

ARCHER, CATHRO
AND ASSOCIATES LTD.
CONSULTING GEOLOGICAL ENGINEERS

Box 1708, WHITEHORSE, Y.T. 667-4113

BENTALL CENTRE, VANCOUVER, B.C. 688-2568

1475 TWO BENTALL CENTRE
555 BARRARD ST.
VANCOUVER 1, B.C.

Summary Report

Casino Project

Yukon Territory

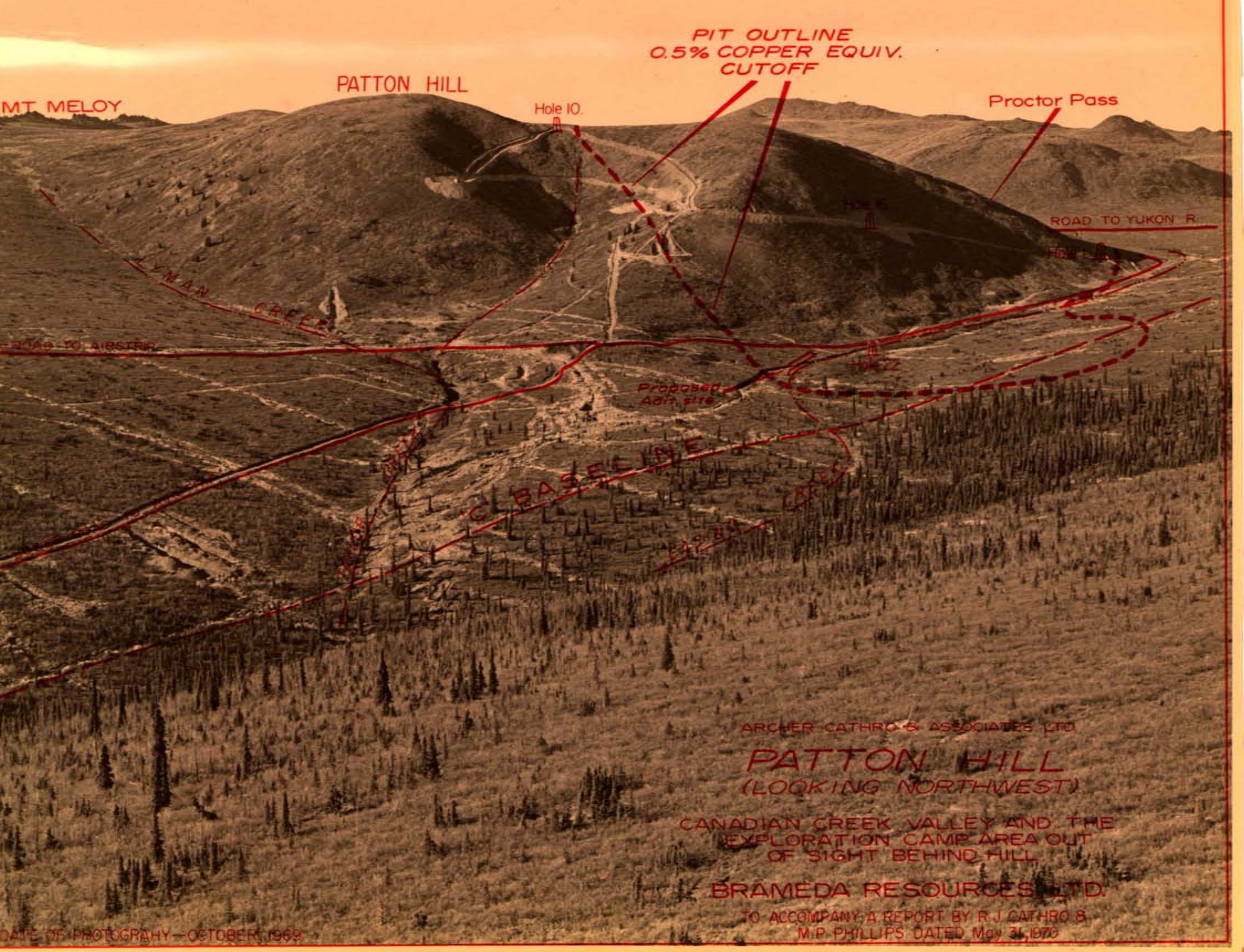
Brameda Resources Ltd.

