ENVIRONMENTAL SERVICES

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Foothills Pipe Lines (South Yukon) Ltd.

APPROACH
TO
WATERCROSSING DESIGN
AND
CONSTRUCTION PLANNING

SUBMISSION 4-5

DECEMBER, 1981

ADDENDUM
TO
THE ENVIRONMENTAL IMPACT STATEMENT
FOR
THE YUKON SECTION
OF
THE ALASKA HIGHWAY GAS PIPELINE

THE ALASKA HIGHWAY GAS PIPELINE PROJECT

Foothills Pipe Lines (South Yukon) Ltd.

WHITEHORSE:
308 STEELE STREET,
WHITEHORSE, N.W.T.,
Y1H 2C5

CALGARY:
1600 - 205 FIFTH AVENUE, S.W.,
CALGARY, ALBERTA
T2P 2V7

This document is one of a series of addenda prepared to meet information requirements placed on Foothills Pipe Lines (South Yukon) Ltd. by the Federal Environmental Assessment and Review Office. Addenda within the series are divided into seven sets of submissions dealing with separate subject areas:

1. Introduction to Addenda Submissions.

2. Project Description and Update for Addenda Submissions.

3. Alternative Routes.

4. Geotechnical, Hydrological, Design Mode and Revegetation Issues.

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1.0 INTRODUCTION

During public hearings concerning the Alaska Highway Gas Pipeline Project conducted by the Environmental Assessment and Review (EAR) Panel the matter of watercrossings has received a great deal of attention. This interest reflected the sensitivity of environmental components at watercrossings as well as that of the pipe installation to natural environmental forces.

Initially, during 1976 hearings before the EAR Panel, concern was expressed for watercrossings in view of the frequent occurrence of high-energy streams along certain portions of the proposed pipeline route. These streams are characterized by variable flow rates, migrating channels and in some cases by flash flooding due to the release of upstream glacier dams. In addition, concerns for fish spawning, migration and overwintering were brought forward, these being related to the timing and nature of construction and to siltation due to erosion, as well as the effects of possible emergency repairs and the possibility of pipeline leaks at crossings.

During the 1976 hearings the Project indicated that heavy-wall pipe would be used at watercrossings, that pipe would be buried below the anticipated scour depth, that the area of deeper burial in a floodplain would take into account possible channel movements, that where possible crossing locations would be moved to avoid important and sensitive fish populations and, that the timing of construction would, where possible, take into account the time periods when fish were most sensitive to construction activities. In its summary report prepared after the 1976 hearings the Panel noted that watercrossing locations were tentative, that insufficient physical and biological information was available to complete its review, that only larger watercrossings had received substantial attention by the Project and that information on small streams would be required. The Panel also noted that studies on the effects of gas leaks were inconclusive, that least-sensitive timing windows for fish populations had not been established and that questions concerning the effects of aufeis and the introduction of oxygen-depleting organic materials to watercourses during construction were outstanding.

In 1979, the Project submitted an Environmental Impact Statement (EIS) for the Alaska Highway Gas Pipeline Project in Yukon Territory. In that statement preliminary plans for watercrossings were presented and a number of supporting technical reports were annexed to the EIS document. In one of the annexed reports eleven preliminary designs which included examples from the range of watercrossings encountered in Yukon Territory were presented in the form of design drawings. Specific requests for impact assessment outlined by the Panel in its 1977 report were addressed within the EIS based on preliminary locations, schedules and plans. These assessments included the anticipated effects upon spawning fish, fish migration and overwintering fish as well as the effects of siltation arising from construction and operation, the latter including emergency repair and underwater gas leakage.

Upon completion of the 1979 public hearings and review of information submitted by the Project, the Panel requested additional information. These requests involved: detailed design for special problem areas for which special crossing crews would be employed together with detailed quantitive geotechnical, hydrologic and other relevant technical data; typical designs for crossings constructed by mainline crews with detailed supporting information (similar to above); detailed scour information including an evaluation of reliability; and detailed information about natural icing of stream crossings. Subsequently, the Panel's requests were clarified and described as "a developed approach to studies on crossings in order to understand the potential environmental impacts and proposed mitigation measures". This addenda submission has been prepared to meet the latter request.

In approaching the task of presenting "a developed approach" to water-crossings, two example crossings have been used. At present, final designs for watercrossings are available for Construction Section 4. In that construction section eight of a total of 18 watercrossings were specially designed. Others will be crossed in a typical manner. Of the eight specific crossing designs available, the Duke River has been chosen to serve as an example because it is one of the larger streams in the Construction Section and is characterized by a number of difficulties. In addition, an

unnamed creek at KP 200 + 360, known as watercrossing 1029 (WX 1029), is presented to illustrate the approach to smaller watercourses which present design difficulties.

Design solutions developed for these two streams illustrate the "developed approach" required. In following sections the approaches taken to selecting crossing locations, collecting required design data and developing designs are discussed. Finally a description of typical approaches to contruction of stream crossings, with specific reference to the example crossings, is included.

2.0 APPROACH TO SELECTING WATERCROSSING LOCATIONS

The approach taken in locating and designing pipeline facilities, including watercrossings, is one which involves several steps of increasing scrutiny aimed at ensuring the selection of suitable locations and the development of effective designs. As each step is taken the question is asked, "IS THIS REASONABLE GIVEN THE AVAILABLE INFORMATION". In the case of watercrossings three steps or stages in location selection are normally recognized: initial route selection, route refinement and final route selection. In some cases the process of refinement may be repeated several times before a final acceptable location is found. Design development takes place in parallel to the location process with the question "CAN AN EFFECTIVE DESIGN BE DEVELOPED AT THIS SITE" being asked at each stage.

2.1 Initial Route Selection

Initial route selection is the first stage of pipeline planning and involves selecting the most appropriate general route between two points. Information at hand usually consists of topographic maps and aerial photographs supplemented by notes and observations resulting from field reconnaissance. Despite the preliminary nature of the task, watercrossing locations are given careful consideration as these locations often become control points dictating the location of intervening terrestrial portions of the pipeline. Factors considered in selecting watercrossing sites during this initial phase relate to major and immediately obvious characteristics of the watercourses involved. Broad stable reaches of streams are preferred and steep or obviously unstable bank conditions are avoided. If a stream presents obvious difficulties throughout its length the location which appears least difficult is chosen. If a stream presents no crossing difficulties then the crossing location is simply an extension of the most logical terrestrial route leading to it. Initial route location is a task for personnel who can envision construction difficulties based on practical experience and who can balance difficulties of one route against another at an overview level.

In the case of the Duke River the general location of the crossing has been established from the outset of Project planning, although the initially-chosen crossing site located downstream of the Alaska Highway bridge was abandoned in favour of a crossing upstream of the bridge. The final crossing site selected lies immediately downstream of the point where the stream issues from the Donjek range. At this location the constricted flow characteristic of upper reaches of the river gives way to a wide braided flow over the lower portions of the Shakwak Valley (trench). Crossing sites upstream of this point are characterized by steep difficult approaches to the crossing and swift, deep, stream flow with attendant deep scouring of the channel bed. Such approaches would make construction difficult and the potential for scour would require exceptionally-deep burial of pipe across the active channel. Downstream crossing sites, including the initially-selected site, would of necessity involve the full width of the alluvial fan formed by the stream as it encounters the flatter slopes lying along the lower portions of the Shakwak Valley. While stream scour is generally not a problem at such sites as stream materials are aggrading, pipe burial must nevertheless be deeper than normal. By avoiding the widest part of the alluvial fan the length of deeper burial could be reduced. The crossing site chosen was one that was intermediate between two extremes. Additional items considered in the initial routing were the presence of the Alaska Highway, the Duke River Highway Bridge, river training works put in place for highway maintenance and the Duke Meadows IBP site.

The location of watercrossing 1029, like that of the Duke River, has remained in the same general vicinity from the outset of project planning but has been adjusted as a result of changes in adjacent terrestrial portions of the pipeline. In the area of the crossing stream characteristics are essentially similar in both upstream and downstream regions.

2.2 Preliminary Studies Leading to Route Refinement

After initial route selection a period of study and survey ensues. These studies and surveys are aimed at refining the selected route based on more detailed information, or at confirming the initially selected route. Rather

than the obvious terrain features, conditions and indicators used in initial route selection, more quantitative information is sought. While a series of preliminary studies or surveys are in most cases specifically planned and executed, these in some instances lead to more detailed study depending upon site-specific circumstances and Project decisions. In some cases studies aimed at selecting suitable crossing locations may continue for several years while in others initial results indicate a suitable location, and further study for the purpose of location selection is not necessary. For stream crossings, studies of terrain conditions, particularly in regards to stream banks, together with hydrological and fisheries investigations are those most often required.

Terrain conditions are evaluated using airphoto interpretation and field reconnaissance, and terrain types are identified and delineated on photomosaic maps. Investigative drilling is undertaken as part of the process of terrain typing. After a terrain typing system is in place, additional drilling in areas of uncertainty and apparent design difficulty ensues. In cases where stream crossing approaches appear to present design or construction problems, these areas are included in such additional exploratory drilling.

Examination of hydrological conditions at stream crossings is also completed as part of the series of preliminary studies and surveys aimed at ensuring the proper selection of watercrossing locations. These studies include the collection of all pertinent information related to regional and site-specific hydrological conditions and field examination of each crossing site. Field examination of crossing sites involves the determination of past high water levels at each site as well as an assessment of the degree of stream bed scouring and the extent of flooding during high water events. Examinations are usually carried out during summer and winter and may include specific seasonal examinations or surveys to document critical events such as break-up or exceptional freshets.

Investigation of biological conditions within streams is also part of preliminary studies at stream crossings. These investigations in most cases are aimed at fisheries resources and are concentrated on the crossing site

and areas downstream of the crossing which may be affected by pipeline activity. Studies of water quality or of other aquatic components may be included with those undertaken to determine the nature of the fisheries resource. Initially biological studies are aimed at determining the presence or absence of a resource. If a stream does not support fish or other important biological components further study is abandoned. Watercourses which do support important biological resources are then studied with the objective of determining the kinds, relative numbers and periods of use by fish or other resources as well as the kinds and durations of activities these organisms are involved in at or near the crossing site. Studies may continue over several years at sites where the presence/absence or kind/duration of activity cannot be immediately determined. However, where these factors are clearly established during initial studies further work is usually discontinued. In some cases where particularly important resources are involved or where the duration of pipeline activity is in question additional studies may be undertaken.

The following sections outline the sequence of events associated with geotechnical, hydrological and environmental studies leading from initial route selection to final watercrossing location and design.

2.2.1 Geotechnical Studies

A series of field investigations documenting the terrain along the pipeline route began in 1976 and is continuing. These studies are the basis for a terrain typing system which has developed through a series of revisions based on additional information acquired in successive years. These studies include the following:

Klohn Leonoff Consultants Ltd. 1976. Geotechnical investigation - MP 0-100. Report prepared for Foothills Pipe Lines Ltd. Calgary, Alberta.

Klohn Leonoff Consultants Ltd. 1977. Final report - frost heave test drilling programs (MP 0-40). Report prepared for Foothills Pipe Lines Ltd. Calgary, Alberta.

Klohn Leonoff Consultants Ltd. 1977. Terrain evaluation for Foothills (Yukon) pipeline route. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

Hardy Associates (1978) Ltd. 1978. Geotechnical field data report - summer 1978 drilling program. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

Hardy Associates (1978) Ltd. 1978. Geotechnical laboratory data report - summer 1978 drilling program. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

EBA Engineering Consultants Ltd. 1978. Geotechnical investigation - southern Yukon. Report submitted to the Geological Survey of Canada.

Hardy Associates (1978) Ltd. 1979. Geotechnical field data report - summer 1979 drilling program. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

Klohn Leonoff Consultants Ltd. 1979. Report - geotechnical investigation KP 7 to KP 217. Report prepared for Foothills Pipe Lines Ltd. Calgary, Alberta.

Klohn Leonoff Consultants Ltd. 1979. Geophysical surveys, permafrost delineation, KP 7 to 217. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

Hardy Associates (1978) Ltd. 1980. Geotechnical field data report - summer 1980 drilling program. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

In 1981 information arising from the above reports was consolidated in a geotechnical atlas incorporating the terrain type system that had been developed.

Foothills Pipe Lines (South Yukon) Ltd. 1981. The Alaska Highway Gas Pipeline Project, Geotechnical Atlas. Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

Field investigations continued in 1981 and to date.

Hardy Associates (1978) Ltd. 1981. Geotechnical field data report - 1981 field drilling program. Report prepared for Foothills Pipe Lines (Yukon) Ltd. Calgary, Alberta.

Hardy Associates (1978) Ltd. 1981. Geotechnical laboratory data report - summer 1980 drilling program. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

Revisions to the Geotechnical Atlas are being made on a sheet by sheet basis as additional information is acquired.

Geotechnical information which relates to the two example crossings is included in this report as a series of drill hole logs relating to each crossing and as a number of sheets from the Geotechnical Atlas which include the watercrossings in question. (Pouch A). Drill hole logs for crossing sites are as follows, and these are included in Appendix 1.

Duke River	Unnamed Creek at KP 200 + 360
79B-23	79A-20
80-01-66	79A-21
80-11-110(2)	79B-24
81-01-138	79B-25
81-01-139	80-01-78
81-01-140	80-01-79
81-01-141	80-11-117
	80-11-118
	80-11-119
	81-01-152
	81-01-152(2)
	81-01-153

2.2.2 Hydrological Studies

A series of field investigations of hydrological conditions in streams crossed by the Alaska Highway Gas Pipeline was begun in 1978 and is

continuing. These studies provide the basis for hydrological calculations and decisions leading to selection of final water crossing locations and designs.

Northwest Hydraulic Consultants Ltd. 1978. Yukon stream survey data. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

Northwest Hydraulic Consultants Ltd. 1978. 1978 spring break-up observations along the proposed South Yukon pipeline route. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

Northwest Hydraulic Consultants Ltd. 1978. Assessment of South Yukon flood hydrology. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

Northwest Hydraulic Consultants Ltd. 1978. Multidiscipline reconnaissance of selected stream crossings along the South Yukon pipeline route. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

Northwest Hydraulic Consultants Ltd. 1978. Multi-discipline stream characteristics along the Foothills (South Yukon) pipeline route. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

Van Everdingen, R.O. 1978. Springs, seepage areas, open water reaches and icings, Alaska Highway pipeline route, Watson Lake, Y.T. to Alaska border. Unpublished maps and notes.

Northwest Hydraulic Consultants Ltd. 1980. The Alaska Highway Gas Pipeline Project (South Yukon Route) - Alaska/Yukon border to Cracker Creek (KP 0 - 330) stream inventory. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

Northwest Hydraulic Consultants Ltd. 1980. The Alaska Highway Gas Pipeline Project (South Yukon Route) - Alaska/Yukon border to Cracker Creek (KP 0 - 330) stream survey data. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

Northwest Hydraulic Consultants Ltd. 1981. The Alaska Highway Gas Pipeline Project (South Yukon Route) - Cracker Creek to Yukon/B.C. border (KP 330-830) - Stream Inventory. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

Northwest Hydraulic Consultants Ltd. 1981. The Alaska Highway Gas Pipeline Project (South Yukon Route) - Alaska/Yukon border to Cracker Creek (KP 0 to 330) - Stream Crossing Design. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

Extracts from the last noted document (stream crossing design) are included in Appendix 2 and deal with the Duke River and the unnamed creek at KP 200 + 360.

2.2.3 Environmental Studies

Studies of streams and fish populations encountered by the Alaska Highway Gas Pipeline were begun in 1976 and continue at present. Reports of these studies which deal with the two example streams dealt with in this submission are as follows:

Doyle, P. MS 1977. Winter survey, Alcan Pipeline. Department of Fisheries and the Environment, Fisheries and Marine Service. Vancouver, British Columbia. Unpubl. memorandum report. 62 pp.

Beak Consultants Limited. 1977. A preliminary inventory of fish resources in southern Yukon Territory, 1976. Report prepared for Foothills Pipe Lines (Yukon) Ltd. Calgary, Alberta.

Beak Consultants Limited. 1977. Winter fish investigations of selected watercourses in Yukon Territory, 1977. Report prepared for Foothills Pipe Lines (Yukon) Ltd. Calgary, Alberta.

Northern Natural Resource Services Limited. 1977. Collection of fisheries information from waterbodies along the proposed Alaska Highway gas pipeline route to July 15, 1977. Report prepared for the Department of Fisheries and the Environment, Fisheries and Marine Service. Vancouver, British Columbia.

Beak Consultants Limited. 1977. A spring inventory of fishery resources along the proposed Alaska Highway pipeline in Yukon Territory, 1977. Report prepared for Foothills Pipe Lines (Yukon) Ltd. Calgary, Alberta.

Wickstrom, R.D. 1977. Fish distribution in Kluane National Park and peripheral area. Report prepared for Parks Canada by the Canadian Wildlife Service. Winnipeg, Manitoba.

Beak Consultants Limited. 1977. A summer inventory of fishery resources along the proposed Alaska Highway pipeline in Yukon Territory, 1977. Report prepared for Foothills Pipe Lines (Yukon) Ltd. Calgary, Alberta.

Beak Consultants Limited. 1977. A survey of fall spawning fish species in waterbodies within the influence of the proposed Alaska Highway pipeline in Yukon Territory, 1977. Report prepared for Foothills Pipe Lines (Yukon) Ltd. Calgary, Alberta.

Beak Consultants Limited. 1978. A summary of fishery investigations in waterbodies within the influence of the proposed Alaska Highway pipeline in Yukon Territory, 1976-77. Prepared for Foothills Pipe Lines (Yukon) Ltd. Calgary, Alberta.

Department of Public Works, Canada and U.S. Department of Transportation Federal Highway Administration. 1977. Environmental impact statement, Shakwak Highway improvement, British Columbia and Yukon, Canada. Department of Public Works, Project Number 010417. Vancouver, British Columbia. Federal Highway Administration Report Number FHWABC/YTEIS7701D. Washington, D.C.

Beak Consultants Limited. 1979. A summary of fisheries resource investigations in waterbodies within the influence of the Alaska Highway Gas Pipeline in Yukon Territory, 1978. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

Beak Consultants Limited. 1979. Reconnaissance of streams previously identified as having no fish habitat, spring 1979. Report prepared for Foothills Pipe Lines (Yukon) Ltd. Calgary, Alberta.

Beak Consultants Limited. 1979. Summer observations on streams with low potential for fisheries habitat along the Alaska Highway Gas Pipeline in Yukon Territory. Report prepared for Foothills Pipe Lines (Yukon) Ltd. Calgary, Alberta.

Environmental Management Associates. 1980. Enumeration of spawning salmon in aquatic systems along the Alaska Highway gas pipeline in southern Yukon Territory, 1980. Report prepared for Foothills Pipe Lines (South Yukon) Ltd. Calgary, Alberta.

These and other studies were consolidated in a catalogue format to assist in dealing with site-specific fishery-related topics during final pipeline design.

> Foothills Pipe Lines (Yukon) Ltd. 1981. Catalogue of fisheries resource information for waterbodies crossed by the Alaska Highway Gas Pipeline route in southern Yukon Territory. Foothills Pipe Lines (Yukon) Ltd. Calgary, Alberta.

Extracts from the 1978 summary of fisheries resource investigations and from the fisheries catalogue (above) dealing with the Duke River are presented in Appendix 3. Fish were not found in the watercrossings at KP 200 + 360. In the latter case extremely shallow water and an impassable downstream culvert in the Alaska Highway prevent fish utilization. An extract from the report dealing with the limitations of the unnamed creek at KP 200 + 360 is included in Appendix 3.

3.0 FINAL SITE SELECTION AND APPROACH TO DESIGN AT WATERCROSSINGS

Based on the surveys and studies outlined in Section 2.2, the locations of watercrossings at the Duke River and at watercrossing WX-1029 were finalized. Design work proceeded utilizing information gathered during preliminary and ongoing studies. A summary of location, geotechnical, hydrological and environmental information used in crossing design for the two example crossings is presented in the following sections. Design drawings for the crossings are included in Pouch B together with alignment sheets showing adjacent pipeline locations, construction details and layout. In addition, Pouch B contains a "typical" crossing drawing which would be utilized for smaller streams requiring no specific design details. This latter item is included solely as additional information and does not relate to either the Duke or watercrossing WX-1029 examples. Alignment sheets showing design for adjacent terrestrial sections are included in Pouch C.

3.1 DESIGN INFORMATION - DUKE RIVER

SURVEY AND GENERAL INFORMATION

UTM location - Zone 7 - 599,120E - 6,805,840N

Pipeline location - KP 178 + 144

Construction year - 1983

Construction season - February 1 to April 15

Gas temperature (operating) - max. 19.2°C - min. 8.0°C

Pipe outside diameter - 1219 mm - 1

Pipe wall thickness - 18.3 mm

Pipe grade - 483

Pipe category - II

Pipe class - 1

Design factor - 0.6

GENERAL CHARACTERISTICS OF CROSSING SITE

Description - The Duke River emerges from a narrow mountain canyon upstream of the crossing and spreads out through the crossing reach to form a wide and highly braided floodway.

Channel width - 139 m

Channel bankfull depth - 1.2 m

Total design width - 975 m

CROSS REFERENCE INFORMATION

Alignment sheet - 2010200 AL 0026

Plan profile book of reference - 2010200 PP 0026

Geotechnical atlas - 2010201 GT 0026

Crossing detail drawing - 2010200 WX 1026

GEOTECHNICAL FIELD DATA

Boreholes: 79B - 23
80 - 01 - 66
80 - 11 - 110 (2)
81 - 01 - 138
81 - 01 - 139
81 - 01 - 140
81 - 01 - 141

GEOTECHNICAL INFORMATION - LEFT BANK

Main channel at KP 178 + 075

Terrain type - f/gAF

peat, organic silt, volcanic ash over till, silty gravel, gravel over unconsolidated deposits

Depth to bedrock - greater than 10 m

Soil temperature - unfrozen KP 178 + 030 to 178 + 740 with the remainder frozen or uncertain

Slope - approximately 17° at KP 178 + 076 (2.5 m high)

Erosion - channel bank is part of a highway dike and erosion is minimized by rip-rap

Bank stability - bank stability problems are not anticipated as highway dike will be replaced

GEOTECHNICAL INFORMATION - RIGHT BANK

Main channel at KP 178 + 210

Terrain type - gAc

peat, organic silt, silt, volcanic ash over silty gravel, silty sand, gravel, cobbly gravel over unconsolidated deposits

Depth to bedrock - greater than 10 m

Soil temperature - unfrozen KP 178 + 030 to 178 + 740 with remainder frozen or uncertain

Slope - less than 10° at KP 178 + 212 (2.0 m high)

Erosion - immediate channel bank is moderately susceptible to erosion

Bank stability - bank stability problems are not anticipated

HYDROLOGICAL INFORMATION

Design Discharge - 300 m^3/s

Design High Water Stage - 855.5 m (ice related)

Bankfull Discharge - 85 m^3/s

Design Flood Frequency - 1:100

Minimum Scour Elevation - scour level is 1.6 m below channel bottom (851.2 m)

Bedding Material Sizes - D_{50} = 23 - 52 mm
D_{90E} = 49 - 110 mm

Low Water Season - winter

Low Water Level - 852.8 m

High Water Season - summer

High Water Mark - 854.1 m

Winter Freeze-up - November

Spring Break-up - mid-May

Flow Duration - year round

Ice conditions

- River ice is normally quite thin but on at least one occasion a substantial icing (approximately 1.0 m thick) occurred along the right 1/3 of the main channel and the level 1 floodplain. Aufeis occurrence is possible on levels 1, 2 and 3 floodplains.

Extent of potential flooding

- Existing dike elevations provide a vertical free board of 1.5 to 2.0 m, which is considered adequate for open water and aufeis conditions. The left bank floodplain is protected from direct flow conditions.

Special considerations

- Maximum pipe elevation will be maintained through level 2 floodplain to design for possible migration of main channel into this section. Rock riprap design will extend the full width of the disturbed right-of-way. Riprap in the trench shall extend from within 300 mm of the top of the concrete coating on the pipe to the top of the dike. Riprap outside of the trench shall be replaced from the top of the existing buried rock riprap to the top of the dike. Rock riprap shall be placed on a 2.5:1 slope, with a minimum thickness of 0.9 m.

ENVIRONMENTAL INFORMATION

Important fish species are present in the watercourse. Chum salmon spawn sporadically at the mouth of the Duke River (in Kluane River) approximately 8 km downstream of the crossing. Arctic grayling use Kluane River for rearing and as adult summer habitat. No sensitive habitats exist within the influence of the crossing. Important wildlife species are present in the vicinity of the crossing in the form of a pair of nesting Golden Eagles. During the year of mainline construction, no activities will be allowed within 2 km of this nest from April 1 to July 31. No activities prior or subsequent to the year of mainline construction from March 20 to July 31 within 2 km of nest.

3.2 DESIGN INFORMATION - UNNAMED CREEK AT KP 200 + 360

SURVEY AND GENERAL INFORMATION

UTM location - Zone 7 - 617,000E - 6,793,580N

Pipeline location - KP 200 + 360

Construction year - 1983

Construction season - February 1 to April 15

Gas temperature (operating) - max. 16.6°C - min. 2.4°C

Pipe outside diameter - 1219 mm

Pipe wall thickness - 18.3 mm

Pipe grade - 483

Pipe category - II

Pipe class - 1

Design factor - 0.6

GENERAL CHARACTERISTICS OF CROSSING SITE

Description - A small stream exhibiting a large alluvial fan with an active channel at 201 + 090 and an inactive channel at 200 + 360.

Channel width - 25 m

Channel bankfull depth - 1.5 m

Total design width - 1880 m

CROSS REFERENCE INFORMATION

Alignment sheet - 2010200 AL 0029

Plan profile book of reference - 2010200 PP 0029

Geotechnical atlas - 2010201 GT 0029

Crossing detail drawing - 2010200 WX 1029

GEOTECHNICAL FIELD DATA

Boreholes:
79-A - 20
79-A - 21
79-B - 24
79-B - 25
80 - 01 - 78
80 - 01 - 79
80 - 11 - 117
80 - 11 - 118
80 - 11 - 119
81 - 01 - 152
81 - 01 - 152(2)
81 - 01 - 153

GEOTECHNICAL INFORMATION - LEFT BANK

Main channel at KP 200 + 350

Terrain type - f.aAA - organic silt, silt, clayey silt, peat layers over silty sand, silty gravel, silty clay, thin peat layers over till or silty gravel

Depth to bedrock - greater than 10 m

Soil temperature - unfrozen KP 200 + 810 to 201 + 340 with the remainder of the section (KP 197 + 500 to 204 + 700) frozen or uncertain

Slope - less than 10° at KP 200 + 350 (1.0 m high)

Erosion - the immediate channel bank is moderately susceptible to erosion

Bank stability - design problems due to bank stability are not anticipated

GEOTECHNICAL INFORMATION - RIGHT BANK

Main channel at KP 200 + 370

Terrain type - f.aAA - organic silt, silt, clayey silt, peat layers over silty sand, silty gravel, silty clay, thin peak layers over till or silty gravel

Depth to bedrock - greater than 10 m

Soil temperature - unfrozen KP 200 + 810 to 201 + 340 with the remainder of section (KP 197 + 500 to 204 + 700) frozen or uncertain

Slope - less than 10° at KP 200 + 372 (1.0 m high)

Erosion - the immediate channel bank is moderately susceptible to erosion

Bank stability - design problems due to bank stability are not anticipated

HYDROLOGICAL INFORMATION

Design Discharge - 20 m^3/s

Design High Water Stage - not applicable, as flow is not contained within a defined channel

Bankfull Discharge - not known

Design Flood Frequency - 1:100

Minimum Scour Elevation - variable; mean scour level to 3.0 m below alluvial fan surface

Bedding Material Size - not known

Low Water Season - winter

Low Water Level - no surface flow

High Water Season - summer

High Water Mark - not known

Winter Freeze-up - not known

Spring Break-up - not known

Flow Duration - not known

Ice conditions

- extensive icing occurs as ground water is forced to sur- face several hundred metres downstream of the dry creek channel. This process frequently advances upstream past the pipeline right-of-way.

Extent of potential flooding

- the stream is of the alluvial fan type and flow is not contained within a defined channel or floodplain during the design flood event. The active channel was maintained by highway maintenance (1980) between stations 201 + 050 and 201 + 150. General overland flow can be expected between stations 199 + 900 and 201 + 550 with possible new channel development between stations 200 + 920 and 201 + 520. The largest percentage of flood design flows would be across the buried sections of the crossing.

Special considerations

- based on examination of aerial photography a new channel is developing in the vicinity of station 201 + 090 and a new 2.0 m minimum degraded channel can be anticipated.

ENVIRONMENTAL INFORMATION

No important fish species present in this watercourse. No wildlife concerns present in the vicinity of this crossing.

4.0 ENGINEERING DESIGN

The development of engineering design for the Duke River and watercrossing WX 1029 is based on the location, geotechnical, hydrological and environmental information presented in Section 3.1 and 3.2. The engineering design is also presented in the form of design drawings, which may be found in Pouch B of this submission. In addition to designs for the Duke River and watercrossing WX 1029, the design for a "typical" crossing, which would be utilized for smaller streams requiring no specific design details, is also included in Pouch B. This latter item is included solely as additional information and does not relate to either the Duke River or watercrossing WX 1029 examples. Alignment sheets showing design for terrestrial sections adjacent the two watercrossings under discussion are presented in Pouch C of this submission.

4.1 Duke River

The construction mode for the Duke River crossing will be deep burial. The minimum depths of cover over the pipe will be 2300 mm beneath the main channel, and 1500 mm beneath the eastern floodplain. The pipe will have a 10 percent negative buoyance, which will be provided by a 161 mm thick concrete coating, from 178 + 005 to 178 + 830. The trench will be backfilled with native materials over a minimum cover of 450 mm of select fill. The Department of Public Works dikes will be restored to, as near as possible, their original conditions, or as directed by the Department of Public Works immediately following construction. The pipe section from 177 + 950 to 178 + 850 will be hydrostatically tested prior to installation. Activities will be restricted in the section from 177 + 663 to 177 + 900 to avoid making cuts in the ice-rich slope to the south of the right-of-way. The concrete coating from 178 + 005 to 178 + 830 will be spiral reinforced to mitigate against differential settlement.

