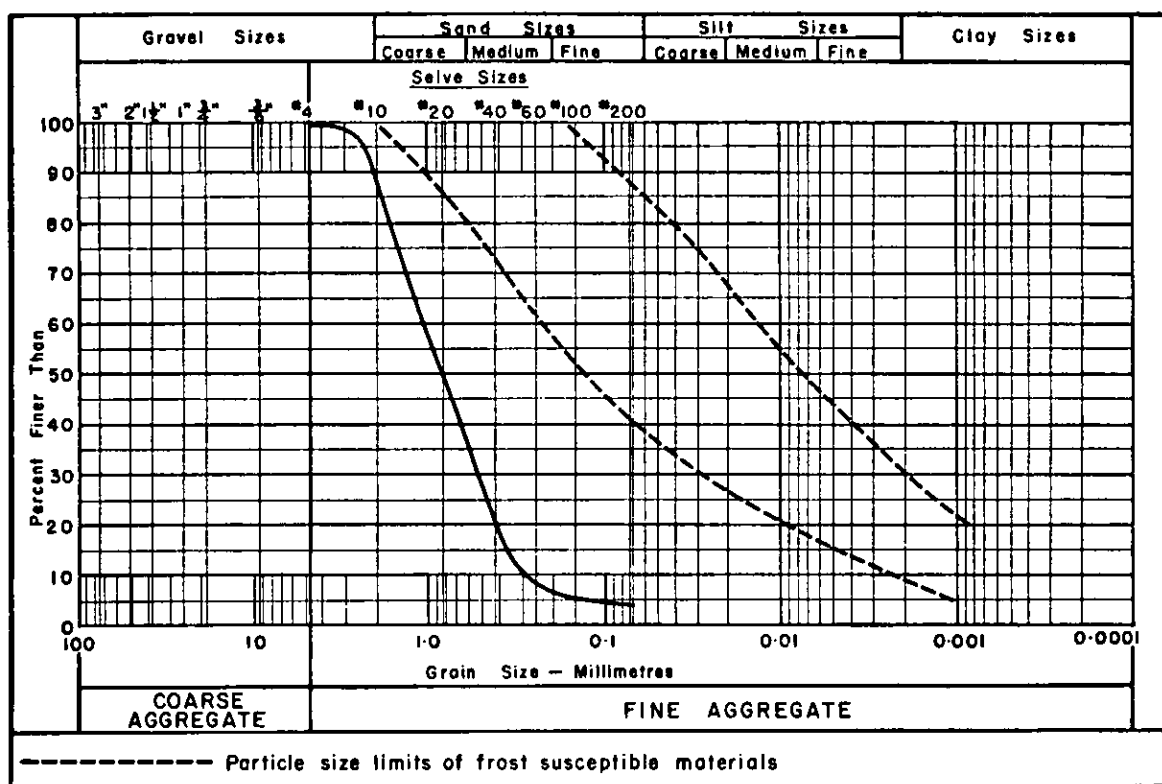
Sample Depth (Feet): 8.0

Moisture Content (%): -

Ice Content (%): -

Organic Content (%): -

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS:

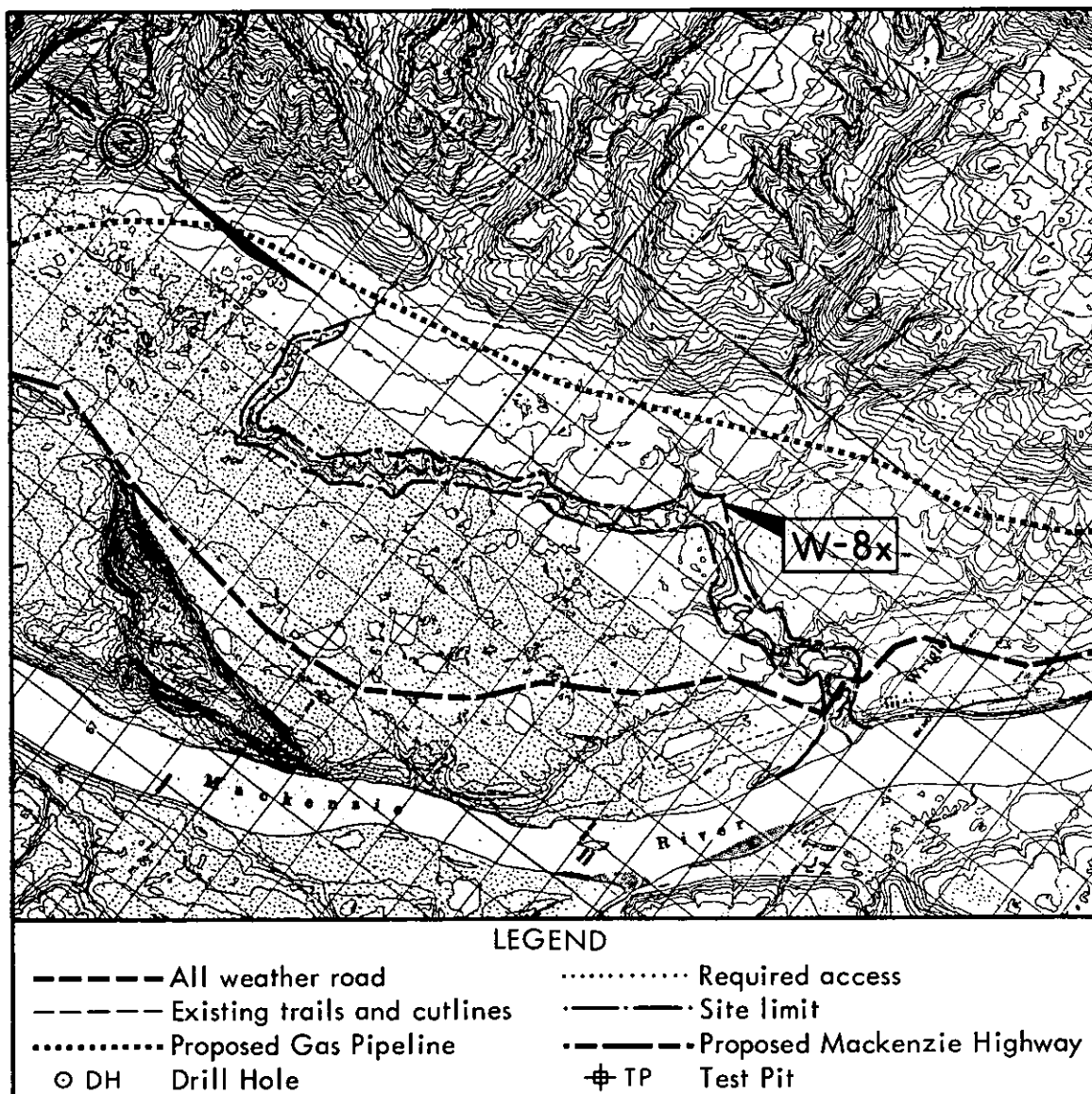
SITE NO. W 8X

Site W 8X' consists of gravel deposits in the active stream channel of Hodgson Creek and extends from the base of the McConnell Range to the mouth of the channel at the Mackenzie River. The site is approximately 10 miles in length.

Type of Material: Sand and Gravel.

Estimated Volume: Not established.

Assessment: This site is not recommended for development because it is located, entirely, in the active stream channel of Hodgson Creek.



National Topographic System
Map Sheets 950/3, 4, 5, 6

Approximate scale: 1" = 17,900'



ENVIRONMENT

Site W 8X consists of alluvial gravel deposits in the active stream channel of Hodgson Creek which extends from the base of the McConnell Range to the mouth of the channel at the Mackenzie River. The entire site area encompasses approximately 10 miles of the Hodgson Creek stream channel.

The upstream portion of the site, some 6 miles in length and located in the braided active floodplain, consists of stratified sand and gravel bars with some silt. The downstream portion of the site, some 4 miles in length, is composed of low-alluvial terraces developed in the stream meanders. The terraces consist of sand and gravel with a cover of alluvial silt.

The floodplain area above the high water level is sparsely wooded with spruce, pine, birch and poplar. The organic topsoil layer is very shallow.

There are no known critical wildlife areas in the immediate vicinity of the site. However, the majority of the site area is within and adjacent to the channel of Hodgson Creek; therefore, an assessment of fishery resources within the watercourse should be made prior to any development of the site.

There is no existing access to the site area except where the winter road crosses the stream channel immediately east of the confluence of the Mackenzie River and Hodgson Creek.

DEVELOPMENT

Site W 8X is not recommended for development because the entire site area is located in the active stream channel of Hodgson Creek.

SUMMARY OF LABORATORY TEST DATA

Sample Location: W 8X (Gravel Bar)

Sample obtained approximately
12 miles upstream from the mouth
of Hodgson Creek.

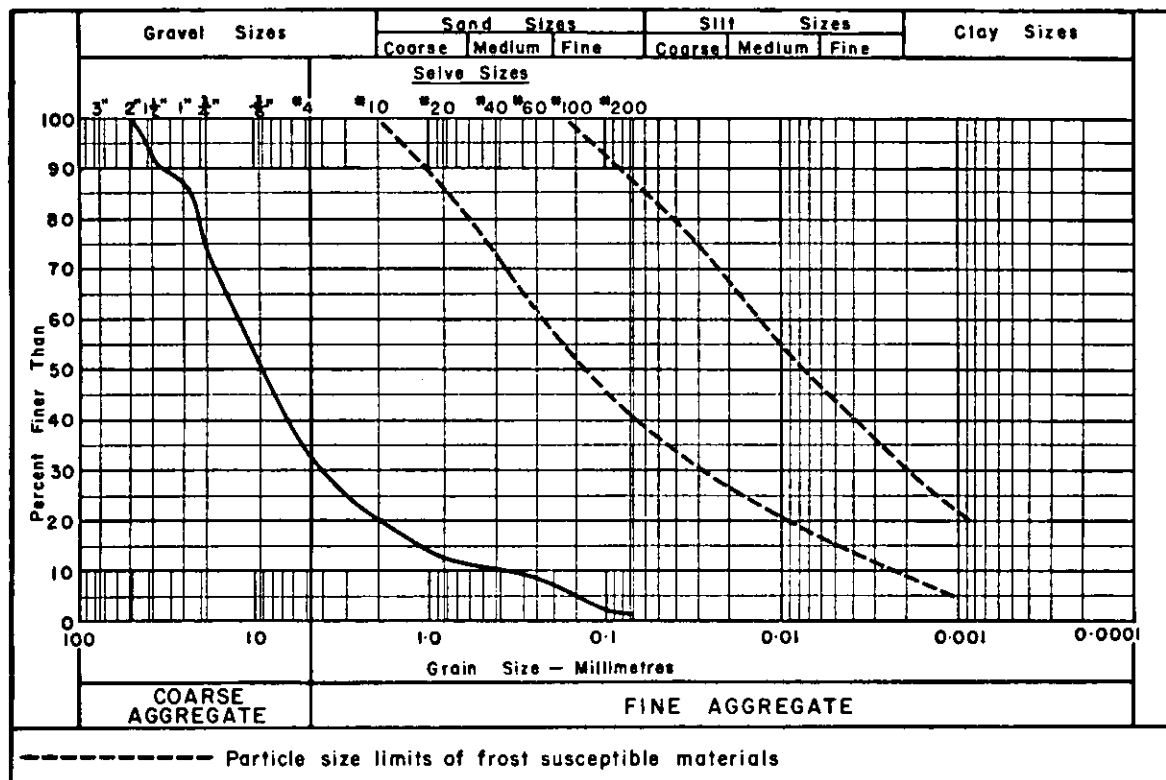
Sample Depth (Feet): Surface

Moisture Content (%): -

Ice Content (%): -

Organic Content (%): -

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS:

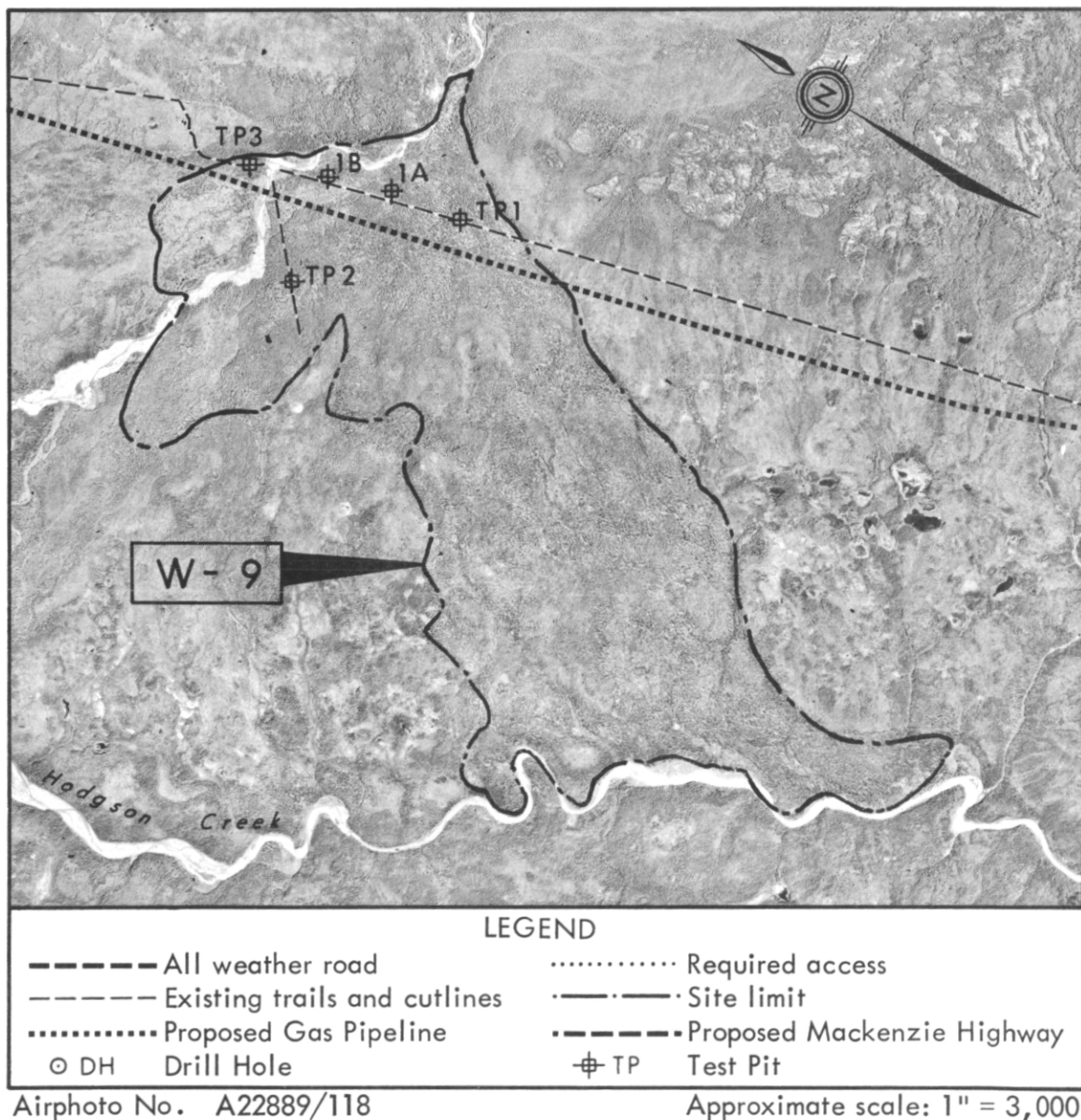
SITE NO. W 9

Located approximately 9 miles north of Wrigley, Site W 9 consists of a large alluvial fan located at the base of the McConnell Range where Hodgson Creek is incised into the foothills. Existing access along seismic cutlines to the site is 11 miles from Wrigley.

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

Estimated Volume: Not established.

Assessment: Good quality granular material for various categories of construction aggregates. Site W 9 is not recommended for immediate development because of difficult access. However, this site may be considered as a source of granular materials for the requirements of local utilities.





ENVIRONMENT

Site W 9 is located approximately 7 miles north of Wrigley at the base of the McConnell Range of the Franklin Mountains. The site consists of a large alluvial fan, approximately 4 miles in length and in excess of 1 mile in width. Hodgson Creek is deeply incised into the foothills of the McConnell Range upstream from the apex of the alluvial fan.

The granular material encountered at this site consists of medium to coarse grained, well graded gravels with some sand near the apex of the alluvial fan. The deposit is, however, heterogeneous and pockets of silts and sands should be expected. In general, the grain size of the material is inversely proportional to the distance of transport. The coarse deposits are encountered close to the mountain side while finer materials were carried further downstream. A thin mantle of organic topsoil, 6 to 8 inches in depth, covers the site area and supports growth of moderately dense trees consisting primarily of spruce with sparsely interspersed growths of poplar. The trees range in height from 10 to 60 feet and vary from 4 to 12 inches in trunk diameter. The understory growth, generally, consists of moss, sedge grass and small bush. Test pits show minor depressions consisting of very organic silts between pronounced ridges of gravels. These depressions may be infilled stream beds developed during the active period of the alluvial fan.

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

The existing access to the site area is very difficult and consists primarily of 11 miles of seismic cutline. The proposed routes of both the gas pipeline and the Mackenzie Highway pass through Site W 9.

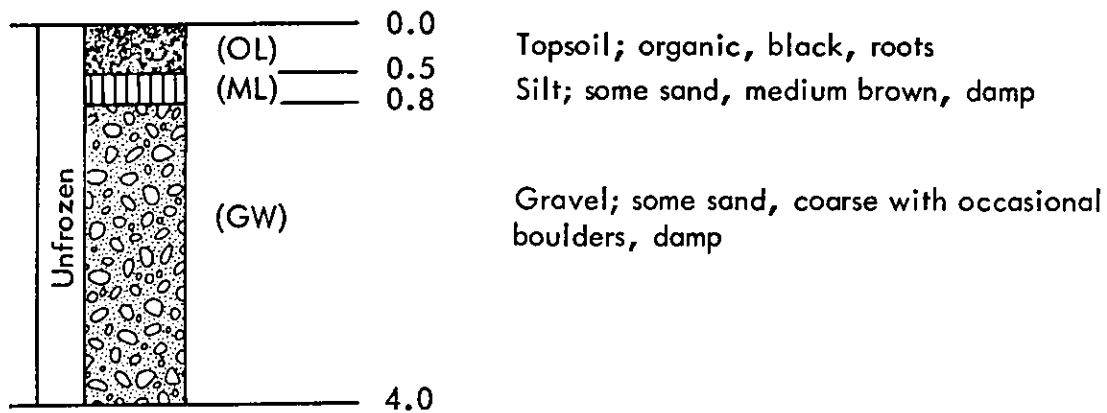
DEVELOPMENT

Site W 9 is not currently recommended for development for granular materials for the community of Wrigley. Although considerable quantities of good quality granular materials are available within closer reaches of the Wrigley community, it is considered that this site, because of its potentially large volume of material, is of significant interest particularly since the proposed gas pipeline route traverses this site.

