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INVESTIGATION OF ALTERNATE ROUTES TO ALASKA HIGHWAY PIPELINE

PRELIMINARY REPORT

JUNE 8, 1977

Inland Waters Directorate
Pacific and Yukon Region
Vancouver, B.C.

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INTRODUCTION

This report provides preliminary assessment of the hydrologic and river conditions on the alternates to the proposed Alcan Pipeline route, viz., Klondike Highway, Dempster Highway and Tintina Trench.

Assessment involved:

1. Literature and government agency search to determine previous relevant information of a hydrologic nature (Appendices B, C and D).
2. Map examination of terrain characteristics.
3. Field reconnaissance of rivers along the alternates during the period June 2 to June 6 (Appendix A).

Major objectives have been:

(a) to identify concerns

(b) to identify deficiencies in information related to the concerns. Results of these two activities are given in summarized form in Table 1 and Figure 1.

It should be emphasized that the data base for this report is minimal. Whilst an attempt has been made to draw on all currently available information, the current status of hydrology is inadequate, particularly along the Dempster highway. However the investigation is more than simply a "desk study" since valuable input was received from Department of Public Works staff in Whitehorse familiar with the Klondike and Dempster Highway routes and who have been involved with work in these areas; similarly, four members of Inland Waters Directorate staff were over the routes for familiarization with the environment setting and identification of concerns from a hydrologic standpoint.

Environmental conditions are much more fragile along the Dempster Highway in the Tundra and Alpine sections than on the Klondike and Tintina routes. In recognition of this there have been no extensive excavations in these delicate areas during the construction of the Dempster highway; instead gravel and fill were brought in from river banks and floodplains to build up the road. Consequently, there is no evidence of apparent failures through permafrost disintegration. However, environmental effects of road construction are not necessarily the same as those of pipeline construction where extensive excavations may be required; direct extrapolations therefore may not be valid.

A good example of the ability of terrain to recover from construction activity is the abandoned water pipeline in the mountains above Dawson City. This pipeline was abandoned in the early 1930's and there is now an excellent grass cover and poplars along the ditch; permafrost is present at 10 inches beneath a thick organic cover. (Appendices A & E)

TABLE 1

Klondike Highway

TABLE 1

SUMMARY

INVESTIGATION OF ALTERNATES TO ALASKA HIGHWAY PIPELINE ROUTES - INLAND WATERS DIRECTORATE

A. Klondike Highway

Major Environmental Concerns	Location	Explanation of Concern	Impact	Related Hydrologic Information: Available	Related Hydrologic Information: Required
Bank and Channel Bed Stability	Yukon River (Carmacks to Minto)	Road follows the Yukon River along eastern banks where slope stability could be a problem. This is most evident at Tatchun Creek crossing where extensive slumping has occurred on the southern banks; gullies are evident on the northern slope. Permafrost.	Possible Increase in suspended sediment load and organic material during construction & maintenance could cause serious depression of dissolved oxygen during discharge under ice cover.	Pilot project is being initiated by the Water Quality Branch to investigate loadings of physical and chemical elements in the Yukon River.	Suspended sediment information on current conditions on the Klondike River
	Stewart River (Stewart Crossing to Slough Creek)	Very active and wide river bed with frequent channel diversions and water logging (meanders, meander scars, braiding etc.) Old banks are steep and high, actively eroding along outer banks of meanders. Both the north and south banks are susceptable.	Improper design, particularly in permafrost areas could contribute to instability of terrain.	Water levels and discharge at various locations on the Yukon River and tributaries (Appendix B)	
	Flat Creek at junction with Klondike River	Bank undercutting at junction with Klondike River is common. Placer activity in various Flat Creek tributary introduces additional sediment load. There are bedrock exposures along the sideslope with a small and relatively steep footslope of debris at the base. Road crosses this footslope in several places. Klondike River then crosses extensive reworked placer gravel from 1900 Klondike mining activity.	The Flat Creek and Klondike River already carry heavy sediment load as a result of man-made activity; further impact in this area from pipeline construction could be debatable.	Preliminary data on location and horizons of permafrost (Appendix C)	Evaluation of the effects of the past and present placer activity Aerial Photography

TABLE 1

Dempster Highway

SUMMARY

TABLE 1

INVESTIGATION OF ALTERNATES TO ALASKA HIGHWAY PIPELINE ROUTES - INLAND WATERS DIRECTORATE

B. Dempster Highway

Major Environmental Concerns	Location	Explanation of Concern	Impact	Related Hydrologic Information: Available	Related Hydrologic Information: Required
Permafrost	North Fork Pass (Mile 50)	Alpine Tundra under permafrost regime. Very delicate, as can be seen from a few construction cuts which have become gullies. Great care is being taken by road builders to avoid cuts. How can this problem be overcome in pipeline construction?		Water levels and discharge on Ogilvie River at Mile 123 Peel River above Canyon Creek North Klondike River near the mouth. (Appendix B)	Channel geometry at strategic streams to calculate estimates of flow in order to supplement deficiencies in data network.
	Eagle Plain (Mile 152-225)	Continuous permafrost at ½' to 1' below surface. Road follows summits and crests of gently sloping hills showing exposure of shale and sandstone.	Increase in suspended sediments and organic materials in streams and rivers; possible drainage diversion		Access to permafrost expertise (arrangements will be made with Owen Hughes EMR about July 1 upon his return to Calgary)
	Footslopes of Richard Mountains (Mile 242)	Very fragile tundra with permafrost at ½'- Tributaries to major streams do not have exposed channels but form distinct seepage lines. Drainage was observed in active layer near surface. Pipeline excavation might trigger development of new drainage patterns.			Aerial Photography

TABLE 1

Tintina Trench

SUMMARY

TABLE 1

INVESTIGATION OF ALTERNATES TO ALASKA HIGHWAY PIPELINE ROUTES - INLAND WATERS DIRECTORATE

C. Tintina Trench

Major Environmental Concerns	Location	Explanation of Concern	Impact	Related Hydrologic Information	
				Available	Required

Because of the ruggedness of terrain, numerous engineering problems will have to be overcome during the construction phase; environmental effects from pipeline construction and operation may be substantially avoided by proper technology, as is evidenced in work on the Dempster Highway. (Appendix A) The 60 miles of Tintina Trench where no man-made activities now exist must be paid special attention in the introduction of such activities.

