REPORT ON SURVEY

TRANS-CANADIAN ALASKA RAILWAY LOCATION

ADDRESS REPLY TO
THE DISTRICT ENGINEER
U. S. ENGINEER OFFICE
700 CENTRAL BUILDING
SEATTLE, WASH.

REFER TO FILE NO. ____________

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
SEATTLE, WASHINGTON

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TRANS-CANADIAN ALASKA RAILWAY LOCATION

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Syllabus

The district engineer reports completion of Trans-Canadian Alaska Railway location survey and incorporates condensed profiles, maps, and preliminary estimates in his report. Field and district office work is still under way on construction studies, evaluation of possible revisions and permanent records.

WAR DEPARTMENT
United States Engineer Office
Seattle, Washington

October 12, 1942.

Subject: Report on Survey of Trans-Canadian Alaska Railway Location.

To: The Division Engineer, North Pacific Division, Portland, Oregon.

1. Authority. - The following directive was issued by the Commanding General, Services of Supply, Washington, D. C., March 25, 1942:

"MEMORANDUM FOR THE CHIEF OF ENGINEERS:

"1. It is directed that a field survey be undertaken at the earliest practicable date and pushed to completion for the construction of a rail route via the Rocky Mountain Trench from Prince George, British Columbia, to Fairbanks, Alaska. The survey should be completed during the coming season. It is desired that an experienced railway locating engineer familiar with the northwest be placed in charge of the survey or attached to it in a superior executive capacity.

"2. That the general specifications for this projected location be restricted to meet the requirements of a military railroad only.

"3. That the area northwest of Fairbanks, Alaska, be reconnoitered, both by air and ground, in order to have more knowledge on file as to the possibilities of that terrain in case of emergency.

BREHON SOMERVELL,
Lieutenant General,
Commanding."

a. In compliance with paragraphs 1 and 2 of the above-quoted directive, the following report, with appendices A to I, inclusive, is submitted on the survey of a railroad location from Prince George, British Columbia, to a rail connection with the Alaska Railroad.

b. A reconnaissance of the area west of Fairbanks to tidewater, authorized in paragraph 3 of the directive, has been made the subject of a separate report, file 7559(Trans-Canadian Alaska Ry.)167, submitted June 15, 1942.

2. Conduct of Survey.

a. Establishment of field divisions: In order to facilitate field operations, the route was divided into three location divisions, namely, Alaska, Yukon Territory and British Columbia, each under the direct supervision of a Principal Locating Engineer with headquarters at Fairbanks, Alaska, Whitehorse, Yukon Territory, and Prince George, British Columbia, respectively.

b. District office activity: A section was established in the office of the District Engineer, Seattle, for the express purpose of conducting this survey. This section interviewed and selected the personnel for the locating parties and arranged transportation to the several division headquarters; issued instructions governing the survey; established uniform reporting procedure; purchased and shipped all equipment and supplies; secured and issued to the field all maps and data available, and coordinated the transfer of parties and equipment between field divisions.

c. Aerial reconnaissance: An aerial reconnaissance of the route was made during the period, May 3 to May 12, inclusive. A report on this reconnaissance is included with this report as Appendix "A".

d. Methods and instructions: The route adopted is through relatively unexplored portions of Canada and Alaska and it was readily apparent that locating crews would be out of contact with their division engineers for considerable periods of time. In order to secure maximum uniformity in line development and presentation of data by the several locators under these conditions, written instructions governing the location were issued. A copy of these instructions is made a part of this report and listed as Appendix "B".

e. Personnel: Field surveys were started in Alaska in advance of the receipt of authority to initiate the surveys in Canada. Upon receipt of such authority, crews were immediately sent into the field in Yukon Territory. Considerable delay developed in the British Columbia Division. This office selected as principal locator in British Columbia, a highly recommended locating engineer formerly in the employ of the Canadian National Railway and now serving with the Canadian Army. Request was immediately made through channels for the assignment of this officer to duty with the office of the District Engineer. However, this officer was not officially released by the Canadian Army until June 1, 1942. The original plan for conducting the survey contemplated using eighteen crews. However, as the nature of the problems in Yukon Territory became known, and the starting date in British Columbia was postponed, the number was increased until a total of twenty-four crews were in the field by the end of July. Men with known railroad locating experience were contacted first, who in turn recommended other qualified engineers. A number of men with railway survey experience were so obtained, but the majority were from the ranks of highway departments in the Northwest. Partymen, such as rodmen, chainmen, axemen, cooks, and flunkeys, were recruited from Washington, Idaho and Oregon, or in the vicinity of the work. Six parties made up of Canadians entirely were employed in British Columbia. Peak employment was 556 persons on July 15. The actual number employed during the survey is shown in Appendix "C".

f. Transportation and supply: Transportation and supply of field crews was one of the most difficult problems encountered.

(1) The key men of the first two crews were transported by commercial air lines and Army transport planes from Seattle April 21 to Big Delta, Alaska, at which point field work was started on April 23, 1942. The remainder of the crews in the

Alaska Division travelled by steamer to Seward, by Alaska Railroad to Fairbanks, and thence by boat, air and tractor trail to the initial point on their assigned sections.

(2) Crews for Yukon Territory were sent by steamer to Skagway and by White Pass and Yukon Railroad to Whitehorse. From Whitehorse, crews in the northern and central sections of Yukon Territory travelled chiefly by riverboat to the site of their work. The crews in southern Yukon Territory were flown in by chartered plane which was the only feasible means of transportation.

(3) Three crews assigned to work in northern British Columbia were sent from Seattle to Wrangell by steamer, thence to Telegraph Creek, British Columbia, by Stikine River boats and by highway from Telegraph Creek to Dease Lake, from which point they were flown by chartered plane to points near the site of their work. Crews for southern British Columbia travelled by rail from Seattle to Prince George, thence by plane and riverboat to their starting point.

(4) Initial subsistence supplies and crew equipment were purchased in Seattle prior to the crews' departure. It was found that adequate quantities of subsistence items were procurable at Prince George, British Columbia, at reasonable cost. Other sections of the survey continued to be supplied from Seattle. River transportation was utilized in Alaska and northern Yukon Territory, except in emergencies, for the subsequent supply of these crews. To supply the crews in Yukon Territory along the

Frances and Pelly Rivers and in British Columbia north of Sifton Pass, the only practicable means was by chartered or rented airplanes. Crews in British Columbia south of Sifton Pass were generally supplied by riverboat except in emergencies when private plane was used.

(5) Transportation of the crews on the job was by boat wherever possible. This proved quite satisfactory for the crews on the Parsnip and Finlay Rivers, along the Frances River and Frances Lake section, along the Pelly River, and from Little Salmon Lake to the mouth of the White River. This method was available to thirteen crews. The remaining eleven crews were forced to rely on pack horses, native back-packers and pack dogs. Pack stock in many cases had to travel from 100 to 200 miles to reach the site of their work. Due to heavy demands of other agencies operating in this locality and scarcity of pack stock, crews were forced to accept animals in poor condition, poorly equipped, and which ordinarily would not have been considered usable.

(6) Crews using boats or rafts along the rivers suffered some delay when, due to the low-water stage late in the summer, outboard motor equipment was damaged. One of the difficulties encountered by crews using pack trains was that along a large portion of the route, trails had to be built before the pack trains could move, and where old trails existed, an excessive amount of clearing and repairing was necessary before they were usable. Feed for pack animals had to be provided practically the entire summer due to the scarcity of forage along the route.

(7) The planes used under rental contracts consisted of one Waco with a 285 H.P. motor, one Waco with 225 H.P., one Fairchild with a 145 H.P., and one small Taylorcraft, all on floats. These planes proved very practical for periodic contacts with the crews by the division engineers, and for emergency use in transporting sick and injured personnel from the field to medical facilities. However, the type of plane used, proved unsatisfactory for transporting any quantity of freight. Major freight or personnel movements were made by Canadian Pacific Air Line's planes, Junkers type, which proved to have a freight capacity of approximately 1500 pounds. Rough flying weather necessitated numerous repairs to the ships.

(8) Communication between crews and field division offices was chiefly by plane contact. A few crews working along the Yukon River were equipped with field telephone sets, enabling them to cut in on the existing Dominion telegraph line west of Selkirk, Yukon Territory. An attempt was made early in June to secure portable field radios for crews in isolated sections, but these were not obtained prior to completion of the survey. In the few emergencies that arose, these crews managed to send messages to the nearest Hudson Bay post from which point, the message was transmitted to the division headquarters.

g. Existing maps and records: Following receipt of the directive authorizing the survey, attempt was made to locate all available maps of the territory to be traversed. U. S. Geological Survey maps gave complete coverage in Alaska. These maps are on a scale of 1 to 250,000 with 200-foot contour intervals. Various proofs of aeronautical charts were obtained covering the entire route and were of help in showing the drainages. Elevations shown on these charts were only approximate. These were the best maps available for Yukon Territory. The Rocky Mountain Trench route through British Columbia had been previously mapped by the Department of Lands of British Columbia. Although the maps were not available at the start of the survey, they were received in June. Various other maps, chiefly of a local nature, were obtained but were of little value because of incomplete or incorrect data.

h. Aerial photography: Due to lack of adequate maps in Yukon Territory and because two important summits were involved, it was deemed advisable to have aerial photographs made of the section from Lower Post to Little Salmon. This was done by the Aero Service Corporation early in May. Control points were tentatively selected from stereoscopic study of the contact prints and these points noted on a mosaic which had been made up from individual prints. Copies of the mosaic prints were furnished locating engineers and proved of considerable value in guiding the field location. Supplementing existing maps and aerial photography, the small chartered planes were used periodically to acquaint the several locators with the nature of the terrain ahead of their located line for distances varying from 5 to 20 miles. This procedure was found most effective and frequently enabled the locators to establish a satisfactory located line without the necessity of running a preliminary line.

i. Rate of progress: The rate of progress in the conduct of this survey is graphically shown in Part "A" of the final field progress report for the period ending September 30, 1942. A copy of this report is attached and marked Appendix "C".

3. Description of Route.

a. General: Preliminary map study and aerial reconnaissance revealed that the most favorable junction point with the Alaska Railroad would be at Kobe, Alaska, a rail station 85 miles south of Fairbanks. The selected route between Prince George, British Columbia, on the main line of the Canadian National Railway and Kobe, Alaska, on the Alaska Railroad is about 250 miles inland and practically parallel to the coast line of Alaska. The route follows two general courses, which may be described with sufficient accuracy for orientation on small scale maps, as follows: From Prince George, British Columbia, to Fort Frances, Yukon Territory, an air line distance of 570 miles on a true bearing of 332 degrees, thence 285 degrees true, an air line distance of 650 miles to Kobe, Alaska. The developed line does not diverge from these two general courses by more than 30 miles at any point in the entire total length of the line which is 1417 miles.

b. Drainages and summits: The eastern portion of this route follows through the Rocky Mountain Trench from Prince George, British Columbia, to its northern terminus near the 60th parallel of latitude. The trench is a relatively straight, narrow valley at the foot of the western slope of the Rocky Mountains. The floor of the trench has a mean elevation of 2500 feet above sea level. In this section, the located line rises to a minor summit about 30 miles north of Prince George, then descends along a northern-flowing drainage to the head of the Peace River about Milepost 170. The line then rises on a slight grade along the southern-flowing tributaries of the Peace River to the summit of Sifton Pass, the highest point reached on the route, 3273 feet, at a distance of 350 miles from Prince George. From the summit of Sifton Pass the line drops to the crossing of the Liard River in the vicinity of Lower Post near the northern boundary of British Columbia. The line follows the same general course north of the Liard Crossing to Frances Lake, Yukon Territory, utilizing the valley of the Frances River, a southern-flowing tributary of the Liard River. From Frances Lake the line swings sharply to the west and continues to ascend to the summit of the Arctic-Bering Divide, approximately three miles west of Finlayson Lake and then descends along the Pelly River valley for a distance of about 100 miles from the Arctic-Bering Divide at which point it leaves the Pelly drainage, crosses a minor summit and then descends the Magundy and Little Salmon drainage to its confluence with the Yukon River at the trading post of Little Salmon, Yukon Territory. The line follows the right limit of the Yukon River to Five Finger Rapids where pinnacles of rock in the river channel afford excellent bridge rests for a crossing. After crossing the Yukon, the line continues along the left limit of the Yukon River to the mouth of the White River, thence up the right limit of the White to a point immediately below the confluence of the Ladue River, an eastward-flowing tributary of the White, where the line crosses the White and then ascends the Ladue River to a summit between the Ladue and the Tanana Rivers. From this summit the line drops rapidly to the Tanana Valley floor, crosses immediately to the left limit of the Tanana River and follows along the foot of the northern slope of the Alaska Range to a junction with the Alaska Railroad at station Kobe, 273 rail miles north of Anchorage, and approximately 85 miles south of Fairbanks. The route of the projected railroad is shown on map marked Appendix "D" of this report.

(1) The entire route offers favorable location for a railway line. Summits may be reached by relatively easy grades and the conformation of the valleys permits satisfactory alignment for the service contemplated. Rockwork is negligible, very little soft ground is encountered and the use of an undulating grade line with a 2% maximum grade makes possible a very light line, capable of rapid construction.

4. Description of Located Line. - It is readily apparent from examination of the data gathered by the several locating engineers that instructions issued by the District Office were uniformly observed, resulting in a location survey which is consistent throughout the project. The uniformity thus obtained makes possible a brief description of the located line confined to topographical changes.

a. British Columbia Division.

(1) Physical characteristics.

(a) Junction -- Divide Section: (Mile 0 to Mile 27). The location leaves the Canadian National Junction immediately west of the yards at Prince George and crosses the Nechako River in the first mile. From the north bridge head of the Nechako, the line ascends on $1\frac{1}{2}$% compensated grade with considerable generated line in heavy work up McMillan Creek, a tributary of the Nechako, for about 6 miles. From this point to the summit of the Continental Divide at Mile 27, the location is in light to medium construction with an undulating grade and fair alignment. This portion of the location is through some improved land and is in close proximity to a gravel road from Prince George to Summit Lake.

(b) Divide -- Finlay Forks: (Mile 27 to Mile 173). The drainage flows toward the north from Divide to Finlay Forks. The location follows the Crooked, Pack and Parsnip Rivers in the order named and drops 500 feet on a line distance of 146 miles. Some adverse grade is adopted to avoid bad ground adjacent to the rivers. Alignment is good and the work is classed as medium.

(c) Finlay Forks -- Ware: (Mile 173 to Mile 301). Five miles north of the junction of the Parsnip and Finlay Rivers the line crosses to the left limit of the Finlay and closely follows the river to the end of this section, Mile 301, rising 540 feet in a distance of 128 miles. This portion of the line is largely sidehill development. The alignment is good and less than 10% can be classified as heavy work.

(d) Ware — Sifton Pass: (Mile 301 to Mile 345). After crossing the Kwadacha River at Fort Ware and the Fox River at Mile 305, the line follows the west limit of the trench in good ground to Mile 318. At this point, which is opposite Fox Pass, a prominent break in the range to the west, the location starts across the valley floor to the east side of the trench which is followed to the summit. The valley between Fort Ware and Fox Lake, Mile 336, is 2-1/2 miles wide but narrows rapidly above the lake to a width of 1/4 mile at the summit. The gradient does not exceed 1.5% against north-bound traffic. Excavation is glacial material consisting of clay, gravel, and boulders, and is light work except for a 6-mile section immediately above Fort Ware, where heavy grading is encountered in a canyon section. The summit itself is scarcely distinguishable and while the low point in the saddle is elevation 3,273 feet, the line crosses at an elevation of 3,299 feet to avoid swampy sections in the valley bottom.

(e) Sifton Pass — Gataga Forks: (Mile 345 to Mile 401). The location north from the summit is in light grading, following the Kechika River and crossing it at several places to avoid difficult sidehill work. Some sidehill development to the top of a bench is resorted to at a point 11 miles above the confluence of the Kechika and Gataga Rivers in order to avoid a 4-mile canyon section on the Kechika. From the crossing of the Frog River at Mile 396, the line is in good ground along the western edge of a bench above river level. Very little hard rock is encountered in the section from Sifton Pass to Gataga Forks. Excavation will be chiefly glacial drift with some cemented conglomerate which will not require blasting.

(f) Gataga Forks -- Chee House: (Mile 401 to Mile 447). At Gataga Forks, the confluence of the Gataga and Kechika Rivers, the valley widens abruptly to 2-1/2 miles and increases in width to 4 miles at the confluence of the Turnagain River. The Kechika River holds generally to the east side of the trench and the west side is characterized by a series of river terraces. The location follows along one of these terraces on a fairly uniform grade except where incised side drainages are crossed. Grading is light and is entirely in glacial material. At Chee House, an abandoned trading post near the mouth of the Turnagain River, the Kechika turns eastward and the Rocky Mountains deteriorate to foothills.

(g) Chee House -- Lower Post: (Mile 447 to Mile 518). Leaving the Kechika Valley 3 miles north of Chee House, the location continues to Lower Post across a region of typically broken glaciated topography marked by gravel ridges and intermediary small lakes and swamps. The line is essentially straight except for deviations necessary to avoid heavy grading and to secure suitable crossings of the several creeks. Large swamps were avoided successfully, and those that were crossed present no construction difficulties. A minor summit is crossed 26 miles south of Lower Post, which necessitates some 1.5% grade in the approach and some 2.0% grade in the descent to the Liard River, Mile 518. No ledge rock is encountered in this section.

(2) Revisions: To avoid the steep climb out of Prince George with its objectionable heavy grading and line development, an alternate route starting from the Canadian National Railway at Willow Creek, 19 miles east of Prince George, and proceeding up the Salmon River Valley to a junction with the original line to Summit Lake, is being located. This route will reduce the length of new construction by 10 miles and offers better grade, alignment and lighter construction. It will necessitate a crossing of the Fraser River but will obviate crossings of the Nechako and Salmon Rivers. An excellent site for the crossing of the Fraser is developed. Although this junction is east of Prince George and may result in some back haul from Prince George Division yards, there is adequate room for sidings at the Willow Creek Junction. With only minor revisions, several points of heavy earthwork elsewhere in the British Columbia Division may be avoided. These revisions may be projected from available topographic data.

(3) Vegetation: Dense stands of timber with trees up to 24 inches in diameter cover most of the trench between Prince George and Fort Ware. North of Fort Ware, there is a fair forest covering, but stands are thinner and poorer in quality. The principal species are spruce and tamarack. Lodgepole pine, Douglas fir (mountain type), cottonwood, aspen and white birch are also present. Sufficient timber may be found adjacent to the line throughout its length in British Columbia to supply all construction requirements but imported timber for bridge stringers and truss members is recommended because of its superior structural qualities. Extensive forest fires have occurred in many places in the trench and these burned areas are in various stages of reforestation although the more recent burns are still barren or grass-covered. Other openings in the forest occur at swampy places which are covered with brush and moss. Swamps along the route are due to the immature drainage system or operations of beavers and firm ground is encountered at slight depth.

(4) Drainage: The waters of the trench between the Continental Divide and Sifton Pass find their outlet through the Peace River and, north of the Pass, flow to the Liard River. Aside from these major water courses, the drainage is poorly defined due to the effects of glaciation as evidenced by the numerous small lakes and swamps. The major streams in lowering their beds have left terrace remnants which are a prominent

feature of the valley. Cross drainages enter the main streams through deeply cut channels. Rapids in the rivers are generally due to accumulations of boulders rather than to projecting bed rock. Melting snows cause the heaviest run-off which occurs in the spring and early summer.

(5) Climatic conditions: Authentic weather records for the portion of British Columbia traversed by the line are meager but information gathered indicates that precipitation is light, averaging about 20 inches per year. The greater portion of this falls during the summer season. Accumulated snow depths in winter seldom exceed two feet. Even in Sifton Pass, settlers in the vicinity report a maximum depth of five feet and this depth has been observed only a few times in the past twenty years. The wide range of temperatures characteristic of inland regions is observed throughout the trench route. Temperatures of 50 degrees below zero, Fahrenheit, are noted but it is reported that these extremely low temperatures are of short duration with intervening periods of relatively mild but freezing weather throughout the winter. The smaller rivers freeze early in October. River navigation opens about May 10, although there may be some local delays due to high water in canyon sections.

(6) A condensed profile and plan of the route in the British Columbia Division is attached as Appendix "E".

b. Yukon Division.

(1) Physical characteristics.

(a) Watson Lake Section: (Mile 518.8 to Mile 570.5). This section begins at the north bridge head of the Liard River, Mile 518.8. The crossing of the Liard River is about one and one-half miles below the confluence of the Dease River. From the crossing, a gradual departure is made from the river level, ascending on maximum compensating grade with the curves up to 12 degrees in medium work through an area of densely wooded ridges and benches to Mile 529. The line continues in a northwesterly direction in light construction through rolling, wooded country with undulating grades and light curves to Mile 570.5 where the line crosses from the left to the right limit of the Frances River. This crossing is approximately 475 feet wide between rock walls and 60 feet above water level. From Mile 523, the line is in close proximity to the existing road between Lower Post on the Liard River and the Watson Lake airport at Mile 544.

(b) Frances River Section: (Mile 570.5 to Mile 640.7). From its source at Frances Lake to its confluence with the Liard River, the Frances River descends by rapids through box canyons with intervening reaches of sluggish channels in relatively broad, densely forested valleys. In this section the line follows the right limit of the Frances Valley but departs some distance from the river in several places to secure more favorable alignment and to avoid heavy rockwork along the box canyons. From Mile 572.5

to Mile 630 the line may be classified as light construction. At Mile 630 the line leaves the Frances River, swings to the west to skirt the western shore of Frances Lake, crossing drainages and intervening ridges in medium to heavy work.

(c) Frances Lake Section: (Mile 640.7 to Mile 695.5). The line continues northerly along the west shore of Lake Frances through light to medium construction, light rolling grades, short tangents and moderate curves to Mile 665. Departing from the lake the line follows the west side of the Finlayson River and Finlayson Lake to the Arctic-Bering Divide at Mile 695.5. Occasional rock outcroppings are encountered in this portion of the line and many small structures are required.

(d) Pelly River Section: (Mile 695.5 to Mile 812.6). Descending from the Arctic-Bering Divide, the line follows Campbell Creek to Pelly River, continuing along its left limit, crossing numerous northerly flowing tributaries of the Pelly River to Mile 800; thence across Magundy Summit to the Magundy River, Mile 812.6, the end of the section. The line follows through medium to heavy construction departing from the river in numerous places to avoid river cutbanks, to shorten distance and to reach more favorable ground on light grades, moderate length tangents and curves.

(e) Little Salmon Lake Section: (Mile 812.6 to Mile 890). The line continues westward through a park-like valley, one to three miles wide, along the Magundy River, coming to Little Salmon Lake at Mile 837. The north shore of Little Salmon Lake is developed with considerable curvature and flat grade for a distance of 24 miles, then departure is made from the lake to higher ground along the Little Salmon River Valley, coming to the course of the Little Salmon River at Mile 875, and following in close proximity thereto, to the Lewes River at the end of the section, Mile 890. The line involves light work except for short stretches and offers excellent alignment and grades. The valley formed by the Magundy River, Little Salmon Lake and Little Salmon River is between distant snow-covered peaks with dense forest covering of the adjacent slopes.

(f) Carmacks Section: (Mile 890 to Mile 924.1). From the mouth of the Little Salmon River the location follows the right limit of the Lewes River. Light work on long tangents and easy curves is encountered to Mile 896, continuing through heavy and light work intermittently tc Mile 913. Between this point and Mile 919, the line traverses steep, sloughing slopes along high riverbank, entailing heavy work on a curved line with short tangents and broken grade to Five Finger Rapids bridge site at the end of the section, Mile 924.1. The formation traversed is composed of gravel, considerable ledge rock outcrops and large shale slides overgrown with spruce and cottonwood.

(g) Five Finger-Selkirk Section: (Mile 924.1 to Mile 977). A natural bridge site exists at Five Finger Rapids and is formed by three solid rock islets extending some 30 feet above the surface of the water. After crossing to the left limit of the Lewes River, the line encounters medium work on long curves and tangents and light, rolling grades to Mile 939. From this point, heavy rockwork is encountered intermittently with light work on moderate curvature and rolling grade to Mile 969. The location leaves the river for short distances in this section to avoid bad ground or exceptionally heavy work. The remainder of the line from Mile 969 to Selkirk is in light construction with long tangents, easy curves and undulating grade. The village of Selkirk, Mile 977, is located at the confluence of the Lewes and Pelly Rivers which combine to form the Yukon River flowing westerly from this point.

(h) Yukon River Section: (Mile 977 to Mile 1070). Beginning at Selkirk, where an airport of sufficient size to accomodate the larger planes is situated, the line continues on the left limit of the Yukon River and in close proximity to it for the entire length of the section. The work varies from extremely light to sections of medium work where rock outcrops along the riverbank are encountered. Alignment varies from light curvature with long tangents to occasional sections of short tangents and easy curves to avoid heavy work. Forest covering of suitable timber for construction purposes is light in this section. However, the locator notes the existence of 1500 40-foot spruce trees suitable for piling and 1,000,000 board feet of timber suitable for lumber in a stand on Independence Creek approximately 8 miles south of Mile 1054.

(i) White River - Boundary Section: (Mile 1070 to Mile 1119). At the beginning of this section the line swings sharply toward the west following the right limit of the White River in light to medium work with excellent alignment and a rolling grade to Mile 1075. West of Mile 1075, somewhat heavier work in sidehill is taken to the crossing of the White River at Mile 1092.0. At this point the line crosses and then follows the left limit of the White River to Mile 1097 where it leaves the White and continues westerly up the Ladue Valley to the Alaska boundary, Mile 1119. Light work with long tangents and moderate curvature predominates in this section. Forest covering varies from scattered spruce and birch to open hillsides with fair stands of tie timber along the watercourses.

(2) Revisions: Owing to the difficult ground and heavy construction encountered in the Carmacks section and particularly between Mile 913 and 919 an alternate route has been investigated. A preliminary survey of a revision to eliminate this section has been made. The revision leaves the located line at Mile 885, near the western end of the Little Salmon Lake section, and traverses a shallow valley 5 miles north of the present location, returning to the river line at the Five Finger Rapids bridge site, Mile 924.1. The proposed revision is largely in gravel formation and will provide a light line with excellent grade and alignment and will shorten the distance 6.5 miles. The only objection to the revision is its

distance away from transportation on the river. The route is shown on map, Appendix "F". Minor revisions of the line elsewhere in the division are under consideration.

(3) Vegetation: The forest covering is composed of spruce, pine, tamarack, hemlock, birch, poplar and aspen. Sufficient quantities of piling, tie and culvert timber are available along the route with relatively short haul. Spruce is predominant and reaches diameters of 24 inches. There is considerable variation in ground cover ranging from large areas of moss and peat to heavy grass and brush growth in both the open and timbered section. Grassy areas are common to south and west facing slopes in the lower altitudes, while the north and east slopes are usually well timbered. The timber line is generally at an elevation of 4000 feet. Throughout this region, a multitude of ponds, lakes, swamps and tributary streams are encountered. The swamps are rarely of great extent and are so situated as to be entirely avoided or narrowly crossed by the line. The low ground usually has a firm base of gravel or small boulders about a foot below the surface and will present no unusual construction problem.

(4) Drainage: The route traverses relatively broad valleys surrounded by gentle to medium slopes leading to distant mountains, some of which in the high altitudes, maintain perpetual snows. The drainages are generally in well-defined channels. Classed as semi-arid, the region is subject to light snowfall and seasonal rains in early spring and late fall with periodic rains

throughout the summer season. On the high side of excavations and embankments, small interceptor drain ditches are planned to lessen the occurrence of slides and reduce the number of small culverts required. A minimum size culvert of three-foot span and two-foot height is deemed advisable due to the presence of ice, snow, drift, and sediment. Using this dimension as minimum, culverts will readily permit easy maintenance and lessen the danger of obstruction during run-offs.

(5) Climatic conditions: While few official records of the climate exist, the conclusion is drawn from information gathered from observation, native Indians and whites, that the climate is not unlike that of the northwestern states of Dakota, Montana, and Washington, east of the mountains, with proportionately colder and longer winters as the distance increases toward the north. Local variations, due to elevation and protection, are similar to the states referred to above. The route traverses a region of low precipitation and varying, but not high winds, as indicated by the absence of wind erosion and unbalanced tree growth. The depth of snow in the low broad valleys rarely exceeds 18 inches, increasing with the altitude to a maximum depth of 4 feet on the Arctic-Bering Divide and Magundy Summit. Freeze-up occurs generally in October, accompanied by light snows which increase until February, diminishing about the middle of March. By the middle of April, the route is generally free of snow, and plant growth has begun although the large rivers and lakes may contain ice until the middle of May.

(6) A condensed profile and plan of the route in the Yukon Division is attached as Appendix "F".

c. Alaska Division.

(1) Physical characteristics.

(a) Boundary to Tanacross: (Mile 1119 to Mile 1207). From the Alaska-Canada boundary the line continues in light construction ascending through the mile-wide valley of the Ladue River. A line requiring numerous channel changes of the Ladue River is developed on light grades, long tangents and easy curvatures to Mile 1169 from which point the line continues up the west fork of the Ladue with increased gradients and curvatures to the summit at Mile 1173. From the Ladue Summit the line descends through heavy construction to a crossing of the Tanana River at Mile 1186. This descent is sidehill development with almost continuous curvature, although less than the maximum gradient is used. The line as staked includes three short tunnels and a high structure over a dry gulch. Examination of the alignment, grade and topographic data reveals the need for revisions which can be accomplished, eliminating the high bridge and tunnels. Several other revisions on this 13-mile descent are now obvious and desirable to reduce costs and expedite construction. These revisions can be projected with the data now available. After crossing the Tanana River, Mile 1186.0, the line continues down the left limit of the Tanana Valley on a direct route to Tanacross at which point the river approaches the located line. This portion of the line involves light construction on long tangents and essentially level grades.

(b) Tanana to Big Delta: (Mile 1207 to Mile 1306). From Tanacross to the Johnson River, Mile 1263.7, the line follows closely the left limit of the Tanana River but again departs from the river immediately west of the confluence of the Johnson with the Tanana and skirts the foothills of the Alaska Range, thus avoiding swamp and overflow land adjacent to the Tanana. The line crosses the Richardson Highway at Mile 1305 and the Big Delta River at Mile 1305.2. Light construction is encountered throughout the entire section except for three and one-half miles in the vicinity of the Robertson River crossing, Mile 1230.6 and a four-mile section at the crossing of the Johnson River, Mile 1263.7. The alignment is excellent with tangents exceeding 10 miles in length and light curvature. Gradients are well below the maximum allowed.

(c) Big Delta -- Kobe Section: (Mile 1306 to Mile 1416). The line continues in a westerly direction, crossing the many northern-flowing tributaries of the Tanana River to the junction point with the Alaska Railroad, at station Kobe. The entire section is in light construction, alignment consists of long tangents connected with easy curves and the grade is undulating but below the allowable maximums.

(2) Vegetation: The timber along the route in the Alaska Division is much more limited both in quantity and size than in either the British Columbia or Yukon Divisions. The species to be found are spruce, hemlock, birch and poplar. It is believed that sufficient timber for ties and piling can be secured along the route but line transportation up to 50 miles

will be required in certain sections. The ground generally is carpeted with moss ranging in depth from 3 to 18 inches over gravel or firm ground with isolated patches of bunch grass. A considerable portion of the Tanana lowlands, formerly timbered, has been burned over in recent years and these burned areas are now covered with a dense growth of alder and willow brush.

(3) Drainage: From the Alaska boundary to the Ladue Summit, there are no cross drainages of any consequence. The tributaries of the Ladue are not glacier-fed and there is no indication of flood stages in the Ladue. However, after crossing the Tanana River, practically all the streams entering the Tanana from the Alaska Range discharge from melting glaciers. There is a marked variation in flow of these streams with maximum discharge during the summer. These streams carry a great amount of gravel as they emerge from their canyon sections and deposit this load as the gradient is reduced after entering the Tanana Valley. The channels are threaded and the bank to bank width of the river is much greater than is required for the volume of flow. It is considered inadvisable to constrict these channels and long crossings of pile trestle design are advocated. As these streams head above timberline, there is relatively little floating drift and there is no ice floe since channel ice melts before the high water stages of the summer.

(4) Climatic conditions: Accurate records of the

temperatures in the Tanana Valley are available only for Fairbanks and the immediate vicinity. There are no records of temperatures in the upper reaches of the Tanana drainage. At Fairbanks the mean July temperature is 60.7 degrees and the January mean is minus 15.3 degrees. The extreme range, officially recorded, is from minus 65 degrees to plus 99 degrees. There is an average of 238 days annually with minimum temperatures below freezing. The Tanana River freezes up each year between October 9 and November 13 and the spring break-up is between April 29 and May 11, the average being May 5. The river is open less than 170 days during the year. Fairbanks is the only precipitation recording station maintained in the Tanana Valley but records of this station are available since 1906 and these reveal mean annual total of 11.62 inches.

(5) A condensed profile and plan of the location in Alaska will be found in Appendix "G" to this report.

