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ALASKA HIGHWAY PIPELINE INVESTIGATIONS

PRELIMINARY REPORT

Vancouver, B.C.

3 June 1977

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

ALASKA HIGHWAY PIPELINE

INVESTIGATIONS

INLAND WATERS DIRECTORATE

PACIFIC AND YUKON REGION

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<u>SUMMARY</u>

ALASKA HIGHWAY PIPELINE INVESTIGATIONS - INLAND WATERS DIRECTORATE

Major Environmental Concerns	Location	Impact	Completeness of Proponent's Identification of Concerns and Mitigation Proposals	I.W.D. Program
Drainage Disruption	Kluane Lake - West Side (Pipeline Mileage 115-145)	Siltation could reduce effectiveness of Kluane Lake shoreline as a feeding and rearing area for juvenile fish	Potential for drainage disruption and bank and channel bed erosion is recognized by the proponent; however, site-specific details are lacking. The environmental reports by the proponent summarize by concluding that impacts on aquatic systems will generally be short term and are expected to be negligible in the long term. However, this is not necessarily so. Assumption cannot be made that alterations from siltation in particular will be negligible and reversible. Without adequate mitigation a major aquatic eco-system upset could result.	Only minimal base-line information is available. Requirements include: (a) the study of natural siltation and the extra-polation of increases that can be expected during construction and maintenance of the pipeline (Kluane and Teslin Lakes) (b) site specific information on the location, horizons and characteristics of permafrost.
Bank and Channel Bed Erosion (a) Large Streams in Perma-frost regions	White, Donjek, Duke and Slims Rivers	Physical disruption during construction and maintenance could interfere with fish movements and reproductive success; increase in organic material from White, Teslin and Takhini basins could cause serious depression of dissolved oxygen during under ice cover discharge.		(c) tributary stream-flow runoff on East Side of Teslin Lake and on Liard basin for assessment of siltation.
(b) Small Streams	Teslin Lake - East Shore (Pipeline Mileage 340-368)	Siltation would degrade the productivity of Teslin Lake as a feeding and rearing area for fish.		(c) effects of glaciers on the hydrology of the White River basin. A contract has been let for completion of a study on this subject.

INTRODUCTION

The applicant's proposal for the Alaska Highway Pipeline is identified as Volume 5B-1: Environmental Statement, Foothills Pipelines (Yukon) Ltd., November 1976.

Evaluation of this Statement is based on a reconnaisance of the proposed route during period May 16-20, 1977, (Appendix A), and on a study of existing literature and data. Considerable reliance was placed on judgements and experience of a wide range of specialists from Department of Fisheries and Environment, as well as of Alaska Highway maintenance personnel, viz., Department of Public Works, Whitehorse, Y.T., and Canadian Forces Base, Chilliwack, B.C.

The report is divided according to areas of concern. For each concern there is:

- a description
- an evaluation of the completeness and quality of the proponent's response to that concern
- an identification of requirements for baseline information.

Comments are given on required protection measures to mitigate impacts.

References made here to fish abundance and distribution were taken from reports prepared by Foothills Pipelines (Yukon) Ltd.

Revision of the applicant's "Summary of Selected Stream Flow Data Related to the Proposed Pipeline Route (Yukon Section)" is contained in Appendix C.

A. DRAINAGE DISRUPTION

One of the major areas of environmental concern is the drainage disruption that would ensue in permafrost terrain during construction and maintenance of the pipeline. The numerous small, high energy streams with actively moving beds of silt, volcanic ash, gravel and boulders that descend from Kluane Range and empty into Kluane Lake are considered to be a serious potential problem. The channels are contained in the mountains by channel walls, but on the fans they are unconstrained and are free to shift their courses. During floods the bed material chokes the channel, causing the streams to abruptly flow out of the channel and find a new one elsewhere, where it scours down a similar channel (Figure 2). It is obvious that highway maintenance personnel are in a continuous battle with these streams as they bulldoze gravel to lower the bed and to form dykes to keep the streams from shifting their courses. The question is what happens when an excavation transverses the general drainage pattern of this type of surface material, underlain with permafrost? Will it become a channel for surface and ground water flow?

IMPACT

Although these glacial fed streams generally carry high sediment loads during floods, the initial pipeline trenching and possible permanent maintenance activity (re-trenching) in this unstable area could result in increased loads of silt entering Kluane Lake. The Lake is known to provide spawning habitat along its shores from Destruction Bay to outlet. Along with lake trout, salmon spawn along the shoreline, and the littoral zone serves as feeding and rearing area for juvenile fish. Littoral currents would disperse the suspended sediments along this productive zone. Since it is suspected that salmon spawn in upwelling groundwater along the Kluane lakeshore, any disruption of the subsurface flow by the upslope pipeline trenching could be a further impact.

PROPONENT'S RESPONSE TO THE CONCERN

The proponent recognizes that "The natural drainage patterns will be exposed to potential change by construction of both the proposed pipeline and ancillary structures." (Pages 376-378). However, his statement is devoid of site-specific information. He fails also to comment on siltation, its effect on aquatic ecology and proposed measures to mitigate negative impacts.

It is suggested that location of the pipeline along the foothills above the head of the alluvial fans be considered as a preventative action; the pipeline should be buried below scour depth over the entire reach from about mile 115 to 145.

I.W.D. PROGRAMS

No data is available on the natural sediment transport into Kluane Lake on which to extrapolate the increases that would result from pipeline construction and maintenance. Development of a sediment program for study of siltation on the west shore of Kluane Lake therefore should be considered. The alluvial fan streams are flashy and frequently run dry; consequently study of siltation at outlets of these streams may require development of a special field program; one such program could be the study of delta at one or two index streams and the dispersion of its suspended sediments along the lake shore by the littoral currents.

More detailed information on the location, discontinuity and characteristics of permafrost is required as it is one of the prime parameters in the study of mass movement of material within the alluvial fans.

B. RIVER CROSSINGS - BANK AND CHANNEL BED STABILITY

Major river crossings, particularly in the permafrost areas west of Whitehorse, require special attention with respect to bank stability and scour. Thawing of river banks at construction sites may be serious on the White, Donjek, Duke and Slims Rivers (Figures 3 and 4) and in particular on the first two. In the fine soils that are prevalent at these crossings, aggravated by permafrost and/or ground-ice, the stability (or only near stability) of channel banks is partly dependent upon the maintenance of frozen ground near the channel banks. Examples of major slumps along the river banks were observed during the reconnaisance survey, May 16-20, 1977.