4.2 Unnamed Creek at KP 200 + 360

The design for watercrossing WX 1029 will consist of above-grade restrained pipe from 199 + 970 to 200 + 740 and 201 + 515 to 201 + 560, and deep burial from 197 + 680 to 199 + 870 and 200 + 830 to 201 + 425. The dry creek channel at KP 200 + 360 will therefore be crossed by a free span, while the active channel at KP 201 + 090 will be crossed by deep burial. A 5 percent negative buoyancy will be provided by 6700 kg saddle weights spaced at 4.9 m (centre-to-centre) from 200 + 780 to 201 + 485. In the buried section of the crossing the pipe will covered with 450 mm of select fill, followed by backfilling with native materials. Select fill shall also be used to replace the excavated unstable ground at the transition from the buried mode to the above-grade mode (201 + 430 to 201 + 520). A surface course material will be added to the sections from 199 + 760 to 199 + 970 and 201 + 370 to 201 + 520 during clean-up, over the extent of the disturbed right-of-way. All active and inactive channels will be restored to conditions as near as possible to those originally present to facilitate water flow. Embankment openings will be provided at 200 + 360 and 200 + 670 to sustain drainage capabilities in the event of an icing occurance. Culverts will be placed at stations 200 + 232, 200 + 524 and 201 + 520. This pipe section will not require hydrostatic testing prior to installation. Buried sections of the design actually contain the active flow although no defined stream channel presently exists.

5.0 APPROACH TO CONSTRUCTION OF WATERCROSSINGS

Construction of watercrossings is carried out according to instructions given in design drawings and construction specifications. In the case of watercrossings requiring special designs, specific drawings are prepared. For crossings that do not require special designs a typical design drawing is utilized. (The buried crossing of the active channel adjacent the unnamed creek at KP 200 + 360, discussed in Section 4.2 is actually a typical watercrossing). Construction specifications detail the time of construction if different from the planned construction of adjacent terrestrial pipeline sections and outline a number of "general procedures" which apply to all watercrossing construction activities at both typical and special crossings.

Construction details for the two example crossings are included on design drawings in Pouch B. Construction requirements for typical crossings are outlined on the typical crossing drawing also included in Pouch B. General practices and requirements for construction at all crossings are outlined in Construction Specification for Watercrossings included as Appendix 4. These guidelines are presently in a preliminary form.

The sequence of activities at crossing sites generally follows that used along terrestrial portions of the pipeline, with the addition of several steps where required. Clearing is followed by grading of the stream approach areas, which is then followed by trenching. Trenching may take a number of forms depending upon site-specific characteristics. In cases where a small dry stream bed is involved, a wheel ditcher may proceed through the crossing area as an extension of ditching operations in adjacent areas. In the case of larger flowing streams, backhoes or various forms of dredging may be utilized to complete ditching. Welding of the pipe sections and the application of continuous concrete weighting, or of bolt on weights where these are required, is conducted simultaneously with the ditching operation such that upon completion of the trench the pipe is ready for installation. Pipe sections for watercrossings may be pre-tested (hydrostatic testing) prior to installation. Installation in the prepared trench is achieved using a number of approaches depending upon site conditions and the length of pipe to be put in place. For short sections,

pipe and attached concrete weighting is lifted by sidebooms and "walked" into place. In circumstances where lengthy sections are to be put in place a pull winch may be used in conjunction with floatation tanks and sidebooms. Following installation any required "set on" concrete weights are put in place, and the trench is backfilled using bulldozers working instream or with modified dredges where circumstances require.

Backfill material used is generally that remaining from trenching operations. In some instances, the pipe is covered with a layer of select backfill prior to the use of native materials. If complete backfill is not achieved using material removed from the trench, the ditch is allowed to fill as a result of bed load movement within the stream. With backfilling complete bank approaches are cleaned up and shaped to match pre-construction conditions. Where bank armoring is required this is put in place. Required erosion control structures and revegetation of bank areas are the final construction activities.

In the case of the Duke River the sequence just outlined will be followed in general. The size of the Duke crossing, however, will require extra working room on the river approaches, extending 40 m downstream and 28 m upstream. This area will be cleared and levelled to allow room for crossing activities. Ditching will in all likelihood involve the use of backhoes working instream with ditch spoil being placed in piles downstream on the river ice. The completed ditch may require clearing with a clamshell dredge. Pipe will be made up in 250 m lengths and continuous concrete coating applied. Each individual section will be hydrostatically tested and will be ready for installation once the ditch has been prepared. Pipe placement will involve a pull winch and probably bouyancy tanks. Each section will be pulled into place after attachment to the preceding section. The backfill operation will involve replacing the spoil from the ice to the trench by bulldozers, and clean-up operations will involve reconstruction of diversion dikes presently installed for protection of the Alaska Highway.

Watercrossing WX 1029 is a small, inactive stream. The active stream at KP 201 + 090 will not be discharging during the winter construction period. The length of the design crossing involves both above- and below-grade

placement of pipe. As with other crossings, clearing and levelling will be the first steps taken in construction. Those sections requiring trenching will be ditched using either a wheeled ditcher or a backhoe. In those sections requiring above-grade pipe placement, an insulated gravel pad to support the pipe will be constructed. Pipe will be strung, welded and put in place. Concrete bouyancy weights will be placed over the pipe in trenched areas where these are required. Trenched sections will be backfilled using bulldozers. Concrete pipe restraints will be placed over above-grade sections of pipe. Stream training structures will be replaced to the pre-construction condition, and a careful clean-up to return the crossing area to its previous contouring will be completed.

APPENDIX 1

DRILL HOLE LOGS RELATED TO

DUKE RIVER CROSSING AND

WATERCROSSING WX-1029

DUKE RIVER BOREHOLES

TEST HOLE LOG

HAMMER WT. 63.5 kg
HT. DROP 76 cm.

LOCATION KP 176.8
ELEVATION

PERMAFROST

COHESION - kg./Sq. cm.
0.2 0.6 1.0 1.4 1.8
● FIELD VANE △ LAB VANE □ UNCONF.

SAMPLE DATA				SYMBOL	N.R.C. CLASS	N.F. or F.	DESCRIPTION OF MATERIAL	PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 30 50 70 90%)
DEPTH	TYPE	BLOW/15 cm.	No.					
					ICE		ICE	
							0.7	
1.0	B		1		Nbn			
							GRAVEL -fine to coarse-grained -fairly well graded -some sand -trace of clayey silt -frequent cobbles to 1.3 metres -occasional cobbles below 1.3 metres -grey	
2.0						NF		
	B		2					
	Spt	125	3					
3.0								
	B		4					
4.0								
5.0								
						NF		
6.0								
7.0							7.0 BOTTOM OF HOLE	
8.0								

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JOB No. AL1138
PROJECT Alaska Highway Gas Pipeline
LOCATION Yukon Territory

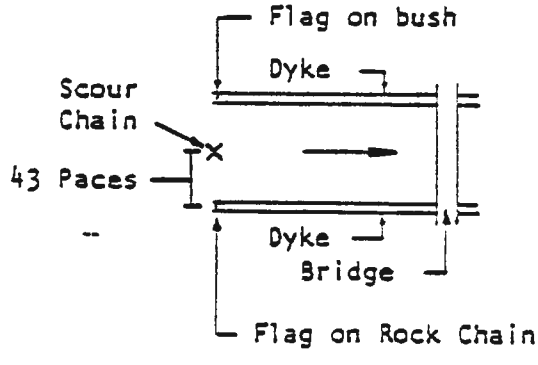
TEST HOLE LOG

HAMMER WT. 63.5 Kg.
HT. DROP 76 cm.
SAMPLE DATA
DEPTH | TYPE | BLOW/15 cm. | No.
SYMBOL
PERMAFROST
N.R.C. CLASS | N.F. or F.
LOCATION KP 176.8
ELEVATION
COHESION - Kg./Sq. cm.
0.2 0.6 1.0 1.4 1.8
● FIELD VANE △ LAB VANE ⊟ UNCONF.
PLASTIC LIMIT | WATER CONTENT | LIQUID LIMIT
X — — — — — O — — — — — X
10 30 50 70 90%

DESCRIPTION OF MATERIAL

NOTES

1. Water encountered at 3.0 metres during drilling.
2. Temperature of water was + 4°C.
3. Leopold scour chain installed with 1.7 metres of chain exposed to river flow.
4. Location of scour chain is illustrated below.



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JOB No. AL1138
PROJECT Alaska Highway Gas Pipeline
LOCATION Yukon Territory
HOLE No.

BOREHOLE LOG – PERMAFROST

DEPTH (metres)	SOIL DESCRIPTION	SAMPLE	GROUND ICE DESCRIPTION	BULK DENSITY (Mg/m^3) ▲ 1.4 1.6 1.8 2.0 2.2 / MOISTURE CONTENT 10 20 30 40 50
0	GRASS			
	GRAVEL (GP-GM) - sandy, trace silt, subangular clasts to 80mm, light grey (5Y 7/1)	GH		
1	(ALLUVIAL)	GH		
	GRAVEL AND SAND (GP-GM) - some silt, subangular clasts to 140 mm, light grey (5Y 7/1)			
2	(ALLUVIAL)	GH		
	NO RECOVERY - very hard drilling			
3				
4	- sloughing hole			
	END OF HOLE - sloughed to 0.35m			
5				
6				
7				

eba

SFC. ELEVATION (m)	DATE DRILLED 16/04/80	BOREHOLE No. 80-01-66
COMPLETION DEPTH (m) 4.0	LOGGED BY RJG	
DRILLING RIG SONIC	LOCATION GS51/0+30	PAGE 1 OF 1

This log is a compilation of subsurface conditions and soil or rock classification obtained from the field as well as from laboratory testing of samples from the operations. Soil zones have been interpreted according to commonly accepted practice. The strata lines [illegible]

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GEOTECHNICAL DIVISION

BOREHOLE LOG

FOOTHILLS PIPE LINES (YUKON) LTD.

BOREHOLE NO. 80-11-110(2)

LOGGED BY: BP	DRAWN BY: MC	CHECKED: ATH	DATE: Oct 23, 1980
RIG: Mobile	METHOD: Sonic/Core	START: 16:15 hrs.	FINISH: 18:30 hrs.
PROJECT NO.: K 5327 A060	TERRAIN TYPE:	LOCATION: 535 1777 + 23	

W_p - ▪ W - ○ W_L - ▲

BULK DENSITY (kg/m^3) ●
1200 1400 1600 1800
MOISTURE CONTENT %
20 40 60 80

DEPTH (metres)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	NRC ICE TYPE / VISUAL ICE	DEPTH (metres)	SAMPLE TYPE & NO.	SAMPLE CONDITION	SAMPLE RETAINED	o/s 4 m N of 535 OTHER INFORMATION
0.15	Pt		PEAT	Vx					
0.3	SS		VOLCANIC ASH wood bits	Nbe	0.15	C1			Up slope of Duke River: Undisturbed Area
1.5	OL		SILT organics, dark brown	Vs 20-25%		C2			
					1.3	C3			
	ML		SILT (Till) little sand, some gravel to 100 mm, subangular to rounded, greyish brown	Vx 15%	2.1				
				Vs 15-20%		VC1		31	
				Vx 20%	3.2	VC2			N.R.
5.4					5.4				
5.7	ICE+		ICE + SILT	ICE+	5.7				
	ICE		ICE cloudy	ICE					
7.1					7.1	VC3			
	ICE+		ICE + SILT						
9.1					9.1				
	CL		CLAY (Till) silty, little sand, little gravel to 60 mm, subangular low plastic, greyish brown	Nbe		VC4			
10			Bottom of Hole at 10.0 m						

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BOREHOLE LOG

FOOTHILLS PIPE LINES (SOUTH YUKON) LTD.

BOREHOLE NO. 81-01-136

LOGGED BY: SA	DRAWN BY: SB	CHECKED: GNL/RH	DATE: Apr. 29, 1981
RIG: CME 750	METHOD: Auger/CBRSL	START:	FINISH:
PROJECT NO.: K 5500 L	LOCATION: Sta 177+637 (13 m d/s from PI 026-07)		OFFSET: 26m N of SBS

W_p - ⊕ W - ⊙ W_L - ▲

BULK DENSITY (kg/m^3) ●
1200 1400 1600 1800

MOISTURE CONTENT %
20 40 60 80

DEPTH (metres)	SOIL GROUP SYMBOL	STRATA DEPTH (m)	DESCRIPTION	NRC ICE TYPE / VISUAL ICE	DEPTH (metres)	SAMPLE TYPE & NO.	SAMPLE CONDITION	SAMPLE RETAINED	OTHER INFORMATION
	Pt	0.3	PEAT woody, fibrous, trace silt, brown	UF	0.3				
			[illegible]	[illegible]	0.45				
	Pt	1.1	PEAT woody, fibrous, trace silt, brown	Vs 10%	1.1	C1			
			CLAY very silty, green-brown	9%	1.4	C2			Very difficult to auger
	CL		CLAY silty, little gravel, little sand, cobbles, low plastic, grey	6%					
				Nbn	5.7	D1			
						D2			
						D3			
			.. boulder						Auger refusal at 7.6 m
			Bottom of hole at 7.6 m						

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BOREHOLE LOG

FOOTHILLS PIPE LINES (SOUTH YUKON) LTD.

BOREHOLE NO. 81-01-141

LOGGED BY: SA / RGC	DRAWN BY: SB	CHECKED: GNL / RH	DATE: May 30, 1981
RIG: CME 750 / Midwest	METHOD: Auger / Sonic	START: 12:10 hrs 12:15 hrs	FINISH: 14:35 hrs 12:00 hrs
PROJECT NO.: K 5500 L	LOCATION: Sta 178+350; d/s from Duke River		OFFSET: 5m S of SBS (CME) 5m SSS (Midwest)

W_p - ▲ W - ○ W_L - ▲

BULK DENSITY (kg/m^3) ●
1200 1400 1600 1800
MOISTURE CONTENT %
20 40 60 80

DEPTH (metres)	SOIL GROUP SYMBOL	STRATA DEPTH (m)	DESCRIPTION	NRC ICE TYPE / VISUAL ICE	DEPTH (metres)	SAMPLE TYPE & NO.	SAMPLE CONDITION	SAMPLE RETAINED	OTHER INFORMATION
			Sand, little fine sand, trace organics, wet		0.1				
1	GW	1.7	GRAVEL some sand, trace silt, cobbles, boulders, brown	F		VC1 D1			bouncing on cobble, T.R. Very difficult to auger in coarse gravel
	SW		SAND fine to coarse grained, little gravel, trace silt, brown						
2		2.0				VC2		B1'	Grain Size Set casing to 3m. (Midwest) Attempt SPT, bouncing
	GW-GP		GRAVEL and SAND, coarse to fine gravel, medium to coarse-grained sand						
3		3.0			3.0	VC3 D1			Hole caving in at 3.0m
	GW		GRAVEL little sand, trace silt, cobbles, boulders, brown, damp	GF		VC4			(CME) Auger refusal at 4.5 m
4		4.5							
	GW-GM		GRAVEL and SAND trace silt, fine to coarse gravel, coarse to fine-grained sand			VC5			Further attempt by Midwest Sonic drill
5									
6		6.2	---saturated and free-draining---					B2'	Grain Size SPT: No Penetration
	GW		GRAVEL coarse to fine, some coarse to fine-grained sand, (trace silt)			D2			
7						VC6			
8									
9								B3'	Grain Size
						VC7			
10			Bottom of Hole at 10.0 m G.W.L. at 6.2 m on completion of drilling						
11									

WX-1029 BOREHOLES

TEST HOLE LOG

HAMMER WT. 63.5 Kg.
HT. DROP 76 cm.
SAMPLE DATA
DEPTH | TYPE | BLOW/15 cm. | No.

SYMBOL

PERMAFROST
N.R.C. CLASS
N.F. or F.

LOCATION DK 79-29 (Station 3+50W)
ELEVATION

COHESION - Kg./Sq. cm.
0.2 0.6 1.0 1.4 1.8
● FIELD VANE △ LAB VANE ■ UNCONF.

PLASTIC LIMIT | WATER CONTENT | LIQUID LIMIT
% 10 30 50 70 90%

DESCRIPTION OF MATERIAL

DEPTH	TYPE	BLOW/15 cm.	No.	PERMAFROST CLASS	N.F. or F.	DESCRIPTION OF MATERIAL
	C		1	Vx Vr Vs		PEAT -wood fragments -ice lenses to 2 mm
0.8						-dark brown
1.0	C		2	20%		CLAYEY SILT -trace organic silt -some silty sand and little fine gravel in layers -organic pockets and layers -slightly plastic
2.0	Sy		3		NF	
2.3						-grey and brown
2.5						PEAT
	Sy		4			CLAYEY SILT -trace organic silt -some fine to medium-grained sand -organic pockets -slightly plastic
3.0						
3.5						-grey
4.0	Sy		5			
5.0					NF	
	SS	2 11 13	6			SILT and CLAY -and well graded sand -little fine to medium-grained gravel -pockets of silt -trace of organics -low plastic -grey (TILL)
6.0						
7.0	SS	11 16 24	7			
8.0						
	SS	13 25 32	8		NF	
9.0						
9.5						SAND -fairly well graded -trace to little fine to coarse-grained gravel -trace of silt -grey
10.0	SS	30	9			

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JOB No. AL1138
PROJECT Alaska Highway Gas Pipeline
LOCATION Yukon Territory

TEST HOLE LOG

HAMMER WT. 63.5 kg. | HT DROP 76 cm. | SAMPLE DATA: DEPTH, TYPE, BLOW/15 cm., No. | SYMBOL | PERMAFROST: N.R.C. CLASS, N.F. or F. | LOCATION DK 79-29 (Station 3+50W) | ELEVATION | COHESION - kg./sq. cm. (0.2, 0.6, 1.0, 1.4, 1.8; ● FIELD VANE △ LAB VANE ⊟ UNCONF.)

DEPTH	TYPE	BLOW/15 cm.	No.	SYMBOL	N.R.C. CLASS	N.F. or F.	DESCRIPTION OF MATERIAL	PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10, 30, 50, 70, 90%)
	SS	88	9			NF	10:25 SAND - as above	⊙
11.0							BOTTOM OF HOLE	

NOTE:

1. Water encountered at 9.8 metres during drilling.

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JOB No. AL1138
PROJECT Alaska Highway Gas Pipeline
LOCATION Yukon Territory
HOLE No. 79-30

TEST HOLE LOG

HAMMER WT. 63.5 Kg.
HT. DROP 76 cm.
SAMPLE DATA
DEPTH | TYPE | BLOWS/6" | No.
SYMBOL
PERMAFROST
N.R.C. CLASS | N.F. or F.
LOCATION DK 79-29 (Station 1+15W)
ELEVATION
COHESION - Kg./Sq. cm.
0.2 0.6 1.0 1.4 1.8
● FIELD VANE △ LAB VANE ☐ UNCONF.
PLASTIC LIMIT | WATER CONTENT | LIQUID LIMIT
10 30 50 70 90%

DEPTH	TYPE	BLOWS/6"	No.	N.R.C. CLASS	N.F. or F.	DESCRIPTION OF MATERIAL
	C		1			0.1 ORGANIC SILT
1.0	B		2	Nbn		GRAVEL -fine to coarse-grained -little to some sand 1.0 -trace of silt; dark grey
2.0	B		3		NF	SAND and GRAVEL -well graded -fine to medium gravel -trace of clayey silt 2.2 -dark grey
3.0	SS	3/3/3	4			CLAYEY SILT -little sand in pockets -trace of fine gravel -organic layers 3.3 -slightly plastic -dark grey
4.0	Sy		5			ORGANIC SILT -little to some organics in layers 4.2 -trace fine-grained sand -wood fragments -dark brown to black
5.0					NF	
6.0	SS	5/5/5	6			SAND -fairly well graded -and low plastic silt and clay -some fine to medium-grained gravel -grey
7.0	DSy		7			
8.0						
	DSy		8			
9.0					NF	
10.0	SS	3	9			

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JOB No. AL1138
PROJECT Alaska Highway Gas Pipeline
LOCATION Yukon Territory

TEST HOLE LOG

HAMMER WT. 63.5 kg. | HT. DROP 76 cm. | SAMPLE DATA | SYMBOL | PERMAFROST | LOCATION DK 79-29 (Station 1+15W) | ELEVATION | COHESION - kg./Sq. cm. (0.2 0.6 1.0 1.4 1.8; ● FIELD VANE △ LAB VANE ☐ UNCONF.)

DEPTH	TYPE	BLOWS/15 cm.	No.	SYMBOL	N.R.C. CLASS	N.P. or P.	DESCRIPTION OF MATERIAL	PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 30 50 70 90%)
	SS	2	9			NP	10.25 SAND - as above	①
11.0							BOTTOM OF HOLE	

NOTE:

1. Water encountered at 5.3 metres during drilling.

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JOB No. AL1138
PROJECT Alaska Highway Gas Pipeline
LOCATION Yukon Territory

TEST HOLE LOG

HAMMER WT. 63.5 kg. | WT. DROP 76 cm. | SAMPLE DATA | PERMAFROST | LOCATION DK 79-29 (Sta. 14+35W O/S) | ELEVATION | COHESION - kg./Sq. cm. (0.2, 0.6, 1.0, 1.4, 1.8; ● FIELD VANE △ LAB VANE ET UNCONF.)

DEPTH	TYPE	BLOW/15 cm	No.	SYMBOL	N.R.C. CLASS	N.F. or F.	DESCRIPTION OF MATERIAL	PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (x — o — x)
					ICE		0.3 ICE	
							PEAT -some organic silt -ice lenses to 1 cm	
1.0	C		1		Vr		1.0	
							1.2 ORGANIC SILT -some fine-grained gravel -little sand; roots -wood fragments	
						NF		
2.0	SS	17 27 21	2		Vx Nbn		2.1 SAND -poorly graded -some fine to medium-grained gravel -trace to little silt -trace organic silt -dark grey	
	SS	9 10 15	3		Nbn			
3.0								
4.0	SS	9 23 23	4		Nbn Vx		SILT and CLAY -little to some sand -trace fine to medium gravel; trace organics -layered -slight to low plastic -dark grey	
							4.5	
5.0								
	SS	9 14 17	5		Vs			
6.0							SILT and CLAY and SAND -sand is fine to medium -trace of coarse sand and fine-grained gravel -trace organic silt -layers of silty sand -organic pockets and layers -ice lenses to 5 mm -low plastic -grey	
7.0	SS	15 21 26	6		Vs Vr			
8.0								
	SS	25 26 23	7		Vs Vr			
9.0							GRAVEL -fine to medium-grained -some sand -trace to little silt -grey	
							9.8	
10.0	SS	17	8					

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JOB No. AL1130
PROJECT Alaska Highway Gas Pipeline
LOCATION Yukon Territory
HOLE No. 708-74

TEST HOLE LOG

HAMMER WT. 63.5 Kg.	SYMBOL	PERMAFROST	LOCATION DK 79-29 (Sta. 14+35W O/S)	COHESION - Kg./Sq. cm.	
HT. DROP 76 cm.			ELEVATION	0.2 0.6 1.0 1.4 1.8 ● FIELD VANE △ LAB VANE □ UNCONF	
SAMPLE DATA		N.R.C.	N.P. or P.	DESCRIPTION OF MATERIAL	PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT
DEPTH TYPE BLOW/15cm. No.		CLASS			10 30 50 70 90%
33 HQR 3 No. 4		FVM4	10.1	GRAVEL - as above	
				BOTTOM OF HOLE	
11.0					

NOTE:

1. Water encountered at 1.4 metres during drilling.

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JOB No.	AL1136
PROJECT	Alaska Highway Gas Pipeline
LOCATION	Yukon Territory
HOLE No.	79B-24

TEST HOLE LOG

HAMMER WT. 63.5 kg. — HT. DROP 76 cm.

LOCATION DK 79-29 (Sta. 9+40W 0/S)

ELEVATION

COHESION - kg./Sq. cm. — 0.2 0.6 1.0 1.4 1.8 — ● FIELD VANE △ LAB VANE □ UNCONF.

SAMPLE DATA DEPTH	TYPE	BLOW/15 cm.	No.	SYMBOL	PERMAFROST N.R.C. CLASS	PERMAFROST N.F. or F.	DESCRIPTION OF MATERIAL	PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 30 50 70 90%)
	C		1		Vs, Vr 25%		PEAT -pockets of organic silt and fine to coarse sand -ice lenses to 1 cm	
0.8								
1.0	C		2		Vx Vs, Vr		SAND -fine to coarse-grained -trace to little silt -trace gravel -ice lenses to 3 mm -grey and brownish grey	
1.5								
2.0	SS	3, 4, 5	3					
	SS	3, 4, 5	4			NF	CLAYEY SILT -and fine to coarse sand -trace organic silt -trace fine-grained gravel -slightly plastic -dark grey	
3.0								
3.0								
4.0	SS	6, 12, 18	5					
					Vs, Vr		CLAYEY SILT -trace organic silt -little fine to medium sand -wood fragments -slightly plastic -ice lenses to 20 mm -dark grey	
5.0								
5.3								
	SS	17, 30, 50	6		Vs		SILT and CLAY -trace organic silt -trace to little sand -small lenses and layers of fine gravel and sand -pockets of organics -low plastic -ice lenses to 15 mm -dark grey	
6.0								
7.0	SS	16, 19, 34	7		Vs			
7.4								
8.0							GRAVEL -fine to medium-grained -some silt and clay -little sand -low plastic -grey	
	SS	110	8		Vx			
9.0								
10.0	SS	125	9		Vx		10.0 BOTTOM OF HOLE	

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JOB No. AL1138

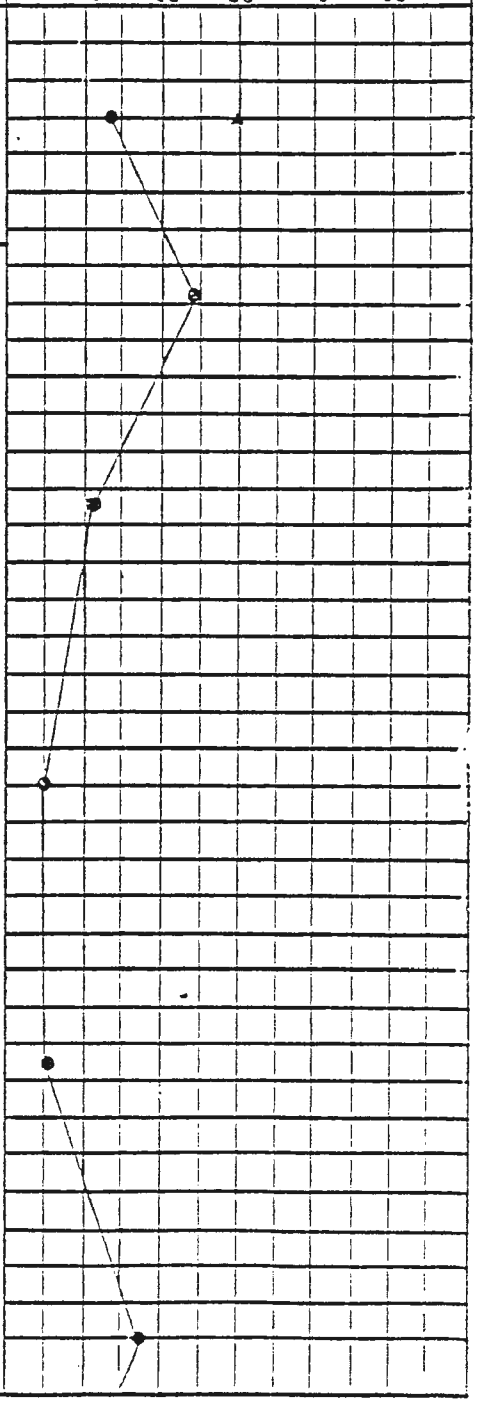
PROJECT Alaska Highway Gas Pipeline

LOCATION Yukon Territory

BOREHOLE LOG – PERMAFROST

DEPTH (metres)	SOIL DESCRIPTION	SAMPLE	GROUND ICE DESCRIPTION
0	SILT AND SAND(ML) - trace clay and gravel, some silt layers, very dark grey (5Y 3/1), dark grey (5Y 4/1)		Nbn
		C	
1			
	- black (5Y 2.5/1)		NOT FROZEN
2			
		S	PP=360kPa
3			
	(ALLUVIAL)		
4	SAND(SM) - gravelly, some silt, clasts to 20mm	S	PP=420kPa
5	(ALLUVIAL)		
	SAND AND GRAVEL(SP) - trace silt, subangular clasts to 35mm, very dark grey (5Y 3/1)	G	
6			
	(ALLUVIAL)		
7	SAND(SM) - silty, gravelly	S	

BULK DENSITY (Mg/m³) ▲
1.4 1.6 1.8 2.0 2.2
MOISTURE CONTENT
10 20 30 40 50



eca

SFC. ELEVATION (m)	DATE DRILLED 15/04/80	BOREHOLE No. 80-01-78
COMPLETION DEPTH (m) 10.43	LOGGED BY TJ	
DRILLING RIG CME 750	LOCATION GS 60/5+60	PAGE 1 OF 2

This log is a compilation of numerous comments and lab or field testing which may have been made as well as those taken while testing of samples from the borehole. Soil zones

BOREHOLE LOG – PERMAFROST

DEPTH (metres)	SOIL DESCRIPTION	SAMPLE	GROUND ICE DESCRIPTION
8	SAND(SM) - silty, gravelly, subangular clasts to 35mm, very dark grey (5Y 3/1)	S	NOT FROZEN
	(ALLUVIAL)		
9	GRAVEL AND SAND(GW) - sub-angular clasts to 60mm, very dark grey (5Y 3/1)		
	(ALLUVIAL)		
10	SILT(ML) - gravelly, dense, stiff (TILL)?		
	END OF HOLE		
11			
12			
13			
14			

BULK DENSITY (Mg/m^3) ▲
1.4 1.6 1.8 2.0 2.2
MOISTURE CONTENT
10 20 30 40 60

eca

SFC ELEVATION (m)	DATE DRILLED 15/04/80
COMPLETION DEPTH (m)	LOGGED BY TJ
DRILLING RIG CME 750	LOCATION GS 60/5+60

BOREHOLE No. 80-01-78

PAGE 2 OF 2

This log is a compilation of subsurface conditions and should not be used separately from the report. Soil types have been determined according to commonly accepted practice. The change from one type to another is indicated on the log, but may be transitional and dependent on future Groundwater conditions refer only to those observed at the times and dates indicated and may vary with time. [illegible]

BOREHOLE LOG – PERMAFROST

DEPTH (metres)	SOIL DESCRIPTION	SAMPLE	GROUND ICE DESCRIPTION
0	PEAT - dark brown (ORGANIC)		
	SAND, SILT, AND GRAVEL - trace clay, rounded clasts to 25mm, olive (5Y 4/3), light olive grey (5Y 6/2)	C	Vs 50%
1			
	- subrounded clasts to 50mm - low plastic fines	C	Vs 15%
2			
	- olive grey (5Y 5/2), light olive grey (5Y 6/2)	C	Vs 5-10%
3	- light grey (5Y 7/2)	C	Vs 0-5%
4			
		G	
5			
	- very dense, dark grey (5Y 4/1)	G	
	(TILL)		NOT FROZEN
6		G	
	SAND(SM) - silty, some clay, trace gravel, subrounded clasts to 5mm, dark grey (5Y 4/1)		
		G	
7			
	(TILL)		

BULK DENSITY (Mg/m^3) ▲
1.4 1.6 1.8 2.0 2.2
MOISTURE CONTENT
10 20 30 40 50
65

SFC. ELEVATION (m)	DATE DRILLED 14/04/80	BOREHOLE No.
COMPLETION DEPTH (m) 10.0	LOGGED BY TJ	80-01-79
DRILLING RIG CME 750	LOCATION GS60/10+80	PAGE 1 OF 2

This log is a representation of subsurface conditions and the stratigraphic boundaries indicated on the log are based on visual examination and laboratory testing of samples from the boreholes. Soil zones have been interpreted according to Community Account of ECA. The actual transition between zones may be gradual as indicated on the log, may be transitional and discontinuous in nature.