5. Bridges. - The location crosses six rivers sufficiently large to be classed as navigable waterways although only three have been so used in recent years. These larger streams are the Nechako, Finlay and Liard Rivers in British Columbia; the Yukon (Lewes) and White Rivers in Yukon Territory and the Tanana in Alaska. The Nechako River flows into the Fraser River at Prince George and was used as a navigable waterway during the construction of the Canadian National Railway and prior thereto. The railroad bridge of the Canadian National across the Fraser at the mouth of

the Nechako was designed to permit navigation. However the bascule has been converted to a fixed span and the highway crossing of the Nechako adjacent to the site of the proposed Trans-Canadian Alaska Railway crossing is on fixed spans at an elevation only slightly above maximum high water. The Finlay and Liard Rivers are used by small shallow-draft power boats and barges. Fixed spans with vertical and horizontal clearances required for a safe structure will provide adequate clearances for any possible navigation on these streams. The Yukon River is an important inland waterway, navigated by river steamers. A vertical clearance of 72 feet was authorized for fixed spans over the navigable channel. The horizontal clearance is fixed by the position of the rock pinnacles in the river which provide the bridge rests for this structure. The White and Tanana Rivers, like the Finlay and Liard, are used by small boats and barges only occasionally. The crossing of all these streams with the exception of the Yukon will be effected with multiple-span bridges of Howe or Towne truss design on pile abutments and piers with rock-filled log cribs and pile trestle approaches as required. Studies now under way indicate that steel spans will be required for the crossing of the Yukon. Estimates contained in this report are of a preliminary nature and are intentionally high. It is expected that a reduction can be made in the costs of bridging as the result of further study and investigation. The type of bridge presently planned for each crossing is shown on the profiles, Appendices "E", "F" and "G".

6. Terminal Facilities at Junctions.

a. Prince George, British Columbia: The railway yard at Prince George, a division point on the Canadian National Railway, occupies about 300 acres and is situated between the town and the Nechako River. There are three sidings about a mile in length along the main line, with four other house tracks and short spur tracks in the yard. Rail weights used vary from 60 to 80 pound. There is adequate area for expansion with only a slight amount of grading. Engine service facilities include a 12-stall roundhouse with a 90-foot turntable. The machine shop is equipped to handle all the usual repairs. Miscellaneous facilities consist of fuel oil storage tank, pump house, water crane, ice house and coal station, the latter not in use at present. There is also a concrete culvert casting yard which utilizes bank run gravel from the adjacent Nechako River. Train crews are housed in the town or in outfit cars set out in the yard. The existing engine and train service facilities at Prince George are believed to be no greater than are required for main line service on the Canadian National. Relatively little yard expansion is deemed necessary but complete facilities for an engine terminal with housing for operating personnel should be included in the construction program.

b. Kobe, Alaska: At present there are no terminal facilities at Kobe. Sufficient area is available and the terrain is favorable for installation of the terminal development required. Locomotive and car shops are not contemplated as these facilities are available at Nenana, 25 miles north of Kobe on the Alaska Railroad. The yard at Kobe should include make-up yards for both north and south-bound traffic on the Alaska Railroad, as well as east-bound on the Trans-Canadian system.

7. Tributary Area. - Pursuant to request made by this office, the National Resources Planning Board through its Portland, Oregon field office prepared and submitted a description of the area traversed by the Trans-Canadian Alaska Railway route and districts tributary thereto. This description is a thorough presentation of all available data and is included in its entirety as Appendix "I", thus obviating the necessity for treatment of this subject in the body of this report. In addition thereto, the National Resources Planning Board has furnished this office a treatise dealing with the economic justification of the proposed construction. The directive issued by the Commanding General, Services of Supply, indicates that this project should be considered as a military necessity; therefore economic justification is not properly within the scope of this report. Consequently, these findings of the National Resources Planning Board are not reproduced but have been placed on file in the office of the District Engineer for future reference or transmittal to higher authority if so directed.

It should be noted that the development of a line from Prince George, British Columbia, to Kobe, Alaska, under economic standards would differ in some respects from the present location which has been layed down without regard to the creation of rail tonnage enroute.

8. <u>Proposed Standards</u>. - The standards governing the location survey and subsequent design are based on the requirements for a military railway. Speed of construction was given first consideration in selection of the route with cost of operation and maintenance of secondary importance.

<u>a</u>. Clearing and grubbing: The width of right-of-way for purposes of estimating quantities has been taken as 200 feet. Trees within the right-of-way and dangerous trees adjacent thereto will be removed and debris burned under favorable or controlled conditions to reduce future fire hazard. Experience on the Alaska Railroad in areas of permanently frozen ground has shown that a usable roadbed may be obtained more quickly by maintaining the frozen condition than by attempting to thaw it. The native moss and other vegetative matter on the surface will be preserved as much as possible to serve as an insulating layer under the embankment. Decay of organic matter under conditions existing along the route will cause only minor disturbance of the roadbed. Trees will be cut at ground line in light fill sections where the ground line is less than two feet below subgrade, and where greater, not to exceed the diameter. Material cleared from the right-of-way will be utilized as much as possible for corduroy mats, ties, piling and culvert timber. Borrow pits for ballast or embankment materials will be cleared and stripped of unsuitable material prior to excavation.

<u>b</u>. Grading: Width of roadway has been taken as 16 feet in cuts and 14 feet for fills. Side slopes of 1:1 in common excavation,

$\frac{1}{4}$:1 in rock excavation, and $1\frac{1}{2}$:1 in embankment are considered satisfactory for the materials encountered. Throughout the line, grades in light earthwork sections are carried 2 to 3 feet above ground level to minimize and facilitate snow removal. Through cuts are avoided where possible and sidehill cuts are "daylighted".

c. Bridges, trestles, culverts: Local timber is available in sufficient quantity to meet most of the structural requirements, thus avoiding use of critical metals and reducing the materials that must be procured from commercial markets. With only a few exceptions, multiple-span bridges may be used at the major river crossings. Foundation conditions, and required height of piers are such that span lengths may be varied at will to fit standard truss lengths. Wooden trusses, with a maximum span of 150 feet, will fit these conditions in practically all cases. Steel trusses are required for the crossing of the Lewes River at Five Finger Rapids where spacing of the islands requires one span of 300 feet and one span of 270 feet. Further studies are being made to determine the advisability of utilizing steel trusses at canyon crossings where extreme height makes false work supports impractical and the cantilever method of construction necessary. Timber trusses in several standard lengths may be prefabricated at points of suitable structural timber supply for rapid assembly at the construction site. Rock-filled cribs and piling will provide satisfactory abutments and piers for timber structures. Where navigation, ice, drift, or flood conditions do not require clear openings, crossings will be made on pile trestle, following A.R.E.A., 4 pile bent design. Materials for piling, caps, and bracing are obtainable in the vicinity of the route. Stringer material may not be available in the vicinity of the point of use, but may be obtained at Prince George and other points without drawing on the commercial market for high grade structural timber. Local timber will be adequate for construction of culverts. Rock suitable for riprap protection of bridge and culvert foundations will be available in the vicinity of the work, with only short hauls.

d. Ties, rail, and track-laying: Second grade ties, 6" x 7" x 8', are considered satisfactory for the service proposed for this railway. Although tie material along the route is not of the best decay-resistant type, it is considered that strength and durability are sufficient for the use contemplated. Tie materials to these standards will be obtainable from timber along the line, and haul distance to any point should not exceed 50 miles. Lightweight rail of 60-pound and not to exceed 70 pounds per yard will prove satisfactory and is desirable for the service intended. Advantages gained from the use of light rail are reduction in tonnage of materials to be transported to the job, a considerable saving in amount of steel required, and ease of placing. Light rail will permit bending in the field to the required curvature, as it is laid whereas heavier sections would require pre-curving which could not be properly coordinated for rapid track-laying under existing transportation conditions. The saving in steel between 60 and 80-pound rail would amount to approximately 50,000 gross tons. Inasmuch as rail and rail accessories constitute the largest item of construction material that must be brought in, this represents a substantial reduction of the transportation problem.

e. Ballasting and surfacing: Suitable ballast materials may be found along the entire route. Haul distances will be short, in no case exceeding 20 miles. A ballast section providiug 6-inch depth under the ties which will require 2,000 cubic yards per mile, has been adopted.

f. Yards and sidings: For military use, the train movements will generally be through to destination. It is not considered likely that trains will need to be broken up at intermediate points. Yards at division points will therefore consist only of a few house tracks, and a wye track for turning. Yard and transfer facilities will be needed at Watson Lake, at which point the Alcan Highway is crossed, and possibly at Little Salmon, if Yukon River transportation is to be utilized. No. 7 turnouts will be satisfactory in yards. Sidings one-half mile in length will be placed at approximate 10-mile intervals. To aid in starting trains in cold weather, a grade of 0.25 percent will be built into the sidings where possible. No. 9 turnouts will be used from the main line.

g. Stations and buildings: It is believed that motorized section cars will permit the adoption of 10-mile section lengths. The use of double section houses and tool sheds at 20-mile intervals is recommended. Water tanks should be installed at alternate section houses or at approximately 40-mile intervals on steam operated sections of the line. Fuel stations will be located at division points only, which will average 120 miles apart. In view of the fact that there is an adequate supply of merchantable grade timber along the route in British Columbia and southern Yukon Territory, it is proposed to establish semi-portable sawmills in the accessible stands along the right-of-way to supply trestle and culvert timber. These mills can also produce suitable rough lumber or slabbed timbers for the construction of all permanent buildings in these portions of the line. In western Yukon Territory and Alaska where the timber is less suitable for building purposes, and transportation is less difficult, the use of prefabricated, winterized T/O type buildings is contemplated as a temporary measure pending completion of the rail line at which time, a more permanent type of structure can be erected by maintenance forces with train-hauled materials.

h. Engine service installations: The design of shops, engine sheds, fuel and water stations, and the nature of shop equipment will depend on the type of motive power adopted. The use of steam locomotives in Alaska seems preferable for the following reasons: 1. Fuel can be obtained from operating mines at Healy on the Alaska Railroad, 25 miles south of Kobe junction; 2. Water supply is satisfactory and should require no treatment plants; 3. The Alaska Railroad maintains shops at Fairbanks, Nenana and Anchorage, thus necessitating minimum shop equipment at engine terminals; 4. This portion of the line will undoubtedly continue to operate in the future as a branch line of the Alaska Railroad which is a steam line.

(1) An advantage of steam is long engine life and superior performance at higher speeds but these factors do not appear to be applicable to the line through Canada which is considered as a temporary military requirement only. Under these conditions, the advantages of diesel power assume greater importance. The thermal efficiency of a diesel-electric locomotive is approximately 26% whereas a modern steam locomotive rates about 6%. Diesel stand-by losses are negligible. This is particularly important where fuel must be delivered over long haul. Engine servicing facilities are materially simplified. Fuel delivery and stations; water supply, treatment plants and tanks; fire protection; engine sheds and shops are items on which substantial first cost savings can be effected and permit earlier operation of the line. The chief objection to diesel is the sharp reduction in tractive effort as road speeds are increased but since the maximum speed for which this line is designed is 35 miles per hour, this characteristic is not significant, and under relatively low speed operation, diesel power increases the ratio of tonnage hauled to total train weight.

(2) If diesel power is adopted, multiple stall engine sheds of native timber, shed-roofed and of the simplest construction will be adequate. Since diesel locomotives are equipped with built-in heaters in the engine cooling system to provide for line

lay-overs, there is no need for heating plants in the sheds. A division shop, 40' wide and 80' long, with two stub-tracks is considered sufficiently large for this service. A boiler house is not required. The principal equipment would consist of an overhead crane for the removal and replacement of power units and a wheel press. The remainder of the equipment would differ but little from the average well-equipped garage or small machine shop.

(3) No turntables are contemplated. Yard wyes will serve all requirements either for steam or diesel operation.

(4) Ash pits and ash disposal equipment are not required where diesel power is used.

(5) Intermediate fuel stations are unnecessary with diesel-electric locomotives which are capable of operating 18 to 20 hours at full load on their tanks. Tank cars set out in division yards will serve this requirement and obviate the need for permanent tanks.

(6) In general, the water along the route and particularly in British Columbia and Yukon Territory is extremely hard and usually carries considerable vegetable matter in suspension. In order to prevent foaming and scale, treatment plants will be necessary for a steam operated line. This item can be disregarded for diesel service.

(7) Sand houses of conventional design will be required at engine terminals.

(8) Oil houses will also be located at engine terminals. These buildings will be merely storage sheds with racks for barrels of lubricants. The installation of fixed tanks is not recommended.

i. Train service installations:

(1) Way station buildings — The addition of a small telegraph office and platform to the double section houses located at alternate sidings, 20 miles apart, will provide adequate train control. Freight sheds at way stations are not indicated for the service contemplated.

(2) Division stations — These station buildings should be designed to provide in addition to waiting room, baggage room and agents' office, all necessary office space for the division superintendent, dispatcher, engineer M. of W., master mechanic, roadmaster, yardmaster, chief of T. and T. and division storekeeper. A two-story frame building, 30 feet by 60 feet in size with platform 30 feet wide and 80 feet along the main line will satisfy these requirements.

(3) Freight sheds — It is not expected that any appreciable volume of way freight will be handled over this system. A freight shed, 30' x 120' with 8' platform, should be constructed at car floor level on a siding opposite the division station office. A 40-foot section of this shed should be insulated for warm storage. It is anticipated that this building will serve primarily as the division warehouse.

(4) Personnel quarters — Winterized T/O type buildings

for the housing of train crews and other personnel on duty in division offices, yards and shops must be provided. A suitable cantonment would consist of one barracks for division officers, six barracks for train crews and shopmen, one 250-man mess hall, two recreation rooms, one infirmary and a post exchange.

(5) Utilities -- The nature and size of water supply, sewage disposal and electric power plants for cantonment buildings, offices and shops at the division points, will vary with the locations, but it is not expected that these installations will prove either difficult or expensive.

(6) Blacksmith and car shops -- These facilities will be located at division points only and in connection with the locomotive shops or as close thereto as the yard layout will permit. Both shops may be housed in a frame building, 40' x 100', with two stub-tracks extending 60 feet therein for car repair. The remainder of the building will provide sufficient space for the blacksmith shop and car truck repair. The use of portable welders and compressors is contemplated in all division shops rather than fixed installations.

(7) Carpenter and paint shops -- Carpentry and painting of roadway structures will either be performed during the initial construction or by maintenance of way forces as required. The need for these shops is not indicated for train service.

(8) Track scales are not required.

(9) Ice houses — Instead of the usual type of ice house located in the yards for servicing refrigerator cars, it is recommended that ice be kept in cut and cover type storage of log and sod construction near the lake from which the ice is harvested. Delivery can be made as required by truck and the cars serviced from an elevated platform. The capacity of ice storage vaults should be 200 tons.

j. Miscellaneous roadway construction: The erection of fences, cattle guards, rail racks, mileposts, and all signal boards can be performed by maintenance of way forces and are not included in the initial construction program.

k. Telephone and telegraph: A four-wire system is considered adequate for the operation of this railway. In order to facilitate construction of the road, it is proposed to erect this line immediately following the clearing of right-of-way. The use of tripods rather than poles has been found preferable on the Alaska Railroad, both from a standpoint of economy and speed of erection. It has also been found that in localities where perpetual frost is encountered, poles will freeze out of the ground.

9. Plan of Construction.

a. The location of existing access routes indicates the desirability of subdividing the project for construction purposes into four grand divisions, as follows:

(1) Southern Division -- 345 miles.
From Prince George to the summit of Sifton Pass.

(2) Central Division — 351 miles.
Summit of Sifton Pass to Arctic-Bering Divide.

(3) Northern Division — 423 miles.
Arctic-Bering Divide to Alaska boundary.

(4) Alaska Division — 298 miles.
Alaska boundary to Kobe junction.

b. The various access routes are shown on map accompanying this report, Appendix "D".

(1) In the Southern Division, there are existing roads from Prince George along the projected route to Summit Lake for 30 miles and from Vanderhoof, a rail station on the Canadian National Railroad, 70 miles west of Prince George, to Manson River. It is proposed to construct a 40-mile extension of the Vanderhoof-Manson River road to connect this road system with Finlay Forks, Mile 170 on the line, from which point the line may be served between Milepost 100 and Milepost 300 by water route during the navigation season and by tractor train in winter. This leaves 70 miles on the south end and 50 miles on the north end of the division where the construction of a low standard tractor road along the right-of-way is necessary to facilitate construction.

(2) All access routes to the Central Division converge on the line in the vicinity of Watson Lake near the center of the division and do not provide line coverage. These routes are as follows:

(a) The Stikine River route from Wrangell, Alaska, consisting of 165 miles of river navigation from Wrangell, Alaska, to Telegraph Creek, British Columbia; thence by highway 72 miles to Dease Lake, and again by water route on the Dease River, approximately 140 miles, to its confluence with the Liard River at Lower Post.

(b) White Pass and Yukon Railway from Skagway to Carcross; thence by Alcan Highway from Carcross to Watson Lake.

(c) The Alcan Highway from Fort St. John to Watson Lake. Although the Frances and Kechika Rivers can be navigated by very shallow-draft boats and barges, it is believed that a tractor trail along the right-of-way should be constructed from Lower Post south to the summit of Sifton Pass and north from Watson Lake to the Arctic-Bering Divide.

(3) The Northern Division will be served by the White Pass and Yukon Railroad from Skagway, Alaska. This route includes 110 miles of railroad from Skagway to Whitehorse, Yukon Territory, from which point transportation may be either by riverboats and barges to the project at Little Salmon or by road from Whitehorse to the project in the vicinity of Five Finger Rapids. Transportation from these points may be effected by river route, either barge haul in summer or tractor train in winter, westward as far as the mouth of the Ladue River. A tractor road will be required from the mouth of the Ladue to the Alaska boundary, a distance of approximately 20 miles. The project east of Little Salmon must be served by tractor trail to the Arctic-Bering Divide, although heavy tonnage can be barged up the Pelly River from Selkirk to the mouth of Ross River during the summer navigation season.

(4) There are three principal points of access to the project in the Alaska Division. These are Kobe, the junction point with the Alaska Railroad; Big Delta, at the crossing of the rail line with the Richardson Highway; and Tanacross on the Tanana River. These points are approximately 100 miles apart on the project and construction can be pushed both ways from each of these bases. Kobe is served directly by rail over the Alaska Railroad. The Big Delta base can be supplied either from Valdez, Alaska, direct over the Richardson Highway or from Fairbanks. Tanacross will be supplied by river route from Big Delta or by road now under construction direct from the Richardson Highway. A tractor trail from Tanacross to the Alaska boundary may be required but end construction from the three base points would appear to be satisfactory in this division.

(5) The total construction road to provide access to the project throughout is as follows:

	Truck Road	Tractor Road
Southern Division	40	120
Central Division	0	355
Northern Division	0	240
Alaska Division	0	80
Total	40	795

c. Subdivision of the grand divisions into construction sections will be made on the basis of engine stages, approximately 120 miles long. It is believed that this procedure will result in greater uniformity of the constructed project within an operating stage and will afford closer control over construction.

10. Factors Effecting Construction.

a. Climatic conditions: Although this line is projected through country where winter temperatures of 30 degrees below zero Fahrenheit are normal and may reach minus 60 for short periods of time, there is relatively little precipitation. Snowfall is light and will not seriously hamper winter construction or operation of the line. Winter construction can be successfully prosecuted in all clearing, rockwork, heavy cutting and hauled fills. Span erection can be more readily performed in winter than in summer in view of the ease with which false work can be foundationed on ice. The erection of pile trestle bridges over cross-drainages will progress more rapidly during the winter months due to the fact that skid drivers can be readily moved on the ice of the rivers paralleling the line and in advance of grading operations. Scratchwork grading cannot be performed in winter unless the material is well-drained. It is believed that a considerable portion of the light line on this route is sufficiently well-drained to permit winter operations but, in general, scratchwork grading, frame trestle erection, permanent buildings, shops, fuel stations and water supply should be programmed for summer construction. During construction of the Alaska Railroad, there was a marked reduction in the effectiveness of labor in severely cold periods, but this can be largely offset by the increased use of mechanical equipment now available. To further compensate for a lowered efficiency of workmen, the transportation of materials and supplies is rendered less difficult.

It is generally recognized in the north that winter transportation by tractor trains is the cheapest and most effective method of supplying remote, undeveloped districts. This procedure was followed in the construction of the Alaska Railroad, and is also used by the Alaska Road Commission and mining interests in both Alaska and Yukon Territory. Winter construction camps of rough log and pole design, chinked with native moss, and with pole and paper roofing are favored for the more permanent camps, but canvas is not impractical for camps in the Southern Division in winter. For small, rapidly moving crews, such as clearing forces and bridge gangs, the use of skid-mounted wannagans similar to railroad outfit cars have proved satisfactory on similar work.

b. Labor: This line has been located with a view to rapid construction. Clearing will be reduced in width to the minimum that will provide protection from blow-down. Ground cutting of trees is favored and grubbing will be quite limited. Erection of telephone lines will be on tripod construction. Grading methods will closely approximate highway practice and the ratio of man-power to yardage will compare favorably with road grading. Production of ties, piling and lumber along the route is included in the labor estimate. Track-laying, surfacing and ballasting are estimated on the basis of 60-pound rail and 6-inch ballast. The manpower required for bridges and culverts is for field erection only and contemplates delivery of sized stringers and framed truss members to the job site. The labor expended on transportation and supply includes the construction of access and haul roads. The erection of camps and buildings are grouped together as the camp construction will be retained insofar as possible as part of the roadway buildings.

(1) An estimate of man days labor required for the project is as follows:

1000-Man Day Units

	Southern	Central	Northern	Alaska	Total
Clearing and grubbing	138	154	164	90	546
Telephone and telegraph	17	20	24	15	76
Grading	966	1,078	1,175	600	3,819
Ties, timbers, etc.	155	175	235	165	730
Track laying	52	58	70	45	225
Surface and ballast	55	60	75	50	240
Bridges and culverts	50	55	75	60	240
Transportation and Supply	91	110	88	41	330
Camps, buildings, misc.	125	154	185	105	569
Totals	1,649	1,864	2,091	1,171	6,775
Assuming 400 days for completion= x 2.5	4,122 men	4,660 men	5,228 men	2,927 men	16,937 men

c. Materials: Aside from rail, track fittings and bridge steel, there is relatively little demand on the materials market for the construction of this roadway. Motive power, rolling stock and other operating equipment are outside the scope of this report except insofar as the nature of the equipment influences the design of roadway. Bridge stringers and all timbers for Howe trusses should be Douglas fir and are included in the estimates of imported materials. However, these designs may be modified for the utilization of local spruce, if found necessary. Local timber will be used for ties, culverts, piling, posts, caps, braces, false work, buildings and floating plant. This procedure will also materially reduce transportation requirements but will increase the labor, camp and subsistence factors. There is very little rockwork on the line and the amount of explosives required is surprisingly small.

(1) The quantities of materials to be imported over access routes for the construction are estimated as follows:

In tons (2000 lbs.)	Southern Division	Central Division	Northern Division	Alaska Division	Total
Rail - 60#	37,340	41,488	51,536	32,672	163,036
Track fittings	3,240	3,600	4,500	2,835	14,175
Bridge steel	679	1,616	1,200	316	3,811
Bridge castings	483	253	360	0	1,096
Tel. and tel.	144	160	200	126	630
Explosives	90	310	785	473	1,658
Douglas fir timber	5,927	3,945	3,150	4,850	17,872
Subsistence and camp	8,245	9,320	10,455	5,855	33,875
Fuel, lub. and misc.	6,000	5,500	7,000	3,500	22,000
Totals	62,148	66,192	79,186	50,627	258,153

d. Plant: The construction plant best adapted to this project will consist of diesel or gasoline powered equipment. Caterpillar-mounted shovels and draglines from 3/4 c.y. to 1-1/4 c.y. capacities are deemed sufficiently large for the initial construction, although railroad shovels may be used at a later date for ballast loading and in sections where "shoo flys" are resorted to in the initial construction. Bull-dozers will be the most effective tool on the job. Compressors should be skid-mounted. Pile drivers will be drop-hammer type skid rigs, powered by gasoline engines. It is desirable to keep track-laying close behind the grading at as many points as possible. The use of light industrial type locomotives and two-axle cars will not only facilitate track-laying, light ballasting and the transportation of materials and supplies from base supply dumps but this equipment can also be most effectively used for long-haul fills where skeleton track is laid on crossways. The use of 10-ton locomotives and 6-yard dump cars will perform better in this service than carry-alls or trucks. The weight of this equipment will not surface kink 60-pound rail in skeleton track.

(1) The major items of construction plant required in each division are estimated as follows:

Type of Plant	Number of Units				
	Southern	Central	Northern	Alaska	Total
Tractors w/dozers	36	40	60	30	166
Draglines, 3/4 c.y.	12	6	15	12	45
Shovels, 1-1/4 c.y.	9	9	12	10	40
Compressors, 210'	8	6	10	10	34
Pile Drivers	6	6	9	6	27
Locomotives, 10 T.	3	2	4	0	9
Dump cars, trucks 6 c.y.	36	24	48	0	108
Flat cars, trucks 8 T.	9	6	12	0	27
Trucks, dump 5 c.y.	12	12	36	63	123
Carry-alls, 10 c.y.	12	6	18	4	40
Saw mills, 30" x 40'	3	3	4	3	13
Small Tools					
Est. wt. - Tons	1,500	1,390	2,300	1,450	6,640

e. Transportation: The capacity of existing and proposed access routes is limited and improvement beyond absolute requirements is to be avoided wherever possible. Although construction plant, camp equipment and some construction materials must be made immediately available, a large percentage of the total tonnage may be on a uniform delivery rate throughout the construction period or in accordance with best conditions. In the following tabulation, the total tonnage by divisions is broken down to show the volume of tonnage required during the first 30 days and the balance for subsequent delivery over the term of the project, herein assumed to be 400 days. Operating equipment and the materials required for engine and train service installations are not included in the estimates of tonnages to be transported over access routes, as these materials can be more readily transported and erected after track has been laid. It should be noted that part of the construction plant may be considered self-propelled over those portions of the access routes that must be developed as a construction feature:

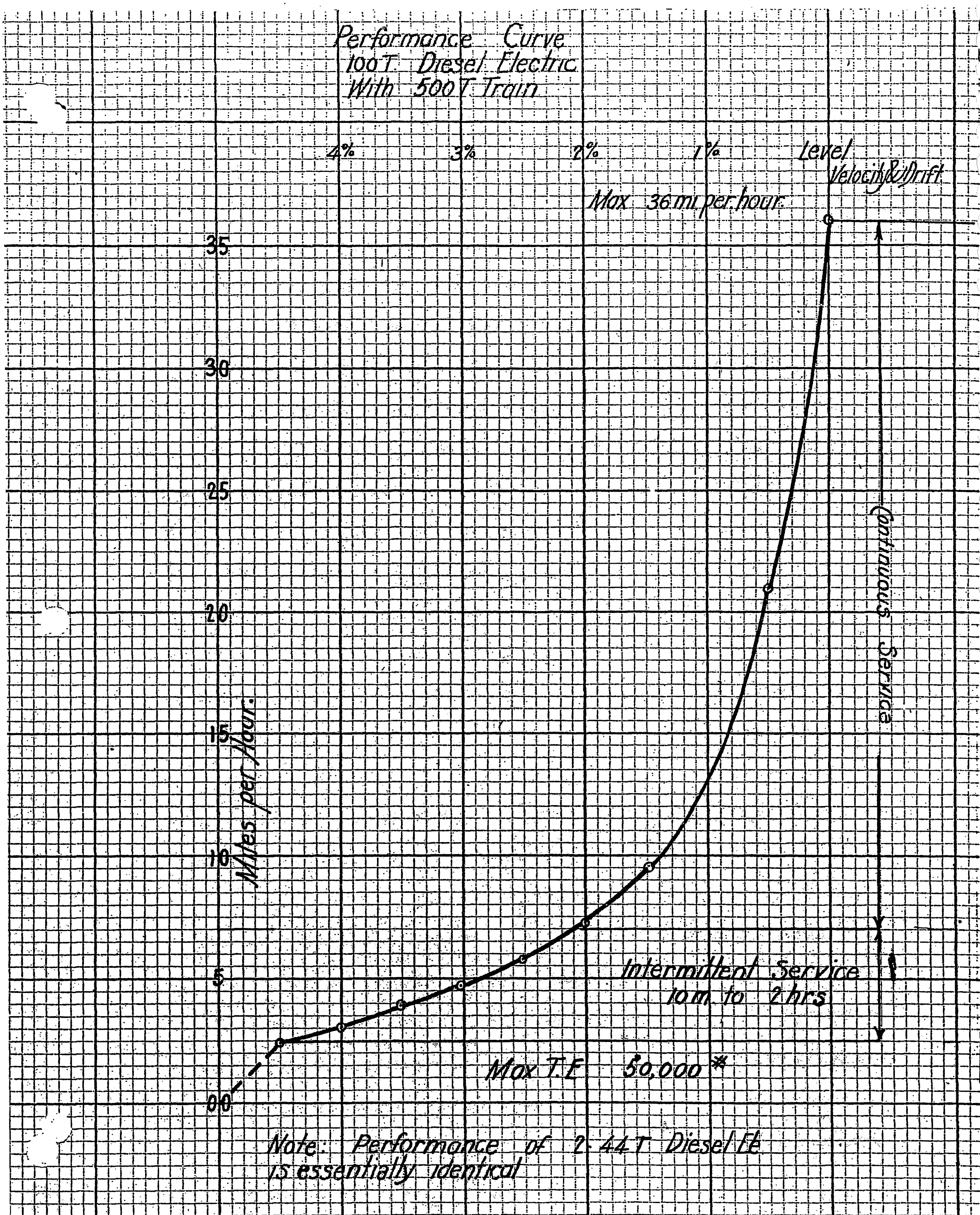
In Tons (2000#)

	Southern	Central	Northern	Alaska	Total
From c. Materials	62,148	66,192	79,186	50,627	258,153
From d. Plant	1,500	1,390	2,300	1,450	6,640
Total	63,648	67,582	81,486	52,077	264,793
Required 1st 30 days	6,030	6,340	8,000	4,950	25,320
Subsequent	57,618	61,242	73,486	47,127	239,473
Total	63,648	67,582	81,486	52,077	264,793

The transfer of this tonnage from common carriers to the division supply dumps is in itself a large task. The labor required for this effort is included in the estimate given in sub-paragraph c above, but the plant required differs from construction equipment and is in addition thereto. Estimated requirements are as follows:

Type of Plant	Units Required				
	Southern	Central	Northern	Alaska	Total
Tractors w/o dozers	17	35	25	20	97
Tractor wagons - 20 T.	34	70	50	10	164
Sleds - #4 s/m	34	20	20	10	84
Trucks - Cargo - 10 T.	2	20	20	3	45
Barges - 20 T. s/m	20	0	20	2	42
Boats - power	10	0	10	2	22
Power barges - 100 T.	0	0	6	0	6
Planes - 4 place	1	1	1	1	4
Planes, freight - 1500#	2	3	4	0	9

11. Operations Structures and Motive Power. - The features of construction required for operation as described in paragraph 8, sub-paragraphs g to i inclusive, are scheduled for construction after the roadway has been completed. The extent of this construction is determined by the type of motive power and the length of engine stages. It is recommended for economic reasons stated in paragraph 8 that diesel-electric locomotives be used and in this connection, attention is invited to the apparent mechanical advantages of the 44-ton, 380 H.P., diesel-electric locomotive described in specifications, Railway 24,147-A, General Electric Company, September 1940. For road service, this locomotive may be used in multiples as dictated by the haul requirements. Outstanding features of this equipment are the use of Caterpillar diesel engines as power units and the design of cab, frame and running gear which are fabricated from standard steel shapes and plates. Personnel and equipment for maintenance, repair or replacement of such equipment should be more readily available than for steam locomotives. Maintenance of roadway will be simplified as the extent of frost heaving in winter seems to increase with the weight of locomotives used. Axle loading is such that light bridge designs may be adopted which, in turn, increase the speed of construction. Consideration should also be given to the fact that this line traverses timbered areas of considerable value to Canada and the fire risk with diesel-operated locomotives is negligible. The length of engine stages and location of engine terminal points have been selected in accordance with the attached performance curve.


Performance Curve
100T Diesel Electric
With 500T Train
4%
3%
2%
1%
Level
Max 36 mi per hour
35
30
25
20
15
10
5
00
Miles per Hour
Continuous Service
Intermittent Service
10m to 2 hrs
Max T.E. 50,000 #
Note: Performance of 2-44T Diesel Ele
is essentially identical

a. Within the limits imposed by the foregoing performance curve, engine terminals have been selected where terrain and grade conditions are favorable. The desirability of combining these installations with necessary yard developments at points of substantial freight transfer has also influenced the selection of sites, as follows:

(1) Diesel-electric section:

Milepost	0	-- Prince George Junction.
*Milepost	85	-- Fort McLeod - Pine Pass Outlet.
*Milepost	193	--
Milepost	302	-- Fort Ware - Head of navigation, Finlay River.
Milepost	423	-- Gataga Forks.
Milepost	532	-- Watson Lake Area - Alcan Highway and Airfield.
Milepost	643	-- Frances Lake.
Milepost	755	-- Ketzah River.
Milepost	885	-- Little Salmon Post - Yukon navigation.
Milepost	1008	-- Selwyn.
Milepost	1119	-- Boundary.

(2) Steam-operated section:

Milepost	1207	-- Tanacross - Airfield, Alcan Highway.
Milepost	1306	-- Big Delta - Airfield, Richardson Highway.
Milepost	1416	-- Kobe Junction.

*Terminal at Finlay Forks, present Milepost 170 may be substituted for terminals at Milepost 85 and Milepost 193 if the Willow Creek revision is adopted.

12. Estimated Quantities.

a. The average mile of the located line from Prince George, British Columbia, to Kobe, Alaska, as now staked may be described as follows: Alignment consists of 4,100 feet of tangent and 1,180 feet of 5-degree curve. Grading can be accomplished with 23,140 cubic yards of common and 3,490 cubic yards of rock excavation. Fifty-seven feet of this mile is on bridge or trestle structure and there are 4 culverts.

b. The estimate of roadway buildings and service installations stated in the tabulation which follows is based on the operation of the line as a diesel-electric system from Prince George to the Alaska boundary and a steam line from the Alaska boundary to Kobe. Grading quantities are approximate as final adjustment of grade lines has not been completed. However, the estimate is liberal and indicates that a light line has been developed. Revisions now under consideration are expected to further reduce the quantities and shorten the line approximately 16.5 miles.

