DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

GEOLOGIC ROAD LOG
ALYESKA HAUL ROAD, ALASKA
JUNE-AUGUST, 1975

by

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INTRODUCTION

A geologic reconnaissance of the newly constructed Alyeska haul road between Livengood and Sagwon Bluff was carried out in the summer of 1975 as part of the U.S. Geological Survey's Arctic Environmental Program. The objectives of the study were to record geologic data exposed in road cuts, to assess present and potential hazards to the haul road and pipeline, and to determine whether any unanticipated environmental problems have developed.

The study was carried out with the assistance of Robert Thorson, while on route to and from Galbraith Lake Camp, our base for a summer field mapping project in the Brooks Range. We left Fairbanks on June 23, and spent three days on route north to Galbraith Lake Camp via Alaska state highways (85 miles) and the Alyeska haul road (283 miles). On July 7 we surveyed the additional 84 miles north to Sagwon, returning to Galbraith Lake Camp that day. The following day Robert Thorson recorded several observations along the haul road from Galbraith Lake Camp south to Chandalar Camp while traveling this 36-mile segment of the route for other purposes. The haul road south of Galbraith Lake Camp was examined again on July 31 and August 1 during a 2-day return journey from Galbraith Lake Camp to Fairbanks.

The following report consists of a road log in four segments, with each segment accompanied by a map (Plates I-IV) and introduced by a brief summary of engineering and environmental aspects. Distances are given in miles; road-cut heights and other short local measurements are presented in metric units. Many of the entries in the road log are purely geologic observations, such as measured sections of road cuts, which were taken to salvage useful information before obliteration of these exposures by sheetwash, revegetation, or regrading to gentler slopes. Other entries, which pinpoint areas of present or potential engineering problems or adverse environmental impact, are highlighted by an asterisk (*) to differentiate them from sites described for purely geologic or geographic purposes. These problem areas are tabulated at the beginning of each segment of the road log.

SEGMENT I. FOX TO YUKON RIVER

Beginning at the junction of the Elliott and Steese Highways 11 miles north of Fairbanks (Mile 0.0), this segment of the road log extends northwestward about 132 miles (Plate I). The route follows the Elliott Highway for more than half of this distance (74 miles), then diverges from preexisting roads about 4.5 miles west of Livengood and follows a new course northward to the south bank of the Yukon River.

This segment was examined on June 23, then was studied again on August 1, 1975. During the June traverse, more than 40 miles of the Elliott Highway southeast of Livengood was found to be extremely wet and soft owing to recent thaw of winter ice segregations in the roadway (Table 1). Its trafficability at that time was much worse than any portion of the haul road farther north. All road cuts appeared stable however. The portion of the haul road northwest of Livengood was in generally good condition on June 23 except for occasional wet and rutted places on valley floors. Most road cuts were stable, but 4 sites exhibited gullying, slumping, or flowage resulting from continued thaw of ice-rich sediments. The road crosses 3 apparently active solifluction slopes where some flowage of the active layer into the roadside ditch is evident.

Table 1. Present and potential engineering or environmental problems, Fox to Yukon River (Segment I).

Site(s)	Element Affected	Problem (June 23)	Status on August 1
2	Roadway	Soft and rutted (39 miles)	Dry and stable
3	Roadway	Soft and rutted (0.3 miles)	Dry and stable
4	Roadway	Soft and rutted (1.6 miles)	Dry and stable
7, 8	Roadway	Wet and slightly rutted (0.3 miles)	Dry and stable
16	Roadway	Trough over subsided culvert	No longer present
10, 14, 18	Roadside ditch	Soil flowage into ditch	Same as June 23
9	Road cut	Slumping	Same as June 23
11	Road cut	Slight gullying	Stable
13	Road cut	Severe gullying	Slight gullying
17	Road cut	Slight slumping and flowage	Dry and stable
20	Road cut	Site not visited	Major slumping and flowage

When revisited on August 1, most of the road cuts and wet places along the roadway northwest of Livengood had become dry and stable (Table 1), and continued problems were noted in only 3 sites along this stretch. Southeast of Livengood, the Elliott Highway was in excellent condition, and no problem areas were noted.

ROAD LOG I. FOX TO YUKON RIVER

Site No.	Mileage	Description
1	0.0	Beginning of Elliott Highway at Fox.
*2	11-50	Many soft and rutted places along highway on June 23. Probably represent recently thawed ice lenses, aggravated by heavy traffic during spring breakup.
*3	56.8-57.1	Floor of Tolovana Valley south of highway bridge. Road soft and badly rutted on June 23.
*4	67.4-69.0	Road descends steep grade to valley of Livengood Creek. Many soft and rutted places where road crosses north-facing slope segments (June 23).
5	69.5	Livengood.
6	80.1	Cut 10 m deep into alluvial terrace north of Lost Creek exposes subrounded to subangular stones to small cobble size, overlain by loess cap 0.5 m thick. Gravel little weathered, but upper 1 m shows oxidation stain. Terrace stands about 50-60 m above flood plain of Lost Creek, and occurs on both valley sides.
*7	86.0-86.3	Silt-filled floor of Erickson Valley. Road wet and slightly rutted, but firm, on June 23; in excellent condition on August 1.
*8	94.2	Road crosses valley of unnamed tributary to Richardson Creek. Roadway wet and slightly rutted on June 23; dry and firm on August 1.
*9	94.7	Cut 10 m deep in organic silt. Although sprayed with plastic foam and partly vegetated, cut still slumping and flowing on August 1 due to thaw of ice-rich permafrost (Fig. 1).
*10	99.4	Probable solifluction slope along west side of road. Some soil flowage into roadside ditch, but condition of roadway is excellent.
*11	104.8	Cut along east side of road showed local minor gullying on June 23 but appeared stable on August 1.

Figure 1. Destruction of insulating plastic foam by slump and flowage into road cut, Mile 94.6 (Site 9), August 1, 1975.

Figure 2. Gullies in cut at Mile 108.5 (Site 13). August 1, 1975.

Site No.	Mileage	Description
12	107.7	Several faults evident in stable bedrock cut.
*13	108.5	Cut severely gullied near north end, with debris cones filling roadside ditch in several places. Cut had become largely stabilized by August 1, and was about 50% vegetated with only 1 gully still active (Fig. 2).
*14	116.7-116.9	Probable solifluction slope along west side of road. Some soil flowage into roadside ditch.
15	116.9-118.2	Road descends steep grade into valley of Isom Creek. Cuts along west side of roadway expose as much as 25 m of bedrock and 10 m of loess and weathered rock. All cuts stable except for minor surface spalling and shallow gullying on June 23. On August 1, silt exposures were still spalling slightly, but debris aprons at their bases were becoming vegetated.
*16	122.7	Trough over a subsided culvert was observed on June 23. No trace of the problem remained on August 1.
*17	128.3-129.4	Steep descent down bluffs south of the Yukon River. Series of cuts 6-15 m deep expose silt above occasional bedrock. Faces of cuts showed minor slumping and flowage on June 23, but most cuts were stable and partly vegetated by August 1. Although a few cuts were still retreating by shallow slumping and gullying on August 1, roadway and cuts were generally in good condition.
*18	129.4-130.6	Road skirts probable solifluction slopes at base of Yukon River bluffs. Some flowage into roadside ditch in places.
19	132.1	South bank of Yukon River at ferry crossing.

*20 On August 1, a side trip was taken to the south abutment of the Yukon River bridge (Site 20, Plate I) where a 20-m cut exposes silt above bedrock. Close to the bluff face, the silt is relatively coarse, well-drained, and ice-free (Fig. 3). Farther south it is oxidized to a depth of about 2 m, and grey, fetid-smelling, ice-rich, permanently frozen muck lies below this level (Fig. 4). Ice wedges begin at the base of the oxidized zone, and extend for an unknown distance down into the muck. The exposed permafrost is thawing and retreating, maintaining a vertical face above a sloping apron of flowing mud.

