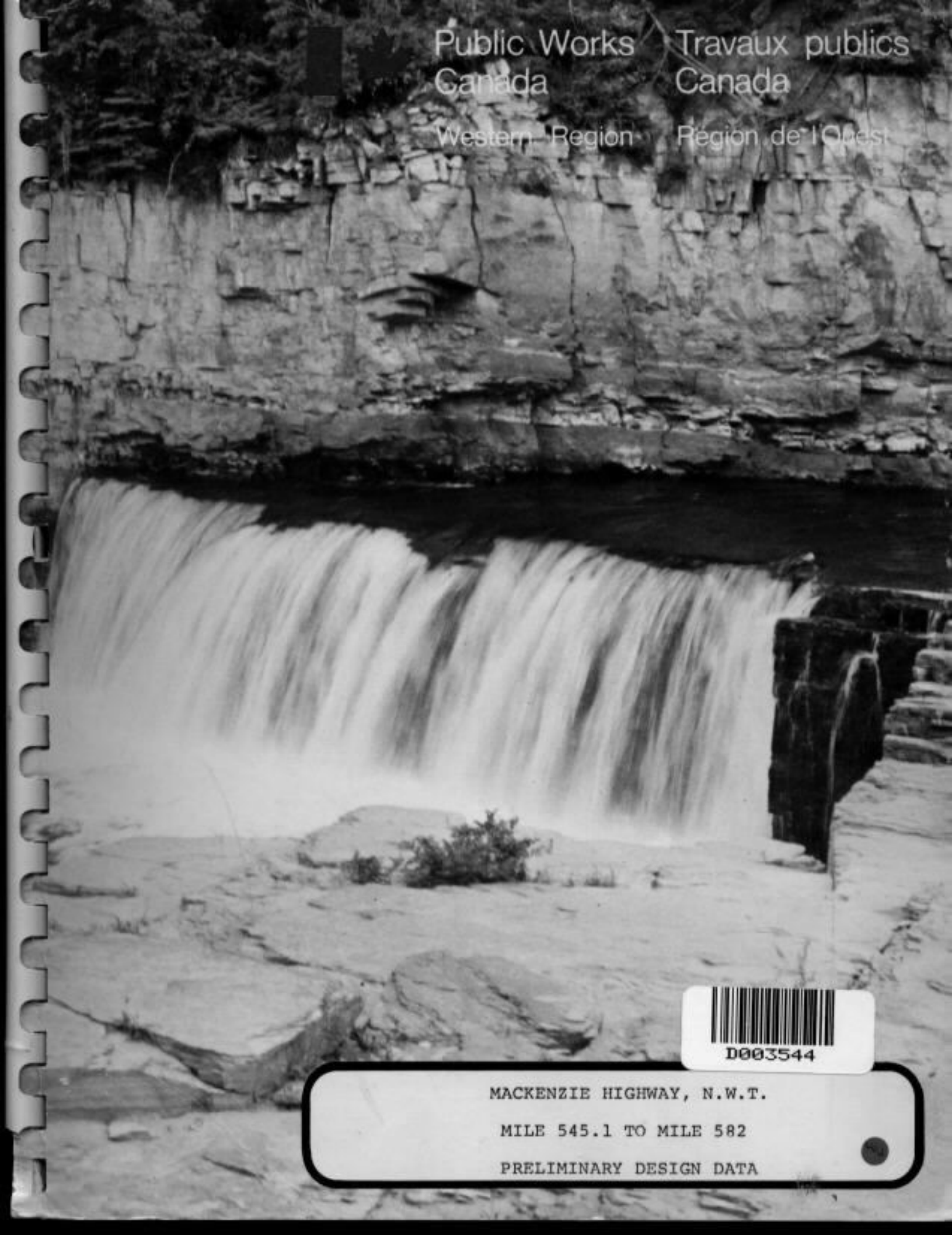

MACKENZIE HIGHWAY, N.W.T.