Clearing	--	30,456 acres
Tel. and Tel.	--	1,416 miles
Grubbing	--	5,600 acres
Grading		
Common	--	32,769,000 cubic yards
Rock	--	4,938,000 cubic yards
Bridges		
Steel	--	2-400'
"	--	1-300'
"	--	1-270'
"	--	2-200'
Wood	--	20-150'
"	--	29-120'
"	--	3-100'
"	--	4-90'
"	--	2-80'
"	--	8-56'
Trestles		
Pile and frame	--	73,220 lineal feet
Culverts (log)	--	5,700
Ties		4,560,000

Rail and fittings		
(60# rail)	—	177,211 tons
Track-laying		
Main line	—	1,416 miles
Yards and sidings	—	104 miles
Surfacing and ballasting	—	1,520 miles
Buildings & service structures	—	
Double section houses	—	72
Tool sheds	—	144
T/O - O.Q.	—	14
" - E.M. barracks	—	84
" - 250-man mess	—	14
" - Day rooms	—	28
" - Canteens	—	14
Mob. type - Infirmaries	—	12
Station buildings	—	14
Freight sheds	—	14
Engine sheds (diesel)	—	11
Engine sheds (steam)	—	4
Locomotive shops (diesel)	—	11
Locomotive shops (steam)	—	1
Water tanks	—	8
Coaling plants	—	4
Sand houses	—	14
Oil houses	—	14
Car shops	—	14
Ice houses	—	14

13. Estimate of Cost. - The field survey of this route was completed September 28, 1942. Detail profiles and sections at bridge sites have not been prepared from the field notes as these data have as yet only been worked to the extent necessary for a descriptive report of this location. Although a better estimate can be prepared when these studies have been completed, it is believed that an accurate estimate of cost under existing labor and materials supply conditions cannot be determined. The procurement of rail involves intangible factors at this time, such as the location of supply and weight of section which in turn effect the cost of transportation, both on commercial carriers and over the access routes.

In arriving at the estimate which follows, unit costs have been based on recent construction in the more remote sections of Alaska, modified by transportation costs and last quoted base prices of the various materials in Seattle. The construction of access roads as well as boats and barges necessary to augment existing transportation facilities are treated as a separate item of cost. The operation of transportation equipment, however, is included in the unit costs of materials in place. Extensions are made to the nearest $1,000.

a. Clearing:

Heavy, 12,182 acres @ $100	$ 1,218,000	$
Light, 18,274 acres @ $ 75	1,371,000	
Total		2,589,000

b. Telephone and Telegraph:

Tripods, 40/M 1,416 @ $ 400	566,400	
4-Wire System 1,416 @ $ 350	495,600	
Station Equipment - 14 @ $6,000	84,000	
Total		1,146,000

c. Grubbing and Ground Cutting:

5,600 acres @ $200		1,120,000

d. Grading

Common, 32,769,000 c.y. @ $ .80	26,215,000	
Rock, 4,938,000 c.y. @ $2.00	9,876,000	
Total		36,091,000

e. Bridges (includes foundations):

Steel:

2 spans, 400' @ $210,000	420,000	

1 span, 300' @ $150,000	$ 150,000	$
1 span, 270' @ 142,000	142,000	
2 spans, 200' @ 105,000	210,000	
Wood:		
20 spans, 150' @ $ 35,000	700,000	
29 spans, 120' @ 27,000	783,000	
3 spans, 100' @ 22,000	66,000	
4 spans, 90' @ 19,000	76,000	
2 spans, 80' @ 16,000	32,000	
8 spans, 56' @ 10,000	80,000	
Total		2,659,000
f. Trestles:		
73,220 l.f. @ $35.00		2,563,000
g. Log Culverts:		
5,700 each @ $120		684,000
h. Cross Ties - #2:		
4,560,000 @ $1.00		4,560,000
i. Rail and Fittings - (60#):		
163,036 tons @ $113	18,423,000	
14,175 tons @ 138	1,956,000	
Total		20,379,000
j. Track-laying:		
1,520 miles @ $1,500		2,280,000
k. Surfacing and Ballasting:		
1,520 miles @ $2,800		4,256,000
l. Buildings and Service Structures:		
Section houses, 72 @ $ 7,000	504,000	
Tool sheds, 144 @ 250	36,000	
O.Q. - T/O, 14 @ 6,000	84,000	
Barracks - T/O, 84 @ 6,500	546,000	

Mess - 250-man	14 @ $20,000	$ 280,000	$	
Day rooms - T/O	28 @ 4,500	126,000		
Post Exch. - T/O	14 @ 5,500	77,000		
Infirmaries	14 @ 9,500	133,000		
Station offices	14 @ 15,000	210,000		
Freight sheds	14 @ 6,000	84,000		
Engine sheds				
Diesel	11 @ 10,000	110,000		
Steam	4 @ 25,000	100,000		
Locomotive shops				
Diesel	11 @ 20,000	220,000		
Steam	1 @ 50,000	50,000		
Water tanks	8 @ 6,000	48,000		
Fuel stations	4 @ 12,000	48,000		
Sand houses	14 @ 1,500	21,000		
Oil houses	14 @ 1,500	21,000		
Car shops	14 @ 12,000	168,000		
Ice houses	14 @ 3,000	42,000		
	Total			2,908,000

m. Access Routes

Truck roads	40 m. @ $12,000	480,000	
Tractor roads	795 m. @ 5,000	3,975,000	
Power barges, 100 T.	6 @ 60,000	360,000	
Barges, 20 T.	42 @ 3,000	126,000	
Power boats, 100 h.p.	22 @ 10,000	220,000	
	Total		5,161,000

n. Land Acquisition:

1,700 acres @ $40 — 68,000

o. Land Ties - (Contract):

1,119 miles @ $100 — 112,000

p. Engineering and Supervision:

5% of $86,576,000 — 4,329,000

q. Contingencies:

15% of $90,905,000 — 13,636,000

r. District and Division Overhead:

7% of $104,541,000	$ 7,318,000
Total estimated cost	111,859,000

The foregoing estimate has been prepared on the basis of 400 days active construction time. It is recognized that this is a very optimistic schedule and dictated by military necessity. In order to conform to this schedule or even closely approach it, far better transportation facilities and supply channels must be made available than have been applicable to previous construction in Alaska and Canada. Unless equipment, labor and materials, particularly rail, are delivered to the ports or railheads serving the access routes, in requisite amounts and on schedule to meet construction requirements, this time limit cannot be met.

14. Acknowledgements. - The District Engineer wishes to acknowledge the cooperation extended by Mr. F. C. Green, Surveyor General of British Columbia, and the National Resources Planning Board. The assistance furnished by these offices has aided materially in the conduct of the survey and preparation of this report.

Peter P. Goerz,
Colonel, Corps of Engineers,
District Engineer.

APPENDIX 'A'

ADDRESS REPLY TO
THE DISTRICT ENGINEER
U. S. ENGINEER OFFICE
700 CENTRAL BUILDING
SEATTLE, WASH.

REFER TO FILE No. SE 7559(Trans-Canadian Alaska Ry.)79

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
SEATTLE, WASHINGTON

4Y

May 15, 1942.

Subject: Aerial Reconnaissance of Trans-Canadian Alaska Rail Route.

To: The District Engineer, U. S. Engineer Office, Seattle, Washington.

1. In compliance with oral instructions from the District Engineer and travel order No. 7034, Office, Division Engineer, dated April 23, 1942, I report completion of an aerial reconnaissance of the proposed Trans-Canadian Alaska Railway route during a period from May 3d to May 12th, inclusive.

2. In company with Mr. F. A. Hansen, engineer assigned in charge of the location surveys in the Yukon Division, I left Paine Field May 3d at 12:45 p.m. by chartered plane and followed the route of the Pacific Great Eastern Railway from the vicinity of Harrison Lake to Prince George, arriving at Prince George at 5:40 p.m.

a. The roadbed of the Pacific Great Eastern appears to be in good condition as viewed from the air. It was noted that a considerable amount of tie replacement is underway, and a small amount of riprapping is being done in the vicinity of Quesnel, the present northern terminus of the line. North of Quesnel, the line has been abandoned and is taken over in part for highway. Location follows the left limit of the Fraser River and connects with the Canadian National at the east end of the Fraser River bridge, approximately 1-1/2 miles east of the town of Prince George.

b. Prince George is located at the confluence of the Nechako and Fraser Rivers, and on the right limit of both streams. Upon arrival at Prince George, I looked over the yard lay-out and found that there are now 7 house tracks approximately 1 mile in length and room for expansion of at least 100 percent without excessive grading. The main line of the Canadian National is 80-pound steel on spruce and hemlock ties, and is gravel ballast. Yard tracks are laid with 60 and 70-pound steel. Yard facilities include a 90-foot turntable, 12-stall roundhouse and machine shop. The Canadian National also maintains a casting yard for concrete culvert pipe, utilizing pit run gravel from the banks of the Nechako River immediately west of the yards. The crossing of the Nechako River does not appear to present any unusual difficulties although some protection of the abutments may be required.

3. I left Prince George at 9:06 a.m., May 4th, and flew the route to Watson Lake, Yukon Territory, arriving at Watson Lake at 2:08 p.m.

a. It appears that little difficulty will be experienced in developing the line north of Prince George to Summit Lake, a distance of approximately 35 miles, following closely the location of the present road to this point. From Summit Lake, the line follows the Crooked River drainage to its confluence with the Parsnip River, and turns down the left limit of the Parsnip River to Finlay Forks and up the Finlay River to Sifton Pass, the highest point reached on the location, i.e., 3,273 feet. The valley floor appears to have an average width of about 4 miles and is remarkably straight, heavily timbered, and all cut banks reveal gravel practically to the surface. Cross drainages are not glacial fed and crossings are not expected to be difficult. Sifton Pass appears from the air to be a gentle summit as the headwaters of both drainages are meandering in their courses in the vicinity of the pass.

b. In general, western and southern facing slopes are preferable from a standpoint of maintenance, but it is believed that in this case a cheaper line can be developed on the opposite slope, particularly on the northern side of Sifton Pass where several deep canyons enter the valley of the Kechika River from the east. Approximately 50 miles of fairly heavy work will be encountered north of Sifton Pass. From this point on to the confluence of the Kechika with the Turnagain, timber thins out considerably and there is evidence of some rock work.

c. Two routes are possible from the mouth of the Kechika to the Lower Post on the Liard. One route would follow the Turnagain River to the Liard, thence up the right limit of the Liard to a crossing in the vicinity of Lower Post. However, I believe that it is entirely practicable to develop a much shorter route directly across country to the Lower Post without resorting to maximum grade.

d. Upon arrival at Watson Lake, I found that the General Construction Company of British Columbia had made great progress in the development of the airfield at that point, having one runway approximately 5,000 feet in length, fine graded, and clearing and grading operations are underway on the second runway. The elevation of the field at Watson Lake is 2,245 feet above sea level. This company has erected a small sawmill, machine shop, substantial office building, bunkhouses, and necessary utilities adjacent to the field. All heavy equipment for this work is freighted in by way of the Stikine River to Telegraph Creek, thence by road to Dease Lake, and down the Dease River to Lower Post. The contractor has constructed a pioneer road from the Lower Post to Watson Lake, a distance of approximately 24 miles. I spent the evening with Mr. A. Holland, resident engineer for the provincial Government, and Mr. A. F. Airey, contractor's superintendent, from whom I secured valuable information relative to the nature of the materials, transportation problems and character of the streams in that locality. Examination of the map and profile of the pioneer road shown me by Mr. Holland leads me to believe that this route will be quite satisfactory for a rail location.

e. Mr. Holland agreed to furnish transportation for our locating parties to establish camps as required along this road, and I believe it will be possible to make all further camp movements by boat on the Frances River. Mr. Airey agreed to furnish lumber from their local sawmill for the construction of suitable poling boats and gave me the names of certain natives at the Lower Post who are supposedly capable of building the boats and operating them.

f. The morning of May 5th, Mr. Canfield and Mr. Krause of the Aero Service Corporation, engaged by Colonel Loper in the Chief's Office, arrived at Watson Lake enroute to Whitehorse. In view of the fact that it was an excellent day for maping, I prepared a flight plan for Mr. Canfield to cover the route from Lower Post to Finlayson Summit, a scaled distance of approximately 165 miles. He estimated his flying time for this mission at 5 hours. I radioed Major Pettit at Whitehorse advising him that this mission had been assigned, and that upon completion Mr. Canfield would proceed to Whitehorse.

4. We left Watson Lake at 9:10 a.m. and flew the route via the Little Salmon drainage into Selkirk on the Yukon, arriving at 1:45 p.m.

a. Frances Valley appears to be rather heavily timbered, and I believe the valley floor is largely gravel. I expect some heavy work in this reach, but do not believe that maximum grade will be required. A ground reconnaissance will have to be made to determine which shore of Frances Lake is preferable. It appears that either side may be used in view of the fact that the apex of this V-shaped lake is little more than a sand bar, and can be readily crossed by trestle.

b. From the northern end of Frances Lake to Finlayson Lake, the route follows a shallow valley and does not appear to offer any location problem, nor does the shore of Finlayson Lake. However, the divide immediately west of Finlayson Lake may require a few miles of fairly heavy rock work into the head of Campbell Creek. I believe that in the upper reaches of Campbell Creek, this stream drops faster than our gradient will permit, and it may be necessary to generate some line southward to the Big Campbell Creek, thence down the Big Campbell Creek to the Pelly River at the trading post of Pelly Banks.

c. Between the Pelly Banks and the trading post of Ross River, the valley is terraced, and it will be possible to retain some elevation above the valley floor, and from Ross River to the divide between the Magundy and the Pelly, it will probably be necessary to adopt some adverse grade to make the summit. Owing to bad cross winds in this pass, I was unable to determine its elevation with any degree of accuracy, and decided to proceed on to Selkirk and remain there until weather conditions would permit a return flight over this route and an examination of the lower Pelly Valley for comparison.

d. From the summit down to the east end of Little Salmon Lake, a distance of approximately 30 miles, the line traverses a shallow valley, and from the nature of the vegetation, it is believed that the valley floor is composed of gravel. I believe the Magundy River can be navigated with shallow draft poling boats. The north shore of Little Salmon Lake, approximately 20 miles long, appears to be less precipitous and cross drainages are in well defined channels. From the west end of Little Salmon Lake, the line follows the right limit of the Little Salmon River for a distance of about 30 miles to its confluence with the Lewes River at the trading post of Little Salmon. Poling boats can be used on the Little Salmon River, but the stream meanders so badly that the river distance is probably three times the actual distance along the axis of the valley.

e. From Little Salmon to Five-Finger Rapids, the line follows the right limit of the Lewes River, and will require about 6 miles of comparatively heavy sidehill benching but the remainder is across timbered bars estimated at 15 to

25 feet above river level. Five-Finger Rapids offers the most desirable crossing obtainable on the Yukon drainage in that at this point the river cuts through a conglomerate rock dike, providing suitable bridge rests, to an elevation that will permit the use of fixed spans. The longest span is estimated to be 160 feet.

f. From Five-Finger Rapids westward the line follows the left limit of the Yukon River, and consists of approximately 20 percent sidehill work, the remainder being across timbered bars where construction will be quite economical.

g. Upon arrival at Selkirk, I met Corporal G. I. Cameron, Royal Canadian Mounted Police, and discussed with him the choice of routes between Selkirk and Ross River. Corporal Cameron was well acquainted with both routes, having traversed them by dog team and he volunteered to accompany me on a return flight, which was made leaving Selkirk at 4:20 p.m., flying by way of Little Salmon and Magundy, Pelly Summit, and thence back the Pelly River into Selkirk, arriving at Selkirk at 7:40 p.m. Atmospheric conditions had improved to such an extent that we were able to fly almost at the tree tops through the pass, registering an elevation of 2,900 feet. The summit is broken and I believe it will be possible to get through this gap at an elevation of approximately 2,650 feet.

h. I do not believe that the Pelly River route is desirable for several reasons, the first and most important being that it deprives us of the favorable crossing of the Yukon at Five-Finger Rapids, and, secondly, that a southern facing slope, which is preferable, will entail 7 major stream crossings and there is evidence of a considerable amount of soft ground and muskeg swamps in the valley floor.

i. On my second return to Selkirk I got in touch with a Mr. A. C. Coward who is an experienced riverboat man and owns several small riverboats and barges I made tentative arrangements with him to transport and supply survey parties operating in this vicinity. I also secured from him the names of other riverboat men along the river who are equipped to perform similar services elsewhere along the river route.

j. As the Dominion telegraph line follows the left limit of the Yukon from Five-Finger Rapids to the mouth of the White River I made inquiries as to the possibility of tapping this line with field sets and was advised that there was no objection to so doing but I was asked in return for this favor that we remove any dangerous trees or repair any breaks in the line that we might find.

5. I left Selkirk at 8:35 a.m., May 6th, flying the route to the mouth of the White River up the White River to the mouth of the Ladue, up the Ladue River Valley to the summit of the divide between the Ladue and the Tanana and thence down the Tanana River to Fairbanks, arriving in Fairbanks at 1:40 p.m., after stopping at Tanacross and Big Delta.

a. From Selkirk to the mouth of the White River there are probably 15 miles of fairly heavy sidehill work and about 80 miles of relatively simple construction on timbered gravel bars. From the mouth of the White River to a point opposite the mouth of the Ladue, a distance of approximately 25 miles, I believe we will encounter our wettest work although a more stable and better roadbed can be established by benching into the northern slope at considerable added expense.

b. An alternate route to avoid this section along the White River may be possible by leaving the Yukon River at a point approximately 15 miles upstream from the mouth of the White River, following up the drainage of Los Angeles Creek to what appears to be a comparatively low summit, and thence down a westward flowing, unnamed tributary to the White River, entering the White River opposite the mouth of the Ladue River. I was unable to determine the height of this summit and I am not inclined to favor it for the present development in view of the difficulties that would be encountered in securing ready access to such a line with construction equipment.

c. The White River crossing will be difficult but I believe that the site selected by Mr. Hansen and myself is the most satisfactory in the lower reaches of the White River. The stream is controlled on its right limit at this point by rock shoulder and appears to be held against this limit by the inflow of the Ladue River some 2 miles upstream. The main channel seems to be fairly well confined and the low bars on the left limit of the White are heavily timbered with evergreens, indicating a greater degree of stability than is evidenced elsewhere in the White River. The Ladue River is not a glacial fed stream and its valley will provide an excellent location. I favor the northern facing slope to a point 20 miles west of the International Boundary, and from this point on to the summit there appears to be no difference in the slopes and the stream is small enough that it may be crossed with bulkhead openings or short trestle-bent structures.

d. From the head of the Ladue the summit breaks off sharply into the Tanana Valley floor. The elevation of this divide is approximately 600 feet above the valley floor and it will be necessary to take sidehill work for a distance of 10 miles down to the site selected for the crossing of the Tanana River. This work may be rather heavy but it is through gravel material and the slopes generally are 30 degrees with the horizontal. From the crossing of the Tanana to the village of Tanacross the line traverses a timbered, gravel plain for a distance of about 25 miles and the crossing of the one tributary of the Tanana, the Tok River, does not present any serious problem.

e. At Tanacross I met the contractor, then engaged in the enlargement of the flying field at that point, who agreed to place at my disposal a tractor and trailer wagon for moving camp and equipment from the river to the initial camp site on the line. I also met Mr. Herman Kessler, trading post operator at Tanacross, and ascertained that he had available 8 head of pack stock as well as a riverboat suitable for transporting one locating party down river from Tanacross.

f. The line west of Tanacross, as far as the crossing of the Robertson River, closely follows the old winter trail and traverses some wet ground. There does not seem to be much choice in the selection of a crossing on the Robertson River as it is a threaded channel throughout its length. The channel ice in this stream appears to melt away before the flood stage caused by melting glaciers and as it heads above the timber line there is very little evidence of drift in the stream. Hence, I see no reason why a trestle structure will not provide a satisfactory crossing.

g. After crossing the Robertson River the line follows quite closely along the left limit of the Tanana River, crossing the Johnson River immediately above its mouth. This stream is very similar to the Robertson River. The Tanana River swings sharply to the north at this point and there appears to be no object in following the river further as a direct line from the crossing of the Johnson to a point on the Delta River immediately below the confluence of Jarvis Creek traverses good ground and the crossings of the Big Gerstle and Little Gerstle Rivers will not be difficult. From Big Delta I proceeded directly to Fairbanks.

6. On the following day, May 7th, I left Fairbanks at 8:05 a.m., accompanied by Mr. Berryhill, engineer in charge of the location in Alaska, flew directly to Station Kobe on the Alaska Railroad and thence east along the projected route to Big Delta.

a. I found upon arrival at Big Delta that the two locating parties initially sent into Alaska with partial equipment had succeeded in laying down 12 miles of line and had reached the limit of their operations without camp equipment. The line established by these parties is a scratch work line with an average fill of about 3 feet and a maximum cut of 4 feet.

b. From Big Delta we flew the route to Tanacross and there arranged with Mr. Kessler for the immediate use of his pack stock for the parties at Big Delta, selected the control point at Tanacross with reference to the beam station location, and arranged with the contractor on the field grading to move one party by tractor and wagon to their initial camp site about 4 miles east of Tanacross.

c. After leaving Tanacross we agreed on the crossings of the Tok and Tanana, and established the summit between the Ladue and the Tanana. I instructed Mr. Berryhill to have party No. 6 work east out of Tanacross down the Ladue to meet party No. 7. This was a change in the original plan which contemplated that party No. 6 would work eastward to the summit only, but in view of the fact that the line east out of Tanacross to the Tanana River can be developed quite rapidly, it seemed advisable to extend the scope of their work and secure the use of another pack train. I therefore flew south to Nabesna and got in touch with Mr. Harry Boyden and arranged for the remainder of his pack stock to make up two pack trains, one to leave immediately for Tanacross and the other to proceed to the mouth of the Ladue. From Nabesna I returned directly to Fairbanks, arriving at 6:40 p.m.

d. On our return to Fairbanks we found that the additional parties for Alaska had arrived with their equipment and we immediately made arrangements with the Star Airways and the Pollock Flying Service to transport two parties to Tanacross and one party to the head of Wood River. The remaining party was sent to Kobe via the Alaska Railroad to start work from that point, east. I believe that the entire line in Alaska will be laid down by July 15th.

7. On the following day, May 8th, I left Fairbanks at 2:00 p.m. and stopped at Burwash Landing at the west end of Kluane Lake.

a. We interviewed the owner of some pack stock in this locality. I was unable to reach a satisfactory agreement on this pack stock.

b. In the landing at Burwash the plane was damaged and the contract terminated. From Burwash Landing I radioed Major Pettit at Whitehorse who arranged to have the small Cessna plane used by the Aero Service Corporation on their photographic mission, and then idle, pick me up May 9th at 10:50 a.m.

8. I arrived in Whitehorse at11:55 a.m.

a. I found that parties No. 7 and No. 8, with their equipment, were ready to go in the field. Although the river was open, the ice on Lake LaBarge was still solid and the riverboat officials advised me that there was every indication that the first river steamer would not be able to get out of Whitehorse before May 25th. I got in touch with the Yukon Southern Airways and arranged a contract to fly these two parties, with minimum equipment sufficient to carry them until June 1st, to Selkirk and arranged by telegraph with Mr. Coward at Selkirk to handle one party down river to the mouth of Los Angeles Creek. This movement was completed on the 9th and 10th.

b. I called on Major Pettit at his headquarters, met Colonel O'Connor and discussed with them the portions of the route common to both locations.

c. I inspected the quarters secured by Mr. Hardison above the Royal Canadian Telegraph station and found them to be entirely too small for the establishment of the division office and wired the District Engineer requesting that a K.D. building, 20' x 60' at least, be made available to augment this office space.

d. I found that the Aero Service Corporation had photographed the Little Salmon drainage from Ross River to Little Salmon and were then preparing to leave for Tanacross to base for the Ladue mapping. I cancelled this portion of the photography as the Ladue Valley location is quite simple and the photography unnecessary, and substituted the intervening stretch between Ross River and Finlayson Summit which would give us continuous photography from the Lower Post on the Liard to the trading post of Little Salmon on the Yukon. Major Pettit was quite anxious to get the services of this contractor to photograph the route between Norman on the McKenzie across to Whitehorse.

e. General Hoge arrived at Whitehorse the morning of May 11th. I called on the General and explained the nature of our mission.

f. I reported to the infirmary and completed my typhoid inoculation and second tetanus vaccination, left Whitehorse at 3:05 p.m. via Yukon Southern, arrived at Prince George at 7:05 p.m.

g. I met Constable Thomas of the Provincial Police who is familiar with the Parsnip River drainage north of Prince George, and secured from him the names of several riverboat men capable of freighting our equipment in this locality.

h. I left Prince George at 10:55 a.m., May 12th, arrived in Seattle at 2:30 p.m. the same day.

9. Conclusions: My previous knowledge of this route was limited to the section westward from Little Salmon, Yukon Territory, to the Alaska Railroad. The aerial reconnaissance, just completed, convinces me that the remainder of

the proposed location will lend itself to rapid and economical construction within the standards established for a military railroad. I believe it will be very difficult to defend any alternate location when a direct line with such low summits is possible through the Rocky Mountain Trench.

Jas. Truitt,
Lt. Colonel, Corps of Engineers,
Executive Assistant.

APPENDIX 'B'

ADDRESS REPLY TO
THE DISTRICT ENGINEER
U. S. ENGINEER OFFICE
700 CENTRAL BUILDING
SEATTLE, WASH.

REFER TO FILE NO. ____________

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
SEATTLE, WASHINGTON

4Y

April 18, 1942

Subject: Instructions governing location.

To: Division and locating engineers.

1. Mission: The task directed consists of the establishment on the ground of suitable location for a standard gauge, single track, military railroad between Prince George, British Columbia, and Kobi, Alaska.

2. Route: The route adopted is through the Rocky Mountain Trench, about 250 miles inland and approximately parallel to the coast line of Southeastern and Southwestern Alaska. The line will be about 1400 miles in length and with the exception of three minor summits, follows river valley floors ranging in width from 3 to 15 miles.

3. Characteristics: In order to provide the service desired, this railroad must be so located that 20-mile traffic can be maintained with 20-car trains. Tonnage will be almost exclusively north-bound. Motive power will be steam and engine stages will be approximately 100 miles. Mogul or Consolidation type locomotives will be used as dictated by the ruling grade and the above requirements. In general, the economic principles governing the determination of curvature and grade limits are not applicable to this location. Where decision must be made between alternate routes, the cost of construction will be considered secondary to speed of construction.

4. Alignment and grades: Effort should be made to establish a line capable of future development into the most favorable alignment practicable over the terrain traversed even though "shoo flys" are initially resorted to in the interests of economy and rapid construction. All curve points should be held as far as practicable from bridge heads. Stream crossings on curves should be avoided if possible. It is preferable to compound curves rather than allow tangents less than 400' between curves in the same direction. Tangent of at least 400' should be allowed between

curves in opposite direction. Curves should not be less than 300 feet in length. Easements will not be calculated or staked in the location survey but will be introduced by the resident engineers on construction. Degree of curvature will not exceed 12 degrees except with the express authorization of the division engineer who may direct the use of increased curvature to a maximum of 16 degrees. The introduction of curves to eliminate excessive excavation, in lieu of tangents, should be the subject of intensive study. Abnormally heavy construction should not be resorted to. All curve computations will be made on the basis of 50-foot cords. Preliminary studies of available maps indicate that an undulating grade line will be the general rule with maximum grades limited to the summits between drainages. It is believed that these ruling grade sections are relatively short. Grades in excess of 1.5% should not be adopted except with the approval of the division engineer. Compensation for curvature will not be required when the curvature is 4 degrees or less. Compensation at the rate of .04% per degree of curve will be introduced for all curvature over 4 degrees. Vertical curves will be fitted for all grade changes in excess of 0.5% and no vertical curve shall be less than 300 feet in length. Grade sags shall not be located in cuts.

5. <u>General instructions</u>:

<u>a</u>. Reconnaissance: Where possible the locating engineer should make a rapid examination of the contemplated route in order to eliminate the running of unnecessary preliminary lines. Consideration should be given to exposure, snow conditions, stability of terrain, possible construction access routes, stream and river crossings and any other conditions that would effect the construction, maintenance and operation of the road.

<u>b</u>. Preliminary: The preliminary survey objective is to make a topographical map of a strip of country from which the final location can be projected. It is desirable to run the preliminary as closely as possible to where the final location will come. A distinctive letter or number shall be given each preliminary line and an equation stake put in at all connections.

<u>c</u>. Location: The located line shall be established on the ground with substantial stakes. All instrument points or hubs should be driven flush with the ground with the guard stake on which the station number is marked driven on the left-hand side. Station numbers shall increase from south to north or east to west. The original location shall bear the identifying letter "L" and subsequent, alternate, or revised lines shall be identified as "L^1", "L^2", etc.

<u>d</u>. Transit and chaining: Calculated courses from solar or polaris observations will be used at the initial point and compass bearings shall be observed and recorded on all tangents. In level country, a 300-foot chain may be used and curves will be offset from the semi-tangents where practicable. The number of the starting and final station of each day's run shall

be noted with the date, weather conditions and members of the transit party, in the transit book.

e. Levels: Where possible, levels will be taken from existing bench marks. Where these do not exist, a datum plane will be assumed and all levels shall be in relation to the assumed datum of each party. Reading on all bench marks shall be to the nearest .01 of a foot and at all stakes and hubs and any immediate point which may be necessary to give a correct profile of the ground, to the nearest .10 of a foot. A permanent bench mark shall be set at least every 1/2 mile and accurately described in the level book. At all stream crossings and in bottom lands subject to overflow, care should be taken to get the extreme high water elevation as well as the existing water elevations. Care should be taken to keep fore and back sights as nearly equal in length as possible. The number of the starting station and final station of each day's work shall be noted in the level book with the date, weather conditions, and members of the level party.

f. Slope noting: Sufficient slope notes will be taken to permit a reasonably accurate determination of quantities. These notes should also include a description of the vegetation, depth of muskeg, and classification of the material to be excavated.

g. Local materials: Notes shall be taken of all native material such as suitable timber for culverts, piling, ties, gravel for ballast, etc., their description and approximate location with reference to line.

h. Maps: A detail map shall be made of the preliminary line showing the topography and upon which the proposed location line shall be projected. In flat country a scale of 400 feet to the inch will be used but in steep broken ground a larger scale is preferable. All equations of chainage, angles or levels should be plainly shown.

i. Profiles: A profile shall be made of all preliminary and located lines and will be plotted from left to right as to station numbers. Plate "A" or a vertical scale of 20 feet to the inch and a horizontal scale of 400 feet to the inch will be used. The location profile will show the ground line, grade line with all changes of grades, and vertical curves. The ground line shall be inked in light lines. The grade line shall be only in pencil on the working profile.

j. Roadway sections: For estimating purposes the roadway shall be 14 feet wide on fills and 16 feet wide in cuts. Cut slopes in rock shall be 1/4 to 1 and other material 1 to 1 except in very special cases. Fill slopes will be $1\frac{1}{2}$ to 1.

For the District Engineer:

Jas Truitt

Jas. Truitt,
Lt. Col., Corps of Engineers,
Executive Assistant.

ADDRESS REPLY TO
THE DISTRICT ENGINEER
U. S. ENGINEER OFFICE
700 CENTRAL BUILDING
SEATTLE, WASH.

REFER TO FILE NO. ______________

WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
SEATTLE, WASHINGTON

4Y

April 21, 1942

Subject: Instructions governing location. (Supplement No. 1)

To: Division and locating engineers.

1. It is desired that division and locating engineers avail themselves of all information procurable from surveys now being conducted on the highway route in Alaska, Yukon Territory, and British Columbia, with a view to eliminating unnecessary reconnaissance where the routes are common.

2. In view of the fact that the road construction may be undertaken at an early date, the advantages of access roads to the rail route during actual construction are readily apparent. It is believed that there are two such areas in this location; first in the vicinity of the Lower Post, Laird River, for a distance of approximately 65 miles, and again in the territory of Alaska between Tanana Crossing and the Richardson Highway.

3. Previous instructions issued by this office, April 18, 1942, are amplified and amended by directive from Office, Chief of Engineers, April 18, 1942, in the following particulars:

a. The maximum curvature that may be authorized by division engineers is reduced from 16 degrees to 15 degrees.

b. Division engineers may authorize a maximum gradient of 2%.

c. Locators will investigate and side note suitable sites for sidings, 1/2 mile in length at intervals of 10 miles.

For the District Engineer:

Jas. Truitt
Jas. Truitt
Lt. Col., Corps of Engineers,
Executive Assistant.

APPENDIX 'C'

FINAL REPORT

Sheet 1 of 6 Sheets.