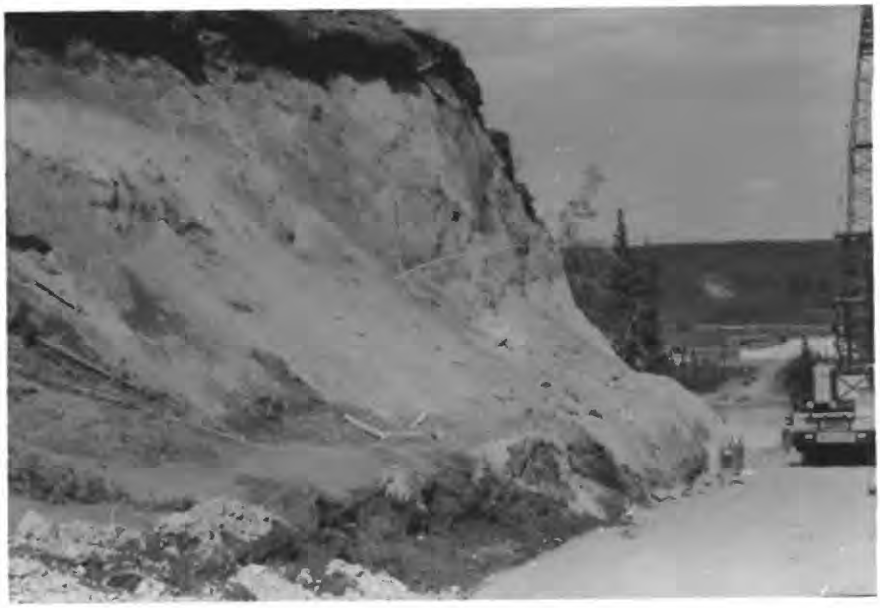

Figure 3 (above). Cut into silt and bedrock at south abutment of Yukon River bridge (Site 20). August 1, 1975.

Figure 4 (left). Ice-rich silt immediately south of area shown in Figure 3. Permafrost is thawing rapidly, causing retreat of vertical face and accumulation of debris slope at its base. August 1, 1975.

Site No.	Mileage	Description
		The access road to the abutment descends the southern bluffs of the Yukon River through a 2-mile stretch comparable to Miles 128.3 to 129.4 along the haul road south of the ferry crossing. A series of road cuts exposes 6-15 m of silt above occasional bedrock. Most exposed faces were dry and stable when viewed on August 1.

SEGMENT II. YUKON RIVER TO COLDFOOT CAMP

The haul road extends northward about 125 miles from the north bank of the Yukon River to Coldfoot Camp in the southern Brooks Range (Plate II). In succession, it crosses unglaciated uplands of interior Alaska (85 miles), very old glaciated terrain within the southern foothills of the Brooks Range (24 miles), and younger glacial deposits within and peripheral to the range (16 miles). This portion of the haul road was examined on June 24 and again on August 1, 1975.

Through the 85-mile stretch across unglaciated terrain, most road cuts expose weathered bedrock, usually with only a very thin cover of loess or colluvium. These cuts were largely stable on June 24, with only shallow and localized gullies, slumps, and spalling on their faces (Table 2). Erosion was most severe, and ditches were most filled with sediment, where road cuts intersected silty swale fillings. Continued instability, usually minor, was noted at 8 road cuts on August 1. Ten other present or potential problem areas were evident along this stretch of the haul road: 5 apparently active solifluction slopes, 2 wet swales presumably underlain by ice-rich permafrost, 2 sites where the roadway was soft or sloughing for undetermined reasons, and 1 additional area of impeded drainage.

The 40-mile stretch through glaciated terrain farther north crosses surficial deposits which range from stable outwash gravel and terrace alluvium to clayey till and lacustrine sediments. Much of this stretch was dry and stable, even in early summer, but some areas pose chronic problems of engineering stability and environmental impact. Eleven problem areas were noted along this stretch on June 24. Drainage was

Table 2. Present and potential engineering or environmental problems, Yukon River to Coldfoot Camp (Segment II).

Site(s)	Element Affected	Problem (June 24)	Status on August 1
31, 75	Road cuts	Slumping and/or flowage	Same as June 24
55	Road cuts	Slumping and/or flowage	Minor raveling
32,56,64,68	Road cuts	Slumping and/or flowage	Dry and stable
24, 46	Road cuts	Gullying	Same as June 24
47	Road cuts	Gullying	Dry and stable
27,28,36	Road cuts	Stable	Slumping or gullying
29	Road cuts	Stable	Minor slump and flow
54	Road cuts	Seepages	Minor raveling and gullying
71	Road cut + ditch	Major gullying and siltation	Local gullying and siltation
26,41	Roadway	Wet swale or valley floor	Dry and firm
33	Roadway	Soft in places	Dry and firm
32	Roadway + ditch	Siltation in ditch	Sloughing of road edge
58	Roadway + ditch	Ditch wet and muddy; sloughing road edge	Same as June 24
76	Roadside ditch	Thermokarst subsidence	Same as June 24
37,38,43,74	General	Solifluction slopes	Same as June 24
48, 51	General	Solifluction slope + impeded drainage	Same as June 24
39,60,63, 69,70	General	Drainage impeded against roadway	Same as June 24

ponded along the roadway at 4 sites, and 4 other sites were slumping or flowing because of thawing permafrost. The remaining 3 sites were wet or unstable because of thaw of seasonal frost, natural seepage zones, and confinement of moisture above impermeable lacustrine clay. Ponded drainage was still evident in late summer, and continued instability and/or excess moisture was noted at 4 of the road-cut sites.

LOAD LOG II. YUKON RIVER TO COLDFOOT CAMP.

Site No.	Mileage[1/]	Description
21	0.0	North bank of Yukon River.
22	1.9	Cuts 4-6 m high along both sides of haul road expose horizontally bedded grey silt which contains occasional granules and snail shells and is interbedded with clayey silt and organic silt layers. Face of east cut is stable, but west cut exhibits minor slumping into roadside ditch (Fig. 5).
23	4.3	Cutbank 6-8 m high opposite entrance to Fivemile Camp (Fig. 6). Alluvial sand and granules, with thin gravel layer near top. Arkosic composition, with feldspar prominent in sand-to-granule range. Capped by loess blanket 0.3 m thick. Some minor slumping on June 24, but exposure appeared entirely stable on August 1.
*24	6.7	Stable cut as much as 9 m deep where road crosses ridge crest exposes loess above bedrock and rock rubble (Fig. 7). Loess bears mature Subarctic Brown Soil profile. At its north end (Mile 6.9), eastern cutbank is 3-6 m high and exposes mainly colluvial silt, fine sand, and rock rubble. Small gullies were active on June 24; minor slumping and gullying were continuing on August 1 (Fig. 8).
25	10.8	Cut 6-8 m deep through minor ridge crest. Alluvial gravel with stones up to 10 cm diameter above frost-shattered bedrock. Bank has been graded back to an angle of about 35°, and stratigraphic details have been smeared.
*26	11.2	Road crosses swale filled with organic sediments. Very wet along roadsides, but roadway itself is in good condition.
*27	11.3	Cut across a minor ridge crest exposes about 2 m of gravel overlying up to 5 m of bedrock (Fig. 9). The gravel is virtually unweathered, but a thick, red, clayey weathering horizon lies along gravel/bedrock contact. North flank of ridge extends into nearly horizontal terrace surface. Minor shallow gullying and slumping in several places on August 1.

[1/] A new mileage sequence is used north of the Yukon River because of necessary changes in the haul road at this point when the new highway bridge replaces the present (1975) ferry.

Figure 5. Bedded silt 1.9 miles north of Yukon R. (Site 22). August 1, 1975.

Figure 6. Bedded sand opposite entrance to Fivemile Camp (Site 23). August 1, 1975.

Figure 7. Loess above bedrock at Mile 6.7 (Site 24). Road crosses ridge crest here. June 24, 1975.

Figure 8. North end of above Site 24 (Mile 6.9). Road is descending north flank of ridge, and colluvial cover above bedrock has thickened. August 1, 1975.

Figure 9. Road cut through ridge crest at Mile 11.3 (Site 27). Man is standing on contact between gravel and highly weathered bedrock. June 24, 1975.

Figure 10. Road cut through colluvium-filled swale at Mile 13.8 (Site 29). August 1, 1975.