April 1, 1969 - March 31, 1970

R.J. Cathro, P. Eng.

M.P. Phillips

May 31, 1970



PIT OUTLINE
0.5% COPPER EQUIV.
CUTOFF

PATTON HILL

Proctor Pass

Hole 10

ROAD TO YUKON R.

LYMAN CREEK

ROAD TO AIRSTRIP

Proposed
Agn site

CL BASELINE

EAPB
EAPB Creek

ARCHER CATHRO & ASSOCIATES LTD

PATTON HILL
(LOOKING NORTHWEST)

CANADIAN CREEK VALLEY AND THE
EXPLORATION CAMP AREA OUT
OF SIGHT BEHIND HILL

BRAMEDA RESOURCES LTD.

TO ACCOMPANY A REPORT BY R J CATHRO &
M P PHILLIPS DATED May 31, 1970

DATE OF PHOTOGRAPHY - OCTOBER, 1969

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INTRODUCTION

By letters of agreement dated August, 1968 from L.S. Trenholme and February, 1969 from B.O. Brynelsen, Archer, Cathro & Associates Ltd. have acted as geological consultants on all work conducted on the Casino Silver Mines Ltd. claims in the Dawson Range, central Yukon Territory, since 1967. This property is referred to in this report as the Casino Project of Brameda Resources Ltd., the company which has financed the program since June 20, 1969. In addition to geological duties, Archer, Cathro & Associates Ltd. has performed all property management functions which could not be handled by Brameda personnel.

Metallurgical studies initiated by Brameda are not discussed in this report.

Drilling of the discovery hole, Pl, commenced on June 5th, 1969, to test a strong soil geochemical anomaly which was situated in a favourable porphyry copper environment. The program grew slowly until October, when Brameda decided that favourable results justified a major development program, including a feasibility study. Financing difficulties forced an abrupt cessation of all work in late March, 1970.

SUMMARY

During the period June 5, 1969 to March 21, 1970, 36,942 feet of core drilling and 5808 feet of rotary drilling were completed in the Patton Hill area. This drilling discovered and substantially defined a major porphyry-type deposit of disseminated, low-grade copper and molybdenum, containing low values in gold, silver and tungsten. Ore reserves for open-pit mining have been calculated to the bottom of the drill holes as follows:

(1) 0.5% Cu.E. cutoff gradeEAST ZONE - PROVEN ORE

24.35 million tons - 0.633% Cu, 0.059% MoS₂,
(0.751% Cu.E.), 0.015 oz/ton Au,
0.033 oz/ton Ag.

5.22 million tons - 0.386% Cu, 0.031% MoS₂,
(0.449% Cu.E.)
(to be stockpiled for later
treatment).

80.2 million tons - waste

Stripping ratio - 2.71

(2) 0.3% Cu.E. cutoff grade (including higher grade ore above).EAST AND WEST ZONES

Proven	105.73 million tons	-0.383% Cu, 0.053% MoS ₂ (0.489% Cu.E.)
Probable	31.85 million tons	-0.316% Cu, 0.052% MoS ₂ (0.420% Cu.E.)
Possible	<u>71.84</u> million tons	-0.325% Cu, 0.036% MoS ₂ (0.397% Cu.E.)