[redacted]

Job No. N-1

FIELD PROGRESS REPORT

PART A

Sheet 1 of 2

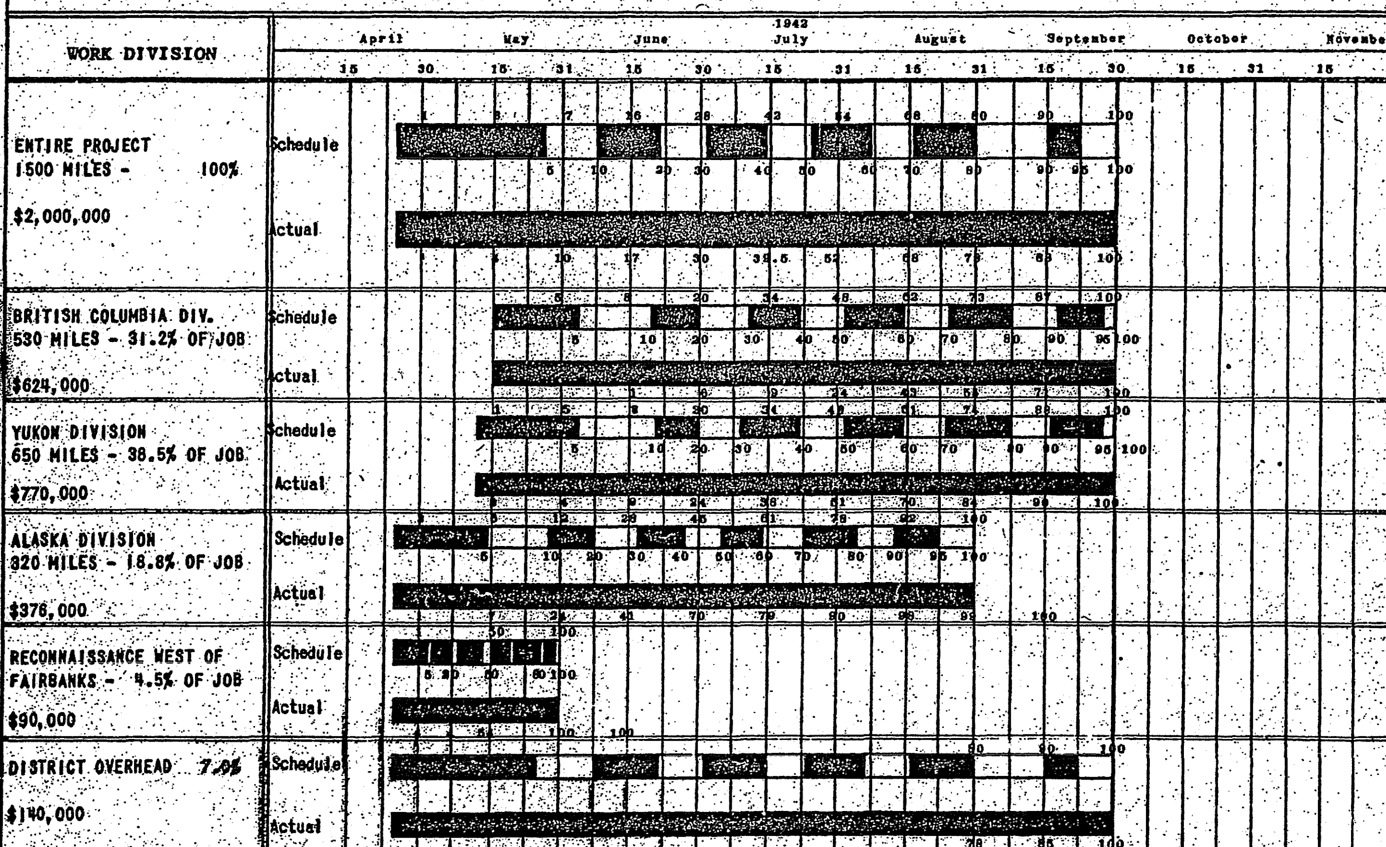
KEY	MARCH		APRIL		MAY		JULY		AUG.		SEPT.	
	15	31	15	30	15	31	15	31	15	31	15	
SCHEDULE		4	2	12	20	34	78	85	90	98	100	
ACTUAL		3	7	5	10	20	30	80	90	95		

Job Name Trans-Canadian Alaska Ry.
Location Prince George, B.C. to Kobi, Alaska. No Area
U.S.E.D. District Seattle
U.S.E.D. Division North Pacific
Period Ending Sept. 30, 1942

1	Physical % Scheduled for Completion	100
	Physical % Actually Completed	100*
3	Date Work Started	April 23, 1942
4	Estimated Date Ready for Use	Oct. 1, 1942
5	Scheduled Completion Date	Oct. 1, 1942
6	Required Completion Date	Oct. 1, 1942
7	A. Original Working Est. End of Last Period	2,837,000
	B. Original Working Est. for Add. Work Authorized	0
	C. Original Working Est. End of This Period	2,937,000
8	A. Present Working Est. End of Last Period	2,000,000
	B. Present Working Est. Revisions This Period	0
	C. Present Working Est. End of This Period	2,000,000 *
9	Present Working Est. (A/E Work Only)	

10	Allotments	680,000
11	Estimated Cost Data	
	A. Cost of Work in Place End of Last Period	1,759,000
	B. Cost of Work Placed During Period	241,000
	C. Cost of Work in Place End of This Period	2,000,000 *
	D. Cost of Material Delivered on Site, in Excess of Material in C	Not Applicable
	E. Materials Ordered but not Delivered in Excess of C & D	"
	F. Contract and Subcontract Obligations for Work not yet Executed in Excess of C, D, & E	"
	G. Amount of Advances to Material Men and Subcontractors in Excess of Payments in C&D	"
	H. Materials not yet Ordered Required to complete Job	0

WORK SCHEDULES



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Job No. N-1

FIELD PROGRESS REPORT
PART A (Cont'd)
Sheet 2 of 2

Job Name Trans-Canadian Alaska Ry.
Location Prince George, B.C. to Kobi, Alaska
No Area
U.S.E.D. District Seattle
U.S.E.D. Division North Pacific
Period Ending Sept. 30, 1942

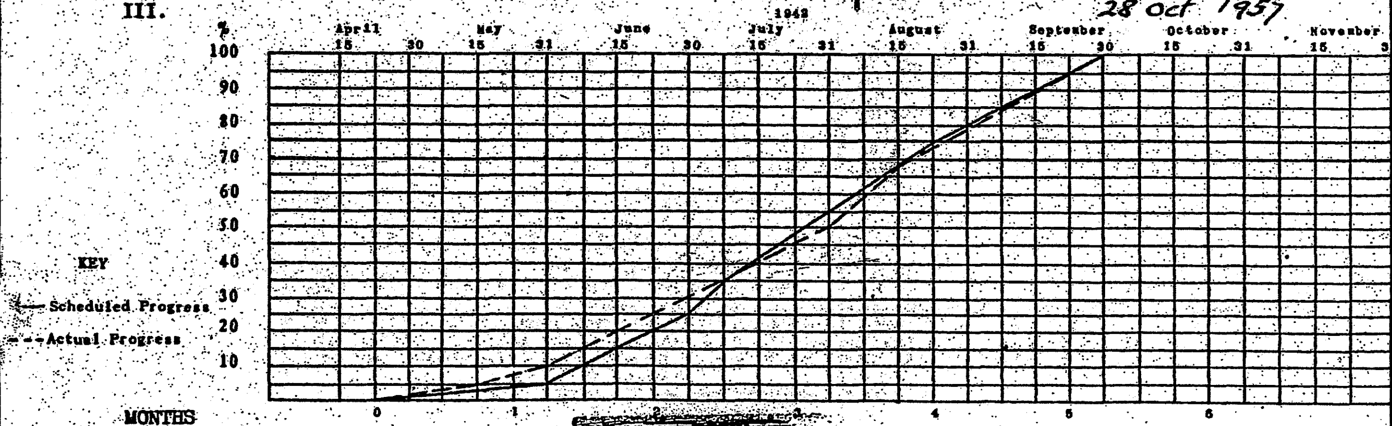
WORK SCHEDULES

WORK DIVISION

Note: Survey is completed. Only completion of office records, reports, field construction studies, and possible line revisions remain to be accomplished.

** Sufficient funds have been reserved and are included in the current Working Estimate to cover outstanding obligations and balance of costs, which might be incurred against this project.*

III.



[redacted]

FINAL REPORT

[redacted]

Job No. N-1

FIELD PROGRESS REPORT
PART C
Sheet 1 of 1

Job Name Trans-Canadian Alaska Ry.
Location Prince George, B.C. to Kobi, Alaska

U.S.E.D. District Seattle
U.S.E.D. Division North Pacific
Period Ending September 30, 1942

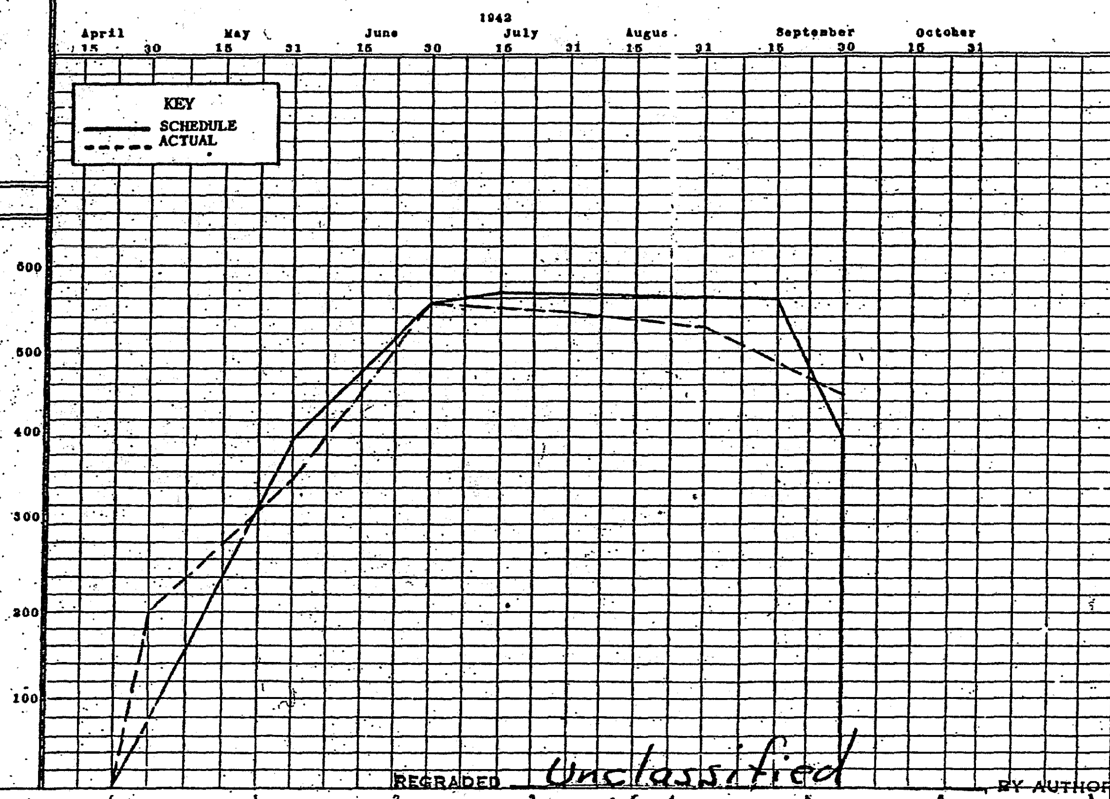
I - EMPLOYMENT, MAN-HOURS, AND PAYROLLS AT THE SITE

	PROJECT EMPLOYEES	No. of Employees	Acc. Man Hours Reported End of Last Period	Man Hours Current Period	Acc. Man Hours End of this Period	Acc. Pay Roll Reported End of Last Period	Pay Roll Current Period	Acc. Pay Roll End of this Period	Est. No. of Employees Next Period	Est. Man Hours Next Period
1	Architect Engineer- Total	0	0	0	0	0	0	0	0	0
2	(a) Professional	0	0	0	0	0	0	0	0	0
3	(b) Construction	0	0	0	0	0	0	0	0	0
4	Area Engineer Office-Total	25	8290	3640	11930	8750	4555	13305	35	7560
5	Officer	1	1048	208	1256	2550	450	3000	1	216
6	Civilian - Total	24	7242	3432	10674	6200	4105	10305	34	7344
7	Job	0	0	0	0	0	0	0	0	0
8	Engineering	16	1568	1976	3544	2103	2932	5035	26	5616
9	Overhead	8	5674	1456	7130	4097	1173	5270	8	1728
10	Hired Labor	421	371246	97864	469110	497097	107238	604,335	321	96,336
11	WPA	0	0	0	0	0	0	0	0	0
12	Contr. & Subcontr.- Total	0	0	0	0	0	0	0	0	0
13	Lump Sum & Unit Price Contr.	0	0	0	0	0	0	0	0	0
14	Fix.Fee-Contr.(Employees)	0	0	0	0	0	0	0	0	0
15	AEM Employees	0	0	0	0	0	0	0	0	0
16	Fix.Fee Contr.& AEM- Total	0	0	0	0	0	0	0	0	0
17	Job	0	0	0	0	0	0	0	0	0
18	Engineering	0	0	0	0	0	0	0	0	0
19	Overhead	0	0	0	0	0	0	0	0	0
20	Project Employees- Total	446	379,536	101,504	481,040	505,847	111,793	617,640	356	76,896
21	Job	421	371,246	97,864	469,110	497,097	107,238	604,335	321	69,336
22	Engineering	16	1,568	1,976	3,544	2,103	2 932	5,035	26	5,616
23	Overhead	9	6,722	1,664	8,386	6,647	1,623	8,270	9	1,944

Line 21 = 7+10+11+13+17
Line 22 = 1+8+18
Line 23 = 5+9+19
Line 20 = 21+22+23 = 1+4+10+11+12
Line 16 = 14+15 = 17+18+19
Line 1 = 2+3
Line 4 = 5+6 = 5+7+8+9
Line 12 = 13+14+15

Personnel on Military or terminal leave excluded.

III -- FORCE SCHEDULE



II -- LABOR

1. Labor supply is adequate.
2. Efficiency has been good.
3. Shortages: None

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by Henry Straub
DE Civil Works Branch
28 Oct 1957

[redacted]

View at Mile 907, along the Yukon showing location on bench. Line follows on top of bench in distance, crosses side stream to the left of camp, and passes under bluff in foreground.

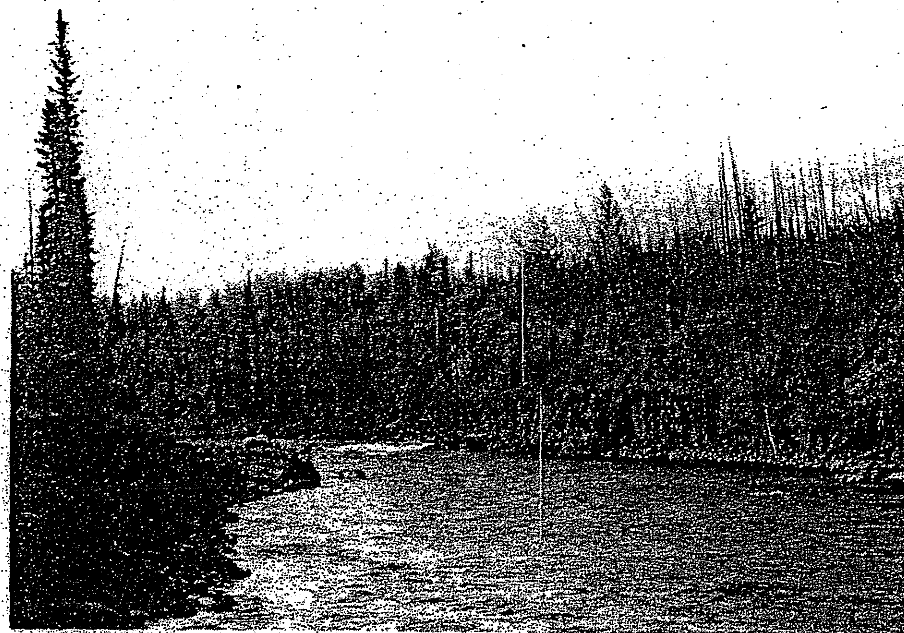
Pelly River at Mile 740. Note forest growth of spruce and fir. Benches similar to those in background are found along a great deal of the route. Gravel stream bed is typical, and eroding gravel bank in center distance is an example of the cut banks encountered at several points in British Columbia and Yukon Territory.

Small lake in Magundy valley. Typical of valleys throughout the route. Swamps bordering on the lake are shallow and have gravel bottoms.

Little Salmon River valley at Mile 874. Representative of small river valleys such as the Ladue, Magundy, Frances, or Kechika. Line skirts base of hill at left.

View of Five Finger Rapids looking upstream. Bridge piers will be on the large center island and the smaller rock island which may be distinguished above the white water on the right, giving span lengths of approximately 300', 270' and 120'. Clearance of 72 feet will be provided for river traffic. Photograph furnished by White Pass and Yukon Route.

Site of Frances River crossing, Mile 570.5, showing excellent character of rock for bridge abutments.

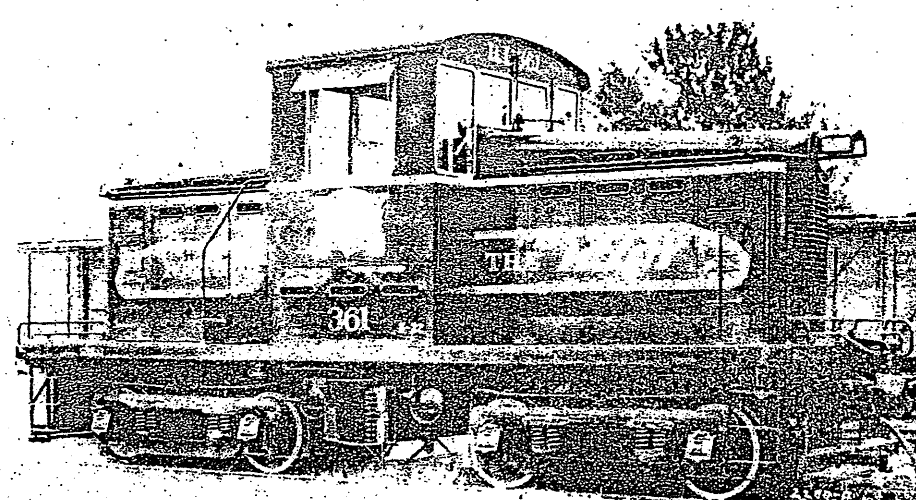


Hoole River crossing, Mile 733, showing rock structure in bank.

Running line on bench, Mile 921, along the Yukon, at a point about five miles upstream from Five Finger Rapids.

Example of an old timber stand. Although most of the timber is not this large, there will be sufficient for piling and cap timber requirements.

Tree root in Pelly River section showing shallow root system due to thin soil cover. Clearing will be relatively simple over the entire route.



Forty-Four-Ton Diesel-Electric Switcher Built by the Davenport Besler Corporation

Rock Island Gets Good Results With 44-Ton Diesel Switchers

Two Davenport Besler locomotives, driven by dual Caterpillar 180-hp. engines with Westinghouse electric transmission, show large savings in operating cost

THE Chicago, Rock Island & Pacific now has in regular service two 44-ton, 360-hp. Diesel-electric switchers, built by the Davenport Besler Corporation, Davenport, Ia., and powered by dual Caterpillar 180-hp. four-cycle Diesel engines, with Westinghouse electric transmission to each pair of wheels in the two four-wheel trucks. One of these locomotives has been used for double-shift industrial switching at Muscatine, Ia., since February, 1939, and the other in combination switching and branch-line service at Atlantic, Ia., since last August. Performance records with the first locomotive over a period of 10 months indicates a combined maintenance and operating cost of only $1.674 per hour, which may be compared with $3.98 per hour for equivalent steam operation. Even on the basis of but one 8-hr. shift a day and 300 days a year, this means a direct saving of $5,535 a year, one reason the Rock Island has recently ordered 10 more locomotives of the same size and type.

Fuel savings with the new 44-ton Diesels are impressive, as they use, on the average, only about 3½ gal. of Diesel oil per hour at a cost of five cents per gal. Other advantages claimed are high availability, low carrying charges and low maintenance; rapid acceleration and easy handling; quiet and clean operation, and a design which incorporates the builder's extensive experience combined with that of the various specialty manufacturers and railroad engineers. Still another feature is the employment of general accessories and equipment in standard use on other Rock Island locomotives, thus avoiding the necessity of carrying added stores inventories. Replacement or repair parts for the Diesel engines are readily obtainable at relatively low cost from any of the conveniently located Caterpillar distributors.

Description of the Locomotive

The Davenport Besler 44-ton Diesel-electric locomotive has the following general dimensions: length over couplers, 33 ft. 10 in.; maximum height above rail, 14 ft. 1½ in.; width over all, 10 ft.; wheel diameter, 33 in.; weight on drivers 88,000 lb. It is designed to negotiate curves of 75 ft. radius and develop 24,800 lb. tractive force at 2.5 m. p. h.; 15,600 lb. for one hour at 5.5 m. p. h.; 11,800 lb. continuously at 8 m. p. h.; and 2,700 lb. at 30 m. p. h., using a total gear ratio of 75 to 13.

The locomotive underframe is made of heavy structural-steel shapes and plates thoroughly braced, reinforced and welded into one strong unit, with provision for mounting the engine and generator sub-base on the center sill. The front and rear end sills are heavy channels with plates welded in to form a box beam construction. Association of American Railroads specification draft gears are installed and couplers with 6-in. by 6-in. shank and 11-in. head.

The individual truck wheel base is 7 ft. and the truck center spacing, 16 ft. 6 in. Commonwealth cast steel side frames and bolsters with center plates cast integral, are applied, the center plates being lined with replaceable, hardened, wear plates. Wear liners are also installed at the pedestal jaws. Anti-slewing brackets on the body bolsters restrict truck movement to 7½ deg. on each side of the center line. Bolster center locks prevent separation of the trucks from the underframe in case of derailment. The wheels are 33 in. rolled steel with A. A. R. standard 5-in. by 9-in. journals and friction bearings.

Dual power plants are installed in the locomotive, the two Diesel engines, furnished by the Caterpillar Tractor Company, Peoria, Ill., being of the Model D-17000 four-cycle type, with eight cylinders, 5¾ in. bore by 8-in. stroke, and developing 180 net horsepower per engine at 975 r. p. m. Caterpillar governors and fuel pumps are installed, as are also Donaldson air cleaners and Purolator and Michiana lubrication oil filters. The capacity of the lubricating oil circulation system is 40 gal. for each engine. Burgess exhaust snubbers are installed and a single engine exhaust is located near the forward end of each hood.

Two Caterpillar engine-mounted radiators are used, the capacity of the combined cooling systems being 70 gal. Standard belt-driven engine-mounted fans provide the air for the radiators. Two overflow pipes for each radiator extend from each side to the top of the radiator and have cones at the bottom to take a ¾-in. hose for filling. Radiator shutters are operated manually from the cab.

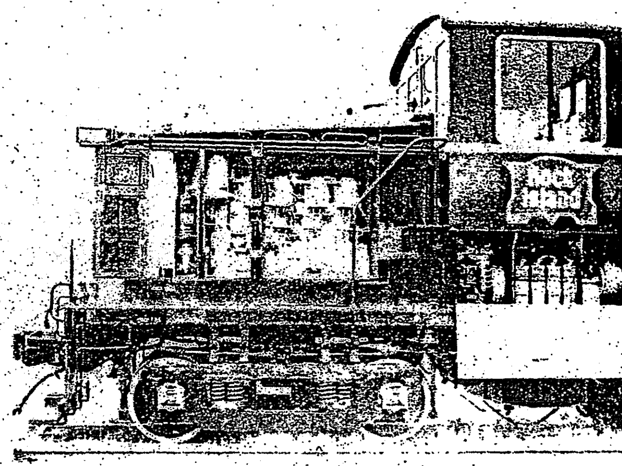
Two kerosene heaters are installed to prevent freezing of the cooling systems, and, also, to keep the engines warm for easy starting; a heater is located back of each radiator. The storage tank is large enough to hold sufficient kerosene for 24 hr. operation.

Principal Features of the Electrical Equipment

Two Westinghouse single-bearing type 184-A-4 electric generators with overhung exciters are installed. Excitation of the main generator fields is supplied by the exciter which in turn is excited from the battery. Engine loading is controlled by the Westinghouse differential system.

The generators are self-ventilated, with fans built in at the ends opposite the commutators. Armatures are carried on anti-friction bearings. Engine-starting windings are built into the generators. Class B insulation is used. The generators are arranged for direct coupling to the engine, with steel disc drives. Ammeter shunts for testing are installed at each generator. A 3-kw. auxiliary generator, belt-driven, is used for battery charging at all speeds.

Four Westinghouse Type 908-G-2 series-wound traction motors, complete with 75 to 13 gearings and gear



Partial View of the Locomotive With Side Doors Open for Inspection of the Engine, Batteries, Etc.

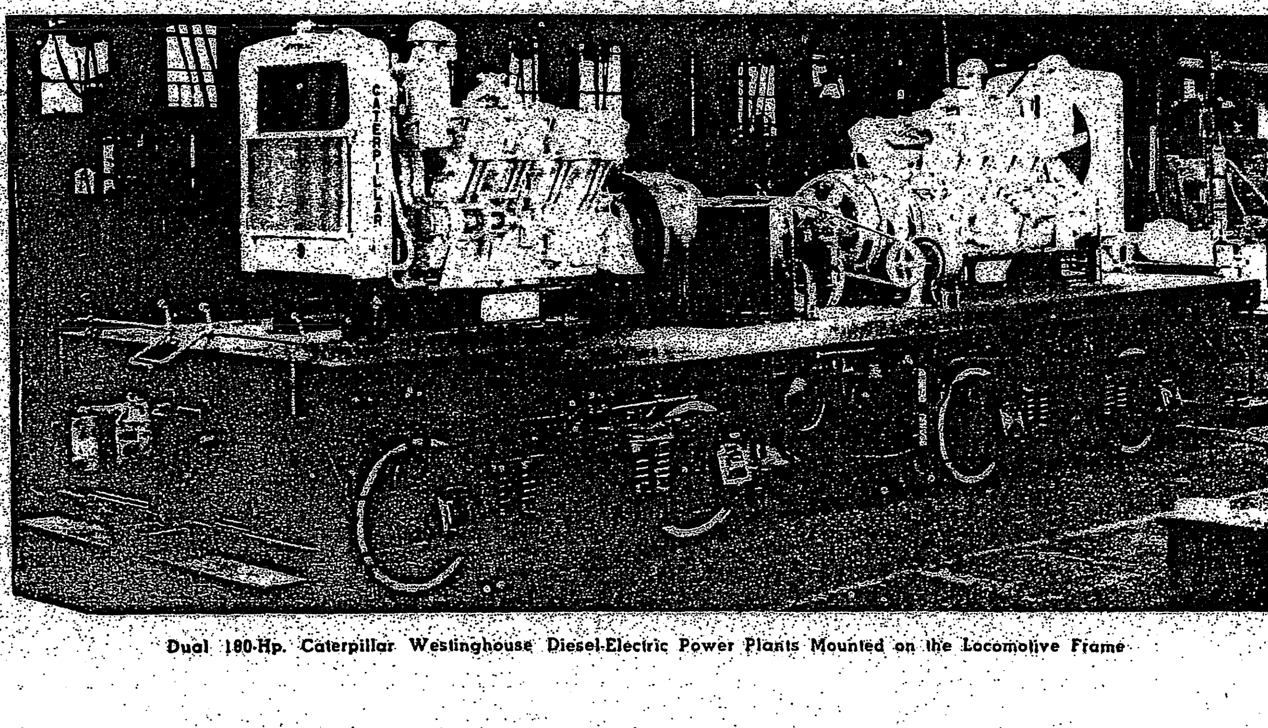
cases, are mounted on the trucks. Armature bearings are anti-friction and each motor is carried directly on the axles by bronze axle bearings, and on the trucks by spring nose suspension to the truck bolsters. Glass Weve insulation and high-temperature solder are used throughout. The minimum clearance with new wheels is 3⅜ in.

The single control station has remote magnetic control, with series-parallel and shunt motor combination forward and reverse. Transition from series to shunt and parallel is automatic. Speed is controlled by the manually operated engine throttle.

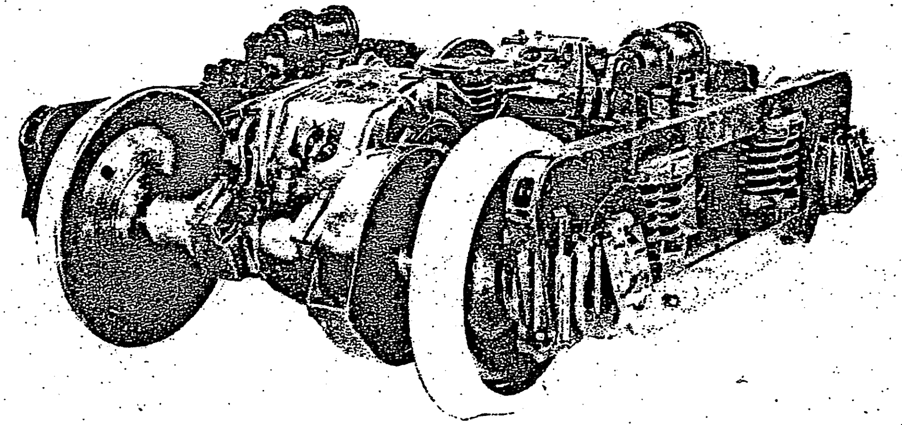
Two Sirocco fan blowers, one belt-driven by each engine, are supplied for motor blowing. These are connected by ducts to the center sills with arrangement such that the air blows through the center plates and truck bolsters and thence by flexible connection to the motors.

An Exide storage battery, of the 64-volt, 13-plate, 215-amp.-hr. type, is located under the cab deck, so as to be readily accessible for servicing and inspection through side drop cab doors.

Westinghouse straight and automatic air brakes,



Dual 180-Hp. Caterpillar Westinghouse Diesel-Electric Power Plants Mounted on the Locomotive Frame



One of the Commonwealth Cast-Steel Trucks Equipped with Westinghouse Electric Drive to Each Pair of Wheels

schedule EL-14, having not less than 30,000 cu. in. reservoir capacity are installed. The two compressors are of the two-stage Gardner-Denver air-cooled type with 50 cu. ft. per min. displacement, each. A mechanical unloader is used.

The foundation brakes are of the fully equalized type with two cylinders per truck, giving equal brake-shoe pressure on each wheel and designed for a 60 per cent braking ratio. The spreaders between brake hangers are easy to adjust. The hand brake is arranged so that the brakes are applied on one truck only.

The roomy steel cab is designed for exceptionally clear vision. Two doors, one at the right back and the one at left front, have stationary sash, and latches are available to hold the doors open. Sliding steel sash are used at side windows, the front and rear windows being fixed. All glass is shatter-proof. Special equipment for the engineman's comfort and convenience includes sun visors, hinged for easy adjustment, air-push window wipers and a hot-water cab heater and personal tool box. Two metal-bound, fibre-back mirrors, 14 in. wide by 38 in. high, are mounted on the left side of the cab and adjusted in angular position so that the engineman has a clear view up and down the track to take signals from the switchman when his view would otherwise be obscured by cars being moved. The switchman can, in turn, see the engineman through the mirrors and know that his signals are being received.

The cab is well insulated with ¼-in. Masonite and ½ in. of hairfelt. Hard-maple decking ⅞-in. thick is used. Hatches give access to all parts under the cab floor for inspection and service. Suitable hoods cover the engines and generators front and back of the main cab, and swing doors give convenient access to these parts for inspection and servicing. The doors are mounted on loose pins for easy removal. Baffles shield the generators from engine heat and are also installed between the fans and engines to protect the engines from dirt. All hood doors are locked from inside the cab and when the cab doors are locked, the locomotive may be safely left over night at outlying points without danger of tampering.

Front and back headlights, streamlined into the top radiator guard, are installed, being arranged so that either can be turned on or off, or dimmed. An instrument-board light, center dome light, a light for engine inspection under each hood, and a trouble light are installed. Marker-light brackets and Pyle-National outlets are applied.

The fuel tank, of 300-gal. capacity, is rectangular in section with suitable baffles installed and reflex-type gages to indicate the fuel level. All fuel, oil and cooling-water lines are copper tubing with sweated fittings.

The blowers are belted by V-belts to an extension shaft and pulley at the back end of each main generator. On the side opposite the blower, the compressors are driven from this extension by means of multiple V-belts, with the compressor sheave-mounted closer to the generators so the maximum load will be closest to the shaft bearing. Auxiliary drives are so arranged that each end is entirely independent of the other, and the locomotive may be operated with one engine and one generator and still have all necessary auxiliaries in operation. The No. 1 engine-generator set furnishes energy for Nos. 1 and 3 traction motors and the No. 2 set supplies the Nos. 2 and 4 traction motors.

The sandbox is built into the underframe of the locomotive and so arranged that the sand is fully protected against the entrance of moisture. Graham-White sanders are installed with a King duplex sander valve.

Engine lubrication is force-feed. Lubrication of the electrical equipment is in accordance with standard Westinghouse practice. Where grease lubrication is used, standard Alemite fittings are applied.

A single-tone Model 66-B Buell horn is supplied. The bell, of Davenport-type with Transportation Devices internal rapid ringer, is installed under the main frame between the floor, footboards and truck.

The instrument board has one lubricating-oil pressure gage, one electric tachometer and one temperature gage for each engine, one ammeter to show battery charge, and two duplex air-brake gages as standard with EL-14 equipment.

The engine throttle lever, air-brake valves, sander valve, bell-ringer valve, etc., are all installed in accordance with the cab arrangement specified by the railroad.