MILE 545.1 TO MILE 582

PRELIMINARY DESIGN DATA

Government of Canada / Gouvernement du Canada

MEMORANDUM **NOTE DE SERVICE**

TO / À
Mr. W. R. Binks
Program Manager (Civil)
Design & Construction
OTTAWA, Ontario

FROM / DE
F. E. Kimball
Project Manager NWT Roads
Western Region

SECURITY CLASSIFICATION / DE SÉCURITÉ

OUR FILE / N/RÉFÉRENCE
9305-52-300

YOUR FILE / V/RÉFÉRENCE
000017

DATE
February 7, 1974

SUBJECT / OBJET
PRELIMINARY DESIGN SUBMISSION - MILE 545.1(N) TO MILE 582 MACKENZIE HIGHWAY

Enclosed are 24 copies of the narrative portion of the above-noted Design Submission. Two sepia copies of the plans have been forwarded under separate cover.

Six copies of the narrative and a sepia of the plans have been forwarded to Mr. J. Hamilton of D.I.N.A. in Yellowknife. Single copies of the narrative and a single set of prints have been forwarded to D.O.E. in Edmonton and Winnipeg and E.M.R. in Calgary.

Every attempt has been made to provide all information required in a Preliminary Design Submission. It would be appreciated if you could obtain an early response identifying any omissions or additional information requirements relative to this Preliminary Design Submission.

F. E. Kimball
Project Manager NWT Roads
Western Region

Encl.

MACKENZIE HIGHWAY

PRELIMINARY DESIGN DATA

MILE 545.1(N) - MILE 582

Department of Public Works
of Canada
Western Region
EDMONTON, Alberta

I N D E X

INTRODUCTION

The general design criteria used by the Department of Public Works design teams in preparing the preliminary and final designs of the Mackenzie Highway are outlined in the General Design Data Report, Section "C", Mile 544 to Mile 725 published on January 29, 1974 by the Public Works of Canada, Western Region. Narratives on specific concerns for this Design Submission are contained in this Report, Preliminary Design Data, Mile 545.1(N) to Mile 582.

The reader should note that this Report forms part of a total Design Submission, the major portion of which is contained in separate plan form.

Attention is also drawn to the fact that the drawings contain complete notes of design and assessment for hydrology, culverts and environmental impact.

CHAPTER 1

OVERLAND DRAINAGE

From Mile 545 to Mile 582 the highway crosses a relatively flat glaciolacustrine plain interspersed with several concentrations of thermokarst associated features occurring along the right of way.

From Mile 545 to Mile 554, the numerous small thermokarst lakes and ponds present potential ponding of overland flow. By the use of numerous culverts it is intended to maintain the existing drainage characteristics of this area.

Starting at Mile 555 the alignment runs along the top of series of sand ridges and across various small dune formations to about Mile 563. Drainage problems in this sector should be minimal due to the generally excellent relief afforded by the alignment.

At Mile 563 the quality of local drainage begins to deteriorate and is generally poor to Mile 568. The frozen fine-grained nature of the soil precludes subsurface drainage and the relatively flat nature of the terrain may lead to some drainage problems. As in other areas of this nature, additional culverts were placed in low spots in the profile.

The alignment from Mile 568 to 573 continues across an area of relatively poor drainage, with numerous thermokarst features. The ground is fairly level, with the general drainage

direction being toward the Mackenzie River.

From Mile 574 to Mile 576.5 the highway follows a raised alluvial slope which has a locally well-defined drainage system, draining into a broad meltwater channel east of the highway. Drainage of the meltwater channel to the Mackenzie River crosses the highway R.O.W. at Mile 573.9 and at Mile 576.6.

From Mile 577.8 to Mile 580 the highway ascends a raised alluvial slope, which again drains to the east into another meltwater channel. Drainage of this meltwater channel to the Mackenzie River crosses the highway R.O.W. at Mile 577.8 and at Mile 579.8.

CHAPTER 2

SOURCES OF BORROW

Borrow requirements for this Design Submission were obtained from a quantity take-off based on the designed gradeline. The location of, and the quantities required from each borrow area is indicated on the 1"=1,000' Mosaics included with the Design Submission. The choice of the borrow area locations are based on available geotechnical information, air photo interpretation, and on the principle of reasonable haul distances. Where available, geotechnical data for the selected borrow areas is included on the 1"=1,000' Mosaics. In some cases, from air photo interpretation, borrow areas other than the areas test drilled by the Geotechnical Consultant last winter were suggested as potential by the designer. These areas will require test drilling and further investigations.