209.42 million tons

Stockpile	13.83 million tons	-0.228% Cu, 0.019% MoS ₂ (0.266% Cu.E.)
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Waste 360.66 million tons

Stripping ratio - 1.62

The deposit is still partially open at depth and to the southwest and west. As well, the West Zone has only been drilled on a wide spacing and the grade of this block may improve with better definition. Reserve grades are considered to be conservative because

(a) they are based mainly on core assays. Assays on rotary cuttings are almost consistently higher, especially in the richer sections.

(b) check assaying has been consistently a little higher than the grades used in the calculations.

Casino is an Arizona-type porphyry. A leached surface capping is underlain by an enriched supergene zone which is gradational downwards into primary mineralization. The area of best enrichment (East Zone) is situated close to surface and the deposit will lend itself to removal of higher than average grade in the early operating years. The topography over the deposit and the climate in the area are very well suited for open-pit mining. Surface rights are held over a large area in the vicinity of the deposit and there will not be any unusual problems in site location or construction. Because of the low precipitation in the region, clean water is somewhat scarce in the immediate vicinity of the deposit.

Access is costly and will remain so until an all-weather highway is built. Estimates of the cost of this

road are approximately \$7-8 million dollars. Freighting costs at present are:

by air \$90-100 per ton

by winter road 60- 80 per ton

by boat 50- 70 per ton

Once the property is connected to the existing Yukon highway system, it will be only 342 miles from the seaport of Skagway, Alaska.

There are abundant, undeveloped hydro, coal, and natural gas reserves in the region. The precedent of massive government assistance to remote mining projects has been well established by the Anvil and Clinton developments. This assistance has been given in the form of power supply, highway access, and townsite development.

CONCLUSIONS AND RECOMMENDATIONS

The ore reserves which are now indicated appear sufficient to support a modest operation of at least 15,000 tons per day capacity. Immediate exploration should be directed towards finding more rich supergene ore which would allow detailed studies to proceed on a plant of 30,000 tons per day or larger, a more attractive investment in this location.

The work completed to date has defined the main problem areas in proceeding to a production decision. These are access and transportation costs; power supply; metallurgy; and water supply. As the first step towards embarking on a formal feasibility study, preliminary engineering studies and discussions with the government are recommended in each area.

Cheap access and transportation costs are most likely to be realized by a road to Carmacks. This would connect to the present highway or to a possible railway extension north from Whitehorse. Power may be derived from known nearby hydro sites on the Pelly River, from extensive bituminous coal reserves at Carmacks, or from proven gas fields to the north or the southeast.

The economic and industrial impact of a development such as Anvil or Casino is so great on a little-developed area like Yukon that studies of each single development

necessarily involve a study of the entire territory. Anvil has recently reached production after an exhaustive feasibility study and much of what was learned by Anvil can be applied to Casino. Anvil will be continuing its studies before 1974 on the feasibility of a smelter. It is imperative that Brameda enter into close consultations with both Anvil, in respect to areas of mutual concern, such as transportation, and the government, regarding studies of power and highway alternatives.

Precipitation records should be carefully compiled at the property and measuring gauges should be installed at once on Dip and Casino Creeks, in cooperation with the Water Resources Branch.

If a major 1970-71 winter program is conducted, attempts should be made to have the government maintain the winter road for Casino, as it did the Canol Road for Anvil in the winters of 1965-66, 1966-67, and 1967-68. This would reduce the freighting costs from \$60.00-\$80.00 per ton to about \$35.00 per ton.

There appears an excellent possibility, from comparisons between rotary and core assays, that further detailed drill or underground sampling may improve the ore reserve grades. In conjunction with the normal metallurgical bench tests now underway, the amount of gold, silver and tungsten which can be recovered with copper or molybdenum should be

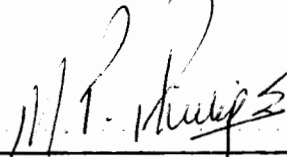
determined early. Following up on the preliminary open-pit design adopted for the ore reserve calculation, a preliminary mining plan should be prepared.