Another problem is the degradation of the channel bed. The silt, sand and gravel are moved along the river beds in dune and sheet transport. During this activity a seasonal scour can occur, the extent of which can be determined best by observation. Under ice cover an increase in discharge is partly met by ice heaving and partly by an increase in stream velocity, thus producing an increase in bed scour potential. During a flood discharge the stream bed may alternately degrade and aggrade with rise and fall of discharges. Only a thorough morphological study of these rivers will clarify the situation.

IMPACT

Both the White and Donjek Rivers have steep banks in fine grained soils and erosion could cause serious stream siltation. However, both rivers already carry very heavy sediment loads. The White River is noted as a migration route downstream of the proposed pipeline crossing and upstream of the proposed crossing is a site considered to be acceptable for spawning. Physical disruption and its interference with fish movements during proposed construction and maintenance appears to be the main potential effect on environment.

The greatest potential for increased sediments in the Teslin River drainage basin is in the area from the outflow of Teslin Lake to Nisutlin Bay. Numerous creeks that descend from the Salmon Range and empty into Teslin Lake would concentrate sediment along the shoreline zone of this lake and move it towards the outlet at Johnsons Crossing. These streams are clean, productive and most appear to support a healthy food web. Siltation would degrade the present quality of these tributaries.

The proposed Teslin River crossing itself is of concern since Teslin River below the lake is a migration and spawning area. Disruption, erosion and sedimentation problems may be largely avoided here as well as at the Yukon River and Takhini River crossings by the use of elevated crossings for the pipeline.

PROPONENT'S RESPONSE TO THE CONCERN

Environmental reports prepared by Foothills Pipelines (Yukon) Ltd. have summarized by concluding that aquatic systems impacts will generally be short term and are expected to be negligible in the long term. However, this is not necessarily so. Assumption cannot be made that alteration, from sedimentation in particular, will be negligible and reversible. Without adequate mitigation, a major aquatic eco-system upset could result. The Teslin River drainage basin is one system in particular that would be in serious danger without adequate protective design measures.

Knowledge of permafrost distribution and its effects on the thermal regime is too scarce to fully comprehend and predict environmental impacts resulting from the pipeline construction. Proponent foresees problems associated with (a) ground settlement due to permafrost degradation, (b) effects on drainage and subsurface flow by frozen bulb soil surrounding the chilled pipeline, and (c) ponding during the summer.

I.W.D. PROGRAMS

Within White, Donjek and Slims drainage basins there are known to be some 40 lakes which are dammed by glaciers. Glacier dammed lakes can suddenly drain causing floods of catastrophic proportions. The likelihood of sudden and unexpected release of lake waters is increased greatly when the lakes are found in association with surging glaciers which can change their configuration very rapidly. There are many surging glaciers in the area including some of the major valley glaciers in the area (e.g., the Donjek and Steele glaciers). Currently a study is underway on the effects the glaciers have on the hydrology and probable magnitude and frequency of glacier induced floods. (Appendix B)

A sediment station has recently been established on the Donjek River for estimating suspended sediment load. This will satisfy requirements at least in the interim on the seriousness of increased siltation that could be expected from large stream crossings in the White River basin. However, a similar estimate is required for Yukon River at Marsh Lake crossing.

M'Clintock River is a large contributor of sediment in the Yukon River. Establishment of a sediment survey station on this stream could satisfy information requirements at the Marsh Lake Crossing.

The pipeline route parallels Teslin Lake for about 35 miles and about 25 tributaries are crossed. Morley River and Morley Lake are paralleled for another 20 miles and 9 of their tributaries are crossed. The Smart and Swift River system is paralleled for a further 32 miles and at least 12 of its tributaries are crossed. No known streamflow data are available on these tributaries. Under natural conditions these streams appear to be running relatively free of suspended sediments. However, because of the silt terraces and sharply incised channels, construction activity will inevitably cause serious stream and lake shore siltation. For assessment of this problem's potential, an estimate of range of discharge of several inflow streams is needed. In addition, an estimate of sediment concentration during summer storms would be valuable.

In the Liard River Basin there is no evidence of lacustrine sediments or any severe hydrologic problems. The relic moraines in the Rancheria system appear stable; however, benches seem to be poorly drained and could represent concentrations of fine materials subject to degradation with disturbance. On the second Rancheria River crossing, the switching of thalweg from left bank above bridge to right bank around mid-channel shoals below, is an indication of possible channel stability problems and that care is required in restoration of regime during construction. For estimation of the potential of these concerns, as above, an estimate of range of discharge of several streams in the area is warranted. Currently there are no streamflow stations on the tributaries in the Liard River drainage basin.

C. OTHER CONCERNS AND THEIR IMPACT ON ENVIRONMENT

1. Studies of the water quality of 36 Alaska Arctic and Sub-Arctic rivers between 1969 and 1972 identified a severe winter dissolved oxygen depression phenomenon in many rivers (EPA-660/3-74-008; Ecological Research Series). The trend observed in many rivers was that the dissolved oxygen depletion usually became more severe when proceeding from the headwaters toward the mouth.

The Yukon River was found to contain 10.5 mg/l (73% saturation) dissolved oxygen at the Canadian Border but only 1.9 mg/l (13% saturation) near the mouth in Alaska. Since the White, Teslin and Takhini River drainage basin tributary crossings could each contribute to an increased deposition of organic material in the Yukon River Basin, the concern over a further depression of dissolved oxygen in downstream reaches of the Yukon is warranted.

2. It is not known what happens when a corridor of impervious material, whether permafrost or hardpan, is torn out, a pipe laid and backfilled with what may no longer be an impervious seal. For instance, when the excavation line follows, longitudinally, the general drainage pattern of a basin, will it become another channel for surface and ground water which will, in effect, drain or reduce the water levels in their natural confines? This is a question of considerable importance in terms of water quality since there does not appear to be sufficient data regarding such intrusions, nor is there adequate permafrost information available for the region.

3. Many swampy areas will have to be temporarily drained to bury the pipeline. Muskegs occur in depressions and flat areas and most often consist of a tightly interwoven network affecting large areas. The drainage of such areas is of major concern since these waters have low pH and high organic matter content. The Teslin Lake area and Haines Road seemed most likely to be affected by this problem.

4. The excavation of a deep trench might affect the groundwater regime over extensive areas, disturbing both vegetation and river regimes. The occurrence of potential aquifers should be examined for this reason. Should the proposed route cross the Yukon River upstream of Whitehorse at Marsh Lake, adequate measures should be implemented to protect this waterway from the introduction of contaminants during construction and operation since the system feeds into Schwatka Lake, a water supply for the City of Whitehorse.