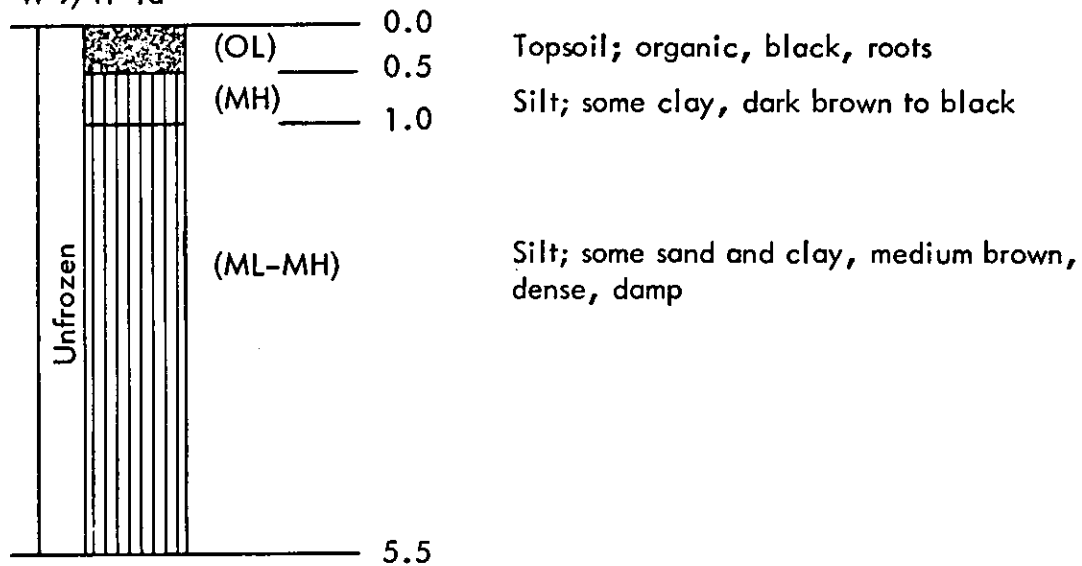
If this site is considered for development at a later date for the exploitation of fair quality general fill material, then an assessment of development procedures coupled with environmentally acceptable restoration guidelines should be established in accordance with the land use regulations that are in effect at that time.

DETAILED TEST PIT LOG

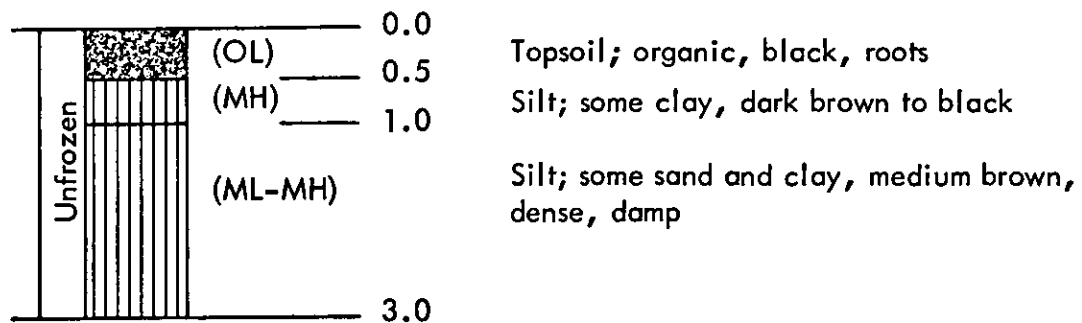
W 9/TP 1



W 9/TP 1a

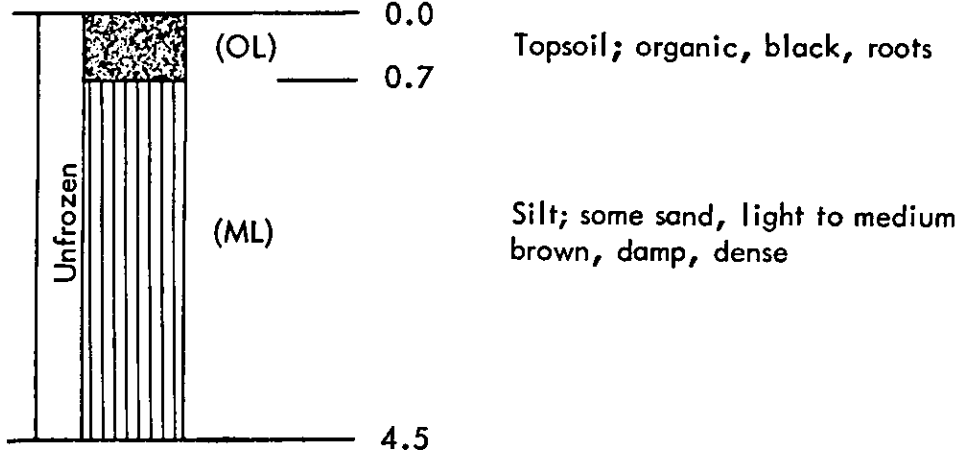


W 9/TP 1b

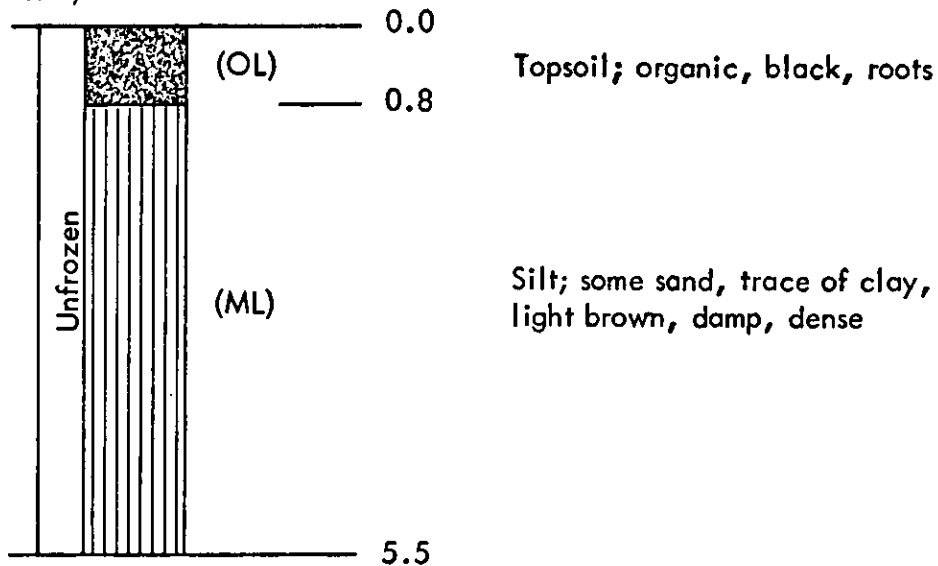


DETAILED TEST PIT LOG

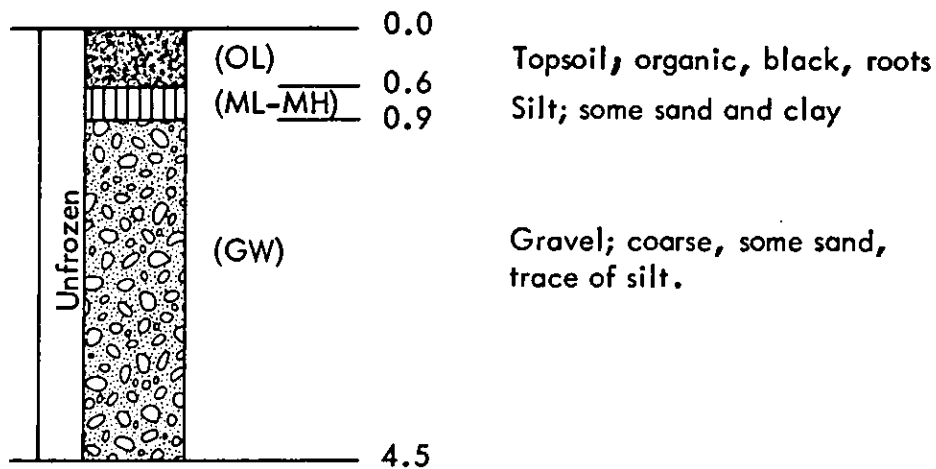
W 9/TP 2



W 9/TP 2b



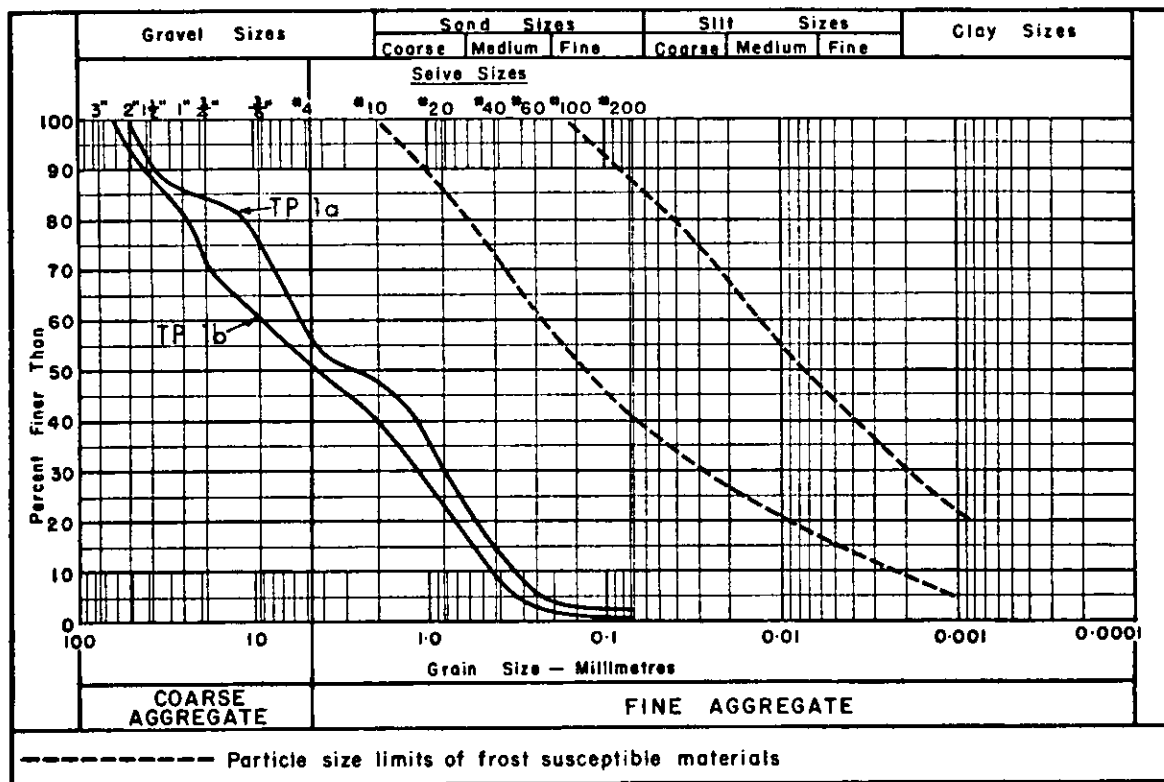
W 9/TP 3



SUMMARY OF LABORATORY TEST DATA

Sample Location:	W 9/TP 1a	W 9/TP 1b
Sample Depth (Feet):	2.5	3.5
Moisture Content (%):	-	-
Ice Content (%):	-	-
Organic Content (%):	-	-

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS:

Limestone and dolomite	29.7 %	Sandstone and siltstone	5.4 %
Igneous material	36.1 %	Sandstone; porous	1.9 %
Quartzites	25.8 %	Cherts	0.9 %

L.A. ABRASION TEST:

Percent loss - 25.1

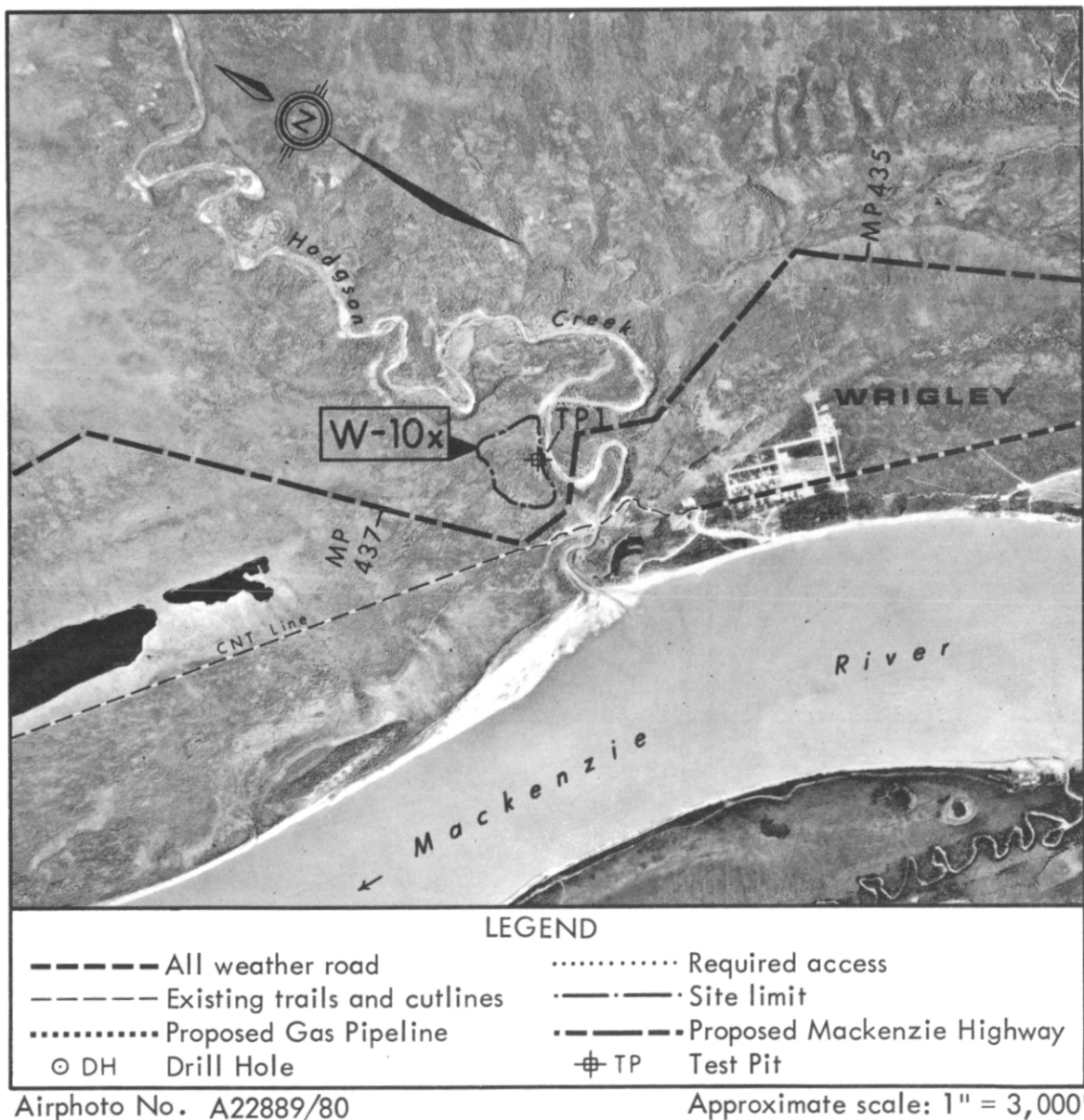
SITE NO. W 10X

Located approximately $\frac{1}{2}$ mile northwest of Wrigley on the west bank of Hodgson Creek, Site W 10X consists of a fluvial terrace remnant.

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

Estimated Volume: 300,000 cubic yards.

Assessment: This site is not recommended for development because of the difficult access, deep overburden and proximity of the adjacent active stream channel.





ENVIRONMENT

Site W 10X is located approximately $\frac{1}{2}$ mile northwest of Wrigley on the west bank of Hodgson Creek, and consists of a high terrace remnant. The site encompasses an area approximately 1500 feet in length by 1000 feet in width. This terrace remnant may be an extension of the terrace located at Site W 7, separated by the Hodgson Creek stream channel.

The terrace remnant consists of sandy gravels with the occasional boulder and some silt pockets. A thin layer of organic topsoil, 3 to 4 inches in depth, underlain by 2 to 3 feet of dry, silt covers the in situ gravel stratum. The organic topsoil supports a dense growth of spruce ranging in height to 30 feet. The site is well drained in a southerly direction into the Hodgson Creek valley. The muskeg terrain adjacent to the northwest is relatively flat and the surficial drainage is quite poor.

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

The western extremity of the site area is within $\frac{1}{4}$ mile of the winter road, but there is no existing access from the winter road to Site W 10X.

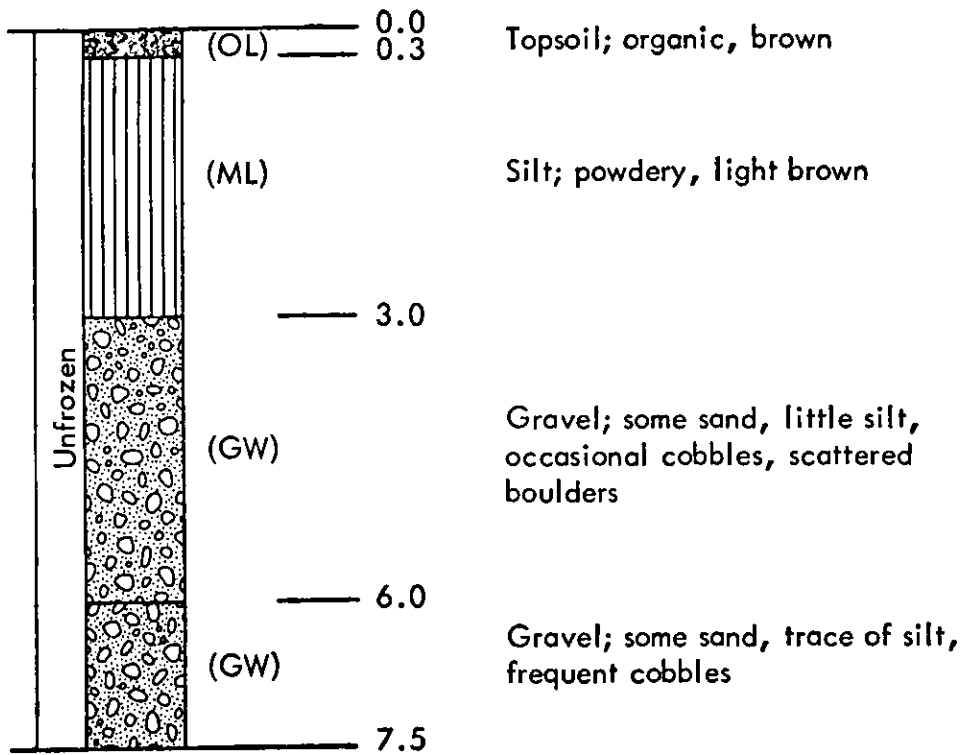
DEVELOPMENT

Site W 10X is not recommended for development for the following reasons:

- The access to the site is quite difficult because of a required stream crossing of Hodgson Creek; therefore exploitation of this source would probably be limited to the winter months.
- The existing overburden of topsoil and silt is quite thick.
- Similar quality materials with better access and less overburden thickness are available at other sites in the Study Area.
- The terrace deposit is located immediately adjacent to the active stream channel of Hodgson Creek; therefore development could have serious environmental implications on the area.

