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IN 1939 Alaska used about 10 million gallons of gasoline and about 53 million gallons of heavy oils.[1] This was before wartime needs became urgent. Every drop of that oil had to be imported, because, although oil is believed to exist in the Territory, none is produced.

The outbreak of war in Europe and the importance of Alaska as a base for possible action against Japan caused plans to be made for an overland link connecting Alaska with the United States. This took two forms. First came a string of large air bases; later in 1942 work was begun on a roadway connecting them. Each of these placed an increasingly heavy burden on oil supplies in the Northwest. The nearest available oil fields were those of California and the relatively small field in the Turner Valley, Alberta, which in normal times was able to produce about one-ninth of Canada's requirements. There was pressing need for an additional source of gasoline and oils near the Alaska Highway and, if possible, near Alaska itself.

Mackenzie River Oil

Oil has been known to exist on the Mackenzie for a long time—since Alexander Mackenzie noted the occurrence of "*Petrolium*, which bears a resemblance to yellow wax."[2] When the Turner Valley field was being developed before the First World War, a promoter urged Colonel J. K. Cornwall, a Northern trader, to invest money in the project. His reply was that he knew where there was far more oil than in the Turner Valley, and that was on the Mackenzie. In 1912 some claims were staked about 50 miles north of Fort Norman. In 1919 they were secured by the Northwest Company, a subsidiary of Imperial Oil, Ltd., of Canada, itself a subsidiary of the

* The author thanks the Hudson's Bay Company for transportation and other courtesies extended during the summer of 1942. He also acknowledges the generous facilities for research furnished by Dartmouth College.

This paper contains only data generally available to students and material based on the author's field work in 1942. The opinions are his own, and some of them are not concurred in by other Canadians.

[1] P. S. Smith: Mineral Industry of Alaska in 1939, *U. S. Geol. Survey Bull. 926-A*, 1941, p. 89 (noted in the *Geogr. Rev.*, Vol. 32, 1942, p. 488, "Oil Possibilities in Alaska and Western Canada").

[2] Alexander Mackenzie: Voyages from Montreal . . . to the Frozen and Pacific Oceans, in the Years 1789 and 1793, London, 1801, p. 79. See also R. G. McConnell: Report on an Exploration in the Yukon and Mackenzie Basins, N.W.T., *Canada Geol. Survey Ann. Rept.*, Vol. 4 (N.S.), 1888-1889, Montreal, 1890, Rept. D, p. 31.

Standard Oil Company of New Jersey. Development was begun after the war. The first well was drilled in 1920 on the right bank of the Mackenzie where Bosworth Creek enters it, on a location selected in 1914. A good flow of oil was discovered at 783 feet, and the well was later deepened to 1025 feet. It was believed capable of producing 100 barrels a day. During the next few years other drilling was done in the same area, but with less spectacular results. For example, in 1921 a hole was drilled on Bear Island but produced little oil, and another drilled to more than 3000 feet on the left bank of the river produced nothing. Although results were unpromising, the market was even less encouraging, and the wells were capped. In 1924–1925 another well was drilled, which produced about 100 barrels a day but was not used commercially. The discovery of radium on Great Bear Lake provided a local market at the mines, and in 1932 one of the old wells was opened up and a steam still that had been on the site for 10 years was put into operation. The mining of gold at Yellowknife, on Great Slave Lake, and the increasing use of Diesel boats on the river led to some expansion in 1939, when a new refinery was shipped in. In that year another hole, the seventh, drilled near the existing wells, produced nothing. At the outbreak of war[3] there were three producing wells, yielding perhaps 200 barrels a day, or about 24,000 barrels during the operating season, from May 10 to September 10. The refinery was capable of handling 850 barrels a day, producing Diesel oil, fuel oil, and gasoline as high as 87-octane. Storage tanks holding 12,500 barrels had been erected. During the summer of 1941, 80,000 gallons of aviation gas, 112,000 gallons of motor gasoline, and 230,000 gallons of fuel oil were distributed from the Norman wells. The sales area extended south to Yellowknife, where oil products shipped in from Edmonton were also sold. Gasoline retailed for about 30 cents a gallon (Imperial) at the wells.

The Norman oil pool occurs in a lowland between the Norman Range of the Franklin Mountains to the east and the Carcajou Range of the Mac-

[3] "In the so-called Norman pool five wells have up to this time been drilled, four more or less together and one about 3 miles distant from said group. Of these five wells only three can be called producers. Two of the producers are only 150 feet apart and the third is less than one-quarter of a mile distant from these two producers. The fourth well to date is nonproductive . . . The fifth well, which is approximately 3 miles from the producers, was a dry hole. . . . We should add that two additional dry holes were drilled about 5 miles to the southeast of the Norman wells in an endeavor to extend the field in that direction" (letter of Imperial Oil, Ltd., May 2, 1942, quoted in "Investigation of the National Defense Program; Additional Report of the Special Committee . . .: The Canol Project," *78th Congr., 1st Sess., Senate Rept. No. 10*, Part 14, 1944 [referred to hereinafter as the "Truman Report"], App. III).

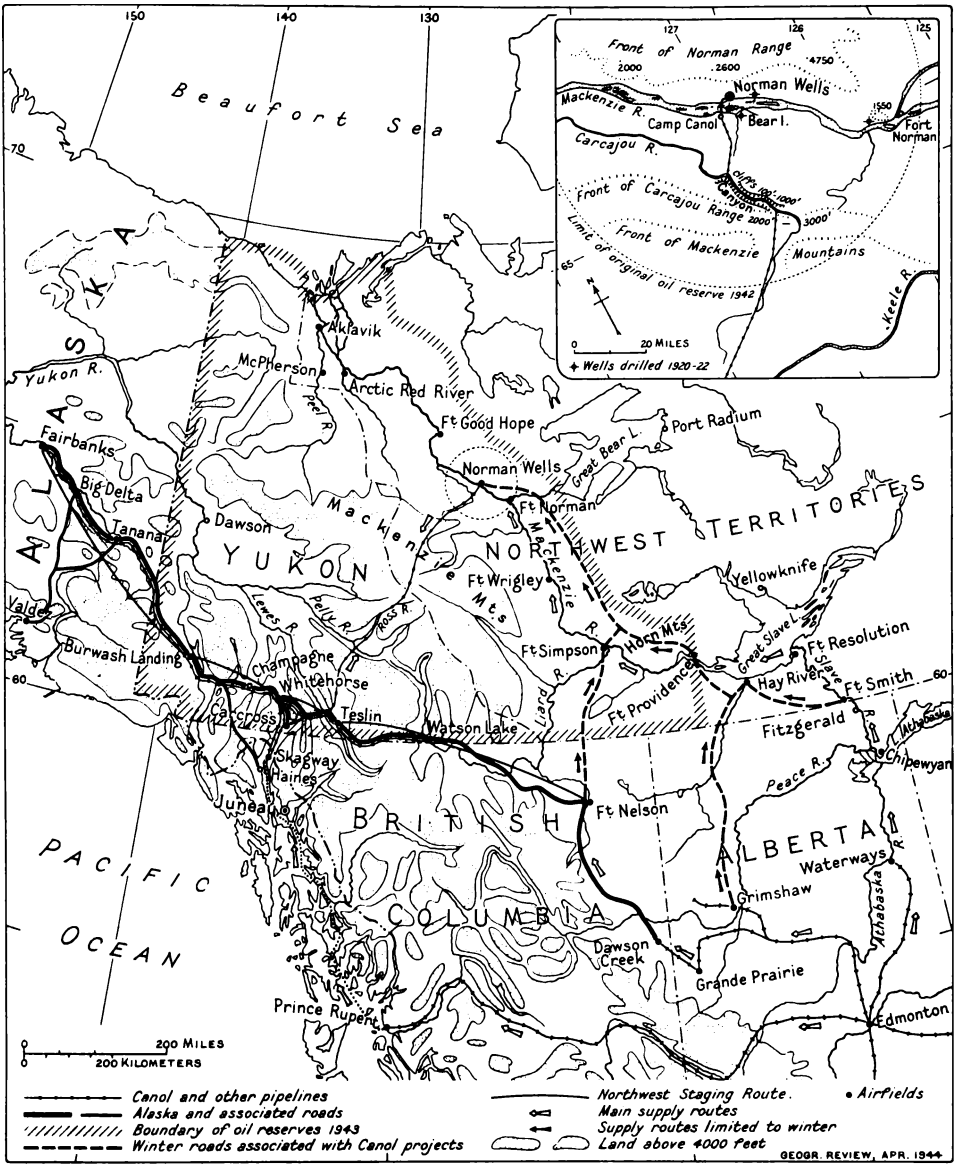

FIG. 1—Map showing supply routes of the Canol project (1 : 16,000,000). (See also maps accompanying Trevor Lloyd: The Mackenzie Waterway: A Northern Supply Route, *Geogr. Rev.*, Vol. 33, 1943, pp. 415–434.) Topography is from the Orographical Map of the Dominion of Canada and Newfoundland, 125 miles to an inch (1931) and the U. S. Coast and Geodetic Survey Aeronautical Chart, 1 : 1,000,000 (1941).