* * *

Photo By P. P. Stewart

A New Class GS Locomotive for Mixed Service Recently Installed by the South African Railways & Harbors Administration on its 3 ft. 6 in.-Gage System

APPENDIX 'I'

CERTAIN ECONOMIC FACTORS
RELATING TO THE
LOCATION, CONSTRUCTION AND FUTURE USEFULNESS
OF THE
TRANS CANADA ALASKA RAILROAD

Material Prepared by National Resources Planning Board
Portland, Oregon October 2, 1942

The decision as to whether to construct a railroad to Alaska from existing continental rail systems, now terminating in Western Canada, will be made entirely on the basis of military necessity. The economic justification for such a line has not, it is understood, been even a secondary consideration in the location survey. Its effect upon development of the surrounding country and the degree of its usefulness in the post-war period have been considered outside the scope of the investigation made by the Corps of Engineers.

As it happens, however, the location under consideration is a good economic route. This brief statement of certain economic factors relating to the proposed railroad is made at the request of the Division Engineer, North Pacific Division, Corps of Engineers. The statement consists of two parts. The first, which follows, is a factual treatment of specific subjects about which the District Engineer requested information and the second is a general discussion of the long-term economic usefulness of the proposed railroad.

SELECTED TOPICS CONCERNING RESOURCES AND TRANSPORTATION IN THE TRANS CANADA ALASKA RAILROAD AREA

I. Towns and Settlements Along the Route

The area traversed by the proposed railroad is one of the least settled portions of North America. The population of British Columbia, while considerable, is heavily concentrated in the southern one-third of the province. The sparsely populated northern two-thirds, through which the railroad would pass, contained in 1931 only 47,245 persons, a population density of 1.9 per square mile. The Yukon Territory in 1931 had a population density of .02 persons per square mile, and Alaska in 1939 had .12 persons per square mile. The census divisions along the rail route in British Columbia, from south to north are: (1) the Nechako-Fraser-Parsnip, which preliminary data from the 1941 census shows to have 4,955 whites, 137 Indians, total 5,092; (2) the Stikine-Liard with 330 whites, 393 Indians, total 723; and (3) the Finlay-Parsnip with 63 whites, 162 Indians, total 225. Data by census divisions are not available for the Yukon Territory. The entire Territory in 1931 had a population of 4,230. Alaska recording districts along the immediate route are the Fairbanks with 5,692 persons and the Nenana with 628 persons.

1. On the Main Route

The incorporated town of Prince George which had a population of 1,989 in 1941, is a division point and repair center for the Canadian National through route from the east and south to Prince Rupert.

In addition it is a distributing center for a large tributary area in which the principal pursuits are farming, lumbering, fur trading and a limited amount of mining. Prince George is a developed modern community with publicly-owned water and power utilities.

For 32 miles along the highway leading north from Prince George are scattered a number of small farms. At Salmon Valley on this road there is a post office and a cluster of houses. Summit Lake, a settlement consisting of a store and a few warehouses, is at the head of navigation for small boats which ply down the Crooked River to the Parsnip River. McLeod Lake, the oldest Hudson's Bay Company trading post on the Pacific slope, has a few stores and is a center for miner trapping activities. Scattered trapping activity and a few small placer mines at the mouth of the Nation River are the only signs of activity between McLeod Lake and the confluence of the Parsnip and Finlay Rivers. Finlay Forks, with an estimated population of 36 whites, is a headquarters for police, game warden and wireless communication. Fort Grahame, with a population of several whites and approximately 100 Indians, is a Hudson's Bay Company post. Ware (also called Whitewater), at the head of navigation on the Finlay, is a Hudson's Bay Company post with an average population of 150 Indians.

From the headwaters of the Kechika all the way to Lower Post on the Liard there is no settlement at present. Chee House is an abandoned settlement on the mouth of the Turnagain River. Lower Post (also called Liard Post), with its Hudson's Bay Company post and independent stores, provides a trading center for the widely scattered Indian population of the area. Watson Lake, 26 miles northwest of Lower Post, is a place of recent and increasing importance as an airport on the Yukon Southern Transport route. Ross River and Little Salmon are stopping places along the trail with no permanent settlement. Carmacks, located where the overland road from Whitehorse to Dawson meets river transportation on the Upper Yukon, is a small settlement which consists of a post office, Royal Canadian Mounted Police post, and several trading establishments. Yukon Crossing, just below Five Finger Rapids, and Minto, are small stopping off places on the overland and river routes to Dawson. Selkirk (Pelly Post Office) at the confluence of the Pelly and the Lewes Rivers, is a trading post and Indian village, with roadhouse and police headquarters. Selwyn, Kirkman Creek and Thistle Creek provide shelter cabins and little else. Tanana Crossing (also called Tanacross) has a population of 16 whites and 127 Indians. It is the site of one of the major airports on the route from the United States to Alaska, and is the point from which shuttle plane service to Anchorage will probably leave the main Pan American Airways route between Whitehorse and Fairbanks. No settlements except small mining camps exist on the remainder of the railway route before it reaches the Alaska Railroad at Kobe. Kobe (sometimes spelled Kobi) is at present no more than a stopping point and maintenance station on the Alaska Railroad.

2. In the Tributary Area

At a considerable distance from the railway line but on one of the few routes of approach to it are situated the communities of Telegraph Creek and McDame Creek. At the head of navigation on the Stikine River lies Telegraph Creek on the old telegraph trail, with its warehouses and trading facilities. Trans-shipment from river boats to trucks for a 75-mile road haul to the head of Dease Lake takes place here. McDame Creek on the Dease River, with its Hudson's Bay Post, is a trading and trapping center for a large area of north-central British Columbia.

Another route of approach to the railroad is the highway network stretching from Whitehorse to Dawson. Whitehorse (1941 population 541) is the head of shipping on the Yukon River and the northern terminus of the White Pass & Yukon Route railroad. It is also an important stop on the main American and Canadian airways into the Yukon Territory and Alaska. Whitehorse supports a considerable number of servicing establishments, a limited local agriculture, and asubstantial town life. In addition to these normal activities it is now the headquarters for construction of the northern portion of the Alaska-Canada highway. Dawson (1941 population 819), capital of Yukon Territory, is an important transportation and servicing point for a large tributary area in which the principal pursuit is gold mining.

The rail line is crossed midway between Tanana Crossing and Kobe by the Richardson Highway, the nearest settled point on which is Big Delta (also known as McCarty or Grundler) situated on the Tanana River. This trading post is an important supply point for the Upper Tanana. Population is 19 whites.

Fairbanks (population 3,800), is the northern terminus of the Richardson Highway, Alaska Railroad and United States-to-Alaska airline. Fairbanks is the center of the Tanana Valley agricultural district, site of the University of Alaska and a famous mining camp. Gold mining is the chief industry of the area. Nenana (population 250 whites, 75 Indians) is a trans-shipment point for rail and river navigation serving the entire Tanana and Yukon systems.

3. Future Possibilities

After completion of the Alaska-Canada Highway and proposed Trans Canada Alaska railroad, various strategic intersection points may be expected to develop as important communities. These are: (1) Finlay Forks, or some other point, at which a rail line from the Northern Alberta Railways in the Peace River valley might some day meet the Trans Canada Alaska route; (2) Lower Post where the railroad and highway first cross; (3) Watson Lake, the site of the major airfield on the inland airway to Alaska; (4) the settlement of Ross River in the Yukon Territory where the oil pipe line from the Fort Norman oil field to Whitehorse will cross the railroad route; (5) Yukon Crossing, where the railroad crosses navigation on the Upper Yukon as well as the road from Whitehorse to Dawson; (6) a point east of Tanana Crossing where the highway and railroad again cross; (7) a point on the Richardson Highway south of Big Delta where that highway is crossed by the railroad; and (8) Kobe. The size of these communities will be determined by the needs for maintaining and operating these new transportation routes as well as by the extent of resource development following the opening of the railway and highway.

II Possible Future Rail Connections

1. Peace River Outlet

Several routes for connecting the Peace River Valley with the proposed railroad have been visualized. That via Pine Pass leaves the present Peace River railhead of the Northern Alberta Railway at Dawson Creek and proceeds along the route on which a highway now exists to the Pine River near East Pine, and thence up the Pine River, over Pine Pass (elevation 2,350 feet), down the Misinchinka River to the Parsnip River, which it would cross, and continue to a meeting with the Trans Canada Alaska Railroad near McLeod Lake.

Another alternate route would leave the Northern Alberta line near Tupper Creek on Swan Lake and procsed generally southwest through Monkman Pass (elevation about 3,000 feet) to the valley of the McGregor River and thence to Prince George.

A third route, using another branch of the Northern Alberta Railway, would leave the railhead at Hines Creek and proceed to Hudson Hope keeping well north of the Peace River on more favorable terrain. From Hudson Hope it would follow an existing road to the Peace River above the canyon, thence through the pass of the Peace River to a junction with the Trans Canada Alaska at Finlay Forks. A line by this route would tap a large area of farm land north of the Peace River which now has no rail outlet. The highest elevation would be about 2,350 feet.

A direct connection between the Peace River Valley and the Canadian National System at Prince George, possibly making use of the Trans Canada Alaska Railroad over a portion of the route, would provide Peace River valley with its long-sought-for outlet to the Pacific.

2. White Pass and Yukon Route Connection

The narrow-gauge White Pass and Yukon Route now runs for 111 miles from tidewater at Skagway, Alaska, to Whitehorse. A connection between Whitehorse and some point on the Trans Canada Alaska Railroad, possibly at Yukon Crossing, would give the line served by the Trans Canada Alaska an outlet to the Inside Passage which provides a protected sealane to Vancouver and Seattle. This connection would entail about 150 miles of new construction and widening of the White Pass line to standard gauge.

3. Pacific Great Eastern Railway Connection

Several methods have been suggested for effecting a rail connection between Prince George and Vancouver, thereby giving the Pacific Coast amore direct connection with the proposed Alaska line. One possibility is to link Prince George with Quesnel, at present the northern extremity of the Pacific Great Eastern Railway, and to make the connection between Clinton on the Pacific Great Eastern and Ashcroft (or some point slightly to the east of Ashcroft) on the Canadian Pacific Line which extends on to Vancouver. This Clinton-Ashcfoft cut-off would eliminate the heaviest grades on the Pacific Great Eastern which are between Clinton and the tidewater extremity of the line at Squamish.

III Navigable Waterways

1. Approaches to the Rail Route

Navigable waterways by means of which materials can be shipped into the proposed railroad route are few in number.

Stikine-Dease Route: At present use is being made of a combination water and land approach to the trench route at Lower Post. River boats ply from the Alaska coast as far as Telegraph Creek on the Stikine River. Thence supplies are carried overland by truck road to Dease Lake, and finally transferred into flat boats for the haul down Dease Lake and Dease River to Lower Post. Improvements in a truck road between Lower Post and a point on Dease River at the head of the rapids (a distance of about 12 miles) would facilitate shipment by this route.

Yukon Route: For approximately 225 miles between Little Salmon and the mouth of the Ladue River, the route of the proposed railroad parallels the Yukon River and its navigable tributaries. There are a number of approaches to the Yukon River which may be made use of in shipping into the proposed railroad route. These are: (1) by way of the Alaska Railroad to Nenana, thence via the Tanana and Yukon Rivers to points on the Upper Yukon touched by the railroad; (2) by the Richardson and the Steese Highways or the Alaska Railroad and the Steese Highway to Circle and thence up the Yukon; (3) by the White Pass and Yukon route to Whitehorse, thence by river boat down the Yukon or by overland road to various construction points, and (4) by the Tanana River which is navigable above Fairbanks for 250 miles to the vicinity of Tanana Crossing. Access to this last mentioned route can be had at Big Delta on the Richardson Highway.

2. Along the Rail Route.

The rivers flowing in the trench are navig ble for considerable distances.

Parsnip-Finlay System: Flat boats up to 45 feet in length, carrying up to four tons and powered with outboard motors of 16 to 24 H.P., can navigate from Summit Lake (32 miles north of Prince George) for 300 miles to Ware, making use of the Crooked, Pack, Parsnip, and Finlay Rivers. The only difficult point in navigation is found at Deserters Canyon, about 30 miles north of Fort Grahame. The Fox River is navigable with difficulty for small boats north of Ware for a few miles.

Liard System: From Braid Creek (20 Miles north of Sifton Pass) on the Kechika River, small boats can navigate to the junction of the

Kechika with the Liard. The Liard cannot be navigated safely from the Kechika to Lower Post without portages. For 30 miles the railroad follows the shore of Frances Lake, on which supplies could be moved.

Yukon System: The railroad route parallels several navigable portions of the Upper Yukon System; (1) the Pelly River, in the neighborhood of Rose River; (2) Little Salmon Lake; (3) the Lewes River from Little Salmon to Selkirk, and (4) the Yukon and White Rivers from Selkirk to the mouth of the Ladue River.

IV. Roads and Trails

The road pattern of British Columbia, Yukon Territory, and Alaska has been revolutionized within the past few months by construction of the initial grade of the Alaska-Canada Highway from Dawson Creek, B.C., by way of Fort St. John, Fort Nelson, Watson Lake and Whitehorse to a point on the Richardson Highway south of Fairbanks. At two points this new road crosses the proposed rail route: (1) at Lower Post, B. C., and (2) at a point a few miles east of Tanana Crossing, Alaska. The extension of the highway will facilitate greatly construction of the railroad by permitting movement of equipment and supplies to these two points. In addition to its primary purpose of servicing the airports between Dawson Creek and its terminus in Alaska, the Alaska-Canada Highway also links together the three main road systems that existed in the area prior to the Alaska-Canada Highway construction.

These are:

Prince George System: Prince George is connected to the south with Vancouver, B.C., and the continental road system of Canada and the

United States; to the west with Hazelton and, upon completion of a section now under construction, with Prince Rupert; to the east with a point about 50 miles from Prince George along the Fraser River; to the north by way of Vanderhoof and Fort James with Germansen on the Omineca River. A local road north from Prince George parallels the rail route as far as Summit Lake.

Whitehorse-Dawson System: The Whitehorse-Dawson system consists of two series of roads, one radiating out from Whitehorse and the other from Dawson, linked together by a north-south road which crosses the railroad and the Lewes River at Yukon Crossing. In addition to being on the Alaska-Canada Highway, Whitehorse has a road connection with Carcross on the south. From Dawson there is a network of roads connecting the major gold fields of Fortymile, Sixtymile, Bonanza, Klondike, Keno Hill and Mayo.

Richardson Highway System: The Richardson Highway system, which the Alaska-Canada Highway will meet at some point on the Gulkana-Nabesna Road, connects Fairbanks with Valdez on the coast and has branches leading to Anchorage and the Matanuska Valley, Chitina, Nabesna, Circle and Livengood.

Possible Highway Connections

A number of new road connections which probably would be made with the advent of the railroad can easily be visualized. One of these would be a connection between the existing Vanderhoof-Germansen road and the railroad at Finlay Forks. Another would connect Finlay Forks with the Peace River road system which now extends slightly west of Hudson Hope. Roads connecting the rail route with the Alaska coast might be built: (1) on the Dease-Stikine route making use of the truck road which already exists between Telegraph Creek and Dease Lake; (2) on the Yukon Crossing-Whitehorse-Skagway route which already has a road from Yukon Crossing to Carcross; and (3) by connecting the Alaska-Canada Highway with Haines by a new road taking off from either Kluane Lake or Champaigne.

In order to fill in the transportation pattern of the area and facilitate the further exploitation of minerals, a trunk highway will ultimately be constructed from Hazelton or Vanderhoof, B.C., by way of the upper Skeena and Nass Rivers, crossing the Stikine above Telegraph Creek, and extending to Atlin and Whitehorse. This is the Route "A" recommended by the Alaska International Highway Commission in its report of April 1940.

Most of the area through which the railroad line would be constructed has been served for many years by a fairly extensive but poorly developed network of trails used primarily by trappers and prospectors.

V. Airports and Sites

Two major commercial airlines, one American and one Canadian, serve the railroad area with scheduled daily flights. Pan American Airways flies from Seattle via Prince George, Juneau and Whitehorse to Fairbanks. Branches of this main trunk reach Bethel and Nome. Pan American uses other enroute fields at Tanana Crossing and Burwash Landing. Yukon Southern Air Transport Ltd. flies a daily schedule from Vancouver via Williams Lake, Prince George, Fort St. John, Fort Nelson and Watson Lake, to Whitehorse and Dawson. Coming into this airway at Fort St. John, via Grande Prairie, is another regular Yukon Southern route from Edmonton. This route parallels very closely the Alaska-Canada Highway. Pan American Airways connects with the airways system of the United States. Yukon Southern connects at Vancouver and Edmonton with Trans Canada Airlines which spans the Dominion.

Regular service in the railroad trench itself is provided by Yukon Southern's branch line from Prince George to Fort McLeod, Finlay Forks, Fort Grahame and Fort Ware.

For several years the Civil Aeronautics Administration has been developing an airways system in Alaska, locating fields, weather observation stations and other aids to air navigation along the several main airways, chief of which is that flown by Pan American over the route described. Other major landing fields are being established for strictly military purposes in both Canada and Alaska.

Numerous small operators in Alaska fly from Fairbanks and Anchorage to all parts of Alaska, using wheel, ski or pontoon planes depending upon flight conditions and the season.

In addition to these commercial operations, Canada-Alaska airways are being flown increasingly by military planes. This heavy movement led, in fact, to the decision to build the Alaska-Canada Highway along the Fort St.John-Fort Nelson-Watson Lake-Whitehorse route as an airways service road.

Possibilities for future aviation development in the North Pacific area are particularly bright, since the wings which planes give to travel are nowhere more useful than in areas where rugged terrain and vast distances make ground travel difficult. As mineral areas remote from the rail and highway routes are prospected and opened for development the cargo plane may become increasingly important in more inaccessible areas in carrying men and supplies to the mine and ore concentrates out. Greater passenger travel and commercial shipments which may be expected after the war will insure that the airfields now being built are used to good purpose.

VI Tie and Trestle Timber

Fortunately considerable amounts of timber suitable for railroad ties can be found along the projected route of the railroad. For the first 50 miles north of Prince George the rail route passes through a forest region in which the principal tree species are Douglas fir (mountain type) and lodgepole pine, with scatterings of Englemann spruce and alpine fir. Stretching north along the Parsnip and Finlay Rivers the forest grades into a general sub-Alpine type in which Englemann spruce, balsam fir and lodgepole pine are the predominating merchantable species. Beyond Sifton Pass in the valleys of the Kechika and Frances Rivers the same types are found, though somewhat more thinly distributed. In the parts of the Yukon Territory and Alaska through which the railroad would run, thin stands of timber, predominately black spruce, tamarack, Alaska white birch and white spruce, grow along the river valleys and in the wet lowlands.

In the Fort George Forest District, which includes the Peace River drainage in British Columbia, as well as the region about Prince George, 900,000 MBM could be cut on a sustained yield basis. The average annual drain on these forests by logging and fire is only 135,000 MBM at present.1/

Along the British Columbia, and to some extent the Yukon, sections of the line, lodgepole pine (also called jack pine) is considered to be the best tie timber. Mature trees attain a size from 50 to 120 feet in height and from 12 to 24 inches in diameter. Lodgepole pine makes a strong tie, holds a spike well, and untreated will resist decay about as well as any species found along the route. Untreated lodgepole pine has frequently served satisfactorily for 8 to 10 years on lines in Canada.

The principal species in the more immediate railroad area in British Columbia are given in the following table:

1/ Mulholland, F.D., THE FOREST RESOURCES OF BRITISH COLUMBIA, Department of Lands, B.C., Forest Service, 1937, p. 108.

MERCHANTABLE TIMBER (IN MILLION BOARD FEET)[1]

River Drainages	Merchantable Acres	Species: Fir	Spruce	Balsam	Lodgepole Pine	Total
Parsnip	633	108	3,079	990	429	4,606
Omineca	42	-	95	70	43	208
Finlay	177	-	831	192	66	1,089
Dease, Kechika	29	-	58	15	72	145
TOTAL	881	108	4,063	1,267	610	6,048

1/ Source: Forest Surveys Division, Department of Lands, British Columbia, May 2, 1938. In addition to these estimates, there is reported to be 144 million board feet of black cottonwood on the Parsnip and Finlay River drainages. The estimate for this species, which occurs along the main water courses, should be considered low. Estimates for the Dease-Kechika drainage basin are taken from Commission of Conservation Report, dated 1917.

Along the northern portion of the route in the Yukon and Tanana drainages the most suitable tie timber seems to be Alaska white birch. It is strong, hard and of sufficient size, but has the drawbacks of being slow-growing, consequently heavy, and of being susceptible to quick decay.1/ Both Alaska white birch and lodgepole pine untreated will last four or five years under good roadbed conditions.

Of all the untreated woods used for ties on the Alaska Railroad, hewn mountain hemlock has proved most serviceable.2/ If it is not required that the ties be cut along the line, Douglas fir (coast) ties could be hauled from the fir forests of southeastern British Columbia, or hemlock (mountain or western) could be obtained from southeastern and south-central Alaska.

Assuming 3,250 ties to the mile, a 1,500 mile line would require five million ties, which at 35 board feet per tie, in the equivalent of 175,000 MBM. During a prosperous year, in the neighborhood of 800,000 ties are cut in the Fort George Forest District for replacements on existing railroads. Indications are that the proposed railroad can be supplied with sufficient cross ties, bridge ties, and posts from sources near the route, except possibly for the northern portions to which ties may have to be hauled by way of the Alaska Railroad, the Richardson Highway and the Skagway-Whitehorse-Yukon Crossing rail and road route.

1/ See unpublished manuscript TIE SUPPLY FOR THE ALASKA RAILROAD By R.R. Robinson, U.S. Forest Service, Alaska.
2/ Ibid. A composite rating taking into account various properties which make for good tie timber lists mountain hemlock-118.8; Alaska white birch 108.1; Douglas fir (coast) 100.0; Sitka Spruce (Ketchikan) 89.7; Douglas fir (mountain) 66.8; western hemlock 83.6; white spruce 81.8; Englemann spruce 63.1.

Since there are no facilities for treating ties in the area and since all possible speed would be necessary in pushing the line through, untreated ties would have to suffice for several years until more permanent ones could be laid. The ties could be hewn by hand by tie cutters operating ahead of construction or could be sawn at small portable saw mills which are moved along with construction.

For the erection of major bridges, Douglas fir timber hauled in to the bridge sites from the coast would probably prove more satisfactory than attempting to utilize inferior, smaller-dimension local lumber. Both the Canadian National Railway and the Department of Public Works of British Columbia ship in coast fir for bridge construction in the interior. For trestle work, culverts, piling, buildings, sheds and maintenance facilities, more of the locally cut lumber could be used. Of the various species found along the railroad route in British Columbia, white spruce and Englemann spruce make the best building lumber. In interior Alaska, white spruce and Alaska white birch of the local woods are most commonly used for building.

VII. Coal and Oil

1. Coal

In the area tributary to the proposed railroad there are quite a number of coal measures which could be made to yield commercial quantities of coal, but very few developed mines.

The deposits which are being or have been worked are located in the vicinity of:

1. Telkwa, about 225 miles west of Prince George near the Canadian National Railroad. Two collieries employing 20 men produced 6,405 tons of bituminous coal during 1941.[1] Coal from this region is supplied to the Canadian National Railways.

2. The Hudson Hope-Pine River area about 80 miles via the Pine Pass route from the proposed line of the Trans Canada Alaska Railroad. The Gethering Mine and the Packwood Mine have in the past produced small amounts of high grade bituminous and semi-anthracite and show promise of containing fairly good reserves. In this general area the Grant seam outcroppings, which occur in the Peace River Canyon, have in recent years produced about 1,000 tons of high quality coal, very little of which could be shipped out because of transportation difficulties. At Hosler Creek, about 104 miles from Dawson Creek in a westerly direction, a small mine operated during the winter of 1940 to produce coal for work on the government oil well at Commotion Creek. No doubt this general area could be made to produce much larger amounts of coal should the demand arise. A certain amount of the coal in this region could be strip-mined.[2]

3. Tantalus Butte across the Lewes River from Carmacks in the Yukon Territory. In 1907 the Five Fingers Coal Company produced 7,233 tons of coal for use by the White Pass and Yukon Route. Because

1/ Annual Report of the Minister of Mines, B.C. for 1941, p.96
For technical data on quality of B.C. coals. See Dickson, James ANALYSIS OF BRITISH COLUMBIA COALS, Bulletin No. 14, B.C. Dept. of Mines, 1941.

2/ See unpublished report by E.R. Hughes, Inspector of Mines, B.C., August 29, 1942.

this coal was too soft and dirty , the railroad and Yukon steamships soon turned to other sources for fuel.1/

4. The Nenana and Healy Rivers in the northern foothills of the Alaska Range near the Alaska Railroad line. Coal in this field is high grade lignite to bituminous and occurs in many beds of thicknesses ranging up to 45 feet. Most of the estimated 9 billion tons of reserves are too low in heating value and too fragile to stand shipment outside Alaska and still meet the competition of other better grades. However, this coal is used by the Alaska Railroad and no doubt could be made to serve the northern divisions of the Trans Canada Alaska line. Existing mines are able to produce 300 tons or more a day.2/

5. Coal from a number of other fields situated farther from the proposed rail line might be utilized. TheMcLeod River-Cadomin area in Alberta as well as many other more remote Alberta fields, the rich mines in southern British Columbia (such as in the East Kootenay District), and the Matanuska coal fields in south-central Alaska are among the possibilities.

Areas in which coal is known to occur but which remain undeveloped include:

1. The Groundhog field in the upper valley of the Nass River. This field is separated from the trench route by the Omineca Mountains and is not served by any developed road or waterway.

1/ Innis, Harold A., SETTLEMENT AND THE MINING FRONTIER, CANADIAN FRONTIERS OF SETTLEMENT, Vol. IX., p. 262

2/ See: Capps, Stephen R. GEOLOGY AND MINERAL RESOURCES OF THE REGION TRAVERSED BY THE ALASKA RAILROAD, U.S.G.S, Bull. 755-C, 1924

2. Along the Liard River at various points, especially near Lower Post and near the junction of the Fort Nelson River and the Liard on Dunedin Creek. These occurrences are thought to be low grade bituminous. Only the deposits near Lower Post would be easily available to the Trans Canada AlaskaRailroad.

3. Along the whole northern flank of the Alaska Range from Muldrow Glacier on the west to the international boundary on the east.

2. Oil

The geological structure underlying the eastern slope of the Rocky Mountains in both British Columbia and District of Mackenzie is known to be favorable for the occurrence of oil. In the Peace River area oil has been located or is thought to exist near Hudson Hope, near Pouce Coupe in Alberta, and at Commotion Creek 85 miles west of Dawson Creek on the Pine River. where the British Columbia government has recently drilled a test well. Several other promising structures are known in this area. Northwest to the Liard River and southeast toward the Wapiti River numerous foothill structures are as yet neither mapped nor prospected, although they would undoubtedly make good prospecting.1/ Lack of sufficient underground pressure to force the oil to the surface may diminish the usefulness of these fields.2/

Far to the north the oil field in the vicinity of Fort Norman on the Mackenzie River is being expanded by the drilling of additional

1/ See Williams M.Y., OIL IN NORTH-EASTERN BRITISH COLUMBIA, in "The Miner", Vancouver, B.C., August 1942, p. 30,31.

2/ For a treatment of the economic and other aspects of the oil industry in British Columbia, see: COAL AND PETROLEUM PRODUCTS COMMISSION(B.C.) REPORT, Vol. 1, on the Petroleum Industry, 1936 wells. As soon as the pipe line now under construction from this field over the mountains to Whitehorse is completed, it is anticipated that 4,000 barrels of oil or gasoline can be delivered through the pipe each day. Refining equipment capable of producing high octane aviation gasoline is being installed at both Fort Norman and Whitehorse. The pipe line will intersect the Trans Canada Alaska route at Ross River. The extent of the Norman field is not known.

In northern Alaska the U. S. Naval Oil Reserve in the Brooks Range may contain extensive oil pools which can be tapped in the future. At present almost nothing is known about the petroleum in this area. It is not linked with the transportation network of interior Alaska.

VIII <u>Water Power and Supply</u>

1. <u>Water Power</u>

Although the North-Pacific part of the continent contains an exceedingly great potential of hydroelectric power,[1] the amount

[1] It is estimated that the hydroelectric power developed on the Columbia River in British Columbia alone, for instance, could be expanded from 250,000 H.P. produced in 1938 to 1,000,000 H.P. The coastal streams in B.C., the most significant of which are the Cheakamus, Dean, Skeena and Nass could yield a further 1,000,000 H.P. over the 100,000 H.P. produced in 1938. The waters of the Fraser River are capable of producing 6,000,000 H.P. when fully developed. (See: WATER POWER-BRITISH COLUMBIA, Department of Lands, B.C., 1931; and WATER POWERS-FRASER RIVER, Department of Lands, B.C. 1938). The short streams of Southeast Alaska, if the demand should arise, could be developed to produce 800,000 H.P. much of which can be concentrated at industrial locations by means of transmission lines. (See: Report to the Federal Power Commission on the Water Powers of Southeastern Alaska, J.C. Dort, 1924; and POST WAR ECONOMIC DEVELOPEMENT OF ALASKA, Alaska Regional Planning Office, National Resources Planning Board, 1942).

which might be developed close to the proposed railroad route is limited.

Scientific information about the possible locations is scarce. The following table summarizes the information that is available.

WATER POWER STATISTICS, 1939

	British Columbia	Yukon & Northwest Territories	British Columbia & Yukon
Available 24-Hour Power at 80% efficiency1/			
At ordinary minimum flow (H.P.)	1,931,000	294,000	
At ordinary six-month flow (H.P.)	5,103,500	731,000	
Turbine installation (H.P.)	788,763	18,199	
In central electric stations (H.P.)	629,286	2,000	
In pulp and paper mills (H.P.)	105,950	nil	
In other industries (H.P.)	53,527	16,199	
Electric Energy generated (Thous.KWH)	1,998,652		
By hydraulic stations (Thous.KWH)	1,989,576		
By fuel stations (Thous.KWH)	9,076		
Main plant equipment of central electric stations			
Water wheels and Turbines (no.)			80
Capacity (H.P.)			584,997
Average capacity (H.P.)			7,312
Dynamos (no.)			122
Capacity (KVA)			483,602
Average capacity (KVA)			396

1/ Based upon rapids, falls and power sites of which the actual drop or the head possible of concentration has been measured, or at least carefully estimated. Many unrecorded rapids and falls exist, particularly in northern areas.

Source: Canada Year Book, 1941, p. 274-281

On the Fraser between Prince George and Quesnel there is a head of 200 feet, most of which will be difficult to utilise. However, it has been estimated that 300,000 H.P. might be obtained. Above Prince George the Fraser does not lend itself easily to power development.1/

Reports of the Water Rights Branch of the British Columbia Department of Lands indicate that the Quesnel River can be developed to produce 100,000 H.P.; Soda Creek, 344,000 H.P.; Nechako River, 20,000 H.P.; and Willow River, 5,000 H.P.

On the Nation River which flows into the Parsnip River from the west about 40 miles south of Finlay Forks approximately 15,000 H.P. can be developed at each of four sites selected between Chuchi Lake and the mouth of the Nation.2/

The Peace River drops 223 feet in 18-1/4 miles as it flows through the canyon just above Hudson Hope. The most logical point for initial development would probably be near the head of the canyon where the river falls 25 feet in one mile. On the Finlay River the most likely place for hydroelectric development in about 4 miles below Thutade Lake where there is a fall of 50 to 60 feet with swift water both above and below the fall.

1/ WATER POWERS-FRASER RIVER, Dept. of Lands, B.C., 1938, p.8. However, the lakes at the headwaters of the Nechako River which joins the Fraser at Prince George, if diverted by tunnel west of the divide, can be made to produce prodigious amounts of power at tidewater points at exceedingly low cost. Whtsuk Lake, diverted to the head of Dean Channel would under a head of 2,160 feet develop 910,000 H.P., while Tahtsa Lake diverted to the head of Gardner Canal would develop 845,000 H.P. under a head of 2,560 feet.

2/ According to estimates in report on the NATION RIVER, Department of Lands, Water Rights Branch, 1938.

Twenty-four miles below the mouth of Dease River on the Liard River is the beginning of a long canyon which consists of a succession of whirlpools, rapids and narrow canyons and continues to where the river narrows at Hell Gate. Some hydroelectric possibilities no doubt exist here.

Coming from either side into the rivers that flow through the trench are quite a number of smaller streams many of which could be harnessed at low cost to produce limited amounts of power for local use should the demand arise. In general, in this region "the character of the main streams is fairly well known, though, where a canyon occurs, it is seldom possible to determine whether it would form a suitable damsite. The available heads have not been measured."1/

Up to the present time water power in the Yukon Territory has been developed almost exclusively in connection with gold mining, the higher summer run-off, and hence water power production, fortunately coinciding with the season of extensive mining. Among the undeveloped water power sites in the part of the Yukon Territory to be traversed by the proposed railroad is the one at Miles Canyon and Whitehorse Rapids on the Lewes River a few miles above Whitehorse where the river drops 30 feet and 22 feet, respectively. By one plan of development which involves creating storage on Marsh Lake by means of the power dam and by other storage dams on Atlin, Tagish and Bennett Lakes a continuous 24-hour supply of 1,800 H.P. could be secured.2/

1/ White, Arthur V., WATER POWERS OF BRITISH COLUMBIA, Ottawa, 1919, p.302. For further discussion of water power potentialities of the trench area see Ch.XIV.

2/ THE YUKON TERRITORY, 1926. Department of the Interior, Canada, p.61-62.

Although there is no specific information available, it can be stated that in all probability hydroelectric units could be installed at various points along the railroad route through the Yukon Territory at minor falls and rapids which occur on the upper Frances River, the upper Pelly River near Hoole River and at Five Finger Rapids on the Lewes River.

In Alaska along the route of the railroad there are no water power sites that have been examined. However, it is possible that limited amounts of power could be produced along the streams which flow from the Alaska range north to the Tanana River.