DETAILED TEST PIT LOG

W 10/TP 1



SUMMARY OF LABORATORY TEST DATA

Sample Location: W 10X/TP 1

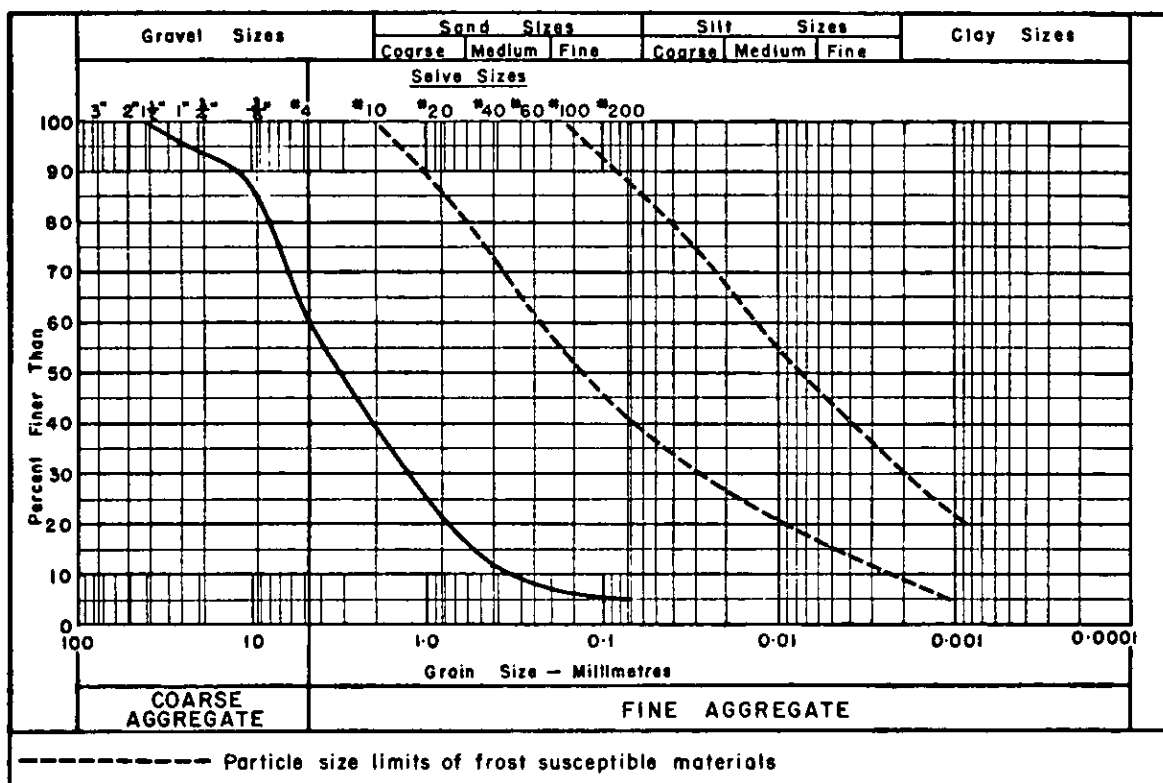
Sample Depth (Feet): 5.0 - 7.5

Moisture Content (%): -

Ice Content (%): -

Organic Content (%): -

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS:

Dolostone	36.1 %	Chert	5.8 %
Quartzite	17.2 %	Claystone; dark	3.3 %
Limestone	17.1 %	Ferruginous concretions	2.2 %
Igneous material	6.9 %		
Possible deleterious marlstone	11.4 %		

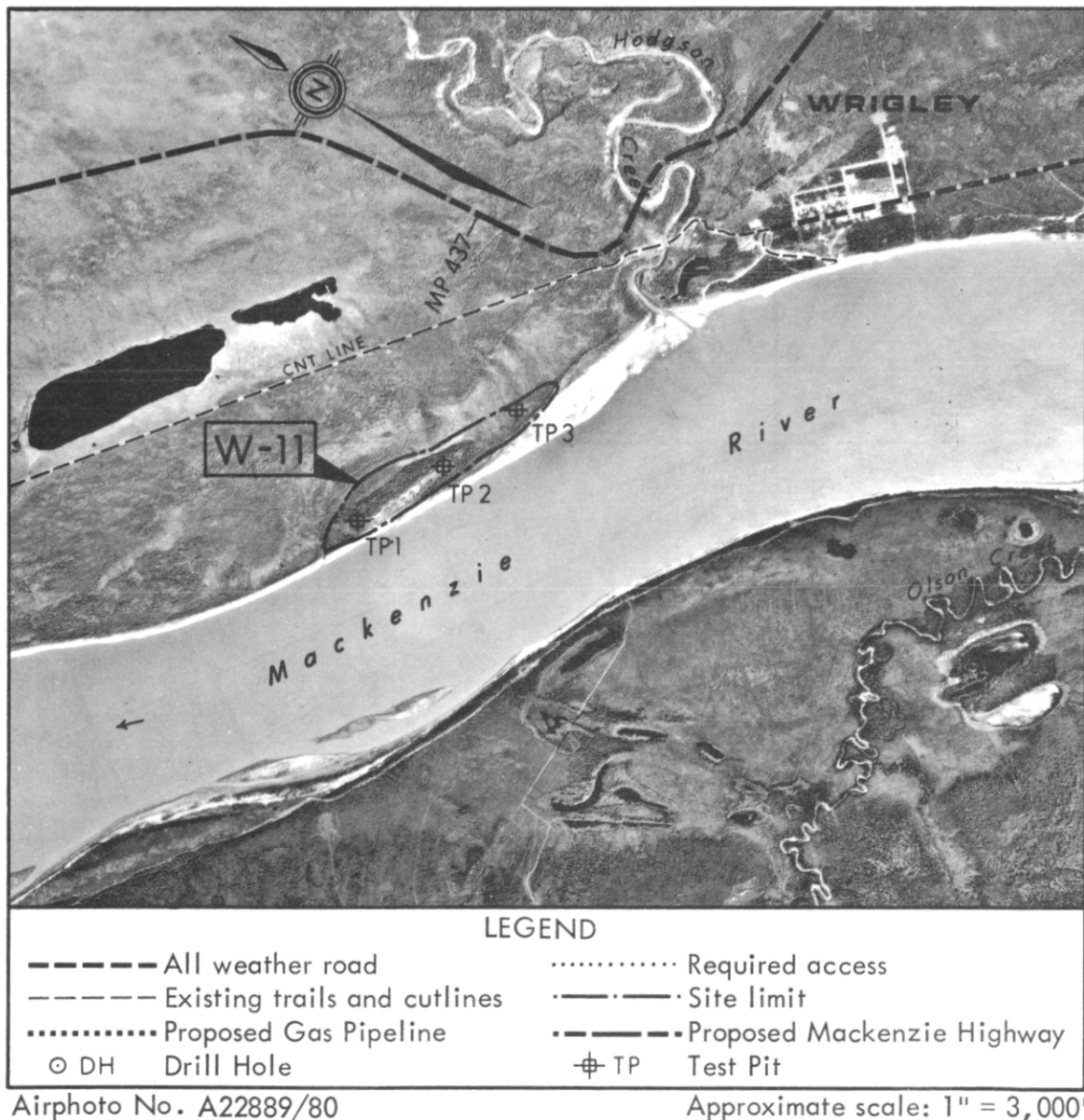
SITE NO. W 11

Located approximately $1\frac{1}{2}$ miles north of Wrigley, Site W 11 consists of a river terrace on the east bank of the Mackenzie River.

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

Estimated Volume: 150,000 cubic yards.

Assessment: Good quality material suitable for most construction requirements. This site is not recommended for immediate development because other sites with better access are available in the Study Area.





ENVIRONMENT

Site W 11 is located along the east bank of the Mackenzie River approximately $1\frac{1}{2}$ miles downstream from Wrigley. The site is approximately 3000 feet in length and 700 feet in width and consists of a river terrace. The plateau of the terrace is approximately 70 to 90 feet above the adjacent water level of the Mackenzie River.

The granular material in the terrace deposit consists of clean, well graded, medium grained gravel with some sand. A very thin veneer of topsoil, 4 to 6 inches thick, supports moderate growths of spruce, birch and poplar. The terrace appears to be well drained and the general surficial drainage is westerly to the Mackenzie River.

There are no known critical wildlife areas in the immediate vicinity of the site; however, the section of the Mackenzie River opposite the site is noted for its domestic fishing resources by the natives of Wrigley.

DEVELOPMENT

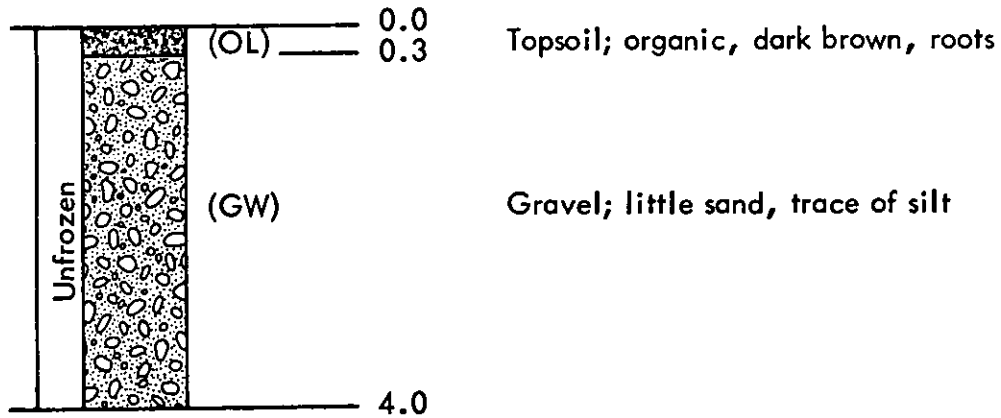
Site W 11 is not recommended for immediate development because of the following reasons:

- Considerable quantities of equally good quality granular materials are available at other sites in the Study Area with better access to Wrigley. The quantity of material available at this site is relatively minimal.
- Any development of borrow pits at this site will entail a stream crossing of Hodgson Creek which may limit the operations to the winter seasons to minimize potential damage to the regime of the stream channel.
- Unless stringent operation procedures are enforced, the proximity of the site to the existing shorelines of the Mackenzie River could result in undesirable effects on the physical and biotic environments, especially those related to fishing operations along the section of the Mackenzie that parallels the site.

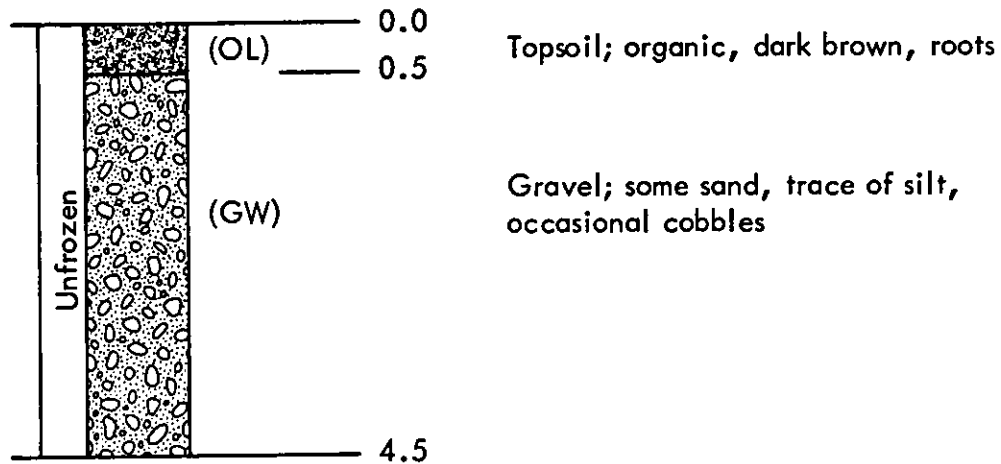
However, if this source is developed at a future date, due to the increased local needs for granular materials, then an assessment should be made relevant to the current status of the area and the proposed development of borrow pits. One of the primary procedures that should be considered at that time is the establishment of adequate vegetation buffer zones in order to protect the aesthetic and fishery resource values in and along the Mackenzie River in this area.

DETAILED TEST PIT LOG

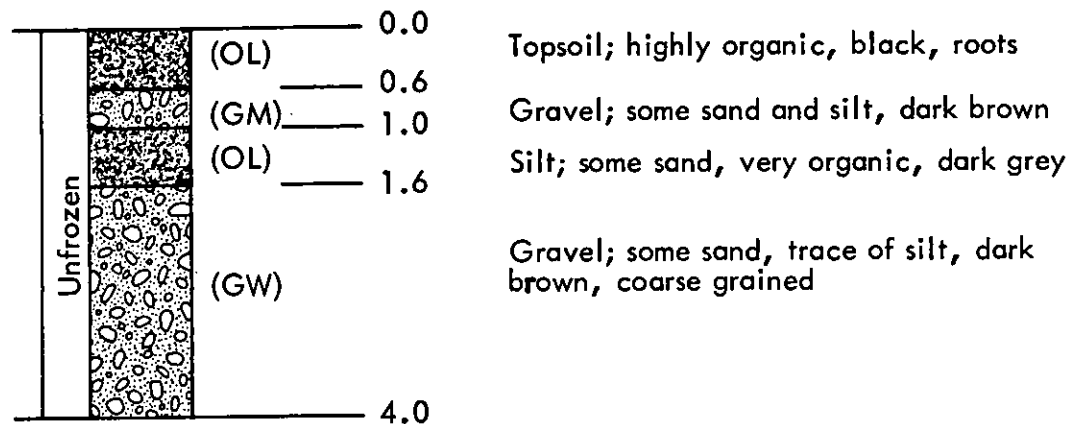
W 11/TP 1



W 11/TP 2



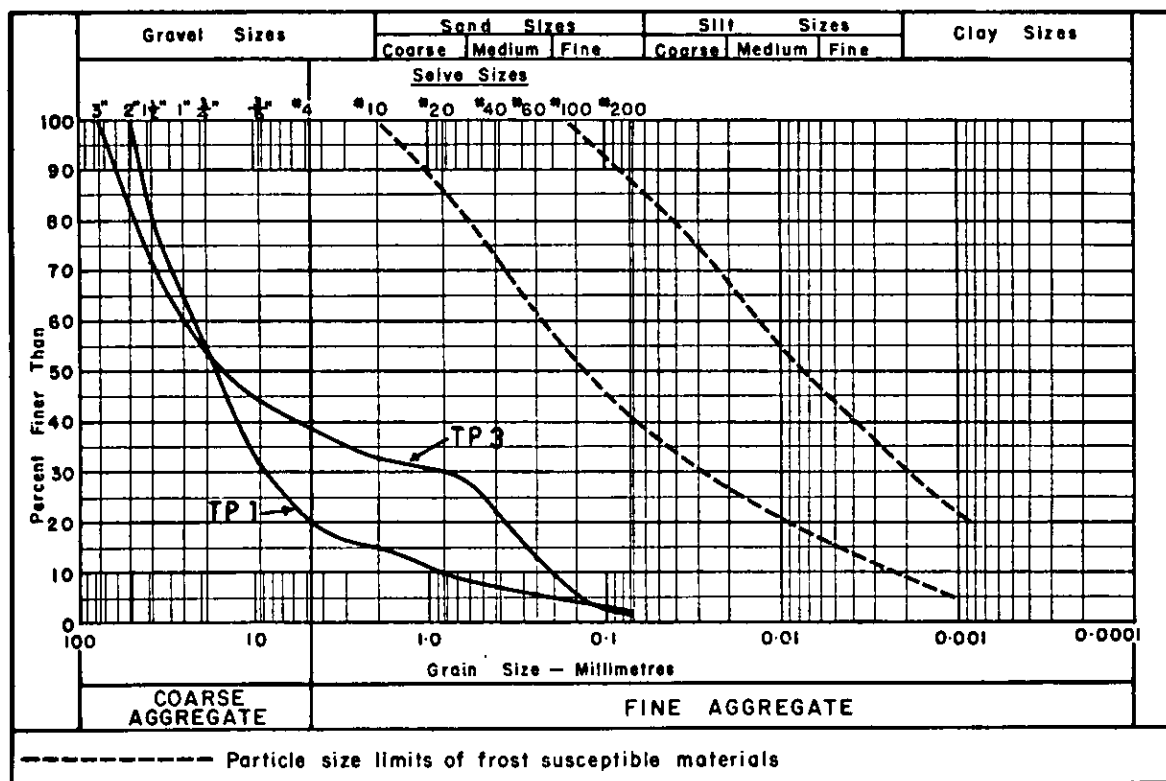
W 11/TP 3



SUMMARY OF LABORATORY TEST DATA

Sample Location:	W 11/TP 1	W 11/TP 3
Sample Depth (Feet):	2.0	1.0
Moisture Content (%):	-	-
Ice Content (%):	-	-
Organic Content (%):	-	-

GRAIN SIZE DISTRIBUTION:



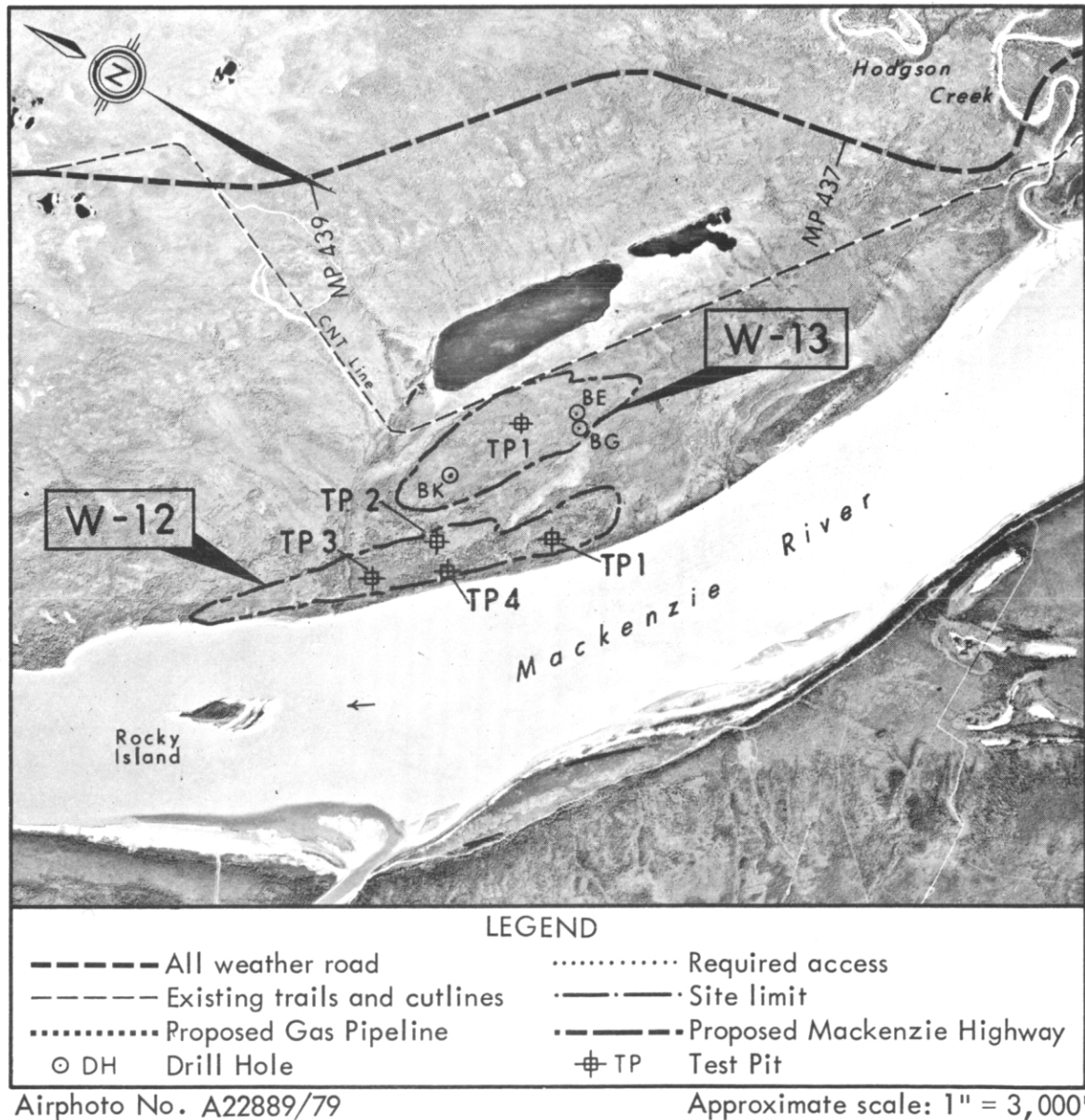
SITE NO. W 12

Located approximately $2\frac{1}{2}$ miles north of Wrigley, Site W 12 consists of a fluvial terrace along the east bank of the Mackenzie River.