Site No.	Mileage	Description
*28	12.4	Cut through minor ridge crest which stands higher than Site 27. Bedrock to crest of ridge, with no overlying gravel. Roadway and cuts stable on June 24; locally gullied on August 1 where thick colluvium overlies bedrock.
*29	13.4-14.9	Cuts through ridge crests at Miles 13.4 and 14.9 expose highly shattered rock with thin loess cap. Faces stable on June 24; stable except for minor loess gullying on August 1. Colluvium-filled swale between these ridges is exposed in a 3-m cut at Mile 13.8. Roadside ditch wet in places on August 1, and bank showed minor flow and collapse features (Fig. 10).
30	15.4 & 15.8	Cuts about 15 m deep expose shattered granitic rock with thin soil cap (Fig. 11). Very little loess above bedrock in this area, and slopes appear relatively well drained and stable.
*31	17.4	South flank of tributary to Ray River. Colluvial silt in cut 5 m deep. Some slump and flowage on June 24; localized slumping and wet zones still evident on August 1.
*32	18.4	Minor siltation in ditch along east side of road on June 24; apparently derived from road subgrade. Continued minor sloughing of road edge evident on August 1.
*33	18.8	Cut 6 m deep along both sides of road has been graded back and badly smeared. Appears to consist of silt and sand above oxidized sandy grus. Minor flowage and gullying of cut faces on June 24, and both ditches were somewhat gullied. No problems noted on August 1.
34	19.2	Cut through ridge crest exposes grus over granitic rock with possible thin gravel cap (too smeared to be certain). Natural ground surface very stable.
35	20.1	Cut through ridge crest exposes 4 m of subrounded to subangular fluvial gravel up to 5 cm in diameter. Upper 0.5 m is oxidized.
*36	21.0	Cut into alluvial terrace exposes sand and granules above gravel. Some gullying evident on August 1, with sloughing into roadside ditch which contained standing water in places (Fig. 12).

Figure 11 (left). Road cut through shattered bedrock at Mile 15.4 (Site 30). June 24, 1975.

Figure 12 (below). Unstable road cut in alluvium at Mile 21.0 (Site 36). August 1, 1975.

Site No.	Mileage	Description
*37	24.1	Road crosses No Name Creek, a tributary to Ray River. Probable solifluction slopes extend down both valley flanks.
*38	24.1-26.5	Road crosses broad stretch of solifluction terrain with very poor drainage.
*39	28.7	Drainage impounded against west side of roadway on June 24. No problems evident on August 1.
*40	29.5	Road soft in places on June 24. Subgrade appeared stable, but surfacing material may have excessive silt or clay content. No problems noted on August 1.
*41	35.2	Road crosses broad and poorly drained valley floor. No adverse effects evident.
42	35.7	Cut through ridge crest exposes bedrock overlain by thin residual soil.
*43	39.1	Road crosses probable solifluction slope. No adverse effects evident.
44	49.7	Cut along west side of road exposes 3-4 m of rock rubble.
45	54.8	North entrance to Old Man Camp.
*46	54.8-55.4	Road cuts 3-5 m high expose grus above granitic rock. Overlying thin soils thicken into colluvial aprons on ridge flanks. Local gullying on June 24 (Fig. 13); continued gullying, seepages, and alluviation of roadside ditches on August 1 (Figs. 14 and 15).
*47	56.2	Cuts 6 m deep along both sides of road expose grus over granite and volcanic rocks. A deep swale fill consisting or arkosic sand has been deeply dissected by gullying at Mile 56.9 (Fig. 16).
*48	59-60	Probable solifluction slope west of road. No evident effect on roadway, but drainage was ponded against road in several places on June 24.
49	61.0	Road crosses Fish Creek.

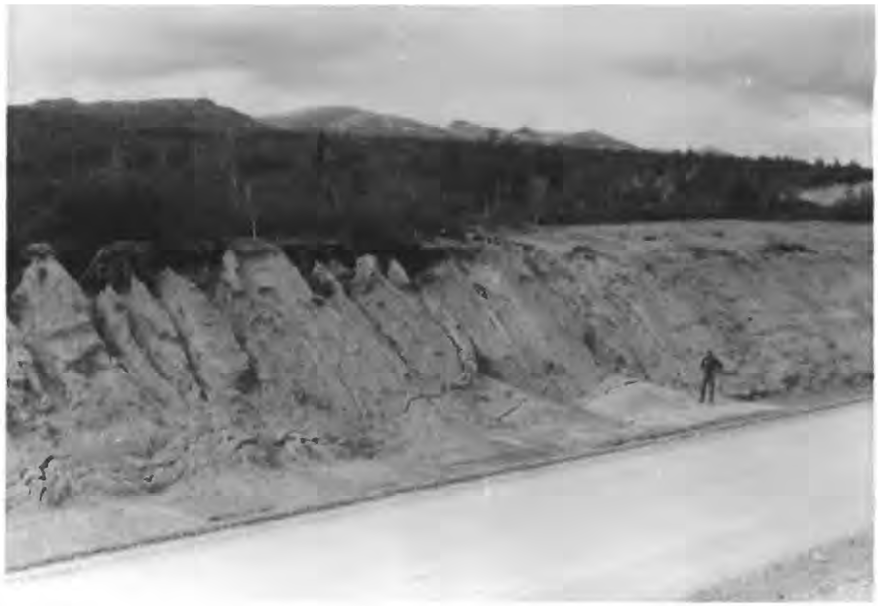

Figure 13. Road cut into grus near Old Man Camp (Site 46). June 24, 1975.

Figure 14. Gullies eroded into road cut near Old Man Camp (Site 46). August 1, 1975.

Figure 15. Wet, debris-filled ditch near Old Man Camp (Site 46). August 1, 1975.

Figure 16. Large gullies and fans on road cut at Mile 56.9 (Site 47). June 24, 1975.

Site No.	Mileage	Description
50	62.2	Phyllitic bedrock with thin rubble cap exposed in 6 m cut. Rubble cap includes igneous rock, which also is exposed in stone nets on ground surface. The igneous rock fragments probably are derived from a local contact between igneous and metamorphic rocks.
*51	66-67	Probable solifluction slope along southeast side of road. Some water ponded against edge of roadway on June 24, but no other adverse effects evident. Area appeared stable on August 1.
52	70.6	Begin gap in air photo coverage of haul road.
53	74-75	Road crosses upland underlain by generally well drained soil with occasional granite tors. Cut at Mile 75.8 exhibits 3 m of granite and grus overlain by up to 0.5 m of residual soil. No erratics are evident in this area.
*54	76-78	Road ascends from Bonanza Creek basin, utilizing cut-and-fill construction for most of this distance. Cut up to 3 m deep along east side of road exposes loess over occasional bedrock on lower part of slope and solifluction rubble above fractured phyllitic rock higher on slope. Many seepages emerging along bedrock contact on June 24. Cut appeared almost entirely stable on August 1, with only minor raveling of bedrock and minor gullying of loess. Wide berm along west side of road appeared entirely stable.
*55	79-81	Road descends into valley of Prospect Creek. Cuts up to 4 m deep along east side of road expose thin (0.5 m) colluvial cover above highly fractured phyllitic rock, which has been dragged downslope by solifluction or creep in places. Some local instability evident, especially where relatively thick swale fillings are intersected by road cuts. Active flows into roadside ditch were observed in several such areas on June 24, and one zone of moderate slumping was noted. Cut was almost entirely stable on August 1, with only minor raveling into the roadside ditch evident at two sites.
56	83.1-83.2	Thin colluvial cover over bedrock in cut to 5 m depth through ridge crest. No erratics evident. Colluvial and frost-churned cover becomes thicker and more highly organic near north end of exposure. This end of cut is subject to minor slumping and flowage.

Site No.	Mileage	Description
57	83.4	Access road to Prospect Creek Camp.
*58	87.0	Cut 5 m deep into alluvial terrace exposes gravel with thin cap of sand and sod (Fig. 17). Floor of roadside ditch consists of moist sand, gravel, and grey clayey silt, churned together by heavy construction machinery. The terrace gravel probably was deposited over Pleistocene lake beds. Ditch was still wet, soft, and muddy on August 1, and had been widened to about 15 m by removal of borrow material. Road shoulder was actively sloughing into ditch (Fig. 18).
59	88.0	Road crosses Jim River near mouth of Douglas Creek.
*60	89.9	Surface drainage ponded along east side of road.
61	95.7	Road ascends and crosses probable moraine front. No cuts available to show character of the glacial drift.
62	99.6	Road crosses recessional moraine which separates Jim River drainage from tributaries to South Fork of Koyukuk River.
*63	104.6	Crossing South Fork Koyukuk River. Several shallow ponds have been dammed by roadway where it extends across floodplain.
*64	105.9	Shallow road cuts at crest of north valley wall of the South Fork expose till above conglomeratic sandstone. Cuts wet and subject to flowage on June 24; they appeared dry and stable on August 1.
65	107.5-108.0	Road crosses moraine front, which marks limit of Itkillik (Late Wisconsin) glaciation in Brooks Range. Proglacial lake deposits from Mile 107.5 to 108.0, where a 3 m road cut through end moriane exposes massive till.
66	108.5	Road crosses probable recessional moraine. Till with abundant faceted and striated clasts is exposed in 3-m cut through moraine crest.
67	111.0	Cut 7 m deep into kame exposes water-washed sand and gravel up to cobble size. Frost churning has created a mixed silty gravel zone as much as 1 m deep.
*68	114.9	Cuts to about 10 m deep at edge of highest terrace along Middle Fork of Koyukuk River expose alluvial sand and gravel below peaty surface cap, which thickens to 2 m and becomes ice-rich in a depression fill near north

Figure 17. Alluvial gravel in road cut near Jim River (Site 58). June 24, 1975.