The inset shows the vicinity of Norman Wells. Topography is based on the Geological Survey of Canada Map, 1977 (1923) and the Topographic Survey, 1923, with data from the author's field notes, 1942. The circle showing a 50-mile radius from Norman Wells delimits the original petroleum reservation set aside in May, 1942; the extended reservation of 1943 is seen on the main map. The location of wells drilled 1920–1925 is indicated. Parenthetically it may be noted that four wells drilled between 1920 and 1930 at the western end of Great Slave Lake proved dry. Production of oil for the Canol project is from wells shown on the inset map and from others drilled in the same vicinity since June, 1942.

kenzie Mountains to the west.[4] One productive well is on a silt island in the Mackenzie; all the others are on the east bank of the river. Earlier drilling on the west bank failed to locate oil. Oil comes from the Upper Devonian Fort Creek formation, which is mainly black shale about 1500 feet thick, and from associated limestones. The wells are on the southwest flank of an anticline that forms the Norman Mountains about 6 miles northeast of the wells. The beds dip gently southwest and pass beneath the Mackenzie to form a syncline west of the river. On the flanks of this syncline the Fort Creek shales outcrop about 1½ miles to the northeast of the wells and 23 miles to the southwest.

Published expert opinion had not been optimistic about the discovery of any large source of oil in the area with a reasonable expenditure on drilling.[5] In the spring of 1942 geologists of Imperial Oil, Ltd., were extremely cautious in estimating what the oil field would produce if it were operated on a year-round basis.[6] However, it should be noted that the manager of Norman Wells is said to have believed that, if new wells were sunk, at least 5000 barrels a day could be found.[7]

Plans for Development

Between February and April, 1942, after it had been decided to build a road to Alaska, a hurried inquiry was made into the possibilities of developing the Norman field.

A memorandum recommending development of the field was submitted to the War Department on April 15, 1942. Two weeks later,

[4] C. S. Lord: Mineral Industry of the Northwest Territories, *Canada Geol. Survey Memoir 230*, 1941, p. 61; E. M. Kindle and T. O. Bosworth: Oil-Bearing Rocks of Lower Mackenzie River Valley, *Canada Geol. Survey Summary Rept.*, 1920, Part B, Ottawa, 1921, pp. 37-63, reference on p. 38.

[5] "From what is known at present it does not appear that the prospects for a large production of oil from this region are very favourable. Certain formations, however, are undoubtedly oil-bearing and a number of horizons are of sufficient porosity to act as oil reservoirs. Future possibilities would appear to depend upon the finding of favourable structures such as minor anticlinal folds superimposed on the general structure of the region" (F. J. Alcock, Geological Survey of Canada, in "Canada's Western Northland," Lands, Parks and Forests Branch, Dept. of Mines and Resources, Canada, 1937, p. 160).

[6] O. B. Hopkins: The "Canol" Project, *Canadian Geogr. Journ.*, Vol. 27, 1943, pp. 238-249; reference on p. 242.

"Accumulation of oil in this pool is controlled either by the existence of a shattered shale horizon or a very poorly developed sand lens and the lateral continuity of either of these conditions may be too limited for the development of any more than a very small pool" (letter of Imperial Oil, Ltd., May 2, 1942, quoted in the Truman Report, App. III).

[7] Richard Finnie: A Route to Alaska through the Northwest Territories, *Geogr. Rev.*, Vol. 32, 1942, pp. 403-416; reference on p. 414.

after a conference with representatives of the oil companies, a project was designed by the United States Army for the drilling of additional wells, the building of storage equipment at the site, the construction of a road and pipe line to Whitehorse, and the construction of a refinery there.[8] The first contract was signed on May 1, later ones about May 20. Meanwhile, by a Canadian Order in Council (P.C. 4140, May 18, 1942), a petroleum reservation had been set aside comprising all territory within 50 miles of the "Discovery well" at Norman Wells. Later Orders in Council (P.C. 1138, February 12, 1943, and P.C. 2447, March 26, 1943) included in the reserve all of the Yukon and the Northwest Territories west of a line about 75 miles east of the Mackenzie River. On June 29, 1942, approval was given by the Canadian government for development of new wells at Norman, the construction of a pipe line, and the building of a refinery at Whitehorse.[9] Details of the Canol project, as it was known, were not submitted for consideration or approval.

Under the various contracts, new wells were to be drilled by Imperial Oil,[10] a refinery was to be operated at Whitehorse by Standard Oil of California, and two American contracting syndicates under the supervision of the Corps of Engineers of the United States Army were to be responsible for the design and construction of the roads, pipe line, pumping stations, and ancillary works. The project was to be completed by October 1, 1942; i.e. five months after the signing of the first contract in Washington.[11] This meant that no plans would be needed for winter operations, since the work would be finished with the closing of summer navigation.

The original Canol project of May, 1942, was subsequently expanded, so that by August, 1942, it had become five projects in one. They were:

1. Drilling of wells near Fort Norman and erection of storage tanks.
2. Conveyance of the crude oil from the Norman Wells storage tanks to Whitehorse.

[8] The full text of these recommendations forms Appendix I of the Truman Report. The original recommendation seems to have been made under the impression that Whitehorse, location of the refinery, was in the Yukon, Alaska.

[9] Letter of the United States Minister to Canada, June 27, 1942. Text released November 19, 1943. Responsibility of the Canadian government was limited, at the request of the United States government, to: (1) acquiring lands and rights of way needed; (2) waiving import duties, taxes, etc. on imported equipment and salaries and wages of personnel; (3) remission of any royalties on the oil; (4) admission of United States citizens to Canada without formality.

[10] Clause 2 of the memorandum initiating the Canol project reads: "To arrange with the company [Standard Oil of New Jersey] for the drilling of a minimum of nine additional wells in the vicinity of Norman for added production by September 1942" (Truman Report, App. 1).

[11] Evidence of Lieutenant General Brehon Somervell before the Truman committee, Washington, December 20, 1943. See the Truman Report, p. 32.

3. Construction of a pipe line from the Pacific seaboard at Skagway, Alaska, to the Alaska Highway near Whitehorse.

4. Construction of a refinery at Whitehorse to use crude oil from Norman.

5. Construction of pipe lines for the distribution of oil products from the Whitehorse refinery and from Skagway.

Importance of Transportation[12]

The base of operations for the more important of the projects was to be Norman Wells. Effective work would begin there. To reach it from Edmonton there was a railroad running 270 miles north to Waterways and a series of rivers and lakes, interrupted at one point by a 16-mile portage, of 1170 miles. The equipment available on the spot to handle traffic along this route consisted of the steamboats and motor tugs of the Hudson's Bay Company and smaller commercial concerns, all of which were normally engaged in carrying supplies to trading posts and to mining camps such as Port Radium, Yellowknife, and Goldfields. In the heaviest year of freighting before 1942 the tonnage moved northward from Waterways was about 12,000.

The navigable waterway was made up of the shallow and twisting Athabaska River and treacherous Lake Athabaska, the Slave River and stormy Great Slave Lake, and the broad, swift Mackenzie. Along this route would have to go all the drilling equipment, the construction machinery, 15,000 tons of line pipe, and men and food. The time available was short; for nothing leaving Waterways after mid-September would reach Norman Wells before freeze-up.

Drilling New Wells

Drilling of the wells and erection of the storage tanks (item 1 above) offered no difficulties that are not inherent in such problems when carried out in the North. Given the need for the oil and the capital to undertake the work, the oil field, long suspected to exist, could have been uncovered at any time between 1920 and 1942.

Drilling was done by Imperial Oil using Canadian personnel from the Turner Valley field. The first new producing well was completed on July 17, 1942, and more than a dozen had been completed by the end of September. By January, 1943, the original flow of oil required for the project, 3000 barrels a day, had been reached. By November, 1943, 26 wells had been

[12] For a discussion of transportation in the region see Trevor Lloyd: The Mackenzie Waterway: A Northern Supply Route, *Geogr. Rev.*, Vol. 33, 1943, pp. 415–434.

completed in the Norman Wells area, of which 23 found some oil. The number of wells in this area "not completed" was not announced. As there had been 3 producing wells in 1941, the total number of wells in operation in November, 1943, was 26. These wells are variously estimated to be capable of producing 7500 barrels a day, 8500 barrels, and even 20,000 barrels. Production data for the Norman wells, so far as available, is shown below.