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

Estimated Volume: 600,000 cubic yards.

Assessment: This site is not recommended for immediate development because other sites with better access and similar quality material are available in the Study Area.





ENVIRONMENT

Site W 12 is located approximately $2\frac{1}{2}$ miles downstream of Wrigley along the east bank of the Mackenzie River. The site consists of a flat fluvial terrace remnant which is incised with an intermittent flowing stream channel. The terrace deposit encompasses an area approximately 6000 feet in length and 700 feet in width and the plateau of the terrace is 60 to 80 feet above the water level of the Mackenzie River.

The granular materials in the terrace deposit consist of clean, well graded, medium grained gravel with some sand. A thin veneer of topsoil, 6 to 8 inches in depth, underlain by a 1 to 4 feet thick layer of lacustrine silt, overlies the deposit. The overburden, consisting of organic topsoil and silt increases in depth towards the incised intermittent stream channel. The area is covered with a moderately dense growth of spruce with the occasional stand of birch and poplar. The site area appears relatively well drained to the west and southwest.

There are no known critical wildlife areas in the immediate vicinity of the site; however, the section of the Mackenzie River opposite the site is utilized as a domestic fishing area by the natives of Wrigley.

There is no direct access to the site, although the winter road is located approximately $\frac{3}{4}$ of a mile to the east. New access will have to be developed from the site to the winter road.

DEVELOPMENT

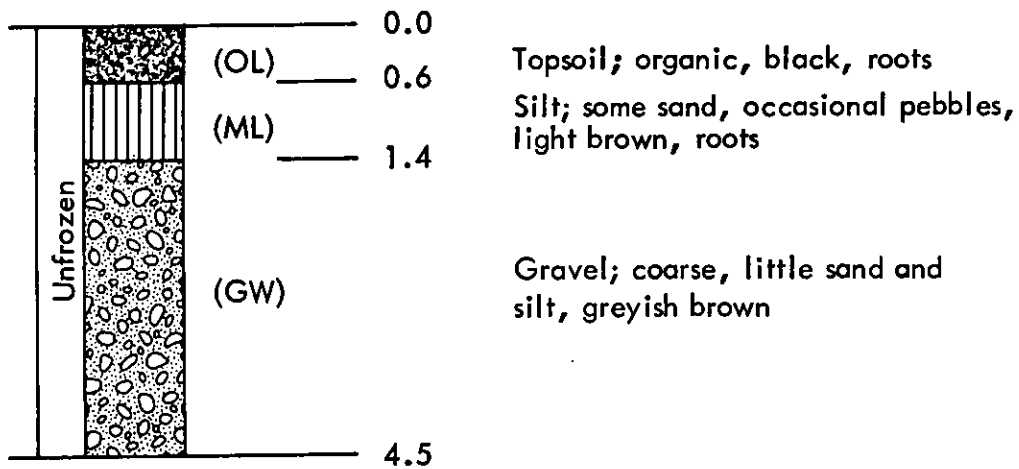
Site W 12 is not recommended for immediate development because of the following reasons:

- Considerable quantities of equally good quality granular materials are available at other sites in the Study Area with better access to Wrigley. The quantity of material available at this site is relatively minimal.
- Any development of borrow pits at this site will entail a stream crossing of Hodgson Creek which may limit the operations to the winter seasons to minimize potential damage to the regime of the stream channel.
- Unless stringent operation procedures are enforced the proximity of the site to the existing shoreline of the Mackenzie River could result in undesirable effects on the physical and biotic environments, especially those related to fishing operations along the section of the Mackenzie that parallels the site.

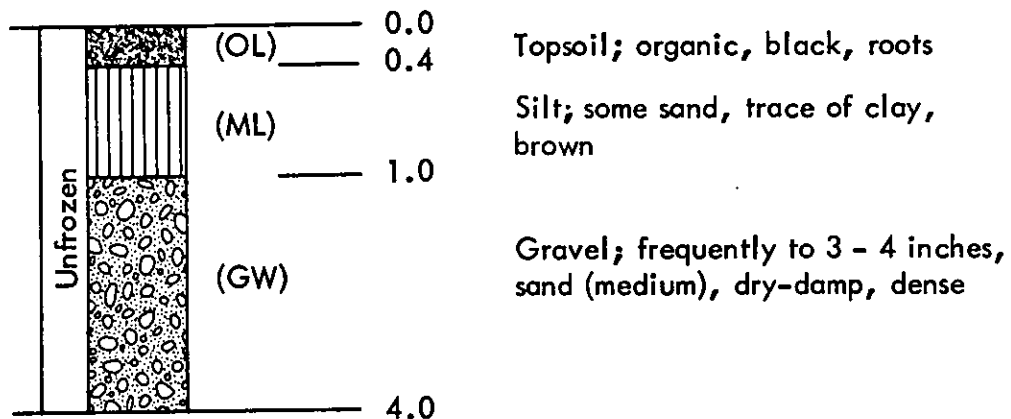
However, if this source is developed at a future date, due to the increased local needs for granular materials, then an assessment should be made relevant to the current status of the area and the proposed development of borrow pits. One of the primary procedures that should be considered at that time is the establishment of adequate vegetation buffer zones in order to protect the aesthetic and fishery resource values in and along the Mackenzie River.

DETAILED TEST PIT LOG

W 12/TP 1

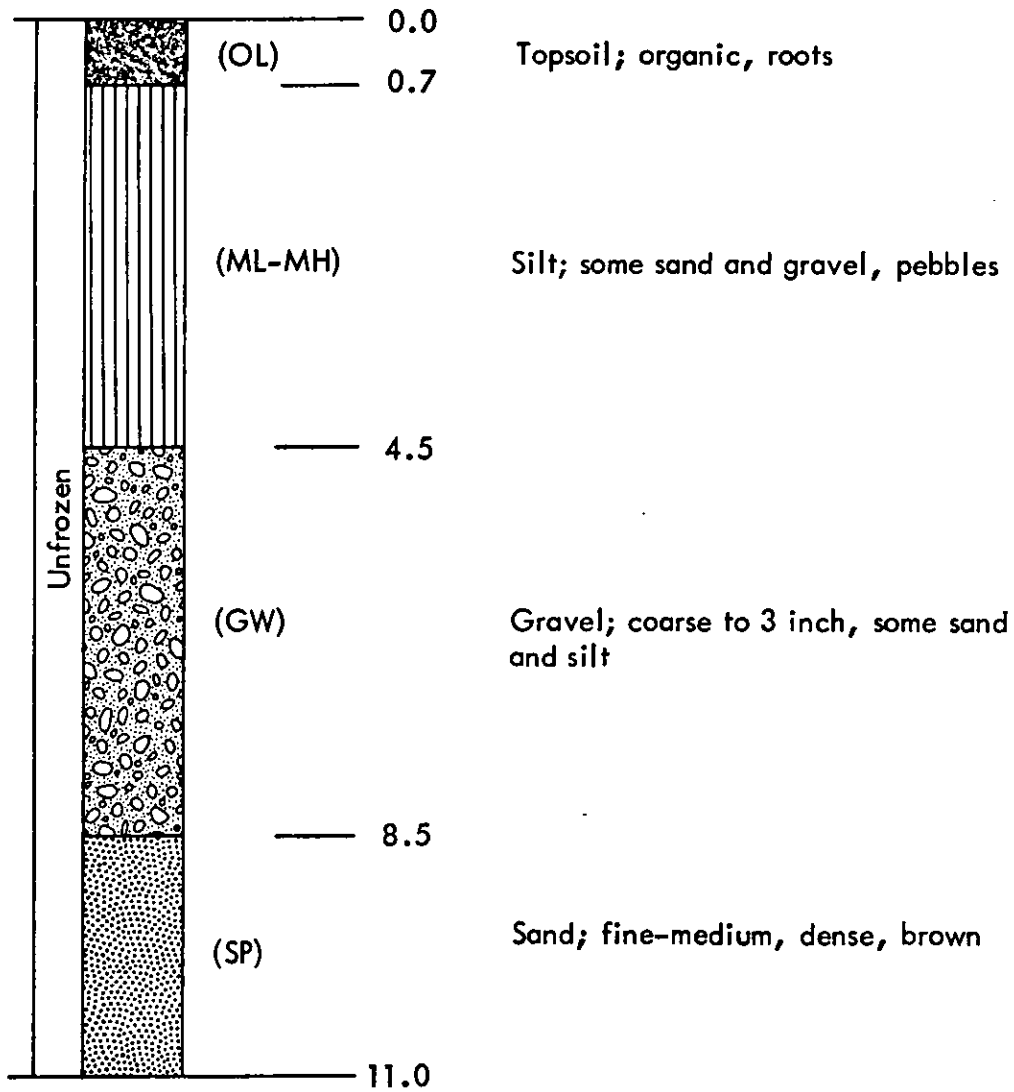


W 12/TP 2



DETAILED TEST PIT LOG

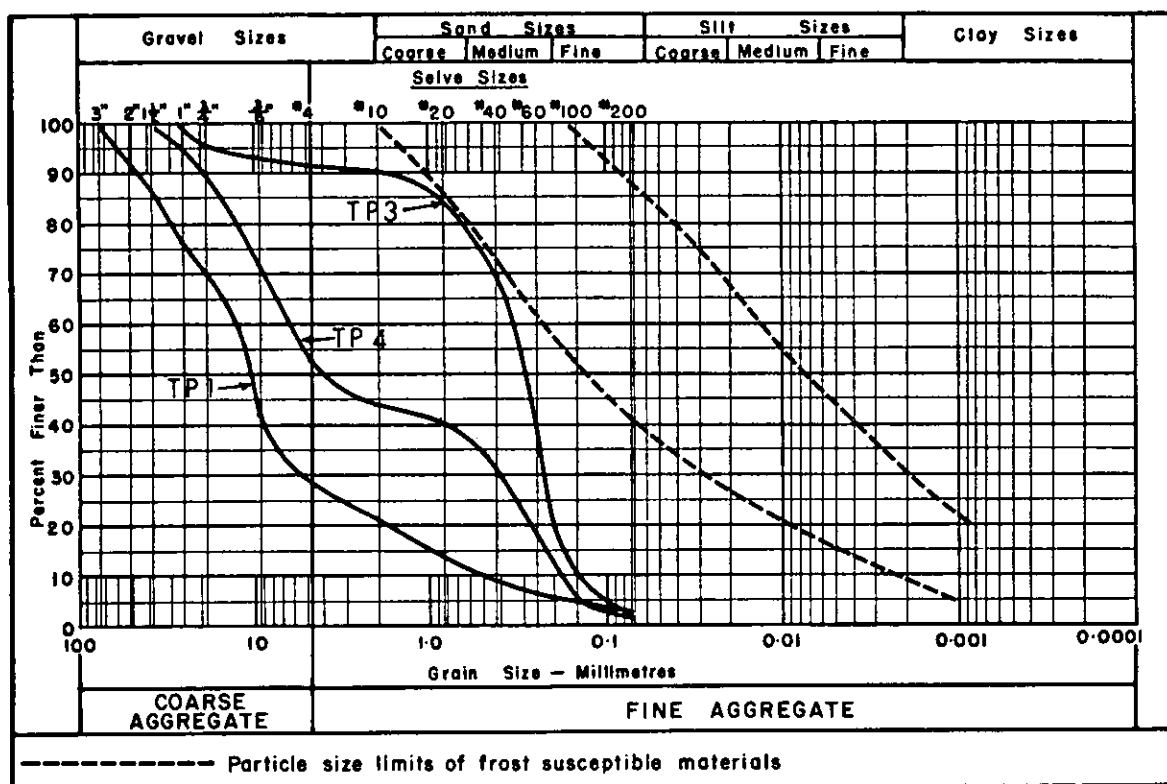
W 12/TP 3



SUMMARY OF LABORATORY TEST DATA

Sample Location:	W 12/TP 1	W 12/TP 3	W 12/TP 4
Sample Depth (Feet):	2.0	8.0	3.0 - 4.0
Moisture Content (%):	1.5	7.6	-
Ice Content (%):	-	-	-
Organic Content (%):	-	-	-

GRAIN SIZE DISTRIBUTION:



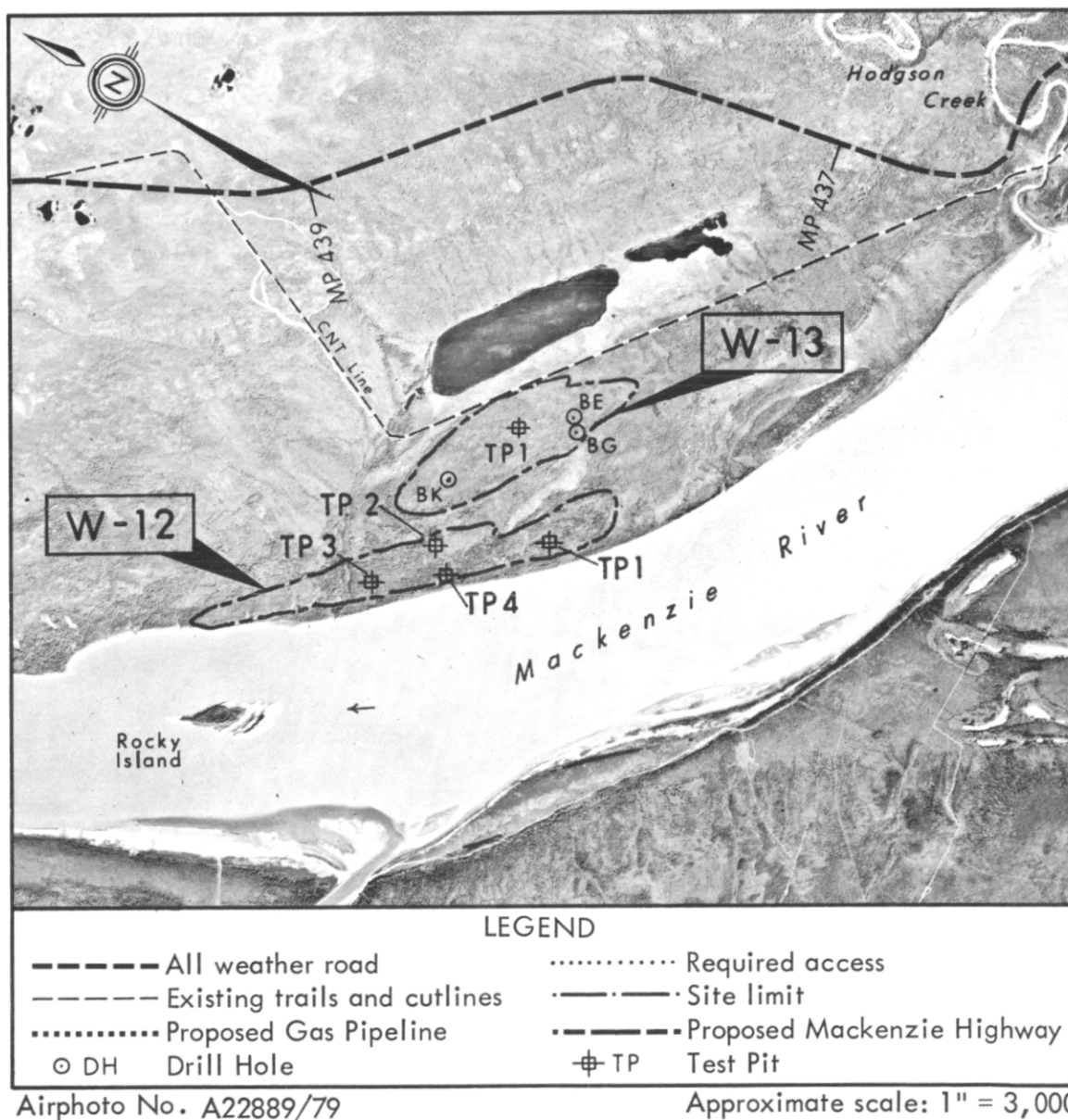
SITE NO. W 13

Located approximately $2\frac{1}{2}$ miles north of Wrigley and $\frac{1}{2}$ mile east of the Mackenzie River, Site W 13 consists of a large, flat ridge considered to be a glacial outwash deposit or a remnant of an early post glacial terrace.

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

Estimated Volume: 1,000,000 cubic yards.

Assessment: This site is not currently recommended for development because other sites with better access and similar quality material are available in the Study Area.





ENVIRONMENT

Site W 13 is located approximately $2\frac{1}{2}$ miles north of Wrigley and $\frac{1}{2}$ mile east of the Mackenzie River. The site consists of a flat, large "ridge" rising slightly above the adjacent terrain and is considered to be a glacial outwash deposit or a remnant of an early post glacial terrace. Site W 13 encompasses an area 4000 feet by 1200 feet. A large melt water channel containing two large lakes forms the eastern boundary of the site.

The material in this site consists of well graded, medium grained, sandy gravel. A thin veneer of organic topsoil and silt, approximately 1 foot in depth, overlies the gravel and supports moderate growths of spruce, birch and poplar ranging from 10 to 40 feet in height and 2 to 8 inches in trunk diameter. The surficial drainage of the site and adjacent terrain is northwesterly into the shallow gully of the intermittent stream channel.

There are no known critical wildlife areas in the immediate vicinity of Site W 13.

The existing winter road flanks the eastern perimeter of the site area and constitutes the only access to this site.

DEVELOPMENT

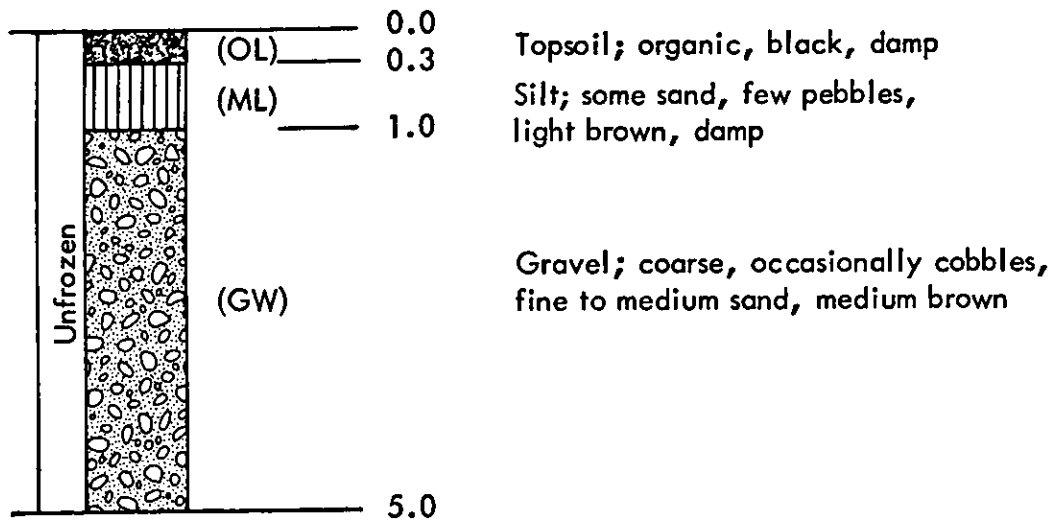
Site W 13 is not recommended for immediate development because of the following reasons:

- Considerable quantities of similar quality granular materials are available at other sites in the Study Area with better access to Wrigley.
- Any development of borrow pits at this site will require a stream crossing at Hodgson Creek, which may limit the exploitation of this site to the winter months in order to minimize potential damage to the regime of the stream channel.