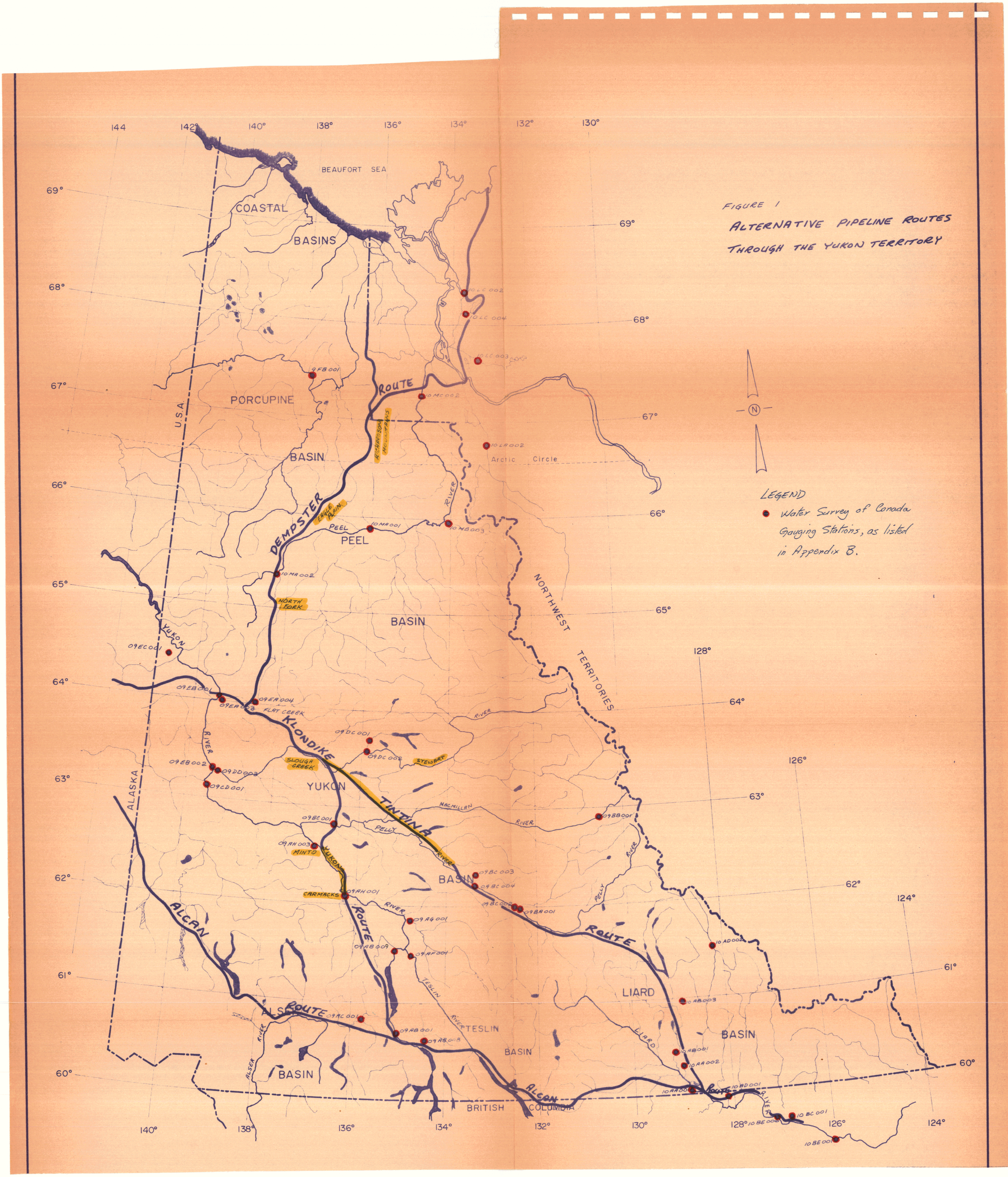

FIGURE 1

ALTERNATIVE PIPELINE ROUTES THROUGH THE YUKON TERRITORY

A Reconnaissance Investigation of Alternative Pipeline Routes along the

(A) Klondike Highway (Whitehorse to Dawson and Alaska Border)

(B) Dempster Highway (Klondike River to Richard Mts.)

(C) Tintina Trench / Robert Campbell Highway (Stewart Crossing - Watson Lake).

Investigation Team:

T. Varzeliotis	Water Planning and Management Branch, Vancouver
R.J. White	Water Planning and Management Branch, Vancouver
M.E. Alford	Water Survey of Canada, Whitehorse
H. Schreier	Water Quality Branch, Vancouver

Mode of Transport: Jet Ranger Helicopter with frequent landings.

A. Klondike Highway (Whitehorse - Dawson - Alaska Border, June 3, 1977)

Section: Carmacks to Minto along Yukon River:

Difficult crossing since Yukon River is deep (min 20' max 28'), has a high mean velocity (7.6' / sec.), and an active meander pattern. Road follows the Yukon River along eastern banks where slope stability is a problem. This is most evident at Tatchun Creek crossing where extensive slumping has occurred on the southern banks; gullies are evident on the northern slope. Permafrost existence has been reported.

Pelly Crossing: Again a major river crossing with substantial flow.

Stewart River Section from Stewart Crossing to Slough Creek Junction:

Major river crossing at Stewart Crossing. Road continues on the northern side of floodplain and in places comes down to floodplain level. Very active and wide river bed with frequent channel diversions and water logging (meanders, meander scars, braiding, etc.). Old banks are steep and up to 20' high being actively eroded along outer banks of meanders. Both the north and south banks are problem areas for pipeline construction.

Stewart River to Klondike River Section:

Glacial plain with numerous kettle lakes. Evidence of discontinuous permafrost near Clear Creek.

Flat Creek - Klondike River / Dawson City:

Road is built on edge and only slightly above current channel bed. Road washouts as a result of bank undercutting at Flat Creek / Klondike Junction are common and clearly evident. In addition there is placer activity in first Flat Creek tributary introducing additional sediment load to river system. There are bedrock exposures along the sideslope with a small and relatively steep footslope of debris material at the base. Road has to cross this footslope in several places. Klondike River then crosses extensive reworked placer gravel from 1900 Klondike mining activity. River crossing of Yukon at Dawson is very difficult since steep mountain slopes are present on both sides. The river is deep (min 25' max 40') and has a high mean velocity.

Section: Yukon River at Dawson to Alaska Border:

Road follows high ridge between headwater of Swede Creek and Yukon tributaries and no major problems are anticipated for pipeline construction in this section. Permafrost evident at Dawson.

B. Dempster Highway (Klondike River to Richards Mts. - NW Territorial border, June 4, 1977)

North Klondike River to North Fork Pass (Mile 50)

Major crossing of Klondike River at North Klondike Junction. Extensive and very active floodplain (extensive braiding). Road avoids the steep somewhat unstable banks (evidence of gullying) and stays on higher grounds. Along the North Klondike the road crosses a series of alluvial fans all of which are cut by mountain streams. The beds seem to be stable and well entrenched and all fans have well established vegetation cover.

North Fork Pass (Mile 50)

Alpine tundra under permafrost regime (extensive patterned ground). Very delicate environment as seen by a few cuts which have become drainage gullies (Mile 58). The road builders have taken great care to avoid any cutting and fill is used almost exclusively to build up the road bed. Gravel and fill material originated from river banks and floodplains.

Ogilvie Mountains

Narrow gap between steep sedimentary mountains (shale and limestone). Mountains are covered with debris from frost action and scree slopes are evident at foot of slopes. Structural outcrops visible in river beds. Some unstable banks on East Ogilvie River.