PRODUCTION OF CRUDE PETROLEUM IN BARRELS*

1938		1939		1940		1941		1942	
AMOUNT	VALUE	AMOUNT	VALUE	AMOUNT	VALUE	AMOUNT	VALUE	AMOUNT	VALUE
22,855	$68,565	20,191	$50,633	18,633	$37,265	23,664	$47,328	75,789	$108,477

* Data from Dominion Bureau of Statistics.

During October, 1943, 23,359 barrels was produced from 10 wells on 105 well days. This averages about 220 barrels a day for each well. At the end of 1943 production of oil products from the Norman field was limited by storage and refinery capacities. Three tanks erected during 1942–1943 have capacities of 80,000, 80,000, and 30,000 barrels respectively. Between March 1 and October 31, 1943, the refinery processed 151,830 barrels of crude (the total for the ten preceding years was 119,000 barrels). Eighty per cent of the crude was being obtained from wells drilled on the original leases held by Imperial Oil since 1920.[13] The cost of drilling the new wells was about $2,000,000 for those completed by January, 1943, and an additional $3,000,000 for those completed in 1943.[14]

CONSTRUCTION AT WHITEHORSE

Items 3, 4, and 5 (p. 280) should also have been within the normal sphere of petroleum engineering. Under approval of the Canadian government on August 15, 1942, a 110-mile, 4-inch pipe line was laid to convey to Whitehorse oil arriving at Skagway by tanker. It was completed long before the refinery, dismantled and moved from Texas, was ready for operation (now planned to be completed in May, 1944).[15] A serious difficulty

[13] For many years Imperial Oil held five leases and one permit in the area, a total of about 3400 acres. Thirty-six further permits (each of a maximum area of 4 square miles) were granted to the company under an Order in Council dated January 28, 1943 (House of Commons Report, June 23, 1943).

[14] Data from Standard Oil of New Jersey. To December 1, 1943, somewhat more than $8,000,000 had been expended "for prospecting and exploration" in the Norman area (Truman Report, p. 5).

[15] Originally the refinery was to have used the Houdry process, but the shortage of certain strategic materials caused it to be redesigned. By the use of the Houdry process the daily output of 100-octane gasoline would have been about 1500 barrels; by the use of the present thermal process production will be 479 barrels of aviation stock a day. The refinery used 7787 tons of new steel and will cost about $24,000,000 (Truman Report).

—common to all operations in the Yukon area— in the laying of the pipe line and the building of the refinery was the 36-inch-gauge railway linking Whitehorse to the sea at Skagway, which was incapable of handling all the freight needing to reach the interior.[16]

The distribution pipe lines (item 5), which are of 2-inch and 3-inch diameter are laid along the Alaska Highway. They convey gasoline and other oil products arriving under high pressure from Skagway northward towards Fairbanks and southward as far as Watson Lake. Eventually oil from Norman Wells, refined at Whitehorse, will also use these lines. The plan to build a pipe line and winter road from Fairbanks to Tanana, on the Yukon River, as part of the Canol project was abandoned sometime between April 1 and July 1, 1943.

The Canol Pipe Line

The only unusually difficult part of the Canol project was item 2—the conveyance of the crude oil from Norman Wells to Whitehorse. A variety of methods for doing this were suggested, including the use of tank trucks, with a pipe line if the demand sufficed. The possibility of using tankers from the Mackenzie River to Alaskan seaports was also mooted.[17] The Imperial oil company suggested the use of tank aircraft.

There was, however, apparently no hesitation on the part of the Army engineers in selecting a pipe line. The controversy over the Canol project has concentrated mainly on the wisdom of building the pipe line from Norman Wells to Whitehorse, and it alone accounts for a large part of the cost[18] and has given rise to most of the difficulties.

Transporting Equipment

In 1942 navigation at Waterways opened on May 12. On May 27 the United States War Department notified the Hudson's Bay Company, the

[16] This led to the construction of a by-pass road from Haines, on the coast, to the Alaska Highway near Champagne, along which much traffic intended for Fairbanks could be rerouted. The usefulness of this cutoff for northbound traffic has been curtailed in summer because of interruptions on the main road. Operation of the Skagway-Whitehorse pipe line has not been continuous. Several breaks are reported.

[17] See Lloyd, *op. cit.*, pp. 431–432, for comments on this.

[18] Approximate costs at November 1, 1943, of the completed project were said to be $134,000,000, made up of distribution lines and docking facilities at Skagway, $35.000,000; prospecting for oil and developing new wells, $17,000,000; construction of the pipe line from Norman Wells to Whitehorse, $31,000,000; erection of refinery at Whitehorse, $24,000,000; and improvements in transportation along the Mackenzie route, $27,000,000 (Truman Report, p. 1).

most important shipping agency, that it had 30,000 tons of Canol freight to be sent to Norman Wells, in addition to hundreds of troops and civilians.

The first United States engineers arrived at Waterways at the beginning of June. With them came trainloads of pontoon bridge-building equipment, bulldozers, and trucks and a large party of men from Missouri, to build and operate wooden barges needed to ship the equipment to Norman. Because of the haste with which the undertaking had been begun, the enormous amount of incoming freight was at first unloaded by labor recruited in response to a radio appeal made the day before in Edmonton. Later, 2000 colored troops were available. They carried the burden of the heavy work done throughout the summer of 1942. Early efforts were concentrated on constructing a camp at "The Prairie," a short distance beyond Waterways, extending the railroad tracks toward it, and clearing space for the incoming material. Equipment and line pipe, which were arriving continuously, needed to be shipped northward toward Norman Wells. Most of the existing tugs and barges were already being used for normal summer work, arranged for many months in advance, and the newcomers set to work to make emergency arrangements.

Wooden barges were built at The Prairie by civilian labor while the Corps of Engineers assembled rafts from bridge-building pontoons. These rafts, loaded with trucks, small cranes, gasoline, and line pipe, were pushed down the Athabaska River by small speedboats. The experiment led to some astonishing experiences for the engineers, some of whom at one time suggested that they were entitled to submarine rates of pay. After a good deal of trouble with sandbanks in the river and wind and rough water on Lake Athabaska, some heavy cargoes arrived at Fitzgerald. They were unloaded and trucked over the portage road to be reloaded at Fort Smith.[19]

As wooden barges built at The Prairie became available on the southern part of the waterway, the pontoons were moved across the portage for use between Fort Smith and Norman Wells. However, this part of the route offered far more serious navigation problems. The Slave River, made choppy by the wind, swamped several open-topped pontoons. The 110 miles of open water in Great Slave Lake, leading to the long, wide, and

[19] It has been widely reported that the 16-mile portage road from Fitzgerald to Fort Smith was constructed as a part of the Canol project. This is not so. Two roads have existed there for some years. New work was limited to cutting short interconnections between them at 1-mile intervals to speed up traffic, and to strengthening culverts. For a photograph of a tractor hauling oil-drilling equipment over this road in 1921 see E. M. Kindle: Canada North of Fifty-Six Degrees, North West Territories and Yukon Branch, Dept. of the Interior, Canada, 1928, Fig. 27B (opp. p. 76).

FIG. 2—Fitzgerald, northern terminus of the water route from Waterways. Freight and equipment are transferred here across a 16-mile road to Fort Smith to avoid rapids on the Slave River. (National Film Board, Canada.)

FIG. 3—Line up of graders in the road-equipment yard at Waterways. (E. Sykes.)

FIG. 4—Canol steel tug and loaded barge setting off from the dock at Fort Smith on the 900-mile journey down the Mackenzie to Norman Wells. (National Film Board.)

FIG. 5—Hudson's Bay Company barge being transferred from Fitzgerald to Fort Smith. (Caterpillar Co.)

windy Mackenzie, was an impassable barrier for this type of equipment. To speed up transportation, parties of troops were located at strategic points along the route. They were intended to handle freight, prepare camp sites, and operate radio stations.[20]

Most of the delays in transporting the equipment needed for the pipe line were due to foreseeable natural hazards. Lake waters were stormy, and particularly dangerous to those accustomed to the calmer, well lighted waterways of the United States. The plagues of mosquitoes, "bulldog" flies, and other pests added their quota to the sufferings of the newcomers. Forest fires at one time threatened to cut the vital portage between Fitzgerald and Fort Smith, and there was no adequate equipment to deal with them. Late in the summer the deep, sandy soil of the Fort Smith portage, which had been unpleasantly dusty for two months, was turned into a quagmire by heavy rains. As the season advanced, many plans had to be radically modified. Both Army officials and contractors found that distances were far greater than had been thought. Shipping was more hazardous, and the navigation season was unexpectedly short.

