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DONALD C. BIRCH (Feb 1943) of J. GORDON TURNBULL and SVERDRUP & PARCEL

PROSPECT AREAS FOR COAL

INTRODUCTION

Coal is desired for fuel at the Whitehorse Refinery to conserve the limited quantity of crude oil at present available for refining to gasoline. Mr. H. H. Hall of the Standard Oil Company drew attention, at a conference held October 29, 1942, to the reported existence of commercial coals within the Whitehorse region.

Our Mr. J. S. Walton of San Francisco subsequently made an exhaustive search of the geologic literature on this region and summarized the results in a report November 3, 1942. The more important areas indicated in his summary were visited and his conclusion that the Carmacks area offered the most reliable source of coal is substantiated in this investigation.

At the suggestion of Mr. J. Gordon Turnbull, a joint party consisting of Mr. Donald C. Birch, geologist representing J. Gordon Turnbull and Sverdrup & Parcel, Architect-engineers and Mr. Bruce Gentry, civil engineer representing Bechtel-Price-Callahan, Contractors, was sent into this area. Both parties are in complete accord on all general conclusions reached.

This party left Edmonton on December 29, 1942, visited the Annie Lake prospect near Whitehorse, and later the Tantalus coal area around Carmacks returning to Edmonton on February 1, 1943.

Considerable time was unavoidably lost due to unfavorable weather delaying plane travel; very little active field work could be accomplished due to the ground being covered with 18-24 inches of snow which obscured the geology, and to the excessive cold which for ten days at Carmacks remained lower than 50 below, however the mines and prospects

were visited and a general yet definite opinion on each formulated.

This report covers in detail all aspects of developing the required coal at the Tantalus Butte, Carmacks; all available data is summarized and areas for future prospecting are briefly outlined should a greater need for coal arise.

All parties seem agreed that the Tantalus Butte is the logical place to develop coal for the Refinery and as such the re-opening of this mine forms the basis of this report.

The published literature and available private reports have been freely drawn upon in supplementing the rather meager data obtainable in the field.

The sincere co-operation of the U. S. Engineers in particular Colonel Montgomery and Major Laurion is hereby acknowledged.

GENERAL DESCRIPTION OF THE TANTALUS REGION

Location

The Tantalus coal region on the Lewes River lies 105 miles, N. N. W. by straight line from Whitehorse. A fairly wide graciated valley bordered by mountains extends northward from Whitehorse, and through this flows the Yukon or Lewes River. Whitehorse represents the "gateway to the Yukon" being the northern termination of the White Pass & Yukon Railway connecting with Skagway an important sea-port.

Population

Carmacks, at the confluence of the Nordenskiold River with the Lewes, is the only settlement within the Tantalus coal-area. The village consists of a telegraph station and post-office, a general store, and a dilapidated road-house together with about 40 log-cabins liberally strewn along 1½ miles of the main street. Population is seasonal and would seem to vary from 50 to 100, about 20 being white and the remainder Indian. The white inhabitants are mostly miners and prospectors while the Indians hunt and trap and cut much of the corded wood used as fuel on the river steamers.

Topography

The country is fairly mountainous, the peaks rising to over 4000 feet but close to the river seldom over 900 or 1000 feet. The topography is usually not steep, glaciation having left the hills rounded off and their slopes gentle and liberally strewn with debris. Several prominent terrace levels or benches exist, but the present valley floor of the Lewes River is rather narrow and in places tortuous; Carmacks, elevation 1718' is located on a narrow recent alluvial flat, 10' or so above river level, however it has never been subject to flooding. The soil of this flat is extremely fertile and produces excellent summer vegetables which are stored for winter consumption or shipped to Whitehorse.

Accessibility

Carmacks is located on the Dawson-Whitehorse Trail -- actually a fair road with open country and fair grade most of the way. It can be travelled either in summer or winter by trucks, little if any muskeg being crossed - it is a road gradually located by "trial and error" through 45 years of experience. This road for much of its northern course follows the Nordenskiold Valley, at one time an alternate route or branch carved by the earlier Yukon glacie which passed through Whitehorse.

Carmacks is now connected to Whitehorse by weekly passenger and mail plane but the short landing field (not extendable) prohibits all but the smallest planes. Mr. Hayes, the Government Telegraph Operator and Agent, reports he has located a flat nearby in Nordenskiold Valley suitable for a long runway and situated well for the prevailing north and south winds which blow through the Yukon Valley.

In summer the Lewes River offers unparalleled accessibility by steamer to Whitehorse or Dawson, barges being used for the bulkier and heavy freight. The river generally opens early in May but the ice on Lake Laberge - through which the river flows - usually blocks navigation until June.

Climate

Carmacks lies 54 miles south of Selkirk, the coldest place in the Yukon, but its recorded temperatures usually run about 10 degrees warmer. On an average it is generally about 15 degrees colder than at Whitehorse. (Lighter elevation and more open and subject to air currents.) These conditions thus require equipment capable of withstanding temperatures to 75 degrees below.

Little arduous outside work can be attempted before March or after November. The ground thaws to as much as 7 to 10 feet on south-facing slopes but on the north slopes remains frozen 1 or 2 feet below the surface. Mine workings in winter should be heated to whatever is considered the ideal working temperature.

Annual snowfall varies 24 to 30 inches.

Timber

The region is fairly well wooded in lower elevations up to about 3000 feet, with white spruce usually attaining sizes of 12 - 18 inches in diameter occasionally up to 24 inches, with uniform long taper.

This material is suitable for construction of log-cabin buildings and mine timbers; it has a long life, the side-walls of the road-house at Carmacks being over 40 years old.

The river flat across from the Butte and the slopes above the old Tantalus mine have an abundant supply of this timber. The east bank of the Lewes River upstream from the Butte was observed from the plane to be well timbered.

A small portable saw-mill, perhaps on a barge, for making narrow planking and square lumber might eliminate much need of imported lumber.

GEOLOGY OF THE TANTALUS COAL - AREA

The Coal-Basin - extent and sediments

The broader aspects of this area should have a decided influence in any evaluation as to whether to re-open the Tantalus Butte mine and as to the likelihood of developing additional coal should the need arise.

The Tantalus coal-basin lies in a narrow trough or syncline trending north north-westerly almost parallel to the course of the Lewes River. It is bordered to the west by the anticlinal uplift of the Dawson Range and to the east by a more complex series of uplifts; these areas were land while the intervening basin was a swamp. The best coal is usually found away from the margins where the land derived sediment settles.