Blackstone alternative around Sapper Hill

Soldier Creek has poor drainage and limited flow. Extensive alluvial plain forms upper Blackstone River. Banks are steep and unstable with evidence of gullying and slumping. Folded limestone and shale mountains with bedrock exposures on both sides of floodplain. Very active river with extensive braiding.

Eagle Plain (Mile 152-225)

Continuous permafrost. Road follows high ground of summits and crests of gently sloping shale and sandstone hills. Permafrost at ½ - 1'. Area under open forest cover. Major river crossing at Eagle River (road bridge almost completed).

Footslopes of Richard Mountains (Mile 242)

Sedimentary hills with extensive scree and rock debris in upper section (frost shattering). Lower slopes are made up of a footslope of coalescent fans. Very fragile tundra with permafrost at ½'. Major streams drain mountains and are entrenched. Tributaries do not have exposed channels but form distinct seepage lines. Subsurface drainage was observed on the ground. Water flows in active layer near surface. Trees are only present in more protected sections of entrenched channels (microclimate). Proposed road has been relocated several times because of awareness of delicate environment.

C. Tintina Trench : Stewart Crossing - Ross River (June 5)

South of Stewart Crossing:

Extensive glacial plain with numerous kettle lakes. Rivers entrenched into limestone with large sinkhole (mile 180) on Crooked Creek tributary with subsurface drainage. Extensive blasting would be required and there is no road connecting the section between Stewart crossing and Faro.

Tintina Trench (Mile 195 - 255)

Series of structurally aligned sedimentary hills; rugged, extensively forested terrain. Bedrock exposed in upper sections of hills. Glacial flow patterns clearly evident. In Pelly floodplain extensive kame deposits. Evidence of volcanic ash surface coverage (recent deposits 1300 years).

Pelly River to Faro (Mile 255 - 310)

Floodplain is entrenched with steep unstable banks. Gullying and slumping at Fishhook Creek, mile 275, 280, 284, 288. Proposed pipeline crossing on Pelly is difficult because eastern banks are unstable. Better location would be one-third the way up mountain slope.

Faro to Ross River

Route follows transmission line and Robert Campbell Highway with no evidence of major problems.

Robert Campbell Highway, Ross River to Watson Lake (June 6)

Glacial plain with numerous kettle lakes and eshers and bedrock exposures. Location of road is excellent and stays in most places above floodplain. Abundance of mixed gravel deposits. Minor problem of drainage and bank stability at Finlayson Lake outflow, Wolverine Creek, Simpson Creek.

General Remarks:

Concerning Klondike and Robert Campbell Highway:

Jim Quong, Design. Eng. DPW Whitehorse, expressed the view that the Klondike Highway would be better suited for pipeline construction since Energy, Mines and Resources have done a reasonable survey of the area before construction (this is not the case along the Alcan route). He also stated that few problems were encountered in the construction of the Klondike and Robert Campbell Highway.

Concerning Dempster Highway:

According to John Hudson (Dempster Highway Construct. Engin.) continuous permafrost exists throughout the whole stretch of the Dempster route. Construction along Richard Mountains is about to start. Thick redeposited gravel covers foot of mountains. Flow of creeks are relatively high but only short and sporadic climatic records are available. The 54-58 year flood at Porcupine River (near Old Crow) was used as a basis for extrapolation. The Eagle River regime is one of high spring run-off with a second peak in August due to thunder showers.

The environmental conditions are much more fragile in the tundra and alpine sections on the Dempster than on the other highways in the Territory. The people in charge of the road construction are aware of this fact and have adjusted their construction approach accordingly. No extensive cutting was observed in delicate areas, instead fill was brought in to build up the road. It should therefore be noted that the environmental effects of the road construction are not necessarily the same as those resulting from a pipeline construction and a direct extrapolation should be avoided.

Environmental assessment of old water pipeline in mountains above Dawson City as a possible indicator for long term environmental impact on the land by construction activity.

Around 1903 a pipeline was built to divert water 35 miles upstream to provide sufficient water pressure for dredging activity in the Klondike.

Pipe built with iron rods and wood was abandoned in the early 1930's and terrain has recovered extremely well. The ditch and pipeline remains have an excellent grass cover and Poplar trees line the ditch. Permafrost is present at 10" beneath a thick organic cover and 5-6" of clay. A few small lakes exist probably as a result of permafrost disturbance during the construction and in places the ditch (about 1-2' deep) has become part of the drainage network. No evidence of gullying and trenching was observed even on steep slopes.

June 7, 1977
H. Schreier

SUMMARY OF STREAMFLOW DATA RELATED TO KLONDIKE HIGHWAY PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum Daily Discharge cfs date	Remarks
Clinton Creek above Wolverine Creek	09EC001	-	1964-65	-	13,400 - 29/5/64	0 -	
Yukon River at Dawson	09EB001	106,000	1944-76	78,400 0.7 (25)	526,000 5.0 11/6/64	6,350 22/2/51	Regulated Since 1925
Yukon River at Stewart River	09EB002	97,300	1956-65	84,100 0.9 (6)	470,000 4.8 12/6/64	10,600 18/4/57	
Klondike River above Bonanza Creek	09EA003	3,010	1965-76	2,180 0.7 (10)	22,600 7.5 29/5/73	170 1/2/74	
North Klondike River near the Mouth	09EA004	423	1974-76	450 1.1 (2)	3,030 7.2 19/6/76	58.0 30/3/76	
Stewart River at the Mouth	09DD003	19,700	1956-76	16,400 0.8 (13)	198,000 10.1 12/6/64	1,250 12/3/74	
Yukon River above White River	09CD001	58,400	1956-76	41,700 0.7 (14)	272,000 4.7 25/6/62	8,000 31/3/59	Regulated Since 1925

APPENDIX B

APPENDIX B

SUMMARY OF STREAMFLOW DATA RELATED TO KLONDIKE HIGHWAY PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum Daily Discharge cfs date	Remarks
Pelly River at Pelly Crossing	09BC001	18,900	1951-76	13,900 0.7 (21)	152,000 8.0 28/5/57	1,000 11/3/74	
Big Creek near the Mouth	9AH003	674	1974-76	324 0.5 (2)	7,260 10.8 15/7/76	1.3 13/2/75	
Yukon River at Carmacks	09AH001	33,600	1951-76	26,200 0.8 (23)	127,000 3.8 24/6/62	4,800 15/3/52	Regulated Since 1969
Big Salmon River near Carmacks	09AG001	2,610	1953-76	2,440 0.9 (13)	23,700 9.8 23/6/62	388 2/4/72	
Yukon River above Frank Creek	09AB009	12,000	1953-76	11,300 0.9 (20)	29,100 2.4 29/8/61	2,500 28/3/56	Regulated Since 1925
Teslin River near Whitehorse	09AF001	13,700	1955-73	11,700 0.9 (13)	65,400 4.8 28/6/62	1,780 1/3/72	