BOREHOLE LOG – PERMAFROST

DEPTH (metres)	SOIL DESCRIPTION	SAMPLE	GROUND ICE DESCRIPTION	BULK DENSITY (Mg/m^3) ▲ 1.4 1.6 1.8 2.0 2.2 / MOISTURE CONTENT 10 20 30 40 50
8	SAND (SM) - silty, some clay, trace gravel, subrounded clasts to 5mm, dark grey (5Y 4/1)	G	NOT FROZEN	
9				
10	(TILL)	G		
	END OF HOLE			
11				
12				
13				
14				

eca

SFC. ELEVATION (m)	DATE DRILLED 14/04/80	BOREHOLE No. 80-01-79
COMPLETION DEPTH (m) 10.0	LOGGED BY TJ	
DRILLING RIG CME 750	LOCATION GS 60/10+80	PAGE 2 OF 2

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GEOTECHNICAL DIVISION

BOREHOLE LOG

FOOTHILLS PIPE LINES (YUKON) LTD.

BOREHOLE NO. 80-11-117

LOGGED BY:	DRAWN BY:	CHECKED:	DATE: Sept. 15, 1980
RIG: CME 750	METHOD: Auger/CFA	START: 7:30 hrs.	FINISH:
PROJECT NO. K5327A060	TERRAIN TYPE:	LOCATION: 80-11-33-46/0-60	

W_p - ⊕ W - ⊙ W_L - ▲

BULK DENSITY (kg/m^3) ●
1200 1400 1600 1800

MOISTURE CONTENT %
20 40 60 80

DEPTH (metres)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	NRC ICE TYPE VISUAL ICE	DEPTH (metres)	SAMPLE TYPE & NO.	SAMPLE CONDITION	SAMPLE RETAINED	OTHER INFORMATION
0.0	Pt		PEAT fine, woody, some silt, brown, rootlets	Gr	0.3				Undisturbed Area
1.5	Mt		SILT sandy, peat inclusions, grey-brown occasional pieces of wood	Vx-Vs 20%	1.2	G1	G1	G1	
3.1	GM		GRAVEL some sand, some silt, sub-angular gravel to 75 mm, occasional pieces of wood	Vx <5%	3.1	G2	G2	G2	
3.6	SM		SAND silty, peat inclusions, some stained, grey, occasional pieces of wood	Vs-Vx 5%	3.6	G3	G3	G3	
4.7	GM		GRAVEL some sand, some silt, gravel sizes to 75 mm, grey	Mbe					
6.3	SM		SAND some silt, little gravel		6.3	S1			Grain Size
8.1	Cl		CLAY silty, peat inclusions, occasional subangular gravel sizes to 15 mm, low to medium plastic, grey, occasional pieces of wood	Vx 5% Mbe	8.1	S2			
9.7	GM		GRAVEL some sand, some clayey silt, gravel sizes to 15 mm, grey			S3			
			Bottom of hole at 9.85 m						

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BOREHOLE LOG

FOOTHILLS PIPE LINES (YUKON) LTD.

BOREHOLE NO. 80-11-113

LOGGED BY: [illegible]	DRAWN BY: [illegible]	CHECKED: [illegible]	DATE: Sept. 15, 1980
RIG: CME 750	METHOD: [illegible]	START: 12:10 hrs.	FINISH:
PROJECT NO.: K 5327 A060	TERRAIN TYPE:	LOCATION: SBS 2005+79	

W_p = ▲ W = ● W_L = ▲

BULK DENSITY (kg/m³) ● 1200 1400 1600 1800

MOISTURE CONTENT % 20 40 60 80

DEPTH (metres)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	NRC ICE TYPE VISUAL ICE	DEPTH (metres)	SAMPLE TYPE & NO.	SAMPLE CONDITION	SAMPLE RETAINED	o/s 24 m N of SBS (80-01-GS-60) OTHER INFORMATION
0	PT		PEAT woody, some silt, black roots — organic, fine grained sand pockets, dark brown, pieces of wood	Vx/Vs 40%	0.3	C1		C1	Undisturbed Area
1.4	SM		SAND some silt, low to non plastic, grey, pieces of wood	35%	1.2	C2		C2	
2.0	GC		GRAVEL some silty clay, brown — silty sand layer, 100 mm	Vx/Vs 10% Vx 5%	2.0	C3		C3	
2.7	CL		CLAY silty, low plastic, grey	Vx/Vs 30%	2.7	C4		C4	
3.7	GC		GRAVEL some clayey silt, brown to black	Vx/Vs 10% Vbe	3.7	C5		C5	
4.2	CL		CLAY silty, occasional peat inclusions low plastic, grey	Vx/Vs 5%	4.2	C6		C6	
4.6	GM		GRAVEL little clayey silt, subangular gravel to 15 mm, grey-brown	Vx 5%	4.6	C7		C7	
5.1	CL		CLAY silty, occasional peat inclusions low plastic, grey	Vx/Vs 5% Vbe	5.1	C8		C8	
5.7	SM		SAND silty, trace clay, laminated, trace sand		5.7				
6.0	GM		GRAVEL sandy, little silt, gravel to [illegible]	Vx 5%	6.0	C9		C9	
6.4	SM		SAND silty, trace clay, laminated, occasional gravels, brown	Vbe	6.4	C10		C10	
7.0	GM		GRAVEL little clayey silt, subangular gravel to 12 mm, grey-brown	Vbe	7.0	C11		C11	
7.2	SM		SAND little clay, low plastic	Vx 10% <5%	7.2	C12		C12	
8.1	CL		CLAY silty, occasional peat inclusions low plastic, grey-brown	Vbe	8.1				
8.7	GM		GRAVEL some clayey silt, gravel to 75 mm, grey, occasional pieces of wood	Vx <5%	8.7				
9.3	SM		SAND fine grained, uniform						
			GRAVEL little clayey silt, gravel to 75 mm, grey, rust stains						
10.0			Bottom of hole at 10.0 m Thermistor string #11 installed 9 m length, top at 1.1 m						

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BOREHOLE LOG

FOOTHILLS PIPE LINES (YUKON) LTD.

BOREHOLE NO. 80-11-119

LOGGED BY: CR	DRAWN BY: ML	CHECKED: [illegible]	DATE: Sept. 17 1980
RIG: [illegible] 750	METHOD: Auger	START: 13:15 hrs	FINISH:
PROJECT NO.: K 5327 A060	TERRAIN TYPE:	LOCATION: [illegible]	

W_p - ▲ W - ● W_L - ▲

BULK DENSITY (kg/m^3) ●
1200 1400 1600 1800

MOISTURE CONTENT %
20 40 60 80

DEPTH (metres)	SOIL GROUP SYMBOL	SOIL GRAPHIC LOG	DESCRIPTION	NRC ICE TYPE VISUAL ICE	DEPTH (metres)	SAMPLE TYPE & NO.	SAMPLE CONDITION	SAMPLE RETAINED	OTHER INFORMATION
0									Undisturbed area
1	SM		SAND little gravel, little silt, subangular gravel to 75 mm, occasional pieces of wood	GF					
			--- gravel to 25 mm, dark grey, occasional pieces of wood					31	Grain Size
2									
			--- sub-angular gravel to 25 mm, occasional pieces of wood						
3									
	CL		CLAY (Till) silty, little sand, gravel to 25 mm, low plastic, brown, sand pockets						88% finer than #200 Sieve
								32	N=12
4									trace of water in hole at 3.8 m
5									
			--- gravel to 75 mm, grey-brown, rust stains, sand pockets						N=17
6									
	SM		SAND (Till) some silt, trace clay, occasional subangular gravel and cobbles, non to low plastic, brown						
7									150 mm + 14
	CL		CLAY (Till) silty, some sand, occasional subangular gravel and cobbles, low plastic, brown						
8									
									150 mm + 37
9									
			--- blue-grey,						
10									150 mm +45
			Bottom of Hole at 10.1 m						
11									

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BOREHOLE LOG

FOOTHILLS PIPE LINES (SOUTH YUKON) LTD.

BOREHOLE NO. 81-01-152

LOGGED BY: MCE	DRAWN BY: CG	CHECKED: GNL/RM	DATE: Apr. 13, 1981
RIG: [illegible]	METHOD: Auger/CORE	START: 13:30 hrs.	FINISH: 15:40 hrs.
PROJECT NO.: K 5500 L	LOCATION: Sta 199+734 (9 m u/s from PI 029-06 R2)		OFFSET: 26 m N of SBS

W_p - ⊕ W - ⊙ W_L - ⊿

BULK DENSITY (kg/m^3) ●
1200 1400 1600 1800

MOISTURE CONTENT %
20 40 60 80

DEPTH (metres)	SOIL GROUP SYMBOL	STRATA DEPTH (m)	DESCRIPTION	NRC ICE TYPE VISUAL ICE	DEPTH (metres)	SAMPLE TYPE & NO.	SAMPLE CONDITION	SAMPLE RETAINED	OTHER INFORMATION
0	Pt	0.8	PEAT woody, fibrous	F	0.8				
1	OL		ORGANIC SILT, clayey, roots, dark grey, ice lenses to 2 mm	Vr 20%		D1	D1		CORE at 1.2 m
						C1	C1		
2		2.1			2.1				Auger at 2.3 m
	CL-ML		CLAY (Till) silty, some sand, some gravel to 20 mm, slight plasticity, brown	10%					
3									
4						D2			
5					5.0				
			numerous cobbles	UF		D3			N.R.
6					6.6				
7				Vr 1%		D4			
8									
9									
10			Bottom of hole at 10.0 m Standpipe installed, tip at 10.0 m						Augering very difficult from 7 to 10 m.
11									

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BOREHOLE LOG

FOOTHILLS PIPE LINES (SOUTH YUKON) LTD.

BOREHOLE NO. 81-91-132(3)

LOGGED BY: [illegible]	DRAWN BY: [illegible]	CHECKED: [illegible]	DATE: Aug. 17, 1981
RIG: [illegible]	METHOD: Auger/Core	START: [illegible]	FINISH: 11:45 hrs.
PROJECT NO.: K 5500 L	LOCATION: Sta 200+446, Pl 320+78 P2		OFFSET: 26 m N of BBS

W_p = ⊕ W = ⊖ W_L = ⊗

BULK DENSITY (kg/m^3) ⊕ 1200 1400 1600 1800

MOISTURE CONTENT % 20 40 60 80

DEPTH (metres)	SOIL GROUP SYMBOL	STRATA DEPTH (m)	DESCRIPTION	NRC ICE TYPE VISUAL ICE	DEPTH (metres)	SAMPLE TYPE & NO.	SAMPLE CONDITION	SAMPLE RETAINED	OTHER INFORMATION
	Pt	0.3	PEAT woody, fibrous	F	0.3				
1	CL		CLAY (Till) silty, little fine sand, little gravel, low plastic, occasional cobbles, brown	Vx-Vr 8%	1.0	D1		D1	
			trace gravel						CORED at 1.3 m
2				Vc 5%		C1		C1	
			peat layer (100 mm)		2.4				
3				Vs 20%		C2		C2	
						C3		C3	
4		4.4				C4		C4	
	Pt	4.8	PEAT		4.8				
5			CLAY some gravel, low plastic	10%	5.0	C5			Auger at 5.0 m
	CL		CLAY silty, trace fine sand, trace gravel to 25 mm, grey	F					
6									
7									
8									
9									
10			Bottom of hole at 10.3 m						
11									

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BOREHOLE LOG

FOOTHILLS PIPE LINES (SOUTH YUKON) LTD.

BOREHOLE NO. 81-01-153

LOGGED BY: [illegible]	DRAWN BY: [illegible]	CHECKED: [illegible]	DATE: Apr. 21, 1981
RIG: [illegible]	METHOD: [illegible]	START: 08:10 hrs.	FINISH: 11:20 hrs.
PROJECT NO.: K 5500 L	LOCATION: KP 201.2		OFFSET: 26 m N of SBS

W_p - ⊟ W - ⊙ W_L - ⊿

BULK DENSITY (kg/m^3) ●
1200 1400 1600 1800
MOISTURE CONTENT %
20 40 60 80

DEPTH (metres)	SOIL GROUP SYMBOL	STRATA DEPTH (m)	DESCRIPTION	NRC ICE TYPE VISUAL ICE	DEPTH (metres)	SAMPLE TYPE & NO.	SAMPLE CONDITION	SAMPLE RETAINED	OTHER INFORMATION
0	GM		GRAVEL and SAND little silt	UF					
1									
2						B1		B1	Grain Size
3									
4			some silt, little medium sand			B2		B2	Grain Size
5		5.2							
	ML		SILT (Till) trace gravel, trace fine sand, brown, moist, hard			D1		D1	100 for 300 mm I_p < 4 = NP
6									
									I_p < 4 = NP
7						D2		D2	100 for 150 mm
						B3		B3	
8			numerous cobbles						
						D3			N.R.
9									
10									Auger very difficult from 8 to 13 m
11			Bottom of hole at 13.0 m Standpipe installed, tip at 13.0 m						

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BOREHOLE LOG

FOOTHILLS PIPE LINES (SOUTH YUKON) LTD.

BOREHOLE NO. 81-01-140

LOGGED BY: SA / RGC	DRAWN BY: SB	CHECKED: GNL / RH	DATE: Apr. 29, 1981 May 30, 31, 1981
RIG: CME 750 / Midwest	METHOD: Auger / Sonic	START: 10:15 hrs 16:30 hrs (May 30)	FINISH: 12:30 hrs 09:30 hrs (May 31)
PROJECT NO.: K 5500 L	LOCATION: Sta 178+042		OFFSET: 26m N of SBS

W_p - ⊕ W - ⊙ W_L - ▲

BULK DENSITY (kg/m^3) ●
1200 1400 1600 1800

MOISTURE CONTENT %
20 40 60 80

DEPTH (metres)	SOIL GROUP SYMBOL	STRATA DEPTH (m)	DESCRIPTION	NRC ICE TYPE VISUAL ICE	DEPTH (metres)	SAMPLE TYPE & NO.	SAMPLE CONDITION	SAMPLE RETAINED	OTHER INFORMATION
	GM	0.5	GRAVEL some sand, some silt, cobbles, boulders, damp	OF					
	GW-GM		GRAVEL and SAND trace silt, fine to coarse gravel, coarse to fine-grained sand, cobbles, boulders			VC1			
1						D1			bouncing on boulder, N.R.
2						VC2		B1"	Grain Size very hard drilling
		2.4				D2			bouncing on boulder, N.R.
	SW		GRAVEL and SAND (trace silt) rounded to subangular fine to coarse gravel, coarse to medium-grained sand, cobbles			VC3 D1			set 3.0 m casing, SPT N.R.
3									CME Auger refusal, 2 attempts at 3.8 m
4			water level			VC4		B2"	3rd attempt by Midwest Sonic Grain Size
5						VC5			Saturated and draining below water table at depth 4.6 m
		6.0				D2			Set casing to 6.0 m, attempt SPT, too coarse
6	GW-GM		GRAVEL coarse to fine, some medium to coarse-grained sand, trace silt			VC6		B3"	B3", Grain Size
7						VC7			Samples dried by Sonic mode and difficult drilling
		7.5							
8	GP-GW		GRAVEL coarse to fine, some fine to coarse-grained sand (trace silt)					B4"	Grain Size $C_c > 3$
9						VC8			
10			Bottom of Hole at 10.0 m						
11									

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BOREHOLE LOG

FOOTHILLS PIPE LINES (SOUTH YUKON) LTD.

BOREHOLE NO. 81-01-139

LOGGED BY: [illegible]	DRAWN BY: SB	CHECKED: GHL/PH	DATE: Aug. 28, 29, 1981
RIG: CME 750	METHOD: Auger/CORING	START:	FINISH:
PROJECT NO.: K 5500 L	LOCATION: Sta 177+930 (130 m d/s of PI at 177+700)		OFFSET: 26m N of SBS

W_p - ▫ W - ⊙ W_L - ▲

BULK DENSITY (kg/m^3) ●
1200 1400 1600 1800

MOISTURE CONTENT %
20 40 60 80

DEPTH (metres)	SOIL GROUP SYMBOL	STRATA DEPTH (m)	DESCRIPTION	NRC ICE TYPE VISUAL ICE	DEPTH (metres)	SAMPLE TYPE & NO.	SAMPLE CONDITION	SAMPLE RETAINED	OTHER INFORMATION
	Pt	0.3	PEAT woody, fibrous, brown	UT					
	VA(?)	0.4	VOLCANIC ASH	Nbe	0.3				
	Pt		PEAT woody, fibrous, trace silt, brown, pieces of partially decayed wood	Vs 7%					CRREL at 0.7 m
		1.4			1.4	C1	C1	C1	
	OL		ORGANIC SILT trace fine sand, olive grey	6%		C2	C2	C2	
		2.2			2.2	C3			
	ML		SILT (TILL) little gravel, little sand, cobbles, occasional boulders	Vs-Vc 4%					Auger at 2.5 m
				1%	3.0				
						01			
						02			
						03			
				Nbn	9.3				
						04		04	
			Bottom of hole at 10.1 m						

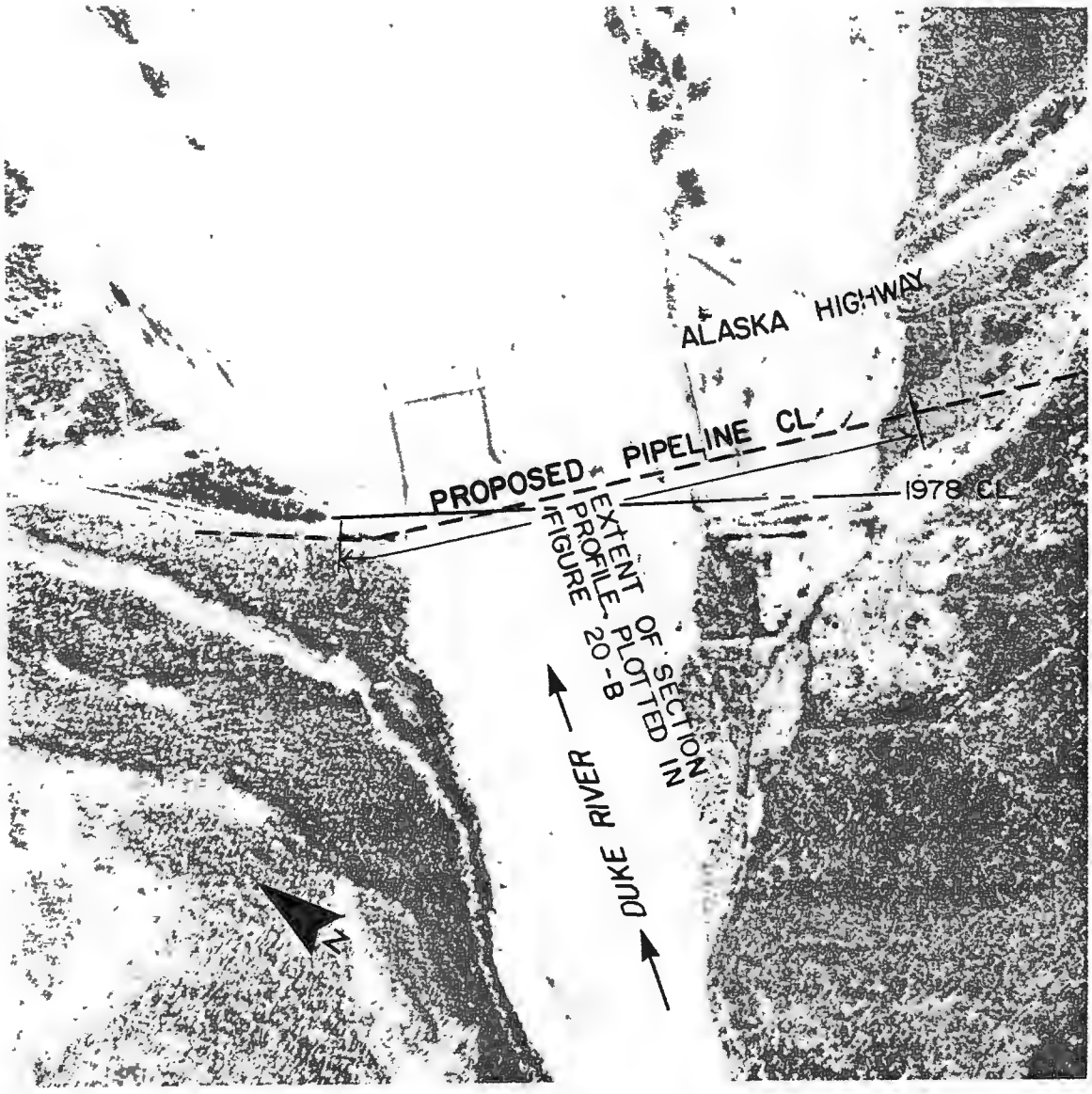
258 140 143

APPENDIX 2

EXTRACTS FROM STREAM SURVEY CROSSING DESIGN REPORT

- DUKE RIVER

- WX-1029



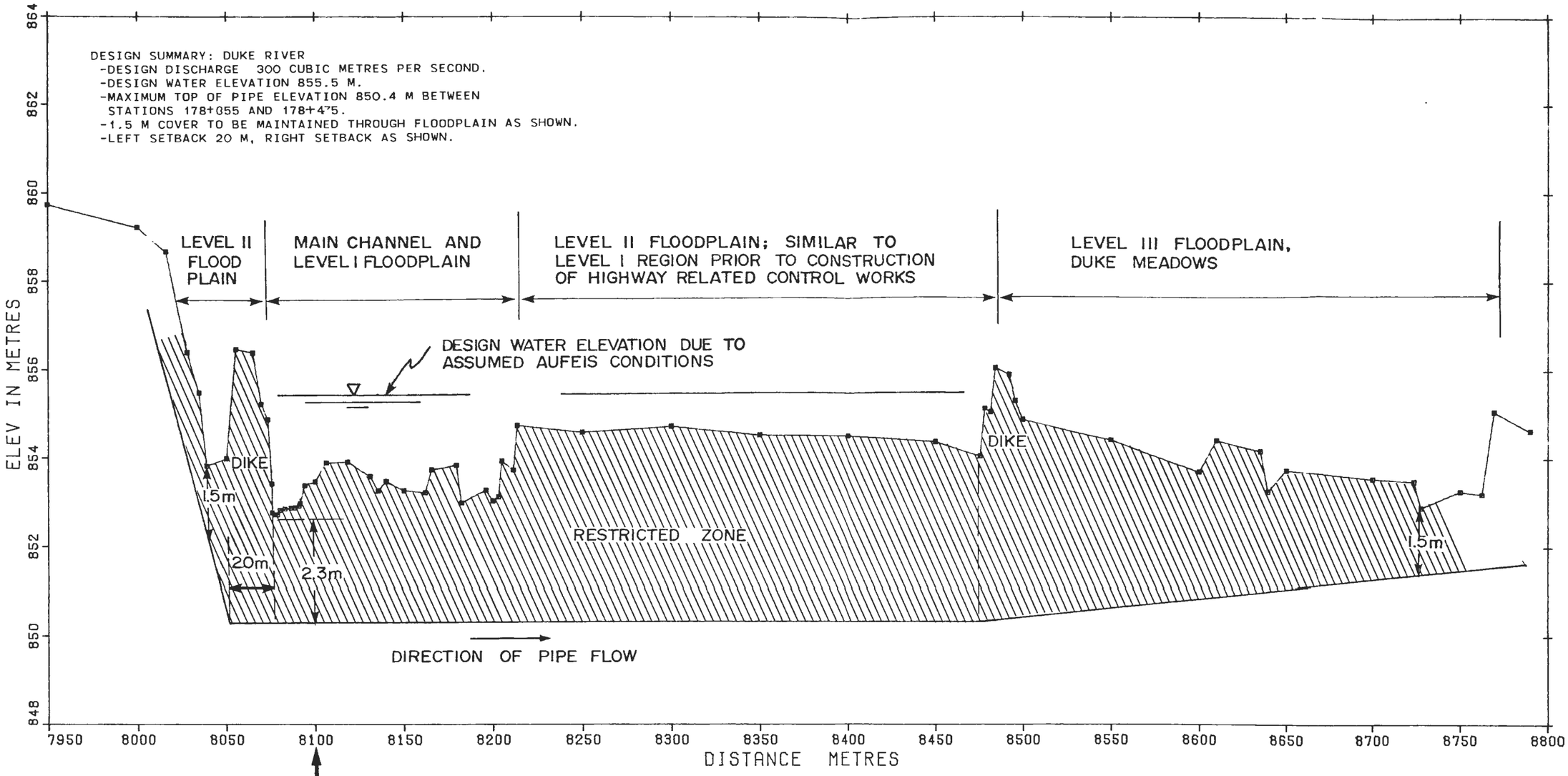
SCALE 1:10,000

FIGURE 20-A

DUKE RIVER KP 178.1 LOCATION PLAN

THE ALASKA HIGHWAY GAS PIPELINE PROJECT
FOOTHILLS PIPELINES (SOUTH YUKON) LIMITED

FILE: 80-443
northwest hydraulic consultants limited



NOTES:

1. NO PORTION OF PIPE OR WEIGHTS TO BE CONSTRUCTED WITHIN RESTRICTED ZONE.
2. RESTRICTED ZONE ASSUMES NO BEDROCK PRESENT; IF ENCOUNTERED, TOP OF PIPE TO BE 1 M BELOW COMPETENT BEDROCK SURFACE UNLESS RESULTANT ELEVATION IS BELOW RESTRICTED ZONE.
3. SETBACK ALLOWANCES TO BE REFERENCED FROM CONSTRUCTED CROSSING APPROACH SLOPE, SHOULD THIS DIFFER FROM EXISTING NATURAL SLOPE.
4. SECTION SURVEYED BY HJA ON JULY 13, 1980; CROSSING WX1-026
5. SECTION PLOTTED VIEWING DOWNSTREAM.
6. EXTENT OF DESIGN SECTION SHOWN ON FIGURE 20-A.

VERTICAL EXAGGERATION 25X

SCALES: 1:100 VERTICAL
1:2500 HORIZONTAL

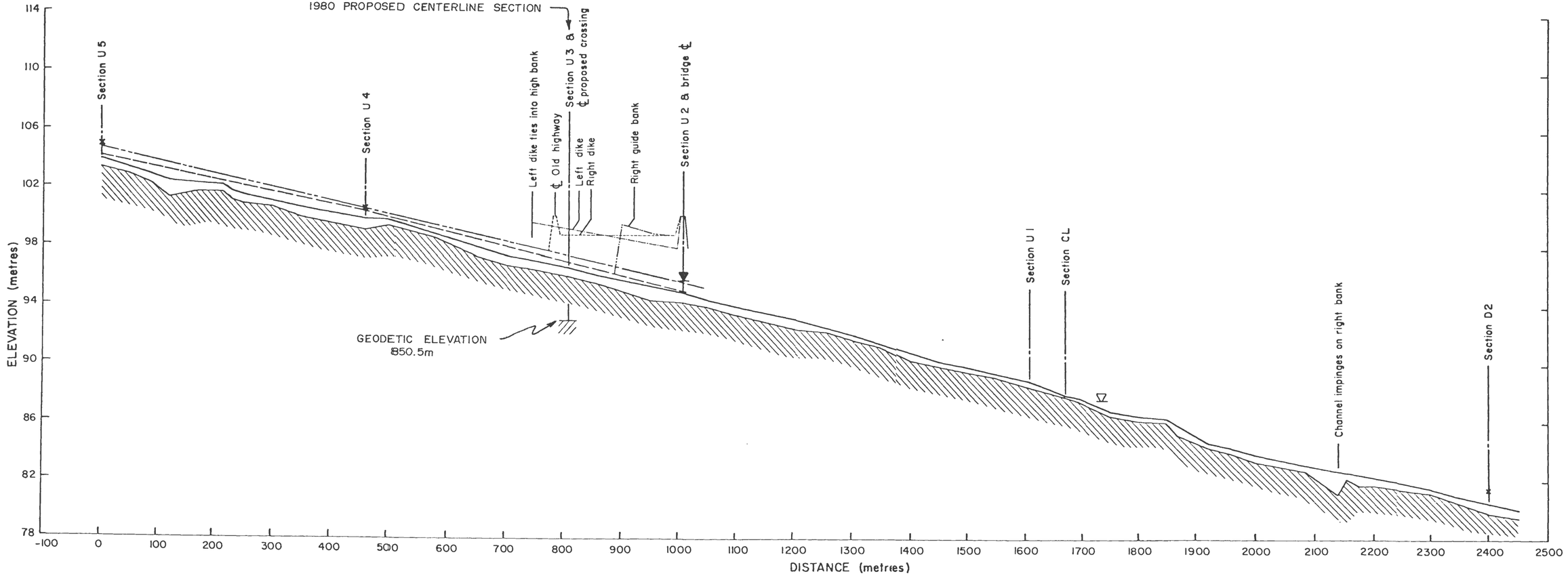
FIGURE 20-B

DUKE RIVER KP 178.1
DESIGN CENTERLINE SECTION

THE ALASKA HIGHWAY GAS PIPELINE PROJECT
FOOTHILLS PIPELINES (SOUTH YUKON) LIMITED

FILE: 80-443

northwest hydraulic consultants limited



LEGEND

- Channel thalweg
- Water level on date of survey
- Approximate bankfull stage, Q = 85 m^3/sec.
- Pipeline design flood level, Q = 300 m /sec.
- Design top of pipe elevation
- Historic high water mark
- Highway design high water level shown on 1954 bridge plans
- April 1978 top of ice elevation

NOTES

1. Channel thalweg and water surface surveyed by Northwest Hydraulic Consultants Ltd., June 26, 1978.
2. All elevations are relative to benchmark G.S.C. 78Y556: brass plug on north east corner of bridge abutment on right (east) bank; assigned elevation = 100.00 metres.
3. Longitudinal distances are measured along the main sub-channel. See figure E-1 for location.
4. Figure reproduced from (NHCL/RMH, 1978), "Design Documentation for Eleven Selected South Yukon Stream Crossings" Report submitted to Foothills Pipe Lines (South Yukon) Ltd. November 1978.
5. Elevation of benchmark G.S.C. 78Y556 is 857.596 m; add 757.6m to assumed 1978 elevations to convert to geodetic datum.