5. In the vicinity of Quill Creek, west of Kluane Lake, is an abandoned or discontinued mining operation (Hudson Bay Smelting) where the proposed pipeline runs immediately adjacent to the old tailings pond. The proponent should take adequate measures to ensure the ground water in the vicinity not be disturbed so as to tap the pollutants underlying this deposition.

PROPONENT'S RESPONSE TO THESE OTHER CONCERNS

No mention is made of potential hazards to the groundwater regime. While this concern is minimal in the NW section of the Alcan route, it is nevertheless of potential importance near Whitehorse. Also, there is no acknowledgement of hazard to surface waters through draining of swampy areas or trenching a corridor of impervious material.

Finally, reference is made to placer activities in Carlick and Burwash Creeks but no mention of old mine tailings as a potential source of water pollution is made. Attention should be drawn to the occurrence of such tailings so that these areas can be avoided in the route selection.

I.W.D. PROGRAMS

Currently a pilot study is being initiated by the Water Quality Branch to investigate the loadings of physical and chemical elements in the Yukon River west of Dawson City, with particular reference to metals, nutrients, sediments and asbestos fibres. Also, two sampling sites are planned to be set up on the Yukon River near Whitehorse for the study of Schwatka Lake. One of the parameters that is incidental in these studies is dissolved oxygen. This program could have some relevance to pipeline investigations.

COMMENTS ON PROTECTION MEASURES

1. A buried pipeline must rest on bed built with permeable material at the bottom of the trench. Such a bed could constitute an underground watercourse and may have profound effects on the groundwater table in various critical locations.

This problem may occur during construction and in the post construction period. Possible solutions are:

(a) construction in susceptible areas during winter, and

(b) construction of impermeable cut-off barriers along the pipeline.

If chilling of the pipeline could create an "ice bulb", it may have also adverse effects on the present pattern of groundwater flows and the resulting water tables. A possible solution could be the maintenance of flow across the line by appropriate granular material blankets below the depth of the "ice bulb".

Disturbance of the groundwater status quo will manifest itself in a changing landscape. This change will carry on to the ecology of the areas affected.

2. Backfill of the trench should conform to natural conditions. This, of course, is of no substantial importance where the pipeline parallels the highway and runs close to it; however, it attains substantial significance where the pipeline diverges from the highway.

3. With the possible exception of the Teslin River crossing, there are no streams where the pipeline may be totally or partially laid upon the riverbed. Therefore, unless pipeline bridges are used, crossing of streams requires special attention.

Trenches preferably must be dug "in the dry". In the smaller streams this can be done only at low water, which would allow diversion within the riverbed. Diversion by bank cutting should definitely be avoided.

In the larger rivers this should be easier since at times other than freshet periods, most of the bed is dry. Diversion within the high water bed of the river should not create problems other than those associated with overloading the water with sediment during construction.

4. The pipeline profile should be well below the maximum scour depth. Where the crossing is in an alluvial fan, or in a braided river, the scour depth should be calculated on the basis of the maximum possible concentration of flow into a single channel and such scour depth should be assumed to occur over the entire width of the river.

If the pipeline is chilled and an "ice bulb" is to be formed around it, it should be ensured that the pipeline does not form a weir at scour conditions. Moreover, the ice bulb may become a barrier to seepage and this, too, should be considered.

5. Bank cuts for pipeline crossings should be backfilled and protected from "leaching out" of soils; for example, a cloth filter of suitable quality and mesh and a thick layer of granular material and rip-rap could be included in the design. In cases where cut is in permafrost, special measures are required to prevent melting of permafrost.

6. In cases where the pipeline crosses widely meandering streams, care should be taken to avoid causing "meander cut-offs", as they may accelerate the meander propagation. Moreover, where the rate of meander propagation demands, the crossing depth should be continued over the total meander width rather than over the present watercourse.

7. Of special interest are short streams emerging from mountainous ranges. Most of them carry seasonal flows and great amounts of sediment. The sediment begins to deposit in the plains thereby elevating the streambed. Eventually, the stream breaks out of its course into the plain cutting a new course for the process to be repeated. Pipeline crossings must therefore allow for these shifts in watercourses. It is recommended that the pipeline be buried well below scour depth over the entire reach from about mile 115 to mile 145.

8. The stream crossings south east of Whitehorse present lesser problems than those in the other areas. Of special interest are crossings involving streams with high and steep banks such as the Teslin River at Johnsons Crossing. As it is not practical to restore such banks to their original state, natural crevices, cut by surface drainage, should be considered as the route of the line.

SOURCES OF INFORMATION

1. Canada Department of Public Works, Whitehorse, Y.T.

2. Canadian Forces Base, Chilliwack, B.C.

3. Church, M. - Reconnaissance of Hydrology and Alluvial Characteristics of Rivers in Northern Alaska and Northern Yukon Territory

4. Wedel, J. H. and Way, J. G. - Eastern Arctic Islands Pipeline Project - Spence Bay to Sabine Peninsula

5. Alaska Highway Pipeline Panel - Initial Environmental Evaluation of the Proposed Alaska Highway Gas Pipeline, Yukon Territory