SUMMARY OF STREAMFLOW DATA RELATED TO KLONDIKE HIGHWAY PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum Daily Discharge cfs date	Remarks
Yukon River at Whitehorse	09AB001	7,500	1902-76	8,440 1.1 (33)	22,800 3.0 9/8/53	1,150 19/5/62	Regulated Since 1925
M'Clintock River near Whitehorse	09AB008	597	1955-76	354 0.6 (11)	3,680 6.2 1/6/72	60.0 29/3/59	
Takhini River near Whitehorse	09AC001	2,700	1948-76	2,170 0.8 (26)	17,200 6.4 2/9/49	153 19/2/51	Regulated Since 1948

APPENDIX E

SUMMARY OF STREAMFLOW DATA RELATED TO DEMPSTER HIGHWAY PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum Daily Discharge cfs date	Remarks
Yukon River at Stewart River	09EB002	97,300	1956-65	84,100 0.9 (6)	470,000 4.8 12/6/64	10,600 18/4/57	
North Klondike River near the Mouth	09EA004	423	1974-76	450 1.1 (2)	3,030 7.2 19/6/76	58.0 30/3/76	
Klondike River above Bonanza Creek	09EA003	3,010	1965-76	2,180 0.7 (10)	22,600 7.5 29/5/73	170 1/2/74	
Yukon River at Dawson	09EB001	106,000	1944-76	78,400 0.7 (25)	526,000 5.0 11/6/64	6,350 22/2/51	Regulated Since 1925
Ogilvie River at Mile 123 Dempster Highway	10MA002	2,090	1974-76	1,100 0.5 (2)	23,400 11.2 31/5/75	20.3 12/2/75	
Peel River above Canyon Creek	10MA001	10,200	1962-76	6,450 0.6 (7)	202,000 19.8 4/6/64	404 21/3/73	

APPENDIX B

SUMMARY OF STREAMFLOW DATA RELATED TO DEMPSTER HIGHWAY PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum Daily Discharge cfs date	Remarks
Peel River above Fort McPherson	10MC002	27,300	1969-76	29,800 1.1 (2)	376,000 13.8 31/5/75	1,620 15/4/72	
Porcupine River below Bell River	9FB001	13,900	1963-65 1968-76	- -	124,000 8.9 28/5/75	1,420 22/11/76	
Arctic Red River near the Mouth	10LA002	5,840	1968-76	5,140 0.9 (1)	74,400 12.7 7/8/74 270,000 * 46.2 22/7/70	260 28/12/75	
Campbell Creek near Inuvik	10LC004	-	1973-74	20.9 - (1)	157 - 15/7/74	0 Jan-May Nov & Dec 1974	Icing throughout winter

* Instantaneous

APPENDIX B

SUMMARY OF STREAMFLOW DATA RELATED TO DEMPSTER HIGHWAY PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum Daily Discharge cfs date	Remarks
Rengleng River below Dempster Highway	10LC003	-	1973-76	36.8 - (1)	251 - 29/5/74	0 Jan-March 1975	Icing throughout winter
Mackenzie River (East Channel) at Inuvik	10LC002	-	1973-76	5,700 - (2)	32,600 - 3/6/75	240 12/3/74	Regulated Since 1968
Snake River near the Mouth	10MB003	3,440	1975-76	-	-	-	

APPENDIX B

SUMMARY OF STREAMFLOW DATA RELATED TO TINTINA TRENCH PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum Daily Discharge cfs date	Remarks
Mayo River near Mayo	09DC001	-	1945-51	-	4,260 - 6/6/49	-	Regulated
Stewart River at Mayo	09DC002	12,100	1949-76	13,100 1·1 (21)	145,000 12.0 10/6/64	538 19/3/74	
Pelly River at Pelly Crossing	09BC001	18,900	1951-76	13,900 0.7 (21)	152,000 8.0 28/5/57	1,000 11/3/74	
Pelly River below Vangorda Creek	09BC004	8,490	1972-76	7,190 0.8 (4)	46,800 5.5 6/6/75	341 11/3/74	
Pelly River at Ross River	09BC002	7,670	1954-76	6,600 0.9 (15)	71,000 9.3 7/6/64	219 11/3/74	
Ross River at Ross River	09BA001	2,800	1960-76	2,340 0.8 (13)	26,200 9.4 1/6/72	100 7/3/74	

APPENDIX B

SUMMARY OF STREAMFLOW DATA RELATED TO TINTINA TRENCH PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum Daily Discharge cfs date	Remarks
Rose Creek below Faro Creek	09BC003	-	1966-69	83.3 - (1)	1,150 - 31/5/67	6.1 10/3/67	Regulated
South MacMillan River at Mile 249 Canol Road	09BB001	385	1974-76	758 2.0 (2)	4,720 12.3 4/6/75	58 22/3/76	
Frances River near Watson Lake	10AB001	4,950	1963-76	5,880 1.2 (11)	38,800 7.8 12/6/64	486 16/4/74	
King Creek at Mile 13 Nahanni Range Road	10AB003	5.3	1975-76	5.5 1.0 (1)	63.8 12.0 3/7/76 76.4 * 14.4 9/6/76	0.55 21/2/76	
Hyland River at Mile 67.4 Nahanni Range Rd.	10AD002	211	Sept./ Dec. 1976	-	-	-	
Coal River at Mouth	10BC001	3,550	1961-76	3,840 1.1 (13)	36,900 10.4 30/5/72 42,300 * 11.9 10/6/76	530 28/3/72	

* Instantaneous

APPENDIX B

SUMMARY OF STREAMFLOW DATA RELATED TO TINTINA TRENCH PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum Daily Discharge cfs date	Remarks
Tom Creek at Mile 21.7 Robert Campbell Highway	10AA002	168	1974-76	149 0.9 (2)	1,080 6.4 3/5/76	16.0 15/3/76	
Hyland River near Lower Post	10AD001	3,650	1947-76	5,010 1.4 (17)	59,800 16.4 10/6/61	460 13/3/74	
Liard River at Upper Crossing	10AA001	12,500	1960-76	14,000 1.1 (16)	108,000 8.6 2/6/72	1,740 8/4/74	
Liard River above Kechika River	10BE006	23,800	1969-76	25,800 1.1 (7)	195,000 8.2 3/6/72	3,300 14/3/74	
Liard River at Lower Crossing	10BE001	40,300	1944-76	40,800 1.0 (20)	301,000 7.5 13/6/64	4,400 21/3/66	

Preliminary Information Regarding Permafrost in Areas of Proposed Pipeline Routes

This appendix contains information excerpted from two reports;

i) R.J.E. Brown, "Permafrost Investigations in British Columbia and Yukon Territory"

- Technical Paper No. 253 of the Division of Building Research, National Research Council of Canada, Ottawa, December 1967.

ii) "Environmental Impact Study of the Dempster Highway"

- a report prepared for Department of Public Works of Canada by

  Shultz International Ltd.,
  325 Howe Street, Vancouver,
  September 1972.