This coal basin cannot be compared to the widespread fields of Alberta, Central and Eastern United States but more to the local fields of Japan and the Philippines, where conditions of deposition appear to have been rather similar. The Tantalus coal basin has been squeezed or compressed so that the coal seams now pitch steeply although the synclinal structure is still preserved. The present coal-basin is 15 miles long but, due to the above compression, only 3 miles wide - the marginal areas where no coal has been found are not included in these figures.

Three commercial coal-mines have operated in succession within this basin, the Five Finger Mine 6½ miles N.N.W. of the Butte, the Tantalus Mine 2½ miles due south of the Butte, and lastly the Tantalus Butte. In addition extensive prospected outcrop continue intermittently south of the Tantalus Mine for a distance of

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15 miles.

These coal mines and prospects together with the mapping of the aerial distribution of the measures clearly depict the extent of the coal-basin, thus the Tantalus Butte Mine in which the best coal has been found, is seen to occupy a central position within the basin. In contrast the others appear marginal the Tantalus Mine coals contained seams of slate or "bone", the Nordenskiold prospects have to date only revealed thin unworkable seams; the seams in the Five Finger Mine while of good quality were considerably thinner, inter-bedded with shale and barely commercial.

This zoning evidence points strongly to the possibility of developing considerable good coal free of bone northward from the Butte towards the Five Fingers Mine.

The coal seams occur in the Tantalus - Laberge formations as mapped by Cairnes[2] and Bostock[3]. These comprise a series of massive hard pebble-conglomerates competent sandstones and thin bedded shales; the coals occur usually at the top or bottom of the shale-sections.

Structure.

The intense folding that this region has undergone plus discrepancies in observed structure does not allow direct connection to be made between the Tantalus Butte and the Tantalus. Although one of the seams may be present in both mines, the interpretation of the intervening structure as a simple syncline seems insufficient to account for the fact that the strike of the seams at Tantalus Butte - when projected would hit the Tantalus Mine --

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but the dips are in opposing directions 50° west and 35° east. It may be that one section is overturned or that a cross-fault has off-set the axis of the syncline; if the former is true, the dip of the strata may be expected to increase towards vertical -- well below river level; this might change the method of mining at those depths in the Tantalus Butte, whereas, normally the beds would be expected to flatten at depth. (See Cross-Section)

However the northerly continuation of the strata of the Tantalus Butte -- which is really not a butte but the termination by the river of a strike-ridge -- is unquestioned, even in the snow the beds can be seen outcropping and continuing northward for over 3000 feet while the strike ridge itself continues boldly for over 2 miles. Even beyond this there is good expectancy of being able to follow the seams underground below the later capping of volcanics towards the Five Finger Mine.

1. Five Finger Mine [2]

History

This mine has been abandoned since 1908 and its workings which are mostly below river-level are filled with water. A slope was sunk 350 feet and rooms driven off it in the best seam which dipped at 16° and varied 3½ to 4 feet.

The shaft collar was located on a slope subject to mud slides; eventually a new shaft was sunk in 1906 on safe ground. It was sunk to 783' and worked a higher seam similarly dipping 16° to the east; this seam contained 22 inches of good clean coal and 24 inches of mixed coal and shale (bone?). In 1907 a winze was sunk to the lower 4½ foot seam previously worked.

Production

Unknown but it is reported that "a considerable amount was mined and sold, chiefly in Dawson".

Analyses

	Upper seam 22"	Lower seam 4½'
Water	5.95	5.29
Volatiles	40.46	36.14
Fixed Carbon	45.16	40.12
Ash	8.43	18.45

Ownership

This mine was owned and operated by the Five Fingers Coal Co., who abandoned it in favor of the Tantalus Butte.

Note: This mine was not visited for obvious reasons.

II TANTALUS MINE

History

The Tantalus was opened in 1905 and continued in production until 1922. Much of the coal was used by the river steamers but difficulties in distributing it to fueling stations up and down the river caused the steamers to revert to using wood. However it is reliably reported that other causes may have been contributive, e.g. the failure to have barges loaded when the steamer called for them and the deliberate mixing of picked waste ("bone") with coal, in order to fill the barges, resulting in clinker trouble and eventual cancellation of the coal contracts by the White Pass and Yukon Railway operators of the steamers.

The mine was closed in 1922 and in the following year the Five Finger Coal Co. opened the Tantalus Butte Mine, because "in comparison it is cheaper to operate" (little if any hand-picking required). Miners however report that a fault was encountered at about 2500 feet which cut the seams off and efforts to locate the seams on the south side of the fault were unsuccessful -- so that other than Coal lying below river-level the mine would appear worked out.

Production This appears at a maximum to have been:

1905 - 1912	59,500 tons	
1912 - 1918	18,000 tons	
1918 - 1922	3,000 tons	
	80,500 tons	Total

Analyses See enclosed Summary of Analyses.

The average picked coal appears to average:

Dry basis -	Volatile combustile	26%
	Fixed Carbon	60%
	Ash	14%

Sulfur content .4%; Water content @ 4%
Fuel ratio, FC/VM 2.3; B.T.U. Value 12,850

Examination of Mine

Condition:

Only the first 300 feet or so of the main haulage way remains open, the tunnel dividing into a Y, the two drifts

SUMMARY OF ANALYSES

T A N T A L U S M I N E

SEAM	REP. WIDTH	WATER%	VOLATILE COMBUST.	FIXED CARBON	ASH	COLLECTOR & ANALYST	AGE OF EXPOSURE	FUEL RATIO FC/VM	B.T.U. VALVE	REFERENCE
Bottom	7'6"	.75	23.61	55.21	20.45	Cairnes & C.G.S.	fresh	2.2	N.D.	D.D. Cairnes Memoir #5 1910 Dept. of Mines
Middle	6'6"	.76	24.74	58.60	15.90	"	"	2.3	"	
Top	3'0"	.82	25.12	66.05	8.05	"	"	2.6	"	
				(Channel samples)						
Top		Dry basis	25.0	58.0	17.0	Cairnes	regular	2.3	12,060	D.D. Cairnes Geol. Surv. Canada Sum. Repts. 1907-1909
		"	26.3	59.9	13.8	Dept. of Mines	washed	2.3	12,800	
Middle		"	26.7	54.1	19.2	"	regular	2.0	11,360	
		"	25.7	60.3	14.0		washed	2.3	12,730	
Bottom		"	27.8	56.0	16.2	"	regular	2.0	12,280	
		"	28.1	59.2	12.7	"	washed	2.1	12,980	
				(500 lb. samples)						
All these analyses are of the seams including the "bone" layers in them - on hand picking this material out, the ash content would seem to drop. "Picked coal" from the two minable seams would seem to average			26 -	60.	14	(Sulfur 4%)	Picked	2.3	12,850	

FIVE FINGER MINE

Upper	22" of 4' seam	5.95	40.46	45.16	8.43		Fresh	1.11		Dr. D.D. Cairnes Memoir #5 Dept. of Mines
Lower	4' 6"	5.29	36.14	40.12	18.45	Dept. of Mines	"	1.11		

following the middle and lower seams. In abandoning the mine the pillars were robbed resulting in the present caved condition, otherwise the roof seems to stand up very well with little timbering required. The coal itself slakes but little and maintains a good upright face.