Throughout this north country, particularly in the Yukon Territory and Alaska, severe winter freezing, by diminishing the water flow, causes a marked reduction in power output during this season. In the past the heaviest demand for hydroelectric power has come during the warm months in which the placer mines are producing.

2. Water Supply

Almost no factual information is available on the amount and quality of either surface or ground water supply available for boiler use for steam locomotives. Apparently there are enough clear streams running into the rivers which flow along the proposed rail route to furnish adequate amounts of water uncontaminated by glacial silt, although on the westernmost sections of the line most of the streams may carry fairly heavy loads of silt from the glaciers in which they rise and from the disturbance caused by gold placers. What further treatment, if any, the available clear water would have to have to be made acceptable for use in steam boilers is not known.

IX. Industrial and Agricultural Developments

The area through which the projected railroad would pass is still largely wilderness. Industrial and agricultural development is slight.

In contrast to most frontier regions the initial development in northern British Columbia, Yukon Territory, and Alaska has not been agricultural. The early trails as well as the later railroads, highways, and airways were opened by prospectors in search of gold, trappers looking for valuable furs, and soldiers seeking to safeguard the security of the area.

The present limited industrial development consists chiefly of railroad maintenance and minor sawmill activity along the Canadian National Railway, in the vicinity of Prince George. In 1936 some 48 sawmills with a combined capacity of 568,000 F.B.M. were operating in the Fort George Forest District, although only two of the mills had a daily capacity of over 50,000 F.BM. Railroad ties, cedar poles, and lumber for local use are the principal timber products.1/

Nearly the whole area of the railroad is highly mineralized. Placer and lode gold, silver, copper, lead and zinc are among the minerals known to occur in many places. Coal, oil, limestone, and various other non-metallics have not been much developed although deposits are widely scattered.

Likewise, over most of the area trapping of fur-bearing animals is carried on. In 1939 the whole Province of British Columbia produced

1/ Mulholland, F. D. THE FOREST RESOURCES OF BRITISH COLUMBIA, p.107.

251,258 pelts (including marten, beaver, fox and mink) valued at $1,116,968; and the Yukon Territory produced 77,475 pelts valued at $267,721.1/

In connection with the transportation routes now being installed and being projected, considerable employment will be provided for maintenance and service workers. The new highways will have to be improved and reconditioned over portions of the routes every year. The airfields will need attention, winter and summer. As the railroad is converted to peace-time traffic and rehabilitated for more permanent use, tie replacement, grading improvements, and bridge repairs will occupy many men. Filling stations, hotels, eating establishments, and other service enterprises will be required at the settlements along the route. Transportation is bound to become a major industry in the region.

Except for the remarkable development of grain and mixed agriculture in the Peace River District of Alberta and British Columbia and the general farming development in the Prince George region, there is only scattered farming near the towns and settlements along the rail route. The farming areas which show most promise for local development are those along the road from Prince George to Summit Lake, the trench floor along the Finlay River from Finlay Forks to Fort Grahame, the vicinity of Lower Post and Watson Lake, sections along the upper Yukon River system, and the Tanana Valley along its whole length but particularly in the Fairbanks region. In these districts root vegetables, potatoes, cabbage, cauliflower,

1/ Canada Year Book, 1941, p. 214.

peas, beans, hay, hardy grains, and several varieties of berries can be grown successfully. The Dominion Agricultural Station at Fort Simpson and the Alaska Agricultural Experiment Station outside of Fairbanks have done research on types of crops and methods of cultivation most suited to these sub-arctic conditions. No important agriculture of the export type should be expected in the area, though agriculture on a subsistence basis should supply many of the food needs of a growing local population.

Both industry and agriculture have been held back because of a lack of adequate transportation and insufficient population. If the highway, rail, and air routes now being brought into existence lead to expansion of only immediately feasible industrial, mining, and agricultural enterprises, then the under-development and under-population which has so long characterized the area will have been broken through.

A pulp and paper industry at Prince George is an example of a new industry which, with new transportation routes and a slight improvement in the comparative cost situation, may be established in the region in the near future. Although the timber in the area tributary to Prince George is scattered and not as dense as the coastal stands, easy access can be had to large volumes of suitable pulp timber by floating logs down the Fraser, Willow, McGregor, Salmon, Nechako, and other rivers which flow toward Prince George. In addition the proposed Trans Canada Alaska Railroad, and possibly other new rail lines and roads, could also act as feeders.

Exploitation of some of the reserves of coal, oil and water power will assist in the establishment of local industries such as saw mills and ore mills. It is difficult to forecast the growth of mining in the area. Suffice to say that deposits of minerals already located as well as many more deposits, the existence of which geological structures indicate, justify the prediction that, with improved access roads, rail lines and airways, the output of copper, lead, zinc, mercury, gold, silver and other metals will increase favorably. A good part of the milling and even smelting of the ores could be done near the mines.

The whole railroad belt can anticipate increasing agricultural and livestock production, without perhaps ever becoming self-sufficient, and an expansion in output of small industry based on local resources to the point where some shipments could be made to outside markets. While it would be over-optimistic to anticipate any very great agricultural and industrial development between Prince George and Alaska, a certain limited amount can be expected along the route based on the increases in population and facility of transport resulting from the railroad construction.

Report

RECONNAISSANCE FOR RAILROAD OR HIGHWAY WEST OF FAIRBANKS

United States Engineer Area Office
Anchorage, Alaska

June 15, 1942

Report

RECONNAISSANCE FOR RAILROAD OR HIGHWAY WEST OF FAIRBANKS

United States Engineer Area Office
Anchorage, Alaska.

Prepared under the direction of
Lt. Col., B. B. Talley, C.E.
Officer in Charge, Alaska Construction

by

Captain James D. Bush, Jr., C. E.

June 15, 1942.

I N D E X

Appendices

A. Directives
B. Maps
C. Photographs
D. Major Richardson's Report
E. List of Personnel

Appendix C - Photographs:

SYLLABUS

1. Subject considered. An air and ground reconnaissance of the area west of Fairbanks, during the period May 1 to May 22, 1942, to determine the following:

a. Location of suitable sites for ocean terminals from Norton Sound to Point Barrow, inclusive.

b. The practicability of rail and highway routes thereto.

c. General features, such as topographical, climatological, soil, forest growth, inhabitants, existing roads, trails, and waterways.

2. Findings. This report is based on a reconnaissance conducted during a season when snow covered most of the terrain and ice packed rivers and streams as well as ports. It is found that:

a. Norton Sound and the Bering Sea, as far south as Bristol Bay, are free of ice from approximately June 1 to October 30. Kotzebue Sound is free of ice from July 15 to September 30. It is probable that the navigation season could be extended for one month by the use of ice breakers. The best protected deep water harbor on the west coast of Alaska north of the Aleutian Islands is at Port Clarence (Teller), on the western tip of the Seward Peninsula. An ocean terminal could be constructed at Port Clarence (Teller) for handling cargo directly from shore to ocean going vessels. The second most suitable ocean terminal is Golofnin Bay on the southern shore of Seward Peninsula. All other sites investigated would require lighterage.

b. Practicable and feasible railroad or highway routes exist between Fairbanks and Port Clarence (Teller), Golofnin Bay, and Unalakleet. A route to Kotzebue was also located. Routes also exist and were found which lead to St. Michael and Nome but are not considered practicable inasmuch as equal or better facilities for terminals were located elsewhere. The portage from Unalakleet on Norton Sound to Kaltag on the Yukon River is an excellent access route to water transportation into interior Alaska. Construction of a railroad or highway along any of the routes mentioned would be difficult, as is all Alaska construction. This difficulty is due mainly to the inaccessibility of sites making uncertain the supply of materials and construction machinery. Nevertheless, the construction is feasible.

c. The ground along all routes is frozen from approximately October 1 to June 1. However, portions are permanently frozen and thaw only on the surface to depths of about five feet during the summer (June to September, inclusive). The topography through which the routes pass varies from low swampy areas to mountain ranges. The routes cross numerous rivers and streams. The climate is generally semiarid. There are no dense forests, portions of the routes being treeless, however some tie material and timber is available.

I. SUBJECT

1. Subject considered. An air and ground reconnaissance of the area west of Fairbanks, during the period May 1 to May 22, 1942, to determine the following:

a. Location of suitable sites for ocean terminals from Norton Sound to Point Barrow, inclusive.

b. The practicability of rail and highway routes thereto.

c. General features, such as topographical, climatological, soil, forest growth, inhabitants, existing roads, trails and waterways.

Due to the fact that there is little known about the area considered, all available information of any nature to be noted and recorded. Also, all available data on past explorations and surveys in the areas considered to be studied in connection with submission of the report.

II. AUTHORITY

1. General.

a. Memorandum for the Chief of Engineers from War Department, Headquarters, Services of Supply, Washington, D. C., dated March 25, 1942, with 1st and 2d indorsements thereto, subject: Survey of Railroad Route to Fairbanks, Alaska.

b. Letter from the Division Engineer, North Pacific Division, Portland, Oregon, dated April 18, 1942, to the District Engineer, Seattle, Washington, subject: Survey of Railroad Route to Fairbanks, Alaska, and 1st indorsement thereto, inclosing a copy of 4th indorsement, dated April 17, 1942, from the Division Engineer to the Chief of Engineers, same subject.

c. Radiotelephone conversation between the District Engineer and the Area Engineer, dated April 20, 1942.

d. Letter from the Chief of Engineers, dated April 20, 1942, to the Division Engineer, North Pacific Division, Portland, Oregon, subject: Survey of Railroad Route to Fairbanks, Alaska.

2. Specific.

a. Radio from the District Engineer to the Area Engineer, dated April 15, 1942.

b. Radio from the District Engineer to the Area Engineer, dated April 26, 1942.

3. Copies of the correspondence cited above are attached to this report as Appendix A.

III. ORGANIZATION AND CHRONICLE OF THE RECONNAISSANCE

1. Organization. On April 21, 1942, James D. Bush, Jr., Captain, Corps of Engineers, Chief of Operations Division, Area Office, was appointed Officer in Charge by the Area Engineer to plan, organize and execute a field reconnaissance. Report of the reconnaissance to be made in three sections, namely: Radio report, interim report, and the final report. Instructions were to the effect that the radio and interim reports were to be in the Office of the Division Engineer not later than June 1, 1942.

Although numerous explorations have been made into the area considered and reports and bulletins of the findings of these explorations published, there is, generally speaking, little consolidated information about this area. Such surveys and explorations as were made were mainly conducted during the latter part of the 19th Century and the first part of the 20th Century. A list of such bulletins, writings and reports as are known and available to this office is presented in Section VIII of this report.

On April 22, 1942 a plan outlining the method of procedure for obtaining the desired data was submitted to the Area Engineer and subsequently approved by the District Engineer. Briefly the plan as outlined envisioned the following methods of obtaining the information desired according to priorities a, b and c listed in the general authority referred to in Section I above:

a. Ocean terminals. To investigate, from the ground and air, all possible ocean terminals from St. Michael on Norton Sound to Kotzebue on Kotzebue Sound, inclusive. To study all available charts, coast line data and previously written reports on harbors and ports within the above limits. In addition, it was planned to contact all reliable persons who were familiar with shipping to and from these ports.

b. Routes to ocean terminals. From U. S. Coast and Geodetic Survey, U. S. Army Air Corps aeronautical and such U. S. Geological Survey maps as were available, to plan routes to all possible ocean terminals prior to field work. (The entire reconnaissance for routes to the ocean terminals was based on the premise that if a railroad route could be located, construction of a highway route would be a simple matter). To place in the field sufficient ground parties to cover all main obstacles along the routes, in addition to covering on the ground as much of all routes as possible during the three week period allowed for the reconnaissance. Each field party to consist of an engineer, an assistant engineer and one guide, with the addition of as many packers or dog team drivers as would be necessary, depending on the section covered by the individual party. Each party to be furnished aneroid barometers, compasses, clinometers, maps, pedometers, cameras, and thermometers in addition to other equipment. The function of each party to determine the most feasible and practical route for a railroad or highway between the definite points assigned. In addition, to determine the practicability of surmounting the main obstacles such as mountain passes, swampy terrain and river crossings along the route. To photograph portions of the route, record all data and submit a chronological report and map of the section covered. An air reconnaissance of the section assigned to be made by each individual party prior to the actual ground reconnaissance.

c. Data on routes. To be obtained from the reports submitted by the individual field parties, the reports of previous investigations and explorations, statements of local residents, trappers, traders, mining concerns, the Alaska Road Commission, University of Alaska, the Alaska Railroad, and commercial airlines and pilots.

2. Chronicle of the Reconnaissance. Two officers, five engineers and one field administrative assistant from the office of the Area Engineer formed the nucleus of the reconnaissance parties. During the period April 27 to 30, 1942, inclusive, engineers, assistants and guides were employed at Fairbanks, Alaska. The services of engineers, mineralogists and geologists were obtained from the U. S. Smelting, Refining and Mining Company, the University of Alaska, and the Alaska Road Commission. Also independent mineralogists, geologists and engineers, as well as guides, were obtained locally in Fairbanks and vicinity. Eight field parties were organized and equipment assembled. A ninth party operated out of Nome and made air reconnaissance of possible routes on the Seward Peninsula and coast of Norton Sound to St. Michael.

Two main routes to the coast had been previously planned as follows: To Norton Sound and the Seward Peninsula by way of the Tanana and Yukon Valleys, to Kotzebue Sound by way of the Tanana, Tozitna, Alatna and Kobuk River valleys. Five parties were assigned sections on the route to Norton Sound and the Seward Peninsula, three parties on the route to Kotzebue Sound. Plans were discussed and detailed instructions issued to individual parties. Mr. William E. Duckering, Dean of the Engineering School, University of Alaska, who has had considerable experience in railroad location, furnished valuable advice on detailed instructions to ground parties.

On May 1st and 2d, all parties were transported to the field by commercial and Army airplanes. The reconnaissance for suitable ocean terminals was made by the Officer in Charge and one assistant. All air reconnaissances of the routes were made by the Officer in Charge and two assistants working individually. Air and ground reconnaissance parties maintained contact and the former furnished the latter with periodic information on the sections to be traversed and necessary supplies of food and equipment. By May 22d, all air and ground reconnaissance was complete and the parties returned to Fairbanks. After submitting chronological reports, field notes and maps, the ground parties were disbanded.

IV. THE RECONNAISSANCE

As set forth in Section I above under the general authority, the mission of the reconnaissance is repeated:

"a. Location of suitable sites for ocean terminals from Norton Sound to Point Barrow, inclusive. (Instructions for the reconnaissance by air and ground of the 'area west and northwest of Fairbanks' was later amended to read 'west of Fairbanks'.)

"b. The practicability of rail and highway routes thereto.

"c. General features, such as topographical, climatological, soil, forest growth, inhabitants, existing roads, trails and waterways".

The detailed data accummulated on this reconnaissance are presented in this section in order of the above priorities. In addition, the ports and routes to each are chronicled in the order of their suitability.

1. Ocean Terminals. The coast of Alaska from Norton Sound to Kotzebue Sound, inclusive, was investigated for the location of suitable sites for ocean terminals. For the purpose of this reconnaissance such "ocean terminals" were considered to mean sheltered, deep water harbors of sufficient size to accommodate the maximum traffic density anticipated over the military railroad from Prince George to Fairbanks. This maximum density has been established by the Chief of Engineers at twenty 1,000-ton trains per day each way.

The western shore of Alaska is bounded by the Bering Sea and the southern Arctic Ocean, separated by the narrow Bering Strait. Fogs, mist, ice, or a combination of all three are prevalent during most seasons of the year. Norton Sound and the Bering Sea, as far south as Bristol Bay, are free of ice from approximately June 1 to October 30. Kotzebue Sound is free of ice from approximately July 15 to September 30. The coasts of Bering Sea and the southern Arctic Ocean are characterized in general by shoal waters, with extensive silt or mud flats along the shores, particularly in the approaches to the various bays and rivers. There is little rock formation and its occurrence, where found, is limited in area.

Seven possible ocean terminals from St. Michael on Norton Sound to Kotzebue on Kotzebue Sound, inclusive, were investigated. Port Clarence (Teller), a large undeveloped deep water harbor, at the western tip of Seward Peninsula, was found to be the best harbor along the coast of Alaska north of the Aleutian Islands. The second most suitable ocean terminal is Golofnin Bay on the southern shore of Seward Peninsula. Unalakleet, on the eastern shore of Norton Sound, is also a possible ocean terminal but definitely limited to lighterage. It has the advantage of being located at the western end of the Kaltag to Unalakleet portage (85 miles long, one pass of 800 feet elevation above sea level), which is a natural passage from the Yukon River to the Bering Sea. However, Unalakleet has no shelter, the coast line is shallow and ocean going boats must stand six miles off shore to lighter. At present it is necessary to lighter from ship to shore at all possible terminals which were investigated. With the exception of Port Clarence (Teller) and Golofnin Bay, all would require lighterage unless extensive harbor construction were undertaken.

a. Port Clarence (Teller) indents the western tip of the Seward Peninsula just south of Cape Prince of Wales. It is a good harbor, close to Bering Strait, free from ocean swell. The harbor is 10 miles wide, 12 miles long, sheltered on two sides by mountain ranges and from the open sea by a low spit of land allowing a four mile entrance. (A submarine net could protect the harbor to a certain extent). There are 112 square miles of water reaching depths greater than 30 feet and 147 square miles of water reaching depths greater than 24 feet at mean lower low water at this harbor. The mean tide range is 1.2 feet, the maximum range is about 4 feet. The tidal velocities are negligible. From Cape Riley, ten miles inside the harbor, 30 foot depths can be reached 2100 feet off shore and 24 foot depths 300 feet off shore. The type of bottom is unknown. In general the beach line is steep and rocky at this point. Attention is invited to U. S. Coast and Geodetic Survey Chart 9385, Appendix B-10. The present lightering distance off the village of Teller is two miles for ocean going ships. Port Clarence (Teller) is connected to an inner bay known as Grantley Harbor by a narrow passage 2000 feet wide by one mile long. This passage at its shallowest depth is 12 feet and the average depth within Grantley Harbor is 16 feet, with approximately 30 square miles of water surface. From Grantley Harbor shallow draft boats now lighter cargoes 50 miles inland. The terminal facilities at Teller consist of one small lighterage concern. The port is visited approximately six times annually by two ocean going vessels. There is little recorded meteorological data on this locality. There are no records on wind or storms other than that prevailing winds are generally easterly. Records for the past five years, obtained from the Teller Commercial Company, show that the port is free of ice, on an average, from the first week in June until the last week in October.

b. Golofnin Bay is located on the southern coast of the Seward Peninsula 70 miles east of Nome. It is approximately 10 miles long by 10 miles wide, shallow at the northern end, partially sheltered on three sides by hills, but having a ten mile outlet to the open sea. The east shore is high and bold with occasional sand and gravel beaches. Considering that portion of the bay north of an east-west line drawn through Cape Darby, there are approximately 13 square miles of water reaching 30 foot depths and 26 square miles of water reaching 24 foot depths, both figures at mean lower low water. The mean range of tide is 2 feet and the maximum range approximately 5 feet. The tidal velocities are negligible. From "Mission Point" on the eastern shore, 30 foot depths can be reached 3000 feet off shore and 24 foot depths 1500 feet off shore. The type of bottom is unknown. The beach lines in the locality are generally flat. Attention is invited to U. S. Coast and Geodetic Survey Chart 9382, Appendix B-11. The present lightering distance off the village of Golovin, at the northern end of the inner bay, is 5 miles for vessels of 24 foot draft. North of Golofnin Bay is a shallow lagoon, Golofnin Sound, averaging approximately 6 feet in depth and having approximately 50 square miles of water surface. It is connected to Golofnin Bay by a narrow deep passage but the channel shoals before reaching deep water in the Bay. Shallow draft boats lighter approximately 50 miles inland on the Fish and Niukluk Rivers to the town of Council. There is one small lighterage concern which operates the terminal facilities at Golovin. Two bights north of Mission appear to be the best terminal sites but extensive dredging would be necessary before they could be used. There are little recorded meteorological data on this locality. The prevailing winds in the summer are from the southeast and southwest and blow straight into the harbor. Records for the past eleven years, obtained from the Lomen Brothers Commercial Company, show that the port is free of ice, on an average, from the first week in June until the last week in October.

c. Unalakleet is a small native village of approximately 100 persons on the eastern shore of Norton Sound at the mouth of the Unalakleet River. There is no harbor. The waters along the coast at this point are exceptionally shallow and ocean going vessels must stand six miles off shore to lighter their cargoes. There is one small lighterage concern. The coast line at Unalakleet is low and swampy and the terrain is mainly tundra. (Attention is invited to Appendices C-1 and C-2.) However, Unalakleet has many advantages as a possible ocean terminal. It is at the western terminus of the Kaltag-Unalakleet portage which lies in a valley varying from one-half to four miles in width, 85 miles in length, and furnishes a ready access from the Bering Sea to Kaltag on the Yukon River. The grade rises gradually to a pass 800 feet above sea level, 55 miles east of Unalakleet. A northern branch of this valley leads to a 1700 foot pass which furnishes a possible railroad or highway route to the vicinity of Nulato, thence to Fairbanks. This portage has been used for years by the natives and early pioneers. There are no recorded meteorological data on Unalakleet. The average tide range is 3 feet. The coast in this locality is usually free of ice from the latter part of May until the first half of November.

d. St. Michael is situated 80 miles east of the mouth of the Yukon River on the southern shore of Norton Sound. It has long been the transfer point for cargoes destined for the interior of Alaska by way of the Yukon River. There is no protected deep water harbor. Ocean going vessels, to lighter their cargoes to St. Michael, must stand 4 miles off shore in an unprotected roadstead to obtain 30 feet of water and two and one-half miles off shore for 24 feet of water. The diurnal range of tide is 3.9 feet. The coast in the vicinity of St. Michael is low and swampy. Records for the past eleven years, obtained from the F. P. Williams Company at St. Michael, show that the port is free of ice, on an average, from the first week in June until the last week in October.

e. Nome, the largest community in Alaska west of Fairbanks, is located on the southern shore of the Seward Peninsula. It is, however, situated on the open sea and there is no natural harbor. The waters along the coast at this point are typical of the western shore of Alaska and are shallow. Ocean going vessels must stand at least two miles off shore in order to lighter their cargoes. The Lomen Brothers Commercial Company operate a lighterage concern and have handled 10,000 to 25,000 tons of cargo during the open navigation season, which is usually from the first part of June until October. The diurnal tide range is 1.6 feet and the tidal current averages approximately one knot at times of strength. The Snake River enters Norton Sound at Nome. The mouth of this river has been improved by the construction, by the War Department, of two parallel jetties 400 feet long and the dredging of a channel to a basin 200 feet wide and 250 feet long in the city of Nome. The controlling depths are as follows: bar, 6 feet; channel, 8-10 feet; basin, 0 to 9 feet. Small coasting vessels enter the basin and discharge directly to the wharves. In strong southerly winds, no landing can be made on the beach and anchorage is unsafe. Southerly winds raise the water and northerly winds lower it. The prevailing winds are northeast. Nome is located approximately in the center of a semicircle bordered by Sledge Island on the west, Cape Nome on the east and low mountains about five miles from the coast. The terrain within this semicircle is flat and treeless. Nome has a population of approximately 1500 persons, one third of which are white, the remainder

Eskimo and Indian. There is an 80 mile narrow gauge railroad which operates in the summer between Nome and Shelton.

f. Kotzebue, a settlement of approximately 300 persons, is located on the northern tip of Baldwin Peninsula, a flat, treeless strip of land which protrudes into Kotzebue Sound. The village itself is approximately 30 miles inside the Arctic Circle. There is no harbor, and the waters of the Sound for 10 miles in any direction from Kotzebue are extremely shallow. Ocean going vessels stand 11 miles off shore in order to lighter their cargoes. An extensive silt bank along the northwest shore of Baldwin Peninsula was deposited by the Noatak River, which enters Kotzebue Sound 8 miles due north of Kotzebue. There is, however, a fair anchorage along the open coast several miles northwest of the village of Shesualik, which is 10 miles across the Sound from Kotzebue. There is one small lighterage concern at Kotzebue. The diurnal tide range is approximately 5 feet. There is little commerce to or from Kotzebue and the ocean going vessels which call at this place mainly bring in food and supplies. The few white persons who live at Kotzebue are mainly government employees besides storekeepers and traders, who deal with the Eskimos. Generally speaking, the entire Kotzebue Sound is of little value insofar as navigation is concerned. There are few sheltered coves and inlets which afford protection. Except for the southern shore, where the coast line is somewhat prominent and bold, its entire fringe is shallow. It is approximately 50 miles in length and 40 miles in width. Kotzebue is seldom open to navigation before July 15 and is closed approximately September 30. There is no harbor improvement of any sort at Kotzebue or at any point on Kotzebue Sound. The prevailing winds are easterly.

g. Deering is located on the southern shore of Kotzebue Sound approximately 45 miles south of Kotzebue. All that has been said about Kotzebue in regard to shallow water, ice free navigation, lightering facilities and population applies on a smaller scale to the village of Deering, which is approximately half the size of Kotzebue.

2. Routes to Ocean Terminals. Central Alaska has as its main source of drainage the Yukon River and its tributaries. This river rises in the southern part of the Canadian Province of Yukon Territory, meanders northwest to the Arctic Circle, turning southwest at a point 120 miles west of the Canadian-Alaskan boundary then flowing south and west to the Bering Sea in the southern edge of Norton Sound. The main Alaskan tributaries of the Yukon are the Tanana and Koyukuk Rivers. Tanana River, the larger of the two, flows westerly reaching the Yukon at a point approximately 140 air miles west of Fairbanks. The Koyukuk River flows generally southwest reaching the Yukon at a point 300 air miles west of Fairbanks and approximately 130 miles from Norton Sound. The valleys formed by these and other tributaries are bordered by mountain ranges often reaching heights of 5000 feet. In addition, Seward Peninsula, on the west coast of Alaska, is generally rugged and mountainous. The main source of drainage of Seward Peninsula is the Kuzitrin River and its tributary rivers, Pilgrim and Kougarak. Due to the action of the sun on the exposed snow and ice surfaces, the southern slopes of all of these mountain ranges are, for the most part, cut by streams and rivers.

Although there are several mountain ranges within the area considered, all possess passes or divides through which a railroad or highway could be constructed. (For the purpose of this reconnaissance, the area "west of Fairbanks" was considered to be roughly the triangle, Kotzebue Sound-Norton Sound-Fairbanks). The Yukon Valley, because of its width and gradual grade, furnishes a natural transportation route, ground or water.

Upon completion of the actual ground and air reconnaissance, it was discovered that a similar reconnaissance from Fairbanks to Council City, in the Seward Peninsula, was made in 1906 under the supervision of Major W. P. Richardson, U. S. War Department. The primary objective of the above-mentioned reconnaissance was to survey a pack trail and mail route. However, the original Congressional Bill envisioned a possible future railroad extension along the route. Subsequently, this portion of the bill was eliminated. Nevertheless, the report of this reconnaissance contains a brief notation on the possibility of a railroad from Fairbanks to the Seward Peninsula. A description of the route, as set forth in Major Richardson's report, is inclosed. (See Appendix D). It is interesting to note that the route selected on this reconnaissance is identical, for a distance of 360 miles, to the route surveyed by Major Richardson's men. The route selected through the Seward Peninsula by the Western Union Telegraph Company in 1865-67 is also identical to the route selected on this reconnaissance, namely, through the Fish River valley thence up the Niukluk River; across to Imuruk Basin and on to Port Clarence (Teller).

The routes to Port Clarence (Teller), Golofnin Bay, Unalakleet, St. Michael, Nome, Kotzebue and Deering were covered entirely by air. Fifty percent of the 740 mile route to Port Clarence (Teller) and eighty percent of the 630 mile route to Kotzebue were covered on the ground by eight parties. The remaining party made an aerial reconnaissance from Nome to St. Michael for possible routes. The major river and stream crossings, mountain passes and difficult terrain were reconnoitered on the ground. The entire reconnaissance was made before, during and after the difficult and dangerous breakup season within a three week period. Travel was by foot, dog team, snow shoes, boat, raft and airplane. Details of the routes are as follows:

a. Fairbanks to Port Clarence (Teller). Fairbanks to Tanana: The existing line from Fairbanks to Dunbar starts the route. In the event a highway is authorized it could parallel the existing Alaska Railroad from Fairbanks to Dunbar. From Dunbar, the route runs north and west to Eureka skirting the Minto Lakes country. The route from Dunbar to Eureka passes along the foothills of two mountain ranges with peaks rising to 4000 feet above sea level. Continuing west from Eureka, the route follows the southern slopes of the foothills of a mountain range through a pass 1200 feet above sea level between Rough Top and Baldry Mountains. From this pass the route continues west 9 miles down the left bank of Fish Creek turning northwest over a 700 foot pass into a small creek, known locally as Dickey Creek, thence 5 miles northwest along the right bank of this creek to its mouth at the Yukon River. The best crossing of the Yukon is at a point known as Rampart

Rapids, where, at the center of the river, there is an island approximately 800 feet long by 400 feet wide. From this crossing the line continues westerly along the right bank of the Yukon to the mouth of Mission Creek six miles above the village of Tanana. Five miles up this creek there is a 540 foot divide, over which the line passes above Tanana some six miles. The route from Dunbar to Tanana is divided into four sections. Details of these routes are as follows:

(1) From Dunbar to Eureka Creek (Mile 0 to Mile 87), (See Sheet 1 Appendix B-3): The length of this section is 87 miles and was covered by plane reconnaissance only. Leaving Dunbar, the right-of-way should follow northward along a cat trail route skirting the hills to the right to latitude 65°7". The Minto Lakes country and area, covering some 400 square miles, is divided by a low hill to the westward. The route should skirt the southern edge of this hill. From the westward tip of this hill, 10 miles of swamp must be crossed before good ground is encountered. The region is practically treeless and covered with niggerheads and moss. The grade will probably not exceed one-half to one percent. The line continues westward to Eureka Creek.

(2) From Eureka Creek to pass north of Rough Top Mountain (Mile 87 to Mile 104), (See Sheet 2, Appendix B-4): The length of this section is 17 miles. The foothills in the vicinity of Eureka Creek have an average slope of 15 degrees. Loose shale rock, probably suitable for ballast, is exposed in several places. On the 17 mile section there is practically no timber except small patches at the creek crossings. This timber is suitable for ties and culverts but is too small for piling or structural timbers. The depth of soil, unsuitable for fill, throughout this section is probably less than two feet, with the exception of the swampy area near Thanksgiving Creek. The line continues up the left bank of the North Fork of Baker Creek to its headwaters crossing the pass at an elevation of 1200 feet. The grade from Eureka Creek to the pass should not exceed one percent. Mining interests in the vicinity of Eureka and Omega Creeks have constructed 20 miles of access road from the community of Manley Hot Springs on the Tanana River. Both the community at Eureka Creek, as well as the community at Omega Creek, have short landing fields suitable for commercial aircraft.

(3) Pass north of Rough Top Mountain to the Rapids on the Yukon River (Mile 104 to Mile 122), (See Sheet 2, Appendix B-4): The length of this section is 18 miles. The route descends from the pass nine miles down the left bank of Fish Creek to a broad plateau between Fish and Dickey Creeks. The elevation of this plateau is approximately 740 feet above sea level. Side slopes from the pass to the plateau are approximately 15 degrees and the excavation would be largely rock. There is some spruce, birch and cottonwood on this section which should furnish considerable tie and culvert material. Crossing the plateau the route continues down the right bank of Dickey Creek approximately five miles to the Yukon River. Barometric elevations show that a 2 percent grade is possible in this five miles. Little rock should be encountered. The excavation would be mainly clay and shale on side slopes not exceeding 10 degrees. From the mouth of Dickey Creek at the Yukon, the route follows the left bank of the main river for two miles to a point opposite an

island in the center of the Yukon River. This island is at the beginning of a short stretch of the river known as Rampart Rapids. The Yukon River at this point is passing through a steep gorge, precipitous when compared with the rest of the lower Yukon Valley. The side slopes of the mountains which reach down to the river bank through this section are sometimes as steep as 40 degrees. The most logical location for a railroad or highway bridge across the Yukon is over the above-mentioned island. This island is approximately 800 feet long by 400 feet wide (See Appendices C-7 to C-9, inclusive). The reconnaissance of this crossing was made before and after the breakup of ice in the Yukon River. Before the breakup the island was entirely visible and was inspected and mapped roughly. Due to the frozen condition of the silt partially covering huge granite boulders, some reaching lengths of 30 to 40 feet, little information could be obtained concerning the underlying material. However, definite signs of bedrock are visible. In the opinion of the mineralogist who made the reconnaissance of this crossing, the island is bedrock. The boulders mentioned have been worn by ice but appear unmoved by its action. Except during stages of unusually low water, the island is covered throughout the open season. Due to the precipitous banks and width of the gorge at the crossing, the bridge would possibly have to be constructed at least 30 degrees of a line normal to the river.

(4) From Yukon Rapids to Tanana (Mile 122 to Mile 159), (See Sheet 2, Appendix B-4): The length of this section is 37 miles and is divided into segments of 7, 11, 6 and 13 miles. Leaving the crossing of the Yukon the route continues down the right bank of the river. The side slopes in this 7 mile section are approximately 40 degrees and are solid rock. At intervals of approximately one mile, small streams have cut sharp channels to the river's edge. Due to the fact that these streams can be crossed close to the river, the grade should fall from the crossing. The next segment of 11 miles is rocky and broken by side creeks. The slope of the bank is approximately 10 degrees. For the next 6 miles the right-of-way should leave the Yukon and be located approximately along the location of the old telegraph line at the foot of the hills. The remaining 13 miles should fall close to the river passing up the Mission Creek valley and crossing the divide and coming out just north of Tanana village. From Tanana village to the Rapids there are three islands in the Yukon River named for the distances from Tanana: Six Mile, Twelve Mile and Sixteen Mile Islands. Part of the reconnaissance of this section was made at a time when the Yukon was frozen over and it was possible to measure the widths of the main river channels at low water. They are: Six Mile Island, 1975 feet; Twelve Mile Island, 2075 feet; Sixteen Mile Island, 1800 feet.