Mile 545N - Mile 555

The highway alignment for this section is over flat topography consisting of silty sands with relatively high water contents and a permafrost table near the surface. The designed gradeline is one of overlay construction and requires borrow material almost entirely for its construction. In general the borrow areas selected contain fine sands which are often silty. These are considered to be suitable for embankment use. The permafrost type was generally classified as

Nbn (non-visible, no excess ice) with moisture contents averaging about 25 per cent.

Mile 555 - Mile 563

The alignment runs along the top of a series of sand ridges and crosses various small dune formations. The gradeline designed for this section is one of balanced cuts and fills. The silty sand material from cuts in this section are considered suitable for embankment use. The permafrost type was generally classified as Nbn (non-visible, no excess ice) with moisture contents varying from 10 - 15 per cent.

Mile 563 - Mile 582

The topography along the route is fairly level with the only steep gradients being found in approaches to three creeks. The soils in this section of the alignment consist of interbedded clays, silts and sands. Moisture contents are extremely variable and are invariably considerably above the optimum for embankment use. The designed gradeline is one of overlay construction and requires borrow material almost entirely for its construction.

(i) Mile 563 - Mile 570

The borrow areas selected for this section contain silty sand with low moisture contents providing for suitable construction material.

(ii) Mile 570 - Mile 582

The borrow areas selected for this section contain clay and silt in different layers with moisture contents varying from 25 to 40 per cent with some considerable ice content. It is recognized that the borrow materials available in this section are generally of a very low quality for embankment construction and prior to the final design further assessment will be done to determine if the material can in fact be acceptably incorporated into the roadway. Consideration will also be given to modifications such as capping with better quality sand materials from the section to the south or rock materials from north of the Great Bear River as well as the possible alternative of hauling all embankment material from one or both of these better quality areas.

CHAPTER 3

SPECIAL DITCH TREATMENT

The following special treatment for planned ditches has been identified in accordance with Section B-9 of the Mackenzie Highway General Design Data, Mile 544 to Mile 725.

MILE	STATION	AVERAGE % SLOPE	ESTIMATED DISCHARGE IN C.F.S.	DITCH PROTECTION OR DITCH CHECK SPACING
552-553	1548-1554	0.6	4	200'
553-554	1518-1526	2.0	2	65'
553-554	1500-1506	2.4	1	55'
553-554	1473-1485	5.0	1	Coarse Gravel
555-556	1414-1424	1.2	5	100'
555-556	1393-1403	4.7	3	Coarse Gravel
555-556	1373-1381	2.0	2	65'
556-557	1332-1345	5.9	1	Coarse Gravel
556-557	1319-1326	1.9	1	70'
557-558	1271-1278	1.2	3	125'
559-560	1188-1201	2.0	3	60'
559-560	1173-1185	2.9	3	40'
563-564	993-1001	1.1	1	130'
565-566	837- 859	0.7	7	150'
568-569	735- 741	4.6	3	Coarse Gravel

MILE	STATION	AVERAGE % SLOPE	ESTIMATE DISCHARGE IN C.F.S.	DITCH PROTECTION OR DITCH CHECK SPACING
568-569	720-726	4.1	2	Coarse Gravel
573-574	433-436	2.8	1	75'
577-578	237-242	1.0	5	150'
579-580	125-143	3.1	5	45'

CHAPTER 4

SUMMARY OF ENVIRONMENTAL DATA

- Prepared by: Lombard North Group,
  Environmental Consultants.

Information presented on the Environmental Data and Litten sheets is the result of many months of intensive field work, literature review, and air photo analysis. Within the portion of alignment under discussion, there are few potentially significant conflicts of alignment vs. environment. Key areas of concern have been identified and, in such cases, suggestions for amelioration of impact or special precautions are presented.

Following are brief discussions of Miles 545 to 582 of the proposed alignment under each of the assessment categories:

Vegetation	Archaeology
Fish	Landscape Architecture
Birds	Recreation
Mammals	Construction
Terrain Analysis	Environmental Assessment

A short synopsis appears at the end of this account.