Coal Seams

Within the coal seams occur bands and lenses of slate or "bone", often highly slickensided or polished and of much heavier weight than the coal. These bands vary from 2 to 3 inches in thickness and are usually separated by 2½ to 3 feet of clean bituminous coal -- in the lower 9 foot seam of coal three such layers were observed. The contact of the coal and bone is sharply marked -- not gradational -- and the bone tends to remain as hard coherent lumps. The middle seam here about 6' thick is not as clean and has 2 or 3 such layers of bone. The two seams at this point are separated by only 4 feet of hard, firm and competent sandstone.

An upper seam of 3 feet of coal is reported[2] to occur about 7 feet above these two seams, but it was not mined.

Structure

The dip of the seams in the limited workings was observed to be about 30° to the east with a strike of about N 30° W. Within the mine the dip is reported to vary as much as from 24 to 40°. Outside the portal to the east, the dip was seen to steepen considerably, but except for this small area of outcropping rock the vicinity is mostly covered with surface debris; the topography is vague and ill-defined and in no way suggestive of the structure. Above the exposed window of Tantalus, formation irregular, slopes covered with glacial material and slide

gently ascend to the summit of the mountain. The mine was indeed fortunate in being able to follow the seams underground for as much as 2000 to 2500 feet before they were faulted off.

Qualify of Coal

The bone layers present were a potential source of contamination of the good coal inasmuch as this waste had to be hand-picked and discarded. Operators never seem to have been very particular of the quality of the material they delivered.

In previous sampling of the mine, for instance when 500 lb. samples of each seam were taken by Cairnes[4] in 1911, the layers of thin bone were included and thereby made the ash content on analyses consider ably higher (16%) than with picked coal (13%). No mention is made in th literature of the presence of these bone layers within the seams and it seems probably that Cairnes was unfamiliar with the distinction between "bone" and coal for in the Annie Lake area near Whitehorse, what is definitely a very similar slate or "bone" he called "coal". The "bone" is non-combustible and averages - 40% ash with less than 8% volatiles.

Much of the clinker trouble reported in using Tantalus coal on the steamers was obviously due to this same bone and not to the coal itself which on burning was observed to ignite easily, to have plenty of "life", and to produce a fine powdery ash.

This discussion should have sufficiently cleared the reputatio that Tantalus coal may have acquired.

POSSIBILITIES FOR PRODUCTION

These are not good nor recommended but if additional demand arises probably about 100 tons per day can be secured but mining costs would seem 50% higher than at the Butte -- about $12.00 per ton.

1. Remaining coal lies mostly below river level -- but mining below the river was carried out in the old Five Finger Mine.
2. Since the formation is not water-bearing but tight and competent and the ground probably frozen for 200 to 300 feet below the surface. The danger from flooding, provided sufficiently distant from the river, seems quite remote. The structure is such that when cave-in occurs following stoping, it should not reasonably affect that portion under the Lewes River.
3. Added costs are due to:

   (a) Investment necessary for
   (1) System of Picking belts.
   (2) Installation of inclined-shaft with hoist, elevator or cage.
   (3) Erection of a rather elaborate forced ventilation system.

   (b) (1) Labour costs of picking coal
   (2) Power and maintenance costs of above.

4. Tonnage:

   The coal seams are proven to exist for a distance over 2000 feet into the hill, assuming a 6' seam 40° dip and with 60% recovery, with levels every 100 feet vertically, amount of coal recoverable = 40,000 tons per level.

   Total tonnage down to -300 level = 120,000 tons below this the continuity of the seams cannot be predicted. If the cross-fault found in the caved mine beyond 2000 feet was eventually encountered

it should be possible from a study of the slip-face to find the off-set portion on the south side and develop additional coal; the existence of coal seams in the Nordenskiöld Valley, 15 miles to the south, might tend to make such an attempt quite attractive.

III

TANTALUS BUTTE MINE

History

The coal seams high on this cliff were prospected between 1904 and 1907 and were examined, described and sampled by Dr. Cairnes[2] in the latter year, and although he expressed the opinion that these were the best seams as yet discovered in the district it was not until 1923 that a mine was opened here by the Five Finger Coal Co. By this time the railroad and steamers had been definitely "cured" of all desire for Tantalus coal and the domestic demand had dwindled with the decline in population of the Yukon. The assumption appears always to have been made that the Butte seams were the same as the Tantalus and that therefore the quality of coal delivered would be the same.

Perhaps another reason for the late opening of this mine was that the samples collected from the surface outcrop were high in water content 13 - 16%, the coal was classed as a lignite and did not give a coherent coke in Laboratory tests whereas the Tantalus material, classed as a coal, gave a good quality "coke" (actually far too high in ash).

Development of the mine has since shown the lignitic character and high water content to be purely a surface affair and that the coal is a bituminous coal and the water content is much lower. In any future surface prospecting this relation is to be remembered.

The mine operated up until 1938 by which time demand

became almost negligible. During the last few years the property was leased out -- unfortunately only on a year-to-year basis which not only did not encourage development, but may have allowed destructive damage to the main tunnel by robbing of the pillars.

Production

300 to 600 tons a year from 1923 to 1938; Probable maximum production 9000 - 12,000 tons. The mine can therefore be considered as barely opened up.

Geology - Strata and Structure

The strata consist of a series of alternating massive - bedded competent pebble - conglomerates, and sandstones with minor amounts of indurated shale. Coal seams occur within the middle portion of the Butte - as shown in the accompanying Cross-Section. Little if any bone appears to occur within the three seams of coal present. The upper seam ± 8 feet is reported[2] to be about 100 feet above a middle seam of ± 9 feet, and a lower seam of 7 feet to lie about 115 feet below. Mining was done in both the lower and middle seams. The roof in the lower seam is a hard cemented conglomeratic sandstone and the floor an indurated shale.