The entire route from Fairbanks to Tanana is uninhabited with the exception of the small mining communities on Omega and Eureka Creeks. The total population of the two will probably not exceed 50 persons. The telegraph stations and lines are no longer in use.

Tanana to Kokrines (Mile 159 to Mile 241), (See Sheet 2, Appendix B-4 and Sheet 3, Appendix B-5): Leaving Tanana the route follows the right bank of the Yukon River along a silt bench varying in elevation from 60 to 125 feet above the normal river water level. This bench is cut by numerous small streams which will require trestles as well as culverts. This section is approximately 84 miles in length and contains 10 miles of side hill rock excavation. The rock is sedimentary to metamorphic and a considerable portion can possibly be excavated by dozer. Side slopes of the foothills bordering the bench will average approximately 20 degrees and are covered with medium birch and spruce. There is some timber suitable for trestles and ties and good ballast material is available in the foothills. No construction difficulties are anticipated in this section.

Kokrines to Galena (Mile 241 to Mile 300), (See Sheet 3, Appendix B-5): This section is divided into four distinct segments of 22, 6, 10 and 21 miles.

(1) From Mile 241 to Mile 263, the route continues down the right bank of the Yukon above the high water line and at the edge of the foothills. These foothills are of varying heights reaching from the mountain range on the north to the river and are separated by numerous small ravines. Ice scars found on the trees along this segment of the section show that the high water of 1937 reached 10 feet below this elevation in the foothills. The line was carried 10 feet above thishigh water mark. An alternate location could be made by following the foothills behind the bench. However, an increase in distance and a loss of long tangents would result. From Mile 248 to Mile 263 the route continues to follow a grade 10 feet above the high water mark. The slopes vary from 33 to 45 degrees and are covered with cottonwood, birch and spruce. At Mile 256 a section of the bank line one-half mile long shows signs of scouring during the breakup and the route may have to be excavated deeper into the hill slopes.

(2) From Mile 263 to Mile 269 the route should leave the river, cutting through a low saddle, turning slightly northwest to a point on the left bank of the Melozitna River opposite a long ridge which juts out from the main range on the north side of the Yukon to the flats along the right bank of the Melozitna. This point was found to be the most likely crossing in this area, and the river is 400 feet wide at this point. The maximum high water depth of the river is approximately 12 feet. The Melozitna River is seldom navigable and at times is even too shallow for motor boats.

(3) From Mile 269 to Mile 279 the route then follows the right bank of the Melozitna due north for 4 miles turning west up the right bank of Grayling Creek through a narrow valley to a 600 foot divide. The possibility of using the left bank of Grayling Creek was considered and found to be impractical. From the crossing of the Melozitna to the pass at the head of Grayling Creek the side slopes vary from 20 to 45 degrees. There is considerable rock on this segment and it is mostly schist with very little overburden.

(4) From Mile 279 to Mile 300: Crossing the pass at the head of Grayling Creek the headwaters of the Whakatna River are reached. In crossing the pass the route should lead from the right bank of Grayling Creek diagonally to the right bank of Whakatna Creek. The divide is open and bare and covered with moss. The line follows the foothills on the north side of the Whakatna Valley in a westerly direction in a fairly straight line. Three large streams

are encountered before the mouth of the valley is reached. These foothills show some outcrops of broken schist and the slopes are covered with a moderate stand of birch and spruce. The Whakatna River follows a meandering course down the floor of its valley, indicating a gentle fall. At Mile 300 the mouth of the valley, about 16 miles northeast of Galena, is reached and from this point the route swings northwest. The terrain in this vicinity is low and swampy covered with willow and birch thickets with an occasional low spruce covered ridge.

From Galena to Nulato (Mile 300 to Mile 363), (See Sheet 3, Appendix B-5): From the vicinity of Galena the route continues northwest across a silt table land which is covered with small spruce and birch, thence along the foothills of a low mesa to the crossing of the Koyukuk River approximately 7 miles above its mouth at the Yukon. The terrain is similar along this section of the Koyukuk and a crossing is mainly determined by location of approach lines. The width of the river at this point is approximately 800 feet. The benches on either side are 20 feet high. A high water mark was observed on the timber on the river bank near the crossing and six feet above the ground line. From the river crossing the route follows the southern slope of a small butte thence about 19 miles to a pass which is 750 feet above sea level and approximately 8 miles west of the village of Koyukuk. The side slopes are regular and average 15 to 20 percent. The timber is medium size spruce with occasional clumps of birch and aspen. Due to the depth of the snow the character of the ground could not be determined, but the nature of the vegetation indicated it was sandy soil and slide rock. Considerable fine grained igneous slide rock was noted along the slopes of the butte and in the valley of the creek leading up to the pass. Some solid rock outcrops were observed. Continuing in a general southwesterly direction from the pass the proposed location would contour around the headwaters of the East Fork of the Nulato River and down its right bank to the North Fork, a distance of approximately 15 miles. This distance is all side hill location, with slopes ranging from 15 percent to 50 percent, with numerous small washes and gullies. The hillsides are thickly timbered with small spruce, birch and aspen. From the mouth of the East Fork the route turns southwest up the left bank of the North Fork and continues 45 miles to a pass at the headwaters. The valley at the junction of East Fork and North Fork is approximately one mile wide, very flat and the stream meanders considerably. The floor of this valley averages one mile in width and the gradient is easy throughout the entire length. The valley is moderately covered with spruce. The pass at the head of the North Fork is the highest on the entire route to Port Clarence (Teller) and is approximately 2100 feet above sea level. However, no difficulty should be encountered in the crossing of this pass inasmuch as there are easy approaches from both sides.

Pass at the headwaters of the North Fork of the Nulato River to the mouth of the Shaktolik River Valley (Mile 408 to Mile 454), (See Sheet 3, Appendix B-5): The route follows a westerly and southwesterly line down the left bank of the Shaktolik River. The floor of the valley is sparsely covered with stands of moderate spruce and the overburden is approximately 2 to 4 feet. In places the river flows through deep sandstone and shale cuts.

Mouth of the Shaktolik River Valley to Kwiniuk River Valley (Mile 454 to Mile 560), See Sheet 3, Appendix B-5 and Sheet 4, Appendix B-6): At the mouth of the Shaktolik Valley the route turns due north crossing the Ungalik and Inglutalik Rivers, thence northwesterly and westerly along the edge of the Koyuk delta. (There is a possibility that the route could turn west from the Shaktolik to the Ungalik River Valley approximately 20 miles above the mouth of the Shaktolik River Valley. However, it is questionable if pass can be traversed without the use of switchbacks or a tunnel). After crossing the Inglutalik River the route continues 20 miles north and west crossing the Koyuk River 4 miles below the village of Dime Landing. The route then turns south and west crossing the headwaters of Kwik River and skirting the deltas of numerous small streams entering Norton Bay in this vicinity. From the headwaters of Kwik River the route is southwesterly crossing the Tubutulik and entering Kwiniuk River Valley at a point approximately 6 miles above its mouth which is near the village of Moses Point. From the mouth of the Shaktolik River to this point the foothills are slightly rolling and sparsely covered with spruce. The lowland is delta country to the crossing of Koyuk River. There are no inhabitants directly along the route from Galena to Moses Point, although several small native villages come within ten miles of it. The delta area of Norton Bay is entirely covered with tundra, which indicates permanently frozen ground. The area south of the vicinity of the headwaters of the North Fork of the Nulato and Shaktolik Rivers has been only partially surveyed and maps of this region are apparently in error as to passes through the mountainous divide between the Yukon and Norton Sound watersheds.

Kwiniuk River Valley mouth to Council (Mile 560 to Mile 630), (Sheet 4, Appendix B-6): Entering Kwiniuk River Valley the route follows the left bank of this stream to the headwaters of its North Fork. This portion is thickly covered with medium size spruce, the timber line being at an elevation of 500 feet. Many rock outcrops were noted in this valley, which is approximately two miles wide. The route crosses a 900 foot pass at the head of the North Fork of the Kwiniuk leading into the watershed of the Fish River at the headwaters of Etchepuk River. No difficulty is anticipated on this pass inasmuch as valleys approaching same have easy gradient. The route follows down the right bank of the Etchepuk River for approximately 25 miles crossing Cache Creek to the Fish River, thence southwesterly down the right bank of this stream through a valley thickly covered with large spruce. The line down the Etchepuk River and Cache Creek crosses easy side hill slopes which show some rock outcrop. Twelve miles north of the village of White Mountain the route leaves the Fish River turning northwest up the Niukluk valley. For thirty miles the route follows this valley on fairly level ground with some side hill slope running up to 20 degrees. The Niukluk River is crossed two miles above the village of Council.

From Council to Port Clarence (Teller) (Mile 630 to Mile 735), (Sheet 4, Appendix B-6): From the crossing of the Niukluk two miles above Council the route continues northwest to the headwaters of the South Fork of the Niukluk (American Creek) crossing a pass of 400 feet elevation. This portion is sparsely covered with medium spruce and the valley varies from one to three miles in width and is slightly rolling with little side hill cut to be expected. From the pass the route continues westerly along the foothills of

Kigluaik (Sawtooth) Mountains which lie to the southwest of the bottom land of the Kuzitrin Valley and Imuruk Basin, to a point two miles southwest (Cape Riley) of the village of Teller on the shore of Port Clarence. These foothills are very gentle and only sparsely covered with small spruce and tundra. The entire Kuzitrin and Imuruk Basin area is similar to the Minto Lakes country in that it is low and swampy, covering approximately one hundred square miles. The upper reaches of this basin to the northeast are volcanic beds. From the Kwiniuk Valley entrance to Port Clarence (Teller) the route passes through practically uninhabited regions, although the village of Council has a population of approximately 100. Frozen ground can be expected on all of the portion from Council to Port Clarence (Teller). At the time of reconnaissance the entire section from the mouth of the Fish River Valley to Port Clarence (Teller) was covered with snow.

b. Fairbanks to Golofnin Bay, (See Sheet 4, Appendix B-6): The route to Golofnin Bay follows the route from Fairbanks to Port Clarence (Teller) to the headwaters of the Kwiniuk River near the southern shore of the Seward Peninsula. Whereas the route to Port Clarence (Teller) turns north and west crossing the pass from the waters of the Kwiniuk River to the headwaters of the Fish and Etchepuk Rivers and Cache Creek, the route will continue from the headwaters of the Kwiniuk River in a general southwesterly direction for 40 miles, crossing an 800 foot pass in the lower Darby foothills, coming out at Mission Point opposite Carolyn Islands in Golofnin Bay. The section from the Kwiniuk Pass to Mission Point is similar to the section from Kwiniuk Pass to the confluence of the Fish and the Etchepuk on the route to Port Clarence (Teller).

c. Fairbanks to Unalakleet, (See Sheet 5, Appendix B-7): There are two possible routes to Unalakleet. Both routes follow the main route to Port Clarence (Teller) as far as the junction of the East and North Forks of the Nulato River. One possibility leaves the route at this point, the other leaves the route to Port Clarence (Teller) at the mouth of the Shaktolik River Valley some 20 miles from the east coast of Norton Sound.

(1) Leaving the mouth of the East Fork the route continues down the right bank of the Nulato River for approximately 5 miles turning southwest up the South Fork of the Nulato River for approximately 40 miles. At the headwaters of the South Fork of the Nulato River a 1700 foot pass is encountered. This pass is very flat and the approaches from both sides are gentle. However, at the time of the reconnaissance it appeared that there was deep snow on the pass. (The reconnaissance of this pass and that on the North Fork was made entirely by air). From the East Fork of the Nulato to the headwaters of the South Fork the route is over gently sloping valley floors sparsely covered with medium spruce. Some outcrops of rock were noted. Crossing the pass the route reaches the headwaters of one of the northern forks of the Unalakleet River. From the pass the route continues approximately 20 miles in a southwesterly direction reaching the main valley of the Unalakleet River. It is through this latter valley that the Unalakleet-Kaltag portage runs. Crossing the main Unalakleet River the route continues southwest on the left bank of the Unalakleet River for approximately 45 miles to a point 4 miles south of the village of Unalakleet on the eastern shore of Norton Sound.

(2) From the mouth of the Shaktolik River valley the route turns southwest for approximately 20 miles thence due north for 30 miles following the coast line. This entire region is practically treeless and the ground is covered with moss and niggerheads. The foothills approaching the coast have easy rolling slopes. The presence of niggerheads along the coast indicates possible permanently frozen subsoil.

d. Fairbanks to St. Michael (See Sheet 8, Appendix B-9 A): The route from Fairbanks to St. Michael follows the route to Unalakleet as far as either the crossing of the Nulato River or the mouth of the Shaktolik River valley, depending on which of the latter alternate routes is followed into Unalakleet. From the point 4 miles south of Unalakleet, the route follows the coast line varying from one to seven miles from the precipitous bluffs on the coast and approaching St. Michael from a circuitous southwesterly direction. The main portion of the route from Unalakleet to St. Michael over the benches bordering the foothills is treeless tundra with volcanic substrata. Outcrops of this volcanic deposit are frequently visible, particularly so for 15 miles of the route. Many streams intersect the foothills and flow into the sea through canyons reaching depths of 300 feet. The last 25 miles of the route to St. Michael is through gradually lowering hills and tundra swamp land. From 8 miles south of St. Michael the route must cross a small ship channel passing around a narrow arm of Norton Sound five miles in length.

e. Fairbanks to Nome, (See Sheet 4, Appendix B-6): This route follows the main Fairbanks to Port Clarence (Teller) route to Iron Creek on the Seward Peninsula Railroad (narrow gauge). From Iron Creek the route follows generally the present line of this railway into Nome. This railroad was constructed in the early 1900's with little regard for grade or degree of curvature, but follows the logical water grade to its end. Certain points on the line reach a maximum grade of approximately 6 percent. However, this condition could be corrected by local alignment. From the point at which the route to Nome leaves the Fairbanks-Port Clarence (Teller) route into Nome, tundra and swamps are encountered, with some rock in the vicinity of Anvil Creek. The region is practically treeless. There are two low divides of 350 and 500 feet in elevation to be crossed. However, the approaches to each are very gentle and the crossings could be made without difficulty.

f. Fairbanks to Kotzebue, (See Sheet 6, Appendix B-8 and Sheet 7, Appendix B-9): The route to Kotzebue will follow the main route from Fairbanks to Port Clarence (Teller) to a point approximately 14 miles west of ~~Fairbanks~~ TANANA on the Yukon River at the mouth of the Tozitna River. From the mouth of the Tozitna the route turns generally north for approximately 35 miles to the East Fork of the Tozitna. The route follows the river valley and for the most part is on fairly level ground. There is a considerable growth of birch, spruce, cottonwood, willow and alder along the river bottom land. Two river crossings are required in this section, each necessitating spans of approximately 400 feet. The possibility of overflow of the Tozitna River demands that the route follow the edge of the foothills above possible flood mark. Approximately 2300 feet of rock work will be required approaching the East Fork. A span of approximately 300 feet would be required to cross the East

Fork. The route continues generally north from this point following again the main valley of the Tozitna along present cat train trail on the left limit for approximately 25 miles. Generally this country is open, sparsely covered with medium spruce and has considerable moss and niggerheads. The side hill slopes are gentle. From the headwaters of the Tozitna the route turns generally northwest continuing on the cat train trail and over a low pass crossing the headwaters of the Melozitna River, thence over 4 low passes to the headwaters of Dodach Creek which flows into Lake Mentanoutli. From the headwaters of the Tozitna to Lake Mentanoutli the route is approximately 35 miles long. This portion of the route is over gently sloping ground and the low passes present no difficulties. There is, however, a possibility of rock excavation. The route continues generally north skirting the western shore of Lake Montanoutli crossing the Kanuti River, thence due north approximately 18 miles to the abandoned village of Bergman on the upper Koyukuk River approximately 8 miles southwest of the village of Allakaket (Alatna). The tree growth of this last section is sparse spruce. The ground covering is moss and niggerheads. There are no rock cuts and gravel can be expected. Soft ground exists in spots. There are two possible crossings of the Koyukuk River in the vicinity of Bergman, one of which is 1500 feet upstream, the other 4500 feet upstream, having widths of 720 feet and 1340 feet respectively. At the former the river has silt banks, whereas the latter crossing has good gravel banks. There is an island in the Koyukuk at the latter crossing which is also gravel. Local available information was to the effect that at times of high water the river remained within its banks at both crossings. To sum up, the route from Tanana to Alatna presents few difficulties other than the river crossings and the swampy terrain. From the crossing of the Koyukuk the route turns northwest 18 miles up the left limit of Pickarts Creek on an easy grade along gentle side hill slopes. There is a low divide at the head of Pickarts Creek leading into the east branch of Albert Creek. The actual divide is exceptionally low, both Pickarts Creek and Albert Creek meandering considerably near the headwaters. The divide itself is swampy although covered with several feet of snow at the time of the reconnaissance. The side hill slopes show no outcrops of rock. Following the right bank of Albert Creek the route reaches the main valley of Siruk Creek. Slopes in this valley are gentle and broad. The route continues along the right bank of Siruk Creek along gentle slopes. There is considerable spruce growth in this area. Continuing in a general westerly direction the route approaches the plateau between the Alatna and Kobuk River Valleys to the headwaters of the Hogatza River. From the low pass at the headwaters between Albert and Pickarts Creeks to the headwaters of the Hogatza River it is approximately 30 miles. Dense ground fog and deep soft snow prevented much reconnaissance work on the plateau. The crossing of the Hogatza is at a point where the river is 200 feet wide and free of bars. The flood plain is swampy with sloughs and old oxbows. There is some spruce timber of medium size in this vicinity. Continuing west, through 11 miles of swampy country, the route skirts the southern edge of Lake Norutak. This lake is bounded by rough glacial moraine rising 75 to 100 feet above the lake level. Lake Norutak is drained by Bridge Creek through a one-quarter to one-half mile wide gorge varying from 75 to 100 feet deep. The floor of this gorge is very suitable for a roadbed. From Lake Norutak it is approximately 10 miles to the Kobuk River. Crossing the Kobuk River the route continues down the right bank through a broad valley to a point two miles north of the village of Shungnak. From the crossing of the Kobuk to the point two miles north of Shungnak it is approximately 70 miles along benchland in the lower foothills of the Kobuk Valley. This valley is moderately covered with medium spruce and at the time of the reconnaissance was covered with a heavy layer of snow. The bench is mostly composed of sand and silt, is above the flood line and relatively flat. From Shungnak to the mouth of the Ambler River the Kobuk meanders across a wide, relatively flat valley to the extent that 100 river miles equal approximately 40 air miles. Sand ridges intersperse the tributary streams in this section. The Ambler River is approximately 100 feet wide two miles above its mouth. The sand banks reach a height of 100 feet on the Ambler River and a rock ridge extends across the river at this point. Below the Ambler the Kobuk is free of meanders across the valley floor although several large bends occur at the passes of benches on the right limit, especially in the regions of Tunuktuk and Kavet Creeks. Between these creeks on the left limit of the Kobuk there is an area comprising approximately 200 square miles which has been completely denuded by winds and blowing sand and now consists of dunes ranging from 50 to 100 feet in height between the troughs. This condition extends up along the slopes of the hills south of the Kobuk River to an elevation of perhaps 500 feet above river level. In places forest stands are exposed in the form of stumps as much as 30 feet below recent surface denuded by wind action. These sand dunes are not to be confused with silt (muck) deposits containing ice lenses. Continuing west the route crosses the Salmon River and follows the bench line crossing the Squirrel River just above the village of Kiana. Below Kallarichuk River the Kobuk edges into a right limit bank of coarse conglomerate and continues between high mountains to the vicinity of Kiana village where it again branches into many sloughs and emerges into a maze of channels on the flat delta. At Kiana the Kobuk and Squirrel Rivers oppose each other in flow at their junction which results in frequent floods in the valley, the waters sometimes backing up Squirrel River to Canyon Creek. Most of the delta of the Kobuk as well as the Baldwin Peninsula consists of muck and ice overlain by peat bogs and shallow lakes, most of which are of the "quaking bog" variety. From Shungnak to Kiana village the route is approximately 120 miles long. The forest growth decreases as the line continues west. The valley of the Kobuk averages approximately 10 miles wide. From Kiana the route continues 20 miles west before leaving the river to turn northwesterly skirting the Kobuk delta, thence continuing in a northwesterly direction along the foothills of Baird Mountains and Igichuk hills crossing the Noatak River 8 miles above its mouth, thence in a southwesterly direction to a point 4 miles northwest of the village of Shesualik, 10 miles distant across the sound from Kotzebue. The region between Kiana and Shungnak is practically uninhabited, the village of Kiana containing only 4 white persons.

g. Fairbanks to Deering. A practicable and feasible route to Deering, on the southern shore of Kotzebue Sound, does not exist. Not "practicable or feasible" inasmuch as better facilities exist at the six other possible terminals investigated. Further, a route around the eastern shore of Kotzebue Sound branching from the Fairbanks to Kotzebue route at the village of Shungnak would be a costly and difficult one, due to the fact that it must cross or skirt the deltas of the Selawik and Kiwalik Rivers.

h. Alternate Route from Koyukuk River to Port Clarence (Teller): Unfavorable weather and lack of time prevented the investigation before the date of the preliminary report of an alternate route to Port Clarence (Teller) via the Kateel and Koyuk River Valleys. An aerial reconnaissance of the section has since been made and a feasible route appears to exist. (See Vicinity Map - Appendix B-1).

Commencing at the western end of the Whakatna Valley north of Galena, bench land can be traversed to Koyukuk River at a point 24 miles north of its mouth. At this point a crossing can be effected. The route continues north along the west bank of the Koyukuk until the Kateel River is reached and a crossing is made near the mouth. In this section about 10 miles of low ground must be crossed. There is less of this type of terrain on this route than the Nulato route contains. From the mouth of Kateel River the route follows the north bank to the headwaters. Several small stream crossings are necessary requiring culverts or trestles and one stream will require a bridge. Side slopes in the Kateel Valley range from 10 to 20 percent and show no rock outcrops. Vegetation consists mainly of scrub spruce, grass and moss.

A pass less than 2000 feet in elevation separates the headwaters of the Kateel River and the Inglutalik River and no difficult construction would be found. A 20 mile section near the headwaters of the Inglutalik is rugged and the route must pass sections where side slopes are 40 to 60 percent, and in this section heavy cuts will be necessary. From here the route follows gentle hills to Koyuk River about five miles east of Dime Landing.

The distance from Whakatna Valley to the Koyuk River is approximately 25 miles shorter by the Kateel route than by the Nulato route. Sufficient information is not available to definitely decide which route is the better. However, from information now at hand the Kateel-Inglutalik route seems to be better than the Nulato-Shaktolik route.

From the Koyuk River crossing near Dime Landing the route to Port Clarence (Teller) may proceed northwesterly on the southern slopes of Koyuk Valley. The valley floor is flat with many lakes and swamps making it unsuitable for road construction, but the valley sides have gentle slopes, 5 to 10 percent, and provide good location possibilities. The route follows the Koyuk to its headwaters where a broad pass about 1300 feet in elevation leads to Imuruk Lake region and Kuzitrin River Valley. This is the section where relatively recent lava flows have spread out over the tundra in the Kuzitrin Valley bottom land. The transportation route does not cross much of this area but follows the mild northern slopes of Bendeleben Mountains. Vegetation consists only of grass and moss and construction should not be difficult. From the pass south of Imuruk Lake the route traverses the foothills to Bunker Hill and on to Pilgrim Springs where it joins the route previously described. This section from Dime Landing which follows the interior of Seward Peninsula is entirely feasible and provides a route 25 miles shorter than the southern route to Port Clarence (Teller). However, if Golofnin Bay is to be used as a secondary or primary port, the southern route is preferable.

This is the best Route by far. Except Bering Land Bridge

V. METEOROLOGY

1. The entire region from Fairbanks west to the Bering Sea Coast has similar meteorological characteristics. Precipitation is generally light, in no case exceeding 20 inches per year. At Kotzebue annual precipitation is only 6 inches, which is typical of the arctic regions. Nome and Ruby have the greatest amount, annual precipitation being 18 inches. Snow falls almost every month except June, July and August; however, it is only the winter snows which commence in October and November and continue in sizeable amounts until March or April that would be of concern in railroad construction and operation. Operation and maintenance of a transportation route in this area might be affected more by drifting snow than by the depth or amount of snowfall.

2. Along the Yukon and in the Seward Peninsula the spring thaw or "breakup" starts in May. During this period floods, which are the result of ice jams, may be expected. Nearly all the villages from Tanana downstream have been at least partially inundated at various times. The Yukon River is open for navigation usually by the third week of May and ships can get into Nome about June 1st. Sea ice along the coast from Golovin to Teller drifts southward leaving the coast open but, together with other ice packs, prevents ships from passing through Bering Sea. Kotzebue Sound is farther north and the breakup there is about one month later than Nome and Teller. Unalakleet and St. Michael being the most southerly ports are free of shore ice sooner but ships cannot reach them any earlier than Nome or Golovin due to the ice pack in Bering Sea.

3. Temperatures during the winter months are consistently low. Below freezing temperatures prevail from October to May with extreme low temperatures reaching -30 degrees and -40 degrees Fahrenheit at many stations throughout the area. Fairbanks has a somewhat colder winter and the temperature sometimes falls to -50 degrees or -60 degrees Fahrenheit. The summer season from June until September is warm and working conditions are excellent.

4. Meteorological records have been kept for 20 years or more at a few places in the area; at others regular weather observations have recently commenced and at present the entire area is well covered. A summary of available records is given below:

Station	Annual Means		
	Temperature °Fahrenheit	Precipitation Inches	Snowfall (unmelted) Inches
Kotzebue	21	6	74
Allakaket	19	14	67
Tanana	24	15	76
Nome	26	18	66
Nulato	25	16	71
Ruby	26	18	71
Nenana	27	12	75
Fairbanks	26	12	87
Teller (Port Clarence)	26	12	57
White Mountain	27	16	51
Council	24	17	65
Noorvik	22	15	-

MEAN MONTHLY AND ANNUAL TEMPERATURE
1921 to 1941, incl.

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Kotzebue	- 2.3	- 2.9	- 5.0	14.8	29.7	44.2	51.8	50.4	41.2	24.9	9.4	- 6.8	21.2
Allakaket	-14.6	-10.7	- 2.3	18.2	41.0	56.4	57.4	51.6	40.2	22.0	-3.7	-17.6	18.6
Tanana	- 9.1	- 5.2	5.3	24.5	43.8	56.6	58.0	53.2	40.2	24.9	3.5	- 8.5	24.1
Nome	4.7	5.5	7.6	20.7	33.5	44.6	49.5	49.4	42.0	29.8	16.3	8.9	26.3
Nulato	- 7.1	- 2.2	8.1	23.0	41.0	55.5	57.7	53.7	43.3	28.6	6.1	- 3.6	25.3
Ruby	- 4.3	- 3.9	5.4	27.8	42.7	56.6	57.3	54.7	44.7	28.2	4.9	- 5.5	26.2
Nenana	- 8.9	- 4.7	8.6	30.0	50.0	52.9	60.5	55.4	44.5	26.8	6.6	- 6.5	27.2
Fairbanks	- 8.5	- 2.5	9.1	28.6	46.6	58.1	59.4	54.6	44.1	27.7	5.3	- 7.2	26.3
Teller	- .5	1.1	8.9	21.1	30.2	46.4	52.3	52.0	42.5	30.8	16.9	5.9	25.5
White Mt.	1.8	3.5	9.3	22.6	36.8	51.9	54.4	51.2	42.3	27.6	13.0	6.1	27.3
Council	- 2.7	4.1	6.7	26.0	35.6	50.3	52.1	50.2	39.9	26.0	9.4	1.8	24.5
Noorvik	- 0.4	- 2.0	- 1.9	13.7	32.9	48.8	53.3	54.6	40.5	28.8	10.9	-12.0	22.3

MEAN MONTHLY AND ANNUAL PRECIPITATION
1921 to 1941, inclusive.
(in inches)

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Kotzebue	0.90	0.23	0.23	0.49	0.11	0.56	1.08	0.95	0.72	0.42	0.36	0.38	6.43
Allakaket	0.76	0.73	0.71	0.43	0.69	1.39	2.52	2.41	1.66	1.13	0.93	0.68	14.04
Tanana	0.96	0.70	0.58	0.27	0.61	1.44	2.54	3.09	2.57	1.09	0.78	0.53	15.16
Nome	1.31	0.74	0.91	0.80	0.50	1.18	2.42	3.71	3.11	1.68	0.99	1.13	18.48
Nulato	1.44	0.77	0.99	0.49	0.69	0.94	2.74	2.86	2.00	1.63	1.13	0.77	16.44
Ruby	1.90	0.80	0.84	0.40	0.77	1.03	3.54	3.93	1.98	1.06	0.96	0.81	18.03
Nenana	0.87	0.62	0.62	0.23	0.55	1.35	2.41	2.14	1.15	0.53	0.58	0.55	11.59
Fairbanks	1.13	0.52	0.50	0.27	0.59	1.25	1.98	2.22	1.32	0.87	0.70	0.53	11.88
Teller	1.85	0.75	0.43	0.91	0.58	0.63	1.54	2.03	1.77	0.57	0.73	0.47	12.26
White Mt.	1.51	0.73	0.70	0.34	0.30	1.07	2.47	3.17	3.45	0.81	0.66	0.87	16.08
Council	0.36	0.53	0.56	0.56	0.73	0.55	1.83	4.77	2.21	1.53	2.81	0.53	16.97
Noorvik	1.35	0.57	0.48	0.68	0.84	1.40	1.67	3.12	2.73	1.42	0.23	0.52	15.00

MEAN MONTHLY AND ANNUAL SNOWFALL (Unmelted)
(in inches and tenths)
1935 - 1941, inclusive

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Kotzebue	35.8	5.33	7.38	9.4	2.5	—	—	—	0.85	5.4	4.33	2.95	73.94
Allakaket	12.9	12.12	8.30	4.83	—	—	—	—	—	4.23	17.73	6.80	66.91
Tanana	14.0	11.12	11.75	6.05	—	—	—	—	3.0	14.83	6.40	9.16	76.31
Nome	12.95	8.93	12.75	7.73	2.73	—	—	—	1.0	4.17	7.83	7.86	65.94
Nulato	18.3	7.16	7.86	3.17	1.6	—	—	—	—	8.50	10.64	14.26	71.49
Ruby	21.1	5.00	7.87	3.50	3.40	—	—	—	1.0	6.60	12.10	10.13	70.70
Nenana	29.8	8.17	11.50	3.00	—	—	—	—	—	3.20	14.54	4.63	74.88
Fairbanks	23.4	8.04	12.55	4.13	0.80	—	—	—	0.70	11.36	15.45	10.04	86.52
Teller	17.0	6.05	5.96	10.0	5.07	—	—	—	—	3.00	5.60	4.23	56.88
White Mt.	9.0	8.32	10.33	6.07	4.90	—	—	—	—	0.95	3.00	8.90	51.48
Council	6.4	6.75	10.25	5.25	5.30	—	—	—	—	5.50	17.90	8.00	65.40

VI. VEGETATION AND FOREST GROWTH

(This section was written by Mr. James L. Giddings, Jr., Assistant Professor of Geology, University of Alaska, a member of one of the reconnaissance parties.)

The vegetation of the area west of Fairbanks can be described generally in three divisions: timbered areas, muskeg, and tundra.

1. Timbered Areas. The timbered areas are confined as a rule to valley bottoms of large rivers and tributary streams extending into the mountains only along creek beds. Certain favorable south hillsides lack a moss cover and support stands of timber of some importance, but these disappear towards the western coasts. Timbered areas fringe the shores of a river, its sloughs, and, to a certain extent, the dead sloughs representing old meanders of the stream. These areas usually are narrow, bordering on muskeg, and outlining permanently thawed subsoil. The vegetation here is relatively luxuriant, consisting of Alaskan spruce (Picea canadensis Mill.; Picea mariana Mill.), birch, poplar, alder, several varieties of willow, and cranberries, currants, ferns, and other small plants of similar associations. The ground underfoot is generally hard, though to a certain extent sphagnum moss is nearly always present. Redtop grass grows dense in cleared spaces along the stream edge of timbered areas. Birch, spruce, and poplar grows tall and large, furnishing birch bark suitable for canoe-making and spruce for saw timber. The growth of spruce in the timbered areas varies considerably. Favored stands may grow to an 18-inch diameter in 50 years, to 24 inches in 100 years. These rapidly growing trees are always straight-grained, tall and well formed. A special effect of latitude is always present in certain spruces of a stand, however, and becomes more and more prevalent towards "tree line" to the west and north, causing trees to grow slowly with a spirally twisted grain in both trunk and branches. These trees are invariably slower growing than straight-grained trees and live to a greater age; and since they are less suitable for lumber the decrease in saw timber is also marked to the west and north.

The oldest straight-grained trees (around 250 years) recorded in the interior of Alaska are also the largest (3½ feet in diameter; 125-150 feet tall). They are on Globe Creek in the Tolovana drainage. Trees with twisted grain, on the other hand, commonly reach 300-400 years of age without much increase in size.