A) The following information was taken from "Permafrost Investigations in British Columbia and Yukon Territory" (see (i) above). The data was collected during field surveys in 1964. The absence of permafrost at a particular site does not necessarily mean it does not exist nearby in a different type of terrain.

Note: The Legend for the soil types is:

G - gravel
Sa - sand
Si - silt
C - clay
X - scattered stones
O - organic
(w) - standing water or wet

See tables on the following pages

Mileage	Soil Type	Depth to Mineral Soil	Existence of Permafrost	Depth to Permafrost	Thickness of Permafrost
			ALASKA HIGHWAY		
627	Sa.	3ft 0 inch	No	-	-
657.8	-	-	Yes	-	-
681.8	Si,Sa,X	2' 2"	Yes	1ft 9 inch	0ft 9 inch
682.4	-	-	No	-	-
731	(w)	-	No	-	-
758.1	(w)	-	No	-	-
762.4	(w)	0' 9"	No	-	-
771.6	Si,Sa,X	0' 9"	No	-	-
774	-	0' 6"	No	-	-
776.5	G,Sa	1' 0"	No	-	-
785.1	-	-	No	-	-
788.8	C,Si	>4' 6"	Yes	1' 6"	>3' 0"
794.8	C,Si,X	2' 0"	Yes	1' 6"	>2' 8"
802.5	Si,Sa,X	5' 0"	Yes	2' 3"	>3' 3"
803.3	X	3' 0"	Yes	2' 3"	>0' 9"
807.3	Si,Sa	1' 0"	Yes	2' 4"	1' 0"
814	C,Si,X	2' 0"	No	-	-
819.1	Sa,Si,X	1' 10"	Yes	2' 0"	>1' 7"
825.2	Sa,Si,X	1' 6"	Yes	1' 7"	>1' 7"
828.8	Sa,Si	1' 0"	Yes	1' 10"	>5' 8"
834	Si	0' 2"	No	-	-
844.1	Sa,X	2' 0"	Yes	1' 7"	>0' 8"
849	C,Si	0' 2"	No	-	-
849.8	-	-	No	-	-
854	Si	-	No	-	-
863.6	-	-	Yes	-	-
882	Sa,Si	2' 0"	Yes	1' 10"	0' 3"
886.5	C,Si	0' 3"	No	-	-
891.5	(w)	0' 5"	No	-	-
1034	X	-	No	-	-
1113	G	-	Yes	-	-
1127.5	-	-	Yes	-	-
1196	-	-	-	-	-
1202	G	-	No	-	-
1210	Si,Sa,X	-	Yes	2' 0"	20' 0"
1217	-	-	Yes	2' 6"	-
1223	(w)	-	Yes	2' 0"	-
1250	(w)	2' 0"	Yes	2' 0"	-

APPENDIX C

Mileage	Soil Type	Depth to Mineral Soil	Existence of Permafrost	Depth to Permafrost	Thickness of Permafrost
WHITEHORSE - MAYO HIGHWAY (KLONDIKE)					
35.7	C,Si,	1' 0"	Yes	-	-
47	Si,X	1' 0"	Yes	1' 0"	-
50-90	G,	-	No	-	-
92	G,	-	Yes	-	-
109	Si,Sa,X	0' 9"	Yes	2' 0"	-
114	G,C	-	Yes	-	-
116	-	-	Yes	-	-
158	Sa,Si	Sa,Si	Yes	1' 6"	-
166	-	-	Yes	-	-
197	G,X	-	Yes	-	-
213-43	Si,G	0' 6"	No	-	-
232.7	Sa,X,(w)	5' 0"	Yes	1' 6"	-
251	Sa,X	0' 9"	No	-	-
257	X	5' 0"	Yes	1' 6"	-
DAWSON HIGHWAY					
9	(w)	3' 6"	Yes	1' 9"	-
20.5	Si,Sa,X	0' 3"	No	-	-
52.8	0,Si	1' 6"	Yes	3' 6"	-
54	Sa,X	-	No	-	-
DEMPSTER HIGHWAY					
0-78	-	-	Yes	-	-

B) The following information was taken from Permafrost Investigations in British Columbia and Yukon Territory" (see (i) above). The data was obtained by Mr. R.J.E. Brown from technical literature, questionnaires and interviews. All references are listed at the end of this section.

The locations and sources are listed in alphabetical order. The reliability of the observations has not been verified. The absence of permafrost at a particular site does not necessarily mean it does not exist nearby in a different type of terrain.

a) Alaska Highway From Whitehorse southeast to the upper crossing of the Liard River near Watson Lake, a distance of 275 miles, the highway was bu built over permafrost for only 19 miles - 6.5 percent. Permafrost was also noted at a few isolated spots further south. Between Whitehorse and Big Delta Alaska, 28 percent of the road is built over permafrost (20) at the time of construction (23).

b) Alsek River (Kathleen Canyon Dam Site) 60°45'N, 137°25'W
Frozen ground (permafrost) encountered on north facing side of river valley in till and glacialacustrine silt on lower river terrace and on slope beneath upper terrace. Depth to frozen ground varied from 10 to 18 inch beneath moss and peat on Sept. 9, 1961. (11)

c) Dempster Highway Permafrost was encountered along the entire length except in a few steep south facing gravel slopes at the south end. (16).

d) Donjek River 61°39'N, 139°47'W Permafrost encountered at Alaska Highway bridge crossing. (26).

e) Frances River (i) False Canyon Site: 60°43'N, 129°05'W.
Frozen ground (probably permafrost) encountered in one test pit dug in sand to depth of 8 ft (11).
(ii) Lower Canyon Dam Site: 60°26'N, 129°11'W. Frozen ground (probably permafrost) encountered in fill. (11)

f) Haines Junction Permafrost encountered in moss covered fine-grained soils at a depth of 1 ft: Ice layers increase in thickness with depth. (13). Permafrost was encountered at a few scattered locations in the early 1950's at the Dominion Experimental Farm, Mile 1019, Alaska Highway, 3 miles West of Haines Junction. After cultivation, the permafrost thawed and did not re-form. (9).

g) Klondike District Permafrost encountered in glacial drift.
It is thinner on ridge summits than in valleys and more widespread on north facing slopes. On a ridge south of Eldorado Creek the bottom of the permafrost was encountered at a depth of 60 ft. (31).

h) Klondike River Permafrost is 175 ft. thick on plateau between Bonanza Creek and Klondike River. (31).

i) Kluane District Permafrost encountered in gravel benches along Burwash Creek. (31).

j) Kluane Lake Continuous permafrost encountered at depth of 18 inches in moss-covered silt, sand and gravel. (19).

k) Kluane River 61°30'N, 139°10'W. Frozen ground (probably permafrost) is widespread. (11).

l) Liard River (i) Lower Canyon Site. 60°01'N, 128°36'W. Frozen ground (probably permafrost) encountered at this location. (ii) Upper Liard Canyon Site. 60°02'N, 128°36'W. No frozen ground encountered.