The beds strike from N 10 E to due north and pitch steeply to the west at about 50°, this dip remaining remarkably constant. The consolidation, folding or compression that these rocks have undergone has produced factors of importance to mining.

More frequently coal is found in flat-lying beds - often

not too well consolidated -- much "fossil" water still remaining in the sediments and causing heaving or swelling ground. The Tantalus Butte in contrast is a pile of steeply-dipping competent rocks, dried and drained out, (but now frozen) the roof over the coal seams remaining firm and strong and the floor not swelling. Because of the strength of the individual beds and of their steep angle of inclination no vertical pressure is present in either the haulage ways or rooms. Timbering, except in the main haulage ways to prevent sagging of the roof-seam and eventual scaling and scabing, will be minor. The lack of active continuous pressure will eliminate constant replacement of timbers. No gas is present and the danger from mine fires -- started by self-combustion through oxidation of iron sulfides -- largely absent.

Thus in many respects operation of this mine would be more like that of a "hard rock" mine as to conditions present and resulting methods employed. The apparent high yield of coal per miner reported as over 5 tons at the Tantalus Mine was undoubtedly due to the rather favorable conditions present; the outlook for the Butte is even better, the 50° slope of the seam providing a natural chute for the coal as it is mined up dip in the rooms, little handling of the mined coal and loading by hand shovel of the cars being necessary.

SUMMARY OF ANALYSES

T A N T A L U S B U T T E

SEAM	REP. WIDTH	WATER	VOLATILE COMBUST.	FIXED CARBON	ASH	COLLECTOR & ANALYST	AGE OF EXPOSURE	FUEL RATIO FC/VM	BTU VALUE	REFERENCE
Top	8'10"	13.64	31.84	51.84	2.69	Cairnes & Dept. of Mines	Outcrop	1.63	ND	D.D. Cairnes
Middle	9'10"	16.32	31.72	42.13	9.83	"	"	1.33	ND	Memoir #45 1910
Lower	6'or7'	12.87	31.72	49.51	5.90	"	"	1.56	ND	Dept. of Mines
Outcrop Material was classed as a "lignite", material in mine subsequently opened became a coal.										
Lower	9'9"	6.1	31.2	53.8	8.9	Bostock	Fresh	1.70	11,800	H.S.Bostock Memoir 189 1936
Lower	9'4"	5.4	30.7	53.4	10.5	A.R.Johnstone Dept. of Mines	1 yr.	1.75	11,930	"
13717 # "	8'6"	4.5	30.9	53.1	11.5	"	45 days	1.72	11,990	"
13718 # "	8'0"	3.7	32.9	54.3	9.1	"	40 days	1.65	12,490	"
13719 # "	9'0"	5.6	33.7	49.4	11.3	"	Fresh	1.45	11,840	"
13720 #	Softening point of ash 2,330 F. Sulfur content -0.4%									
	Other than a 3% loss in volatiles and resulting change in fuel ratio, no important changes show that might affect stock - piling of the coal.									
5 tons-hand screened Slack-coal; 13721 #		4.2	32.8	53.0	10.0	A.R.Johnstone Dept. of Mines	Slack	1.60	12,250	"
Last 5 tons mined in 1954; 13722 #		4.4	32.9	51.2	11.5		Fresh	1.55	12,000	"

POSSIBILITIES FOR PRODUCTION - RECOMMENDED

Tonnage Estimate

1. No marked pinching or lensing out of the coal seams has been found in any of the mines; in the Tantalus Mine the coal was followed for over 2000 feet.

2. There is every indication that large reserves of coal exist in the Tantalus Butte.
   (a) Below the old workings at 350' to river level.
   (b) Northerly into the hill beyond the old workings.

3. To date continuance of the coal seams has been proved for over 700 feet into the hill; a maximum of 9000 - 12,000 tons extracted.

4. Three seams of coal occur; they are sufficiently wide apart to be mined separately.

5. Due to the favorable central position of the Butte in the Tantalus coal-basin; to the observed continuance northerly (as a strike-ridge) of the coal-bearing strata towards the old Five Finger Mine a proven length of the coal seams for 1000 feet and a probable length for 3000 feet is used in tonnage estimate.

6. The seams can be mined from near the summit of the ridge, elevation 1000 feet above river-level down to river level, a slope distance of 945' and a horizontal width of 600'.

7. Proven tonnage; Area: 1000' length x 600' width = 14 acres assumed thickness 6'; 1 acre = 15,000 tons (assuming 1 cu. yd. coal = 1 ton) with 60% recovery amount recoverable per acre = 9,000 tons. Total tonnage for 3 seams = 3 x 14 x 9,000 = 378,000 tons.

Probable tonnage assuming 3000' continuity
3 x 378,000 = 1,134,000 tons

Required production 200 tons per day
= 72,000 tons per year

Hence proven tonnage = 5 yrs. supply.

Optimistic Tonnage assuming 5000' continuity and allowing recovery of coal down to -300 below river level.

Conclusions

1. That the mine can be re-opened to produce 200 tons per day

-300 tons if necessary on a basis of 100 tons per haulage

level per two-shift-basis.

2. That a 5 year supply at 200 tons per day is proven, and that a probable supply for 15 years seems present but will require proving by drilling and development.

3. Mr. Bruce Gentry estimates:

   (a) Investment necessary to place mine on 200 per day production basis at about $270,000.00.

   (b) Cost of production including 5 year amortization of this investment as about $7.00 per ton in the bunkers.

   (c) Preliminary quotation of year-round average cost delivered to Whitehorse would still seem remain at about $25.00 per ton.

ORIGINAL WORKINGS AND CONDITION OF MINE

1. Main portal - located on prominent bench 350 feet above the river - largely caved; located in unconsolidated talus.

2. Haulage level then cross-cuts through formation to lower coal seam.

3. Level then follows seam in for a distance of ± 500 feet; only the first ± 200 feet accessible, rock-fall blocking further access.

4. An undetermined number of rooms taking off from 3. up the dip of the seam; chutes feeding directly onto haulage level.