VEGETATION

Within the area under consideration in this Submission, little can be said of the forest cover other than that the greatly predominant tree species is black spruce. Additional tree species, of less prominence, include white spruce, aspen, birch, and

larch. Black spruce forests cover over 75 per cent of the alignment area, the remainder being composed of riparian communities, mixed forest, sparsely treed muskeg, and scattered open meadows. Generalized forest cover types have been indicated on the Environmental Data sheets.

There appear to be no critical areas with respect to vegetation. Deciduous forests provide a pleasant change from the routine black spruce and thus can be used to good advantage. Areas of deciduous and mixed forest along the alignment should be preserved where possible. This is often difficult as these same areas are often underlain by valuable borrow material.

Impact on the forest cover will be primarily a result of alteration of natural drainage patterns and clearing for the alignment, borrow areas and visual open spaces. Changes in forest cover may set off a chain reaction, as those wildlife species adapted to particular forest types will be affected. Effects may also be felt in the permafrost levels as a reduction in forest density allows increased insolation to reach ground level, thereby possibly resulting in increased permafrost melt.

FISH

The area traversed by Miles 545 to 582 is a glaciolacustrine thermokarst plain. Surface waters include thermokarst lakes, bogs, and small streams with high organic debris contents. The alignment crosses unnamed streams at Miles 546.0 and 548.3

and designated streams at the following locations:

Creek "A"	Mile 551.0
Creek "B"	Mile 555.0
Creek "C"	Mile 568.2
Creek "D"	Mile 573.9
Creek "E"	Mile 579.8

A general description of the respective drainage basins and physical and chemical characteristics of the streams have been noted on the Environmental Data sheets. In addition, fish seen or caught during sampling periods, and fishing potential have been indicated. "Fishing potential" denotes the assessed capability for sport fishing. Graphic symbols have been used on the Environmental Data sheet mosaics to indicate presence or absence of fish in streams, and the direction of flow.

Generally, streams within the section of alignment under discussion have single channels with silt as a major component of their beds. Dissolved oxygen concentrations approached saturation in all creeks tested, except in Creek "A".

Creeks "A", "B", and "E" may be considered unsuitable as significant sport fish habitat. Creeks at Miles 546.0 and 548.3 were sampled by F. F. Slaney and Company Limited. No fish were found in either stream. As suitability for fish is poor in both streams, standard culverts have been recommended.

The presence of immature arctic grayling in Creeks "C" and "D" indicate that these two water bodies may be used by grayling as spawning areas and, therefore, fish passage culverts have been recommended. Sport fishery potential for the entire 37-mile extent is rated as generally poor.

BIRDS

Miles 545 to 582 of the proposed Mackenzie Highway alignment traverses an area which comprises excellent to marginal waterfowl habitats. Good to excellent habitat is found along the proposed right-of-way approximately from Miles 548.5 to 555.2, 554.5 to 557.5, 562.0 to 565.5, and 574.5 to 578.0. Ponds and lakes are necessary requisites for waterfowl both during spring and fall migration and during the summer nesting season. Although the proposed highway route impinges on waterfowl habitats, access from the right-of-way to the ponds and lakes will remain difficult due to the terrain and vegetation. Thus, any detrimental impact will be limited to a relatively narrow belt along the alignment. It is felt that use of the proposed route location will have little or no impact on waterfowl utilizing the Mackenzie River, as access to the river from the alignment is presently nonexistent.

No rare or endangered avian species are found within this section of alignment and, although several terrestrial and wetland species do exist, their ability to cope with changes in local habitats minimizes the highway's possible affect upon them.

Impacts on birds could result from habitat alterations due to changes in drainage patterns. The already expressed intentions to utilize culverts, where necessary, to maintain natural drainage patterns should alleviate most of these potential problems.

MAMMALS

Several mammal species inhabit the forest and wetland habitats along the highway route south of Fort Norman. These include moose, beaver, muskrat, marten, mink, black bear, wolf, and fox. No rare or endangered species are known to exist in the area. Residents of Fort Norman hunt and trap in the area traversed by the highway route, though not to a great extent.