6. R. J. E. Brown - Permafrost Investigations in British Columbia and Yukon Territory

ALCAN PIPELINE ROUTE

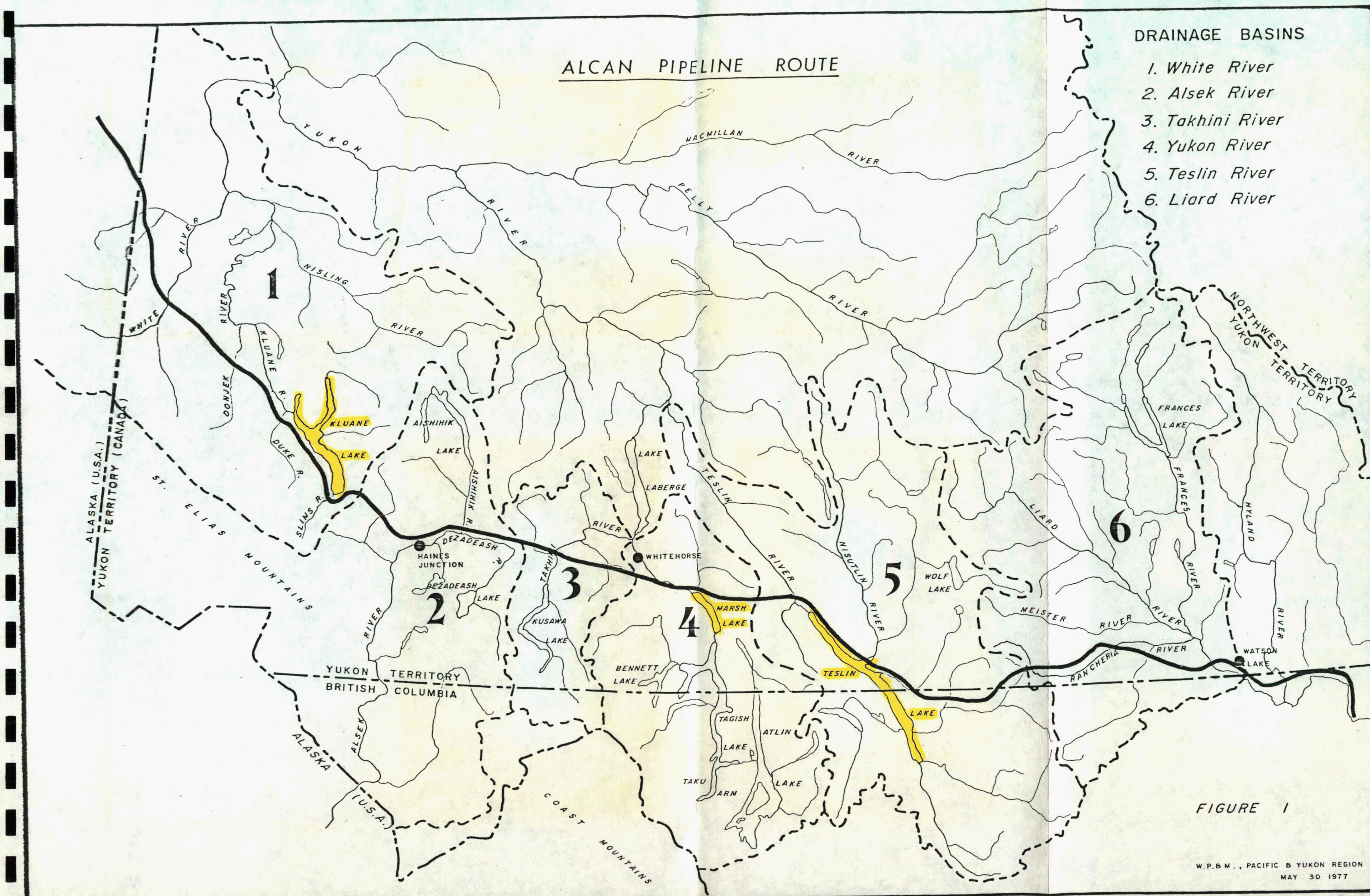
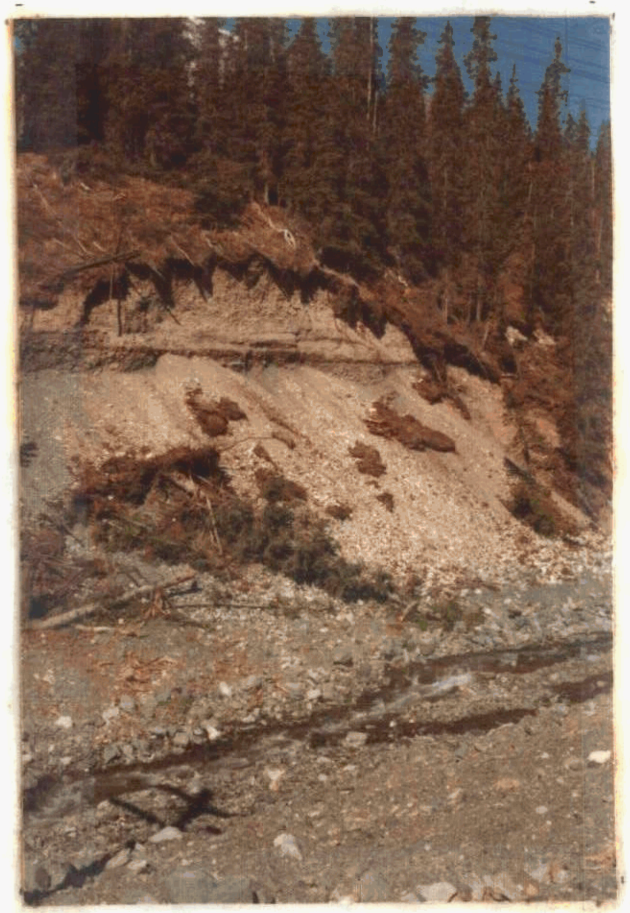