Figure 18. Sloughing of road edge into ditch at Site 58. August 1, 1975.

Site No.	Mileage	Description
		end of eastern road cut (Fig. 19). Peat was wet and thawing on June 24; dry and stable on August 1.
*69	115.0	Drainage dammed between road and pipeline work pad has formed shallow pond at edge of floodplain.
*70	115.5-116.3	Drainage dammed at several places between road and valley wall.
*71	117.0	Road ascends from floodplain to surface of drift sheet (Fig. 20). Sandy alluvium underlies 5-8 m of glacial drift, which consists of till west of road and ice-marginal stream gravel to east. Till forms a ridge which probably is end moraine; gravel occupies channel-like depression which later filled with colluvium and organic matter. Ditch along east side of roadway had eroded deeply into the fine-grained channel fill on June 24, causing extensive siltation at base of grade (Figs. 21 and 22). This problem area was largely stabilized on July 31. Gully incisions had been filled with coarse gravel, with grass growing in places. Debris fan at base of grade no longer was receiving sediments; road cuts and ditches were dry and stable (Fig. 23). However, local piping along ditch suggests that erosion still is taking place beneath coarse gravel fill (Fig. 24). Air photo coverage of haul road is complete beyond this point.
72	117.2	Road cut 12-15 m high exposes probable fan deposits (Fig. 25). Clasts poorly bedded and sorted, but most are angular, of local lithology, and range from pebbles to very small boulders. No striated or faceted clasts evident. Cut dry and stable, with only slight raveling.
73	117.4	Shallow (2-3 m) cuts into till. Dry and stable.
*74	117.5-118.5	Road crosses poorly drained upland which appears to be ground moraine. Solifluction appears to be widespread, but roadway dry and stable.
*75	119.7	Cut along east side of road stands 6-7 m high. Muck and gravel alternately exposed, with ice-rich muck probably forming channel fills in gravel. Upon thawing, muck yields lobes of flowing mud which have nearly filled roadside ditch in places (Fig. 26). Two flow lobes still

Figure 19. Peaty depression fill in alluvial terrace along Middle Fork of Koyukuk River (Site 68). June 24, 1975.

Figure 20. Haul road ascending moraine front in Middle Fork Valley (Site 71). June 24, 1975.

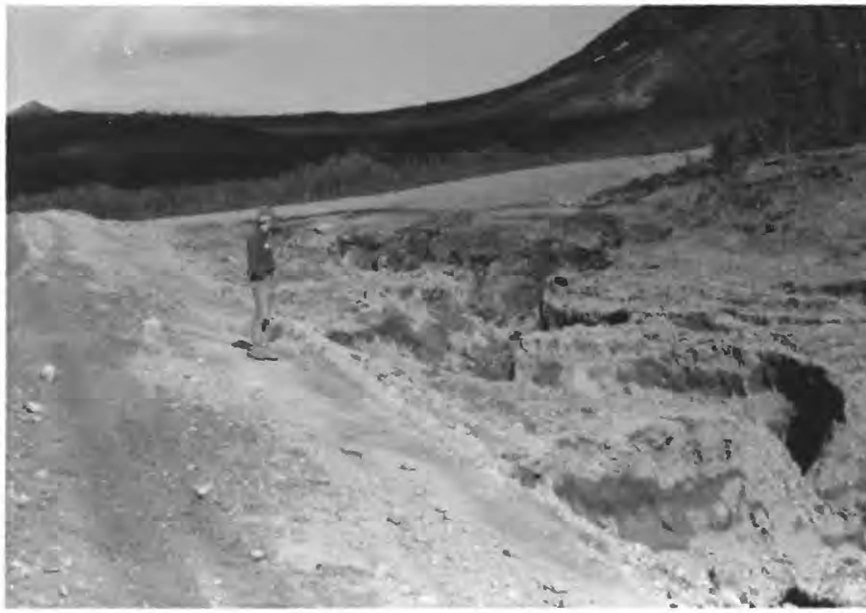

Figure 21. Gully erosion in roadside ditch at Site 71. June 24, 1975.

Figure 22. Siltation at base of road grade, Site 71. June 24, 1975.

Figure 23. Site 71 on July 31, 1975.

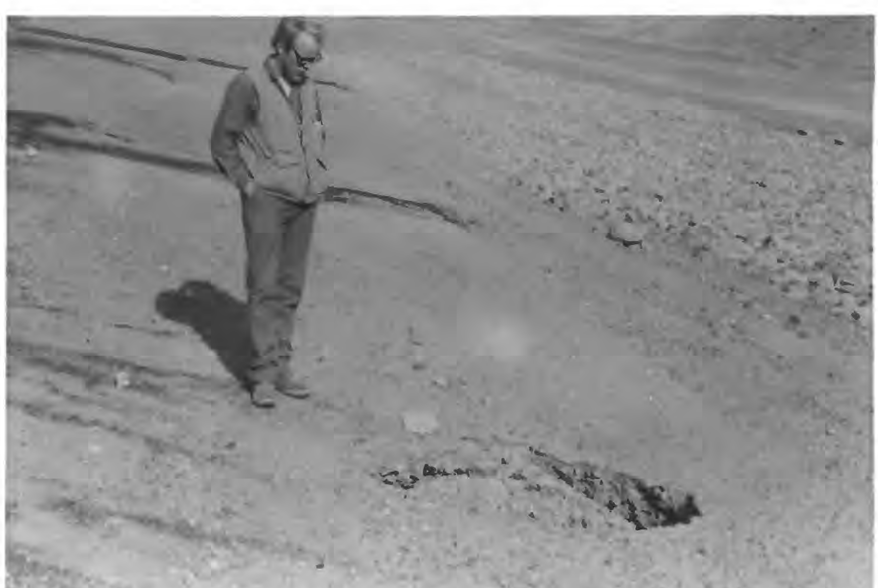

Figure 24. Piping in roadside ditch at Site 71. July 31, 1975.

Figure 25. Fan gravel exposed at Site 72. June 24, 1974.

Figure 26. Mudflow at Site 75. June 24, 1975.

Site No.	Mileage	Description
		evident on July 31, but both appeared fairly dry and nearly stable. Bank was still receding in one place owing to continued thaw of permafrost.
*76	120.0	Cut about 5 m high along west side of road exhibits:

Unit	Thickness (m)	Description
3	3	Fluvial gravel. Contains frost structures in places (involutions, mixing, vertical fabric, and one wedge cast).
2	0.5	Bedded sand and silty fine sand. Contains twigs in 1 locality.
1	1.5	Covered. Probably same as Unit 2.

Site No.	Mileage	Description
		Roadside ditches very wet and unstable; probably floored by silt and sand (as in Unit 2). Ditches were still wet on July 31. They appeared to be subsiding, probably due to melting of ice-rich permafrost.
77	120.3	Cut along east side of road exposes 4 m of sand and gravel. Appeared stable on June 24, but ditch at base was wet from ground-water seepage. Site dry and stable on July 31.
78	124.7	Entrance to Coldfoot Camp.

SEGMENT III. COLDFOOT CAMP TO GALBRAITH LAKE CAMP

This 105-mile segment of the haul road crosses the Brooks Range via valleys and connecting passes of the Dietrich, Chandalar, and Atigun Rivers (Plate III). Problem areas are more frequent here than in segments farther south owing to steeper slopes crossed or skirted by the haul road, presence of alpine mass-wasting and other high-altitude processes, and greater frequency of near-surface permafrost.

Thirty-three existing or potential problem areas were noted along this stretch of the road on June 25, 1975 (Table 3). Nine solifluction slopes cross or abut against the roadway, and thaw ponds or impeded drainage also are common at these sites. Nine zones of slumping, flowage, seepage, raveling bedrock, or persisting snowbanks occur on steep slopes in the Dietrich Pass (Chandalar Shelf) and Atigun Pass areas. Four steep alpine fans crossed by the haul road have boulder-littered surfaces indicative of recent debris flows or possibly slushflows, and at least 4 broader and gentler alluvial fans have aufeis or flood-hazard zones which potentially endanger parts of the road. The remaining five problem areas consist of 2 muskeg zones with thermokarst development, 2 landslide tongues crossed by the road, and 1 site where minor slumping is taking place in a sandy road cut.