Although taking no formal part in the Canol project, various local Canadian authorities offered help as it was needed. The Mackenzie region has been used for fur trading for some 150 years, and a line of settlements along the route to Norman Wells meant that many kinds of assistance were available. The Hudson's Bay Company not only moved thousands of tons of freight but was able to supply materials and services from its trading posts as emergencies arose. Tonnages of Canol freight handled during the summer of 1942 were:[21]

	WATERWAYS TO FITZGERALD		FORT SMITH TO NORMAN WELLS	
	Tons (300 miles)	*Percentage*	*Tons* (900 miles)	*Percentage*
U. S. Army	9,135	30	1,450	15
H. Bay Co.	15,000	50	6,000	60
Others	5,265	20	2,300	25

[20] Early in the summer a camp was opened at "Sawmill Snye" near Chipewyan in an effort to hasten the transfer of material across Lake Athabaska, since water was falling rapidly in the Athabaska River. Another camp was located at "Resdelta," the mouth of the Slave River, to handle supplies freighted down the river but unable to cross Great Slave Lake. A third camp was opened at Wrigley Harbour, Brabant Island, at the entrance to the Mackenzie. It was intended to transfer freight here from lake barges to river barges. Toward the end of the summer small camps were set up at Providence, Fort Simpson, and Wrigley.

[21] Data from *The Beaver*, Sept., 1943, p. 5. Data for 1943 are not available except for the freight moved by the Hudson's Bay Company: Waterways to Fort Smith, 12,000 tons; Fort Smith to Norman Wells, 4500 tons. Other shipments were made by a United States concern, Marine Operators. It has been stated that 40,000 tons left Waterways and that about the same tonnage reached Norman Wells.

The Canadian Corps of Signals, through the radio stations established about 20 years before at strategic points, was able to relay the messages of United States Army signalers and to assist them in setting up their equipment and learning the techniques of Northern operation. The only airplanes available throughout the first summer were the few regularly operated by Canadian Pacific Airways on its mail and passenger routes. The demand placed on them was extremely heavy, and the resulting congestion was accentuated by a reduction in flying time due to smoke from many forest fires.

By the end of the summer of 1942, as thin ice was beginning to form on rivers and lakes, and when soldiers and civilians were ready to move out of tents into warmer habitations, those responsible for constructing the pipe line realized that they had undertaken a task that would scarcely be begun by October 1.

After four strenuous months they could list the following achievements:

1. A line of summer camps had been set up between Waterways and Norman Wells, some of them with radio facilities and Army personnel attached.

2. Air landing strips had been roughed out at Waterways, Fort Smith, Hay River, Fort Simpson, and Norman Wells, and wheel planes were operating in the region for the first time in its history.

3. Contractors had installed the advance guard of their men at Camp Canol, across the Mackenzie River from Norman Wells.

4. A good deal of heavy equipment—bulldozers, tractors, graders, carryalls, trucks, etc.—had been distributed up and down the waterway.

5. Moving the 15,000 tons of line pipe to Norman Wells had been only partly successful. Practically none had reached its destination, but 9000 tons was stacked for the winter at the mouth of the Slave River, on the south side of Great Slave Lake, halfway to Norman Wells. The remainder was to be shipped to the Whitehorse end of the pipe-line route.

As the unfamiliar winter closed in on the soldiers and civilians, a route for the pipe line from Norman Wells across the Mackenzie Mountains to Whitehorse was still to be found.

Winter Freighting

When the project organizers realized, during August and September, 1942, that the pipe line was not going to be finished before winter, and possibly not before a second winter, plans were radically altered. It became imperative to utilize every possible means of shipping supplies and equipment to the men already at Norman Wells. This caused a last-minute rush of boats and barges northward in September, and several of them were

frozen in for the winter near Norman Wells.[22] Because of this they faced the long journey southward to Fort Smith with empty holds in June, 1943, before they could be used to carry further tonnage northward. New landing strips for aircraft made it possible to fly in emergency personnel and special equipment, but ground communications had to be established to provide the stores and construction materials that would be needed for the pipe line long before the first boats could arrive in 1943. A system of winter roads or trails to be used by tractors and sledges was decided on. Men long resident in the region had noted with surprise that the freight arriving during the summer of 1942 did not include sledges for use in winter. Because of this, much of the equipment had to be constructed locally.

Among the disadvantages of the Mackenzie River as a summer navigation route is the fact that it cannot be reached from Fort Smith until long after it is free of ice. The obstruction is caused by ice in Great Slave Lake. To overcome this, it was long ago suggested that an overland route should be opened from the Peace River region to Providence, on the Mackenzie.[23] The beginning of such a route existed in 1942 in an all-weather road running 85 miles northward from the railroad at Grimshaw. From its end a winter trail continued to Hay River, on Great Slave Lake. During the early part of the winter of 1942–1943 the trail was improved and in places relocated, and a cutoff was made from Alexandra Falls to Providence. Tractors were for a time unable to make effective use of parts of this route because of a lack of snow, and much of the freight that eventually passed over it was carried by trucks. When the trail was opened, about 9000 tons of freight awaited shipment at Grimshaw, but no data are available on the tonnage that ultimately reached Providence. Meanwhile, contractors seeking other routes to Norman Wells used the Alaska Highway as far as Fort Nelson and cleared a winter trail from there to Fort Simpson.

To the winter-bound men in Camp Canol such plans were of little use unless a trail could be made that would link them to Fort Simpson or Providence. This was clearly a difficult undertaking. The country to be crossed was largely unexplored and mountainous. However, by the middle of February, 1943, bulldozers had cleared a trail roughly parallel to the Mackenzie River but about 50 miles to the east, crossing the Great Bear River and passing through the Horn Mountains. During the next two months a

[22] Photograph in *The Beaver*, Sept., 1943, p. 14.

[23] Stefansson proposed in 1921 that a railroad should be built to reach Great Slave Lake at Hay River Post.

FIG. 6—Four-inch Canol pipe being laid at the eastern end of the route. (Caterpillar Co.)
FIG. 7—Pipe being laid along the Alaska Highway. (National Film Board.)
FIG. 8—Winter freighting by tractor and sledge in northern Canada. (Caterpillar Co.)

small number of trains of sledges hauled by tractors were able to reach Norman Wells from Providence and Fort Simpson, but it was definitely an emergency operation. The Mackenzie itself had been suggested as an obvious winter sledge road,[24] but it was used only as a bridge for crossing from bank to bank near Providence, near Fort Simpson, and between Norman Wells and Camp Canol. Use of the winter route from Grimshaw to Norman Wells has been discontinued by the United States Army.

Among the most effective pieces of midwinter freighting was that across Great Slave Lake from the delta of the Slave River. Of the 9000 tons of line pipe left there, about 2200 tons was hauled on sledges to Mills Lake, near Providence, during March and April, 1943, by a private contractor from Yellowknife.

One additional important aid to transportation was prepared during the winter of 1942–1943. Experience during the previous summer had shown that the most serious delays were due to lack of suitable barges and tugboats to carry material across the lakes and down the Mackenzie. This was remedied by the construction during the winter of large wood and steel barges at Waterways and by assembling there prefabricated steel tugboats powered with large Diesel engines. Thus, in spite of the absence of much Hudson's Bay Company equipment at Norman Wells during the early part of the summer, freight was able to move forward from the railhead as soon as the Athabaska River opened.

Finding a Route for the Pipe Line

Norman Wells is on the right bank of the Mackenzie River, about 280 feet above sea level. Whitehorse is on the left bank of the Lewes River, 2083 feet above sea level and somewhat more than a hundred miles inland from the Pacific Ocean but separated from it by high mountains. Although the two ends of the projected pipe line are little more than 400 miles apart, any practicable route between them needs to be at least 550 miles long. Across such a route lie several important headwaters of the Yukon—the Teslin, the Big Salmon, the Pelly, and the Macmillan—and the Keele and Carcajou Rivers, which are tributaries of the Mackenzie. The divide between the Yukon drainage basin and that of the Mackenzie lies about 180 miles

[24] "The Mackenzie itself is a road—ice for tractors and trucks in winter, water for boats and barges in summer" (Finnie, *op. cit.*, p. 416). It should be added that Finnie, after experience in the area with the Canol project, does not now believe that such "river roads" are practicable. On the other hand, Stefansson, drawing evidence from Siberia, is still convinced that by using the proper methods winter sledge roads on large rivers are possible.

FIG. 9

FIG. 10

FIG. 9—View of the Itsi Mountains from Ross River (Keele's Pl. V). These rugged granite peaks lie southwest of the Atlantic-Pacific divide at Christie Pass.

FIG. 10—Wilson Peak from Christie Pass (Keele's Pl. VIII).

Figures 9 and 10 are two of the many interesting views in the Mackenzie Mountains illustrating Keele's report (see footnote 26). They are reproduced by courtesy of the Bureau of Geology and Topography, Ottawa, Canada.

southwest of Norman Wells and is formed by the crest of the Mackenzie Mountains.