Respectfully submitted

ARCHER, CATHRO & ASSOCIATES LTD.



R.J. Cathro, P. Eng.



M.P. Phillips

May 31, 1970

PROPERTY

Casino Silver Mines Ltd. owns 426 unpatented mineral claims comprising about 30 square miles. Of these, 260 were staked following the discovery hole. They are situated within the Whitehorse Mining District and registered at Whitehorse under the Yukon Quartz Mining Act. Eight claims were staked to protect surface rights at a possible town-site location at the mouth of Britannia Creek on the Yukon River. The other 418 claims form a single irregular shaped block which fully protect the porphyry deposit.

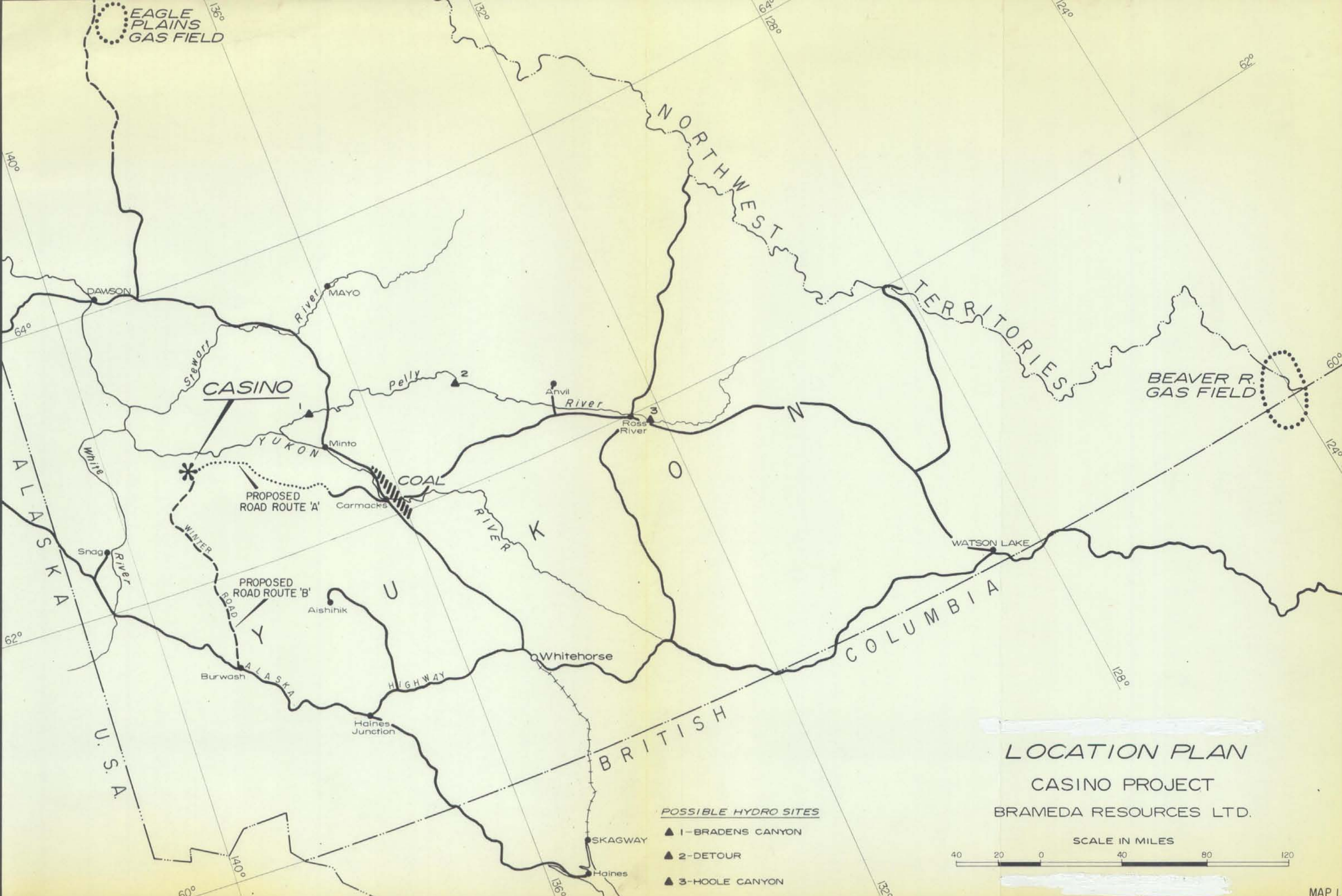
In addition to the mineral claims, further surface protection was gained by staking three placer prospecting leases under the Yukon Placer Act on the streams draining the deposit. This was necessary because small placer operations have been carried out here in the past. Water, which is in short supply, was further protected by obtaining the appropriate licenses. Mineral claims provide normal surface rights for the owner and, as assurance has now been received from the Mining Recorder that Casino will be free from interference by other parties, the placer and water rights within the property can be dropped.