m) Mayo 63°35'N, 135°51'W. Permafrost containing ice encountered at depth of 6 ft. in peat-covered fine-grained soil in excavation on bank of Stewart River near Mayo (13). Layers of permafrost encountered in well drilling in silt bank of Stewart River in southeast section of Mayo. (11).

n) Pelly River Frozen soil (probably permafrost) observed at several locations along the north facing bank of the river at depth of 1 ft. 6 inch and extending to water level. (22).

o) Ross River - Carmacks Road Permafrost is discontinuous along this (proposed 1964) road location. It occurs on most north facing slopes and in depressions with thick moss cover. Permafrost is not found in south facing slopes or mineral soils with little or no moss cover. (28).

p) Stewart Crossing - Dawson - Alaska Boundary
   (i) Mile 5.6 - Permafrost islands in both banks of creek to depths exceeding 10 ft. (16).
   (ii) Mile 7.0 - Permafrost encountered in muck at Dry Creek bridge crossing. (16).
   (iii) Mile 52 - Permafrost encountered in both banks of creek (16).

q) East of Dawson permafrost is widespread in Klondike River valley flats in muck deposits. The most difficult section of road to maintain lies between Dawson and the Dempster Highway junction where melting of ground ice causes dips in the road. Permafrost occurs in all north facing slopes and is widespread in south facing slopes but not as extensive or thick. (16).

r) Takhini River Frozen ground (probably permafrost) encountered at depth of 25 ft. in bridge pier construction (60°51'N, 135°30'W). (6). Some pitted areas, particularly south of Takhini River opposite mouth of Little River may be marked by thaw lakes and depressions (60°53'N,135°43'W). Shallow pitted areas may represent thaw depressions rather than kettles. (44).

s) Watson Lake - Ross River Highway Patches of permafrost encountered along 30-mile stretch of highway southwest of Ross River. Along the next 20-mile stretch of highway, permafrost was encountered at Mile 34 (west approach of Frances River crossing). Mile 50-55, Mile 67, and Mile 106. (16).

t) White River Permafrost reported to be 90 ft. thick (31).
(i) Lower Canyon Dam Site (61°55'N,140°30'W) Frozen ground (probably permafrost) reported to be widespread. (11).

u) Whitehorse - Mayo Highway
   (i) Pelly River, No permafrost encountered.
   (ii) Mile 205, permafrost encountered in both slopes of Crooked creek.
   (iii) Mayo to Elsa, permafrost is widespread. It was encountered at Glacier Hill a few miles north of Mayo.
   (iv) Elsa to Keno, permafrost occurs on all north facing slopes. (16).

List of references as referred to above:

(9) Canada - Experimental Farm Service, Department of Agriculture, Haines Junction, Y.T.

(11) Canada - G.S.C., E.M.R., Ottawa, Ontario.

(13) Canada - Royal Canadian Mounted Police.

(16) Canada - Yukon Territorial Government, Whitehorse, Y,T.

(19) Clark, A.R., Toronto, Ontario.

(20) Conwest Exploration Company Ltd., Toronto, Ontario.

(22) Dawson, G.M. Geological Survey of Canada Annual Report 1887-1888, Vol. III, Part 1.

(23) Denny, C.S. Late Quaternary Geology and Frost Phenomena Along Alaska Highway, Northern British Columbia and Southeastern Yukon. Bull. Geol. Soc. Am., Vol. 63. Sept. 1952, pp.883-922.

(26) Hardy, R.M., Dean of Engineering, University of Alberta, Edmonton, Alberta.

(28) Hunting Survey Corp. Toronto-Montreal

(31) Johnston, W.A. Frozen Ground in the Glaciated Parts of Northern Canada. Roy. Soc. Can. Trans. Sect.3:24, Dec. 4, 1930.

(44) Wheeler, J.O. Whitehorse Map Area, Y.T. Geological Survey of Canada Memoir 312, 1961.

C) The following section is an excerpt from the report "Environmental Impact Study of the Dempster Highway", by Shultz International Ltd. (see (ii) above). This is a brief discussion of permafrost conditions along the Dempster Highway route.

"Permafrost is general to all sections of the Highway and for practical purposes the entire length of the Highway from Dawson to Arctic Red River may be considered to be an area of continuous permafrost, with the exception of streambed areas of rivers, streams, lakes and ponds. The area of continuous permafrost is normally accepted to begin at about the location of Fort McPherson, but since much of the Highway is located in high mountains or high plateau areas, it is safe to assume permafrost to be almost universally present.

The thickness of permafrost along the Highway alignment is not known and can only be inferred from conditions general to the Arctic. It is normally about 200 feet thick at the boundary of the continuous permafrost zone and may range from values in this order to a few inches at the southern limits of the discontinuous permafrost.

Permafrost is defined as perennially frozen ground and includes all the crustal deposits known in milder climates: rock, gravel sand, silt, clay, peat, etc. The permafrost which gives rise to most of the difficulties in construction activities is that containing an unusually high percentage of water. Difficulty with ice is minimal; the problems arise from thawing, the excess of water available during thawing, loss of strength, and settlement resulting from removal of water. The water or ice content will usually be high in peaty or organic soils and frequently in silt or fine sands where ice lenses have an opportunity to form. (In clays and very fine-grained soils, water movement is too slow to favour ice lens growth; in sands and gravels and very coarse-grained soils, the capillary water movement necessary for ice growth does not occur.)

To illustrate the range of water contents possible with frozen soils, the results of tests from permafrost samples taken at several locations on the Highway are included in Table 2.

TABLE 2

PERMAFROST SAMPLES FROM DEMPSTER HIGHWAY

Location	Sample Description	Water+ Content %
Mile 80 - West of Road Near Airstrip	Brown Fibrous Peat	6880*
Mile 119 - Winter Road	Dark Brown Fibrous Peat With Some Amorphous Peat	220
Mile 142 - Surface Mat	Brown Fibrous Peat With Trace of Lichen	1378
Mile 142 - Ditch Bottom	Black-Brown Fibrous Peat with Some Amorphous Peat	183*
Mile 233 - Surface Mat	Brown Fibrous Peat With Trace of Lichen	908
Mile 233 - Silt (Frost Boil)	Grey-Brown Mottled Silt With Some Clay and Trace of Peat	36
Mile 246 - Creek Bottom	Grey Silt With Trace of Peat	50*

\+ Water Content + Weight of water as percentage of the weight of solid

* Value Low: indeterminate amount of water lost before testing

Many permafrost features were evident along the Highway route:

(a) Solifluction stripes, lobes, and scars where soil is moving slowly downslope under the combined forces of frost action, gravity and fluid flow. (Noted in most Highway sections on sloping ground.)

(b) Frost boils caused by intense frost action in the active layer which brings fine-grained soil to the surface in concentrated circular deposits. (Noted near Eagle River)

(c) Patterned ground: raised-centre frost polygons normally about 25 feet in diameter. (Noted particularly on Blackstone Prairie and western slope of Richardson Mountains.)