5. An upper entry 135 feet above the main level follows in on the middle seam for about 100 feet to where a winze reaches the lower seam connecting with the rooms in it and providing ventilation; trail covered with snow drift and thus not accessible however, ventilation in the mine is most apparent at 50° below and testifies to the open condition of the upper entry and winz

6. The coal-bearing portion of the main level appears in fair condition and most of this is believed recoverable.

PRESENT EQUIPMENT AND BUILDINGS

Most of the old discarded and neglected mining equipment at the Tantalus and Tantalus Butte mines may prove useless, it costing more to recondition than new equipment would cost installed -- this includes boilers, steam engine, pumps, hoists, conveyors, screens etc. However the hand drills, mine cars and track at these mines would be needed in development work and reconditioning that should start whil the new operation equipment above is being ordered, shipped, and installed.

CONCURRENCE OF OPINION REGARDING TANTALUS BUTTE

It seems desirable to bring all opinions together, especially since very little original field work could be accomplished,

1. D. D. Cairnes in Memoir 5, 1910 p. 11.
"Mr. Miller caused work to be commenced at Tantalus--later he located and prospected the Tantalus measures across the river on Tantalus Butte and has shown them to be, probably the best so far discovered in the district."

2. H. S. Bostrock in Memoir 189, 1936 p. 64.
"The chief reserves of coal in the district occur in the areas of the Tantalus formation--in the vicinity of Carmacks and the old Five-Finger Mine. These areas are probably the most accessible areas of good coal in the Yukon."

3. Dr. W. E. Cockfield (6) Geological Survey, Dominion of Canada, in answer to a telegram from Mr. J. S. Walton of San Francisco replied: "Consider Five-Fingers coal mines can be developed to mee any reasonable demand."
It is to be noted that the Five Fingers Coal Co. own and formerly operated the Five Fingers Mine, the Tantalus Mine and the Tantalus Butte and that this opinion did not necessarily indicate the Five-Finger Mine but included the two Tantalus mines.

4. Mr. J. S. Walton (6) in his survey of the literature of November 3rd, 1942, p. 1, concluded: "It is believed safe to say that adequate coal reserves exist within a radius of 175-200 miles of Whitehorse, and that the most accessible deposits are in the vicini of Carmacks."

5. Major B. F. Hake (7) in report to Division Engineer, Edmonton, December 11th, 1942, concluded:
That there is plenty of coal left in the mine;
(a) To the northeast into the mountain there exists much undeveloped coal.
(b) The mine could be reopened if desired at lower levels to stope coal from 300 feet above the river to river leve

6. The writer and Mr. Bruce Gentry of Bechtel, Price and Callahar are mutually agreed that the Tantalus Butte offers the best promise of developing into a substantial coal mine.

OWNERSHIP

This mine is owned by the Five Finger Coal Company of Minneapolis, Minn., U.S.A. A lease agreement for the duration of the Pacific War on basis of 25 U. S. cents per ton is suggested; the use of any existing equipment on either of the two properties should be included in this royalty agreement.

CONCLUSION

If it is desired to use coal as fuel at the Whitehorse Refinery, the Tantalus Butte at Carmacks offers the nearest accessible and reliable source.

The mine is tangible and has a proven tonnage supply for 5 years and a probable tonnage for 15 years, this is adequate balance against the investment necessary to secure production.

The Butte can be put on a production basis with a minimum of delay in contrast to a mere seam prospect, as at Kynocks (Appendix), which, though much nearer to Whitehorse, would require a tremendous amount of exploration, pitting and drilling, before any substantial tonnage, if present, could be proven - all this delay would be necessary before machinery could be ordered and installed, and production secured.

The Refinery is scheduled to begin operation in the Fall of 1943. It is believed possible to have the Tantalus Butte mine on a production basis by June 1st to take advantage of the cheap river transportation available till about October 15th. However, many steps are necessary. (Appendix) should re-opening of this mine be decided upon - of utmost importance is the necessity of having a skeleton crew start immediate work on re-conditioning the mine for opening - without waiting for engineering data, erection of camp and installation of machinery.

Respectfully submitted

Donald C. Birch

DONALD C. BIRCH.
(Exploration Engineer)
J. GORDON TURNBULL AND SVERDRUP & PAR

February 1943

Edmonton, Canada

SUPPLEMENTARY

A P P E N D I X

Containing additional information should

(1) Re-opening of the Tantalus Butte be approved.

(2) Need for additional coal arise.

STEPS NECESSARY TO RE-OPEN TANTALUS BUTTE MINE

Development necessary before production possible, and of which I and II can be done while engineering data is being assembled, equipment and machinery ordered, shipped and installed, and camp erected. March 1st appears the earliest any work can be attempted.

I. Bulldozer to make road from Carmacks post-office, past the old Tantalus Mine following the banks of the river to directly opposite the Butte - a simple job of cutting a path through the trees. Crossing the frozen Lewes River, which has considerable flow and onto which the rough ice has subsided due to the diminishing flow, unsafe for tractors - supplies to be hauled by dog-team to mine camp. (Safety lines across river needed for men on approach of the thaw and ice break-up).

Note. In 3a part of main haulage way may prove irrecoverable in which case that portion will have to be side-passed by entering the wall rock and continuing parallel to the old drift at a distance of several feet, an occasional cross-cut being made to determine the condition of the old drift and extent of stoping done, and eventually to swing back into the seam and continue beyond the old rooms to develop access to the unmined coal.

II. (1). Re-habitation of 2 log cabins for living quarters for skeleton crew and survey party.

Shipping in food supplies and limited equipment---hand tools and supplies for re-opening of mine.

(2).a. Survey party to make accurate topographic map for planning of camp, conveyors, and overhead cable-crossing over the Lewes River.

b. Skeleton crew to clean out mine entry and cross-cut of all rock fall, retracking same, and temporarily re-timbering for safety At and after the spring thaw, danger from rock fall increases tremendously.

(3).a. One party on reaching the main lower-seam drift to continue cleaning out the haulage way, retimbering on a more permanent basis stated loading from old worked-out rooms to be completely cribbed for its protection.
Any roof falls (or sagging roofs to be scabbed) and securely cribbed-up and timbered off.

b. Other party to drive southerly on alignment of the middle seam drift, thence through the talus to establish a new entry and thus secure a safer and straight haulage way - this last stretch through talus requiring very strong timbering. (on eventual arrival of the new tracks and cars - entire haulage way to be re-tracked).

(4). Party (b) at a point on this level about 100 northerly from the contract of the talus with the "measures" to sink a temporary inclined shaft down the slope of the seam to a point suitable for the lower haulage way (150' level) thence to drift northerly along the seam for a short way to determine its strike, thence southerly on this alignment through the cemented gravels of the bench to a suitable exit. Engineers would undoubtedly rather drive this tunnel from the outside in but as Major Blake (7) notes "it is impossible to predict" the dip of the seams at this level, hence the seam might be missed, cross-cutting on both sides being necessary to locate it and an eventual adjustment made in the tunnel to straighten out this crook.