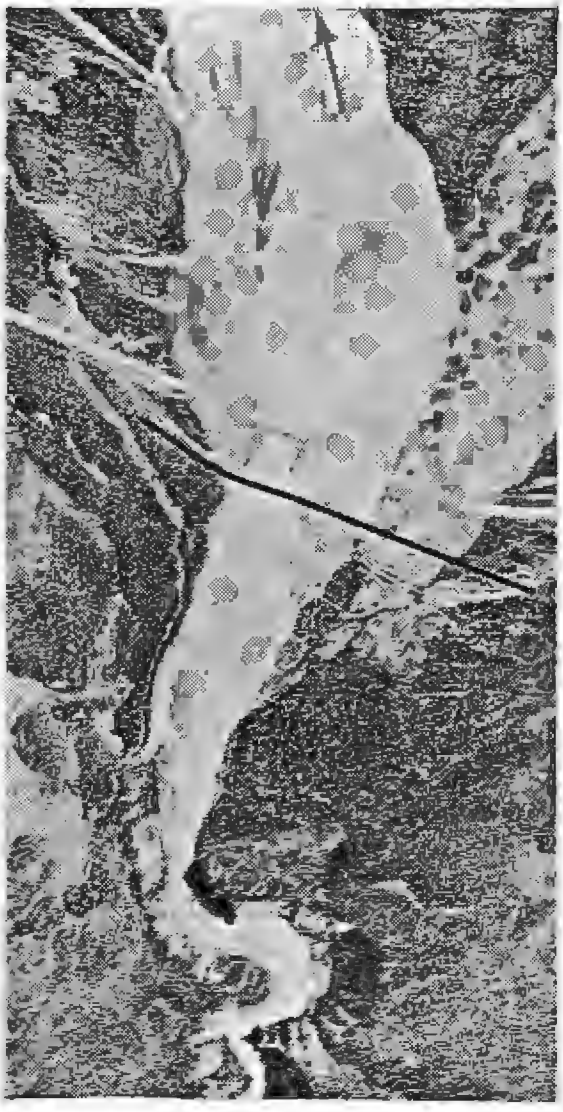
File: 80-443

FIGURE 20-C

DUKE RIVER KP 178.1 DESIGN LONGITUDINAL PROFILE

THE ALASKA HIGHWAY GAS PIPELINE PROJECT
FOOTHILLS PIPELINES (SOUTH YUKON) LIMITED

1952



1976

N

SCALE 1:25,000

PROPOSED PIPELINE CENTERLINE ——

FIGURE 20-D

DUKE RIVER KP 178.1
COMPARATIVE AERIAL PHOTOGRAPHS

THE ALASKA HIGHWAY GAS PIPELINE PROJECT
FOOTHILLS PIPELINES (SOUTH YUKON) LIMITED

FILE: 80-443
northwest hydraulic consultants limited

20. Duke River, 178.1

Analysis and design of a previously proposed Duke River pipeline crossing was jointly conducted by Northwest Hydraulic Consultants Ltd. and R.M. Hardy and Associates Ltd. in 1978. The proposed 1980 crossing intersects the previous design centerline at near the middle of the braided channel and is skewed about 13 degrees to the previous alignment; both alignments are shown on Figure 20-A.

20.1 Summary of Hydraulic Parameters

Total design discharge: 300 m^3/s
- corresponding stage: 854.6 m

Design high water stage: 855.5 m (ice related)
Bankfull discharge: 85 m^3/s (sub-channel)
Bankfull stage: 854.0 m
Observed high water mark: upstream, about 0.3 m higher than corresponding design discharge stage
- corresponding discharge: not estimated; ice related

Mean channel slope: 9.0/1000
Assumed Manning's n: .035

20.2 Summary of Scour Computations

Reference stage: 854.0 m (design sub-channel)
Minimum surveyed stream bed elevation: 852.7 m
Design channel section parameters:

discharge	Q	= 85 m^3/s
surface width	b	= 32 m
bed material	D_{50}	= 40 mm
regime depth	d_r	= 0.8 m
regime velocity	V_r	= 3.3 m^3/s
competent mean velocity	V_c	= 1.9 m^3/s

Design scour elevation:

scour factor	Z	= 3.5
scour depth	d_s	= 2.8 m
scour elevation	elev.	= 851.2 m

minimum cover: 1.5 m
Recommended cover 2.3 m (allowance for scour and local degradation as per 1978 analysis and design)

20.3 Channel Regime and Design Approach

The following comments are based largely on the analysis presented in the 1978 design report.

The Duke River emerges from a narrow mountain canyon upstream of the crosssing and spreads out through the crossing reach to form a wide and highly braided floodway. In plan view the river at this location gives an appearance of an alluvial fan.

Geologically, the river displays a history of gradual degradation. Evidence is provided by high steep banks of alluvial and glacial materials on the left side, through which the river has down-cut, and by the presence and higher level of the Duke River Meadows which once

served as the active floodplain on the right. Other evidence of this historical behaviour is provided by alluvial fan deposits at a higher level further to the right.

Near the crossing, several more recent changes have occurred since relocation of the Alaska Highway bridge to its present location in about 1954. These changes have been brought about by three structures associated with the highway bridge; the highway embankment, a riprapped dike on the left side, and a riprapped guide bank on the right. Together these structures have closed off over three-quarters of the active floodplain, confining the flow through a 120 m wide bridge opening. The overall effect has been to cause some lowering of bed levels to occur under the bridge and for some distance upstream and downstream, in conjunction with siltation of adjacent areas that have been isolated from the main flow.

At present, three levels of floodplain are evident as indicated on Figure 20-B, including: 1. the presently active channel and floodplain; 2. adjacent higher floodplains on the left and right that were part of the active floodplain before 1954; and 3. the Duke River Meadows, an older, higher, and largely abandoned floodplain or terrace on the right that is rarely if ever flooded.

On the left side, the level 2 floodplain upstream of the highway has been diked off. Riprap on this dike and at its toe will have to be removed during the trenching operation, and the dike and riprap must be restored following construction. The riprap otherwise

appears to be of a size and quantity suitable for protection against the pipeline design flood, so little additional upgrading will be required. West of the dike, only a nominal depth of burial will be required.

On the right side of the river, the level 2 floodplain upstream of the bridge has been largely isolated from the main stream by the highway embankment and guide bank; however, some flooding does occur. It is considered quite possible that the active floodplain may meander to the right into this zone, especially if the guide bank or highway embankment were to be damaged, and for this reason deep burial is recommended into the level 3 floodplain.

The level 3 floodplain is above all but the most severe flooding that may occur under rare severe aufeis conditions. Further protection against flood waters is provided by the abandoned highway embankment and a dike connecting it to the present highway. Only nominal burial as determined by mainline design will be required to the east of the sagbend in this zone. The dike should be rebuilt to original condition after pipeline construction is completed.

Gravel has been mined in the past from several areas of the level 2 and 3 floodplains; mining should be discouraged in the future in all areas upstream of the bridge in the interest of protecting both the highway as well as the pipeline. Co-operation of Public Works will be required.

Three existing river training structures have been mentioned with respect to the river regime in this reach. Each of the three was examined to determine its importance in the proposed design and/or effects that pipeline construction might have on the structure:

a. Dike on the left side. This dike excludes river flow from the level 2 floodplain on the left side, and permits shallower burial to the left than might otherwise be necessary. During construction, the dike will be breached for pipelying and will therefore have to be rebuilt to original conditions where it is breached. Because of its importance to the proposed design, the dike was evaluated with repect to its suitability for pipeline design conditions. Relevant design parameters include the vertical freeboard above design high water level, and the size and quantity of existing riprap.

Existing dike elevations provide adequate vertical freeboard of 1.5 to 2 m under design open water and aufeis conditions.

There is little evidence to indicate that the existing riprap has been in distress. A random stone sample of the dike riprap was taken during the 1978 field survey, indicating a median stone size (D_{50}) of approximately 0.57 m on a 2.5:1 side slope (this compares with riprap specifications shown on bridge design drawings, calling for a minimum stone size of approximately 0.57 m on 2:1 side slope). This riprap was judged to be suitable for the computed mean flood velocity of 3.3 m/sec in the main sub-channel.

Existing riprap on the dike face appears to be sufficient in quantity, on the basis of visual observation and specifications in the bridge design drawing. There is little evidence at present of riprap that had been specified in a toe apron; this rock is assumed to have become launched (buried) at the toe of the dike, subject to confirmation during pipeline trenching.

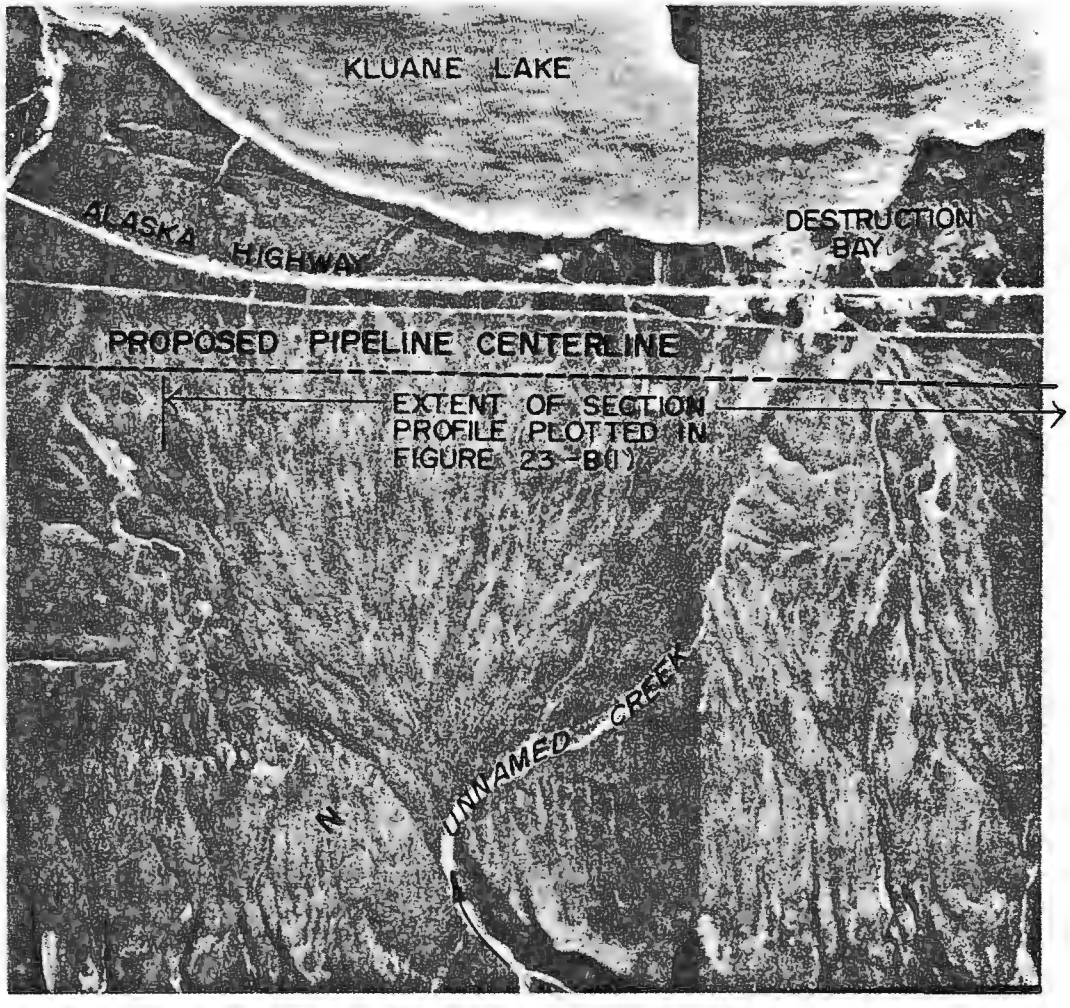
Existing riprap will have to be removed at the dike centreline to permit trenching to take place. During backfilling operations, the dike it to be rebuilt to a 2.5:1 side slope and covered with riprap of a median size (D_{50}) equal to that of the existing riprap; material salvaged from the trenching may be used for this purpose. The riprap layer is to have a minimum thickness of 0.9 m, and should extend downward at a 2.5:1 slope to the top of pipe.

b. Right guide bank. The function of this guide bank appears to be to protect the right bridge abutment and approach embankment. The guide bank is sparsely riprapped and is considered prone to some relatively minor flood damage, especially at its nose. The sagbend is located well to the right in order to allow for the possibility of more substantial damage to the guide bank in a major flood, including destruction of a reasonable section of the highway embankment. Upgrading of the guide bank is consequently of little concern to the pipeline, assuming that Public Works will provide at least minimal maintenance.

c. Dike on the right side. This dike connects the abandoned highway fill with the present highway embankment, and exludes flood waters from the level 3 floodplain. The dike will have to be rebuilt to original conditions following pipeline construction.

The 1978 break-up study (NHCL; 1978-4) indicated that the river ice cover is normally quite thin, but that on at least one occasion a substantial icing occurred. Existing dikes have a freeboard of about 1.5 to 2 m above pipeline design flood level, or over 2 m above the active

floodplain level. This amount of freeboard is considered adequate for all but the most extreme ice thicknesses. A similar freeboard should be considered in determining the pipe weighting requirements. Scour due to confined flow during break-up is not considered to be of significant concern at this crossing.



SCALE 1:40,000

FIGURE 23-A

UNNAMED CREEK KP 200.3 LOCATION PLAN

FILE: 80-443

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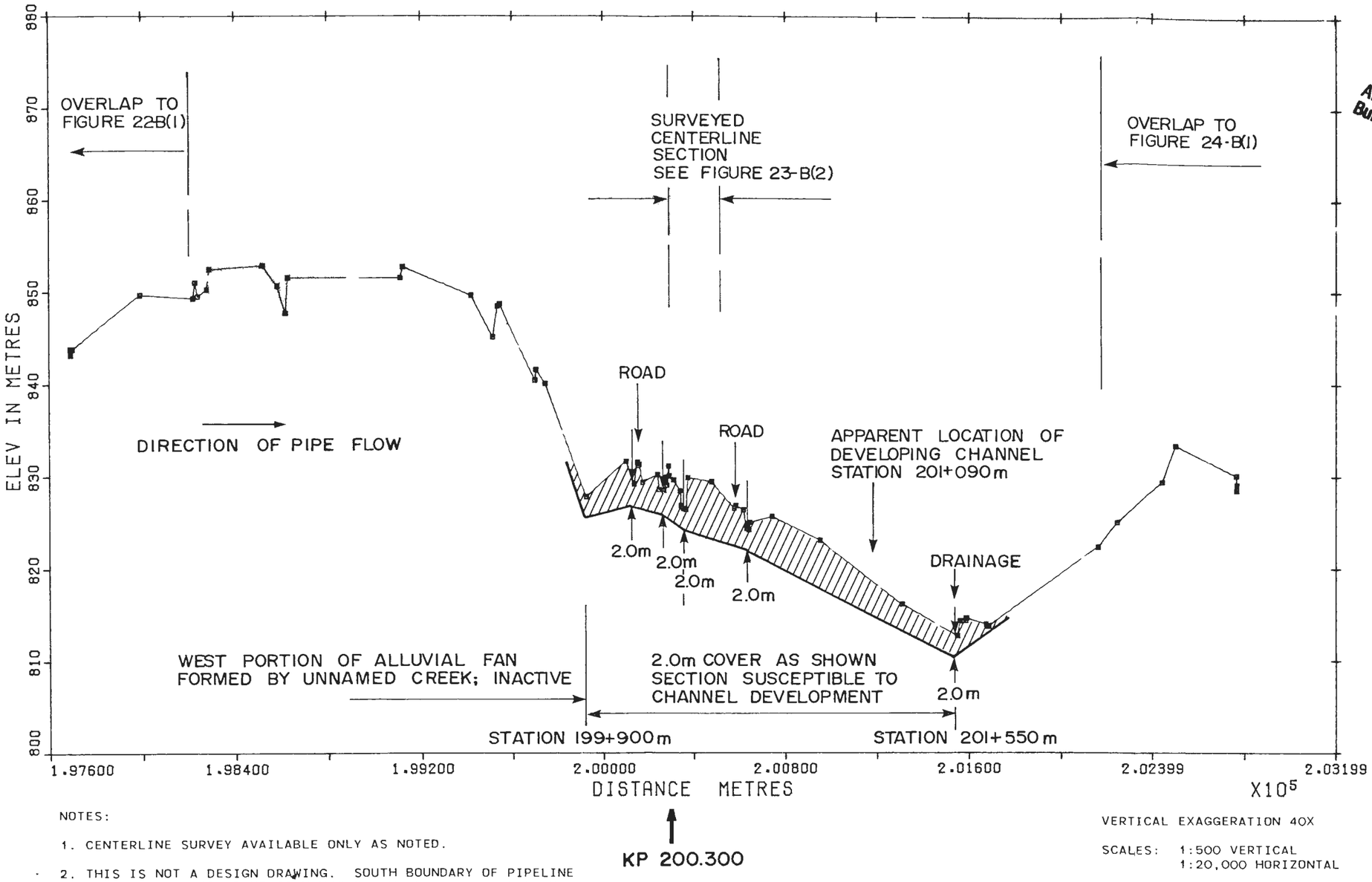
THE ALASKA HIGHWAY GAS PIPELINE PROJECT

FOOTHILLS PIPELINES (SOUTH YUKON) LIMITED



NOTES:

1. CENTERLINE SURVEY AVAILABLE ONLY AS NOTED.
2. THIS IS NOT A DESIGN DRAWING. SOUTH BOUNDARY OF PIPELINE RIGHT OF WAY IS ABOUT 26 M UPSLOPE OF CENTERLINE SECTION, AND MAY NOT REVEAL ALL MINIMUM SURFACE ELEVATIONS AS REQUIRED TO SPECIFY PIPE ELEVATION BASED ON COVER REQUIREMENTS.
3. PROPOSED DESIGN PHILOSOPHY IS TO PROVIDE SUFFICIENT COVER IN ACTIVE PORTION OF ALLUVIAL FAN SUCH THAT 1.0 M MINIMUM COVER SHOULD BE RETAINED SUBSEQUENT TO ANY NEW CHANNEL DEVELOPMENT THEREIN. IN THE VICINITY OF PRESENTLY ACTIVE CHANNELS AND OF HIGHWAYS RELATED MAINTENANCE ACTIVITIES, 2.0 M COVER WITH RESPECT TO MINIMUM STREAMBED ELEVATIONS IS RECOMMENDED.
4. SECTION SURVEYED BY HIW, MAY 1980.
5. SECTION PLOTTED VIEWING DOWNSTREAM.
6. EXTENT OF PLOTTED SECTION SHOWN ON FIGURE 23-A.

VERTICAL EXAGGERATION 40X

SCALES: 1:500 VERTICAL
1:20,000 HORIZONTAL

FIGURE 23-B(1)

UNNAMED CREEK KP 200.3 SOUTH BOUNDARY PROFILE SCHEMATIC DESIGN RECOMMENDATIONS

THE ALASKA HIGHWAY GAS PIPELINE PROJECT
FOOTHILLS PIPELINES (SOUTH YUKON) LIMITED

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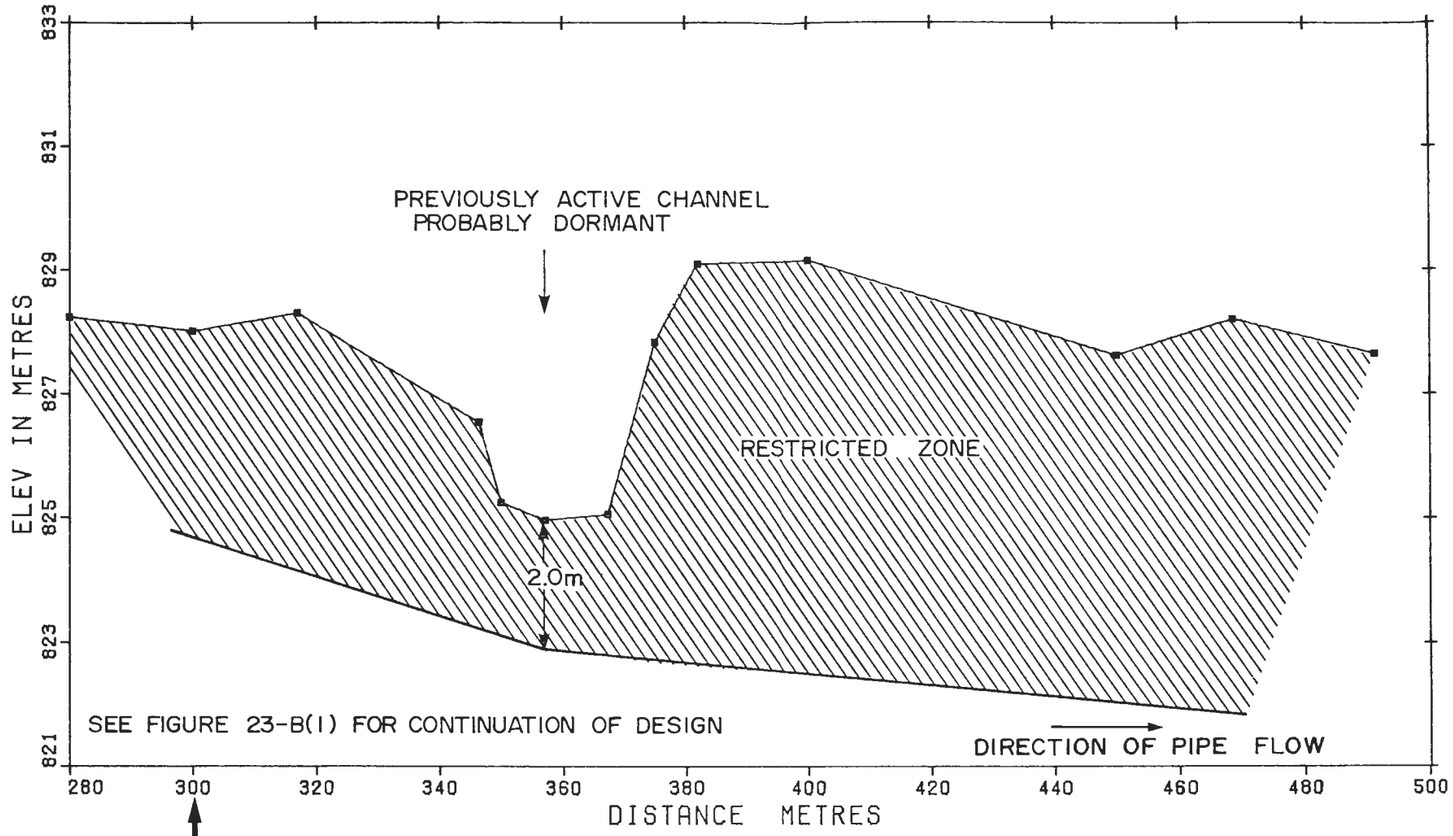

VERTICAL EXAGGERATION 10X

SCALES: 1:100 VERTICAL
1:1000 HORIZONTAL

NOTES:

1. NO PORTION OF PIPE OR WEIGHTS TO BE CONSTRUCTED WITHIN RESTRICTED ZONE.
2. RESTRICTED ZONE ASSUMES NO BEDROCK PRESENT; IF ENCOUNTERED, TOP OF PIPE TO BE 1 M BELOW COMPETENT BEDROCK SURFACE UNLESS RESULTANT ELEVATION IS BELOW RESTRICTED ZONE.
3. SECTION SURVEYED BY HJA ON JULY 10, 1980; CROSSING WX1-029.
4. SECTION PLOTTED VIEWING DOWNSTREAM.
5. EXTENT OF DESIGN SECTION SHOWN ON FIGURE 23-B(1)

FIGURE 23-B(2)

UNNAMED CREEK KP 200.3 DESIGN CENTERLINE SECTION

THE ALASKA HIGHWAY GAS PIPELINE PROJECT
FOOTHILLS PIPELINES (SOUTH YUKON) LIMITED

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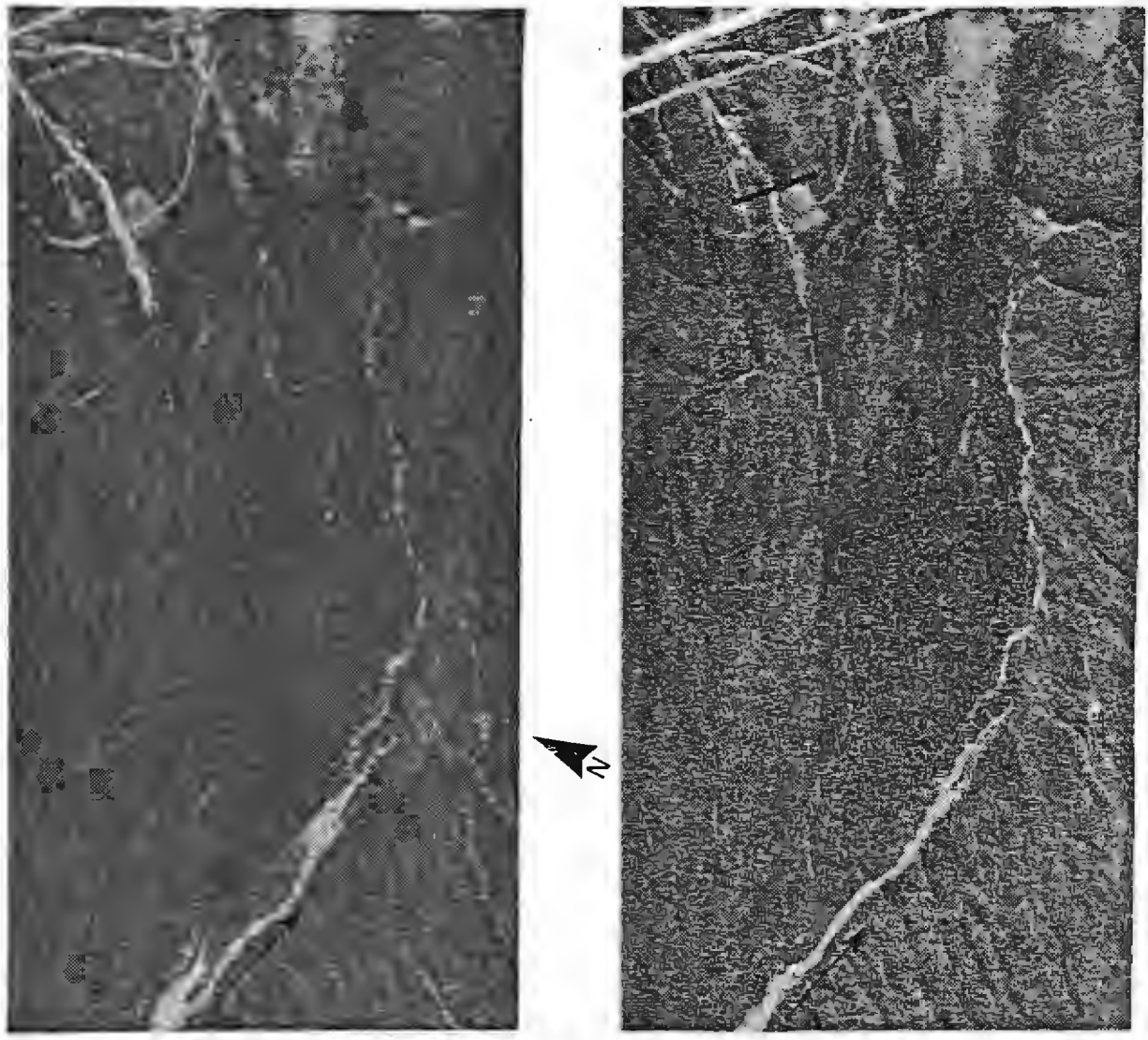

1954 1976

SCALE 1: 20,000

PROPOSED PIPELINE CENTERLINE ——

FIGURE 23-D

UNNAMED CREEK KP 200.3
COMPARATIVE AERIAL PHOTOGRAPHS

THE ALASKA HIGHWAY GAS PIPELINE PROJECT
FOOTHILLS PIPELINES (SOUTH YUKON) LIMITED

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23. Unnamed Creek, K.P. 200.3

23.1 Summary of Hydraulic Parameters

Total design discharge: 20 m^3/s

- other hydraulic parameters not applicable as an active channel is not defined at this time.

23.2 Summary of Scour Computations

- not applicable

Recommended cover: 2.0 m with respect to minimum elevations of all gullies and/or small drainage courses encountered between Stations 199 + 900 m and 201 + 550 m.

23.3 Channel Regime and Design Approach

The unnamed creek at about K.P. 200.3 drains only about 12 km^2 from the Kluane Range of mountains. However, it has historically developed a large alluvial fan which extends between about Stations 197 +280 and 201 + 350 m along the pipeline route. That portion of the fan which is west of about Station 199 + 900 m is at a markedly higher elevation than the east portion of the fan, which is apparently of more recent origin. The west portion of the fan is considered to have been essentially abandoned by the stream, and hence is not of river engineering concern.

What would initially appear to be the stream's active channel is crossed at Station 200 + 360 m, however, within about the last century, upstream changes have

caused this channel to become somewhat dormant. On the basis of aerial photographs, flows would appear to be developing a new channel in the vicinity of Station 201 + 090; survey information is not available to verify this interpretation.

For the purposes of design, it must be considered possible for a new channel to develop anywhere along the east portion of the fan, including a gully at about Station 201 + 550 m, which historically drained a small stream which originates to the east of the fan. On the basis of the old channel crossed at Station 200 + 360, and with the assumption that mature spruce bordering that channel can conservatively be used to define the minimum surface elevation prior to channel development, it can be argued that any new channel development would degrade to less than 2.0 m below existing minimum surface elevations. It is recommended that the crossing be accomplished providing a cover of 2.0 m with respect to minimum elevations of all gullies and/or small drainage courses encountered between Stations 199 + 900 m and 201 + 550 m, and by linearly joining these points as so defined.