(d) Palsa bogs: raised peat bogs. (Noted in Tintina Trench.)

(e) Massive ground ice formed in layers up to several feet in thickness, usually formed as ice lens in fine-grained material. (Noted in Ogilvie Valley.)

(f) Ice wedges formed in irregular shapes and randomly oriented which may be tens to hundreds of feet in vertical or horizontal extent. (Noted in Ogilvie Valley.)

(g) Thermokarst is the term used to describe the uneven land subsidence caused by melting of permafrost, which leaves steep-sided depressions similar to sink hole formation in limestone. (Noted on most Highway sections.)

(h) Beaded streams are a result of joining a number of thermokarst depressions as pools along the course of a stream. (Noted on the Eagle Plain.)

In general, the ice-rich permafrost is protected by a surface mat of insulating moss or turf. If this is not disturbed, seasonal freezing and thawing are restricted to a shallow surface zone frequently about 2 feet thick. Should the surface insulating layer be damaged or removed, thawing continues in summer to a greater depth and thermokarst depressions may result. These depressions tend to pond water and thawing and settlement increase. However, the amount of settlement will always be dependent on the nature of the frozen soil and its initial ice or water content; the thawing of frozen gravel will have little effect, the thawing of massive ground ice will lead to spectacular settlement."

SOURCES OF RELATED INFORMATION

A. Dempster Highway Pipeline Route

1. Shultz International Ltd.

   "Environmental Impact Study of the Dempster Highway"

   A report prepared for the Department of Public Works to assess the ecological and environmental impact of the Dempster Highway.

2. Theberge, J.B.

   "Yukon's Dempster Highway and Environmental Impact"

   A paper that raises several points regarding the Government's lack of concern and care in providing adequate background environmental studies prior to construction of the Dempster Highway.

3. Hill, R.M.

   "Dempster Highway"

   Describes the Dempster Highway and some of its possibilities for future development.

4. Quong, J.Y.C.

   "Highway Construction and Permafrost with Special Reference to Active Layer"

   Reviews road construction techniques in permafrost terrain with particular reference to the Dempster Highway.

5. Jackman, A.H.

   "The Impact of New Highways upon Wilderness Areas"

   Suggests that highways can be constructed so that changes they cause in wilderness areas are acceptable. Sketches the history of the Alaska and Dempster Highways.

6. Donaldson, I. (Parks Canada)

   "Klondike River and North Klondike River Report - Wild Rivers Survey - 1971, Yukon Territory"

   See description under Klondike Highway route.

7. Banfield, A.W.F.

"Northern Ecology, Pipelines, Highways"

Discusses the effects of northern highways and pipelines on the wildlife populations of the area.

8. Harding, L.

"What Are We Doing in the Northern Yukon"

The effect of technological development in the northern Yukon upon the ecosystems of the area is outlined.

9. Lilley, J.W.

"Aquatic Resources Data Summary for Willowlake River, River Between Two Mountains, Hare, Indian Travaillant and Rengleng Rivers, N.W.T."

Preliminary investigations and sampling was concentrated in the vicinity of existing or proposed crossings of the Mackenzie and Dempster Highways.

10. Higgs, R.W. (Canada D.P.W.)

"Tundra Highways"

This paper deals with the difficulties experienced in constructing highways in regions of continuous permafrost, with direct reference to the Dempster Highway.

11. Pufahl, D.E., Morgenstern, N.R. and Roggensack W.D. (University of Alberta)

"Observations on Recent Highway Cuts in Permafrost"

Discusses the physiography and geology of the Dempster Highway route, including permafrost aspects, and outlines the problems encountered in highway construction.

B. Klondike Highway Pipeline Route

1. Donaldson, I. (Parks Canada)

"Klondike River and North Klondike River Report - Wild Rivers Survey - 1971, Yukon Territory"

Weather conditions, tree growth, and wildlife species of the area are described and the geography of the two rivers is discussed.

C. Tintina Trench Pipeline Route

1. Templeman - Kluit, D.J.

"Geology and Origin of the Faro, Vangorda and Swim Concordant Zinc - Lead Deposits, Central Yukon Territory."

Discusses the structural geology of a 600 sq. mile area to the north of Ross River. This could be useful in assessing soil types and erosion problems.

D. Hydrology Related to All Routes

1. Department of Indian and Northern Affairs

   "Small Stream Investigations in the Yukon Territory"

   This is a series of reports prepared by the Department of Indian and Northern Affairs and by various consulting firms, giving stream characteristics, miscellaneous streamflow measurements and estimated flood frequency data for various small basins (less than 200 square miles) throughout the Yukon.

2. United States Department of the Interior, Geological Survey

   "Small-Stream Flood Investigations in Alaska"

   Miscellaneous discharge measurements and stream characteristics for various small basins throughout Alaska. Some of these streams may correlate well with Yukon streams.

3. Inland Waters Directorate, Pacific and Yukon Region

   "Magnitude of Floods, Yukon Territory"

   Contains flood-frequency analyses for all W.S.C. discharge gauging stations in the Yukon.

4. Inland Waters Directorate, Pacific and Yukon Region

   "Low Flows, Yukon Territory"

   Provides frequency analyses of the annual 7-day average low flows for W.S.C. discharge gauging stations in the Yukon.

5. Unies Ltd., March 1975

   "A study of Hydrologic Phenomenon in Yukon Territory"

   A report prepared for Controller of Water Rights, Y.T., DIAND.

6. Unies Ltd., November 1976

   "Report on River Bed Scour, White and Donjek Rivers, Yukon Territory"

   A report prepared for Foothills Pipeline Ltd.

7. Shawinigan Engineering, October 1976

"Regional Analysis of Maximum Flows for Streams Crossed By Proposed Arctic Gas Pipeline Project."

Report prepared for Northern Eng. Service Co. Ltd. (Engineering Arm of Arctic Gas Pipeline Co.)

8. Alaska Power Administration, 1969

"Bibliography & Historic Notes 1946 - 1968 Upper Yukon River Study, Canada and United States, U.S. Department of Interior"

9. Derrick, Childers & Kuentzel, 1964

"Magnitude and Frequency Floods in Alaska South of Yukon River" USGS Circular #493.

A regional dimensionless frequency curve is presented. This may be very similar to the flood frequencies of the western Yukon.

10. Childers, 1970

"Flood Frequency in Alaska"
USGS open file report.
Obtainable from Anchorage, Alaska, USGS.

11. Unies Ltd., 1974

"Yukon Hydrology"

A preliminary study prepared for the Department of Indian and Northern Affairs.

12. Inland Waters Directorate, Water Resources Branch.

"Hydrologic Aspects of Northern Pipeline Development"

13. Kite, G., June 1974

"Case Study of Regional Analysis Technique for Design Flood Estimation"
Canadian Journal of Earth Sciences
Vol. 11, #6, pp 801-808, June 1974

The "square-grid technique" has been used to estimate design floods for highway crossings of small streams.