IV.

Raise to be eventually driven up the slope of one or more of the coal seams to the surface to provide natural ventilation.

A second lower haulage way to be driven when needed in a similar way to 4.

It is suggested that cars would dump into a bin on each level, thence a pan-feeder or feed-o-weigh would deliver the coal to a slightly sloping belt - any waste being hand-picked en route - the belt to dump into a gravity chute to a main storage pile at the foot of the 350' bench.

One of the many troubles attendant upon former operation of the mines was in not having the barges loaded when the steamer called for them. It is essential to eliminate this bottleneck and to have almost instantaneous loading of barge or trucks.

However the mine is on the east bank of the river and access by the 2 mile of new road can only be made to the west bank and to keep the river open an overhead cable-way with bucket seems necessary. A clam-shell bucket on this cable would seem feasible, loading from the major stock-pile at the foot of the bench on the east bank and dumping directly into two large bins or bunkers on the west bank. These bunkers to be equipped with duel loading chutes, one set towards the river for barge loading and one set to the road for truck loading.

In emergency this cable system could be used for direct loading of barges and similarly could be adapted for unloading timber and supplies for the mine. Cable must be capable of remaining flexible yet not breaking under load at temperatures to 75 below.

Dependent Steps in Maintaining Delivery of Coal to Whitehorse

1. Steamers and barges at Whitehorse to be conditioned for use; 2 more barges may be needed.

2. Timber crew to cut and haul - or float down - logs for
   (a) construction of mine and camp buildings
   (b) stock-piling of mine timbers and props for winter use (timber can only be cut when not frozen).

3. Road to Whitehorse to be improved by widening and grading; one small grade needs by-passing.

TRANSPORTATION OF COAL - CARMACKS TO WHITEHORSE

Stern-wheel steamers in summer regularly ply the river between Dawson and Whitehorse - most heavy or bulky freight being carried on large flush-deck barges which are pushed in front. The capacity of these barges is 200 tons, most of the Tantalus coal being formerly moved in this manner.

The river is open to navigation usually from about May 25th to October 15th--4½ months. The flow of the river is rather constant so that no trouble from low water can be expected.

It would be most ideal to ship all coal by this method but such does not seem possible - such a program would either require a production rate of 550 tons per day - certainly not obtainable with present limited and planned mine entries -- or else possible winter stock-piling at the Butte. Both of these would require enormous storage facilities at Whitehorse, the coal, however, does not change appreciably (see analyses) on slaking and danger from self-combustion is absent.

PRESENT AND FUTURE DEMAND FOR COAL

It is becoming increasingly obvious that coal in excess of that required by the Whitehorse Refinery (200 tons per day) will be needed in this region.

I. For domestic heating in the Army and Construction camps, including the steam heating plant of the Standard Oil Co. - Whitehorse Camp.

II. For the Army operated White Pass & Yukon Railway, coal now being brought into Skagway and thence in cars to Whitehorse. Total cost originally reported as about $40.00 a ton Whitehorse. (Wood $15.00 a cord).

III. For the River Steamers between Whitehorse and Dawson.

IV. The route of a contemplated railroad passes by the Tantalus Butte, crossing the river at Five Fingers Rapids. Exactly what source of fuel is planned is unknown but it would seem desirable to use local coal.

ECONOMICS OF WOOD VERSUS COAL

Major Hake (7) has made some interesting notes on this subject:

(a) Transportation

1. "1 Ton of coal is roughly equivalent in domestic heating to 3 cords of wood.
2. 2 Cords of wood can be loaded on a 5 ton truck (type mostly used).
3. Thus the transportation of coal by truck is 8 times as efficient as that of wood.

Hence if wood is being hauled 15 miles it is just as efficient to haul coal 8 times that distance, namely 120 miles."

(b) Personnel Employed

At the camps at Fort St. John and Dawson Creek, Major Hake (7) found that "10 trucks and 56 men supply and deliver about 45 cords of wood per day" this is the equivalent of 15 tons of coal.

If 45 men (subtracting 10 as drivers & 1 foreman) supply the equivalent of 15 tons of coal, the output is 1/3 tons of coal per man.

At the old Tantalus Mine the output was about 5 tons per miner (rather high!) a more conservative figure of 2 tons per man employed will be used.

Hence from a personnel employed status 6 times as many men are required to gather and saw wood as to mine the equivalent value in coal. This "6 times factor" repeats itself in food supply and living accommodations.

In view of the growing scarcity of wood in the Whitehorse area it would seem advantageous to supply coal for I and III in addition to II.

If this should be decided upon, a program of intensive exploration for coal would be necessary and is outlined in the subsequent sections.

PROSPECT - AREAS FOR COAL

I. Nordenskiold Valley - Lone Pine Mtn., and Porter Mtn., south of Carmacks; 118 miles from Whitehorse by Dawson road.

Within 1/2 mile of existing road; 18" seam reported, water 4.68% Volatiles 15.69, Fixed carbon 72.26, Ash 7.47 (a real anthracite?).

Superficial covering reported as heavy and masking outcrops.

Trenching followed by drilling; Not very hopeful.

II. Braeburn - Kynocks area - south-west portion.
Extensive area of Tantalus coal-measures lying in the form of "a large, broken, flat, undulating cake which forms the top and in places the main portions of a number of hills and ridges".

(a) Outcrop, north-east face of Red Ridge - 7 miles of flatish road and 3 miles of mountain road to connect to Dawson Trail.

(b) Good exposure in a small creek on the north-east side of Division Mountain - 4 miles of flatish road to connect with Dawson Trail.

Seam here 7'8", one 4' and several 6"-18" wide; first seam analysed; water 12.02%, volatiles 34.28, Fixed carbon 42.56, Ash 11.14; this evidently a frozed slaked sample and compares by analogy to the Tantalus Butte where outcrop samples ran 12-16% water but later at depth in the mine the water content decreased to 4-6%. The fuel ratio FC/VM is 1.2 which compares closest with that of the Tantalus Butte 1.1, the ash being about the same.

Both areas represent about a 70 mile haul to Whitehorse and are too distant for river transportation.

VERY ATTRACTIVE for investigation after snow-melt.

III. Kluane Lake - north-west end; apparently a fair coal basin, cut through and exposed in the Duke and other rivers in the steep mountainous country to the south-west.