APPENDIX 3

SUMMARY OF FISHERY INFORMATION

- DUKE RIVER

- WX-1029

SUMMARY OF FISHERY INFORMATION FROM DUKE RIVER

The following has been extracted from a summary of fisheries investigations conducted during 1976 and 1977 (ref. 14):

Duke River drains the northeast portion of the Donjek Range and flows into Kluane River approximately 2 km downstream of Kluane Lake. In the crossing region the Duke River widens rapidly to form a broad and extensively braided floodplain. The width of Duke River was measured to be 6.0 m during the winter of 1976/77 when only one channel was flowing. During maximum discharge in July, innumerable braided channels were presented across the 1 km floodplain. During the fall of 1976, three channels (8.0, 22.0, and 10.0 m) were present. The mean depth of the water was 0.4 m under low flow conditions in winter, but could not be determined during the summer flood. There was a very little pool formation in this river, but rather rapidly flowing water in braided channels. There were no inflows or springs observed in the vicinity of the proposed pipeline crossing. The substrate of Duke River consists of 20 percent sand and gravel, 50 percent pebble and 30 percent cobble. The substrate was stable at low flow rates but the braided channels appeared to undergo considerable shifting during high discharge periods. There was no aquatic vegetation observed in this river.

Fishery Investigations

Fisheries sampling in Duke River consisted of:

- electrofishing - 1,753 s
- angling - 2.0 h
- seining - 5 hauls

gillnetting

total length - 22.5 m

total time - 24.0 h

minnow trap - 24.0 h

fry trap - 6.0 h

In addition, visual reconnaissance from helicopter was carried out on five occasions to augment this sampling effort.

During the course of this study, fish species collected or observed were:

Arctic grayling

- 7 juvenile
- 1 adult

chum salmon

- 1 adult (carcass)

The presence of two additional species, round whitefish and slimy sculpin has been reported by Northern Natural Resource Service Ltd. (1977).

Habitat utilization by fish fauna throughout the year was low, due to heavy silt loads during the summer, lack of cover during low discharge periods and the unstable nature of the river channels. No fish were observed in this river during the winter survey, but water quality and quantity was sufficient for overwintering fish species. One chum salmon carcass was observed in the vicinity of the proposed pipeline crossing during 1976. Investigations during 1977 revealed that the Duke River was not utilized by spawning chum salmon during that year. A minor chum salmon spawning area was, however, identified in the Kluane River at the mouth of the Duke River, approximately 8 km below the proposed pipeline crossing.

Subsequent to the preparation of this summary, fisheries studies of the Duke River were conducted in the spring and summer of 1979, during which time juvenile (13) and adult (1) Arctic grayling and a single round whitefish were collected. The Duke River was also surveyed

from the pipeline crossing to the Kluane River during October of 1980, and October and November of 1981 to enumerate any chum salmon which may be spawning in the river, or at the river mouth in Kluane River. No chum salmon or any other fish were observed in this area during these studies, and it was also noted that there were no pool areas between the pipeline crossing and the Kluane River. This observation, in conjunction with the results of open-water surveys led to the conclusion that fish would not overwinter in this reach of the Duke River, but rather move to the Kluane River for the winter season.

Foothills Pipe Lines (Yukon) Ltd.

Map Sheet 4
Crossing No. WX-1026
Name DUKE RIVER
Location KP 178.09

FISH OCCURRENCE AND HABITAT UTILIZATION AT PIPELINE CROSSING LOCATION

Important Species / Habitat Utilization	Reference					
	Chinook Salmon	Chum Salmon	Arctic Grayling	Lake Trout	Lake Whitefish	Dolly Varden Char
Migration Route						
Spawning Area		10b				
Nursery Area						
Rearing Area			6,9,20			
Summer Habitat			6,20			
Over-wintering Area						

Other Species Reported:
round whitefish - 5,11,20; slimy sculpin - 5,8,11

Study Locations:
Prime route (Alaska Highway) - 2,4,11; Downstream region - 3,4,5,6,9, 10a,20; In Kluane River near river mouth - 10b; Unknown - 8

Comments:
Ref. 5,8,10a,11 - Arctic grayling reported, habitat utilization unknown; Ref 3,5 - one chum salmon carcass found near crossing; Ref. 2,4,10a - overwintering potential, not sampled

4.0 References

The documents reviewed during the preparation of this catalogue are listed below.

Ref. No.

1. Slaney, F.F. and Company Limited. 1976. Supplemental environmental considerations and partial field investigations. Volume 1. Fish and Aquatic Resources. Prepared for Gulf Interstate Engineering Company, Houston. 34 + pp.

2. Doyle, P.M.S. 1977. Winter Survey. Alcan Pipeline. Department of Fisheries and the Environment, Fisheries and Marine Service, Vancouver. (Unpublished memorandum report.) 62 pp.

3. Foothills Pipe Lines (Yukon) Ltd. 1977. A preliminary inventory of fish resources in southern Yukon Territory, 1976. Prepared by Beak Consultants Limited, Calgary. 13 + pp.

4. Foothills Pipe Lines (Yukon) Ltd. 1977. Winter fish investigation of selected watercourses in Yukon Territory, 1977. Prepared by Beak Consultants Limited, Calgary. 13 + pp.

5. Northern Natural Resource Services Limited. 1977. Collection of fisheries information from waterbodies along the proposed Alaska Highway gas pipeline route to July 15, 1977. Prepared for the Department of Fisheries and the Environment, Fisheries and Marine Service, Vancouver. 333 + pp.

6. Foothills Pipe Lines (Yukon) Ltd. 1977. A spring inventory of fishery resources along the proposed Alaska Highway pipeline in Yukon Territory, 1977. Prepared by Beak Consultants Limited, Calgary. 54 + pp.

7. Northern Natural Resource Services Limited. 1977. A collection of fisheries information from waterbodies associated with pipeline routes in the Yukon Territory from Dawson to Watson Lake, September 1, 1977. Prepared for the Department of Fisheries and the Environment, Fisheries and Marine Service, Vancouver. 404 pp.

8. Wickstrom, R.D. 1977. Fish distribution in Kluane National Park and peripheral area. Prepared for Parks Canada by Canadian Wildlife Service, Winnipeg. 31 pp.

9. Foothills Pipe Lines (Yukon) Ltd. 1977. A summer inventory of the fishery resource along the proposed Alaska Highway pipeline in Yukon Territory, 1977. Prepared by Beak Consultants Limited, Calgary. 44 + pp.

10. Foothills Pipe Lines (Yukon) Ltd. 1977. A survey of fall spawning fish species in waterbodies within the influence of the proposed Alaska Highway pipeline in Yukon Territory, 1977. Prepared by Beak Consultants Limited, Calgary. 40 + pp.

11. Department of Public Works, Canada, and U.S. Department of Transportation, Federal Highway Administration. 1977. Environmental Impact Statement, Shakwak Highway Improvement, British Columbia and Yukon, Canada. D.P.W. Project Number 010417; FHWA Report Number FHWABC/YTEIS7701D. 2 Vol. and summary report.

12. Foothills Pipe Lines (Yukon) Ltd. 1978. A preliminary assessment of fishery utilization and potential in waterbodies along three proposed Alaska Highway pipeline alternate alignments, fall, 1977. Prepared by Beak Consultants Limited, Calgary. 24 + pp.

13. Thurber Consultants Ltd. 1978. Letter to Mr. L. Bouckhout, Foothills Pipe Lines Limited, dated June 5, 1978, from Mr. R.B. Spencer, Thurber Consultants Ltd.

14. Foothills Pipe Lines (Yukon) Ltd. 1978. A summary of fishery investigations in waterbodies within the influence of the proposed Alaska Highway pipeline in Yukon Territory, 1976-77. Prepared by Beak Consultants Limited, Calgary. 3 Vol.

15. Thurber Consultants Ltd. 1978. Winter and summer fisheries survey for the Shakwak Highway improvement project (Public Works Canada), British Columbia and the Yukon Territory. Prepared by L.G.L. Limited. 63 + pp.

16. Northern Natural Resource Services Ltd. 1978. A compilation of fisheries data from waterbodies adjacent to the Alaska Highway from kilometer 1008 to kilometer 1635. Prepared for Department of Fisheries and the Environment, Fisheries Operations, Vancouver. 445 pp.

17. Slaney, F.F. and Company Limited. 1978. Catalogue of fishery information and concerns at proposed pipeline stream crossings. Prepared for Foothills Pipe Lines (South Yukon) Ltd., Calgary. 18 pp.

18. Beak Consultants Limited. 1978. Field visit report: December 6 to 12, 1978. Prepared for Foothills Pipe Lines (South Yukon) Ltd., Calgary. 4 pp.

19. Beak Consultants Limited. 1979. Fishery resource investigations of waterbodies within the influence of the Alaska Highway Gas Pipeline. Alternative alignments, 1978. 2 Vol. Report prepared for Foothills Pipe Lines (South Yukon) Ltd., Calgary, Alberta.

20. Beak Consultants Limited. 1979. A summary of fisheries resource investigations in waterbodies within the influence of the Alaska Highway Gas Pipeline in Yukon Territory, 1978. Report prepared for Foothills Pipe Lines (South Yukon) Ltd., Calgary, Alberta. 77 + pp.

21. Beak Consultants Limited. 1979. Surveillance of selected watercourse crossings along the Alaska Highway Gas Pipeline route in Yukon Territory, Year 1 (1978). Report prepared for Foothills Pipe Lines (Yukon) Ltd., Calgary, Alberta. 57 + pp.

22. Beak Consultants Limited. 1980. Summary of fisheries investigations of new crossing locations, Alaska Highway Gas Pipeline, Yukon Territory, 1979. Report prepared for Foothills Pipe Lines (Yukon) Ltd., Calgary, Alberta. 39 + pp.

23. Environmental Management Associates. 1980. Winter studies of aquatic systems along the Alaska Highway Gas Pipeline in southern Yukon Territory - Beaver Creek area (KP 0 to KP 219). Report prepared for Foothills Pipe Lines (Yukon) Ltd., Calgary, Alberta. 39 + pp.

24. Environmental Management Associates. 1980. Winter studies of aquatic systems along the Alaska Highway Gas Pipeline in southern Yukon Territory - Nisutlin Bay area (KP 586 to KP 649). Report prepared for Foothills Pipe Lines (Yukon) Ltd., Calgary, Alberta. 35 + pp.

25. Beak Consultants Limited. 1979. Reconnaissance of streams previously identified as having no fish habitat, Spring 1979. Report prepared for Foothills Pipe Lines (Yukon) Ltd., Calgary, Alberta. 13 pp + slides.

26. Beak Consultants Limited. 1979. Summer observations of streams with low potential for fisheries habitat along the Alaska Highway Gas Pipeline in Yukon Territory. Report prepared for Foothills Pipe Lines (Yukon) Ltd., Calgary, Alberta. 13 pp + slides.

27. Environmental Management Associates. 1981. Fishery resource investigations along the Alaska Highway gas pipeline in southern Yukon Territory, 1980. Report prepared for Foothills Pipe Lines (South Yukon) Ltd., Calgary, Alberta. 48 + pp.

28. Environmental Management Associates. 1980. Enumeration of spawning salmon in aquatic systems along the Alaska Highway gas pipeline in southern Yukon Territory, 1980. Report prepared for Foothills Pipe Lines (South Yukon) Ltd., Calgary, Alberta. 48 + pp.

29. Environmental Management Associates. 1980. Fall fisheries investigations of Kluane Lake and north-shore creeks. Report prepared for Foothills Pipe Lines (South Yukon) Ltd., Calgary, Alberta. 29 + pp.

30. Environmental Management Associates. 1981. Winter studies of selected watercourses along the Alaska Highway Gas Pipeline in southern Yukon Territory, 1981. Report prepared for Foothills Pipe Lines (South Yukon) Ltd., Calgary, Alberta. 28 + pp.

31. Environmental Management Associates. 1981. Spring fisheries investigations of selected watercourses along the Alaska Highway Gas Pipeline in southern Yukon Territory, 1981. In prep.

SUMMARY OF FISHERY INFORMATION FROM UNNAMED CREEK AT KP 200 + 360

During the initial reconnaissance of the proposed pipeline route in southern Yukon Territory in 1976, watercourses which exhibited habitat that appeared suitable for use by fish were delineated, and were the subject of subsequent fisheries studies. In this manner, the large number of small, intermittent creeks with no fisheries potential which were crossed by the pipeline route were eliminated from studies designed to collect baseline fisheries information. The watercrossing at KP 200 + 360 falls into the category of creeks which do not provide suitable habitat for fish.

A reconnaissance of all creeks crossed by the pipeline route which were identified as having no fisheries potential was carried out in the spring and summer of 1979. The purpose of this investigation was to provide documentation regarding the factors limiting fish production in each watercourse. The results of the study were presented in two field visit reports, in which the factor(s) limiting productivity were summarized, and accompanied by a photograph(s) of each watercourse in question. The spring investigation revealed that the watercourse at KP 200 + 360 (identified as KP 199.4 in that study) provided habitat with low potential for use by fish (Reconnaissance of Streams Previously Identified as Having No Fish Habitat, Alaska Highway Gas Pipeline, Southern Yukon Territory, Spring 1979. Prepared by Beak Consultants Limited, Calgary, Alberta, for Foothills Pipe Lines (South Yukon) Ltd., Calgary, Alberta). This unnamed creek was visited again during the summer of 1979, at which time the creek did not exhibit any suitable fish habitat, due to its very shallow nature. In addition, a culvert located downstream on the creek was judged to be impassable to fish (Summer Observations on Streams with Low Potential for Fisheries Habitat along the Alaska Highway Gas Pipeline in Yukon Territory. Prepared by Beak Consultants Limited, Calgary, Alberta, for Foothills Pipe Lines (South Yukon) Ltd., Calgary, Alberta).

APPENDIX 4

PRELIMINARY
CONSTRUCTION SPECIFICATIONS
WATERCROSSINGS

Section 2.15 WATER CROSSINGS

2.15.1 General

2.15.1.1 All water crossings shall be installed in full accordance with Drawings and applicable requirements of Authorities having jurisdiction.

2.15.1.2 Water crossings are categorized as Special Design Crossings or Typical Design Crossings. Special Design Crossings shall mean those crossings for which detailed site specific drawings have been prepared and which are listed individually in Attachment "A" of the Form of Bid. Typical Design Crossings shall mean all other water crossings, dry stream beds and intermittent watercourses for which design details are contained in the Typical Drawings (refer to Drawing List, Volume I Section 6).

2.15.1.3 Immediately upon awarding of the contract or at MANAGER'S discretion and prior to the commencement of any work on water crossings, CONTRACTOR shall submit, for MANAGER'S approval, detailed construction plans, schedules and procedures for the installation of each of the Special Design Crossings and for the remainder of the Typical Design Crossings as a group. All water crossings shall be installed in accordance with the Drawings and with all approved plans, schedules and procedures.

2.15.1.4 Certain constraints shall be observed during installation of river and stream crossings, such as; placement of spoil during excavation, construction timing, the limits on interruption of flow, and/or the requirements for fish passage facilities. The Drawings and directions contained herein detail those requirements for each stream to be crossed and CONTRACTOR shall comply fully with these requirements.

2.15.1.5 Temporary facilities to control erosion on banks of rivers, streams and valley slopes shall be installed as shown on the Drawings and as directed by MANAGER. Such facilites shall be maintained until pipe laying operations commence, and shall be removed by CONTRACTOR at the time of installation of permanent drainage and erosion control measures, in accordance with Section 2.19, Cleanup.

2.15.2 Crossing Structures

2.15.2.1 Where water crossings require crossing structures to provide for uninterrupted safe passage of migrating fish and/or minimal disruption or alteration of stream flow, fish habitat and water quality, CONTRACTOR shall construct such structures

where indicated on the alignment sheets or where directed by MANAGER. Consideration will be given to spans where water flow occurs throughout the year.

2.15.2.2 Ice bridges shall not interfere with natural stream flow in watercourses supporting overwintering fish. Approach fills to bridging structures shall not encroach upon the main channel. Adequate culverts shall be installed to bridge approaches within a floodplain to provide passage for high water flows.

2.15.2.3 Prior to spring break-up (April 15) CONTRACTOR shall remove all seasonal construction bridges, spanning structures, approaches, culverts or other facilities which have been placed in watercourses.

2.15.3 Channelization

2.15.3.1 CONTRACTOR shall install all permanent stream diversions and channelization shown on the Drawings to the satisfaction of MANAGER.

2.15.3.2 Temporary channelization of a watercourse shall only be permitted within the established active floodplain. CONTRACTOR shall submit all designs, procedures and schedules for stream diversions 30 days before commencing any Work for approval of MANAGER.

2.15.3.3 CONTRACTOR shall locate such temporary channels with consideration for retention of required stream flow, bed gradient, water velocity necessary to pass migrating fish and avoidance of critical fish habitat. All work shall be scheduled to avoid imposed timing constraints shown on the Drawings.

2.15.3.4 All cofferdams, channels, culverts or diversionary structures used in the preparation of temporary stream channelization shall be removed after construction or prior to spring break-up, and the watercourse restored to approximate original configuration and substrate.

2.15.4 Trenching

2.15.4.1 Trench for Special Design Crossings shall be excavated to the depth required to maintain the minimum cover shown on the Drawings. For Typical Design Crossings the minimum cover shall be 1.5 m as measured from the top of pipe

or the top of concrete or weights, when weighting is used, to the normal bed of the watercrossing. Minimum depth of cover may be reduced if continuous rock is encountered, providing that 0.9m minimum of solid rock is maintained above the top of pipe.

2.15.4.2 CONTRACTOR shall follow only approved procedures when preparing trench by blasting in a watercourse. All materials and procedures shall be in accordance with Section 2.7, Rock Trench and Blasting.

2.15.4.3 Material removed from the pipeline trench shall be stockpiled out of the water or in stockpiles in the water but not windrowed across the channel. The stockpiles will be placed in a manner to avoid the areas of highest water velocity. The disposition of spoil material will be as designated by MANAGER. When the spoil material is to be stockpiled on the streambank CONTRACTOR shall take suitable measures as approved by MANAGER to prevent spoil material from washing back into the stream.

2.15.4.4 Spoil materials unsuitable for use as backfill shall be disposed of in areas designated by MANAGER.

2.15.5 Pre-testing

2.15.5.1 Pre-testing of pipe sections for water crossings shall be performed in accordance with all requirements of Appendix "M" Hydrostatic Testing Procedure, unless otherwise specified on the Drawings.

2.15.5.2 When hydrostatic testing is conducted during freezing temperatures, hoarding, insulation or heated test medium shall be used. Test water shall be completely removed from test sections to the satisfaction of MANAGER.

2.15.6 Buoyancy Control

2.15.6.1 CONTRACTOR shall install continuous concrete coating, saddle weights or bolt-on weights where shown on the Drawings and as directed by MANAGER.

2.15.6.2 Continuous concrete coating, shall be applied in accordance with Appendix "D" of the Specifications.

2.15.6.3 Bolt-on weight clamp bolts shall be tightened to prevent the weight from rotating or sliding on the pipe, but shall not be overtightened causing bolt on concrete fracture. Both shall be brought up to a snug-tight condition attained by a few impacts with an impact wrench or the full effort of one worker using a 1.25 m speed wrench.

2.15.6.4 Metal banded wood lagging shall be installed on the pipe between bolt-on weights as shown on the Drawings.

2.15.6.5 Before pulling or laying a pipe section with bolt-on weights attached, the lifting lugs on the bottom half of such weights shall be cut off flush with the concrete surface.

2.15.7 Laying and Pulling

2.15.7.1 Before installing pipe in water crossing sections CONTRACTOR shall provide assurance to MANAGER that the trench is cleared of ice, loose boulders or other obstructions which may prevent achieving the specified depth of cover or cause pipe spans in excess of maximum allowable lengths.

2.15.7.2 MANAGER may require final trench depth and cross section surveys to be completed immediately prior to installation of pipe into a watercourse. CONTRACTOR shall assist surveyors or divers as directed by MANAGER.

2.15.7.3 CONTRACTOR shall provide all floation gear, winches and other equipment for installation of water crossing sections by bottom pull or float-and-sink methods. All such materials and equipment used in a watercourse shall be free of oil, grease or other hazardous materials, to the satisfaction of MANAGER. Any floation equipment or other material released from the pipe into the waterbody shall be recovered immediately.

2.15.7.4 If water filling is used to bed the pipe in a watercourse or to increase negative buoyancy prior to backfilling, CONTRACTOR shall completely remove such water immediately upon completion of construction to the satisfaction of MANAGER.

2.15.8 Backfilling

2.15.8.1 Immediately prior to any backfilling operation, MANAGER will conduct an as-built survey of the elevation of the top of pipe or concrete and of the linear alignment. CONTRACTOR shall provide assistance as directed and allow time in its schedule for these activities.

2.15.8.2 Native excavated materials shall be used as backfill unless otherwise shown on Drawings or directed by MANAGER.

2.15.8.3 Rock riprap and any bank armouring, rock gabions or terraces shall be installed in accordance with the Drawings and Appendix "E". When directed by MANAGER, alternate bank reinforcement shall be placed by CONTRACTOR.

2.15.9 Restoration

2.15.9.1 Final cleanup at a water crossing shall include removal of all temporary structures, construction materials, equipment and debris.

2.15.9.2 Permanent channelization and training works of streams including restoration of existing dikes, shall be as shown on the Drawings, and in accordance with Appendix "L".

2.15.9.3 All active and inactive channels shall be restored to their approximate original condition and profile or as otherwise indicated on the Drawings and Appendix "L".

2.15.9.4 All cleanup and restoration measures in a water-course shall be completed within the construction time allowed but in no event later than spring break-up (April 15) where there is winter construction.

ATTACHMENTS

POUCH A
- GEOTECHNICAL ATLAS SHEETS
- LEGEND SHEET
- SHEET 2010201 GT 0026
- SHEET 2010201 GT 0029

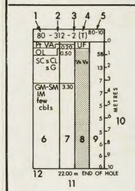
POUCH B
- RIVER CROSSING DESIGN DRAWINGS
- DUKE RIVER - 2010200 WX 1026
- CREEK - 2010200 WX-1029
- TYPICAL WATER CROSSING - 2000200 TP 0042

POUCH C
- ALIGNMENT SHEETS
- SHEET 2010200 AL 0026
- SHEET 2010200 AL 0029

DRILL HOLE DATA

NOTE : THE DRILL HOLE DATA SHOWN AT THE TOP OF THE GEOTECHNICAL ATLAS SHEETS IS ABSTRACTED FROM DRILL HOLE LOGS IN DRILLING CONSULTANTS' REPORTS. SOME DETAILS IN THE REPORTS MAY NOT BE SHOWN ON THE ATLAS LOGS. THE DRILLING CONSULTANTS' REPORTS SHOULD BE REVIEWED WHENEVER DETAILED INFORMATION IS REQUIRED.

DRILL HOLE PRESENTATION



1 YEAR
2 PROGRAM OR FACILITY IDENTIFICATION
3 HOLE NUMBER
4 INSTRUMENTATION PLACED IN HOLE
5 YEAR - MONTH OF DRILLING
6 SOIL CLASSIFICATION COLUMN
7 DEPTH OF BOUNDARIES COLUMN
8 ICE DESCRIPTION COLUMN
9 MOISTURE CONTENT COLUMN
10 DEPTH SCALE
11 DEPTH OF DRILL HOLE
12 OTHER (REFUSAL, etc.)

SOIL CLASSIFICATION

SOIL COMPONENTS
C CLAY
G GRAVEL
M SILT
O ORGANIC
Pt PEAT
S SAND
H HIGH PLASTICITY
I MEDIUM PLASTICITY
L LOW PLASTICITY
P POORLY GRADED
W WELL GRADED
VA VOLCANIC ASH

MINOR SOIL PERCENTAGES
a AND 35-50%
s SOME 20-35%
l LITTLE 10-20%
t TRACE 1-10%

MISCELLANEOUS
bdrk BEDROCK
bldr BOULDERS
few FEW
freq FREQUENT
occ OCCASIONAL

c COARSE
cbl COBBLES
cvr COVER
f FINE
gs GRASS
lyrd LAYERED
lnsd LENSED
m MEDIUM
ms MOSS
org ORGANIC
veg VEGETATION
vvd VARVED

ICE CLASSIFICATION (NRC)

GROUP SYMBOL	SUBGROUP DESCRIPTION	SUBGROUP SYMBOL
UF	UNFROZEN	UF
F	FROZEN	F
N (NON-VISIBLE)	POORLY BONDED OR FRIABLE	NF
	NO EXCESS ICE WELL-BONDED EXCESS ICE	Nb / Nbn / Nbe

V (VISIBLE)	INDIVIDUAL ICE CRYSTAL OR INCLUSIONS	Vx
	ICE COATINGS ON PARTICLES	Vc
	RANDOM OR IRREGULARLY ORIENTED ICE FORMATIONS	Vr
	STRATIFIED OR DISTINCTLY ORIENTED ICE FORMATIONS	Vs
ICE	ICE WITH SOIL INCLUSIONS	ICE + SOIL TYPE
	ICE WITHOUT SOIL INCLUSIONS	ICE

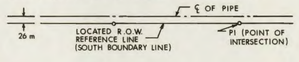
INSTRUMENTATION

T : THERMISTOR
P : PIEZOMETER
S : STANDPIPE
EMR : ENERGY, MINES AND RESOURCES (SPECIAL PIPE)
OTHER : (SPECIFIED AT POSITION 12)

MOSAIC

NOTES

SCALE 1:10 000
TOPOGRAPHIC CONTOUR INTERVAL 3 m (EVERY 15 m ACCENTED)
MOSAIC ILLUSTRATION REPRESENTS THE FOLLOWING:

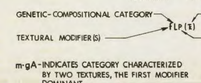


MOSAIC LEGEND

80-11-001 DRILL HOLE LOCATION AND NAME
GEOPHYSICS LINE OFF ROUTE
0 100 GEOPHYSICS LINE ON ROUTE (START AND END CHAINAGES - IN METRES)
KILOMETRE POST

TERRAIN TYPING LEGENDS

TERRAIN TYPING LEGEND



m-gA - INDICATES CATEGORY CHARACTERIZED BY TWO TEXTURES, THE FIRST MODIFIER DOMINANT
fAP STRATIGRAPHIC RELATIONSHIP WHERE gSM UPPER UNIT IS OFTEN LESS THAN 3 METRES THICK
MH-M - INDICATES CATEGORY CHARACTERIZED BY TWO MORPHOLOGIES, THE FIRST MODIFIER DOMINANT
← - INDICATES TERRAIN TYPE OR FEATURE BEING DESCRIBED
f/gAF - INDICATES TWO TEXTURES BELONGING TO THE SAME CATEGORY, THE FIRST TEXTURE USUALLY LESS THAN 3 m THICK OVERLYING THE SECOND

GENETIC COMPOSITION CATEGORIES
A - ALLUVIAL DEPOSITS; SILT, SAND OR GRAVEL
C - COLLUVIUM; UNSORTED MIXTURES OF FINE-GRAINED MATTERIALS & RUBBLE
D - DRIFT, UNDIFFERENTIATED GLACIOFLUVIAL, LACUSTRINE & MORRAINAL DEPOSITS
E - EOLIAN DEPOSITS; SILT, SAND & VOLCANIC ASH
G - GLACIOFLUVIAL DEPOSITS; SAND OR GRAVEL, RARELY SILT
L - LACUSTRINE & PONED DEPOSITS; SILT & SAND, RARELY ORGAANIC OR GRAVEL
M - MORAINAL DEPOSITS; TILL, OCCASIONALLY GRAVEL, SAND & SILT
O - ORGANIC DEPOSITSS, PEAT, ORGANIC SILT, RARELY MARL.
R - BEDROCK

PROCESS OR FORM MODIFIERS
(A) - ACTIVE ALLUVIATION
(E) - STREAM ERODED, STREAM ERODING
(G) - CHANNELLED BY METLWATER STREAMS
(L) - MODIFIED DUE TO SLOPE FAILURE OR RAPID MASS MOVEMENT
(P) - PITTED (KETTLE HHOLE)
(S) - SOLIFLUCTION LOBES & TERRACES
(T) - THERMOKARST; #MODIFIED BY THERMOKARST
(V) - GULLIED
(W) - WAVE WASHED
(Z) - PATTERNED GROUUND

TEXTURAL MODIFIERS
a - SAND OR GRAVEL, COARSE-GRAINED
b - BOULDERS, BLOCKS, BOULDERY, BLOCKY
c - CLAY, CLAYEY
d - DIAMICTON, UNSORTED MATERIAL
f - FINE-GRAINED, SILT, SAND, CLAY, FREQUENTLY ORGANIC
g - GRAVEL, GRAVELLY
m - SILT, SILTY
o - ORGANIC
p - PEAT, PEATY
r - RUBBLE, RUBBLY
s - SAND, SANDY
t - TILL
v - VOLCANIC ASH, TEPHRA
x - COMPLEX

MORPHOLOGIC MODIFIERS
A - APRON
B - BLANKET
C - CHANNEL (NO VEGETATION COVER)
D - DELTA
F - FAN
G - GENTLY SLOPED (<5°)
H - HUMMOCKY
M - ROLLING, UNDULATING
N - MODERATELY SLOPED (5°-15°)
P - PLAIN, POND
R - RIDGE
S - STEEPLY SLOPED (>15°)
T - TERRACE
V - VENEER
X - COMPLEX

BLANKET - CONTINUOUS COVER GENERALLY 0.5-3 METRES THICK
VENEER - BROKEN THIN COVER AVERAGING 0.5 METRES IN THICKNESS

SOIL DESCRIPTION, GEOPHYSICS SITE AND DRILL HOLE DESIGNATION

SOIL DESCRIPTION

2 - 5 PEAT, ORGANIC SILT (HIGH)
10+ GRAVEL (LOW)
EXPECTED EXCESS ICE CONTENT
SOIL TYPE (FIRST TYPE DOMINANT)
LIMITS FOR UNIT THICKNESS
MORE THAN 10 m IN THICKNESS

EXCESS ICE CONTENT	INITIAL FROZEN MOISTURE CONTENT
NIL	0%
LOW	<20%
MEDIUM	20-35%
HIGH	>35%

GEOPHYSICS SITE

EXTENT OF GEOPHYSICS SITES (ELECTRO-MAGNETIC INDUCTION AND HAMMER SEISMIC) PROJECTED HORIZONTALLY
ON R.O.W. (WITHIN CORRIDOR EXTENDING 40 m NORTH OF SOUTH BOUNDARY REFIERENCE LINE) - YEAR, SITE NUMBER, DIRECTION SHOWN
OFF R.O.W. (NOT WITHIN ABOVE CORRIDOR - POSITION SHOWN ON MOSAIC) - YEAR, SITE NUMBER, DIRECTION SHOWN
DIREICTION OF SURVEY

DRILL HOLE DESIGNATION

FOR HORIZONTAL CONTROL
PROJECTED POSITION OF DRILL HOLES, DRAINAGES, ROADS AND OTHER CULTURAL FEATURES
BRACKETED DRILL HOLES ARE NOT LOCATED WITHIN CORRIDOR EXTENDING 40 m NORTH OF SOUTH BOUNDARY REFERENCE LINE

CROSS SECTION ALONG CENTRE LINE

UNIT BOUNDARIES

CONFIDENCE SYMBOL	UNCERTAINTY
———	± 0.5 m
— — — —	± 2 m
. . . . .	± 5 m

PERMAFROST DELINEATION

PERMAFROST PRESENT
PERMAFROST UNCERTAIN (NO DRILL HOLE TO CONFIRM)
BLANK PERMAFROST ABSENT

NOTE : PERMAFROST DELINEATION SYMBOLS FOR PRESENT AND ABSENT SHOWN ONLY WHERE ENCOUNTERED IN DRILL HOLES. INFORMATION EXTENDED BASED ON RESULTS OF GEOPHYSICS SURVEY.