14. F.F. Slaney Co. Ltd. and Bayrock Surficial Geology Ltd.

"Environmental Considerations, Proposed Alberta Natural Gas Pipeline System Expansion"

An environmental impact study for a gas pipeline in the East Kootenay region of B.C. Discusses, among other things, the non-toxicity of natural gas to plants and animals, impacts on watersheds, aquatic systems and fish, including erosion potential, hydrology and pollution hazards.

15. McTaggart - Cowan, I.

"Environmental Impact Assessment, A Methodology for Prediction of Environmental Effects"

A methodology for predicting environmental effects of the proposed Mackenzie Valley Pipeline is discussed in this paper. Winter roads and hydrology are summarized.

16. Britton, M. (Arctic Institute of North America)

"Environmental Impact Assesment, A Methodology for Assessing the Impact of the Proposed Mackenzie Valley Pipeline, A Board Self Appraisal."

Outlines the success, progress and failures of the Enviornmental Protection Board.

17. Mackay, D.K. (Environment Canada)

"Summary Technical Report on Hydrologic Aspects of Northern Pipeline Development"

Discusses the potential hydrologic effects of a pipeline along the Mackenzie River. Catagories covered are rivers, river banks, watershed characteristics and hydroclimatic aspects.

18. Wilson, E.D.

"Transportation of Crude Oil in an Arctic Environment"

Environmental and sociological impact evaluation including river hydrology and permafrost aspects.

19.

"Computer Simulation Study of the Groundwater and Thermal Regimes in an Arctic (Permafrost) Streambed Environment"

Concerns specifically the implications of operation of a chilled pipeline buried within the unfrozen zone beneath the bed of an arctic river. Of particular interest is the development of a frost bulb around the pipeline and the effect of this frost bulb on the surface or groundwater flow regime.

20. Howard, C.D. (Unies Ltd.)

"Environmental Impact Assessment of the Mackenzie Gas Pipeline from Alaska to Alberta, Chapter 7 - Water"

A hydrological analysis of climatological, topographical and geological data was used to estimate flood frequencies and suspended sediment concentrations before and after construction, and to classify all streams according to their hydrologic behaviour.

21. Glaciology Div., Water Resources Branch, Environment Canada

"Hydrologic Aspects of Northern Pipeline Development".

This report contains a collection of research papers on the hydrology of areas that may be affected by the construction of an oil pipeline along the Mackenzie River, including papers that deal with water balance, streamflow, river bank stability, flooding ice jams, precipitation, dendrochronology, frost heaving, geomorphology, and sediment transport.

22. Bryan, J.E. (Environment Canada)

"Influence of Pipeline Development on Freshwater Fishery Resources of Northern Yukon Territory. Aspects of Research Conducted in 1971 and 1972"

The purpose of this study is to evaluate effects of pipeline development on aquatic resources in northern Yukon Territory in order to protect the capacity for fish production. Present information indicates that more fish spawning and rearing areas would be affected by a pipeline in the Porcupine River drainage than in the Beaufort Sea drainage.

23. Neill, C.R. (Research Council of Alberta)

"Technical Report on Aerial Reconnaissance and Study Recommendations for Rivers in the Mackenzie Basin, N.W.T."

Guidelines for this study were to look at a number of rivers, including potential crossing sites, and identify major areas of potential trouble, and to recommend the most significant studies that should be undertaken on the physical characteristics of the major streams in the Mackenzie Basin.

24. Mackay, D.K. and Mackay, J.R. (Glaciology Division, Environment Canada)

"Locations of Spring Ice Jamming on the Mackenzie River, N.W.T."

Historical observations of ice jamming are detailed for the Mackenzie River. Major ice jam sites are noted and some conclusions are drawn as to the influence of the Liard River, the significance of river stage at spring break-up and the relevance of ice jam data to the location of pipeline and highway crossings.

25. Riddle, J.A. (Glaciology Division, Environment Canada)

"Susceptibility to Frost Heaving of Soils at Selected Sites Along the Liard River Valley Determined by Pore Pressure Measurements"

The susceptibility to frost heave or ice lensing of different soil types is an important engineering factor that must be dealt with quantitatively for proper pipeline location in the north. This paper illustrates the usefulness of quantitative frost susceptibility criteria, using soils gathered along the Liard River Valley.

RECONNAISSANCE OF PROPOSED PIPELINE ROUTES IN YUKON*

JUNE 2 - 6, 1977

i) The purpose of the trip was to obtain an understanding of the area and to identify areas of concern from "the centre viewpoint" so as to determine the areas most in need of further study.

ii) The trip was a quick one, conducted by helicopter with not much time available for landing and ground observation.

iii) The route of the pipeline is not as yet defined, except in very general terms. In most of the routes surveyed, the location of a pipeline is far from being obvious and would require extensive engineering work to be determined. The exact location of the line would seriously influence its effects upon the water resources along it.

iv) Of much concern are reaches of the route where there is not much of an obvious corridor between the floodplains of meandering streams and rather steep hillsides, as, for example, about miles 120-130 of the Dempster Highway (north of Dawson City), along the Klondike River, and along the Yukon River south of Minto.

v) Also of major concern are assumed pipeline routes, mainly along highways, which parallel meandering streams. While the meander propagation is rather slow in most of such streams, it can accelerate for one or another reason, one of which is construction activity, another the change in meander movement and currents due to armour protection along the pipeline.

* Supplement to Appendix A

vi) I did not observe serious damage to permafrost from man-activities throughout the route, as I did on the Alcan route.

vii) Of great interest is the fact that the entire Klondike Valley and the valleys of other streams near Dawson have been extensively subjected to man-activities. Other creeks in the area are presently under substantial placer activities. One must recognize how much effect on the environment such activities, past and present, had or have.

viii) Also of great interest is the old water conveyance system, of 35 miles length, through Moosehide Hills, near Dawson. This system consisted of pressure pipe, both woodstave and steel, siphons, canal and wooden sluices. The remains of it are still there, through permafrost plains, rocky hillsides and valleys. Although I cannot possibly say whether the line formed a barrier to migrating animals, it is obvious that its effects on the area are minimal. Vegetation has taken over again and the permafrost, even in areas that have been ditched, seems to be undisturbed. Since terrain, climatic and vegetation conditions are not dissimilar to those of other areas, the effects of this old water conveyence system should be studied so as to provide an insight of what is bound to happen, in other similar areas.

ix) In general terms it can be stated that the construction of a pipeline cannot occur without some adverse effects on the water economy of the region. However, the effects can vary widely from minimal to serious, depending upon the pipeline alignment, means and methods of construction and special efforts exerted to minimize such adverse effects.

x) Specific areas of concern are discussed in the Schreier notes (Appendix A). These notes fully reflect the observations made during this trip. To this, I want to add that the subject routes appear to be less fragile than sections of the Alcan route. This is so, either because the routes follow high ridges which constitute "drainage divides" or because areas are prone to heavier precipitation or because a colder climate can sustain permafrost better.

A.N.T. Varzeliotis
8 June 1977