They resemble the Rocky mountains in general characteristics and are made up of a series of parallel ranges striking northwesterly in the southern part and almost east and west in the northern part.[25]

In 1941 the range still was largely unexplored. Joseph Keele, a Dominion government geologist, had crossed it from the west in 1907–1908, following the Gravel (Keele) River. His report and the map included with it conform to the best traditions of the Canadian Geological Survey. The map, on the scale of 8 miles to the inch, is a careful track survey by compass and micrometer checked by transit bearings every 6 to 10 miles. Parts of it were published in "The Wilderness of the Upper Yukon" by Charles Sheldon (1911), and it is still the best available survey of the route from the Mackenzie River along the Gravel River to the Christie Pass, described on Keele's map as "Pacific-Arctic Watershed about 4525'." Keele called the range "the greatest mountain group in Canada" (see two of his photographs, p. 291).[26]

As no detailed maps of most of the area existed and the schedule did not permit adequate aerial and ground surveys, a provisional route had been decided on after a hurried aerial reconnaissance flight made on June 6, 1942, between Norman Wells and Whitehorse. It was to run northward along the right bank of the Mackenzie River for about 17 miles, at which point a crossing was to be made near Ogilvie's Island. From the west bank the line was to run inland to the Carcajou River. This was to be followed for some miles when the line would run across country toward the headwaters of the Keele River and thence over the divide at Christie Pass. Once on the western slope it would follow the Ross River, cross the Pelly, and eventually join the Alaska Highway a few miles west of Teslin. The western part of the line traversed country relatively well known and was eventually followed fairly closely. On the east side of the divide important changes became necessary as exploration advanced. The natural hazards to be overcome included a climb of about 4000 feet to reach the Yukon boundary; a good deal of muskeg, which, although frozen in winter, becomes a shifting marsh in summer; and glacier-filled streams and narrow canyons passable

[25] Charles Camsell and Wyatt Malcolm: The Mackenzie River Basin, *Canada Geol. Survey Memoir 108*, 1919, p. 16.

[26] Joseph Keele: A Reconnaissance across the Mackenzie Mountains on the Pelly, Ross, and Gravel Rivers, Yukon and North West Territories, Canada Geol. Survey, Ottawa, 1910, p. 13.

late in the summer and in the winter but raging torrents in the spring. Early attempts to survey a route for the pipe line from the Mackenzie River at Ogilvie's Island westward to the Carcajou River were given up after a few miles because of the widespread muskeg encountered. In August, 1942, Canadian Pacific Airways photographed the country between Norman Wells and Whitehorse, so that reconnaissance parties could be sent out to select the best route, aided by the aerial photographs.

Laying the Pipe Line

During the busy winter many parties using dog teams traversed the interior between the Mackenzie and Pelly Rivers.[27] By May, 1943, a route had been finally selected. This done, work proceeded as follows. Survey parties working from east and west[28] followed the selected route, laying out the precise course and choosing sites for 10 pumping stations at intervals averaging about 50 miles.[29] They were followed by bulldozers, which roughed out a trail to be later improved by road-making equipment until it was passable for trucks. These brought in camp equipment, supplies, and men and finally the 22-foot lengths of 4-inch pipe to be laid on the ground and welded.

By the first of October, 1943, 16 months after the beginning of the project, the "tote" road from the west side was within about 75 miles of the divide, which forms the Yukon boundary. From the east side, road construction had reached a point about 60 miles from Camp Canol, or within about 120 miles of the boundary (by air-line distance). Construction of the pioneer road was completed on January 5, 1944. This is a winter trail in many places, passable only because the ground is frozen. It may well be unusable after the Spring thaw. Where much muskeg was encountered, a reasonably good road has been made by adopting the technique perfected in building parts of the Hudson Bay railroad to Churchill, Manitoba, some

[27] Of the seven parties that attempted to find a suitable route, only one was successful. This was led by the veteran Northern surveyor G. H. Blanchet. On April 1, 1943, the advisers to the War Department said: "Reconnaissance surveys over the general area involved have been made and approximate profiles obtained. While the route has not yet been completely determined, we do know that extremely difficult, mountainous country must be traversed" (letter of Standard Oil of California, quoted in the Truman Report, p. 12).

[28] Because of the difficulty of transporting material by the Mackenzie route, plans had been made to lay half of the pipe line from the west end. This was made easier by the fact that the first 75 miles from Whitehorse followed the Alaska Highway.

[29] With a 4-inch pipe line, 12 pumping stations would be needed. With a 6-inch line, it is said that only 2 would be needed for the same amount of oil. Inasmuch as about a hundred miles of 6-inch line was actually laid at the west end of the route, the number of pumping stations being built is 10.

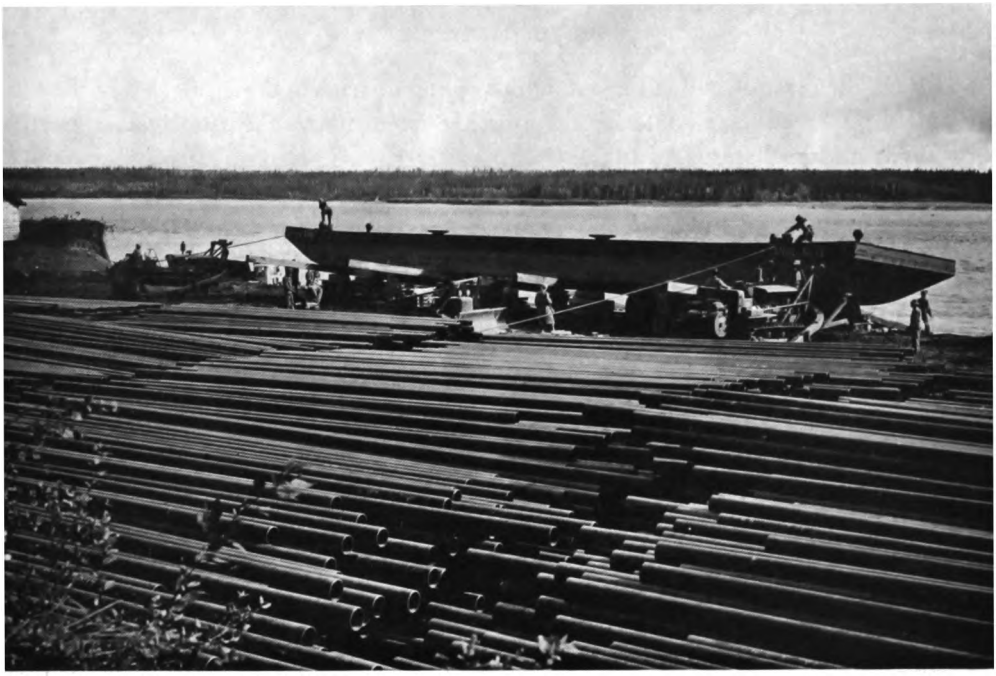

FIG. 11—Line pipe at Fort Smith en route for the Slave River delta, August, 1942. Barge being relaunched after crossing portage. (Caterpillar Co.)

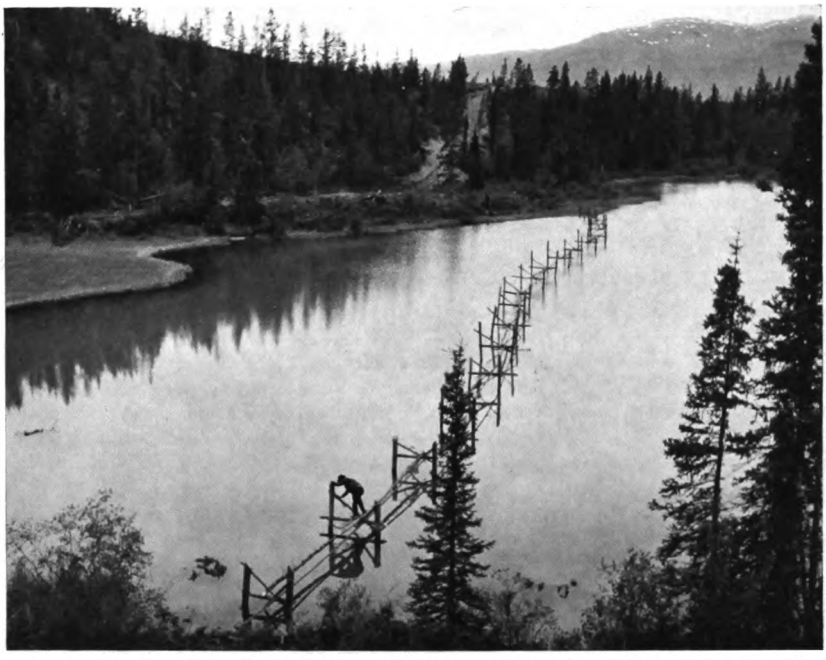

FIG. 12—A section of Canol pipe line being laid across a Yukon lake. (National Film Board.)