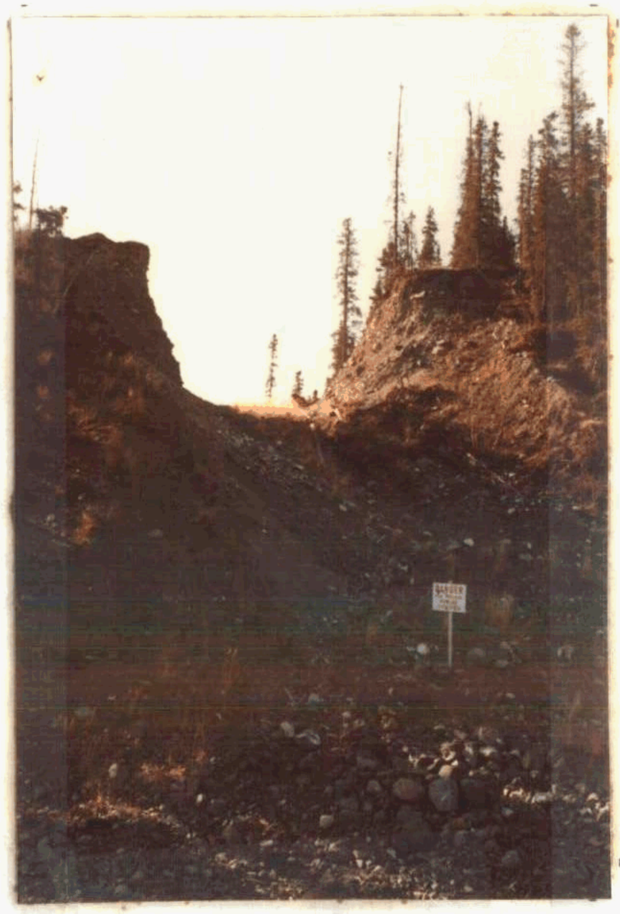
FIGURE 1

FLUVIAL FANS, WEST SIDE OF KLUANE LAKE

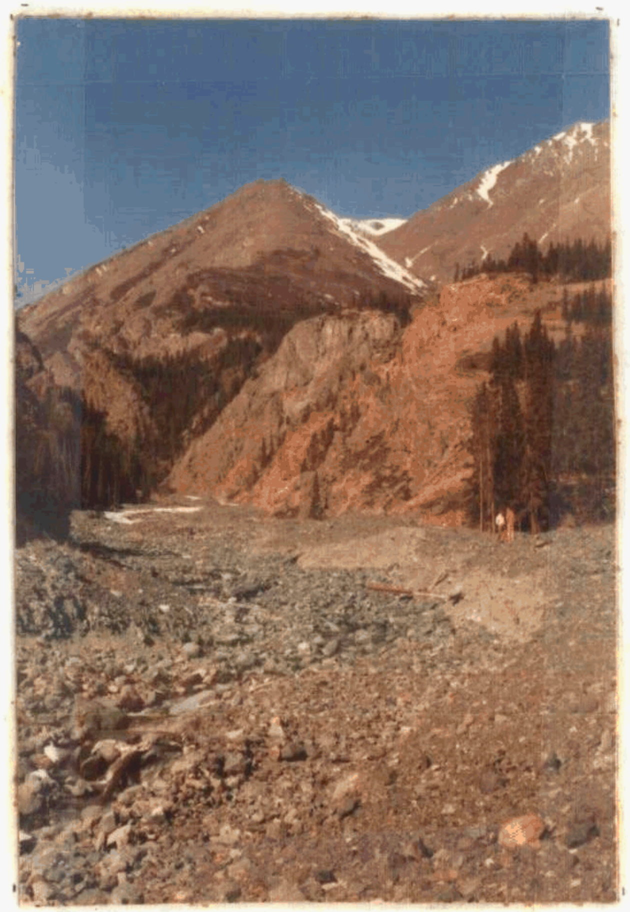
looking downstream towards Kluane Lake
Williscroft Creek (pipeline mile 137)



typical bank condition

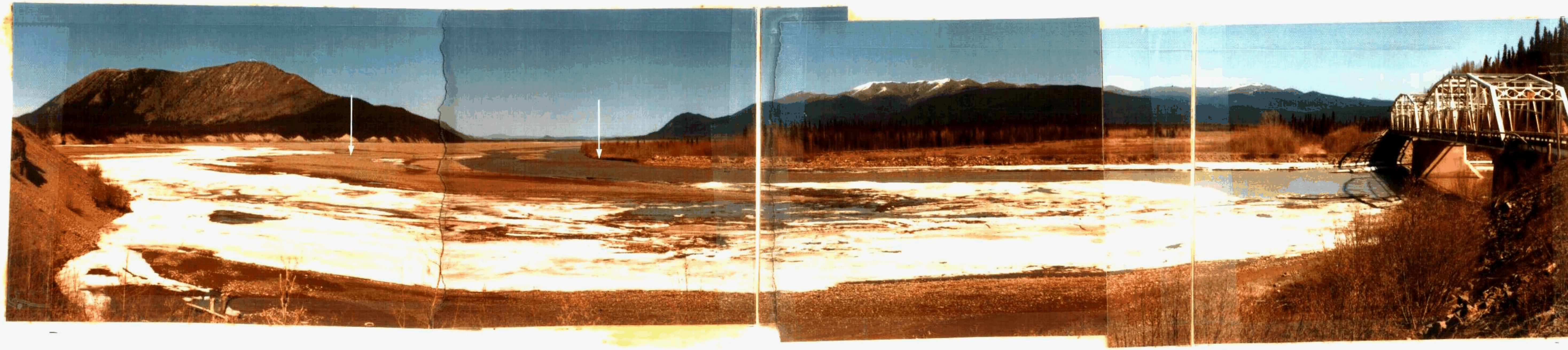


8" dia. pipeline crossing

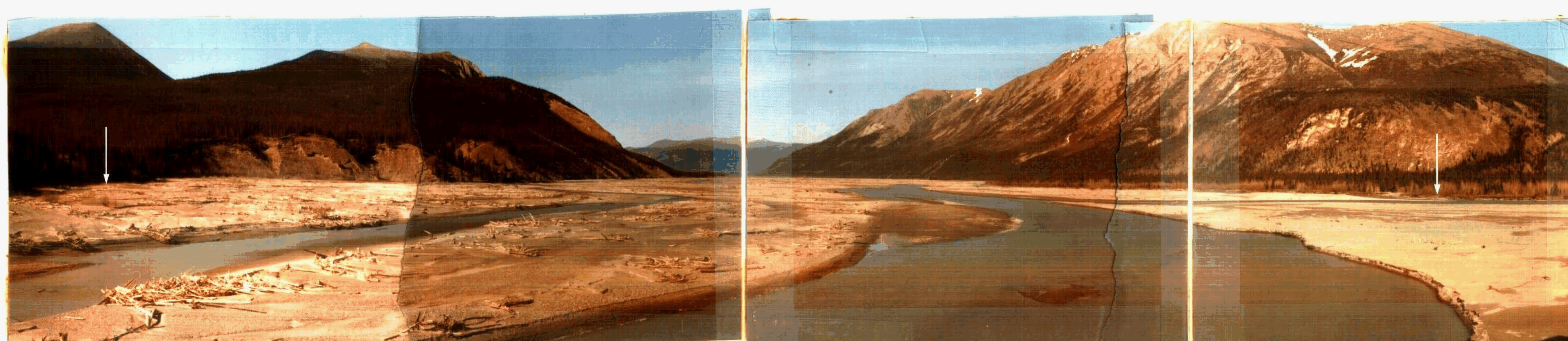


looking upstream (note washout of 8" dia. pipeline)