OTHER SYMBOLS

BOREHOLES
– UNFROZEN
– FROZEN
F? – NOT DEFINITELY KNOWN
( ) – COMMENT (OCCURRENCE OF BOULDERS, POSITION OF DRILL HOLE, etc.)

GROUND ICE DESCRIPTIONS

GROUND ICE

(1) DESCRIBED BY INITIAL FROZEN MOISTURE CONTENT AND VARIATION WITH DEPTH. (SEE SOIL DESCRIPTION)

(2) DESCRIBED BY PERCENTAGE VISIBLE ICE REPORTED IN DIRILL HOLES. EXPECTED, PROBAIBLE USED WHERE NO DRILL HOLES IN UNIT.. ICE LENSES REFER GENERALLY TO GROUND ICE. MASSIVE, SEGREGATED ICE REFER SPECIFICALLY TO ICE MASSES.

FREQUENCY OF OCCURRENCE	% VISUAL ICE
RARE	3 - 10 %
FEW	10 - 20 %
OCCASIONAL	20 - 35 %
FREQUENT, COMMON	>35 %

THAW SETTLEMENT POTENTIAL

THAW SETTLEMENT POTENTIAL. CALCULATED FOR TERRAIN TYPE GROUPS. TERRAIN TYPE GROUPS CATEGORIZE COMBINATIONS OF SIMILAR TERRAIN TYPES WITHIN CERTAIN BOUNDED ZONES ALONG THE PIPE LINE ROUTE. GROUP NUMBER SHOWN ADJACENT TO TERRAIN TYPE BENEATH MOSAIC.

THAW SETTLEMENT POTENTIAL SHOWN FOR UPPER 10 m WHEN PIPE BURIAL IS AT		CALCULATED SETTLEMENTS AVERAGE	(MAXIMUM)
SURFACE	(0-10m)	2.0	(4.0)
or 2 m	(2-10m)	1.0	(2.0)
or 4 m	(4-10m)	0.5	(1.0)

ERODIBILITY

SLOPE

BOUYANCY

SPECIAL CONSIDERATIONS

FROST HEAVE POTENTIAL

APPLIES TO REGION OF COLD FLOW (SHEETS 1-10)

FROST HEAVE SUSCEPTIBILITY RATING	PERCENT BY WEIGHT FINER THAN 0.02 mm
LOW	<5 %
MEDIUM	5 - 15 %
HIGH	>15 %

NO.	REVISION	DATE	BY	CHKD	APPD

ENGINEERING RECORDS

	DATE
DRAWN BY	
CHECKED BY	
ENGINEER	

APPROVALS

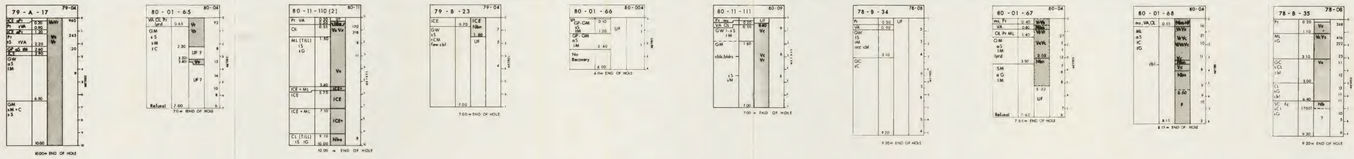
Foothills Pipe Lines (South Yukon) Ltd.

TITLE
THE ALASKA HIGHWAY GAS PIPELINE PROJECT
GEOTECHNICAL ATLAS LEGEND LEAD SHEET

PREPARED BY TERRAIN ANALYSIS AND MAPPING SERVICES LTD.
GEO-PHYSICON CO. LTD.

RGN	ZONE	FACILITY	NO.	DWG.TYPE	DRAWING NO.	REV.
2	01	02	01	GT	0000	

DRILL HOLE DATA

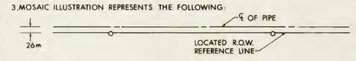


MOSAIC
SCALE 1:10 000

TERRAIN TYPE & GROUP	tMv aGP (24)	dCB D(E)	f/gAF (6)	gAc(A) (6)	gAc (6)	gAF (6)	dCB D(E)	tMM (23)
LENGTH ALONG ℄ (m)	1290	110	370	590	260	870	40	3620
SOIL DESCRIPTION	0-4 PEAT, ORGANIC SILT, SILT, VOLCANIC ASH (MEDIUM-HIGH) 5-8 UNSORTED SILT, SAND, GRAVEL (MEDIUM-HIGH) 2-7 SAND, GRAVEL, SILTY SAND, SILTY GRAVEL (LOW-NIL) 2-10+ INTERLAYERED SILTY GRAVEL, GRAVEL AND TILL (LOW-HIGH) 1+ UNCONSOLIDATED DEPOSITS (LOW-NIL)		0-3 CLAYEY SILT, SANDY SILT (MEDIUM-HIGH) 4-10 SILTY GRAVEL, SILTY SAND, GRAVEL, COBBLY GRAVEL (LOW-NIL) 4+ UNCONSOLIDATED DEPOSITS (LOW-NIL)	6-12+ SILTY GRAVEL, SILTY SAND, GRAVEL, COBBLY GRAVEL 4+ UNCONSOLIDATED DEPOSITS		0-2 PEAT, ORGANIC SILT, SILT, VOLCANIC ASH (LOW) 1-8 SILTY GRAVEL, SILTY SAND, GRAVEL, COBBLY GRAVEL (LOW-NIL) 0-7 TILL AND SILTY GRAVEL (LOW-NIL) 4+ UNCONSOLIDATED DEPOSITS (LOW-NIL)		0-4 PEAT, ORGANIC SILT, SILT, VOLCANIC ASH (LOW-HIGH) 1-8 UNSORTED SILT, SAND, GRAVEL (LOW-HIGH) 7-12+ TILL AND SILTY GRAVEL (LOW) 1+ UNCONSOLIDATED DEPOSITS (LOW-NIL)
GEOPHYSICS SITE ON R.O.W.	80-01-GS-50					80-01-GS-51		80-01-GS-52
GEOPHYSICS SITE OFF R.O.W.	OFF MOSAIC 78-GS-51					78-GS-52		78-GS-53
DRILL HOLE DESIGNATION	(79-A-17) 80-01-65 ALASKA HIGHWAY (ABANDONED) 80-11-110 (2)		(79-B-23) DUKE RIVER	80-01-66 TRAIL		TRAIL ALASKA HIGHWAY (ABANDONED) 80-11-111		80-01-67 CREEK TRAIL 80-01-68 TRAIL (78-B-35) TRAIL
CROSS SECTION ALONG ℄ (depth in metres)	PEAT, ORGANIC SILT, VOLCANIC ASH; SAND, GRAVEL, SILTY SAND, SILTY GRAVEL; UF?; UF?; INTERLAYERED SILTY GRAVEL, GRAVEL AND TILL		CLAYEY SILT, SANDY SILT; UNSORTED SILT, SAND, GRAVEL; SILTY GRAVEL, SILTY SAND, GRAVEL, COBBLY GRAVEL			PEAT, ORGANIC SILT, SILT, VOLCANIC ASH; UNCONSOLIDATED DEPOSITS (CLAY, SILT, SAND, GRAVEL OR TILL)		PEAT, ORGANIC SILT, SILT, VOLCANIC ASH; UNSORTED SILT, SAND, GRAVEL; UF?; TILL AND SILTY GRAVEL; F?
GROUND ICE	MEDIUM TO HIGH ICE CONTENT IN UPPER 2 m, LOW BELOW. FEW TO FREQUENT ICE LENSES IN UPPER 2 m, RARE BELOW.	FREQUENT OCCURRENCES OF SEGREGATED ICE AT DEPTH UNDER SLOPE.	LOW ICE CONTENT BELOW FINE GRAINED COVER. FEW TO FREQUENT OCCURRENCES OF ICE LENSES IN UPPER 2 m, RARE BELOW.			LOW ICE CONTENT, RARE OCCURRENCES OF ICE LENSES.	FREQUENT OCCURRENCES OF SEGREGATED ICE AT DEPTH UNDER SLOPE.	LOW ICE CONTENT BELOW FINE GRAINED COVER. FEW TO FREQUENT OCCURRENCES OF ICE LENSES IN UPPER 2-5 m, RARE BELOW.
THAW SETTLEMENT POTENTIAL 0-10 m			1.6 (4.5)			1.6 (4.5)		0.6 (1.3)
THAW SETTLEMENT POTENTIAL 2-10 m			1.2 (4.1)			1.2 (4.1)		0.3 (0.5)
THAW SETTLEMENT POTENTIAL 4-10 m			0.8 (2.8)			0.8 (2.8)		0.1 (0.2)
SLOPE ∥ ℄ LENGTH (m)								
SLOPE ∥ ℄ ANGLE								
SLOPE ⊥ ℄ LENGTH (m) > 30°								
ERODIBILITY								
BUOYANCY								
REFERENCES & NOTES								

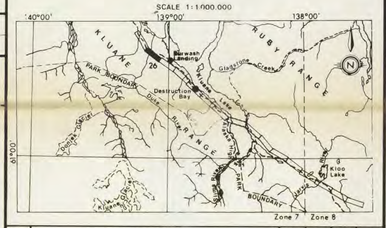
GENERAL NOTES

1. COORDINATES SHOWN HEREON ARE RELATED TO THE UNIVERSAL TRANSVERSE MERCATOR (U.T.M.) GRID.
2. ALL NOTED MEASUREMENTS ARE IN METRES UNLESS OTHERWISE SPECIFIED.
3. MOSAIC ILLUSTRATION REPRESENTS THE FOLLOWING:



REFERENCES & NOTES

INDEX MAP
SCALE 1:1 000 000



NO.	REVISION	DATE	BY	CHKD	APPD
1	GENERAL FORMAT AND DATA UPDATE	JAN.81			

ENGINEERING RECORDS			APPROVALS
DRAWN BY	B.T.	DATE FEB/81	
CHECKED BY	A.N.S.	FEB/81	
ENGINEER			

Foothills Pipe Lines (South Yukon) Ltd.

TITLE

THE ALASKA HIGHWAY GAS PIPELINE PROJECT

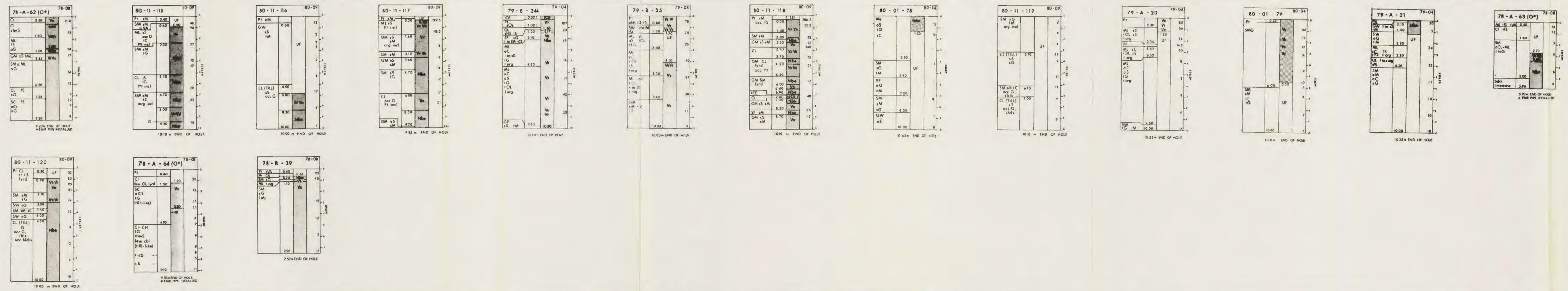
GEOTECHNICAL ATLAS

TR 880.51 F6 E48 1981 no.4-5 sheet 1

PREPARED BY
TERRAIN ANALYSIS AND MAPPING SERVICES LTD.
GEO-PHYSI-CON CO. LTD.

RGN	ZONE	FACILITY	NO.	DWG.TYPE	DRAWING NO.	REV.
2	01	02	01	GT	0026	1

DRILL HOLE DATA



GENERAL NOTES

1. COORDINATES SHOWN HEREON ARE RELATED TO THE UNIVERSAL TRANSVERSE MERCATOR (U.T.M.) GRID.
2. ALL NOTED MEASUREMENTS ARE IN METRES UNLESS OTHERWISE SPECIFIED.
3. MOSAIC ILLUSTRATION REPRESENTS THE FOLLOWING:

℄ OF PIPE
26 m
LOCATED R.O.W. REFERENCE LINE

REFERENCES & NOTES

MOSAIC
SCALE 1:10 000

TERRAIN TYPE & GROUP	fAB/aAF (13)	fAA (13)	AB/tMM (15)	mEV/tMM (23)	fAA (13)	fAA(A) (13)	fAA (13)	fAA(A) (13)	fAA (13)	mEV/tMM (23)	f/aAF (6)	f/gAF (6)
LENGTH ALONG ℄ (m)	1880	260	220	90	840	130	190	140	1130	1510	60	800

SOIL DESCRIPTION

fAB/aAF (13):
- 1-7 SILT, ORGANIC SILT, CLAYEY SILT, SILTY SAND, PEAT LAYERS (MEDIUM-HIGH)
- 0-5 GRAVEL, SILTY GRAVEL, SILTY SAND (LOW-MEDIUM)
- 3-8+ TILL OR SILTY GRAVEL (LOW)
- 1+ UNCONSOLIDATED DEPOSITS (LOW-NIL)

fAA (13):
- 0-5 SILT, ORGANIC SILT, CLAYEY SILT, SILTY SAND, PEAT LAYERS (MEDIUM-HIGH)
- 0-11 SILTY SAND, SILTY GRAVEL, SILTY CLAY, SILT, THIN PEAT LAYERS (LOW-MEDIUM, OCCASIONALLY HIGH)
- 0-6 SAND, GRAVEL, SILTY GRAVEL, SILTY SAND (LOW, OCCASIONALLY HIGH)
- 0-11+ TILL OR SILTY GRAVEL (LOW)
- 1+ UNCONSOLIDATED DEPOSITS (LOW-NIL)

mEV/tMM (23):
- 0-2 SILT, ORGANIC SILT, PEAT (LOW-MEDIUM)
- 0-5 SILTY SAND, SILTY GRAVEL, SILTY CLAY, THIN PEAT LAYERS, SILT (LOW-MEDIUM)
- 8-12+ TILL OR SILTY GRAVEL (LOW)
- 4+ BEDROCK (?) OR UNCONSOLIDATED DEPOSITS (LOW-NIL)

f/gAF (6):
- 0-3 SILT, ORGANIC SILT, PEAT (LOW-MEDIUM)
- 7-12+ GRAVEL, SILTY SAND, SILTY GRAVEL, FEW SILTY LAYERS (LOW)
- 1+ UNCONSOLIDATED DEPOSITS (LOW-NIL)

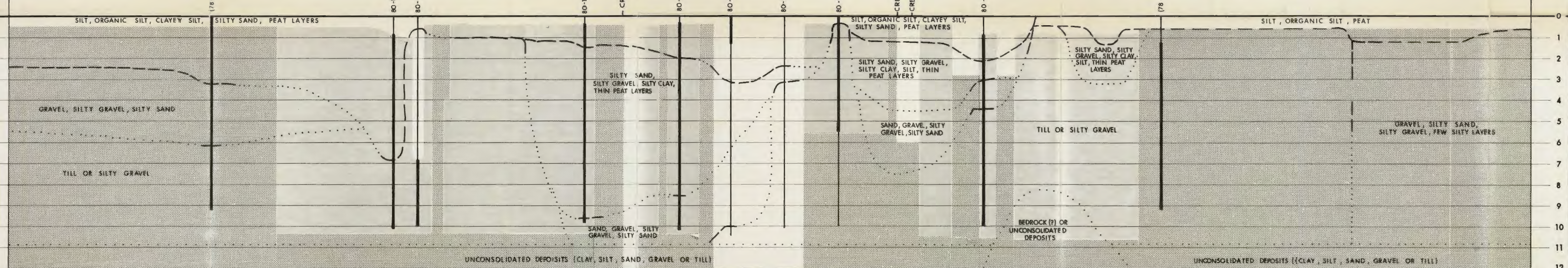
GEOPHYSICS SITE

ON R.O.W.: 80-11-GS-46 ←; 80-01-GS-60 →; 80-11-GS-47 →; 80-01-GS-61

OFF R.O.W.: cont'd ← 78-GS-62; ← 78-GS-63; 79-DK-29 →; 78-GS-64 →; 78-GS-65 →

DRILL HOLE DESIGNATION: (78-A-62), 80-11-115, 80-11-116, 80-11-117, CREEK, 80-11-118, 80-01-78, 80-11-119, 80-01-79, CREEK, CREEK, 80-11-120, (78-A-64)

CROSS SECTION ALONG ℄ (depth in metres)



GROUND ICE

- fAB/aAF: ICE CONTENTS MEDIUM TO HIGH IN UPPER 3 m, LOW TO MEDIUM BELOW. RARE TO FREQUENT OCCURRENCES OF ICE LENSES ABOVE 3 m, RARE TO FEW BELOW.
- fAA: HIGH ICE CONTENT IN UPPER 3-5 m, LOW TO OCCASIONALLY HIGH BELOW 3-5m. GENERALLY RARE OCCURRENCES OF ICE LENSES OR SEGREGATED ICE BELOW 5 m.
- fAA (1130): HIGH ICE CONTENT IN UPPER 3-5 m, LOW BELOW. OCCASIONAL TO FREQUENT OCCURRENCES OF ICE LENSES IN UPPER 3-5 m, RARE BELOW.
- mEV/tMM: LOW ICE CONTENT EXPECTED. RARE TO FEW OCCURRENCES OF ICE LENSES IN UPPER 2.5 m.

THAW SETTLEMENT POTENTIAL

	fAB/aAF	fAA	AB/tMM	fAA	fAA	mEV/tMM	f/gAF
0-10 m	1.2 (3.2)	1.1 (2.8)	0.6 (1.3)	1.2 (3.2)	1.2 (3.2)	0.6 (1.3)	1.6 (4.5)
2-10 m	0.7 (2.8)	0.6 (2.3)	0.3 (0.5)	0.7 (2.8)	0.7 (2.8)	0.3 (0.5)	1.2 (4.1)
4-10 m	0.5 (1.6)	0.1 (0.2)	0.1 (0.2)	0.5 (1.6)	0.5 (1.6)	0.1 (0.2)	0.8 (2.8)

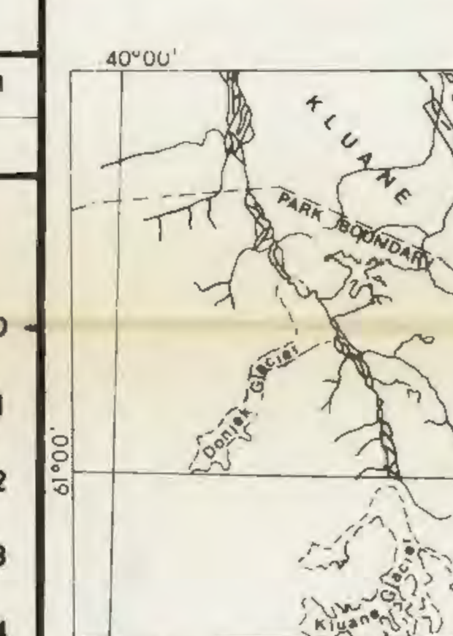
SLOPE: ALONG ℄ LENGTH (m); ANGLE; ⊥ ℄ LENGTH (m) > 10°

ERODIBILITY

BUOYANCY

REFERENCES & NOTES: IRREGULAR TALIKS MAY BE MORE COMMON THAN INDICATED

INDEX MAP
SCALE 1:1 000 000



NO.	REVISION	DATE	BY	CHKD	APPD
1	GENERAL FORMAT AND DATA UPDATE	JAN.81			

ENGINEERING RECORDS		DATE
DRAWN BY	B.T.	FEB/81
CHECKED BY	A.N.S.	FEB/81
ENGINEER		

APPROVALS

Foothills Pipe Lines (South Yukon) Ltd.

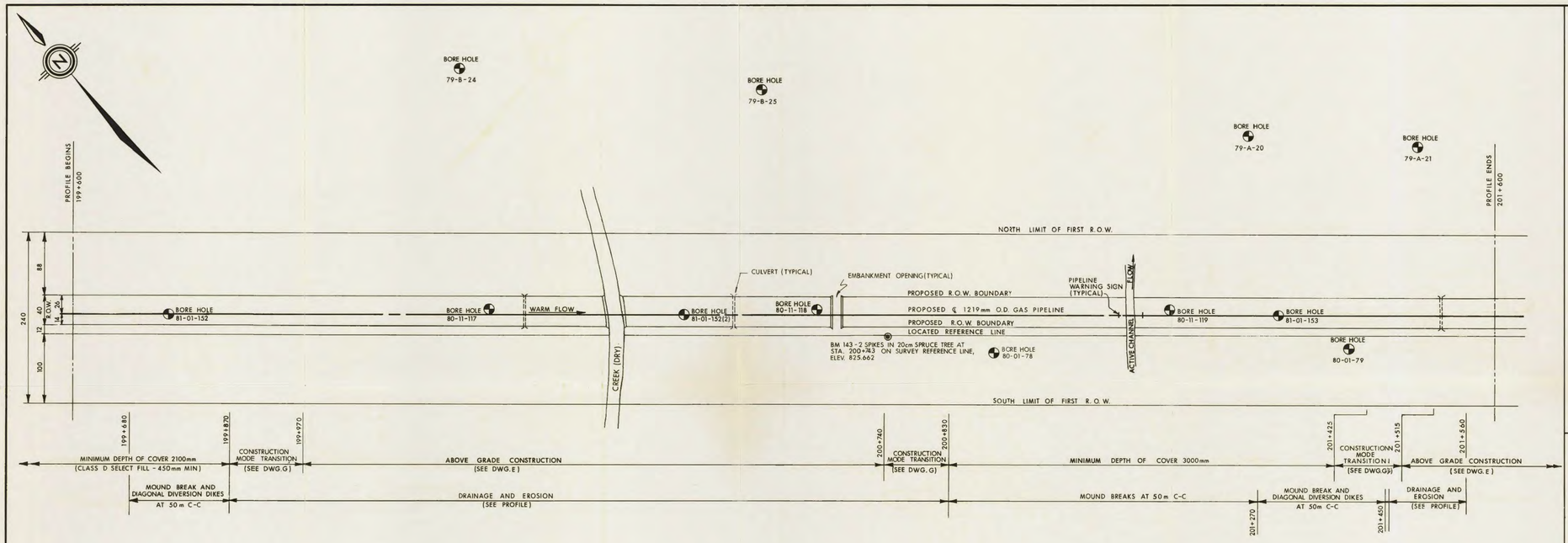
TITLE

THE ALASKA HIGHWAY GAS PIPELINE PROJECT

GEOTECHNICAL ATLAS

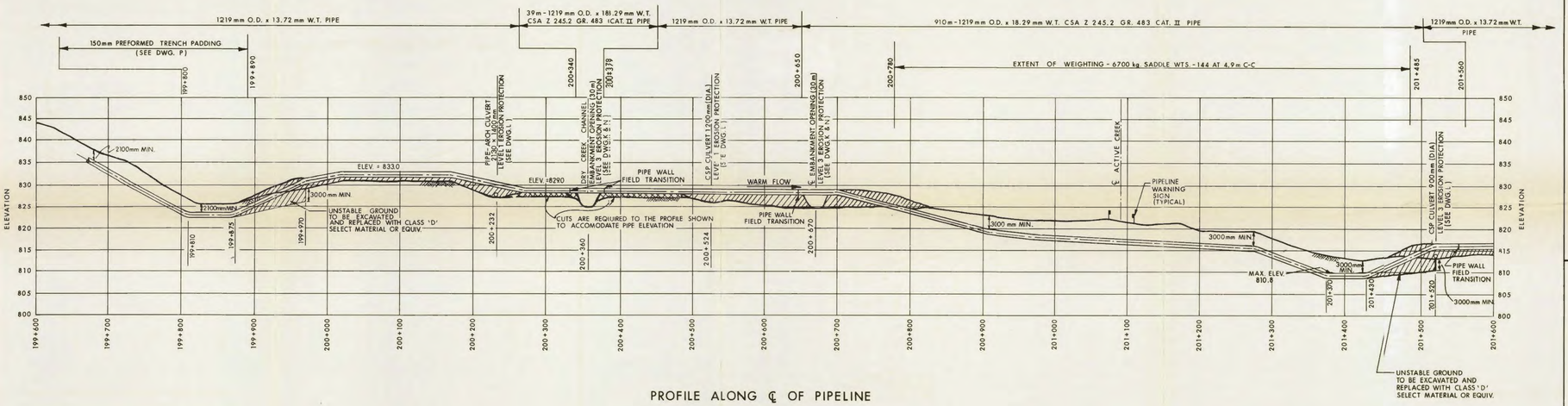
PREPARED BY TERRAIN ANALYSIS AND MAPPING SERVICES LTD.
GEO - PHYSI - CON CO. LTD.

RGN	ZONE	FACILITY	NO.	DWG.TYPE	DRAWING NO.	REV.
2	0 1	0 2	0 1	G T	0 0 2 9	1



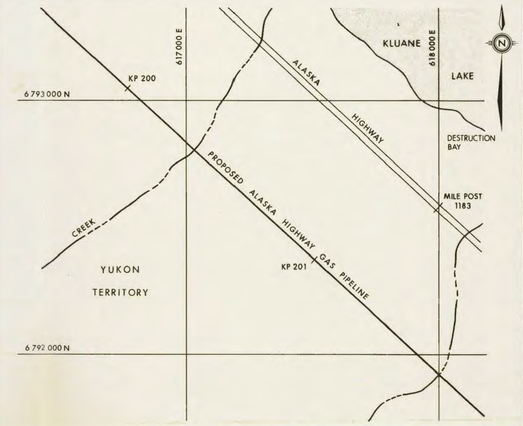
DETAIL PLAN

SCALE 1: 3000



PROFILE ALONG ℄ OF PIPELINE

SCALE : HORIZ. 1: 3000
VERT. 1: 500



LOCATION PLAN

UTM ZONE 7

SCALE 1:10 000

NOTES

1. MAXIMUM ELEVATIONS NOTED ON THE PROFILE SHALL NOT BE EXCEEDED. IN ADDITION, AT THE TIME OF THE CONSTRUCTION, CONTRACTOR SHALL ENSURE THAT THE MINIMUM DEPTHS OF COVER NOTED ON THE DRAWING ARE PROVIDED.
2. HYDROSTATIC TESTING PRIOR TO INSTALLATION IS NOT REQUIRED THROUGH UNNAMED CREEK DESIGN SECTION.
3. THE SECTIONS FROM 199 + 760 TO 199 + 970 AND 201 + 370 TO 201 + 520 SHALL BE RESTORED TO ORIGINAL CONTOURS. A SURFACE COURSE (300 mm APPROX.) OF CLASS 'E' SELECT MATERIAL (AS PER SPECIFICATIONS) SHALL BE ADDED TO THESE SECTIONS AT CLEAN-UP OVER THE EXTENT OF THE DISTURBED R.O.W.

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF ALBERTA
PERMIT NUMBER P 3220
Yukon Pipeline Design Joint Venture (YPD)

PIPE SPECIFICATIONS

1219 mm O.D. x 18.29 mm W.T. CSA Z245.2 GRADE 483, CATEGORY II AND FOOTHILLS SPEC: P-100, LATEST REVISION

1219 mm O.D. x 13.72 mm W.T. CSA Z245.2 GRADE 483, CATEGORY II AND FOOTHILLS SPEC: P-100, LATEST REVISION

MAXIMUM OPERATING PRESSURE: 8690 kPa

MINIMUM HYDROSTATIC TEST PRESSURE: 10870 kPa

MAXIMUM HYDROSTATIC TEST PRESSURE: 11950 kPa

MINIMUM MILL TEST PRESSURE: 95% SMYS

CORROSION PROTECTION: FUSION BONDED EPOXY THIN FILM COATING, NOMINAL THICKNESS 0.3 mm
FOOTHILLS SPEC: C-801, LATEST REVISION

RADIOGRAPHY: 100%

TW 380.51 F6 E68 addn. no.4-5 sheet 4

GENERAL NOTES

A. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE SPECIFIED.
B. ALL FIELD BENDS SHOWN ARE APPROXIMATE ONLY AND ALTERNATE CONFIGURATIONS SHALL BE FIELD DETERMINED.
C. ALL ELEVATIONS ARE GEODETIC.
D. THE CROSSINGS HAVE BEEN DESIGNED AND SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE PROVISIONS AND LATEST REVISIONS OF:
-THE NORTHERN PIPELINE ACT
-THE NATIONAL ENERGY BOARD ACT AND THE NEB GAS PIPELINE REGULATIONS
-CSA Z184-M1979

REFERENCE DRAWINGS

CODE	TITLE	DWG. NO.
A	ALIGNMENT SHEET	2 01 02 00 AL 0029
B	GEOTECHNICAL ATLAS	2 01 02 01 GT 0029
C	PLAN AND PROFILE	2 01 02 00 PP 0029
D	SADDLE WEIGHT 6700 kg (1219mm)	2 00 02 00 EN 0040
E	CONCRETE RESTRAINING WEIGHT WARM FLOW (1219 mm)	2 00 02 00 EN 0048
F	PIPELINE WARNING SIGN	2 00 02 00 EN 0032
G	TYPICAL TRANSITION BURIED TO ABOVE GRADE	2 00 02 00 TP 0066
H	PIPE WALL FIELD TRANSISTION	2 00 02 00 EN 0029
J	TYPICAL MOUND BREAK & DIVERSION DIKES - 2 SHEETS	2 00 02 00 TP 0050
K	TYPICAL EMBANKMENT OPENING	2 00 02 00 TP 0052
L	TYPICAL CULVERT INSTALLATION - 2 SHEETS	2 00 02 00 TP 0054
M	TYPICAL TRENCH CROSS SECTION WARM FLOW	2 00 02 00 TP 0062
N	INSULATED COAXIAL STEEL FREE SPAN	2 00 02 00 EN 0049
P	PREFORMED TRENCH PADDING DETAIL	2 01 02 00 EN 0039

MICROFILM RECORD

FILM NO.	DATE

REVISIONS

NO.	DESCRIPTION	DATE	BY	CHKD.	APPR. TYP.	APPR. FIL.
A	FORWAL APPROVAL	81/04/22				
B	GENERAL	81/10/23				
C	GENERAL	81/12/03				
D	PREFORMED TRENCH PADDING	81/12/17				

REFERENCE DRAWINGS

CODE	TITLE	DWG. NO.