However, if this site is developed at a future date due to the increased local needs for granular materials, then an assessment should be made relevant to the current status of the area and the proposed development of borrow pits.

DETAILED TEST PIT LOG

W 13/TP 1



DETAILED DRILL HOLE LOG

SITE NO. W 13

HOLE NO. B E

DATE: FEB. 24, 1973 LOGGED BY: ☐ PEMCAN ☒ ACRES CONSULTING

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

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		SP	Brown fine Sand and Gravel		Nf			0
2								2
4								4
6								6
8								8
10								10
12								12
14								14
16		SW	- brown silty Sand with fine Gravel	UF				16
18								18
20			END OF HOLE 15.0'					20

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"


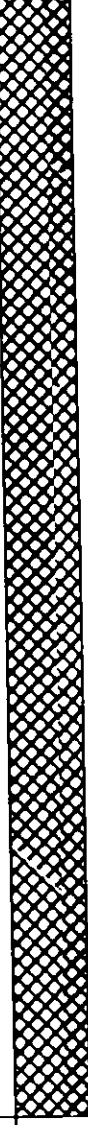
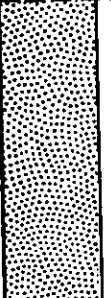
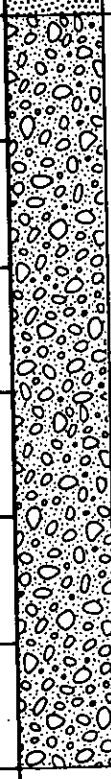
DETAILED DRILL HOLE LOG

SITE NO. W 13

HOLE NO. B G

DATE: FEB. 24, 1973 LOGGED BY: ☐ PEMCAN ☒ ACRES CONSULTING

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

DEPTH (feet)	GRAPH SYMBOL	UNIFIED GROUP SYMBOL	MATERIAL DESCRIPTION	GROUND CONDITIONS			SAMPLE TYPE	DEPTH (feet)
				GEN'L CLASS	N.R.C. CLASS	ICE EST'D CONT.		
0		Pt	Peaty Top Soil		Nf			0
1.0							GS	1.0
2		SW	- brown fine Sand and Gravel					2
4								4
6								6
6.0							GS	6.0
8		GW	Brown gravelly Till		Nf			8
10								10
12								12
14								14
14							GS	14
16								16
18								18
18.0								18
			END OF HOLE 18.0'					

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

DETAILED DRILL HOLE LOG

SITE NO. W 13

HOLE NO. B K

DATE: FEB. 24, 1973 LOGGED BY: ☐ PEMCAN ☒ ACRES CONSULTING

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

CONVENTIONAL CIRCULATION											
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	Peaty Top Soil		Nf			0			
1		SC	- brown sandy till, some fine gravel					GS		1	
2										2	
3										3	
4										4	
5										5	
6										6	
7										7	
8										GS	8
9										9	
10	10.0	END OF HOLE 10.0'						10			

10.0 — END OF HOLE 10.0'

GOVERNMENT OF CANADA
DEPARTMENT OF INDIAN AFFAIRS
AND NORTHERN DEVELOPMENT

GRANULAR MATERIALS INVENTORY



PEMCAN SERVICES "72"

SUMMARY OF LABORATORY TEST DATA

Sample Location: W 13/TP 1

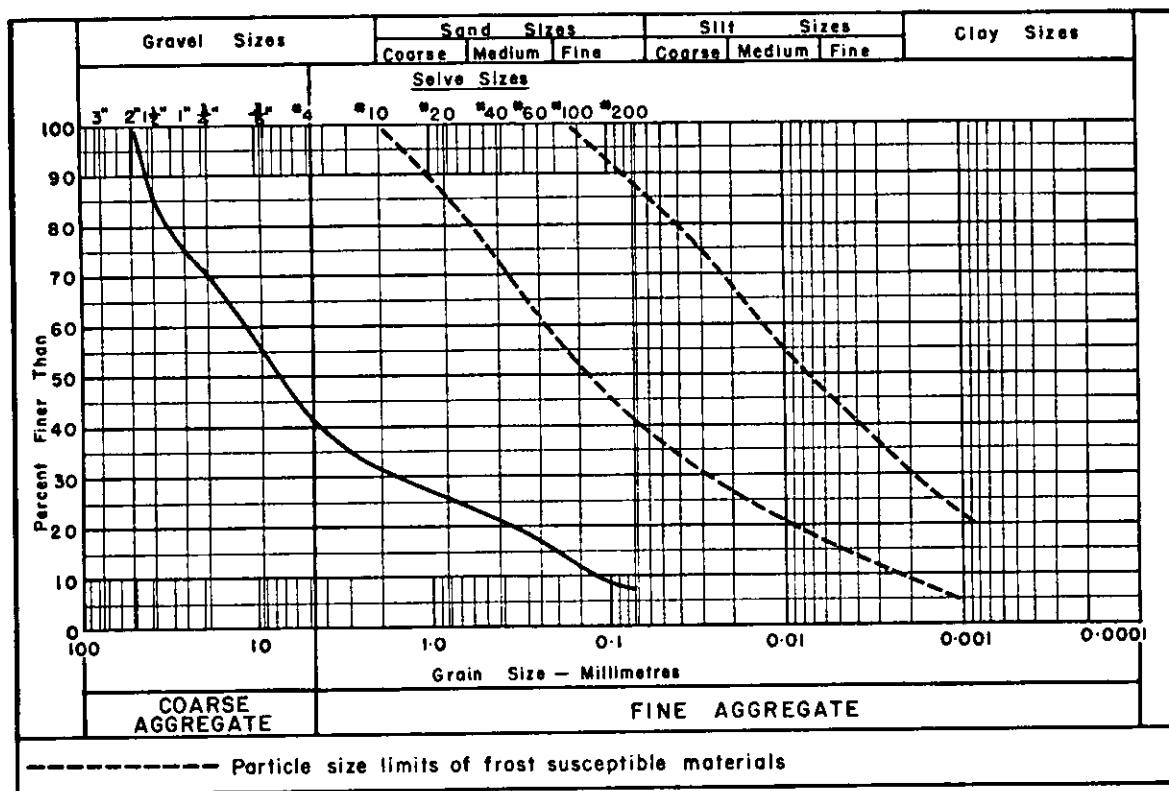
Sample Depth (Feet): 2.0

Moisture Content (%): -

Ice Content (%): -

Organic Content (%): -

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS:

Quartzite	36.9 %	Chert	5.5 %
Igneous material	28.8 %	Limestone	5.4 %
Dolostone	22.4 %		
Deleterious mica schist	1.0 %		

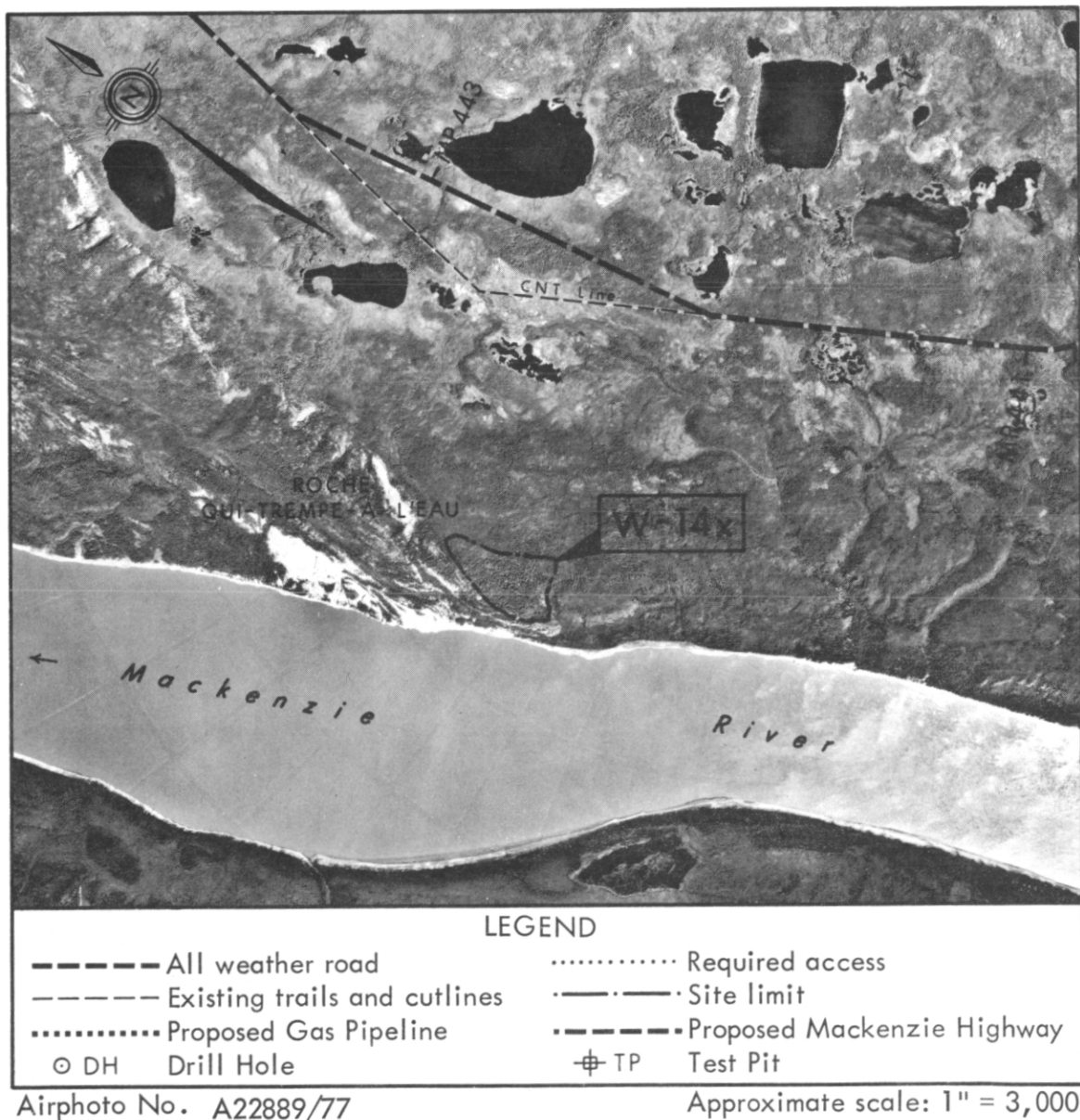
SITE NO. W 14X

Located approximately 7 miles northwest of Wrigley on the east bank of the Mackenzie River, Site W 14X consists of limestone fragments overlying bedrock along the south-east base of Roche Qui Trempe a l'Eau.

Type of Material: Limestone fragments; sand and silt.

Estimated Volume: 250,000 cubic yards.

Assessment: This site is not recommended for development because other sites with better quality granular materials and better access are available in the Study Area.





ENVIRONMENT

Site W 14X is located approximately 7 miles northwest of Wrigley immediately adjacent to the east bank of the Mackenzie River. The site consists of limestone fragments overlying bedrock along the southeast base of the rock massif cartographically designated as Roche Qui Trempe a l'Eau.

The material at Site W 14X consists of weathered limestone fragments from the rock massif intermixed with sands and silts. This material is of low quality and suitable only for general fill requirements. Fine to coarse grained, medium to thick bedded Devonian Limestone of the Nahanni Formation is exposed at the toe of the Mackenzie River bank and along the western slopes of Site W 14X. The fault zone paralleling the east slopes of the hill and Mount Gaudet has facilitated erosion processes and has resulted in the deposition of rock debris in this area.

The surficial drainage of the site area and adjacent terrain is southwesterly into the Mackenzie River. The organic topsoil layer is shallow and supports moderate growths of spruce, birch and poplar.

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

The existing winter road is located approximately 1 mile east of the site area.

DEVELOPMENT

Site W 14X is not recommended for development because other sites with considerably better access and quality of granular materials are available in the Study Area.

In addition, this mountainous terrain contains aesthetic features related to the thermal springs and unique surrounding vegetation.

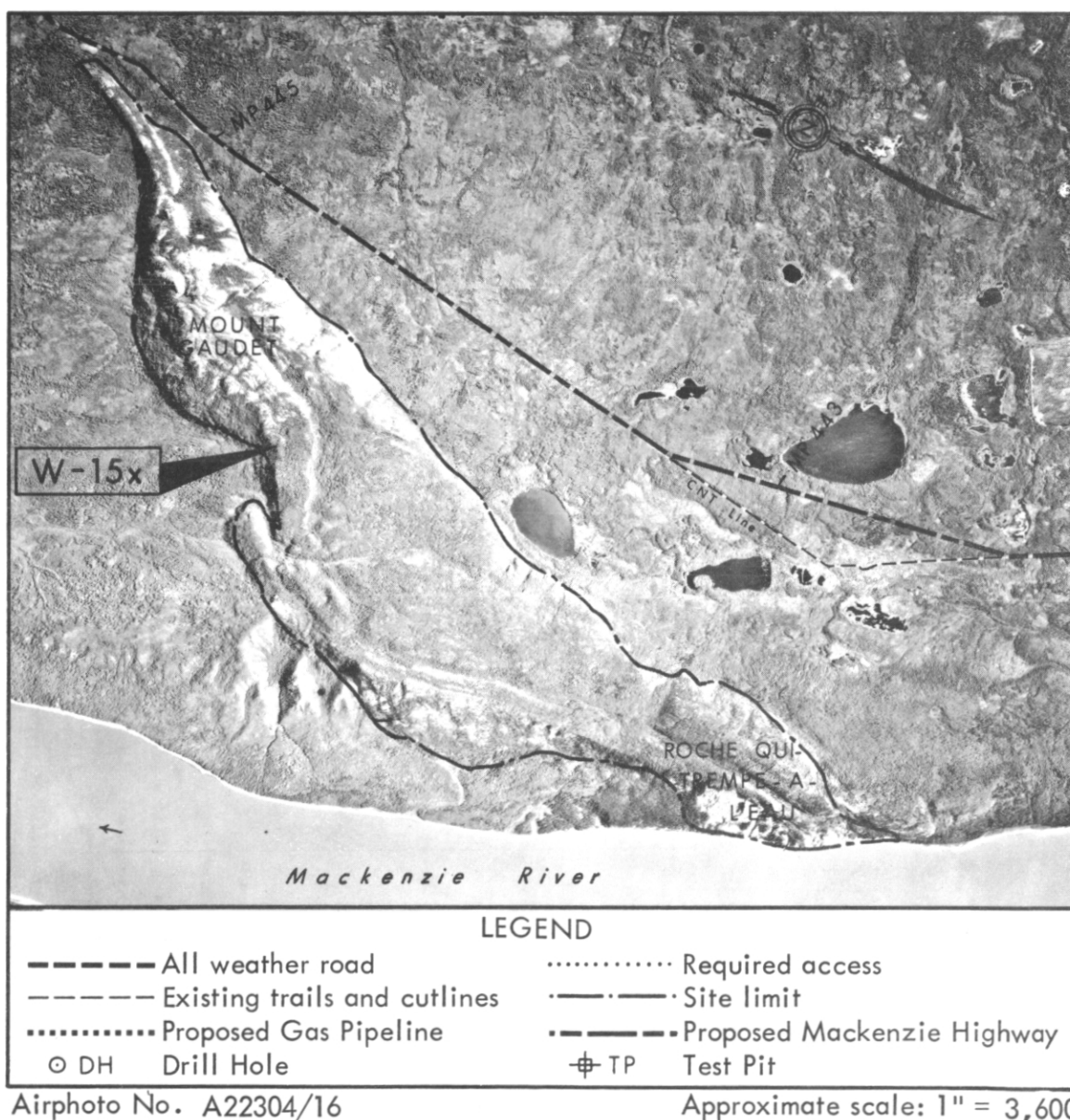
SITE NO. W 15X

Located 8 to 9 miles northwest of Wrigley, Site W 15X encompasses rocky hills known as Mount Gaudet and Roche Qui Trempe a l'Eau.

Type of Material: Limestone and massive brecciated dolomite.

Estimated Volume: Unlimited.

Assessment: Fair to good quality crushable rock for production of various categories of aggregates for construction requirements. This site is not recommended for development because community requirements for granular materials can be obtained from other sites with better access.





ENVIRONMENT

Site W 15X is located approximately 8 to 9 miles northwest of Wrigley and encompasses the rocky hills cartographically designated as Mount Gaudet and Roche Qui Trempe a l'Eau. The peak of Mount Gaudet rises approximately 1000 feet above the adjacent flat glaciated Mackenzie Plain. The rock massif extending from Roche Qui Trempe a l'Eau at the southeast extremity of the site to the northern extremity of Mount Gaudet is approximately 4 miles in length and 1 mile in width. The eastern periphery of the site area is a steep escarpment which has been formed by a major fault (see Figure 1) while the western perimeter of the site is more rugged and moderately sloped.

The range consists of medium to thick bedded grey limestones of the Nahanni Formation and of massive brecciated dolomite and limestone of the Bear Rock Formation. Rocks of these formations are competent and break into large blocks. The rock strata which are thrust upwards in the two faults, are domed around the northwest side of Mount Gaudet, and plunge to the southwest.

Thermal saline springs issue water (70° to 88° F) from rock fissures and bedding planes along the southwestern toe of the range. Old springs which have ceased to flow are marked with travertine beds, 100 feet or more above the river. Spring waters also form a small creek north of the main rock outcrops. A unique halophytic plant community which exists around this creek has been described by Lindsey (1953).

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

Access to this site consists of the winter road which runs along the northern tip of the mountain, and the Mackenzie River.

DEVELOPMENT

Site W 15X is not recommended for development because of the following reasons:

- Exploitation of granular materials from this site will require quarry operations including blasting and crushing.
- Better quality granular materials in the pit run condition in extensive quantities are available at other sites in the Study Area by opening new cracks and fissures.
- Blasting operations may disturb the existing hydrological equilibrium of the site area by opening new cracks and fissures.
- Quarry operations will adversely affect the aesthetic conditions of the site area.
- The rock faces are predominantly steep and would be unsuitable for potential quarry locations.