FIGURE 3



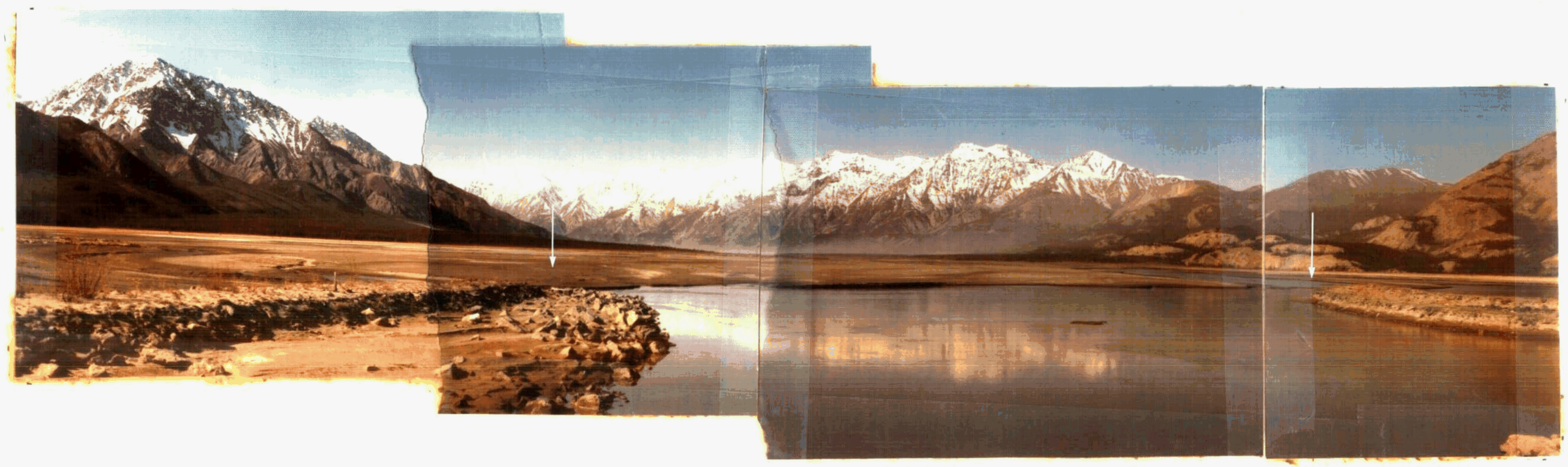
White River crossing site (see arrow)



Donjek River crossing site (see arrow)

FIGURE 4

Duke River crossing site (see arrow)



Slims River crossing site (see arrow)

ALASKA HIGHWAY PIPELINE INVESTIGATIONS

INLAND WATERS DIRECTORATE

Reconnaissance Survey, May 17 - 19, 1977

Composition of survey team:

J. Quong	DPW	Whitehorse, Y.T. (May 17 to noon May 18 only)
J. Taylor	IWD	Water Quality Branch
A. N. T. Varzeliotis	IWD	Water Planning & Management Branch
R. J. White	IWD	Water Planning & Management Branch
R. O. Lyons	IWD	Water Planning & Management Branch
V. Bartnik	IWD	Water Planning & Management Branch
J. H. Wedel	IWD	Water Survey of Canada, Winnipeg, Manitoba
M. E. Alford	IWD	Water Survey of Canada, Whitehorse, Y.T.
L. Steizenberger	Fisheries & Marine	
P. W. Strilaeff	IWD	

All team members are from Vancouver, except where otherwise noted.

May 17 - Mode of travel: single-engine Otter aircraft during a.m. between Whitehorse and Beaver Creek with an intermediate landing at Haines Junction; by vehicles during p.m. between Beaver Creek and Destruction Bay.

Items of note:

1. Takhini River at pipeline Mile 243 - a meandering stream with many active slip-off slopes; the pipeline crossing site appears to be more stable than highway crossing; this should be confirmed during forthcoming helicopter survey; terrace systems appear to be of gravel and

are stable; however, some active cut banks of fine material are evident to the northwest.

2. Alternate pipeline route S.W. of the village of Takhini - in the 1958 burn area, thermokarst activity suggests that the valley floor has substantial ground ice, which has degraded after vegetation was removed. Stripping vegetation from pipeline right-of-way could generate similar problems.
3. Mendenhall Crossing - banks unstable; high suspended sediment load.
4. Dezadeash River Valley - strong meander pattern, in unconsolidated material. Question: why crowd the pipeline between the road and such an active river?
5. Mile 175 - tundra-type ponds - could be an area of severe permafrost degradation if vegetation is removed.
6. Slims River - no foreseeable problems if pipe is buried sufficiently deep across entire floodplain; entry and exit from floodplain could be the biggest problem.
7. West side of Kluane Lake - coalescing alluvial fans of glacial debris; very high rates of gravel discharge during flood pose severe problems to highways; water courses subject to frequent shifts. Question:
   (a) What is the depth of degradation in a new channel and how much of the stream bed becomes active in flood?
   (b) Can the rechanneling of flow be prevented along a pipeline traverse on this completely uncohesive material?
8. Koidern River, downstream of Pickhandle Lake - unstable banks; active meanders; evidence of thermokarst or permafrost degradation.

9. White and Donjek Rivers - sections on entire floodplain could at one time or another contain principal channel. In both of these rivers, channel approach stability is critical especially if excessive ground ice occurs; left bank on Donjek is steep with evidence of instability; Jim Quong says that stabilization at bridge site took 3 years.

May 18 - Mode of travel: vehicles between Destruction Bay and Kluane Strip; aircraft between Kluane Strip and Squanga Strip, with a stop at Whitehorse; vehicles between Squanga and Teslin.

1. West Side of Kluane Lake - on the ground inspection confirmed the concern from the air that the traversing of alluvial fans by the pipeline trench could lead to unpredictable problems. Steep torrents drain the St. Elias Mountains and discharge onto large alluvial fans. The channels are contained in the mountains by the valley walls; on the fans they are unconstrained and thus frequently shift their courses. During floods the bed material chokes the channel, causing the stream to abruptly flow out of the old channel and find a new one elsewhere, where it scours down a similar channel. A preventative action could be the location of the pipeline crossing in the valleys above the head of the fans.

2. Teslin River at Johnsons Crossing - approach slopes on left bank appear o.k.; right bank is steep and excavation could cause problems; perhaps the pipeline should follow a natural crevice on the right bank.

3. Teslin Lake from mile 340 to mile 350 - silt terrace, sharply incised; construction activity will entrain silt in clear water systems - a

Fisheries concern; terrace is very sharply incised by numerous small water courses having extremely steep sidewalls; do you bridge them? Bridging would be best in that it would generate least amounts of sediment.

May 19 - Mode of travel: aircraft between Teslin and Watson Lake with an intermediate landing at Pine Lake; vehicles between Watson Lake and Big Creek and return; back to Whitehorse during the evening via aircraft.

1. Morley River - no evidence of lacustrine sediments; evidence of poor drainage on terrace above highway at mile 375.
2. Rancheria systems - there do not appear to be any severe hydrologic problems in this reach of pipeline from mile 440 to Watson Lake.
   - Smart Creek - no room below highway; upstream there is bog, sub-soil condition unknown.
   - Screw Creek - approaches are steep, approximately 60' deep.
   - Seagull Creek - very sharp relief.
   - Swift River - meander pattern; evidence of considerable movement; treat floodplain as active channel.
   - Second Rancheria Crossing - gentle approach slopes. Thalweg switches from left bank above bridge to right bank around some mid-channel shoals below.
   - ensure restoration of regime to maintain channel stability.