Continued thaw of ice-rich permafrost caused chronic problems which were still apparent at 5 sites on July 31. Active flows of wet mud and debris were taking place at 3 sites; subsidence and development of thermokarst pits was occurring at 2 others. Further chronic problems were seepage zones at Site 123 and rockfalls from fractured bedrock exposed in road cuts at Dietrich and Atigun Passes.

Table 3. Present and potential engineering or environmental problems, Coldfoot Camp to Galbraith Lake Camp (Segment III).

I. PRESENT PROBLEMS

Site(s)	Element affected	Problem (June 25)	Status on July 31
78-79	Roadway	Water ponded along roadside	Somewhat drier
92, 108	Roadway	Solifluction slope + impeded drainage	Somewhat drier
100	Roadway	Solifluction slope + thaw pond	Same as June 25
94	Roadway	Muskeg terrain	Subsidence (thermokarst)
83	Roadside ditch	Thermokarst subsidence	Same as June 25
144	Road cut	Slumping	Same as June 25
119-120	Road cuts + roadway	Chronic slumps, flows, and slides, Dietrich Pass (Chandalar Shelf) area	
123-125 and 127-130	Road cuts + roadway	Chronic slumps, flows, slides, seepages, raveling and persisting snowbanks, Atigun Pass area	

II. POTENTIAL HAZARDS ZONES

Site(s)	Description
87, 102, 105, 111, 145	Solifluction slopes
107	Solifluction slope + rock glacier
91, 97, 104	Aufeis zone
117, 122	Landslide deposit at or near road edge
131, 137, 138, 139	Steep alpine fan (debris flow and/or slushflow hazard)
140	Steep alpine fan (flood hazard)

III. COLDFOOT CAMP TO GALBRAITH LAKE

Site No.	Mileage	Description
*78	124.7	Entrance to Coldfoot Camp.
		Between Miles 124.7 and 131.6, road follows alluvial terrace flanked by possible solifluction slope to east. Foot of slope occasionally extends to road edge, where small amounts of water are ponded against road bed in places.
79	131.6	Road ascends to surface of higher alluvial terrace. Cut 7 m deep at terrace edge exhibits fluvial gravel with minor sand beds beneath thin (0.5 m) loess cap (Fig. 27). Bank appears entirely stable.
		Road follows terrace surface from Mile 131.6 to 134.1. Roadway stable, and ditches generally dry. No cuts present.
80	135.4-135.6	Cuts 3-5 m deep into hummocky surfaces along both sides of road. Fluvial sand and gravel throughout, and faces are stable.
81	136.3	Cut similar to Site 80, east side road.
82	136.7	Cut 4-5 m deep along west side road exposes bedded sand and gravel above 2 diamicton (till-like) units separated by a buried Histosol (organic soil) (Fig. 28). Measured section near midpoint of exposure shows:

Unit	Thickness (m)	Description
4	2	Upper diamicton. Unsorted and unstratified pebbles and cobbles in silty sand matrix.
3	0.5	Histosol. Black to dark reddish brown (5 YR 2/2) peaty muck. Overlain by thin (0.5 cm) layer of white diatomite(?). Pebbles from Unit 4 have been pressed down into the paleosol
2	0.5	Gleyed and occasionally slightly organic silty fine sand. Probably depression fill on surface of lower diamicton.
1	1.5	Lower diamicton. Same as Unit 4.

Figure 27. Terrace gravel at Site 79. June 25, 1975.

Figure 28. Buried Histosol in diamicton at Site 82. June 25, 1975.

Site No.	Mileage	Description
*83	137.0	Cut 5-7 m deep along west side of road exposes till which contains deep kettle fill of silt and organic matter. Fill probably was permanently frozen and ice-rich prior to road construction because concentric tension fractures now surround an actively subsiding thermokarst depression at this site (Fig. 29). Area was still actively subsiding on July 31 (Fig. 30), and subsidence also was noted on pipeline work pad about 1 mile to the southwest.
84	137.1-137.2	Long cut where road drops from moraine surface down to fan of Minnie Creek. South end of cut exposes water-washed ice-contact drift of 2 kames; north end of cut exposes up to 10 m of stratified ice-contact deposits associated with a third kame (Fig. 31). Cut was stable on July 31, but minor flows, slumps, and creep had obscured its face.
85	137.3	Road crosses Minnie Creek.
86	137.7	Cut 4 m deep along east side of road exposes gravel of Minnie Creek fan. Boulders up to 50 cm diameter are common, with clasts occasionally as large as 70 cm. Minnie Creek may have reworked older glacial deposits, because nearly all large clasts are subrounded rather than angular to subangular.
*87	137.9-138.4	Probable solifluction slope impinges on road from east (Fig. 32). Silt and organic silt are exposed in cut 2 m deep at Mile 138.4 where road begins to drop onto active floodplain of Middle Fork of the Koyukuk River.
88	138.6	Road crosses Middle Fork then follows its floodplain. Occasional cuts expose fluvial sand and gravel in banks up to 2 m high.
89	141.0	Road crosses Middle Fork again, resuming position along east bank of river.
90	148.0	Road crosses Gold Creek. Fluvial sand and gravel exposed in cuts 3-4 m deep where road drops to floor of Gold Creek Valley.
91	148.8	Road crosses Linda Creek. Cuts on both sides of creek, as at Site 90. Graded, seeded, and stable by July 31.
*92	149.7-152.7	Probable solifluction slope extends from valley side to east edge of haul road. Some drainage ponded in ditch along road edge, and road shoulder appears soft in places. Slope steepens to 7° at Mile 151.9, where solifluction appears especially active.

Figure 29. Thermokarst subsidence at Site 83. Subsidence is taking place beneath a berm of gravel which has been emplaced over face of road cut. June 25, 1975.

Figure 30. Continued thermokarst subsidence at Site 83. July 31, 1975.

Figure 31. Ice-contact gravel at Site 84. Note steeply dipping foreset beds. June 25, 1975.

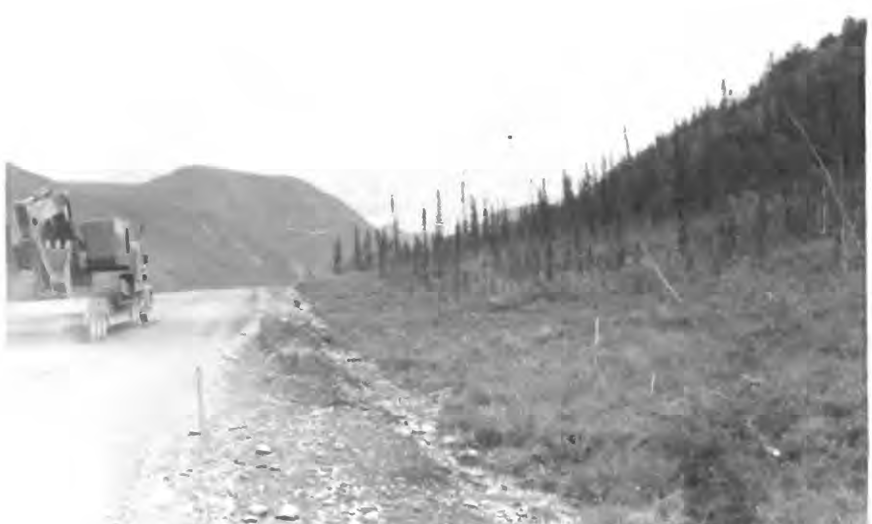

Figure 32. Active solifluction slope (Site 87). June 25, 1975.

2.7

Site No.	Mileage	Description
93	154.2	Borrow pit east of road provides fresh exposures of the coarse limestone rubble at base of Sukakpak Mtn. Probably landslide deposit rather than rock glacier because (1) it is not connected to any modern or ancient talus slope, (2) a relatively fresh detachment scar overlooks the deposit, and (3) deposit contains many huge blocks much larger than those in modern talus of the mountain.
*94	154.6-154.9	Road crosses muskeg terrain which has poor surface drainage and many frost mounds (palsas) (Fig. 33). Mounds range in height up to 1.5 m, occur along both sides of road and are currently active, with open tension cracks 20-50 cm deep. They appear to be ice-cored because thaw leads to formation of nearly circular small ponds (Fig. 34). This stretch of road (ca. Mile 154.4 to 154.9) was being rebuilt and regraded on July 31. Substantial quantities of gravel were being added, suggesting that thaw of permafrost and/or compression or soft bog sediments had caused appreciable subsidence.
95	155.4 & 155.6	Road crosses two channels of the Middle Fork, then follows its floodplain.
96	158.3	Road crosses Dietrich River.
*97	159.7	Road crosses unnamed tributary. Stream channel filled by aufeis on June 25.
98	159.8	Cut 4 m deep through ridge of fan gravel. Stable and vegetated on July 31.
99	160.7	Entrance to Dietrich Camp.
*100	162.7-164.7	Probable solifluction slope along east side of road. Slope is forested, but many trees are bent and contorted owing to soil instability. Small pond along east side of road at Mile 164.6 (Fig. 35) does not appear on air photos of area, hence must have formed since road construction.
101	165.4	Road crosses Snowden Creek.
*102	166.6-167.6	Probable solifluction slope extends from valley side to east edge of road.