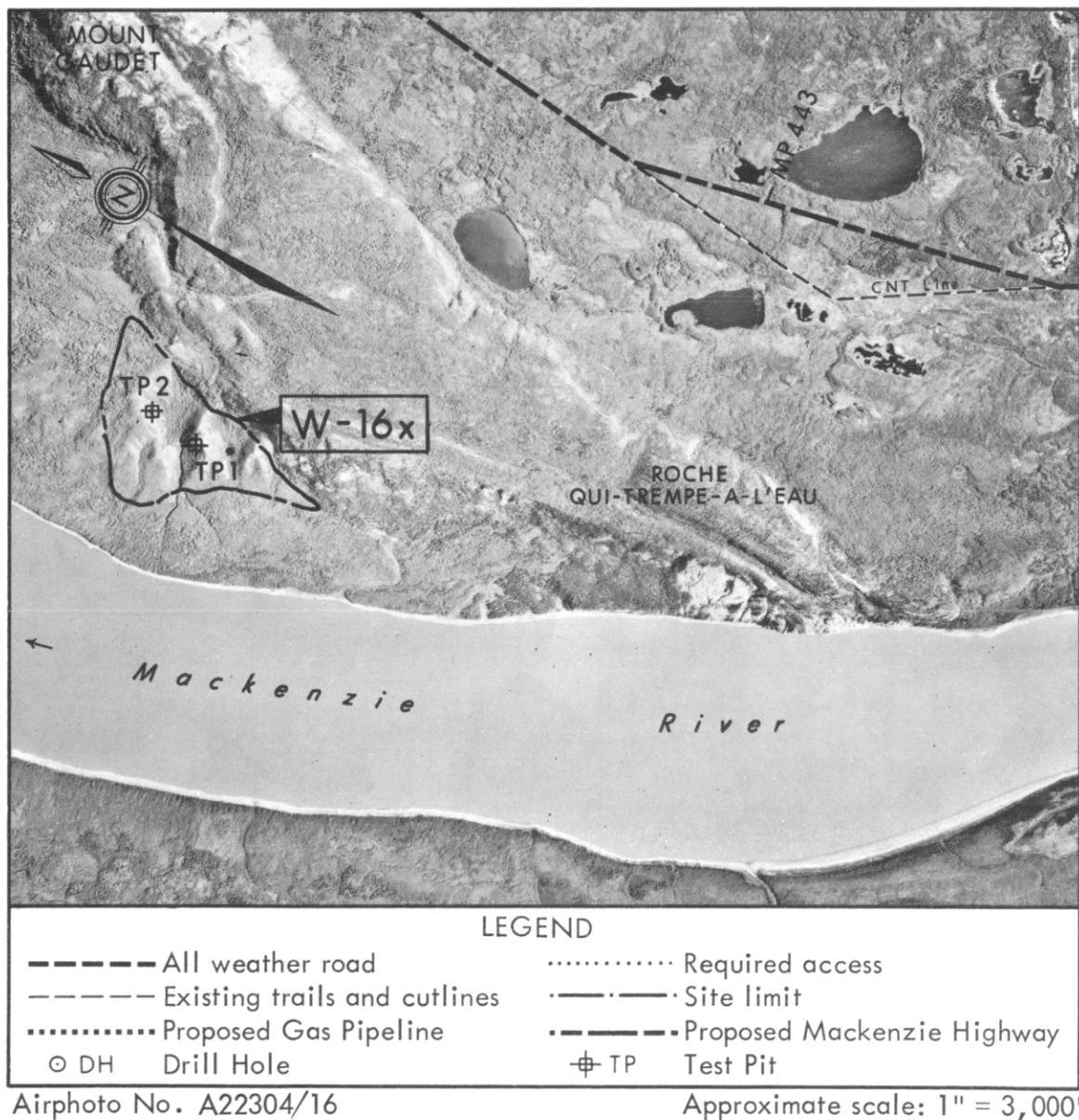
SITE NO. W 16X

Located approximately 9 miles northwest of Wrigley, Site W 16X consists of scree and slopewash deposits along the west slopes of Mount Gaudet. These deposits form a narrow, flat river terrace adjacent to the east bank of the Mackenzie River.

Type of Material: Gravel, limestone fragments, some sand.

Estimated Volume: 1,000,000 cubic yards.

Assessment: Fair to poor quality material for general fill only. This site is not recommended for development because of environmental considerations, difficult access and the availability of better quality materials at other sites in the Study Area.





ENVIRONMENT

Site W 16X is located approximately 9 miles northwest of Wrigley, and consists of relatively steep screes and slope wash debris along the western flank of Mount Gaudet. These deposits form a narrow, flat river terrace adjacent to the east bank of the Mackenzie River. The site encompasses an area approximately 4000 feet in length and 1000 feet in width.

The material at this site consists of a mixture of gravel, limestone fragments and sand which is primarily suitable for general fill requirements. The organic topsoil layer is 2 to 3 inches in depth, and supports moderate growths of birch and spruce with some poplar. The site area is well drained into the Mackenzie River. The gully bottom shows relatively strong signs of seepage.

There are no known critical wildlife areas in the immediate vicinity of the site. However, the area contains unique thermal springs and associated vegetation that offers an interesting aesthetic setting.

This site is extremely isolated and the only access is by water along the Mackenzie River.

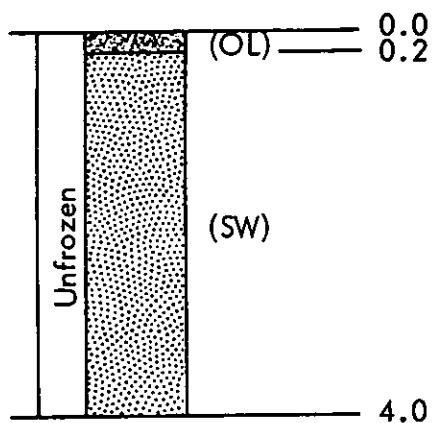
DEVELOPMENT

Site W 16X is not recommended for development because of its isolated location and relatively poor quality of available granular materials.

In addition, this terrain contains aesthetic conditions related to the thermal springs and unique surrounding vegetation.

DETAILED TEST PIT LOG

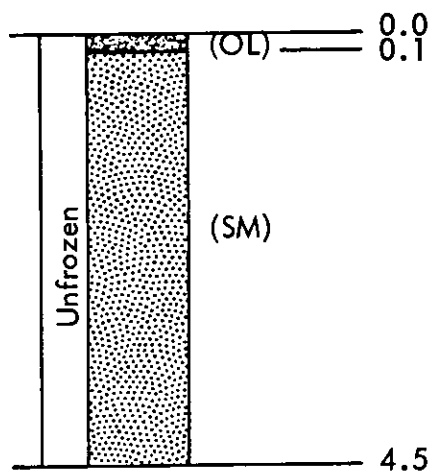
W 16X/TP 1



Topsoil; organic, dark brown, roots

Sand; some gravel, little silt. Gravel consists mostly of subangular limestone fragments to 4 inches.

W 16X/TP 2



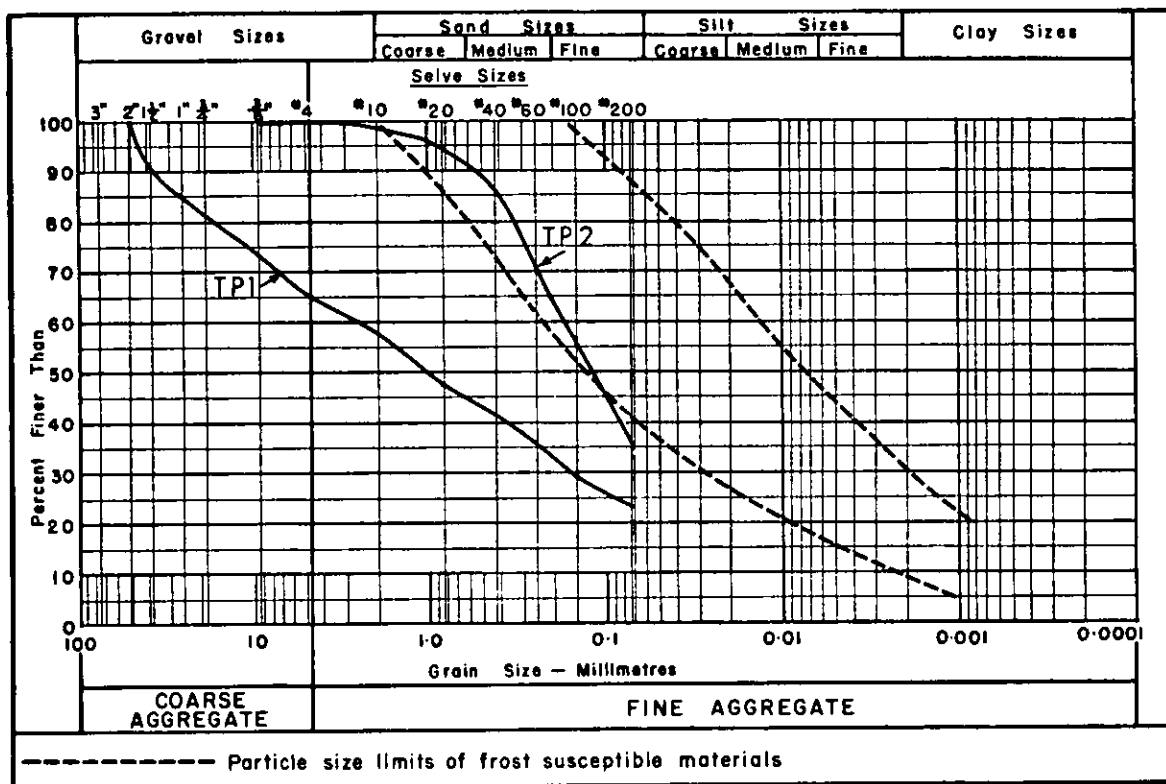
Topsoil; organic, roots

Sand; some silt, fine to medium grained, occasional limestone fragments, damp, light brown.

SUMMARY OF LABORATORY TEST DATA

Sample Location:	W 16X/TP 1	W 16X/TP 2
Sample Depth (Feet):	3.0	3.5
Moisture Content (%):	-	-
Ice Content (%):	-	-
Organic Content (%):	-	-

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS:

Limestone & dolomite	75.6 %	Cherts	1.9 %
Igneous material	17.4 %	Metamorphics	0.4 %
Quartzites	1.9 %		
Deleterious limestone and dolomite (porous)			1.5 %
Deleterious siltstone and sandstone (ferruginous)			1.0 %

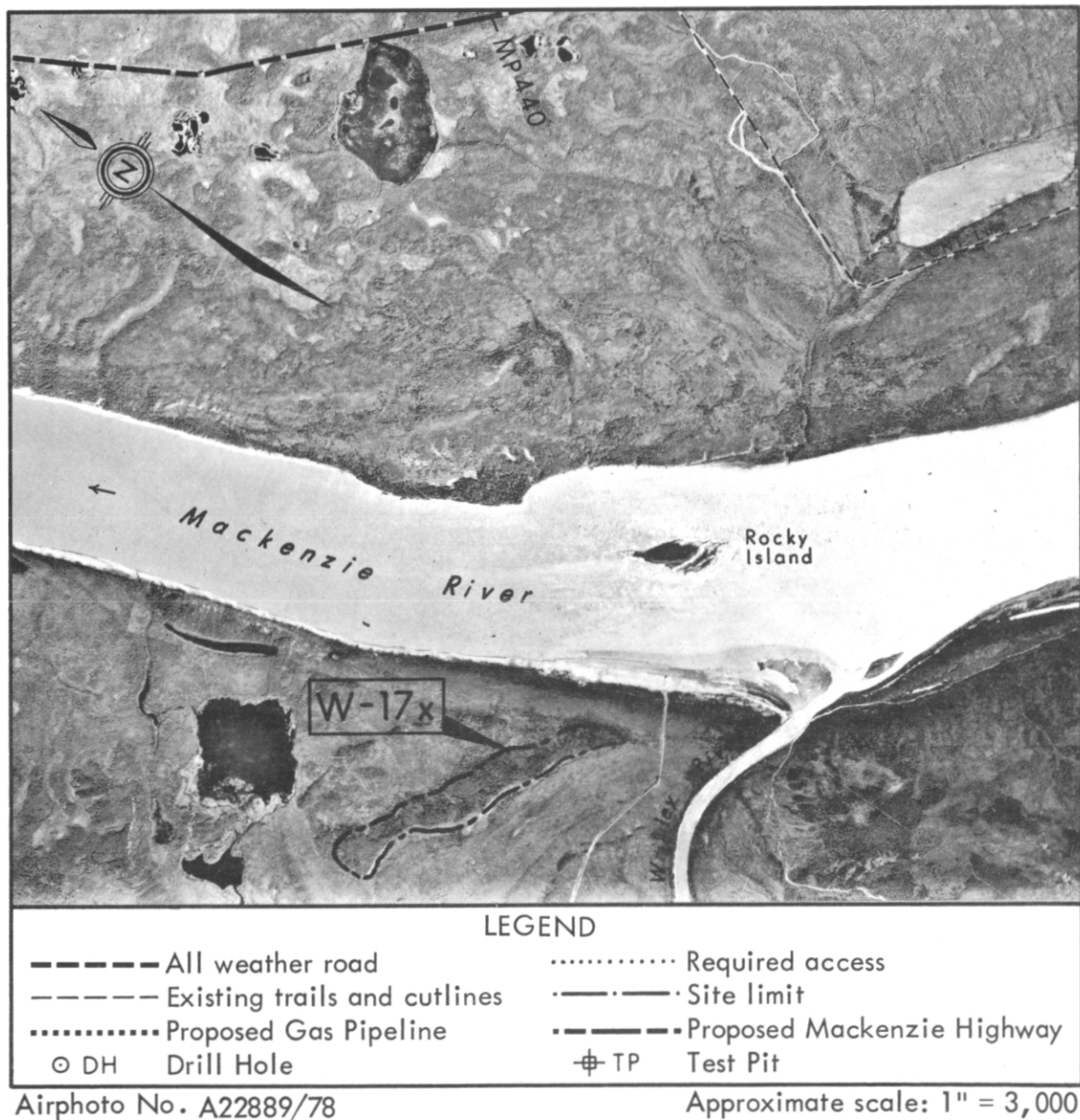
SITE NO. W 17X

Located approximately 5 miles northwest of Wrigley on the west bank of the Mackenzie River at the confluence of the Wrigley River, Site W 17X consists of a sandstone and shale ridge mantled with colluvium and residual soil.

Type of Material: Sandstone and shale fragments with silt and sand.

Estimated Volume: Not established.

Assessment: Site W 17 X is not recommended for development because other sites with considerably better quality material and access are available in the Study Area. Also, the site is adjacent to the eastern periphery of a critical wintering range for caribou.





ENVIRONMENT

Site W 17X is located approximately 5 miles northwest of Wrigley on the west bank of the Mackenzie River immediately adjacent to the north shoreline at the mouth of the Wrigley River. The site consists of a sandstone ridge approximately 1 mile in length and 800 feet in width and represents an erosional remnant of bedrock thrust up between two major fault zones. (Figure 1).

This ridge represents a more competent part of the Devonian, fine grained sandstones as compared to the similar rock outcrops exposed upstream in the Wrigley River valley. This formation also contains silty shales which are more easily eroded. In general, the rock formations in this area are less competent than those forming the Mount Gaudet or McConnell Range formations.

The sandstone ridge is mantled with residual soils and colluvium consisting of sandstone and shale debris partially cemented by a silty matrix. The mantle is very shallow on the steep southern exposures of the ridge and considerably thicker on the gentler northern slopes of the ridge. This mantle supports very sparse growths of birch and poplar.

The sandstone ridge itself is well drained while the surrounding terrain is a flat, poorly drained floodplain of the Wrigley River.

Site W 17X is adjacent to the eastern periphery of a critical wintering range for woodland caribou.

The existing access to this site consists of the Mackenzie River.

DEVELOPMENT

Site W 17X is not recommended for development because of the following reasons:

- Very difficult access involving a crossing of the Mackenzie River.
- Very poor quality material which is only marginally suitable for general fill requirements.
- The site is adjacent to a critical wildlife area.
- Other sites with considerably better quality granular materials and better access to Wrigley are available in the Study Area.

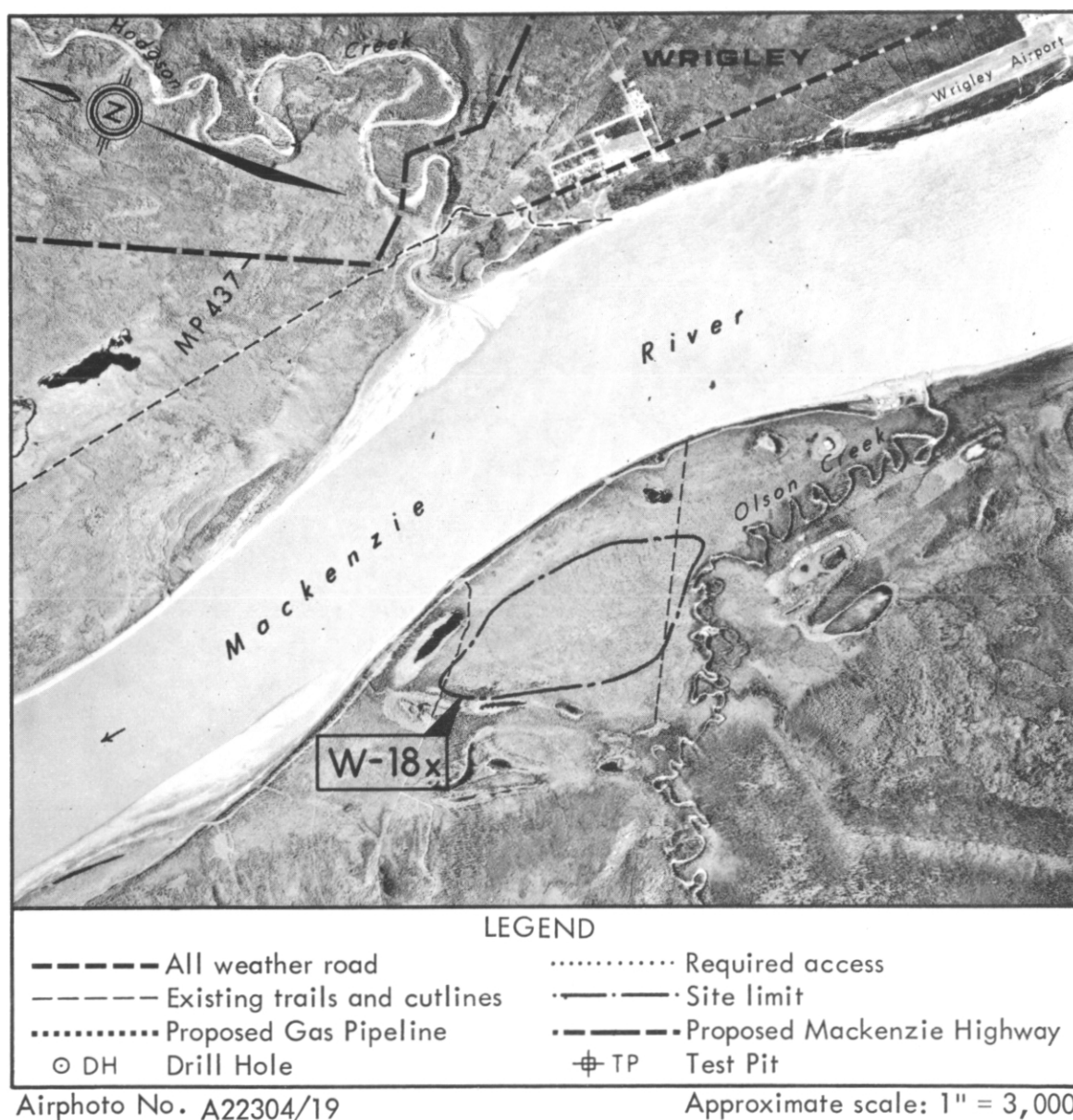
SITE NO. W 18X

Located approximately 2 miles west of Wrigley on the west bank of the Mackenzie River, Site W 18X consists of an old alluvial fan at the mouth of Olson Creek.