NORTHERN PIPELINE AGENCY CANADA

ENGINEERING RECORDS

	DRAWN BY	CHECKED BY	DATE
	D. WONG		81 08 28
ENGINEER			
SUPERVISOR			81 12 04
MANAGER			81 12 17

FOOTHILLS APPROVALS

ENGINEER	81 12 17
SUPERVISOR	81-12-17
MANAGER	81-12-17

Foothills Pipe Lines (South Yukon) Ltd.

THE ALASKA HIGHWAY GAS PIPELINE PROJECT

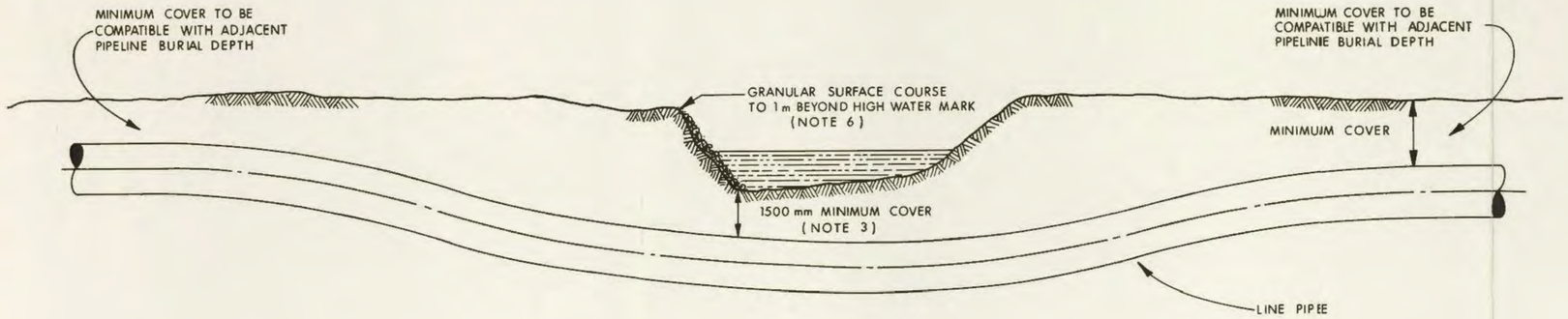
1219mm O.D. GAS PIPELINE CROSSING

CREEK WX 1029

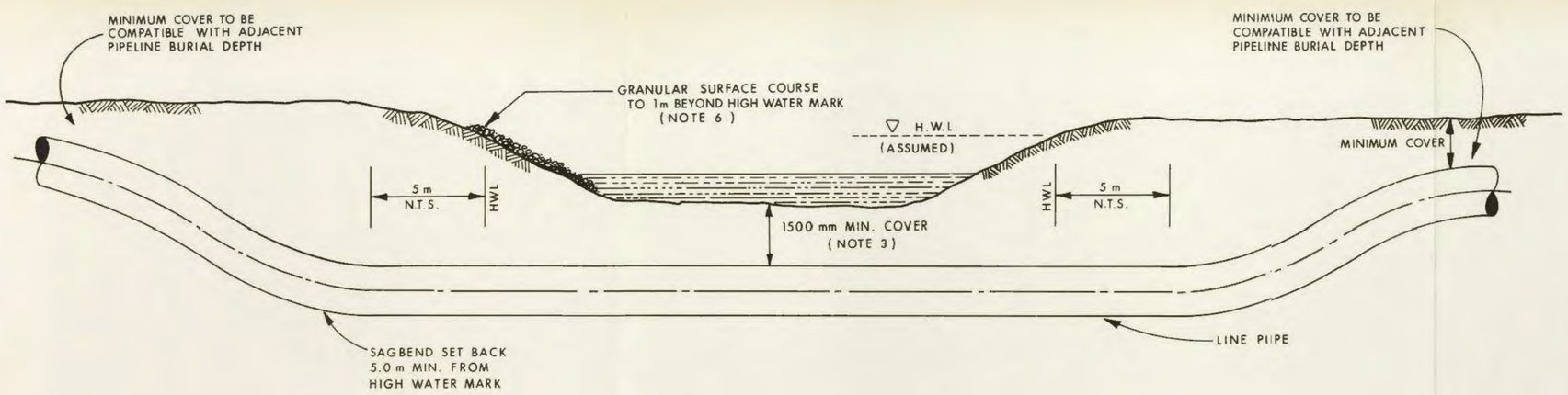
PREPARED BY YUKON PIPELINE DESIGN JOINT VENTURE
APK CANUCK MONENCO PETROTECH

SCALE:	RGN.	ZONE	FACILITY	NO.	DWG. TYPE	DRAWING NO.	REV.
AS SHOWN	2	0 1	0 2	0 0	W X	1 0 2 9	

METRIC B1 SUPP. FORM 277, SEPT. 80 PIPELINE & GENERAL



SINGLE SAG



DOUBLE SAG

NOTES

1. SINGLE SAG CROSSINGS SHALL BE USED WHERE STREAM GEOMETRY PERMITS MINIMUM COVER TO BE MAINTAINED, AND NO EVIDENCE OF CAVING BANKS, WASH, SCOUR OR SHIFTING BOTTOM CONDITIONS EXISTS.
2. DOUBLE SAG CROSSINGS SHALL BE USED WHERE GEOMETRY DOES NOT PERMIT USE OF THE SINGLE SAG DESIGN, OR WHERE, DUE TO ERODING BANK CONDITIONS, THE PIPELINE MUST BE CARRIED INTO THE BANKS TO MAINTAIN MINIMUM COVER DURING THE LIFETIME OF THE PIPELINE.
3. MINIMUM COVER IN SOLID ROCK MAY BE REDUCED TO 0.9 m ABOVE TOP OF PIPE.
4. THE CROSSING SHALL BE DESIGNED AND CONSTRUCTED IN ACCORDANCE WITH C.S.A. Z 184, THE NATIONAL ENERGY BOARD REGULATIONS AND THE NORTHERN PIPELINE ACT.
5. STREAM CROSSING SHALL BE RESTORED TO APPROXIMATE ORIGINAL CONDITIONS AND PROFILE.
6. BANKS WILL BE COVERED WITH A 150 mm GRANULAR BLANKET OF CLASS "C" MATERIAL OR BETTER WHEN DIRECTED BY MANAGER.
7. BUOYANCY CONTROL WEIGHTS SHALL BE INSTALLED AT LOCATIONS SPECIFIED ON THE ALIGNMENT SHEETS OR AS DIRECTED BY MANAGER DURING INSTALLATION.

GENERAL NOTES

REFERENCE DRAWING

DRAWING NO.	TITLE

MICROFILM RECORD

FILE NO.	DATE

REVISIONS

NO.	DESCRIPTION	DATE	BY	CHKD.	APPR. YPD	APPR. FPL
A	INFORMAL REVIEW	820108				
B	GENERAL	820122				

NORTHERN PIPELINE AGENCY

ENGINEERING RECORDS

DRAWN BY	CHECKED BY	DATE:
G. Y.		81 10 16
ENGINEER		
SUPERVISOR		
MANAGER		

FOOTHILLS APPROVALS

ENGINEER	DATE:
SUPERVISOR	
MANAGER	

SCALE N. T. S.

Foothills Pipe Lines (South Yukon) Ltd.

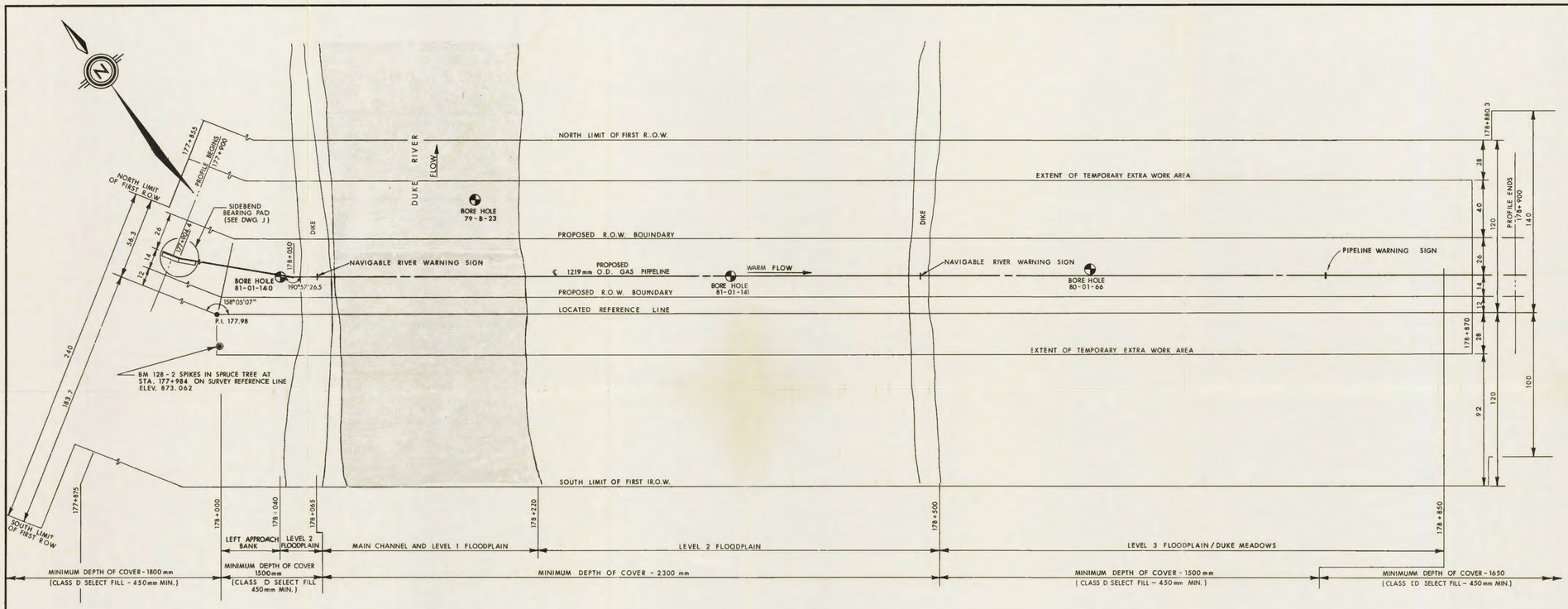
THE ALASKA HIGHWAY GAS PIPELINE PROJECT

TYPICAL WATER CROSSING

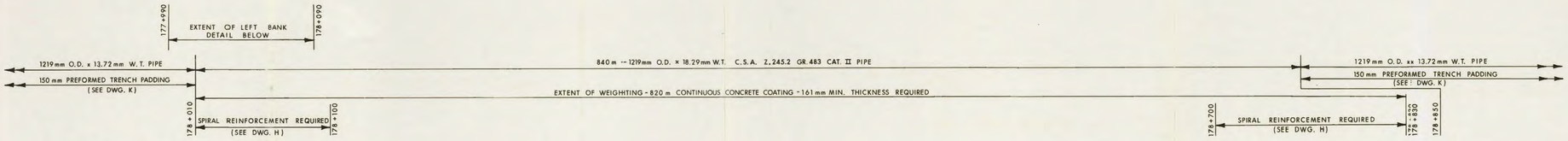
PREPARED BY
YUKON PIPELINE DESIGN JOINT VENTURE
APK CANUCK MONENCO PETROTECH

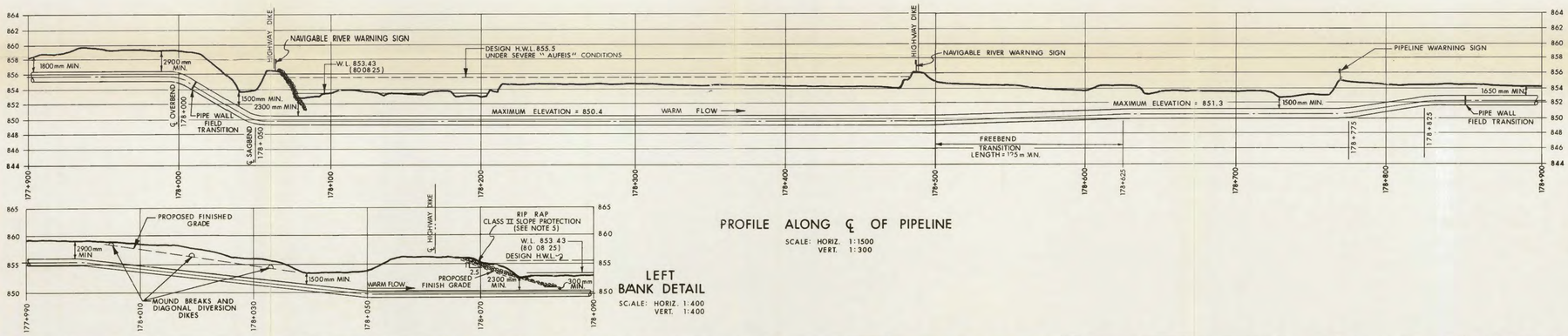
RGN	ZONE	FACILITY	NO.	DWG. TYPE	DRAWING NO.	REV.
2	0 0	0 2	0 0	T P	0 0 4 2	B

METRIC A2, FORM 260 AUG. 80



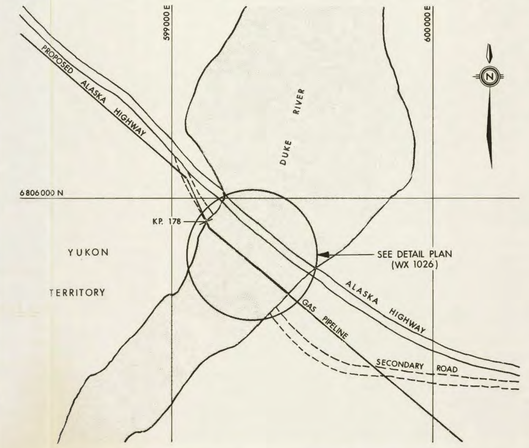
DETAIL PLAN
SCALE: 1:1500





PROFILE ALONG ℄ OF PIPELINE
SCALE: HORIZ. 1:1500
VERT. 1:300

LEFT BANK DETAIL
SCALE: HORIZ. 1:400
VERT. 1:400



LOCATION PLAN
UTM ZONE 7
SCALE 1:10000

NOTES

1. MAXIMUM ELEVATIONS NOTED ON THE PROFILE SHALL NOT BE EXCEEDED. IN ADDITION, AT THE TIME OF THE CONSTRUCTION, CONTRACTOR SHALL ENSURE THAT THE MINIMUM DEPTHS OF COVER NOTED ON THE DRAWING ARE PROVIDED.
2. THE SECTION FROM 177 + 950 TO 178 + 850 SHALL BE HYDROSTATICALLY TESTED AT A MINIMUM PRESSURE OF 11950 kPa FOR ONE HOUR PRIOR TO INSTALLATION.
3. ALL SIDE SLOPES ALONG THE GRADED LEFT APPROACH SLOPE SHALL NOT BE FINISHED STEEPER THAN 2(H) : 1(V).
4. A BEARING PAD EXTENDING FROM DITCH BOTTOM TO FINISHED GRADE, SHALL BE CONSTRUCTED AS SHOWN, OF CLASS 'D' MATERIAL OR EQUIVALENT IN MAXIMUM 0.15 m LIFTS AND COMPACTED TO 95% STANDARD PROCTOR AS PER ASTM D-698.
5. ROCK RIP RAP IS EXISTING IN PRESENT HIGHWAY DIKE AND SHALL BE SALVAGED DURING GRADING (OR EQUIVALENT CLASS II MATERIAL PROVIDED) AND RE-PLACED TO A MINIMUM 0.9 m THICKNESS, EXTENDING FROM 0.3 m FROM TOP OF CONCRETE COATING IN THE TRENCH TO THE TOP OF THE DIKE AS SHOWN. DIKE IS CURRENTLY KEYED INTO THE LEFT UPSTREAM BANK AND THIS TIE-IN IS TO RE-MAIN UNDISTURBED. CONTRACTOR SHALL ENSURE THAT NO GAP EXISTS IN THE CONTINUITY OF THE ROCK RIP RAP OUTSIDE OF THE TRENCH BETWEEN THE EX-POSED PORTION AND THE EXISTING BURIED PORTION.
6. THE SECTION FROM 178 + 065 TO 178 + 770 SHALL BE BACKFILLED TO APPROX-IMATELY THE ORIGINAL GROUND SURFACE.

PIPE SPECIFICATIONS

1219 mm O.D. x 18.29 mm W.T. CSA Z245.2 GRADE 483, CATEGORY II AND FOOTHILLS SPEC: P-100, LATEST REVISION

1219 mm O.D. x 13.72 mm W.T. CSA Z245.2 GRADE 483, CATEGORY II AND FOOTHILLS SPEC: P-100, LATEST REVISION

MAXIMUM OPERATING PRESSURE: 8690 kPa

MINIMUM HYDROSTATIC TEST PRESSURE: 10870 kPa

MAXIMUM HYDROSTATIC TEST PRESSURE: 11950 kPa

MINIMUM MILL TEST PRESSURE: 95% SMYS

CORROSION PROTECTION: FUSION BONDED EPOXY THIN FILM COATING, NOMINAL THICKNESS 0.3 mm FOOTHILLS SPEC: C-801, LATEST REVISION

RADIOGRAPHY: 100%

TN 440.81 FC E&W addn. no. 4-5 sheet 6

GENERAL NOTES

A. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE SPECIFIED.
B. ALL FIELD BENDS SHOWN ARE APPROXIMATE ONLY AND ALTERNATE CONFIGURATIONS SHALL BE FIELD DETERMINED.
C. ALL ELEVATIONS ARE GEODETIC.
D. THE CROSSINGS HAVE BEEN DESIGNED AND SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE PROVISIONS AND LATEST REVISIONS OF:
-THE NORTHERN PIPELINE ACT
-THE NATIONAL ENERGY BOARD ACT AND THE NEB GAS PIPELINE REGULATIONS
-CSA Z184-M1979

REFERENCE DRAWINGS

CODE	TITLE	DWG. NO.
A	ALIGNMENT SHEET	2 01 02 00 AL 0026
B	GEOTECHNICAL ATLAS	2 01 02 01 GT 0026
C	PLAN AND PROFILE	2 01 02 00 PP 0026
D	PIPELINE WARNING SIGN	2 00 02 00 EN 0032
E	NAVIGABLE RIVER WARNING SIGN	2 00 02 00 EN 0033
F	TYPICAL TRENCH CROSS SECTIONS WARM FLOW	2 00 02 00 TP 0062
G	TYPICAL MOUND BREAK & DIVERSION DIKES - 2 SHEETS	2 00 02 00 TP 0050
H	CONTINUOUS CONCRETE COATING	2 00 02 00 EN 0044
J	TYPICAL SIDEBEND BEARINGS PAD	2 00 02 00 TP 0060
K	PREFORMED TRENCH PADDING DETAIL	2 01 02 00 EN 0039
L	PIPE WALL FIELD TRANSITION	2 00 02 00 EN 0029

MICROFILM RECORD

FILM NO.	DATE

REVISIONS

NO.	DESCRIPTION	DATE	BY	CHKD.	APPR. YPD	APPR. FPL
0	SUBMIT TO NPA	811211				

NORTHERN PIPELINE AGENCY CANADA

ENGINEERING RECORDS

DRAWN BY L. LITORCO	CHECKED BY	DATE 81 04 16
ENGINEER		81 11 10
SUPERVISOR		81 11 10
MANAGER		81 12 10

FOOTHILLS APPROVALS

ENGINEER	81/12/8
SUPERVISOR	81/12/10
MANAGER	81/12/11

SCALE: AS SHOWN

Foothills Pipe Lines (South Yukon) Ltd.

THE ALASKA HIGHWAY GAS PIPELINE PROJECT
1219mm O.D. GAS PIPELINE
CROSSING
DUKE RIVER
WX 1026

PREPARED BY YUKON PIPELINE DESIGN JOINT VENTURE
AKL ... MONENCO PETRTECH

RGN.	ZONE	FACILITY	NO.	DWG. TYPE	DRAWING NO.	REV.
2	01	02	00	WX	1026	0

METRIC B1 SUPP. FORM 217, SEPT. 80 PIPELINE & GENERAL

TRACT NO.		1-026	2-026	3-026	4-026	5-0216	6-026	7-026	8-026	9-026
OWNERSHIP		T.L.-DIAND (KLUANE GAME SANCTUARY)	C.L. ROAD	T.L-DIAND (KLUANE GAME SANCTUARY)	T.L. P.W.C. B.H. RES.	T.L-DIAIND (KLUANE GAME SANCTUARY)	C.L. ROAD	T.L.-DIAND (KLUANE GAME SANCTUARY)	C.L. ROAD	T.L. DIAND (KLUANE GAME SANCTUARY)

Tract boundaries: 177+039.2, 177+060.8, 177+977.2, 178+282.2, 178+955.9, 178+981.9, 180+114.9, 180+135.2

SPECIAL CONDITIONS: NO CONSTRUCTION ACTIVITY ALLOWED MAY 1 - JUL 31, 1984; OTHER YEARS, NO CONSTRUCTION ACTIVITY ALLOWED MAR 20 - JUL 31I. AVOID POSTED SITE SOUTH OF R.O.W. (181+580.0 – 181+610.0)

STATION: 176+240.0 | 177+000.0 | 179+000.0 | 181+580.0 | 181+610.0 | 183+280.0

RIGHT OF WAY (ENGINEERING / ENVIRONMENTAL CONSTRUCTION)

DRAINAGE / EROSION — ACROSS: REF. A; TYPE: DUKE RIVER (WX-1026)

DRAINAGE / EROSION — ALONG:

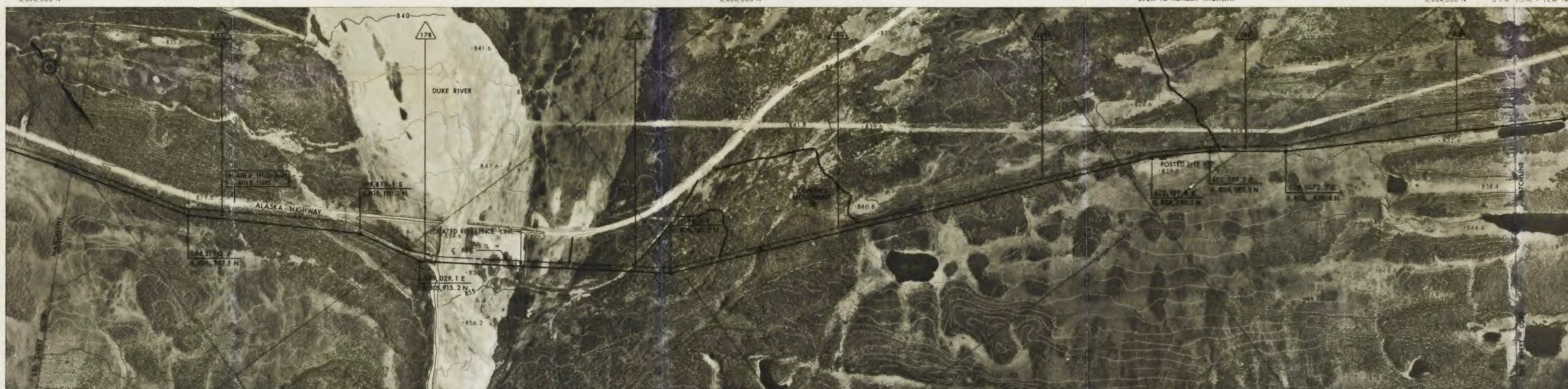
STN.	TYPE	REF.
176+240.0 – 176+970	MOUND BREAK AVG. 150m SPACING	E
176+970 – 177+470	MOUND BREAK AVG. 50m SPACING	E
177+470 – 177+650	MOUND BREAK AVG. 65m SPACING & DIAGONAL DIKES	E
177+650 – 177+875	MOUND BREAK AVG. 65m SPACING	E
178+850	MOUND BREAK AVG. 150m SPACING	E
– 179+600	MOUND BREAK AVG. 30m SPACING, DIAGONAL DIKES	E
179+700 – 180+000	MOUND BREAK AVG. 50m SPACING & HERRING BONE DIKES	E
180+000 –	MOUND BREAK AVG. 150m SPACING	E

PIPELINE OFFSET FROM REFERENCE LINE: 26m ℄ PIPE; 176+821.2; 30m 176+839.2; LOCATED REFERENCE LINE; 52m 177+590.9; 26m 177+663.41; 26m 36m 177+904.4; 178+050.0 26m 178+000.0; REFER TO TYPICAL R.O.W. FROM KP 178+050.0 TO KP 182+191.3; 26m 182+191.3; ℄ PIPE LOCATED REFERENCE LINE 90m 182+797.0; 90m 76m 183+152.0

TEST WATER: TEST SECTION: 214-1 (13.53 km FROM KP. 164+968 TO KP 178+500) — WATER SOURCE: DUKE RIVER; WATER DISCHARGE: KP 165+015; TEST MEDIUM: WARM WATER — WATER SOURCE 178+500 — TEST SECTION: 214-2 (11.80 km FROM KP 178+500 TO KP 190+300) — WATER SOURCE: DUKE RIVER; WATER DISCHARGE: KP 190+408; TEST MEDIUM: WARM WATER

RESTORATION: ACTIVE REVEGETATION (PROCEDURE 2-01-B) 176+990 ACTIVE REVEGETATION (PROCEDURE 2-02-B) 178+030 178+460 ACTIVE REVEGETATION (PROCEDURE 2-01-B)

MOSAIC SCALE 1:10,000



CHAINAGE EQUATION +188.5

SURVEY DATA — HORIZ. CHAINAGE (SLACK CHAINAGE) — LOCATED REFERENCE LINE

176+240.0 (176,240.0); 176+682.4; 176+790.9; 176+839.2 (194°28'52"); 176+884.0; 177+225.4; 177+558.5; 177+624.5; 177+663.4 (161°17'02"); 177+706.9; 177+934.7; 177+977.2 (201°54'53"); 178+031.1; 178+501.2; 178+929.1; ℄ ROAD; 179+125.5; 179+169.3 (196°18'02"); 179+210.8; 179+705.6; 179+896.1; 180+298.9; 180+741.3; 181+151.4; 181+547.9 (172°38'23"); 181+826.6 (173°54'15"); 182+191.3 (186°48'14"); 182+606.9; 183+133.7; 183+280.0 (183,285.9)

REF. DWG. CODE

PIPELINE (ENGINEERING / ENVIRONMENTAL / CONSTRUCTION)

PIPELINE DATA AND CONSTRUCTION MODES: MATCHLINE 176+240.0; 177+000.0; 177+039.2; ℄ ROAD; 177+060.8; 1219mm O.D.×18.29mm W.T. GR. 483; 177+050.0; 177+534.0; 177+604.0; ℄ BEARING PAD; 177+894.4; 177+904.4; 177+914.4; 178+000.0; 178+010.0; SPIRALLY REINFORCED; 178+065.0; 178+100.0; ℄ ACTIVE CHANNEL; 178+144.0; 1219mm O.D.×18.29mm W.T. GR. 483; 178+500.0; 178+700.0; SPIRALLY REINFORCED; 178+830.0; 178+850.0; 178+977.0; ℄ ROAD; 179+003.1; 179+010.0; 178+990.1; 1219mm O.D.×18.29mm W.T. GR. 483; 179+070.2; ℄ I.B.V.-213; 179+089.8; 179+500.0; 179+620.0; 179+080.0; 179+550.0; 179+620.0; 179+716.0; DT; 180+000.0; 180+125.1; 180+114.9; ℄ ROAD; 180+135.2; 1219mm O.D.×18.29mm W.T. GR. 483; 180+500.0; 181+000.0; WARM FLOW; ℄ CREEK; 181+850.0; 182+000.0; ℄ BEARING PAD; 182+181.3; 182+191.3; 182+201.3; 183+000.0; MATCHLINE 183+280.0; 150mm FOAM; 300mm FOAM; FT

MAXIMUM OPERATING PRESSURE - 8690 kPa
MINIMUM FIELD TEST PRESSURE - 10870 kPa

REFERENCE DRAWING: C | D | C | N | C AND P | A | C AND P | D AND P | C AND P | B | C AND P | N | C AND P | N | C | D | C | L | M

RANGE OF CROSS-SLOPE PERCENT: -2.5 TO -5.0 (176+450.0); -7.5 TO -10.0 (176+550.0); -2.5 TO -5.0 (176+650.0); 0 TO -2.5 (176+750.0); 2.5 TO 5.0 (176+850.0); 0 TO -2.5 (177+039.2); - (177+060.8); 5.0 TO 15.0 (177+350.0); 10.0 TO 15.0 (177+650.0); 0 TO 7.5 (177+875.0); – (178+850.0); 0 TO 2.5 (178+977.0); - (179+003.1); 0 TO 2.5 (179+070.2); - (179+089.8); 0 TO 2.5; 2.5 TO 5.0 (179+750.0); 0 TO 2.5 (179+950.0); 0 TO 7.5 (180+114.9); - (180+135.2); 0 TO 7.5 (180+350.0); 0 TO -2.5 (180+450.0); 2.5 TO 7.5 (180+750.0); 0 TO 2.5 (180+850.0); 2.5 TO 7.5 (181+150.0); 0 TO 5.0 (181+450.0); 0 TO -2.5 (181+550.0); -2.5 TO -7.5 (181+950.0); 0 TO -5.0 (182+450.0); -2.5 TO -7.5 (182+950.0); -7.5 TO -10.0 (183+050.0); -10.0 TO -15.0 (183+150.0); -15.0 TO -20.0

MIN. DEPTH OF TRENCH: 3.2 | 3.1 (177+505.0 – 177+534.0) | – | 3.4 (177+604.0) | DUKE RIVER | 3.2 | – | 3.2 | 4.8 (179+550.0 – 179+620.0; 179+646.0 – 179+716.0) | 2.9

DEPTH OF SELECT BACKFILL: 0.5 | 0.9 | – | 0.5 | DUKE RIVER | 0.5 | – | 0.5 | 3.1 | 0.5

GENERAL NOTES

1. COORDINATES SHOWN HEREON ARE RELATED TO THE UNIVERSAL TRANSVERSE MERCATOR (U.T.M.) GRID.
2. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE SPECIFIED.
3. DRAWING NOT TO SCALE UNLESS OTHERWISE INDICATED.
4. REFER TO PLAN AND PROFILE AND BOOK OF REFERENCE FOR ADDITIONAL LAND AND SURVEY INFORMATION.
5. PIPELINE OFFSET INDICATES VARIATION OF PIPE CENTRELINE FROM LOCATED REFERENCE LINE.
6. CROSS SLOPES ARE APPROXIMATE AND WILL BE FIELD CHECKED. POSITIVE CROSS SLOPES DROP TO THE NORTH OR THE EAST. NEGATIVE CROSS SLOPES DROP TO THE SOUTH OR THE WEST.
7. LOCATION OF DRAINAGE, EROSION AND CROSSING RAMP FACILITIES ARE APPROXIMATE AND ARE SUBJECT TO FIELD ADJUSTMENT. LEVEL NUMBERS REFER TO EROSION PROTECTION CLASSIFICATION.