FIG. 13—Tank farm at the Whitehorse end of the pipe line. (National Film Board.)

FIG. 14—Pipe line in position near the western end of the Canol route. A Texas oilman checks joint weldings. (National Film Board.)

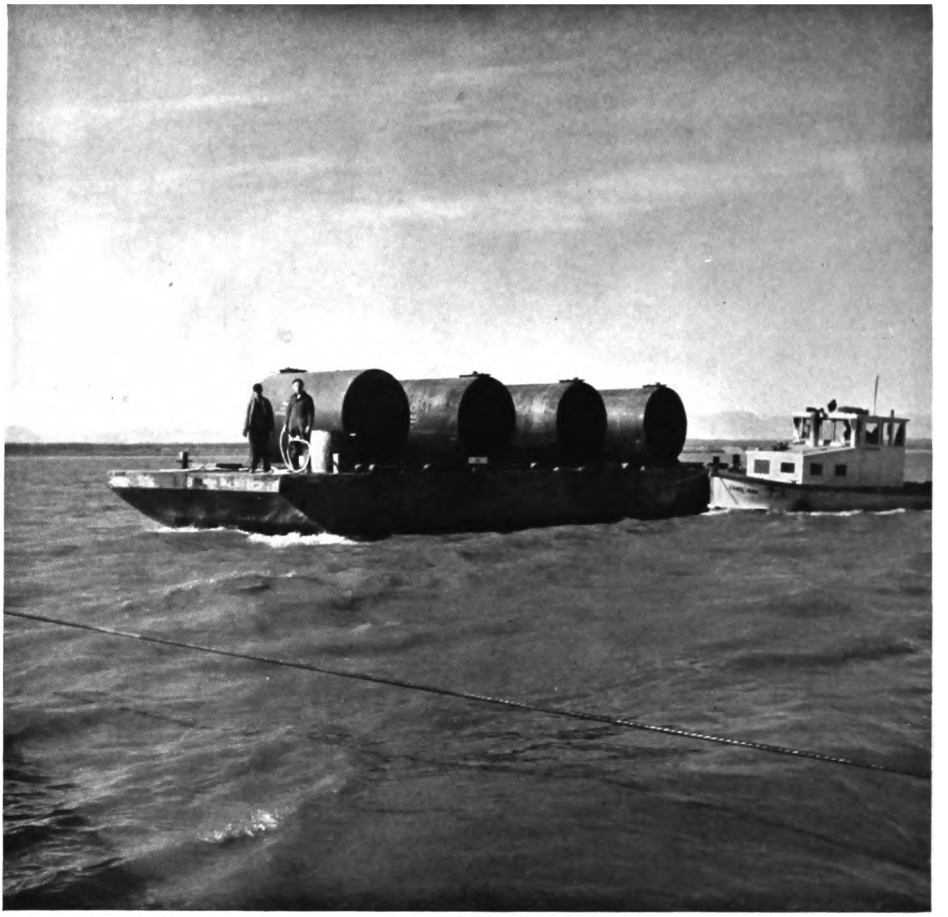

FIG. 15—When the ice went out in May, 1943, at Norman Wells, the pipe line across the river went out too. During the early summer of 1943 oil was ferried to Camp Canol on the west side of the river. (National Film Board.)

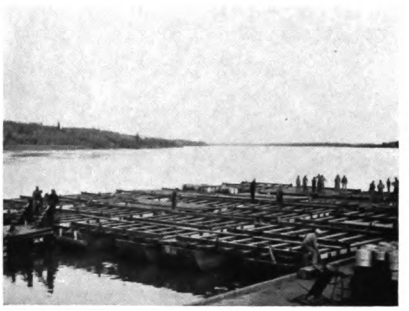

FIG. 16

FIG. 17

FIG. 16—The largest pontoon raft, with 38 units, at Fitzgerald. (Trevor Lloyd.)

FIG. 17—Unloading equipment from a river barge at the first camp Canol, August, 1942. This site was later given up. (Trevor Lloyd.)

FIG. 18—Canadian drilling crew at work at Norman Wells; note the trenching to drain off water from the thawing muskeg. (National Film Board.)

FIG. 19—Water front at Norman Wells in 1942, before Canol development. The Norman Range is seen in the background. (Trevor Lloyd.)

For other photographs along the Mackenzie waterway see Trevor Lloyd, *op. cit.*, footnote 12; Richard Finnie, *op. cit.*, footnote 7.

15 years ago.[30] While the ground was still frozen, gravel from a nearby river was laid on it. Gravel usually provides a fairly good surface and insulates frozen ground from summer heat. The Carcajou River itself offered engineering problems where it flows for 15 miles through a narrow canyon with walls between 100 and 1000 feet high. The only possible truck route near the river lies along the canyon bottom, which is fairly free from water in summer and winter. Here the pipe has been laid.[31] When spring thaws flood the canyon, the trail will be submerged. What will happen to the pipe line is uncertain. Forty-five miles from Camp Canol the line reaches the crest of the Carcajou Range. Beyond is a broad valley and twenty miles away lies the foot of the Mackenzie Mountains, which rise to 7000–8000 feet, with peaks that are snow-covered throughout the year. The route selected crosses the Arctic-Pacific divide at Christie Pass but at the time of writing (January, 1944) about a hundred miles of the pipe line in this region remains to be laid.

Winter Operation of Pipe Line

The effectiveness of the pipe line for conveying oil in the depth of winter will not be known until it has been in regular use. It has generally been stated that the low pour point of the crude and the small amount of paraffin in it will enable it to flow at unusually low temperatures.[32] However, a different view is held by some.[33] The admixture of natural gas with the crude has been suggested to increase its mobility. Pumping stations with Diesel engines will use oil from the pipe line. All oil will be heated by passing it through the cooling system of the engines before it leaves the pumping station.[34]

An authority[35] at Norman Wells has stated that sufficient snow is expected to cover the pipe line, which lies on the surface for more than 620 miles, to prevent the temperature of the oil from falling below −10° to −20° F.[36]

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[30] H. A. Innis: The Hudson Bay Railway, *Geogr. Rev.*, Vol. 20, 1930, pp. 1–30.

[31] A striking photograph appears in *Life*, Dec. 27, 1943, p. 23.

[32] Estimates differ. Finnie, *op. cit.*, p. 414, gives 90° below zero. Hopkins, *op. cit.*, p. 242, quotes 70° below zero.

[33] Leroy Whitney, technical consultant, War Production Board, reported in March, 1943, that the Norman crude has a pour point of −40° F. and that paraffin precipitates at −20° F. and sticks to pipe walls. He added that Fort Norman winter temperatures fall to −53° F.

[34] H. G. Cochran: Gas for the March on Japan, *Canadian Mining Journ.*, Vol. 64, 1943, pp. 641–646; reference on p. 646.

[35] B. W. Lambright, petroleum engineer, quoted in the Winnipeg *Tribune*, Oct. 4, 1943.

[36] The pipe line from Skagway to Whitehorse and the distribution lines had already had many serious breaks due to temperature changes. See the *Oil and Gas Journ.*, Dec. 2, 1943, p. 24.

The pipe line was in operation across the Mackenzie River between Norman Wells and Camp Canol during the winter of 1942–1943 but was damaged in the breakup. In December, 1943, the oil was said to be moving freely in the line for 20 miles west of Camp Canol when air temperatures were about −15° F.

The Imperial Oil personnel has had considerable experience in drilling and operating wells in a cold climate during its undertakings in the Turner Valley, Alberta. However, it is worth noting that the mean January temperature in the Turner Valley is about + 10° F., whereas at Fort Norman it is −18.6° F. and at Carcross, near Whitehorse, it is −4° F. Presumably winters in the Mackenzie Mountains are far more rigorous than this. Although snowfall is notably small in the Mackenzie Valley itself (37 inches at Fort Norman), it is heavy enough on the western slope to impede construction (about 120 inches in the Whitehorse area).

Canol contractors early discovered one way in which the climate would make operations difficult. In August, 1942, an attempt was made to construct a base camp on the west bank of the Mackenzie near Ogilvie's Island, 17 miles downstream from Norman Wells, where the pipe line was to have crossed. Bulldozers quickly removed the light brush and moss that covered a low terrace. The frozen gravel and clay thawed when exposed to the warm air,[37] and soon innumerable small streams were running across the foreshore. The more the bulldozers were used in an attempt to clean up the site, the muddier it became. Finally, at the end of the month, as the close of the navigation season approached, the site was abandoned to the elements, and a new one was selected on the same side of the river but within 3 miles of Norman Wells. Here the winter camp was laid out that developed into Camp Canol, the permanent eastern base of operations. It is, of course, very muddy in summer.