Any alteration in the habitat will have some impact on local mammal species. Better access provided by a highway may also result in increased hunting and trapping pressure. Care must be taken to avoid or to minimize encroachment on potential denning areas located on well-drained slopes and ridges. In general, however, construction of the highway along the present alignment should not result in any critical impact on mammals, provided major alterations of drainage patterns do not occur. No viable route alternatives exist which would improve the situation without creating further potential problems

TERRAIN ANALYSIS

Landform from Miles 545 to 582 is comprised mainly of upland terrace levels dissected by V-shaped stream beds. Scarp slopes vary from gentle in areas with restricted weathering to moderate and steep in areas adjoining river and stream valleys or thermokarst lakes. Isolated local features include glacial gouging,

a large collapse basin (Miles 554 to 557), and a meltwater channel (north of Miles 575 to 578). There are seven major stream crossings with varying bank heights and slopes.

There are seven crossings of thermokarst depressions or of channels between depressions. Most banks range from 1 to 20 feet high, and slopes from 1 to 15 per cent grade. Several streamlets also cross the road. Major scarps occur adjacent to a large collapse basin in the vicinity of Old Fort Point. Banks vary from 35 to 120 feet high.

Slope failures are present mainly on stream or river banks and include landslides, slump areas, mudslides, and solifluction. Crustal failure resulting in thermokarst lakes is present throughout the upland area. The present route location dips down into a portion of the collapse basin, crossing and paralleling several of the major defining faults.

Major problem areas include river and stream crossings, thermokarst depression and sink hole crossings, mudslide or solifluction crossings, and crossing of the collapse basin. Virtually all of these difficulties can be surmounted via appropriate construction materials and techniques.

ARCHAEOLOGY

No archaeological sites were found during a survey of the proposed route between Miles 545 and 582. As a result, this portion of the highway alignment may be considered to have only

fair to poor archaeological potential. It is certainly possible, however, that sites do exist.

The most likely locations include those areas along stream courses and near lakes where fish, waterfowl, furbearing mammals, and moose can all be found. Particular attention will be given to archaeological surveillance during alignment preparation and highway construction in those areas indicated on the mosaic assessment sheets.

LANDSCAPE ARCHITECTURE

Topics dealt with under the category of Landscape Architecture include borrow areas and associated access roads, selective clearing for visual variety, and other practices to enhance the visual potential of the highway alignment. Recommendations have been included on the appropriate Environmental Data sheets. In addition, Litten comment and evaluation sheets depicting intensity of interest, sequential notation, scale and proportion, and alignment profile and diagramatic vegetation types have been included in the submission.

Areas having good potential for selective clearing, after sub-grade construction, have been identified. They are often associated with borrow areas.

Selective clearing may be done for the following purposes:

1. Integrating tangent cuts at curves with general right-of-way.
2. Emphasizing small bogs, ponds, and open spaces.
3. Integrating trail cuts with general right-of-way, and accentrating trails with views to ponds, lakes, etc.

4. Minimizing right-of-way widths through mixed vegetation.
5. Deflecting views away from C.N.T. line.
6. Breaking monotony of long stretches of black spruce.
7. Increase right-of-way at high points. Integrate clearing with cuts.

The proposed alignment, from Miles 545 to 582, covers a relatively monotonous portion of the total Mackenzie Highway route. Variety is restricted to scattered open spaces, drainage crossings, small ridges, and limited vegetation diversity. Practices such as selective clearing and utilizing some borrow areas as visual breaks, could help to alleviate some of the monotony for both tourist and commercial traveller alike. A discussion of Borrow Area development is included in Chapter 5 of this Preliminary Design Data Report.

RECREATION

Aside from possible scenic overlooks and limited landscape views, the portion of alignment under discussion provides almost no opportunity for recreation. Fishery potential from Miles 545 to 582 is generally poor; the landscape does not particularly lend itself to activities such as hiking, camping, and canoeing. It is possible that rest stops or campgrounds, or both, may be located within the area.