General Comments

A. In the glacier fed streams to the west of Whitehorse great depths of coarse gravels cover the floodplain and the principal channel switches its course indiscriminately over the surface. Scour during flood must go to considerable depths (how deep is unknown at present) and could occur anywhere in the floodplain. Also valley approaches are believed to be underlain by permafrost and problems of stabilization and ongoing degradation from the removal of the vegetated cover and trenching activities could be present for a number of years after construction. Jim Quong states that near surface permafrost temperatures are very close to $0^{o}C$ and thus would be in precarious thermal balance. Surface disturbance will alter this regime - requires careful planning by the proponent.

B. The Dezadeash and Takhini valleys show evidence of subterranean ground ice. After the 1958 burn, thermokarst activity is evident. This becomes a hydrologic problem only where such areas are in near vicinity of streams and where disturbed by activity.

C. Lacustrine terraces along the N.E. shore of Teslin Lake appear to be of fine materials. Bands are highly cohesive (steep banks). Construction period will be noteworthy for high sediment yields in clear streams such as Brooks Brook.

D. The relic moraines in the Rancheria system appear quite stable although some of the benches seem to be poorly drained. These may represent concentrations of fine materials subject to degradation with disturbance.

23 May, 1977

THE ALCAN PIPELINE

THE EFFECTS OF GLACIERS ON RIVER REGIMES

There are extensive glacier-covered areas in the upper reaches of the White, Donjek, Slims and Alsek River catchments. The glaciers themselves are far enough away from the pipeline route to pose no direct danger to it. There are, however, ways in which glaciers may have an indirect but potentially important influence on the pipeline.

It is known that in the White, Donjek and Slims catchments there are some 40 lakes which are dammed by glacier ice. Such lakes can empty very suddenly and unpredictably by either overflowing or underflowing the ice barrier. The maximum instantaneous discharge of floods resulting from such outbursts will vary in proportion to the total volume of water released, but commonly in such circumstances the flood peak is far greater than flood peaks associated with snow-melt or rainfall-induced floods in the same catchments.

Most of the glacier dammed lakes are small and are far from the glacier termini. They are therefore probably stable, unlikely to suddenly release and would not cause dangerous floods. Significantly, however, the larger lakes are found mostly in the lower reaches of the glaciers in situations where release is often a distinct possibility. Significantly, too, many of the damming glaciers are of the surging type - new lakes may thus form relatively quickly after a side valley has been blocked off by a rapidly advancing glacier. For example, there is clear evidence on air photographs that a large lake was once formed by the surging Donjek glacier in just such a manner.

In order to estimate likely effects on the pipeline, it is necessary to identify existing and possible future glacier-dammed lakes; estimate volumes of water which could be released from the lakes; estimate probabilities of lake release; estimate likely maximum instantaneous discharges from the ensuing floods; estimate the extent to which the flood peaks may be diminished as they pass downvalley; estimate the likely extent of river bed scour in the vicinity of the pipeline crossings.

Within the Alsek valley the Lowell Glacier is known to surge periodically. In doing so it can dam the upper Alsek River to form a lake which has in the past submerged the area now occupied by Haines Junction. This is not envisaged as a catastrophic event for the lake would take several years to form and evasive action such as artificial draining of the lake could be accomplished. This situation should, however, be further investigated and contingency plans be prepared.

30 May, 1977

GORDON J. YOUNG.

SUMMARY OF STREAMFLOW DATA RELATED TO ALCAN PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum Daily Discharge cfs date	Remarks
White River Drainage							
White R. at Mile 1169.2 Alaska Highway	09CB001	2,410	1974-76	3,850 1.6 (2)	34,000 14.1 2/8/76	478 26/12/76	
Kluane R. at Outlet of Kluane Lake	09CA002	1,910	1952-76	2,520 1.3 (22)	13,500 7.1 14/8/71	19.0 27/2/71	
Alsek River Drainage							
Alsek R. above Bates Creek	08AB001	6,250	1974-76	7,940 1,27 (1)	39,900 6.4 13/7/75	1,000 5/3/75	
Dezadeash R. at Haines Junction	08AA003	3,280	1952-76	1,520 0.5 (23)	10,100 3.1 28/6/61	238 22/3/67	Regulated since 1974
Aishihik River near Whitehorse	08AA001	1,660	1950-76	514 0.3 (24)	5,050 3.0 20/6/62	79 20/3/52	Regulated since 1974
Kathleen River near Haines Junction	08AA004	249	1959-64	392 1.6 (4)	2,300 9.2 20/6/64	71 14/4/60	

SUMMARY OF STREAMFLOW DATA RELATED TO ALCAN PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum Daily Discharge cfs date	Remarks
Takhini River Drainage							
Takhini R. at Outlet of Kusawa Lake	09AC004	1,570	1952-76	1,800 1.2 (15)	9,850 6.3 21/6/64	128 1/4/56	
Takhini River near Whitehorse	09AC001	2,700	1948-76	2,170 0.8 (26)	17,200 6.4 2/9/49	153 19/2/51	Regulated since 1948
Yukon River Drainage							
Yukon River at Whitehorse	09AB001	7,500	1902-76	8,440 1.1 (33)	22,800 3.0 9/8/53	1,150 19/5/62	Regulated since 1925
Yukon River above Frank Creek	09AB009	12,000	1953-76	11,300 0.9 (20)	29,100 2.4 29/8/61	2,500 28/3/56	Regulated since 1925
M'Clintock River near Whitehorse	09AB008	597	1955-76	354 0.6 (11)	3,680 6.2 1/6/72	60.0 29/3/59	
Lubbock River near Atlin	09AA007	684	1954-76	161 0.2 (9)	833 1.2 4/6/72	51.7 29/8/71	

SUMMARY OF STREAMFLOW DATA RELATED TO ALCAN PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum Daily Discharge cfs date	Remarks
Yukon River Drainage - continued							
Wheaton River near Carcross	09AA012	337	1955-76	269 0.8 (10)	2,420 7.2 10/6/64	32.8 16/3/72	
Watson River near Carcross	09AA009	452	1955-61 1966-73	189 0.4 (9)	1,550 3.4 26/6/71 1,730 * 3.8 24/5/68	10.0 1/4/56	
Tagish Creek near Carcross	09AA011	31	1952-62 1965-71	10.4 0.3 (5)	144 4.6 21/5/57	2.8 19/3/58	
Atlin River near Atlin	09AA006	2,630	1950-76	3,210 1.2 (26)	10,800 4.1 25/8/61	623 9/5/56	
Pine Creek near Atlin	09AA008	269	1955-70	183 0.7 (8)	1,280 4.8 8/7/56	27.1 16/1/57	