A single placer claim was staked on Dip Creek, just above the Casino Creek junction, for the purpose of obtaining the water rights on the Dip Creek drainage basin.

A legal survey of 39 claims, covering the limits of the Casino Stock, was made during 1969 by White, Hosford & Impey Ltd. of Whitehorse, at a cost of \$375.00 per claim. These claims can now be taken to 21 year lease. However, leased claims cannot be grouped with unpatented claims for assessment credit. Since most of the future exploration expenditure will be within the surveyed areas, these claims should not be taken to lease until at least ten years credit has been applied to the entire property. Most of the claims are now in good standing until 1974 or later. The expiry dates and property location is shown on Map 2.

LOCATION

The Casino property is situated 187 air miles northwest of Whitehorse, at 62°43'N and 138°49'W (see Map 1). It lies at a height of land between Canadian Creek, (a tributary of Britannia Creek, which flows north to Yukon River), and Casino Creek, (which flows south and west into Donjek River and White River, and eventually into the Yukon River). The property is within claim sheets 115-J-10 and 115-J-15 (N.T.S.), while, physiographically, it lies within the Dawson Range, a subdued mountainous portion of the Yukon Plateau. The Alaska Highway passes within 75 air miles on the southwest, while the Whitehorse-Keno road (Highway 2), passes within 65 air miles on the east. The Yukon River, which was the main transportation route in the Territory prior to World War Two, passes within 12 road miles on the north. The Alaska Boundary is 70 air miles west. Of special interest is the fact that the property lies within a small area of Canada that, due to dryness, was never covered by Continental ice sheet glaciation during the youngest (Pleistocene) ice advance.



EAGLE PLAINS GAS FIELD

BEAVER R. GAS FIELD

CASINO

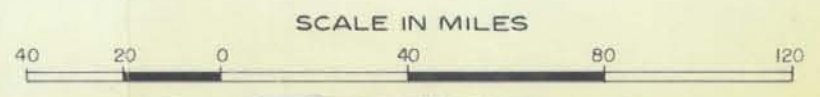
PROPOSED ROAD ROUTE 'A'

PROPOSED ROAD ROUTE 'B'