CONSTRUCTION

This category has been used to indicate cut sections and balanced earthwork situations, recommended culvert types, and the location of borrow areas. It is assumed that, except in cut situations, overlay construction methods will be employed. Also, it is assumed that clearing along creek-beds at crossings will be done by hand.

ENVIRONMENTAL ASSESSMENT

This category has been used to highlight particular considerations which must be taken into account within the area covered by the respective mosaic. The comments are general and relate to comments in other categories above.

SYNOPSIS

Miles 545 to 582 of the proposed alignment appear to present no critical conflict with environmental parameters provided appropriate precautions are taken. Relocation of the alignment would, in most cases, cause more harm than good. Fish passage culverts have been recommended for two of the seven major stream crossings. Natural drainage patterns will be maintained, as completely as possible, via standard culverts. Wildlife may be locally affected; however, serious large scale impacts are not anticipated.

Recreation potential and several areas for selective clearing have been identified. A discussion on borrow area design and future use can be found in the "Borrow Area Development" section of this Preliminary Design Data Report.

CHAPTER 5

BORROW AREA DEVELOPMENT

- Prepared by: Lombard North Group,
Environmental Consultants.

Borrow pits are a necessity in highway construction, however, poorly planned, haphazard borrow areas will detract from the general appearance of the landscape. Even if borrow pits are hidden from the motorist's view, they will remain visible to those flying overhead. This may be a significant point since the Mackenzie Valley provides a rather narrow, well-used flight corridor.

It should be practical to design borrow areas which will provide necessary construction material, yet still blend into the landscape. Some borrow areas may be used for other purposes after highway construction. They may serve as parking areas for rest stops, as emergency pulloffs and recreation areas, as interpretive features depicting natural vegetation succession, and as wildlife viewing areas since various species of wildlife will undoubtedly invade these clearings. Such potential uses must be taken into account as the borrow pits are excavated.

At present, the general concensus appears to be that borrow areas should be hidden from the highway alignment. It must be borne in mind that natural landscape variety and features of interest are not uniformly distributed along the Mackenzie Highway route. Thus, it may be advantageous, in some instances,

to develop borrow areas which are open to the alignment. These would provide open space and, with proper contouring and re-vegetation measures, would improve rather than detract from the visual properties of the landscape.

Methods of excavating borrow material may require that the original pit shape be rectangular. The original boundaries may then be expanded by excavating material, to a lesser depth, in tongues from the rectangle and by accessory dozing and contour grading. Principles of selective clearing applied along the right-of-way can apply equally to borrow areas. Clearing may be used to modulate the vegetation edge, to accentuate certain vegetation types by isolating them, and to accentuate landscape features such as lakes, bogs, and ridges by providing visual access to them.

Conceptual designs for borrow areas are convenient in that they can be easily identified and may be applied to level or otherwise uniform terrain. In most areas, including those designated as borrow sites along the Mackenzie Highway alignment, it would be difficult, if not impossible, to construct a borrow pit which would totally conform to a predetermined shape. The final shape, size, and contours of a borrow area must be determined by the amount of material to be taken, location and shape of suitable deposits, local topography and drainage, and potential future use of the borrow area. Borrow areas will take one of two very general shapes: linear where the material

lies in ridges, or amoeboid where the material is found in irregular deposits below flat or undulating terrain. Working designs will be prepared following site inspections during the summer of 1974. Final decisions must be made, on site, by agreement between the environmental consultant and the construction engineer to insure an amenable balance between environmental and aesthetic factors and engineering suitability.

CHAPTER 6

HYDROLOGY DATA FOR CULVERT DESIGN - MILE 545.1N. TO MILE 582

The formula used by the hydrology consultant, Bolter, Parish, Trimble Ltd. was as developed in their Hydrology Study and Design of Culverts, Mile 297 to Mile 345, November, 1972 and modified as outlined in their subsequent reports on Mile 403.1 and Mile 407.5, June 12, 1973 and in their Report on Mile 406.2, September 20, 1973 and Modified Rational Formula Mile 545 - 725, February 1974.

Three sites in this portion of Highway that were originally scheduled as culvert sites but because of various local conditions are now being investigated for possible bridge sites.