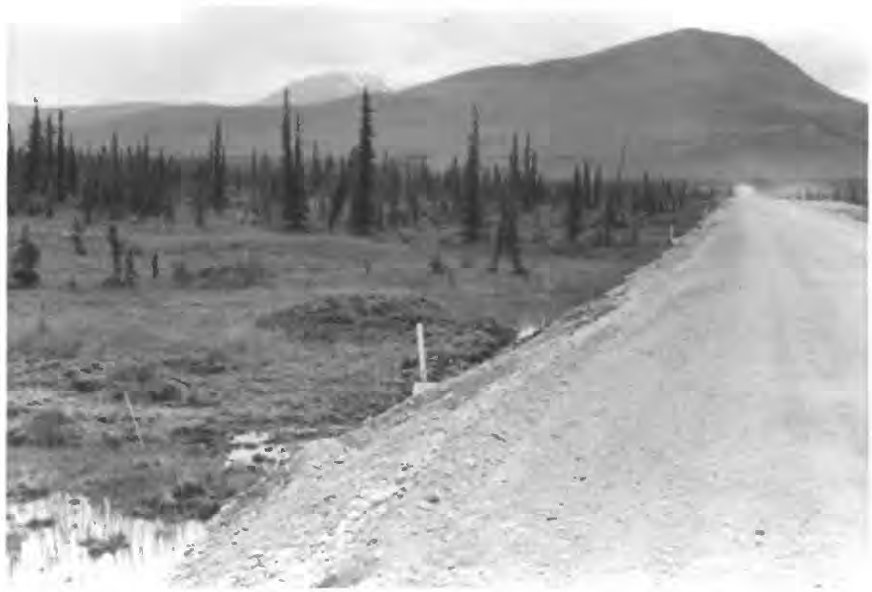

Figure 33 (above). Muskeg terrain and palsas at Site 94. June 25, 1975.

Figure 34 (left). Active palsa (note tension cracks) and thaw pond at Site 94. June 25, 1975.

Figure 35. Pond formed since road construction (Site 100). June 25, 1975.

Figure 36. Front of probably active rock glacier close to haul road at Site 107. June 25, 1975.

Site No.	Mileage	Description
103	167.6	Road begins ascent of alluvial fan. Sand and gravel are exposed in shallow cuts.
*104	168.2	Road crosses unnamed tributary stream. Aufeis in channel on June 25..
*105	168.7-169.7	Possible solifluction slope flanks road to the east.
106	169.7-170.1	Road crosses alluvial fan. Sand and gravel exposed in shallow cuts.
*107	170.1-171.0	Possible solifluction slope flanks road to east. Inactive rock glacier lies east of road at Mile 170.5, and unvegetated front of possibly active rock glacier stands close to road at Mile 171.0 (Fig. 36).
*108	171.1-172.1	Possible solifluction slope flanks road to east. Water is ponded along east side or roadway at several places.
109	172.1-173.6	Road crosses alluvial fans of 2 unnamed tributary systems.
110	173.6-179.7	Road follows floodplain of Dietrich River, crossing an alluvial fan at Mile 176.7. Cuts 3 m deep at Miles 177.2, 177.5, and 177.7 expose alluvial gravel; cuts at Miles 178.3 and 179.7 expose bedrock beneath thin (< 0.5 m) colluvial cover.
*111	180.0	Possible solifluction slope extends to road edge from east valley wall.
112	180.2	Road crosses Nutiruik Creek.
113	181.0	Slate exposed in cut 5 m deep along east side of road.
114	181.4	Slate exposed in cut 8-10 m deep along east side of road.
115	183.6	Slate or phyllite in several low bedrock exposures near east side of road.
116	184.1	Road crosses series of alluvial fans. Fan gravel exposed in cuts up to 5 m high along east side of road.
*117	188.7	Possible landslide from north valley wall. Its front, eroded back by Dietrich River, stands only 20 m from road. Heavily vegetated, and apparently stable for a long time.
118	189.2	Road begins ascent toward Dietrich pass (Chandalar Shelf).

Site No.	Mileage	Description
*119	189.6-190.6	Nearly continuous cuts 10-20 m high border road to the east, exposing slate beneath colluvium which thickens across floors of swales. Minor raveling of exposed bedrock was noted on June 25, and debris cones were encroaching on road in a few places. Slope activity was observed in 2 areas on July 31. A portion of the cut intersecting a silt-filled drainage swale at Mile 190.0 exhibited minor slumps and flows, which disrupted the blanket of straw insulation placed at this site (Fig. 37). A large elongate flow at Mile 190.1 extends from roadway down to the valley bottom (Fig. 38). It is fed by water and mud emerging from drainage swales along east side of the roadway (Fig. 39), at a place where road has been inadequately culverted. The flow was covered with a blanket of straw, which has been broken by continued flowage.
*120	190.6	Dietrich Pass (Chandalar Shelf). Cuts up to nearly 30 m height expose black slate. Cut along east side of road is generally stable, but cut along west side is subject to landsliding down cleavage planes which dip steeply toward road. Numerous slides cover this portion of the cut, and many tension cracks occur above its head.
121	193.1	Entrance to Chandalar Camp.
*122	195.3	Kamelike knobs of rock rubble lie above bedrock along both sides of road (Fig. 40). Probable landside deposit, possibly deposited on stagnating glacier.
*123	196.2	Road begins ascent toward Atigun Pass (Fig. 41). Several debris flows below the road appear to have originated from roadbed (Figs. 41 and 42). One of the flows appears generated by concentration of runoff water through a culvert (Fig. 42).
*124	196.6-198.6	Almost continuous series of road cuts into colluvium flank northwest side of road (Fig. 41). Through Miles 196.6-197.0, the cuts are relatively low (3-5 m) and mainly expose solifluction rubble; farther up the slope they are mainly into talus. Close to the Pass, many of the cuts are as deep as 10-20 m and several expose bedrock at their base. Exposed strata dip directly downslope toward road in only 1 locality.

Figure 37. Colluvium-filled swale reactivated by road cut at Mile 190.0 (Site 119). July 31, 1975.

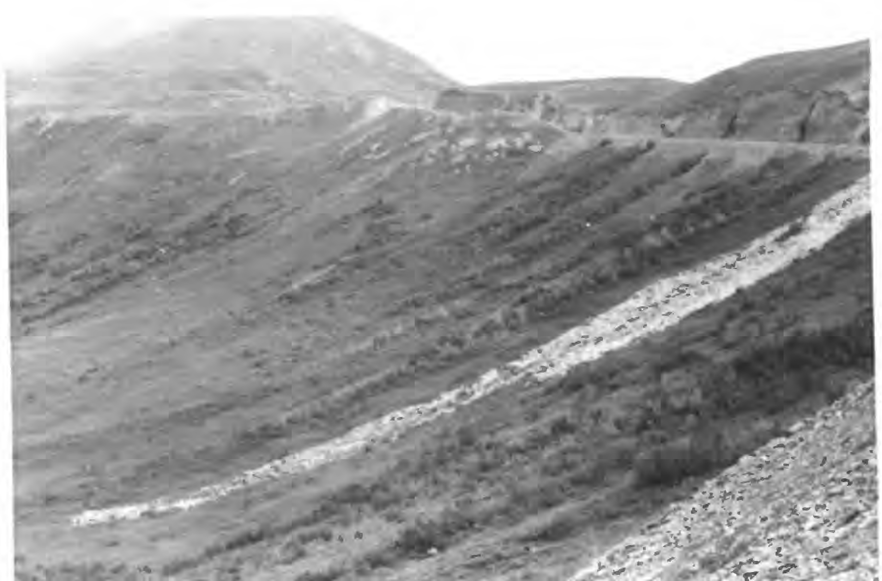

Figure 38. Large earthflow originating at Mile 190.1 (Site 119). July 31, 1975.