Pipe-Line Capacity

The 4-inch pipe-line laid from Norman Wells to Whitehorse is capable of carrying about 3000 barrels of oil a day when pumped at 4 miles an hour. The oil will thus take about 6½ days to reach the Whitehorse refinery.[38]

[37] Drilling at Norman Wells shows that the lower limit of permanently frozen ground is about 90 feet below the surface. Ice was found within 15 inches of the surface in mid-August, but cleared land thaws to more than 4 feet.

[38] Imperial Oil stated on April 17, 1943, that the line would carry a maximum of 4000 barrels a day (Truman Report, p. 13). The 3000-barrels-a-day refinery at Whitehorse is expected to produce 479 barrels of aviation stock, 1018 barrels of motor gasoline, and 650 barrels of heavy fuel oil (*ibid.*, p. 42).

As the oil wells drilled by the end of 1943 are said to be capable of producing 8500[39] barrels a day, the line can carry only a fraction of the oil that may be available. It has been suggested by designers of the project that a larger pipe can readily be laid beside the existing one. A 6-inch pipe will carry about twice as much at the same pressure as a 4-inch pipe. The simplicity of laying a new pipe line should not be overestimated. Line pipe can reach Norman Wells only during the season of open water, and it must be hauled from the railhead at Waterways, 1200 miles to the south. Although transport equipment has been much improved, this is still an immense undertaking. All the pipe would need to be unloaded and reloaded at the Fort Smith portage. Further, as a permanent road has not been made beside the pipe line, some of the difficulties met with in the laying of the existing line—melting in muskeg and flooding—are likely to be encountered again. An additional line would probably take at least 12 months to complete.

Lessons to Be Learned from Canol Experience

With the background of events outlined above, it may help in planning similar undertakings in the future to suggest what might have been done when development of the Norman wells was first seriously considered in February, 1942. Would consultation with those familiar with local conditions in the Mackenzie region or with trained geographers in Washington have modified the course of events? It is safe to say that there would have been agreement among such consultants that the project could not be completed in a single summer.[40] They would probably have suggested that it would take at least two summers and one winter, or about 18 months, before oil could reach Whitehorse, and thus the project would offer no solution to the immediate problem of getting oil to Alaska. Had the length of time needed to complete the project been realized in April, 1942, it might not have been approved.[41] If, in spite of the length of time needed, the project had still received approval, the months of February and March, 1942, could have been occupied with a rapid "office survey" of the prob-

[39] The figure of 20,000 barrels a day was often used at this time in public discussions.

[40] This was, in fact, stated by Standard Oil of California, the consultants, in a letter dated June 4, 1942 (quoted in the Truman Report, App. IV), and implied by Imperial Oil on May 2, 1942 (*ibid.*, App. III). It was generally agreed among residents of the Mackenzie Valley in June, 1942, that the project could not be completed in less than 18 months.

[41] General Somervell is quoted in the *New York Times*, Dec. 21, 1943, as saying that, "had he known how long it would take to complete the project, he would not have recommended it."

lems likely to be encountered. It would have been discovered at once that "on a map, or from the air," the Mackenzie waterway "looks easily navigable; but the men who have been operating steamers and barges along it for sixty years know that it is very treacherous."[42] Adequate plans for summer freighting could have been made.

The possibility of supplementing the waterway with summer and winter roads would at once have been studied. Examination of the meager data on the routes westward from the Mackenzie River toward Whitehorse and other conditions in the area would certainly have resulted in reports emphasizing the difficult terrain and the severe climate. Such reports, made ready by the end of May, 1942, would have enabled those planning the project to appreciate the seriousness of the undertaking. Meanwhile, oil geologists employed by the Canadian government could have given their opinions, based on 20 years of work in the area, on the wisdom of expending large sums of money, equipment, and labor on an extensive drilling program.

However, if, in spite of the most careful (although not long delayed) considerations, the Canol project had gone ahead, these preliminary inquiries would still have been worth while. Aerial surveys and mapping of possible routes would have been shown to be essential in April rather than at the end of August. The decision to build a network of winter roads and choice of their locations would have formed part of a well coordinated scheme rather than a last-minute improvisation in the face of a Northern winter. Airfields, winter camps, radio facilities, docking and unloading equipment, suitable clothing and stores would have been available in a reasonable sequence rather than sporadically as immediate circumstances demanded them. Although the pipe line might have been no further ahead under such an approach than it was in fact by September, 1942, across the Mackenzie River, sound foundations would have been laid for a concerted attack during the coming winter, when operations in the swampy lands west of the Mackenzie can be carried out faster than in summer.

Such planning, based on the available facts—and they were more numerous than has been generally realized—and on the experience of personnel long familiar with the country, would probably have cut the time of completion by 25 per cent. This might have avoided a second winter spent in carrying construction through the most difficult parts of the Mackenzie Mountains. It would certainly have reduced the cost greatly.

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[42] *The Beaver*, Sept., 1943, p. 5.

The Future of Canol: Quantity of Oil

The future of the Canol project depends on three factors: (1) the quantity of oil available, not only in the Norman Wells area but also in other parts of the Mackenzie Valley; (2) the extent to which settlement and general development of the valley may take place after the war; and (3) the manner in which any available oil is to be used outside the areas where it may occur.

For 50 years there has been no doubt in the minds of some geologists that the Mackenzie Valley as a whole is a rich oil reservoir. As long ago as 1888 a Select Committee of the Canadian Senate reported that

> in the Mackenzie District the petroleum area is so extensive as to justify the belief that eventually it will supply the larger part of this continent and be shipped from Churchill or some more northern Hudson Bay port to England.[43]

A geologist familiar with the region wrote:

> Its remoteness from the present centres of population, and its situation north of the still unworked Athabasca and Peace River oil field will probably delay its development for some years to come, but this is only a question of time.[44]

More concrete evidence has been available since 1912, when specimens of oil from Norman were first analyzed and claims staked. Since that time the problem has been one of test drilling at likely locations. A series of reports on the geology of the Mackenzie River region has suggested where drilling might usefully be carried on.[45] Some promising localities in addition to those near Norman were said to be the western end of Great Slave Lake; from Fort Simpson to the mouth of the South Nahanni River and northward to the Ebbutt hills; from Fort Simpson westward to the Mackenzie Mountains; and near Good Hope.

The original intention of the Canol project was to produce oil from additional wells close to Norman Wells on land owned by Imperial Oil. An area of 50 miles around their Discovery well was set aside by the Canadian government as an oil reserve on May 18, 1942. However, when the initial requirement of about 3000 barrels a day seemed likely to be met, the government was asked to permit "wildcat" drilling and prospecting by United States authorities over a much wider area; namely the whole of the Northwest Territories west of the 112th meridian. The object was to locate

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[43] Report of Select Committee of the Senate Appointed to Investigate the Natural Resources of the Mackenzie Region, 1887–1888.

[44] McConnell, *op. cit.*, pp. 31–32.

[45] *Canada Geol. Survey Summary Rept.*, Part B, for 1920, 1921, 1922, and 1923.

wells capable of producing 20,000 barrels of crude a day. In discussing the terms of the agreement the United States War Department said that most of the drilling would probably be done within about 25 miles on each side of the Mackenzie River between Wrigley and Good Hope. However, permission was asked, and granted on March 13, 1943, to explore and drill in a much larger area—all the Yukon Territory north of the 66th parallel and all land within 75 miles of the Mackenzie River between Great Slave Lake and the Arctic Sea. Meanwhile, some criticism had arisen in the United States because of the cost of this additional undertaking (estimated to be about $17,000,000).[46]

On July 6, 1943, among other recommendations made to the Chief of Staff of the War Department by General Somervell was one

> that present drilling operations be continued in known structures, within a radius of 50 miles of the Fort Norman field, and that the number of wells to be drilled be determined by the results of the drilling (Truman Report, p. 40).

The exact meaning of this recommendation is not clear, but it probably means restriction of prospecting and drilling to the original area within 50 miles of the Discovery well referred to (p. 279) above. If so, no wildcatting program in the very large area reserved by the agreement of March 13, 1943, is to be carried on at this time.[47]

Full data on prospecting and drilling in the Mackenzie region have not been released, though a statement quoted previously (p. 280) was made public by the Canadian government in November, 1943. This included reference to some wells drilled outside the immediate vicinity of the Norman pool:

> Under the United States contract 4 wells outside the Norman Wells field were drilled at a considerable distance from the productive area and 3 were on the edges of the area.

The further text of the statement, which refers to 26 other producing wells, implies that no oil was found in these 7 wells, but this is uncertain.