The Hydrology Consultant's recommendations are based on the following considerations:

Creek - Mile 548.3

This creek in the region of the proposed crossing is in an incised, treed valley about 35 feet deep with steep banks. The south bank is saturated and springs flow from streambed to about 12 feet above streambed all year round. In the winter of 1972 - 1973, icing from these springs built up about 10.5 feet thick along this bank and extended across the valley to the north bank. Local slumping is present along the south bank and trees are leaning and falling; considerable deadfall exists in the channel.

A culvert at this site is not recommended because of the extreme adverse icing conditions present and the unstability of the bank. A bridge structure is recommended to span the entire south bank and with one central pier located close to the north bank with due provision allowed for possible unequal lateral ice pressure.

Hydrologist Dwg. 115-3-200 shows preliminary details of the site.

Creek - Mile 555.0

The proposed crossing of this creek occurs at its immediate source from a lake. The lake level is influenced by a large beaver dam over the creek about 150 feet downstream from centreline.

The gradeline, about 50 feet above streambed would require the fills to spill into the lake for about 60 feet from water's edge if a culvert were installed and the practical difficulties of installing the culvert in water, extending into the lake and traversing the beaver pond are obvious. The downstream end of the culvert would extend to within 50 feet of the beaver dam.

The Hydrology Consultant recommends that a bridge be utilized at this site and that piers be kept out of the main channel.

Hydrologist Dwg. 115-3-201 shows preliminary details of the site.

Creek - Mile 568.2

This creek with a total drainage area of 53.5 square miles flows in an incised valley about 75 feet deep. Extensive icing was recorded during the winter of 1972 - 1973 and during spring break-up, moving ice floes up to 10 feet by 15 feet were noted, causing damage to trees about 8 feet above streambed.

The Hydrology Consultant feels that this site, subject to winter icing and spring ice movement has a potential for adverse conditions for a culvert and that a bridge is warranted. Preliminary site details are shown on Hydrologist Dwg. 115-3-202.

The following summary of Data used supplements the Culvert Design sheets included in the Final Design Submission.

HYDROLOGY SUMMARY

PRELIMINARY - SUBJECT TO REVISION

MILE 545 TO MILE 582

MILE	546.0	548.3	551.0	555.0	568.2	573.9	579.8
Drainage Area (A) TOTAL (sq. miles)	4.0	4.0	5.6	17.7	53.5	14.8	9.0
Qhwm (c.f.s.)	148	-(2)	207	550	1950	360	-(3)
Drainage Area (Ae) EFFECTIVE (sq. miles)					20.0	3.0	4.0
Relief (feet)					100	100	100
(100 - L) Water Retained for Runoff					.20	.20	.20
Rainfall (inches in 24 hours)					3.5	3.5	3.5
M Ratio					3.36	4.04	3.96
Qe (c.f.s.)					1256	226	288
Drainage Area (Alc) LAKE CONTROL (sq. mi.)	4.0	4.0	5.6	17.7	33.5	11.8	5.0
Relief (feet)	75	50	50	150	100	50	75
(100 - L)	.19	.19	.19	.20	.20	.19	.19
Rainfall (inches in 24 hours)	3.5	3.5	3.5	3.5	3.5	3.5	3.5
M (1)	2.6	2.6	2.6	2.4	2.1	2.5	2.6
Qlc (c.f.s.)	185	185	258	754	1315	524	231
Drainage Area (Am) MUSKEG (sq. miles)	-	-	-	-	-	-	-
Qm (c.f.s.)	-	-	-	-	-	-	-
Q rational (c.f.s.) (Qe + Qlc + Qm)	185	185	258	754	2571	750	519
Q design (c.f.s.)	185	185	260	750	2600	750	520

(1) Modified M for lake control, Ref. Modified Rational Formula, Mile 545- 725, February 1974.

(2) Extensive icing, Qhwm indeterminate.

(3) Qhwm not assessed at this crossing, requires field inspection prior to final design.

CHAPTER 7

CONTENTS OF PRELIMINARY DESIGN SUBMISSION MILE 545.1(N) - MILE 582

Hydrologist Drawings

115-3-144	----------	1
-201	----------	1
-202	----------	1
-145	----------	1
-146	----------	1
	Total	79