Type of Material: Sand; some silt.

Estimated Volume: Not applicable.

Assessment: Site W 18X is not recommended for development because it does not contain any granular type material. Also, the site is adjacent to a critical wildlife area.





ENVIRONMENT

Site W 18X is located approximately 2 miles west of Wrigley on the west bank of the Mackenzie River and consists of an old alluvial fan adjacent to the mouth of Olson Creek. The site encompasses an area approximately 3000 feet in length and 1500 feet in width.

The alluvial fan is comprised of silt with some sand. The site area is poorly drained and relatively flat, and supports very sparse growths of bushes and muskeg vegetation.

The site is adjacent to the eastern periphery of a critical wintering range for woodland caribou.

The only access to Site W 18X consists of the Mackenzie River.

DEVELOPMENT

Site W 18X is not recommended for development because the site does not consist of any granular type material.

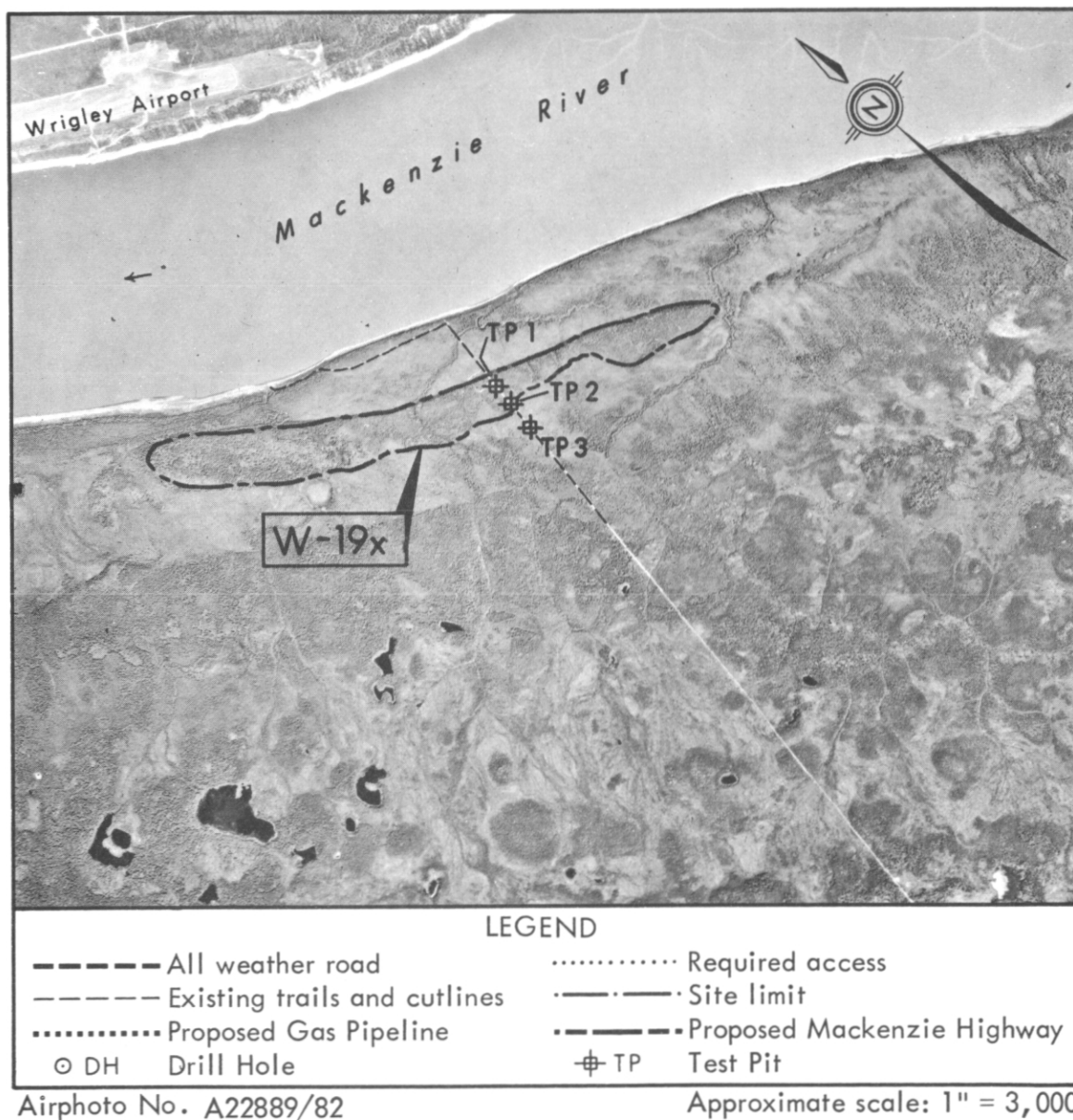
SITE NO. W 19X

Located approximately 2 miles southwest of Wrigley on the west bank of the Mackenzie River, Site W 19X consists of a pronounced river terrace.

Type of Material: Sand and Silt.

Estimated Volume: Not applicable.

Assessment: Site W 19X is not recommended for development because it contains very poor quality material.





ENVIRONMENT

Site W 19X is located approximately 2 miles southwest of Wrigley on the west bank of the Mackenzie River almost directly across from the Wrigley airstrip. The site consists of a pronounced river terrace approximately 2 miles in length and 400 feet in width, and is relatively well drained towards the Mackenzie River.

The river terrace is comprised of stratified silt and sand deposits and is mantled with a thin veneer of organic topsoil approximately 6 inches in depth. The terrace supports moderate growths of spruce, birch and poplar ranging from 10 to 40 feet in height and 2 to 8 inches in trunk diameter.

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

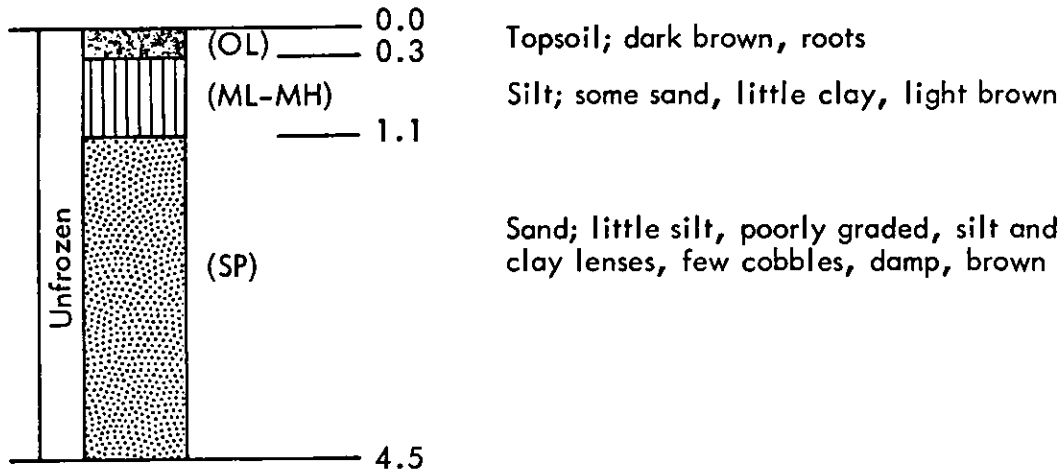
An existing seismic cutline dissects the site area; however, the only access from the site to Wrigley is by the Mackenzie River.

DEVELOPMENT

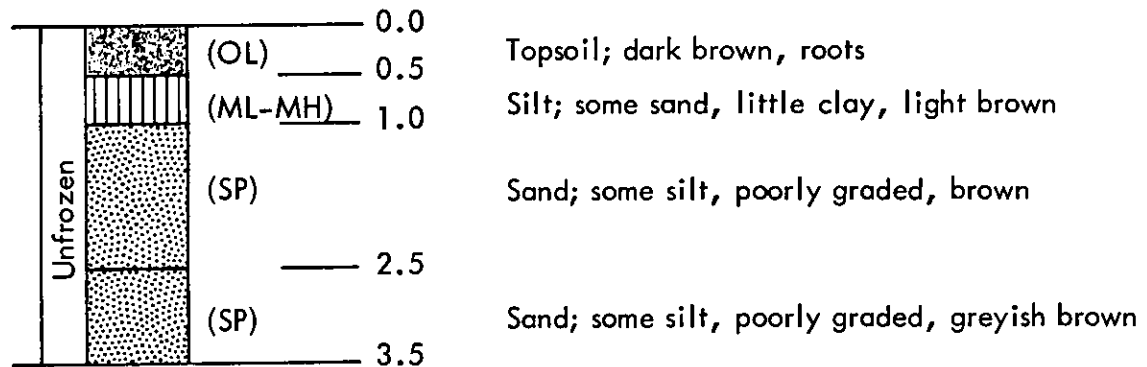
Site W 19X is not recommended for development because it contains very poor quality material.

DETAILED TEST PIT LOG

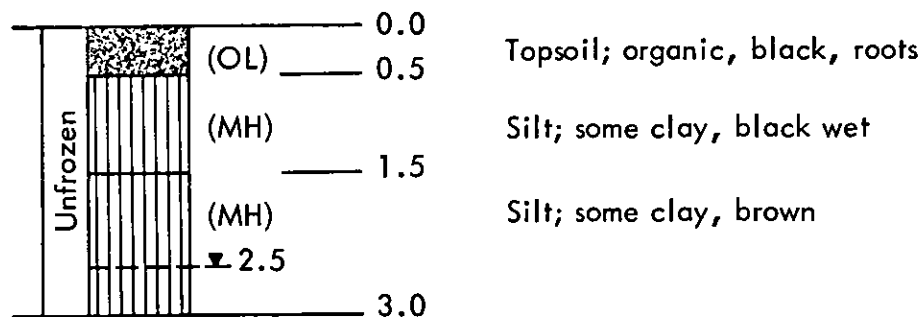
W 19X/TP 1



W 19X/TP 2



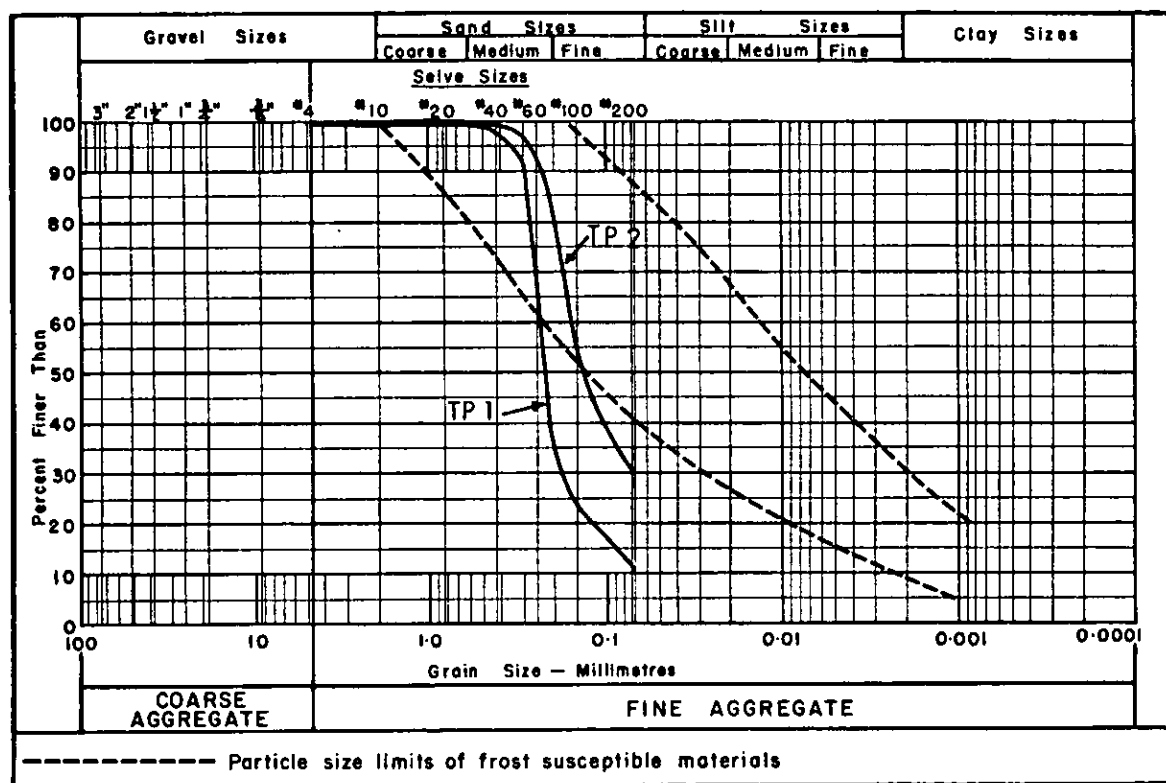
W 19X/TP 3



SUMMARY OF LABORATORY TEST DATA

Sample Location:	W 19X/TP 1	W 19X/TP 2
Sample Depth (Feet):	2.0	2.0 - 3.0
Moisture Content (%):	-	-
Ice Content (%):	-	-
Organic Content (%):	-	-

GRAIN SIZE DISTRIBUTION:



PETROGRAPHIC ANALYSIS:

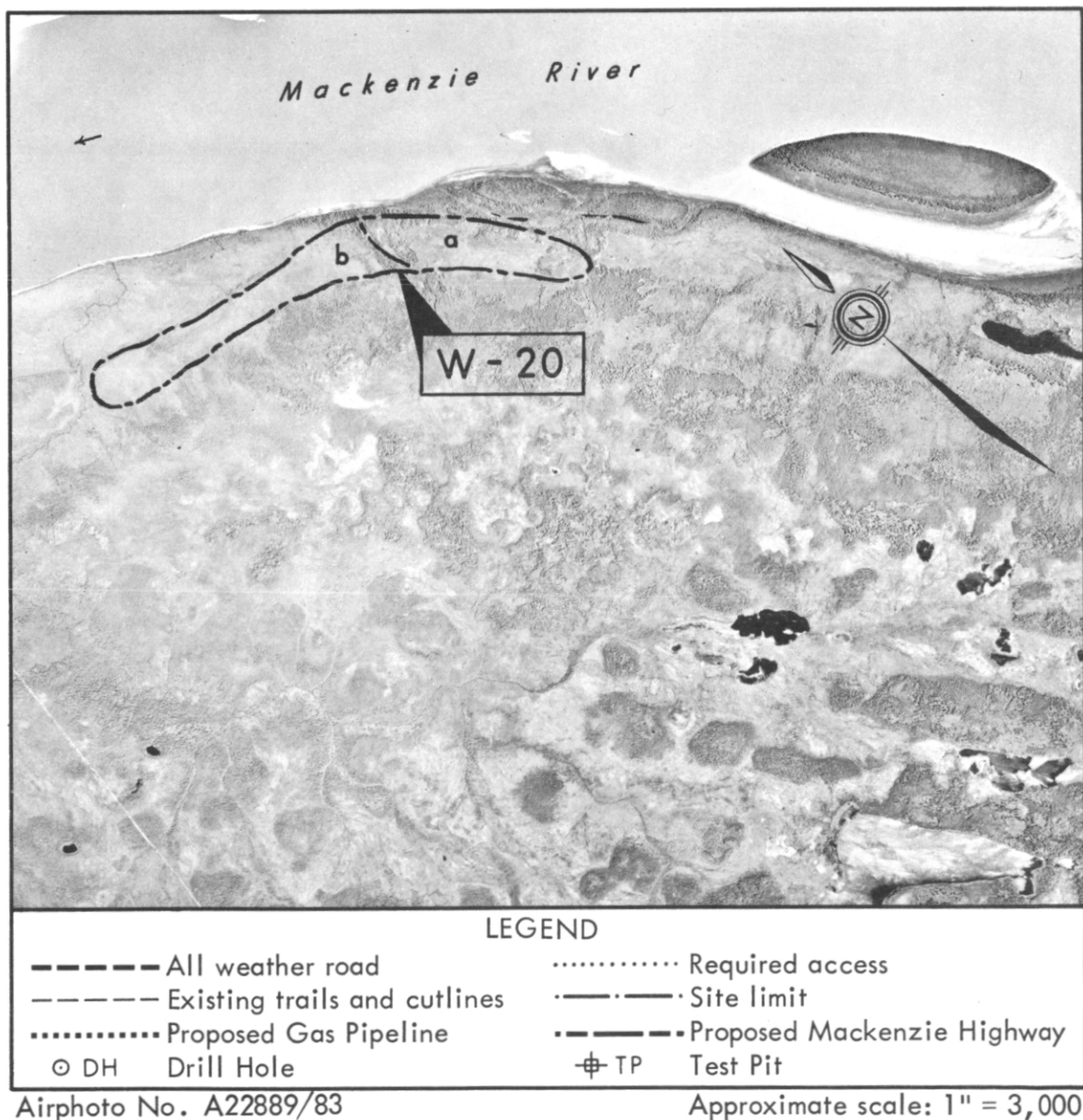
SITE NO. W 20

Located approximately 5 miles southwest of Wrigley, Site W 20 consists of a river terrace on the west bank of the Mackenzie River.

Type of Material: Gravel; Sand; Silt.

Estimated Volume: 200,000 cubic yards.

Assessment: This site is not recommended for community development. However, the site may be considered for development if local utilities are constructed in the immediate vicinity of the site at a future date.





ENVIRONMENT

Site W 20X is located approximately 5 miles southwest of Wrigley on the west bank of the Mackenzie River and consists of a relatively large river terrace on the adjacent floodplain. The site is approximately $1\frac{1}{2}$ miles in length and 500 feet in width. The adjacent terrain is relatively flat and poorly drained and consists of muskeg type terrain.

The upstream portion of the terrace, designated as part "a" on the site airphoto (Page 20-1) consists of sandy gravels, and its slopes are relatively steep and appear to be well drained. The downstream portion of the terrace designated as part "b" exhibits gentler slopes, and is poorly wooded consisting primarily of willows and small brush indicating finer grained soils.

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

There is no existing land access to Site W 20 and the Mackenzie River represents the only access from the site to Wrigley. An existing seismic cutline is located approximately $\frac{1}{2}$ mile north of the northern extremity of the site area.

DEVELOPMENT

Site W 20 is not recommended for development for the granular requirements of the Wrigley community.

However, the portion of the site designated as part "a" does consist of marginal quality granular material which may be considered for development for the granular requirements of local utilities if these are constructed in the immediate vicinity of the site at a future date.