A high proportion of straight-grained trees has been observed in stands along the banks of the Tanana and Yukon Rivers as far west as Tanana Village, at Alatna on the Koyukuk, in the headwaters of the Hogatza, and along the upper Kobuk as far west as Shungnak. From Shungnak to the mouth of the Kobuk timberline drops rapidly, timbered areas become more restricted, and tall trees suitable for lumber give way to stocky trees with a twisted grain and a rapid taper to the trunk. Except in a few limited localities, notably Noorvik on the lower river, the spruces from this point westward are not suitable for lumber, and have the appearance of timberline trees. On the delta of the Kobuk patches of spruce occur only at wide intervals, but some were observed within a mile or two of Hotham Inlet.

Extended observations along the Yukon and its tributaries have not been made, but it is assumed that somewhere along the lower Yukon a change takes place analogous to that on the Kobuk.

Timberline, the highest elevation at which spruce trees grow, ranges from 3,200 feet near Fairbanks to 2,500 feet on the upper Koyukuk, to 1,500 feet near Shungnak, to 500 feet or less where trees approach the Arctic Ocean and Bering Sea. Spruce reaches salt water only along the shores of Norton Bay, but approaches Hotham Inlet on the Kobuk delta and at the mouth of the Noatak River.

River bars adjacent to timbered areas, but subject to occasional flooding, are commonly covered with dense growths of alder and willow.

2. Muskeg. With the exception of the timbered areas and certain hillsides the interior of Alaska is covered with a plant association commonly known as "muskeg". Growing on top of permanently frozen subsoil, the muskeg consists of tufts, or "niggerheads", of bunch grass surrounded by sphagnum moss, out of which grow scrub spruce, tamarack, compact willow thickets, clumps of ground birch, and an assortment of small plants including cranberry, cloudberry, blueberry, and the Alaskan variety of Labrador tea. The muskeg contains numerous small pools, occasional "quaking bogs", and offers great resistance to mobility on foot or on wheel. Spruce trees growing in the muskeg often reach great age without attaining much size. More than 200 annual rings have been counted in muskeg trees less than one inch in diameter. The scattered muskeg trees have no value other than as poles for firewood, but they fill in large areas within the forested belt, as, for example, between the Koyukuk and Kobuk Rivers, and in the Hogatza drainage system.

3. Tundra. Towards the western coasts the muskeg gives way to tundra, which is identical with muskeg except for the absence of spruce and other tall plants. The tundra is a carpet of bunch grass, sphagnum moss, and lichens (reindeer moss), along with numerous low herbs, covering permanently frozen subsoil of a peaty nature. The "barren tundra" refers to great expanses above the surface of which stands neither tree nor thicket to break the monotony. Characterizing these regions are frost polygons forming a network of shallow, ditch-like depressions on the ground surface. In deep ravines willow and alder forms dense, impenetrable thickets from one to three feet high which appear to be almost solid across the top.

The tundra extends from "tree line" out to the coast along the edge of Norton Sound, over most coastal areas of Seward Peninsula, and around Kotzebue Sound, including the whole of the Baldwin Peninsula.

Where mountains of any size occur along the western coastal area, as on Seward Peninsula and in the lower Kobuk drainage, the slopes and ridges are largely free of vegetation other than grasses and herbs, and offer good footing for man and pack animal.

VII. GENERAL GEOLOGY

(This section was written by Mr. Ernest F. Fox, Professor of Geology, University of Alaska, chief of one of the reconnaissance parties).

The general geology of the area west of Fairbanks between the Kobuk and the Yukon River basins is so diverse that any general statement bears little significance without a confusing amount of supporting detail. Accordingly, in the following notes the country is covered by districts, beginning from the east, and attention is given only to surface geological features along the principal routes of interest.

1. Fairbanks - Tanana - Rampart Area. (Reference - U. S. Geological Survey Bulletins 535 and 872). Throughout a broad area south of Fairbanks, and extending westward down the Yukon, the main Tanana and Yukon River valleys and their tributaries are underlain by recent superficial stream and wind deposits. Since these sediments are so extensive throughout Central Alaska, particularly in all lowland regions and in most of the interior valleys, and since any overland transport route would advisedly follow them, they are of first interest in any consideration of the geology west of Fairbanks for this purpose.

In this area, as in most areas where they occur, these unconsolidated surface deposits are composed of "muck" (silt with black vegetal matter), stratified silt, and silt with lenses of sand and gravel. Commonly they rest on older, unconsolidated gravel deposits. As referred to in this report these "silt-gravel" deposits include recent flood plain alluvium, which, as is especially the case in the region of the Minto Flats and along most of the main rivers, are characteristically swampy with muskeg and old stream channels and oxbows; they include also, along many of the larger streams, at least one or more terraces at elevations from 75 to several hundred feet above the river flood plains, these terraces being generally uniformly flat or very gently tilted plains; in some regions also silt covers the hill slopes that bound the valleys as a thin veneer up to several hundred feet above the level of the streams and above the upper terraces.

In the vicinity of Fairbanks these silt-gravel deposits exceed 100 feet in thickness; elsewhere thicknesses of "a few feet" to over 100 feet are reported. In places where surface mining operations have encountered these deposits the muck and silt, and sometimes also the gravel, have been frequently found solidly and permanently frozen, and in places they contain also lenses of clear ice. Commonly, where moss-covered, they remain frozen to the moss-roots throughout the year, although when the moss is removed thaw sets in rapidly during summer.

In most places in Alaska road building experience on these deposits has revealed an ample supply of gravel for ballast, either from pebble lenses in the silt or from recent stream gravel derived from the silt-gravel deposits. Valleys underlain by these deposits are generally broadly flat and spruce covered.

From Tanana up to Rampart the main valley of the Yukon, as compared with the Tanana and Tolovana, is narrow and in part confined between rock outcrops, with the silt-gravel deposits at higher levels largely on the south side. This silt-gravel covered area extends also in a narrow strip (probably not deep) along the North Fork of Baker Creek from the Yukon Rapids, across the Baker drainage and up Niggerhead Creek to the Tolovana basin, so that a continuous route from rail head at Fairbanks to Dunbar to the Yukon Rapids is on silt-gravel deposits.

In the broad highlands (maximum elevations in the inter-confluence area between the lower Tanana and the Yukon is about 2,800 feet on Roughtop Mountain and 4,200 feet on Baldry Mountain) bordering this upland route between the Yukon and Tolovana Rivers, greenstone (altered basic lava, etc.), mixed limestone and sedimentary schist, and much distorted sedimentary rock formations outcrop in roughly northeast-southwest trending ranges through which are intruded granite (monzonite) stocks in the Hot Springs, Roughtop Mountain, and Yukon Rapids areas. Between the Tolovana and Fairbanks the highlands are of various metamorphic rocks, with mica schist and quartzite schist predominating.

At various points between the mouth of the Chena River (west of Fairbanks) and Nenana, and from the Minto Flats on the lower Tolovana two-thirds of the way westward to Tanana, these areas of bed rock outcrop approach or actually reach the north bank of the river, and at many places up the Yukon through the Rapids (Rampart) region the river is bordered by rock outcrop. Most prominent of these localities is at the Rapids where the Yukon is confined to a narrow, precipitous rock-cut gorge with walls of granite (or monzonite) rising to heights of 1,000 feet or more before they emerge with the surrounding hills.

2. The Middle Yukon - Tanana to Ruby. (Reference, U. S. Geological Survey Bulletin 631; see also Bulletins 667 and 754). The great plains of muck, silt, sand and gravel so wide spread along the lower Tanana south of Fairbanks and Tolovana, extend westward through the middle Yukon Valley, with the river bordering the northern limit of the plain. An embayment of these silt-gravel deposits (about 20 miles wide) extends north across the Yukon up the Tozitna River valley west of Tanana. Elsewhere between Tanana and Ruby a narrow sand and gravel terrace bounds the north bank of the river, except between the Tozitna and Grant Creek (first north tributary of the Yukon west of the Tozitna), where bluffs of quartzite schist, slate, etc. approach near the stream. With this apparently the only exception, the route along the north bank of the Yukon through this region is again over recent, unconsolidated clastic sediments. Bounding this narrow strip of loose material north of the river the hills which rise abruptly from the valley to 2,000 feet and over are of mixed metamorphic rocks (schist, schistose limestone, quartzite, and greenstone), with granitic intrusives.

3. Ruby - Nulato - Seward Peninsula. (Reference, U. S. Geological Survey Bulletins 631, 449, 773; also 247 and 328, which latter are not available for this report). From Ruby northwest across the Melozitna to the

head of Whakatna Creek, for five miles through the hills by the Melozitna Canyon, schist outcrop with little overburden is reported. The hills in general through this stretch west of the Melozitna are of clastic sediments (conglomerate and sandstone), metamorphosed locally near intrusives. Whakatna Creek valley reportedly is underlain by silt-gravel deposits, and these deposits cover another broad area 20 to 30 miles wide from the mouth of the Whakatna north along the east side of the lower Koyukuk River.

From the Koyukuk River westward across Seward Peninsula, the general nature of the terrain changes; the country for the most part is higher, the valleys are narrower, and the silt-gravel deposits are less widespread, being confined mainly to the Koyuk and Kuzitrin River valleys and the north coastal area of the peninsula, and to narrow strips along the smaller streams and the south coastal area.

Throughout the Nulato-Council region, that is, from the Koyukuk-Yukon basin west onto Seward Peninsula, the relief is in general about 2,000 feet above sea level, with few hills above 3,000 feet. In the Nulato-Norton Bay region, the highlands are formed by numerous parallel ridges of sandstone, slate and shale. Farther west on the peninsula other irregular highlands are made up variously of metamorphics, granite, and basalt.

Steep slopes lead from the stream bottoms to the highlands. The gradients of the main streams are generally low; gradients of the small tributaries rise rapidly headward. Main valleys in places are through narrow, shallow rock-walled canyons; in other places flat flood plains and gravel deposits occur along the streams.

The Nulato River valley is long and straight and narrow with a broad gravel-filled floor on which the stream meanders. Smooth slopes rise steeply from the valley floor to the uplands. A pass "easily traversable by horse" is reported between the Nulato and the Shaktolik. The valley of the Shaktolik is also comparatively broad and gravel-filled; and the Ungalik and Inglutalik likewise are in gravel-floored valleys.

The Gisasa River, a stream 70 to 100 feet wide along its middle course, is gravel bottomed along portions of its valley but in other parts it flows through a narrow cut between rock walls (sandstone, shale, slate) up to 50 feet high.

The general features of the Kateel River are similar to those of the Gisasa except that its valley is wider and it has longer tributaries. Low passes lead from the Kateel into the Ungalik (or into the Inglutalik), and probably also into the Buckland.

The Koyuk River, entering Norton Sound from the north, but trending mainly east-west from the central part of the peninsula, flows by tortuous meanders through a broad, in part swampy, valley. From its mouth to the mouth of the East Fork it is practically at sea-level as evidenced by upstream tidal currents. It is reported navigable by canoe past the mouth of Knowles

Creek, beyond which the valley narrows, the gravel fill ends, and the gradient steepens. The upper part of this valley, the pass between this valley and the upper drainage of the Kuzitrin River (estimated at about 1,300 feet above sea level), is across country covered by vesicular basaltic lava, resting on metamorphic rocks (mainly quartz schists) which outcrop in a few places only along the valley route, but which cover a large region south of the route.

No details concerning the Kuzitrin River are here available but in general it is known that below the upper reaches which drain from the lava country the valley is broad and gravel covered to its mouth in Imuruk Basin east of Port Clarence (Teller). The region around Port Clarence (Teller) is underlain by sedimentary and metamorphic limestones and slates.

4. Nulato - Kaltag - Unalakleet. (Reference, U. S. Geological Survey Bulletin 449 and Reconnaissance Canadian-Alaskan Railroad Party No. 5 Report of May, 1942). From the mouth of the Koyukuk River southwest by Nulato to Kaltag (and beyond) the Yukon River, except at the mouth of the Nulato and other smaller tributaries, bears close against hills of sandstone, shale, and slate on its northwest bank, while the broad silt-gravel plain referred to above (extending between Whakatna Creek and the Koyukuk) continues southwestward on the opposite side. Silt-gravel deposits are indicated in the lower valleys of tributaries that enter from the west.

From Kaltag west by way of the Kaltag and Unalakleet Rivers to Unalakleet, little is recorded of the geology. The Kaltag flows down from the hills of sandstone, shale, and slate mentioned above, with considerable silt-gravel fill in its lower valley. From the evidence of adjoining areas it is probable that these same rock formations extend considerably westward beyond the Yukon-Norton Sound divide. Reference is made to considerable talus along the headwaters of streams which flow from this divide. "Long benches" are mentioned as extending for nearly 20 miles west of the divide along the south side of the Unalakleet valley, but it is not known whether these are detrital or rock-cut terraces. Beyond this, in Old Woman Mountain and elsewhere along the middle Unalakleet, granite is reported. From this section there is said to be gentle slopes westward, with beach terraces along the coast south of Unalakleet.

5. Tanana North to Allakaket. (Reference, U. S. Geological Survey Bulletin 631). In large part this region is geologically unexplored. Geological reconnaissance by H. M. Eakin for the U. S. Geological Survey in 1913 indicates that the silt-gravel deposits form lowland plains across the central part of this region, flooring the middle sections of the Tozitna and Melozitna basins, which also are reported connected by a swampy, alluvial divide considerably lower in elevation than some of the hills bordering the lower courses of these same streams. A similar low alluvial divide is indicated as probably also connecting through to Kanuti River drainage, and hence through both by the Kanuti and Lake Mentanoutli to the Koyukuk. Excepting that the actual presence of the low Kanuti-Melozitna divide is not verified, the evidence again is that a route continuously through the area under consideration is possible on low, unconsolidated sediments.

The highlands of this area, bordering the lowland routes mentioned above, are made up in the south of various metamorphic rocks intruded by granite, and in the north largely of sedimentary rocks (conglomerates, sandstone, and shale).

6. Allakaket Northwest by Lake Norutak to the Kobuk River. (Reference, U. S. Geological Survey Bulletins 536, and 815; Reconnaissance Canadian-Alaskan Railroad Party No. 6, Report of May, 1942). Geologically this region is unexplored except that Reconnaissance Party No. 6 crossed it (during May when it was still snow-bound) and made general observations. The stream valleys in this area, even the smaller streams, are silt-gravel bottomed; bluff cuts along the Koyukuk and Alatna Rivers at Allakaket, Siruk Creek, and the upper Hogatza drainage, are all probably of silt with minor gravel lenses. Locally these larger valleys are swampy in flood plain areas, and the large area between the upper branches of the Hogatza are swampy. Around Lake Norutak, and between this lake and the Kobuk River are low hills (50 to 200 feet above lake level) and hummocky piles of glacial till composed mainly of silt with gravel and cobbles. The low ridges between the streams throughout the area, where observations have been made, are underlain by sandstone, conglomerate, and shale. From their low rounded form they appear to be soil-covered.

7. The Kobuk River Valley. (Reference, U. S. Geological Survey Bulletins 536 and 815). From its gorge between Lake Norutak and Reed River the Kobuk enters a valley some six miles wide in its upper reaches, and nearly twice this width below the mouth of the Pah River. This width of valley is underlain by silt-gravel terraces standing 100 to 200 feet above the stream which meanders over a flood plain incised through the terraces. Except that tributary streams also cut deeply through the silt-gravel deposits, the terraces are comparatively level and well drained. Bedrock outcrops occur only in the mountains which rise on each side of the valley. The valley is of this character westward to about 15 miles above Squirrel River, where, for a distance of 8 miles, the valley floor is only about 2 miles wide with rock outcrops (schist) on both banks of the stream.

Below Squirrel River the Kobuk enters upon the delta portion of its course, the delta being about 35 miles long and 20 to 30 miles wide. In this area the main stream splits into a network of channels with the intervening islands below flood level. Coastal lowlands of gravel and silt skirt the sides of the delta.

VIII. PREVIOUS INVESTIGATIONS

There is presented below a list of the reports, bulletins and writings, pertinent to the area considered, as are known and available to this office at the present time. All were considered in compiling this report.

"Geology and Mineral Resources of Northwestern Alaska", U. S. Geological Survey Bulletin 815, 1930.

"Southeastern Seward Peninsula and the Norton Bay-Nulato Region", U. S. Geological Survey Bulletin 449, by Philip S. Smith and H. M. Eakin, 1911.

"Geology and Mineral Resources of the Solomon and Casadepaga Quadrangles, Seward Peninsula, Alaska", U. S. Geological Survey Bulletin 433, by Philip S. Smith, 1910.

"Geology of the York Tin Deposits, Alaska", U. S. Geological Survey Bulletin 733, by Edward Steidtmann and S. H. Cathcart, 1922.

"A reconnaissance of the Cape Nome and Adjacent Gold Fields of Seward Peninsula, Alaska, in 1900" by Alfred H. Brooks, U. S. Geological Survey.

"Reconnaissance of Northwestern Portion of Seward Peninsula, Alaska", U. S. Geological Survey, Professional Paper No. 2, by Arthur J. Collier, 1902.

"A Geologic Reconnaissance of a part of the Rampart Quadrangle, Alaska", by Henry M. Eakin, U. S. Geological Survey Bulletin 535, 1913.

"The Yukon-Koyukuk Region, Alaska", by Henry M. Eakin, U. S. Geological Survey Bulletin 631, 1916.

"Surface Water Supply of the Yukon-Tanana Region, Alaska", U. S. Geological Survey Water-Supply Paper No. 342, 1915, by C. E. Ellsworth and R. W. Davenport.

"Mineral Deposits of the Rampart and Hot Springs Districts Alaska", by J. B. Mertie, Jr., U. S. Geological Survey Bulletin 844-D, 1931.

"Mineral Resources of Alaska - Report on Progress of Investigations in 1921", by A. H. Brooks and others. U. S. Geological Survey Bulletin 739.

"The Anvik-Andreafski Region Alaska", by George L. Harrington, U. S. Geological Survey Bulletin 683.

"The Kaiyuh Hills, Alaska", By J. B. Mertie, Jr., U. S. Geological Survey Bulletin 868-D, 1934.

"The Noatak-Kobuk Region, Alaska", by Philip S. Smith, U. S. Geological Survey Bulletin 536, 1913.

"Geographic Dictionary of Alaska", by Marcus Baker, 2d Edition, 1906.

U. S. Coast Pilot, Part II, 1938.

"Narratives of Explorations in Alaska" - Reference S-Rep. 1023 56 1, which includes the following reports:

"Reconnaissance of the Yukon River", by Charles P. Raymond.

"Population, Resources, etc. of Alaska, From the Census Report of 1880", by Ivan Petrof.

"Military Reconnaissance in Alaska", by Frederick Schwatka, 1st Lt. 3d Cavalry Expedition.

"Report of a Military Reconnaissance in Alaska" made in 1885 by Lt. Henry T. Allen, 2d U. S. Cavalry.

"Alaska - 1899, Yukon River Exploring Expedition", by Captain W. P. Richardson, 8th Infantry, U. S. Army, Commanding.

"Report on Survey of Tanana River, Alaska, November 1, 1940", submitted by the District Engineer, U. S. Engineer Office, Seattle, Washington.

"Report on preliminary examination of Grantley Harbor at Teller, Alaska", submitted by the District Engineer, U. S. Engineer Office, Seattle, Washington, September 30, 1938.

"Reconnaissance and Survey for a Land Route from Fairbanks to Council City, Alaska", by Major W. P. Richardson, Ninth Infantry. Senate Document No. 214, 59th Congress, 2d Session. (An excerpt of this report, "Railroad Route from Fairbanks to the Seward Peninsula", is included in Appendix D).

IX. FINDINGS

1. The purpose of this reconnaissance was to locate possible ocean terminals west of Fairbanks, Alaska, railroad or highway routes thereto, and to obtain all possible data on the routes and terminals. From the report of the reconnaissance, described in the preceding pages, from the reports of previous explorations and other available data, it is found that:

a. Ocean Terminals. General: Any ocean terminal selected north of Bering Strait would be limited to three months of open navigation. Any terminal selected south of Bering Strait and north of the Aleutian Islands can be considered on a basis of at least five, and possibly six, months of open navigation through the use of ice breakers. For this reason, terminal sites south of Bering Strait should be given more consideration.

Specific: There is little difference in the periods of open navigation on any of the possible sites investigated south of Bering Strait. The entire west coast of Alaska is shallow, having few possible ocean terminals. Norton Sound and the Bering Sea, as far south as Bristol Bay, are free of ice from approximately June 1 to October 30. Kotzebue Sound is free of ice from approximately July 15 to September 30. Of all possible ocean terminals investigated, only Port Clarence (Teller) and Golofnin Bay have the requisites of a major port. The other sites are unprotected and shoal and would require lightering. However, Unalakleet, because of its proximity to Fairbanks (500 miles) should be considered as a possible terminal. Port Clarence (Teller) is the best protected deep water harbor on the coast of Alaska north of the Aleutian Islands. It is on the western tip of the Seward Peninsula and an ocean terminal could be constructed there for handling cargo directly from shore to ocean going vessels. Depths are such that wharves can be built without dredging, and there is adequate space for terminal facilities such as wharves, warehouses, railroad yards and open storage space. Grantley Harbor, an arm of Port Clarence (Teller), is nearly landlocked and, with dredging, an excellent inner harbor could be provided.

Golofnin Bay, on the southern coast of Seward Peninsula, 70 miles east of Nome, is fairly well protected from all directions except south. The harbor does not have uniform depths and dredging would be required before dock facilities could be provided.

Unalakleet is a small native village on the southern shore of Norton Sound. There is no harbor and the waters along the coast at this point are exceptionally shallow. Ocean going vessels must stand six miles off shore to lighter their cargoes.

The remaining possible ocean terminal sites have been discussed in Section IV of this report. Decision as to the final location of the ocean terminal will rest on whether or not is more feasible to lighter at Unalakleet or to construct a railroad or highway the additional distance from Fairbanks to Golofnin Bay (94 miles) or Port Clarence (235 miles) where lighterage will not be required.

b. Routes to Ocean Terminals. The shortest and most logical route for a railroad or highway from the standpoint of construction, supply and maintenance, is westward from Fairbanks through the Yukon River Valley. This route has been described in detail in preceding paragraphs, and certain sections of it may be traversed by several alternate locations. The entire Yukon Valley route is feasible for construction of a railroad or highway. Extraordinary or difficult construction features will not be encountered and supply of construction materials and equipment will present the greatest problem. Access roads and expanded use of river transportation on the Yukon would be necessary for rapid construction. From the Yukon River Valley, routes were located to six possible ocean terminals.

The route to Kotzebue via the Tanana, Tozitna and Kobuk River Valleys presents more construction problems than the Yukon River Valley route. In addition, the maintenance would be greater on this northern route. The routes to St. Michael and Nome, while feasible, are not practical inasmuch as equal or better terminal facilities may be found at shorter distances from Fairbanks.

c. General Features. The western shore of Alaska is bounded by the Bering Sea and the southern Arctic Ocean, separated by the narrow Bering Strait. Fogs, mist, ice, or a combination of all three, are prevalent during most seasons of the year. The coast line is characterized in general by shoal waters with extensive silt or mud flats, particularly in the approaches to the various bays and rivers. There is little rock formation and its occurrence, where found, is limited in area. The topography along the routes varies from flat lowlands to rugged mountains not exceeding 5000 feet in elevation. Generally, railroad or highway construction would not require extensive excavation and the swampy lowlands may be skirted by following the foothills of the mountain ranges. The climate is severe, with long cold winters and short summers. Forest growth and vegetation are abundant in interior valleys although timber for construction purposes is generally scarce. Roads or trails suitable for the lightest vehicular traffic are practically nonexistent. Communication is by water, airplane and dog team.

2. In view of the findings set forth in paragraph 1 above, it may be seen that construction of a railroad or highway west of Fairbanks to a suitable ocean terminal on the Bering Sea is feasible and practicable. As is all Alaska construction, the work would be difficult due to problems of supply and equipment. Nevertheless, the project is feasible and could be done.

APPENDIX D

SEWARD PENINSULA

Reconnaissance and Survey for a Land Route from Fairbanks to Council City, Alaska - By Major W. P. Richardson, Ninth Infantry. Senate Document No. 214, 59th Congress, 2d Session.

Wherein is given a discussion of a

"Railroad Route from Fairbanks to the Seward Peninsula"

"As a number of railroads are being built and projected from open harbors on the south coast of Alaska to Fairbanks, careful consideration was given to the feasibility of a railroad route from Fairbanks to the Seward Peninsula.

"From Fairbanks a railroad route would cross the Goldstream Divide, and follow down Goldstream Valley to the east edge of the Tolovana flats. Crossing these flats to Niggerhead Divide, the projected line of the trail would be followed more or less closely to the Yukon River.

"In this distance of 127 miles, three divides will be crossed: The Goldstream Divide, at an elevation of approximately 170 feet above the Tanana Valley; the Niggerhead Divide, at an elevation of about 420 feet above the Tolovana flats; and Stephens Divide, at an elevation of 825 feet above the Yukon River. The approaches on both sides of these divides are over light rolling slopes, over which easy grades can be developed with little work. From Stephens Divide to the Yukon a maximum grade of 2 percent can be secured without materially increasing the length of the line.

"The only rivers of any size to be crossed in this distance are the Tolovana and Katathana. The width of the former is about 200 feet and the latter about 150 feet. The length of bridges over the other streams will not exceed 80 feet.

"The Tolovana flats will be crossed on a 3 to 4 foot fill. Short lengths of pile trestle would probably be required in a number of places.

"To a pier-bridge crossing of the Yukon there are serious objections. The run of ice at the breakup of the river in the spring is, I understand, greater than on any bridged river.

"The piers would have to be sufficiently massive to withstand an enormous pressure, and if placed close together they would cause ice jams the destructive force of which would be hard to estimate. Such a structure would have to be a draw span to permit the passage of steamers, and in few places along the Yukon, with the exception of the vicinity of the rapids, are the channels permanent.

"Below the mouth of the Tanana there is no place at which the channels are permanent and bed rock is undoubtedly at great depth.

"The most favorable site for a suspension or cantilever bridge is at the rapids. The span would be 1,250 feet, the width of the river at low water. On either side additional spans of 100 feet to high water will be required, and a clearance of 90 feet should be left for the passage of steamers. A height of about 150 feet would probably give the cheapest approaches.

"For a distance of 1½ miles of approach to the crossing at Rampart Rapids, and for a distance of 7 miles below it the work will be heavy along slopes of from 10° to 30°, and along which a considerable amount of solid rock will be encountered.

"From the crossing of the Yukon to the mouth of the Tozi, 26 miles will be along slopes of from 5° to 30°. Twenty-two miles will be over rolling benches, and tundra and marshy flats where short lengths of pile trestle will be required. The creeks crossed in this distance are all small streams, the longest bridge required being probably 50 feet.

"As the Kateel Valley will probably be followed west from the Koyukuk River, a more direct route than one following the Yukon might be found through the Melozi and Koyukuk ranges from some point up the Tozi Valley. It is certain that considerable adverse grade will be encountered on such a route.

"From the mouth of the Tozi to within about 3 miles east of the mouth of the Melozi, a distance of 97 miles along the right bank of the Yukon, about 27 miles will be along slopes of from 5° to 25° and 70 miles over rolling slopes and benches and across level flats. Material, principally gravel and loam, There will probably be an aggregate of 4 miles of heavy rock work in this distance.

"For the greater portion of the distance along the bank of the Yukon the roadbed would be from 5 to 25 feet above extreme high water. For short distances and to avoid heavy work the economical grade line would be at an elevation of from 50 to 100 feet above the river.

"The line would leave the Yukon River about 3 miles above the mouth of the Melozi and cross the latter at the trail crossing. Following the route of the trail there is an adverse grade of 430 feet in the 7 miles west from the crossing of the Melozi to the divide at the head of Whakatna Creek. The distance down Whakatna Creek to the junction of the Yukon and Koyukuk valleys is over light slopes where an easy grade can be developed with light work.

"Sufficient data was not obtained to decide as to the route for a railroad between the Koyukuk and Koyuk Rivers. This is an area of mountain ridges extending north and south at an angle of from 60° to 90° from a direct route across this region, and will be crossed only at a loss of distance. The probable route will be up the Kateel River and one of the tributaries to the summit of Brooks Divide, at the headwaters of either the Inglutalik or Ungalik rivers. If a practicable route can be found westerly from the summit of the divide around the headwaters of the Inglutalik into a tributary of the Koyuk, it would result in a saving of considerable distance -- 40 to 50 miles. If such a route is not to be had, the Inglutalik or the Ungalik would be followed southwesterly to the head of Norton Bay.

"From this point the probable railroad route would be up the Koyuk Valley to its headwaters. Crossing to the headwaters of the Kuzitrin, the latter would be followed westerly to a connection with the railroads building north from Nome and Solomon, which I understand are to be extended to the north side of the Peninsula. Such a route would pass through the center of the Seward Peninsula, from which all portions could be easily reached.

"The point of crossing of the Koyukuk River can only be decided after a careful examination is made of the river from its mouth to the mouth of the Kateel. The length of crossing will probably be about 1,200 feet. As the river is navigable, a draw span will be required. Although the crossing of this river will prove an item of considerable expense, I do not think any great difficulty will be encountered that cannot be readily overcome. The volume of water is probably not one-quarter the amount that is carried by the Yukon at Rampart Rapids and the current is slight.

"As the slopes on both sides of Brooks Divide are to a great extent rolling, I do not think any difficulty will be experienced in securing a maximum grade of 2 percent across this divide. Such a grade can be secured at the crossing of the divide at the head of the Caribou Creek.

"Although a considerable loss in distance will be encountered in crossing the region between the Koyukuk and Koyuk rivers, the greater portion of this distance will be in the river valleys.

"The length of a railroad route from Fairbanks to the head of the Koyuk River, crossing Brooks Divide by way of the Kateel and Ungalik rivers, will be about 620 miles. Aside from the crossing of the Yukon and Koyukuk rivers, which will be costly, no engineering difficulties will be encountered. With the exception of the short lengths of heavy work along the banks of the Yukon the line will for the greater length of its distance be through level valleys and along rolling slopes, where the work of construction will be light.

"With the rapidly increasing development of the mineral resources throughout Alaska the time is rapidly drawing near when a railroad from an open harbor on the south coast of Alaska will be extended through the interior to the Seward Peninsula. Nothing will conduce more to the opening up and development of this vast storehouse of mineral resources than the transportation facilities that a railroad will afford.

"Respectfully submitted,

J. L. McPherson,
Engineer in Charge,
Fairbanks-Council City Survey.

Maj. W. P. Richardson,
Ninth Infantry, President Alaska Road Commission."

APPENDIX E

List of Personnel

Captain James D. Bush, Jr. - Officer in Charge - Area Engineer Office, Anchorage, Alaska.

2d Lt. Byron J. Clark - Assistant Officer in Charge - Area Engineer Office, Anchorage, Alaska.

Bruce Rider - Assistant to Officer in Charge - U. S. Engineer Office, Fairbanks, Alaska.

Albert L. deBaer - Field Administration - Area Engineer Office, Anchorage, Alaska.

Party No. 1

Lawrence E. Hough - Chief of Party - Professor of Civil Engineering, University of Alaska, Fairbanks, Alaska.

Alfred M. Swarner - Assistant - Engineer, U. S. Smelting, Refining and Mining Company, Fairbanks, Alaska.

Charles A. Shade - Guide - Alaskan Guide, Nenaha, Alaska.

Party No. 2

Erwin F. Wann - Chief of Party - Engineer, U. S. Smelting, Refining and Mining Company, Fairbanks, Alaska.

Wallace Whiting - Assistant - Area Engineer Office, Anchorage, Alaska.

Ted R. Lambert - Guide - Alaskan Guide, Fairbanks, Alaska.

Party No. 3

George E. Purser - Chief of Party - Engineer, Livengood Placers, Livengood, Alaska.

Norman Sylar, - Assistant - Area Engineer Office, Anchorage, Alaska.

Party No. 4

Ben D. Stewart, Jr. - Chief of Party - Engineer, Alaska Road Commission, Fairbanks, Alaska.

Donald A. Fowler - Assistant - Engineer, U. S. Engineer Office, Fairbanks, Alaska.

Robert L. Buzby - Guide - Alaskan Guide - Fairbanks, Alaska.

Party No. 5

Irving McKay Reed,-Chief of Party - Mineralogist, Fairbanks, Alaska.

James F. Barkle - Assistant - Area Engineer Office, Anchorage, Alaska.

George W. Moore - Guide - Alaskan Guide,Fairbanks, Alaska.

Party No. 6

Ernest F. Fox - Chief of Party - Professor of Geology, University of Alaska, Fairbanks, Alaska.

Lee S. Linck - Assistant - Engineer, U. S. Smelting, Refining and Mining Company, Fairbanks, Alaska.
Ernest M. Johnson - Guide - Engineer, U. S. Engineer Office, Fairbanks, Alaska.

Party No. 7

Harry D. Draper - Chief of Party - Engineer, Fairbanks, Alaska.
James L. Giddings, Jr. - Assistant - Assistant Professor of Geology, University of Alaska, Fairbanks, Alaska.

Party No. 8

Clarence E. Isberg - Chief of Party - Engineer, U. S. Smelting, Refining and Mining Company, Fairbanks, Alaska.
Donald Davis - Assistant - Area Engineer Office, Anchorage, Alaska.
Keith W. Harkness - Guide - Engineer, U. S. Engineer Office, Fairbanks, Alaska.

Party No. 9

Captain B. M. Tanner - Chief of Party - Resident Engineer, U. S. Engineer Office, Nome, Alaska.
Dean Hodges - Assistant - Engineer, U. S. Engineer Office, Nome, Alaska.