The analyses of this coal average Water 10.5%, Volatiles 40, Fixed carbon 40, Ash 9.5, fuel ratio FC/VM = 1 show it to be a true lignite. The high volatile content predicts danger of both gas in the mine and danger from mine-fires.

No data on the geology of the area has been found but the beds are reported in places to be flat-lying and elsewhere to be folded up into strike-ridges; an area suitable for stripping might be found.

This area seems to offer great promise of supplying many of the camps along the Alcan Highway and the possibility arises of empty south-bound trucks carrying a pay-load even to Whitehorse, a distance of about 185 miles.

SUMMARY OF ANALYSES

PROSPECT AREAS

	AREA	SEAM WIDTH	WATER	VOLATILE COMBUST.	ASH	FIXED CARBON	COLLECTOR	FUEL RATIO FC/VM	BTU VALVE	REFERENCE
	Nordenskield Valley Porter Mtn.	18"	4.68	15.59 (A real anthracite coal)	7.47	72.26	Cairnes		ND	D.D.Cairnes Memoir #5
I	Braeburn-Kynocks Division Mtn.	18"	8.98	29.62	13.10	48.30	Cairnes	1.63	ND	1910
		7'to8'	12.02	34.28	11.14	42.56	Cairnes	1.24	ND	Dept. of Mines
	These are surface frozen samples, at depth by analogy with other samples the water content would probably be about 5.5%.									
II	Kluane Lake									
	Head of Shop Creek	#416	10.9	41.0	9.6	38.5	Research Council of	0.9	ND	Research Council of
	Left Fork-Burwash Creek	#417	10.2	42.0	9.1	38.7	Alberta	0.9	ND	Alberta
	Left limit Granite Creek	#418	11.2	40.9	5.4	42.5		1.0	ND	
	Left limit Granite Creek	#419	9.8	42.5	1.6	44.7		1.0	ND	

POSSIBILITY OF RECOVERING COAL BELOW THE OLD TANTALUS MINE

The tonnage has been previously discussed. Most of this coal exists down dip and below river level, however, the two Five Finger mine workings were both way below river-level.

Extraction

The seams vary somewhat, the section is reported to average:

Upper Seam	3'
Intervening rock	7'
Middle Seam	6' 6"
Intervening rock	4' (minimum)
Lower Seam	7'6"

The two lower seams were worked in the old mine, and it might be possible to work out a system for recovering 50% of the middle seam, i.e., 100,000 tons to - 300 feet. In most coal mines this is impossible but in the Tantalus region due to the abnormal competency of the strata and their steep angle of inclination it is believed well possible.

Development

(a) Haulage way should be in the lower seam, and, so as not to endanger it, that portion of the overlying middle seam should be left intact.

(b) Rooms driven in the lower seam - pillars to be left.

(c) A raise to be driven from above the chute and of each room to the overlying seam - this raise to act as a chute.

(d) Rooms to be driven in the middle seam with pillars left at right angles to the seam directly pressing on the pillars in the lower seam.

(e) Pulling of pillars in the middle seam.

(f) To what extent roof-falls and cave-ins follow (e) will determine the feasibility of pulling pillars in the lower seam.

Other possibilities of developing coal by exploration within the vicinity of the Tantalus mine are discussed in the following section.

COMPARISON OF THE TANTALUS COALS AND POSSIBILITY OF FINDING OTHER COAL SEAMS WITHIN THE VICINITY

1. It is interesting to note that the three coal mines of this region are located where the coal actually outcrops right at the surface - the Tantalus and Five Finger seams being actually seen and recorded by Dr. Dawson (1) in 1887 when he travelled up the river -- the Butte was too distant for those seams to be seen. When it is realized that fully 75% of the country is actually covered with debris and soil, it is interesting to speculate on how many seams might remain buried in this 75% of concealed country.

2. It has usually been assumed that the seams at the Butte and the Tantalus were the same, (the fuel ration of Volatile combustile to Fixed carbon FC/VM is largely independent of the ash and water content (and also of surface slaking). A comparison of these ratios reveals rather remarkable differences:

	Tantalus	Tantalus Butte	Five Fingers
Upper Seam	2.1-2.2	1.6	1.1
Middle "	2.3	1.3	
Lower "	2.1-2.2	1.5-1.6	1.1

None of the seams correlate on this basis. Moreover the quality of the Tantalus coal is not as good as that of the Butte - due not only to the presence of bone layers but also to the actual ash content of the clean coal.

3. It might be possible to explain the fuel-ratio difference by variations in the intensity of metamorphism (heat and pressure) that each area had suffered, but unexplainable differences also exist in the spacing of the seams.

Tantalus				Tantalus Butte		
3'	Coal	}		8'10"	Coal	}
7'	Strata	}	+	100'	Strata	}
6'6"	Coal	} = 28'		9'10"	Coal	} = 244'
4'	Strata	}	+	115'	Strata	}
7'6"	Coal	}	+	6'	Coal	

Thus it would seem impossible to correlate either the strata or the coals; 700' of strata is <u>exposed</u> on the face of the Butte but only + 300' by the Tantalus, the remainder being <u>covered</u> yet a fairly steep slope exists for a mile both east and west of this mine, (see photographs) at right angles to the strike of the beds. This entire section of about 1000' of beds <u>should be trenched</u> in an effort to locate some of the seams present in the Butte, the <u>alternate course</u> being to drive cross-cuts east and west from within the old Tantalus mine, perhaps eventually less expensive and safer.

EXPLORATION DRILLING

This always sounds such an attractive method of exploration ? it is adapted to some types of country and not to others.

1. Tremendous failures have frequently resulted in mis-interpretation of core-drill data.

(a) Unless the dip of the beds at the point from which the samples come is known, the thickness cannot be determined; if the dip is steep it may be only 1 foot or so instead of the 10 foot apparent penetration.

(b) Core recovery is very variable; 10 feet may be drilled yet only 4 feet of core recovered. Fractured coals are to brittle to core readily, and instead "drill-up"; Tantalus coal would seem in this category.

2. The intensely hard character of many of the sandstone and conglomerate beds in the Tantalus formation may present difficulties; much formation is silicified - the pebbles, mostly of quartz and chert, breaking across instead of around; and the wear on bits might be rather excessive.

Rather than experiment with various types of drills and perhaps fail, an old fashioned churn-drill with 9" bit, with accurate logging of the abundant failings produced, seems more reliable; a series of shallow holes -- tracing out the seam and computing the dip and thickness is more desirable than a few deep holes; a hand-mirror reflected down usually gives a pretty fair idea of the dip and other conditions in the hole.