AERIAL PHOTOGRAPHY

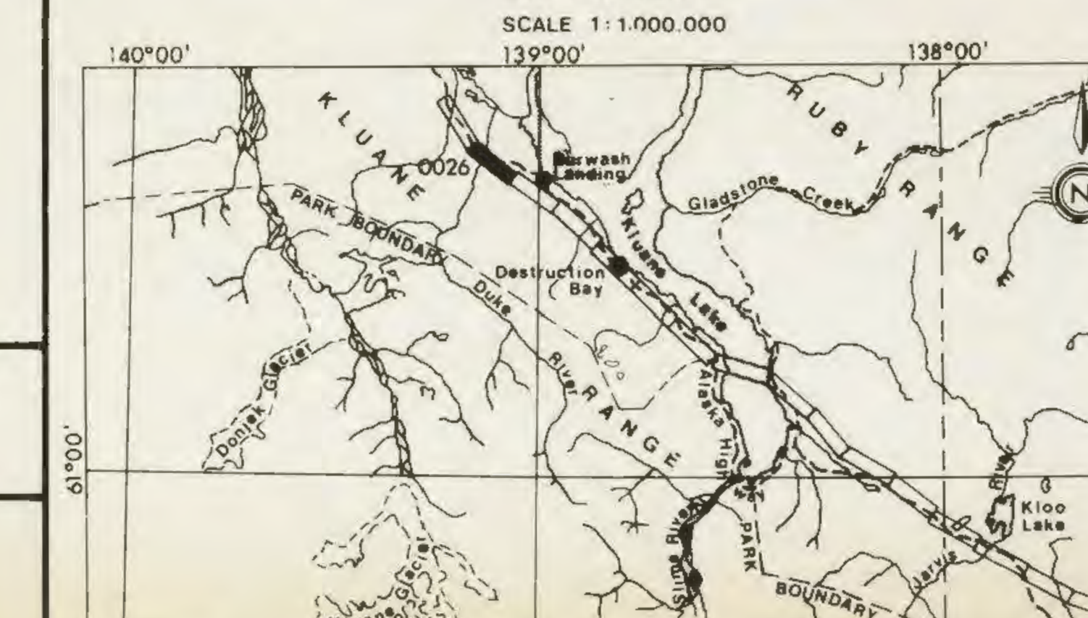
ROLL NO.	LINE NO.	PHOTO NOS.	SCALE	DATE
NW67778	85E	154-159	1:24 000	1978

PIPELINE MATERIALS LIST

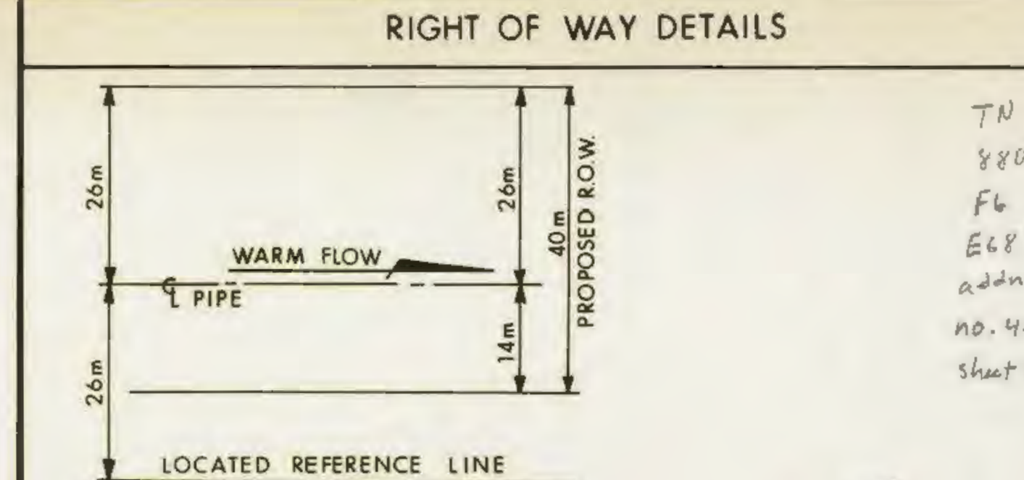
QUANTITY	DESCRIPTION	WBS NO.
6120m	PIPE, 1219mm O.D. × 13.72mm W.T. GR. 483	
	CSA Z 245.2 CAT. II, FOOTHILLS SPEC. P-100	
910m	PIPE, 1219mm O.D. × 18.29mm W.T. GR. 483	
	CSA Z 245.2 CAT. II,	
	FOOTHILLS SPEC. P-100	
1	INTERMEDIATE BLOCK VALVE I.B.V. - 213 (SEE REF.	
	DRAWING CODE 'B' FOR DETAILED MATERIALS LIST)	
9	PIPELINE WARNING SIGN	
2	WARNING SIGN-NAVIGABLE RIVER TYPE	
6	TEST LEAD - 2P/4Z/R TYPE	
1	TEST LEAD - 2P/4Z/R/H TYPE	
2	TEST LEAD - 4C TYPE	
1	TEST LEAD - P/R/H TYPE	
1	AERIAL MARKER	
12460m	ZINC RIBBON	
20m	PIPE, 1219mm O.D. x 18.29mm W.T. GR. 483	
	CSA Z 245.2 CAT. II, FOOTHILLS SPEC. P-100	
	FOR I.B.V. BLOWDOWN ASSEMBLY	

INDEX MAP

SCALE 1:1,000,000



RIGHT OF WAY DETAILS



TYPICAL

TN 880.51 F6 E68 addn. no. 4-5 sheet 7

PROFESSIONAL ENGINEER ALASKA — F. F. SMITH

MOSAIC & SURVEY LEGEND

- LOCATED REFERENCE LINE
- P.I. OR DEFLECTION POINT
- POINT ON TANGENT
- CONTROL MONUMENT
- SURVEY CHECK POINT
- U.T.M. COORDINATE (451530 E / 674480 N)
- KILOMETRE POST (100)
- BURIED CABLE
- FENCE
- TELEPHONE OR TELEGRAPH LINE
- POWER LINE
- FOREIGN PIPELINE
- PROPOSED PERMANENT ACCESS
- EXISTING TEMPORARY ACCESS
- PROPOSED TEMPORARY ACCESS

PIPELINE LEGEND

- CARRIER PIPE
- HEAVY WALL PIPE
- CASING PIPE
- CARRIER PIPE AND ZINC RIBBON
- INSULATED PIPE
- CONCRETE COATED PIPE
- BOLT-ON WEIGHT
- SET-ON WEIGHT
- SELECT BACKFILL
- WARNING SIGNS
- BLOCK VALVE ASSEMBLY
- SCRAPER TRAP ASSEMBLY
- SIDE TAP
- TEST LEAD
- 100 AERIAL MARKER
- FT FIELD TRANSITION
- CULVERT
- CULVERT WITH END SECTION
- DT DEPTH TRANSITION

ROAD CROSSING, GRADE, SIDE BEND BEARING PAD, ABOVE GRADE, CONCRETE RESTRAINED MODE, CROSSING RAMP, EMBANKMENT OPENING, BURIED PIPE, PREFORMED TRENCH BEDDING, WATER CROSSING

REFERENCE DRAWINGS

CODE	TITLE	DRAWING NUMBER
A	DUKE RIVER WX-1026	2 01 02 00 WX 1026
B	INTERMEDIATE BLOCK VALVE (I.B.V.-213) BLOWDOWN ASSEMBLY	2 01 02 00 EN 0021
C	TYPICAL TRENCH CROSS SECTIONS WARM FLOW	2 00 02 00 TP 0062
D	TYPICAL SECONDARY ROAD CROSSING-UNCASED HEAVY WALL PIPE	2 00 02 00 TP 0044
E	TYPICAL MOUND BREAK AND DIVERSION DIKES (2 SHEETS)	2 00 02 00 TP 0050
F	TYPICAL MONITORING - TEST STATION TYPE 2P/4Z/R	2 00 02 00 TP 0203
G	TYPICAL MONITORING - TEST STATION TYPE 4C	2 00 02 00 TP 0206
H	PIPELINE AERIAL MARKER	2 00 02 00 EN 0034
J	TYPICAL MONITORING - TEST STATION TYPE 2P/4Z/R/H	2 00 02 00 TP 0204
K	TYPICAL MONITORING - TEST STATION TYPE P/R/H	2 00 02 00 TP 0205
L	TYPICAL WATER CROSSING	2 00 02 00 TP 0042
M	TYPICAL SIDEBEND BEARING PAD	2 00 02 00 TP 0060
N	TYPICAL DEPTH TRANSITION BURIED WARM FLOW	2 01 02 00 TP 0067
P	PREFORMED TRENCH BEDDING	2 01 02 00 EN 0039
Q		
R		
S		
T		
U		

REVISIONS

NO.	DESCRIPTION	DATE	BY	CHKD.	APPR. YPD	APPR. FPL
A	INFORMAL REVIEW	81 10 20	A.S			
B	FORMAL REVIEW	81 12 09	A.S			
C	PREFORMED TRENCH BEDDING	82-01-07	A.S			
D	GENERAL	82-01-22	A.S			
E	DESIGN SUSPENDED	82 02 05				

MICROFILM

FILM NO.	DATE

NORTHERN PIPELINE AGENCY CANADA

ENGINEERING RECORDS

	DATE
DRAWN V.J. ROMANCHUK	81 04 09
DRAFTING CHECK RPT	81 10 20
DESIGN CHECK A.S	81 10 21
ENGINEER	81 12 10
ENVIRONMENTAL	
DESIGN MANAGER	82.01.27
PROJECT MANAGER	

FOOTHILLS PIPE LINES APPROVALS

	DATE
ENGINEER	
SUPERVISOR	
MANAGER	

Foothills Pipe Lines (South Yukon) Ltd.

DESIGN SUSPENDED

THE ALASKA HIGHWAY GAS PIPELINE PROJECT

ALIGNMENT OF 1219mm O.D. GAS PIPELINE

WARM FLOW DESIGN

STA. 176+240.0 TO STA. 183+280.0

PREPARED BY YUKON PIPELINE DESIGN JOINT VENTURE
APK CANUCK MONENCO PETROTECH

RGN.	ZONE	FACILITY	NO.	DWG. TYPE	DRAWING NO.	REV.
2	0 1	0 2	0 0	A L	0 0 2 6	E

TRACT NO.	1-029	198+555.0	2-029	202+4750	3-029
OWNERSHIP	T.L.-DIAND (KLUANE GAME SANCTUARY)		C.L. (DESTRUCTION BAY B.L.T.)		T.L. - DIAND (KLUANE GAME SANTUJARY)

SPECIAL CONDITIONS — STATION: 197+440.0 … 204+710.0

RIGHT OF WAY
ENGINEERING / ENVIRONMENTAL CONSTRUCTION

DRAINAGE / EROSION — ACROSS

REF.	A	G AND P	G AND P	H	H	B
TYPE	UNNAMED CREEK CROSSING (WX - 1029)	EMBANKMENT OPENING SPAN 30m CLEARANCE 4m LEVEL 3	EMBANKMENT OPENING SPAN 30m CLEARANCE 4m LEVEL 3	3 CULVERTS Ø 0.9m LEVEL-2	CULVERT Ø 1.2m LEVEL-0	BOCKS BROOK (WX-10030)

STN.: 199+400, 199+680, 201+560, 201+680, 201+760, 201+900, 201+975, 202+170, 202+300, 202+330, 202+680

DRAINAGE / EROSION — ALONG

- TYPE: MOUND BREAK AVG. 65m SPACING (REF. J); MOUND BREAK AVG. 50m SPACING DIAGONAL DIKES (REF. J); –; MOUND BREAK AVG. 50m SPACING (REF. J)

PIPELINE OFFSET FROM REFERENCE LINE: REFER TO TYPICAL R.O.W.

TEST WATER:
- TEST SECTION 214 - 3 (9.90 km FROM KP 190+300 TO KP 200+200)
- WATER SOURCE : KLUANE LAKE(200+200) WATER SOURCE 200+200; WATER DISCHARGE : KP 190+408 AND 200+200; TEST MEDIUM : WARM WATER
- TEST SECTION 214-4 (9.8 km FROM KP 200+200 TO KP 210+000)
- WATER SOURCE : KLUANE LAKE (200+200); WATER DISCHARGE : KP 209+610 AND 200+200; TEST MEDIUM : WARM WATER

RESTORATION: ACTIVE REVEGETATION (PROCEDURE 2-01-B) | 199+330 ACTIVE REVEGETATION (PROCEDURE 2-02-B) 199+970 | ACTIVE REVEGETATION (PROCDURE 2-03-O) 200+740 | ACTIVE REVEGETATION (PROCEDURE 2-01-B) 201+515 | ACTIVE REVEGETATION (PROCEDURE 2-03-O) 202+330 | ACTIVE REVEGETATION (PROCEDURE 2-01-B)

MOSAIC
SCALE 1:10,000 (100, 0, 500, 1000)

616,000 E — 6,794,000 — 618,000 E — 620,000 E — U T M ZONE 7 (CM 141° L)

6,792,000 N — 6,7990,000 N

CHAINAGE EQUATION +188.5

SURVEY DATA
LOCATED REFERENCE LINE

HORIZ. CHAINAGE (SLACK CHAINAGE): 197+440.0 (197,440.0); 197+991.1; 198+520.9; 199+109.8; 199+544.9; 199+743.6; 200+312.7; 200+479.7; 200+9523; 201+560.5; 202+160.3; 202+498.9; 203+050.3; 203+486.5 (184°39'47''); 203+700.0; 204+296.3; 204+710.0 (204,712.9)

REF. DWG. CODE: K, K, L, M, L, L, L, Q, K, K

PIPELINE
ENGINEERING / ENVIRONMENTAL / CONSTRUCTION

PIPELINE DATA AND CONSTRUCTION MODES:

MATCHLINE 197+440.0; 198+000.0; 199+000.0; 199+680.0; 199+870.0; 199+970.0; 200+000.0; [200] WARM FLOW; 200+340.0; 200+344.0; ℄ EMBANKMENT OPENING; 200+376.0; 200+379.0; 200+650.0; ℄ EMBANKMENT OPENING; 200+686.0; 200+780.0; 200+830.0; 6700 kg. SADDLE WTS. 144 @ 4.9m C-C; ℄ ACTIVE CREEK; 201+290.0; 201+425.0; 201+485.0; 201+560.0; 201+660.5; 201+664.0; ℄ EMBANKMENT OPENING; 201+696.0; 201+699.5; 201+740.5; 201+744.0; ℄ EMBANKMENT OPENING 201+776.0; 201+779.5; 202+430.0; 202+493.9; ℄ 114.3mm TAP; 202+506.1; 202+680.0; 203+000.0; 203+800.0; 204+000.0; MATCHLINE 204+710.0

FT 1219 mm O.D. × 18.29mm W.T. GR. 483 FT FT; 1219 mm O.D. × 18.29mm W.T. GR. 483; FT FT 1219mm O.D. × 18.29mm W.T. GR. 483 FT FT FT

199+800.0; 199+890.0; 200+232.0; 200+360.0; 200+524.0; 200+670.0; 200+740.0; 200+830.0; 201+090.0; 201+515.0; 201+520.0; 201+680; 201+760.0; 201+900.0; 201+975.0; 202+170.0; 202+300.0; 202+430.0; 202+500.0

MAXIMUM OPERATING PRESSURE - 8690 kPa
MINIMUM FIELD TEST PRESSURE - 10870 kPa

150mm FOAM; DT 300mm FOAM; DT 300mm FOAM; DT 150mm FOAM; 150mm FOAM; 150 mm FOAM

REFERENCE DRAWING	C AND R	N	C	N	C AND R	N	C	G AND P A G AND P	G AND P D	E	C	F	C	B
RANGE OF CROSS - SLOPE PERCENT	2.5 TO 7.5			10 TO 15				–	0 TO 5.0	0 TO 2.5		–	0 TO 5.0	–
MIN. DEPTH OF TRENCH	4.8	–	5.4	–	4.0	–	3.5	UNNAMED CREEK	–	–	2.9	–	2.9	BOCKS BROOOK
DEPTH OF SELECT BACKFILL	0.5	–	0.5	–	0.5	–	0.5	UNNAMED CREEK	–	–	0.5	–	0.5	BOCKS BROOOK

Stations: 199+264.0; 199+334.0; 199+486.0; 199+556.0; 199+566.0; 199+636.0; 199+680.0; 201+560.0; 202+330.0; 202+430.0; 202+493.9; 202+506.1; 202+680.0

GENERAL NOTES
1. COORDINATES SHOWN HEREON ARE RELATED TO THE UNIVERSAL TRANSVERSE MERCATOR (U.T.M.) GRID.
2. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE SPECIFIED.
3. DRAWING NOT TO SCALE UNLESS OTHERWISE INDICATED.
4. REFER TO PLAN AND PROFILE AND BOOK OF REFERENCE FOR ADDITIONAL LAND AND SURVEY INFORMATION.
5. PIPELINE OFFSET INDICATES VARIATION OF PIPE CENTRELINE FROM LOCATED REFERENCE LINE.
6. CROSS SLOPES ARE APPROXIMATE AND WILL BE FIELD CHECKED. POSITIVE CROSS SLOPES DROP TO THE NORTH OR THE EAST. NEGATIVE CROSS SLOPES DROP TO THE SOUTH OR THE WEST.
7. LOCATION OF DRAINAGE, EROSION AND CROSSING RAMP FACILITIES ARE APPROXIMATE AND ARE SUBJECT TO FIELD ADJUSTMENT. LEVEL NUMBERS REFER TO EROSION PROTECTION CLASSIFICATION.

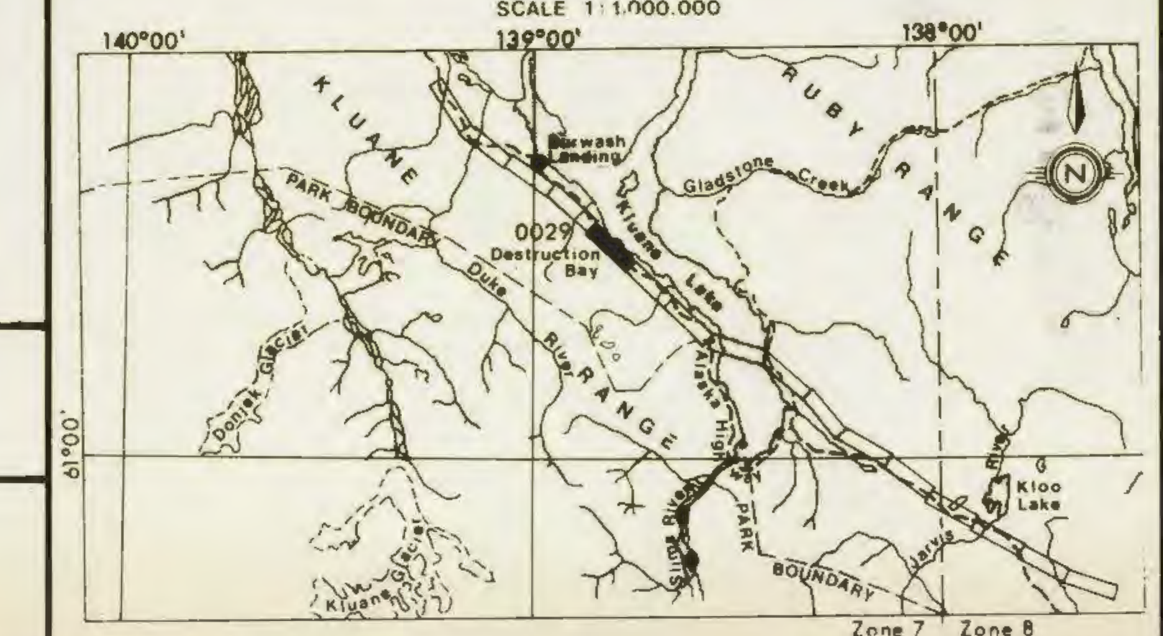
AERIAL PHOTOGRAPHY

ROLL NO.	LINE NO.	PHOTO NOS.	SCALE	DATE
NW 66778	8 NW	072 - 077	1:24 000	1978

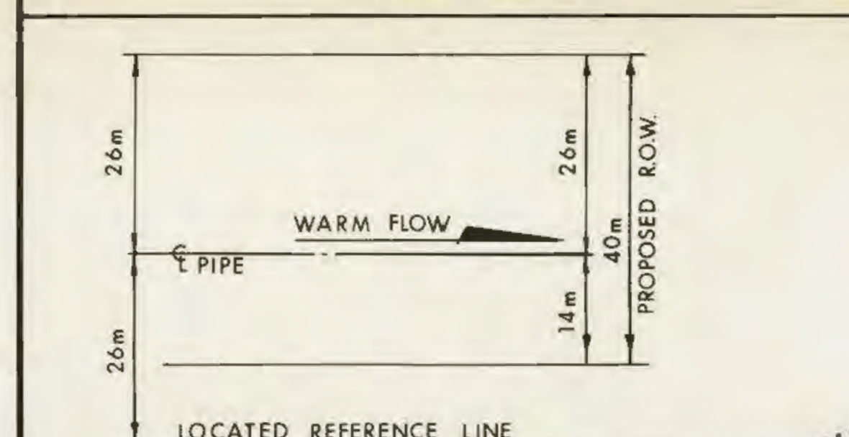
PIPELINE MATERIALS LIST

QUANTITY	DESCRIPTION	WBS NO.
6240m	PIPE 1219 mm O.D. × 13.72 mm W.T. GR. 483	
	CSA Z 245.2 CAT. II, FOOTHILLS SPEC. P-100	
1030m	PIPE 1219 mm O.D. × 18.29mm W.T. GR. 483	
	CSA Z 245.2 CAT. II, FOOTHILLS SPEC. P-100	
144	CONCRETE WEIGHT - SADDLE (6700 kg)	
740	CONCRETE WEIGHT - RESTRAINED (1219mm)	
1	COMMUNITY GAS SUPPLY TAP (1219 × 114.3mm)	
	(SEE REFERENCE DRAWING CODE "Q" FOR DETAILED	
	MATERIALS LIST.)	
128m	CASING PIPE, 1422mm O.D. × 13.72 mm W.T. GR. 483,	
	CSA Z 245.2 CAT. II. FOOTHILLS SPEC. P-100	
170m	CIRCULAR CORRUGATED STEEL PIPE	
	900mm Ø × 2.0 mm W.T., CORRUGATIONS 68 × 13mm	
80m	CIRCULAR CORRUGATED STEEL PIPE	
	1200mm Ø ×1.6mm W.T., CORRUGATIONS 125 × 25mm	
50m	CORRUGATED STEEL PIPE - ARCH,	
	2130 × 1400mm, 3.5mm W.T. CORRUGATIONS 68 × 13mm	
4	PRE-MANUFACTURED END SECTION FOR 1200mm Ø	
	CULVERT	
2	PRE-MANUFACTURED END SECTION FOR 2130 × 1400mm	
	PIPE - ARCH CULVERT	
14	CULVERT MARKER	
4	TEST LEAD - 2P/4Z/R TYPE	
4	TEST LEAD - 2P/2Z/R/H TYPE	
10620m	ZINC RIBBON	
1	AERIAL MARKER	
13m	PIPE 1219mm O.D. × 18.29mm W.T. GR. 483 CSA Z 245.2	
	CAT II FOOTHILLS SPEC P-100 COMMUNITY GAS TAP.	
2	PIPELINE WARNING SIGN	
1	TEST LEAD - 2P/2X TYPE	

INDEX MAP
SCALE 1:1,000,000



RIGHT OF WAY DETAILS



TYPICAL

TN 880.51 F6 E68 addn. no. 4-5 sheet 8

PROFESSIONAL ENGINEER ALBERTA (seal) 81-12-10

MOSAIC & SURVEY LEGEND
- LOCATED REFERENCE LINE
- P.I. OR DEFLECTION POINT
- POINT ON TANGENT
- CONTROL MONUMENT
- SURVEY CHECK POINT
- 451530 E / 674480 N — U.T.M. COORDINATE
- 100 — KILOMETRE POST
- BURIED CABLE
- FENCE
- TELEPHONE OR TELEGRAPH LINE
- POWER LINE
- FOREIGN PIPELINE
- PROPOSED PERMANENT ACCESS
- EXISTING TEMPORARY ACCESS
- PROPOSED TEMPORARY ACCESS

PIPELINE LEGEND
- CARRIER PIPE
- HEAVY WALL PIPE
- CASING PIPE
- CARRIER PIPE AND ZINC RIBBON
- INSULATED PIPE
- CONCRETE COATED PIPE
- BOLT-ON WEIGHT
- SET-ON WEIGHT
- SELECT BACKFILL
- WARNING SIGNS
- BLOCK VALVE ASSEMBLY
- SCRAPER TRAP ASSEMBLY
- SIDE TAP
- TEST LEAD
- [100] AERIAL MARKER
- FT FIELD TRANSITION
- CULVERT
- CULVERT WITH END SECTION
- DT DEPTH TRANSITION

GRADE ROAD CROSSING; SIDE BEND BEARING PAD; ABOVE GRADE; CONCRETE RESTRAINED MODE; CROSSING RAMP; EMBANKMENT OPENING; BURIED PIPE; WATER CROSSING; PREFORMED TRENCH BEDDING

REFERENCE DRAWINGS

CODE	TITLE	DRAWING NUMBER
A	UNNAMED CREEK WX 1029	2 01 02 00 WX 1029
B	BOCIKS BROOK WX 1030	2 01 02 00 WX 1030
C	TYPICAL TRENCH CROSS SECTIONS WARM FLOW	2 00 02 00 TP 0062
D	CONCRETE RESTRAINING WEIGHT WARM FLOW (1219mm)	2 00 02 00 EN 0048
E	TYPICAL TRANSITION BURIED TO ABOVE GRADE	2 00 02 00 TP 0066
F	TYPICAL COMMUNITY GAS SUPPLY TAP (1219 × 114.3mm)	2 00 02 00 TP 0025
G	TYPICAL EMBANKMENT OPENING	2 00 02 00 TP 0052
H	TYPICAL CULVERT INSTALLATION (2 SHEETS)	2 00 02 00 TP 0054
J	TYPICAL MOUND BREAK AND DIVERSION DIKES (2 SHEETS)	2 00 02 00 TP 0050
K	TYPICAL MONITORING - TEST STATION TYPE 2P/4Z/R	2 00 02 00 TP 0203
L	TYPICAL MONITORING - TEST STATION TYPE 2P/2Z/R/H	2 00 02 00 TP 0202
M	PIPELINE AERIAL MARKER	2 00 02 00 EN 0034
N	TYPICAL DEPTH TRANSITION BURIED WARM FLOW	2 01 02 00 TP 0067
P	INSULATED CO-AXIAL STEEL FREE SPAN	2 00 02 00 EN 0049
Q	TYPICAL MONITORING - TEST STATION TYPE 2P/2X	2 00 02 00 TP 0207
R	PREFFORMED TRENCH BEDDING	2 01 02 00 EN 0039
S		
T		
U		

REVISIONS

NO.	DESCRIPTION	DATE	BY	CHKD.	APPR. YPD	APPR. FPL
A	INFORMAL REVIEW	81 10 27	AW			
B	FORMAL REVIEW	81 12 09	AW			
C	PREFORMED TRENCH BEDDING	82 01 07	AW			
D	GENERAL	82 01 22	AW			
E	DESIGN SUSPENDED	82 02 05				

MICROFILM

FILM NO.	DATE

NORTHERN PIPELINE AGENCY CANADA

ENGINEERING RECORDS

		DATE
DRAWN	R. STEELE	81 10 27
DRAFTING CHECK		81 10 23
DESIGN CHECK		81 10 30
ENGINEER		81 12 10
ENVIRONMENTAL		
DESIGN MANAGER		82 01 27
PROJECT MANAGER		

FOOTHILLS PIPE LINES APPROVALS

	DATE
ENGINEER	
SUPERVISOR	
MANAGER	

Foothills Pipe Lines (South Yukon) Ltd.

DESIGN SUSPENDED

THE ALASKA HIGHWAY GAS PIPELINE PROJECT

ALIGNMENT OF 1219 mm O.D. GAS PIPELINE
WARM FLOW DESIGN
STA.197+440.0 TO STA. 204+710.0

PREPARED BY YUKON PIPELINE DESIGN JOINT VENTURE — APK CANUCK MONENCO PETROTECH

RGN.	ZONE	FACILITY	NO.	DWG. TYPE	DRAWING NO.	REV.
2	0 1	0 2	0 0	A L	0 0 2 9	E