Figure 39 (left). Active flows and debris cone east of road at Mile 190.1 (Site 119). July 31, 1975.

Figure 40 (below). Landslide rubble in road cut at Site 122. July 31, 1975.

Figure 41. Panoramic view of south flank of Atigun Pass from Site 123. June 25, 1975.

Figure 42. Closeup of debris tongues and earthflow which originate along road bed at ca. Mile 197.2 (Site 124). June 25, 1975.

Site No.	Mileage	Description
		Most of the cuts were fairly stable on June 25, although a few slumps were evident and occasional tension cracks occurred at tops of the cuts. Most cuts still appeared stable on July 31, but 4 minor problem areas were noted: Mile 196.9: Soft spot on road associated with seepage zone in road cut. Mile 197.3: Soft spot on road; cause unknown. Mile 197.5: Ditch filled with rubble from small slides. Mile 197.7: Seepage zone in road cut.
*125	198.6	Summit of Atigun Pass. Talus and bedrock exposed in cuts to 20 m deep along west side of road. The rock is highly fractured and subject to minor raveling.
126	199.0	Road crosses inactive rock glacier (Fig. 43).
*127	199.5	Persisting snowbanks along east side of road on June 25.
*128	199.7	Cut along east side of road exposes 3-6 m of ice-rich stony silt. Minor flows extended from base of cut into roadside ditch on June 25 (Fig. 44). When revisited on July 8, cut had been freshly graded and covered with mat of insulating material. Renewed flowage had disrupted much of the insulating mat by July 31, and about 10% of the cut was actively flowing (Fig. 45).
*129	199.7-199.9	Persisting snowbanks along southeast side of road on June 25 (Fig. 46).
*130	200.4	Road crosses very active debris slope (Fig. 47). Cuts 3-5 m deep expose rock rubble in ice-rich silty matrix. Cut west of road was highly unstable on June 25 owing to thaw of ice-rich permafrost. Mudflows, generated along face of cut, were filling roadside ditch (Fig. 48). Bank had been freshly covered with mat of insulating material when seen again on July 8, but by July 31 active flows had disrupted about 10% of the mat along both sides of road (Figs. 49 and 50).
*131	201.1	Road intersects a steep alpine fan which bears fresh-appearing levees and boulder litter indicative of repeated debris flows or slush flows (Fig. 51). Most boulders are weathered, but some lack weathering and lichen cover and may have been deposited recently (Fig. 52).

Figure 43. Inactive rock glacier crossed by haul road at north end of Atigun Pass (Site 126). June 25, 1975.

Figure 44. Flows into roadside ditch along north flank of Atigun Pass (Site 128). June 25, 1975.

Figure 45. Continued flowage at Site 128. July 31, 1975.

Figure 46. Persisting snowbank at road margin on north flank of Atigun Pass (Site 129). June 25, 1975.

Figure 47. View east from Atigun Pass to Site 130. July 31, 1975.

Figure 48. Flows into western roadside ditch at Site 130. June 25, 1975.

Figure 49. Active flows into eastern roadside ditch at Site 130. July 31, 1975.

Figure 50. Active flows into western roadside ditch at Site 130. July 31, 1975.

Figure 51 (left). Steep alpine fan north of Atigun Pass (Site 131). Haul road visible at base of photograph. July 31, 1975.

Figure 52 (below). Near view of Site 131. Heavy boulder litter on fan surface. July 31, 1975.

Site No.	Mileage	Description
132	201.7 & 202.2	Cuts 6 m and 10 m deep along west side of road expose grey slate overlain by thin (less than 0.2 m) colluvial cover. Numerous protalus ramparts along base of valley walls.
133	202.6	Cut 3-5 m deep in steep alpine fan exposes rock rubble beneath thin sod mat.
134	203.4	Entrance to Atigun Camp. Valley becomes relatively broad and gentle here, and road is less subject to alpine mass-wastage processes.
135	205.3-205.6	Cut 3 m deep into steep alpine fan along west side of road exposes small (< 10 cm) rock fragments which lack obvious water-sorting or stratification.
136	208.5	Cut 15 m deep along east side of road exposes bedrock (conglomerate) with thin rubble cover.
*137	210.4 & 210.6	Steep alpine fans with active, levee-bordered flow channels extend to within 50 m of road.
*138	213.0 & 213.3	Steep alpine fans with active levee-bordered flow channels extend to within 100 m of road.
*139	214.4	Steep alpine fan with prominent levees and channel intersects haul road (Fig. 53). Boulders with diameters of 1 m or more have been carried by flows of debris or slush rather than by running water.
*140	218.8	Road crosses an active alluvial fan. Unweathered, lichen-free boulders up to 60-70 cm (and occasionally 1 m) diameter litter fan surface along both sides of roadway.
141	221.3	Road crosses inactive alluvial fan with surface almost entirely vegetated. Stones to nearly 1 m diameter are exposed in road cuts 3-4 m deep.
142	224.0	Cuts 3 m deep along both sides of road expose eolian sand above glaciolacustrine sand. The sand is bedded, and contains buried organic matter.
143	224.8	Road crosses Atigun River.
*144	224.9	Cuts up to 9 m deep along both sides of road expose fluvial or glaciolacustrine sand and peat, with some overlying eolian sand. Cuts had been revegetated when revisited on July 31, but were still subject to continued minor slumping (Fig. 54).

Figure 53. Cut into alpine fan intersected by road at Site 139. June 25, 1975.

Figure 54. Slumping of eastern roadcut at north bank of Atigun River (Site 144). July 31, 1975.

Site No.	Mileage	Description
*145	225.6-228.1	Road crosses steep solifluction slope which appears to be currently active.
146	229.4	Entrance to Galbraith Lake Camp.

SEGMENT IV. GALBRAITH LAKE CAMP TO SAGWON BLUFF

The haul road between Galbraith Lake Camp and Sagwon Bluff traverses Pleistocene glacial deposits and Holocene alluvium at and beyond the north flank of the Brooks Range (Plate IV). Local relief is gentle to moderate, and slopes crossed by the road are steep only along the flanks of incised stream courses. This 84-mile segment of the haul road was examined on July 7, 1975, in a 1-day trip which began and ended at Galbraith Lake Camp. Despite nearly ubiquitous near-surface permafrost along the route, the roadway and road cuts generally were in excellent condition.

Eleven present or potential problem areas were noted along this segment of the haul road (Table 4). Drainage had been ponded against the upslope edge of the roadway at 6 sites, and 2 of these sites also lay on apparently active solifluction slopes. Subsidence due to thaw of ice-rich permafrost was noted at Sites 149 and 150, and melting of massive ground ice in a road cut had led to extensive mudflows at Site 162. The 2 remaining problem areas are a solifluction slope without ponded drainage and a soft section of the roadway whose origin could not be determined.

Table 4. Present and potential engineering or environmental problems. Galbraith Lake Camp to Sagwon (Segment IV).

Site(s)	Element Affected	Problem (July 7)
150	Roadway	Thermokarst subsidence along road edge
158,161,164,167	Roadway	Impeded drainage
160	Roadway	Soft places, cause unknown
162	Road cuts + ditches	Extensive slump, flow, and siltation
147, 169	General	Solifluction slope + impeded drainage
171	General	Solifluction slope
149	General	Thermokarst near roadside

IV. GALBRAITH LAKE CAMP TO SAGWON BLUFF

Site No.	Mileage	Description
146	229.4	Entrance to Galbraith Lake Camp.
*147	229.4-232.2	Crossing solifluction slope on lateral moraine along base of east valley wall. Some water ponded against roadway in a few places.
148	232.2-239.1	Crossing series of recessional moraines of Itkillik (Late Wisconsin) age. Boulders abundant on drift surface, as are kamelike sand and gravel deposits. Both road and natural slopes appear stable.
*149	239.1	Entrance to Toolik Camp. Haul road begins to ascend outer moraines of Itkillik age. Swales between moraines show slight thermokarst formation along roadside.
*150	240.5	Slump along south side of roadway is marked by concentric tension cracks which bound a series of individual subsiding blocks probably caused by thaw of ice-rich permafrost. Slump structures extend about 3 m in from the road edge, and are associated with a moist segment of the roadside ditch.
151	241.1	Outer edge of outermost Itkillik lateral moraine. Bouldery drift surface terminates abruptly at this point.
152	241.1-252.0	Crossing surface of Sagavanirktok-age drift, which is appreciably older and more subdued morphologically than Itkillik drift. More continuous tussock cover suggests finer and moister soils than on Itkillik drift, probably with a generally high permafrost table. No adverse impact on road evident on July 7.
153	252.0	Road intersects Itkillik drift limit at west margin of Sagavanirktok Valley.
154	252.0-259.4	Road crosses Itkillik drift. Soils generally granular and firm, with only minor silty organic swale fillings.
155	259.4	Outer edge of younger Itkillik moraine. Road begins 5-mile stretch along outwash terrace.