The use of a core-drill, for purely geological exploration for coal outside of the mine limits, cannot be recommended.

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COPY

COAL ANALYSIS REPORT
RESEARCH COUNCIL OF ALBERTA
UNIVERSITY OF ALBERTA

Lab.Sample No.402-

MINE: Tantalus Butte LOCATION:

OPERATOR: ADDRESS: Carmacks, Yukon

DESCRIPTION OF SAMPLE: 5-6 lb. sample in cotton sack, taken from lower seam of mine.

SAMPLER: Donald C. Birch DATE OF SAMPLING: January 15 & 16, 1943

SAMPLER'S NO: DATE RECEIVED: February 12th, 1943

MOISTURE RETAINED AT 99.9% HUMIDITY (capacity moisture) 5.0
MOISTURE RETAINED AT 60.0% HUMIDITY (air-dried moisture) 3.8

PROXIMATE ANALYSIS:		As Received	Capacity	Dried
Moisture	%	3.4	5.0	
Ash	%	10.0	9.9	10.4
Volatile Matter	%	34.2	33.6	35.4
Fixed Carbon	%	52.4	51.5	54.2
ULTIMATE ANALYSIS:				
Carbon	%	70.15	68.95	72.55
Hydrogen	%	4.75	4.85	4.55
Ash	%	10.0	9.9	10.4
Sulphur	%	0130	0.30	0.30
Nitrogen	%	0.7	0.7	0.8
Oxygen	%	14.1	15.3	11.4
Calorific Value, gross	B.T.U.per lb.	12,050	11,850	12,470
Calorific Value, net	B.T.U.per lb.			
Fuel Ratio (F.C./V.M.)		1.55		
Carbon/Hydrogen Ratio				15.9

COKING PROPERTIES: Non-coking.

REMARKS: Initial Deformation temp. 2090°F; Softening temp. 2160°F; Fluid Temp. 2260°F. The softening temperature is the temperature usually taken as the fusion temperature of the ash.

This sample, which was received in a cotton bag, may have dried out somewhat in shipment, as humidity tests showed that this sample could contain 5.0% moisture (capacity moisture) without being damp. The analysis with capacity moisture is shown in the middle column.

Date February 23rd, 1943 Signed: D. W. Clarke

Approved: E. Stanfield (?)

COAL ANALYSIS REPORT

Research Council of Alberta

University of Alberta

Lab. Sample No. 401-43

MINE: Old Tantalus Mine

LOCATION:

OPERATOR:

ADDRESS: Cormacks, Yukon

DESCRIPTION OF SAMPLE: 5-6 lb. sample in cotton sack. Lower seam at 9'.

SAMPLER: Donald C. Birch

SAMPLER'S NO.:

DATE OF SAMPLING: Jan. 15 & 16, 1943

DATE RECEIVED: Feb. 12th, 1943

MOISTURE RETAINED AT 99.9% HUMIDITY (Capacity moisture) 2.1

MOISTURE RETAINED AT 60.0% HUMIDITY (air-dried moisture) 1.3

PROXIMATE ANALYSIS:

		As Received	Capacity	Dried
Moisture	%	0.9	2.1	
Ash	%	28.4	28.0	28.6
Volatile Matter	%	21.9	21.6	22.1
Fixed Carbon	%	48.8	48.3	49.3

ULTIMATE ANALYSIS:

Carbon	%	59.95	59.20	60.45
Hydrogen	%	3.65	3.70	3.55
Ash	%	28.4	28.0	28.6
Sulphur	%	0.30	0.30	0.30
Nitrogen	%	0.8	0.8	0.8
Oxygen	%	6.9	8.0	6.3
Calorific Value, gross	B.T.U. per lb.	10,230	10.110	10.320
Calorific Value, net	B.T.U. per lb.			
Fuel Ratio (F.C./V.M.)		2.2		
Carbon/Hydrogen Ratio				17.0

COKING PROPERTIES: Non-coking.

REMARKS: Initial Deformation temp. 2250°F; Softening temp. 2340°F; Fluid temp. 2450°F. The softening temperature is the temperature usually taken as the fusion temperature of the ash.

This sample, which was received in a cotton bag, may have dried out somewhat in shipment as humidity tests showed that this sample could contain 2.1% moisture (capacity moisture) without being damp. The analysis with capacity moisture is shown in the middle column.

Date - February 23rd, 1943.

Signed D. W. Clarke

Approved E. Stanfield. (?)

SUMMARY

1. Abundant partly developed coal reserves exist in the Tantalus Area at Carmacks, 135 miles north of Whitehorse, Y. T.

2. The best place to develop coal with a minimum of delay involved is to re-open the Tantalus Butte Mine.

3. The coal is a semi-bituminous coal of 10-13% ash content, of fuel ratio 1.65 and of heating value, 11,400 to 12,400 BTU.

4. Proven recoverable coal reserves are estimated at 378,000 tons, at a consumption rate of 200 tons per day equivalent to a 5 years supply. Probable reserves at 1,134,000 tons.

5. The seams are well adapted for economical and easy working; production costs would appear about $8.00 per ton.

6. Machinery, equipment and camp must be capable of withstanding temperatures down to 75° below.

7. The mine is situated on the east bank of the Lewes River, allowing cheap transportation of coal by barge, to Whitehorse for 4½ months in the year.

   The remaining 7½ months the coal must be hauled by more costly trucks or tractor-trains over the existing road.

   Average cost delivered Whitehorse would still appear to be about $25.00 per ton.

8. Mr. Gentry, Engineer of Bechtel-Price-Callahan, estimates an investment cost of $270,000.00 is necessary to place the mine on production. Haulage investment will be additional.

SUPPLEMENTARY

9. Since time is an essential factor in securing production to take advantage of this year's river transportation, cleaning out and reconditioning the mine must proceed while engineering data is being assembled, camp erected, new machinery ordered, shipped and installed.

10. Dependent steps in maintaining delivery of coal include re-conditioning of river steamers and barges, improvement of winter road, and cutting of timber for camp construction and for winter use in the mine.

11. There already exists a growing demand for coal from other sections of the Canol Project, the U. S. Army and construction camps; railroad and steamer

12. (a) The transportation of coal is 8 times as efficient as that of wood, (b) 6 times as many personnel are involved in supplying wood as for coal.

13. The possibility of supplying this demand from the Tantalus Area are very good but an exploration and development program is needed. The old Tantalus Mine could probably be re-opened to supply one hundred (100) ton per day. Other areas attractive for exploration are outlined.