General statements about the success of the search for oil in the Mackenzie region have been optimistic. Frequent reference has been made to a potential yield between 58 and 100 million barrels within the Norman Wells field itself, and it has been referred to by General Somervell as "the greatest oil find in North America in the last 15 years" (Truman Report,

[46] A drilling contract was let to drill as many as 100 wells to a depth of 1200 feet for the cost plus a fee of $290,000 (*Oil and Gas Journ.*, p. 24, Dec. 2, 1943).

[47] Exploratory drilling is now being carried on intensively in areas adjacent to the Discovery well where the pioneer work by Imperial in past years had located promising structures ("Oil from the Arctic," *The Lamp*, Standard Oil Company of New Jersey, Vol. 25, No. 8, 1943, pp. 3-7).

p. 27). Such statements have, however, been widely discounted as an exaggeration. Standard Oil of New Jersey says:

> It now appears that the field may exceed 35,000,000 barrels. . . . It is about the size of the average major oil field in the United States. Not all of this oil is accessible, since much of the oil-bearing structure lies under the bed of the Mackenzie River. Ordinary drilling equipment and well fixtures would be destroyed here by the river ice movement. Special drilling and production techniques are being tried to increase the possible recovery. (Quoted in the Truman Report, p. 27).

Reference to the "apparently limitless" possibilities of oil development in the Mackenzie River basin has been made by a geologist who assisted in prospecting there in 1943. He states: "We found oil reservoirs 100 times as big as we first thought prevailed."[48] He adds that no dry holes have been drilled so far as he knows (but see p. 303 above). Published data make it possible at this stage only to suggest that the Mackenzie Valley is the best potential source of crude oil in Canada, except for the Athabaska sands. In view of the staking of claims in 1912, the geological study of the region between 1914 and 1923, and the resources that the oil company at Norman, through its parent the Standard Oil Company of New Jersey, is able to command, it is remarkable that so little drilling has been done in the past 20 years. The unenthusiastic statements about possible production made by the oil companies in 1942 coupled with their present caution in estimating recent discoveries (in contrast with the generally optimistic unofficial statements of those who have worked in the area) leave the possibility that there is no present eagerness to develop in the Mackenzie Valley an oil field that might later prove a serious rival to existing sources of oil for use in western Canada.

Settlement and General Development of the Mackenzie

If the oil produced from the Norman Wells area does not exceed the present potential production of 8500 barrels a day, it is worth while considering whether this amount could not be most usefully employed within the Mackenzie region itself. The prewar market there was very small. Fishing and trading vessels along the Arctic coast and on the rivers and lakes of the Mackenzie waterway need cheap oil. Port Radium, Yellowknife, and such additional mining enterprises as may be set up after the present war would be greatly benefited by an assured supply of cheap fuels.[49] Aircraft,

[48] Professor Lowell R. Laudon, head of the Geology Department, Kansas University, *New York Herald Tribune*, Jan. 2, 1944.

[49] When Yellowknife began using hydroelectric energy, the demand for oil was reduced. Relative costs of hydroelectric installations and oil refining and transport are the deciding factors.

which are likely to become commoner in the region, if only because of existing landing fields[50] and the possible use of the Mackenzie Valley as a low-level route to Asia, will provide a large market for 100-octane fuel.[51]

Demands for oil for heating and lighting houses during the long winters should become increasingly heavy if, as is generally expected, the living standards of both the native and white populations are raised. Without contemplating any startling increases in population or in industrial activities in the Mackenzie region, the promise of cheap—and it should be very cheap[52]—and abundant fuel should reduce some of the obvious physical handicaps (for example, coal imported from Edmonton costs $140 a ton at Aklavik) that face those who live in the North and that have held back the development of the region for the past 50 years.

If, after the war, a serious attempt is made to discover and develop the widespread mineral resources of the Mackenzie District and the Yukon, the wisdom of establishing a metallurgical "combine" near Norman Wells is worth considering. Local use of petroleum would avoid to some extent the problem of transporting petroleum products "outside" to available markets. Such a new Northern industrial area could be supplied with certain foodstuffs it is known can be grown there.[53] The suggestion is not without parallels in similar regions elsewhere.

Outside Use of Mackenzie Oil

The main Canol pipe line and the Whitehorse refinery are within Canada. At present the Yukon is supplied with petroleum products from the Pacific coast at Skagway, to which point they are shipped by barge along the inside passage from the United States, often by way of Prince Rupert. Much of the oil now used in western Canada, and even within the

[50] Royal Canadian Air Force and Canadian Department of Transport agents have during 1943 and 1944 selected possible sites for landing fields north of Norman Wells at locations including Good Hope, Arctic Red River, McPherson, the Bell-Porcupine area, and the Bluefish-Porcupine area.

[51] Norman Wells crude is not particularly good for making this; hence large quantities of crude would be needed. Seventeen per cent of each barrel of crude can be converted into aviation-stock base, and it requires 40 per cent of this base and 60 per cent of imported hydrocodimer as well as 4 cubic centimeters of lead to produce 100-octane aviation gasoline.

[52] The Canadian government under an Order in Council of January 1, 1943 controls the price of petroleum products produced within the Yukon and Northwest Territories and sold within those areas.

[53] This is of course not a new idea. See McConnell, *op. cit.*, p. 33. "Its [the Mackenzie Valley's] agricultural development will depend on a local market being obtained. When the time comes, as come it must, when the undoubted mineral resources of the region are drawn upon, the food required by the mining population, or the greater part of it at least, can be supplied locally."

Mackenzie Valley itself (for example, at Waterways, Fort Smith, and Yellowknife), probably comes originally from the United States.[54] If large supplies are available at Norman Wells, imports into the Mackenzie Valley from the United States will probably cease. The area south of Fort Smith will possibly be supplied from the Athabaska bituminous sand field at McMurray. Any large surplus of Norman oil might find its way to the Yukon and possibly even to the seacoast at Skagway and thence to southern British Columbia. In this manner a really large-scale development in the Norman area (and it is possible only in the distant future under existing published plans) would have a profound effect on the economic development of maritime western Canada, and incidentally on existing agencies supplying the area with oil products. If, as seems clear, it still proved more economical to import into southern British Columbia oil products from California, corresponding amounts from Norman Wells could go to Alaska.

Matters of this kind are in the realm of large-scale planning and are no doubt being considered by bodies such as the North Pacific Planning Project. What is especially important is that the traditional rivalry between international oil companies, which played a part in the early history of the Norman oil field, shall not be allowed to influence in any way the future development of this area.[55]

It is well to remember in taking long-term views concerning Mackenzie oil that, as a result of the Canol project undertaken two years ago, the assets that will be available on completion of the project are not likely to be in proportion to the money that has been spent. They are, in the main:

1. More than 30 wells drilled near Norman or, in a few cases, some distance away capable of producing a total of about 8500 barrels of crude a day.

2. Storage tanks at Norman Wells for about 200,000 barrels of oil and oil products.

3. A 4-inch pipe line from Norman Wells to Whitehorse and ancillary pumping stations.

4. A refinery at Whitehorse capable of handling about 3000 barrels of crude a day (about the capacity of the main pipe line).

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[54] Although details are not available, very large quantities of petroleum products were used in construction and transportation in connection with the Canol project. High-test aviation gasoline from the United States was shipped as far north as Norman Wells.

[55] That the Canadian government is alive to dangers of this kind may be inferred from a paragraph in a letter from the Department of External Affairs to the United States Minister at Ottawa on January 18, 1943, and concurred in by him. "The question has arisen of the best means of avoiding the possibility of the intervention of anyone whose interest is not identical with that of the Canadian government or of the United States government, and who might make application for oil and gas rights in that part of the Northwest Territories under discussion." Text released January 19, 1944.

5. High-pressure gasoline distribution lines along the Alaska Highway from Watson Lake to Fairbanks.

6. A pipe line from Skagway to the Alaska Highway near Whitehorse and docking and storage facilities at Skagway.

7. Various roads and trails, none at present passable at all seasons and some barely passable even in winter. Most of these will require considerable upkeep if they are not to revert to wilderness.

8. Between Waterways and Norman Wells considerable improvement in the summer navigation route in the form of limited storage for oil fuels, wharves, wooden barges, and some Diesel tugs. Much of the equipment was specially designed for the immediate task and may not prove adaptable to peacetime uses, and some will deteriorate rapidly.

9. Landing strips for wheel planes at many settlements.

In addition to these facilities constructed in connection with the Canol project, there already existed at Norman Wells oil storage tanks for about 12,500 barrels and a refinery capable of processing 840 barrels a day.

Such, then, are the physical assets available on, and in connection with, the Norman oil field. The proper use of them and the wise development of the field will call for careful study by the governments of both Canada and the United States and intelligent consideration by an informed public in both countries.