Site No.	Mileage	Description
156	264.7	Begin descent to flood plain of Sagavanirktok River. Cut along west side of road exposes 7 m of grey outwash gravel (rounded stones up to cobble size in a sandy matrix) beneath 40 cm of frost-churned stony silt (Fig. 55).
157	264.7-269.3	Road follows flood plain of Sagavanirktok River. Excellent gravel subgrade.
*158	269.8	Pond has formed on the upslope (west) side of road where intersected by access road leading to pipeline work pad.
159	269.3-275.8	Crossing Itkillik-age end moraines. No problems evident on July 7.
*160	276.2-277.2	Several soft places on road, possibly due either to thaw subsidence or to compaction of poorly graded or improperly emplaced fill. No thermokarst is evident beyond edges of roadway in these places.
*161	277.5	Drainage impounded by road and pipeline work pad has formed 3 shallow ponds.
*162	280.9	Road leaves flood plain of Sagavanirktok River and ascends about 50 m up steep grade to upland surface underlain by bedrock and glacial deposits (Fig. 56). In 1974, road cuts exposed muck and peat with ice wedges and other massive ground ice above a lens of till resting on bedrock (Fig. 57). By July 1975, massive ground ice no longer was visible in road cuts, but continued melting was causing slope retreat by slump and flowage (Fig. 58). Liquefied muck and till were discharging down both roadside ditches into basins behind dikes built at the base of the grade (Fig. 56).
163	280.9-293.4	Crossing ground moraine and end moraines of Sagavanirktok Glaciation. Ice-rich solifluction deposits probably overlie the glacial deposits, but no engineering problems or serious environmental disturbances were noted on July 7. Road was firm and dry, with stable shoulders. No evident intensification of thermokarst or mass wastage processes.
*164	289.6	Small pond has formed east of road where shallow swale was dammed by road pad without a culvert. No evidence on July 7 for enlargement of the pond by thermokarst processes.
165	290.9	Entrance to Happy Valley Camp.

Figure 55. Road cut into gravel of Itkillik Glaciation (Site 156). July 7, 1975.

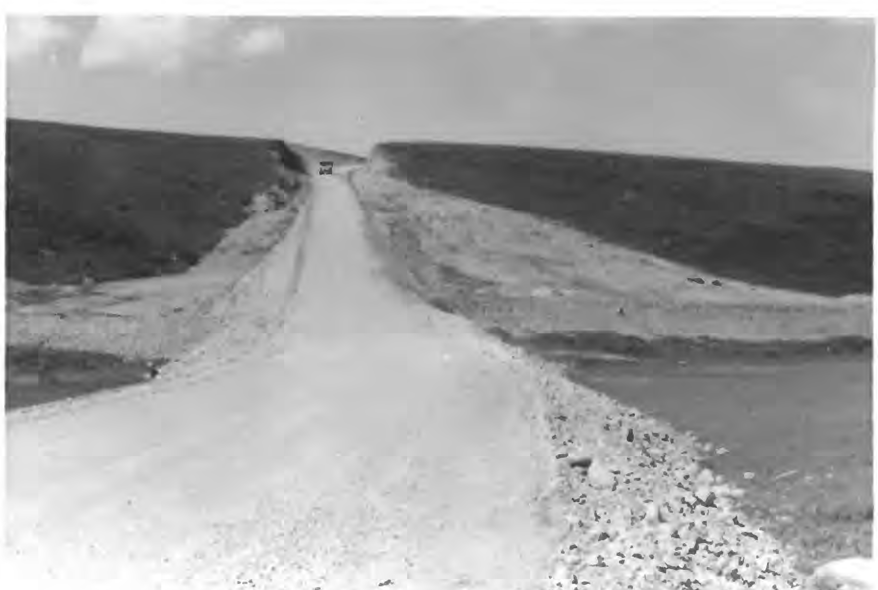

Figure 56. Road cuts into ice-rich muck above till and bedrock (Site 162). Disturbed areas on slope are mudflows and restraining structures. July 7, 1975.

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Figure 57. Western road cut at Site 162 shortly after excavation. June 30, 1974.

Figure 58, Western road cut at Site 162 one year later. July 7, 1975.

Site No.	Mileage	Description
166	293.4	Road begins descent toward flood plain of Sagavanirktok River, which it follows nearly to Sagwon Bluff.
*167	301.2	Small pond has formed east of road where drainage impeded by roadway.
168	304.9	Road begins ascent up Sagwon Bluff.
*169	304.9-306.5	Solifluction slope west of road, and drainage ponded against road in several places. Several old and largely vegetated earth flow scarps are present.
170	306.5-311.5	Road extends along crest of Sagwon Bluff. Yellowish soil colors suggest that deep clayey weathering zones could be a potential hazard.
*171	311.5-312.0	A probably active solifluction slope impinges on road from the east.
172	312.9	North edge of Sagwon Bluff. End of road log.

SUMMARY

Four segments of the Alyeska haul road were examined in the summer of 1975. Each has its own characteristic terrain, geology, engineering problems, and impact on the natural environment.

Segment I, the 132-mile stretch from Fox to the Yukon River, traverses unglaciated terrain of interior Alaska. Bedrock stands close to the surface across ridge crests, and thick accumulations of loess and reworked silt occur above gravel and bedrock on lower slopes and in the smaller valleys. The Elliott Highway between Fox and Livengood was in poor condition during June, when segments totaling more than 40 miles contained frequent soft places and deep ruts owing to thaw of seasonal ice lenses in the subgrade. The 52-mile Alyeska-built portion of the road between Livengood and the Yukon River was in relatively good condition, with only 3 slightly wet or soft spots and 5 unstable road cuts. Site 20, the south abutment of the Yukon River bridge, is considered the most severe problem along this segment of the haul road. Continued thawing of the ice-rich frozen muck which overlies bedrock in this 20 m cut probably generated extensive flows of mud and debris throughout the summer.

Segment II, which extends 125 miles north from the Yukon River, crosses 85 miles of unglaciated terrain followed by 40 miles of glacial deposits near the south flank of the Brooks Range. Through the unglaciated stretch, problems are almost entirely limited to unstable fresh road cuts, although some probable solifluction slopes also are of potential concern. Nine of the road cuts were still subject to slumping, gullying, or flowage in August. The 40-mile stretch farther north has a

greater range of engineering and environmental problems owing to the variability of glacial deposits and the greater frequency of near-surface permafrost with increasing latitude. The most common problems were drainage impounded by the roadway (4 sites) and slumping and flowage of road cuts in ice-rich permafrost (2 sites). Active solifluction slopes, thermokarst subsidence, and sloughing of the road edge were each noted at 1 site. The most serious problem area was Site 71, a steep grade south of Rosie Creek, where slumping and gullying along the road edge was associated with extensive siltation at the base of the slope.

Segment III, the 105 miles between Coldfoot and Galbraith Lake Camps, lies entirely within the Brooks Range. Hazards include unstable slopes on glacial deposits, possible burial by landslides, slushflows, avalanches, and rock glaciers on steep mountain slopes, and the increasing prevalence of near-surface ice-rich permafrost northward along the haul road. The principal problem areas along this segment of the road occur between the head of Dietrich Valley and the north end of Atigun Pass, where slumps and falls of highly fractured rock, flows of saturated muck and debris, and persistent snowdrifts were noted in 9 locations. Other chronic problem areas are probable solifluction slopes (9 sites), and active fans subject to slushflows or mudflows (4 sites), or to aufeis formation or severe flooding (at least 3 sites).

Segment IV, which extends 84 miles from Galbraith Lake Camp to Sagwon, traverses relatively gentle terrain north of the Brooks Range. Although ice-rich permafrost is widespread, this newly built segment of the haul road was mostly stable on July 7, 1975. Only 11 sites were classed as present or potential problem areas: 3 solifluction slopes

(2 with drainage impeded by the roadway), 4 other areas of impeded drainage, 2 small areas of thermokarst subsidence, a soft section of the roadway, and the Site 162 road cut. Site 162, at the top of a steep grade where thaw of massive ground ice has generated extensive flows, is considered the most serious problem area along this segment of the haul road.