* Instantaneous

SUMMARY OF STREAMFLOW DATA RELATED TO ALCAN PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum Daily Discharge cfs date	Remarks
Yukon River Drainage - continued							
Wann River near Atlin	09AA015	104	1957-76	235 2.3 (12)	1,960 18.9 11/6/64	15.6 9/4/72	
Fantail River at Outlet of Fantail Lake	09AA014	277	1956-76	741 2.7 (14)	7,600 27.4 16/9/67	22.9 3/4/74	
Tutshi River at Outlet of Tutshi Lake	09AA013	366	1956-76	562 1.5 (13)	3,650 10.0 14/6/64	71.5 8/3/74	
Lindeman Creek near Bennett	09AA010	92.0	1954-76	348 3.8 (19)	6,500 7.1 16/9/67	5.2 4/2/57	
					9,150 * 9.9 15/9/67		

* Instantaneous

SUMMARY OF STREAMFLOW DATA RELATED TO ALCAN PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum daily Discharge cfs date	Remarks
Teslin River Drainage							
Teslin River near Teslin	09AE001	11,700	1944-46 1948-76	10,900 0.9 (25)	65,000 5.6 28/6/62	1,350 24/2/56	
Teslin River near Whitehorse	09AF001	13,700	1955-73	11,700 0.9 (13)	65,400 4.8 28/6/62	1,780 1/3/72	
Swift River near Swift River	09AE003	1,280	1956-76	1,740 1.4 (16)	15,200 11.9 11/6/64	205 26/3/69	
Gladys River at Outlet of Gladys Lake	09AE004	737	1956-76	531 0.7 (15)	4,240 5.8 13/6/64	83.0 26/4/57	
Liard River Drainage							
Liard River at Upper Crossing	10AA001	12,500	1960-76	14,000 1.1 (16)	108,000 8.6 2/6/72	1,740 8/4/74	
Frances River near Watson Lake	10AB001	4,950	1963-76	5,880 1.2 (11)	38,800 7.8 12/6/64	486 16/4/74	

SUMMARY OF STREAMFLOW DATA RELATED TO ALCAN PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum daily Discharge cfs date	Remarks
Liard River Drainage - continued							
King Creek at Mile 13 Nahanni Range Road	10AB003	5.3	1975-76	5.5 1.0 (1)	63.8 12.0 3/7/76 76.4 * 14.4 9/6/76	0.55 21/2/76	
Tom Creek at Mile 21.7 Robert Campbell Highway	10AA002	168	1974-76	149 0.9 (2)	1,080 6.4 3/5/76	16.0 15/3/76	

* Instantaneous

SUMMARY OF STREAMFLOW DATA RELATED TO ALCAN PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum Daily Discharge cfs date	Remarks
ADDITIONAL RELEVANT STATIONS OUTSIDE THE LISTED BASINS							
Yukon River above White River	09CD001	58,400	1956-76	41,700 0.7 (14)	272,000 4.7 25/6/62	8,000 31/3/59	Regulated since 1925
Yukon River at Dawson	09EB001	106,000	1944-76	78,400 0.7 (25)	526,000 5.0 11/6/64	6,350 22/2/51	Regulated since 1925
Stewart River at the Mouth	09DD003	19,700	1956-76	16,400 0.8 (13)	198,000 10.1 12/6/64	1,250 12/3/74	
Yukon River at Stewart River	09EB002	97,300	1956-65	84,100 0.9 (6)	470,000 4.8 12/6/64	10,600 18/4/57	
Yukon River at Carmacks	09AH001	33,600	1951-76	26,200 0.8 (23)	127,000 3.8 24/6/62	4,800 15/3/52	Regulated since 1969
Pelly River at Ross River	09BC002	7,670	1954-76	6,600 0.9 (15)	71,000 9.3 7/6/64	219 11/3/74	

SUMMARY OF STREAMFLOW DATA RELATED TO ALCAN PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean. cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum Daily Discharge cfs date	Remarks
ADDITIONAL RELEVANT STATIONS OUTSIDE THE LISTED BASINS - CONTINUED							
Pelly River below Vangorda Creek	09BC004	8,490	1972-76	7,190 0.8 (4)	46,800 5.5 6/6/75	341 11/3/74	
Pelly River at Pelly Crossing	09BC001	18,900	1951-76	13,900 0.7 (21)	152,000 8.0 28/5/57	1,000 11/3/74	
Ross River at Ross	09BA001	2,800	1960-76	2,340 0.8 (13)	26,200 9.4 1/6/72	100 7/3/74	
Rose Creek below Faro Creek	09BC003	-	1966-69	83.3 - (1)	1,150 - 31/5/67	6.1 10/3/67	Regulated
South MacMillan River at Mile 249 Canol Road	09BB001	385	1974-76	758 2.0 (2)	4,720 12.3 4/6/75	58 22/3/76	

SUMMARY OF STREAMFLOW DATA RELATED TO ALCAN PIPELINE ROUTE

Stream and Location	WSC Station No.	Drainage Area in Square Miles	Period of Record	Mean cfs cfsm (yrs)	Maximum Daily Discharge cfs cfsm date	Minimum Daily Discharge cfs date	Remarks
ADDITIONAL RELEVANT STATIONS OUTSIDE THE LISTED BASINS - CONTINUED							
Hyland River at Mile 67.4 Nahanni Range Rd.	10AD002	211	Sept./ Dec. 1976	-	-	-	
Coal River at Mouth	10BC001	3,550	1961-76	3,840 1.1 (13)	36,900 10.4 30/5/72 42,300* 11.9 10/6/76	530 28/3/72	
Blue River near the Mouth	10AC004	658	1963-76	652 1.0 (12)	9,800 14.9 18/7/74	31.9 18/4/72	
Hyland River near Lower Post	10AD001	3,650	1947-76	5,010 1.4 (17)	59,800 16/4 10/6/61	460 13/3/74	
Liard River above Kechika River	10BE006	23,800	1969-76	25,800 1.1 (7)	195,000 8.2 3/6/72	3,300 14/3/74	

* Instantaneous

SUMMARY OF STREAMFLOW DATA RELATED TO ALCAN PIPELINE ROUTE

Stream and Location	WSC Station No.	Period of Record	Maximum Daily Elevation ft. date	Minimum Daily Elevation ft. date	Remarks
LAKES CROSSED BY PIPELINE ROUTE					
Kluane Lake near Burwash Landing	09CA001	1953-76	2,564.98 15/8/71	2,556.22 17/2/54	-
Teslin Lake at Teslin	09AE002	1944-49 1951-76	2,252.93 3/7/62	2,228.63 9/2/52	-