GLOSSARY

Alluvium	Stream deposits of comparatively recent time, does not include subaqueous deposits of seas and lakes.
Anhydrite	A mineral, anhydrous calcium sulfate, CaSO_4 . Orthorhombic, commonly massive in evaporite beds.
Annuals	A plant that lives only one year or season.
Autoclave Expansion	Laboratory test procedure as designated by ASTM-C151-63 for determination of expansive qualities for all types of Portland Cement and aggregate reactions.
Berm	A horizontal portion of an earth embankment to ensure greater stability of a long slope.
Biotic	Of or pertaining to life or mode of living.
Boreal	Pertaining to the North.
Boulder	A rock fragment larger than 8" in diameter.
Cartographic	Pertaining to a map. In geology a cartographic unit is a rock or group of rocks that is shown on a geologic map by a single color or pattern.
Clay	Soil particles smaller than 0.002 mm. in diameter.
Cobble	A rock fragment between 3" and 8" in diameter.
Colluvium	A general term applied to loose and incoherent deposits, usually at the foot of a slope or cliff and brought there chiefly by gravity.
Conglomerate	Rounded water-worn fragments of rocks or pebbles, cemented together by another mineral substance which may be of a siliceous or argillaceous nature.
Cretaceous	The third and latest of the periods included in the Mesozoic era; also the system of strata deposited in the Cretaceous period.
Crystalline	Of or pertaining to the nature of a crystal; having regular molecular structure.
Delta Deposits	An alluvial deposit, usually triangular, at the mouth of a river.



Devonian	In the ordinarily accepted classification, the fourth in order of age of periods, comprised in the Paleozoic era, following the Silurian and succeeded by the Mississippian. Also the system of strata deposited at that time.
Dolomite	A mineral, $\text{CaMg}(\text{CO}_3)_2$, commonly with some iron replacing magnesium; a common rock-forming mineral.
Ecology	The study of the mutual relationships between organisms and their environments.
Eolian	Deposits which are due to the transporting action of the wind.
Escarpment	The steep face of a ridge of high land.
Esker	A narrow ridge of gravelly or sandy drift, deposited by a stream in association with glacier ice.
Excess Ice	Ice in excess of the fraction that would be retained as water in the soil voids upon thawing.
Fauna	The animals collectively of any given age or region.
Flood Plain	That portion of a river valley, adjacent to the river channel, which is built of sediments during the present regime of the stream and which is covered with water when the river overflows its banks at flood stages.
Flora	The plants collectively of any given formation, age or region.
Fossiliferous	Containing organic remains.
Geomorphology	The study of landscape and of the geologic forces that produce it. It is the dynamic geology of the face of the earth. It concerns that branch of physical geography dealing with the origin and development of the earth's surface; features (landforms) and the history of geologic changes through the interpretation of topographic forms.
Glacial Till	Non sorted, non stratified sediment carried or deposited by a glacier.
Glaciofluvial	Fluvioglacial. Pertaining to streams flowing from glaciers or to the deposits made by such streams.



Glaciolacustrine	Pertaining to glacial-lake conditions, as in glaciolacustrine deposits.
Gravel	Soil particles smaller than 3" in diameter and larger than 2.0 mm in diameter.
Ground Moraine	A moraine with low relief, devoid of transverse linear elements.
Gypsum	Alabaster. Selenite. Satin Spar. A mineral, $\text{CaSO}_4, 2\text{H}_2\text{O}$. Monoclinic. A common mineral of evaporites.
Heterogeneous	Differing in kind; having unlike qualities; possessed of different characteristics; opposed to homogeneous.
Hummock	A mound or knoll.
Icing	Mass of surface ice formed during winter by successive freezing of sheets of water seeping from the ground, a river or spring.
Kames	A mound composed chiefly of gravel or sand, whose form is the result of original deposition modified by settling during the melting of glacier ice against or upon which the sediment is accumulated.
Karst	A limestone plateau marked by sinkholes and underlain by cavernous carbonate rocks having subterranean drainage channelways that largely follow solution-widened joints, faults, and bedding planes.
Lacustrine	Produced or belonging to lakes.
Lichen	Any of a group of low growing plant formations composed of a certain fungi growing close together with certain algae.
Massif	A French term adopted in geology and physical geography for a mountainous mass or group of connected heights, whether isolated or forming a part of a larger mountain system.
Meandering	Condition of river that follows a winding path owing to natural physical causes not imposed by external restraint. Characterized by alternating shoals and bank erosion.
Moraine	Drift, deposited chiefly by direct glacial action, and having constructional topography independent of control by the surface on which the drift lies.



Morphological	The scientific study of form. Used in various connections, e.g. landforms (geomorphology).
Muskeg	The term designating organic terrain, the physical condition of which is governed by the structure of peat it contains and its related mineral sublayer, considered in relation to topographic features and the surface vegetation with which the peat co-exists.
Ordovician	The second of the periods comprised in the Paleozoic era, in the geological classification now generally used. Also the system of strata deposited during that period.
Perennial	Lasting through the year.
Permafrost	The thermal condition under which earth materials exist at a temperature below 32°F continuously for a number of years.
Petrography	The branch of science treating of the systematic description and classification of rocks.
Proglacial	Pertaining to features of glacial origin beyond the limits of the glacier itself, as...streams,...deposits,...sand.
Sand	Soil particles smaller than 2.0 mm. in diameter and larger than 0.06 mm. in diameter.
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.
Sinuuous	Winding or curving in and out.
Slope Wash	Soil and rock material that is being or has moved down a slope predominantly by the action of gravity assisted by running water that is not concentrated into channels.
Taiga	A Russian word applied to the old, swampy, forested region of the north...that region between the Tundra in the north and the Boreal in the south.



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.



PEMCAN SERVICES

EXPLANATION OF TERMS AND SYMBOLS



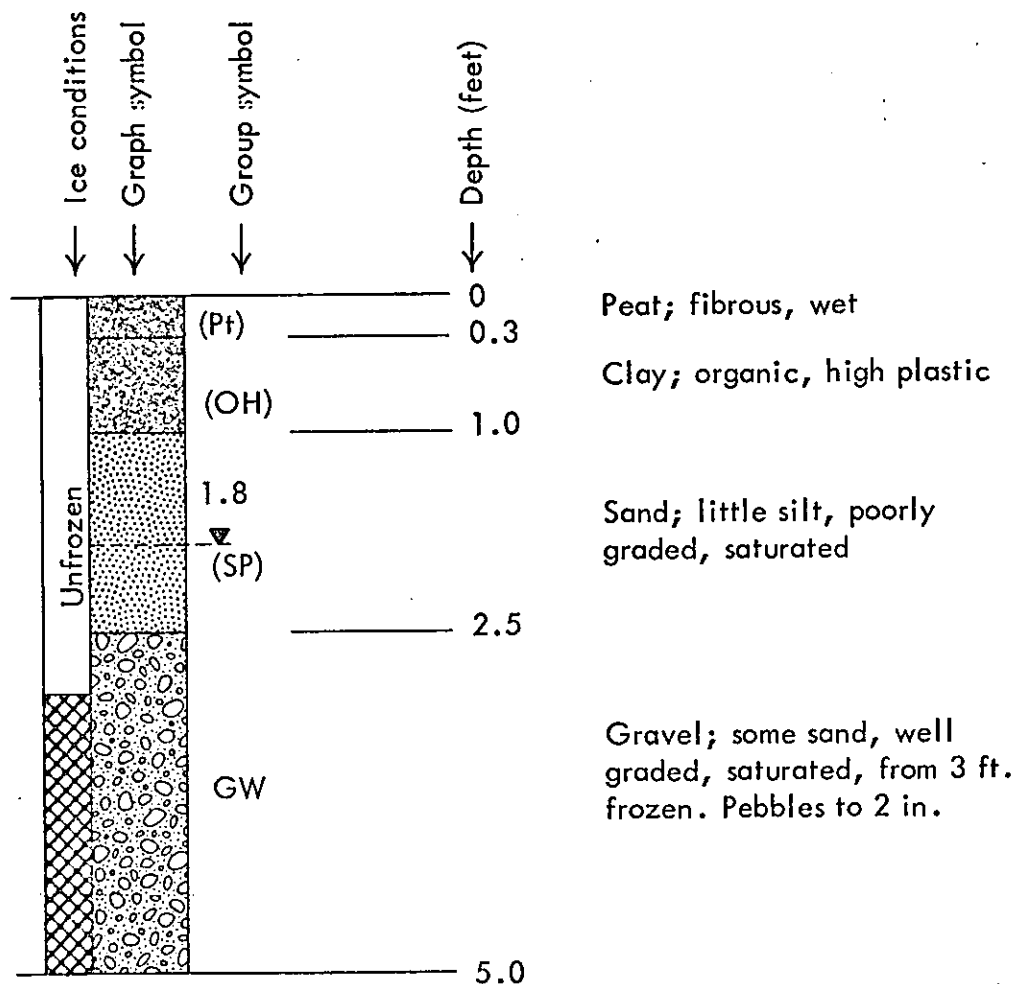
EXPLANATION OF TERMS AND SYMBOLS

DRILL HOLES AND TEST PITS

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

TEST PIT LOG DESCRIPTION

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





DRILL HOLE LOG DESCRIPTION

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

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

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



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

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

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

Column 8:

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

MC:- designates moisture content determinations.

GS:- designates grain size analyses including hydrometer tests.

P:- designates Petrographic analyses.

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

O:- designates Organic Content determinations.

DETAILED DRILL HOLE LOG

SITE NO. 131

HOLE NO. DH-1

DATE: FEB. 15, 1973

LOGGED BY: ☒ PEMCAN

DRILLING METHOD: ☒ X

AIR
CONVENTIONAL

☐ AIR REVERSE CIRCULATION

☐ OTHER:

[illegible]



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:

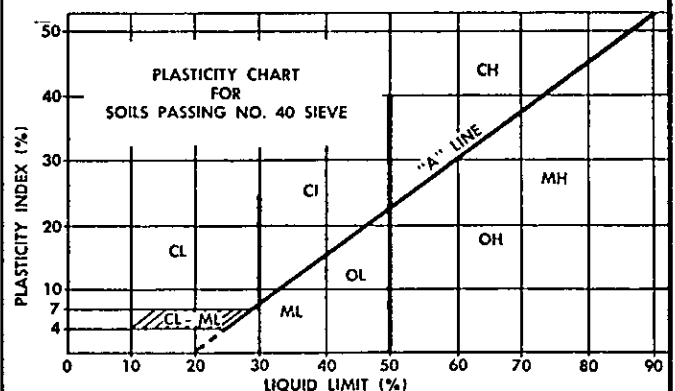
Composite Sand-Gravel Soils		Composite Sand-Silt Soils	
Percentages	Identification	Percentages	Identification
90 to 10	Gravel; trace Sand	95 to 5	Sand; trace - Silt
80 to 20	Gravel; little Sand	90 to 10	Sand; trace + Silt
65 to 35	Gravel; some Sand	80 to 20	Sand; little Silt
50 to 50	Gravel and Sand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

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION			GROUP SYMBOL	GRAPH SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN 200 SIEVE)	GRAVELS MORE THAN HALF COARSE GRAINS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	GW		WELL GRADED GRAVELS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 6$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			GP		POORLY GRADED GRAVELS, AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY GRAVELS (WITH SOME FINES)	GM		SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE P.I. LESS THAN 4
			GC		CLAYEY GRAVELS, GRAVEL-SAND-(SILT) CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
	SANDS MORE THAN HALF FINE GRAINS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	SW		WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	$C_u = \frac{D_{60}}{D_{10}} > 4$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1 \text{ to } 3$	
			SP		POORLY GRADED SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY SANDS (WITH SOME FINES)	SM		SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE P.I. LESS THAN 4
			SC		CLAYEY SANDS, SAND-(SILT) CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE P.I. MORE THAN 7
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES 200 SIEVE)	SILTS BELOW "A" LINE NEGLECTIBLE ORGANIC CONTENT	$w_L < 50\%$	ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	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 NEGLECTIBLE ORGANIC CONTENT	$w_L < 30\%$	CL		INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS		
		$30\% < w_L < 50\%$	CI		INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS		
		$w_L > 50\%$	CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS BELOW "A" LINE ON CHART	$w_L < 50\%$	OL		ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	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

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



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

GROUND ICE CLASSIFICATION

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

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

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

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

FIG A. ICE NOT VISIBLE

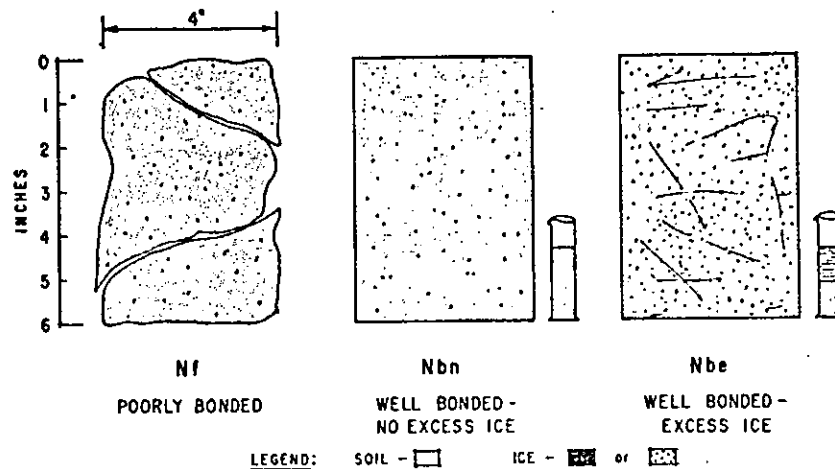


TABLE I (cont'd)
ICE DESCRIPTIONS
B. VISIBLE ICE—LESS THAN 1 INCH THICK^(a)

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

^(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

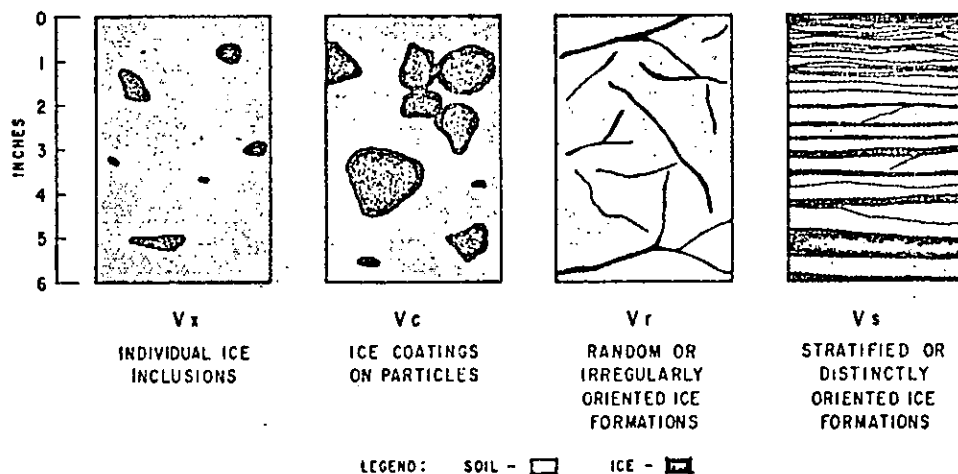


TABLE I (cont'd)
ICE DESCRIPTIONS
C. VISIBLE ICE—GREATER THAN 1 INCH THICK

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

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

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

FIG C. VISIBLE ICE GREATER THAN ONE INCH THICK

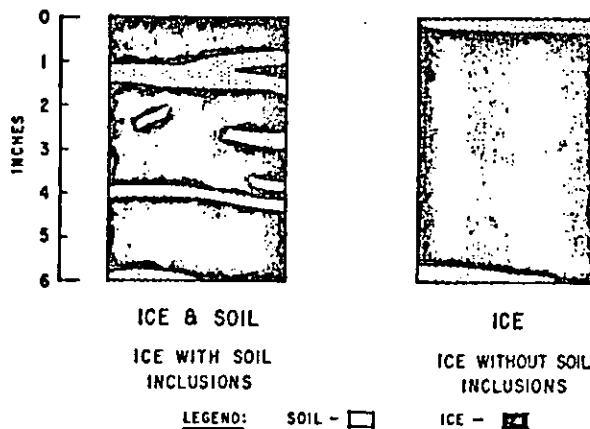




TABLE II

TERMINOLOGY

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

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

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

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

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

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

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

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

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

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

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

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

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

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



EXPLANATION OF TERMS AND SYMBOLS

WILDLIFE AREAS

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

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

COMMUNITY REPORTS

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

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

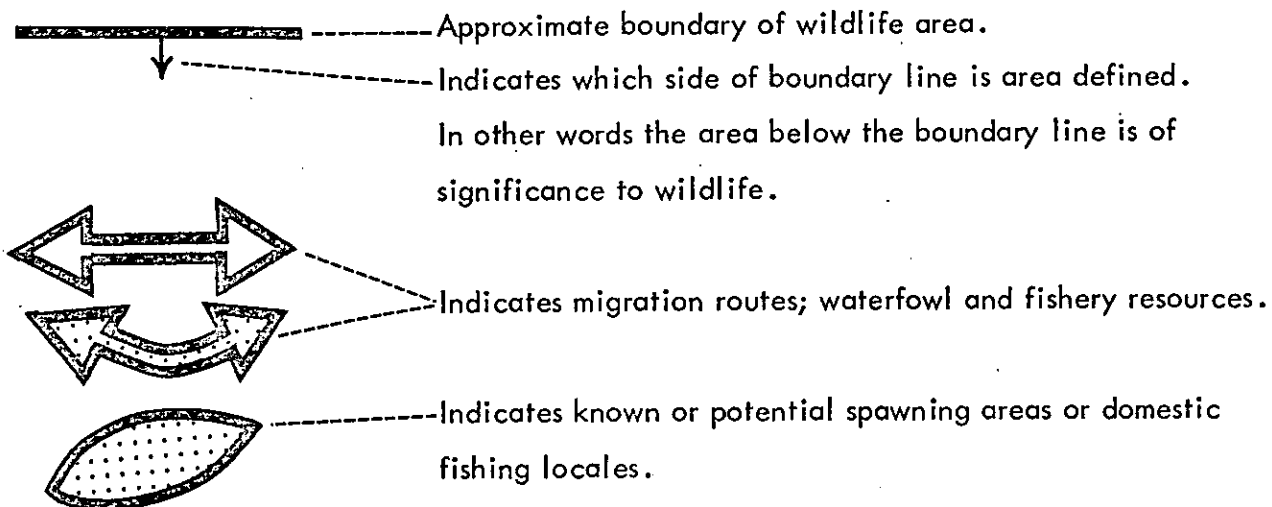
Outlined wildlife areas include both regions of known wildlife habitation and regions which have been historically trapped by northern residents.

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



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

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

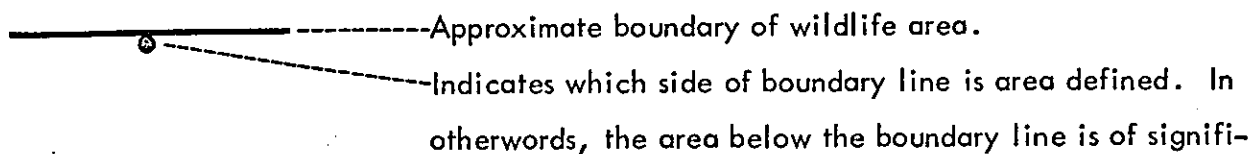


Pertinent wildlife areas are discussed in the Methodology-Evaluation section of the text in each community report. Similar documentation is also presented for sites which occur in significant wildlife areas in the Site Description section of the report.

INTERCOMMUNITY REPORTS

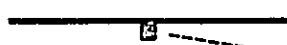
In each Intercommunity Study Area, known "critical" and "important" wildlife, waterfowl and fishery resource areas are outlined on the respective map presentations. A brief description relating to the significance of each area is included within the outlined boundary. Areas that are classified as "critical"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

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





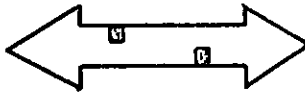
cance to wildlife.



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.



PEMCAN SERVICES

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