POSSIBLE HYDRO SITES

- ▲ 1-BRADENS CANYON
- ▲ 2-DETOUR
- ▲ 3-HOOLE CANYON

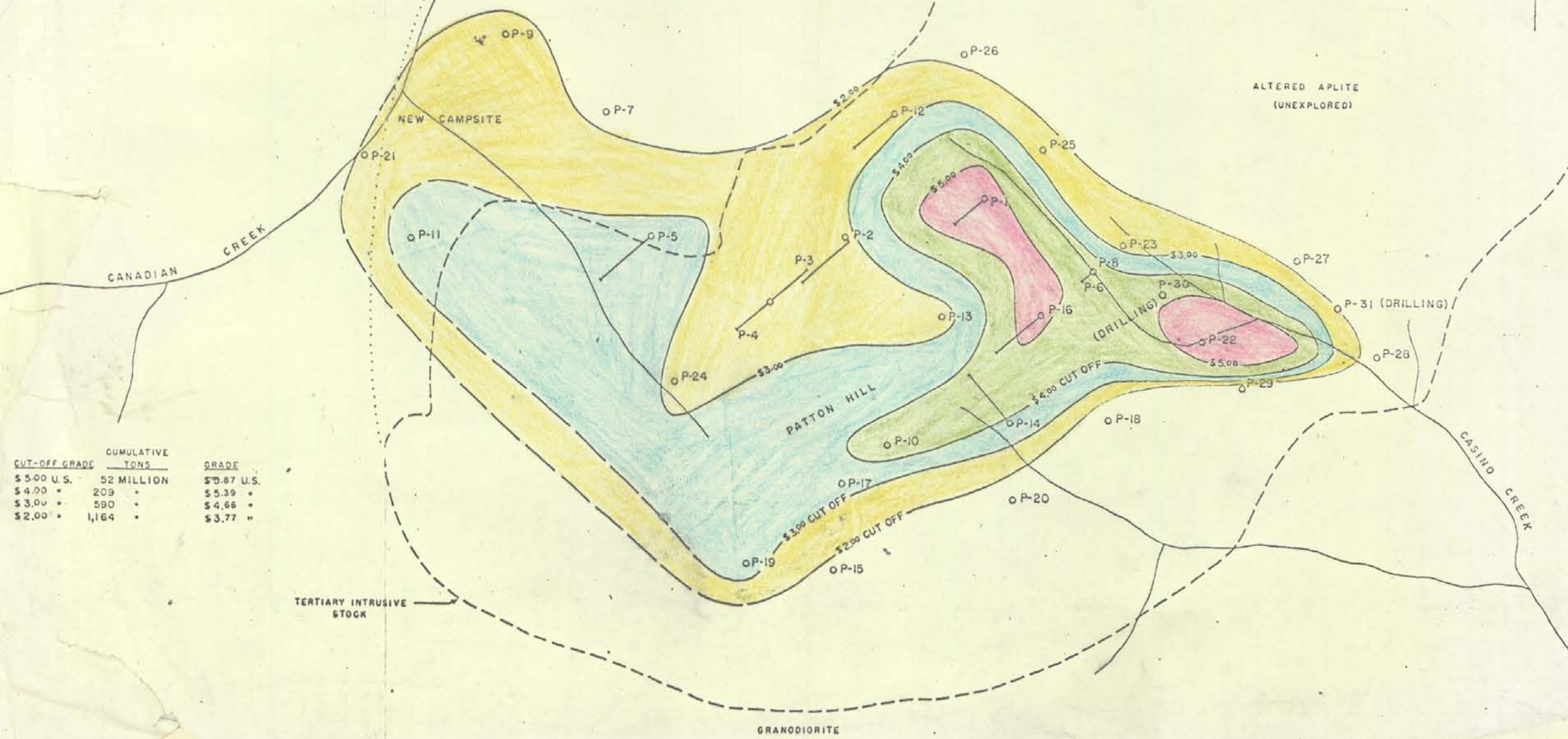
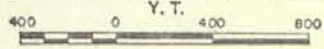
LOCATION PLAN
CASINO PROJECT
BRAMEDA RESOURCES LTD.



BRAMEDA RESOURCES LTD.

DRILLING PLAN

CASINO CREEK PROPERTY



CUT-OFF GRADE	CUMULATIVE TONS	GRADE
\$5.00 U.S.	52 MILLION	\$3.87 U.S.
\$4.00 "	209 "	\$5.39 "
\$3.00 "	590 "	\$4.66 "
\$2.00 "	1,164 "	\$3.77 "

GRANODIORITE

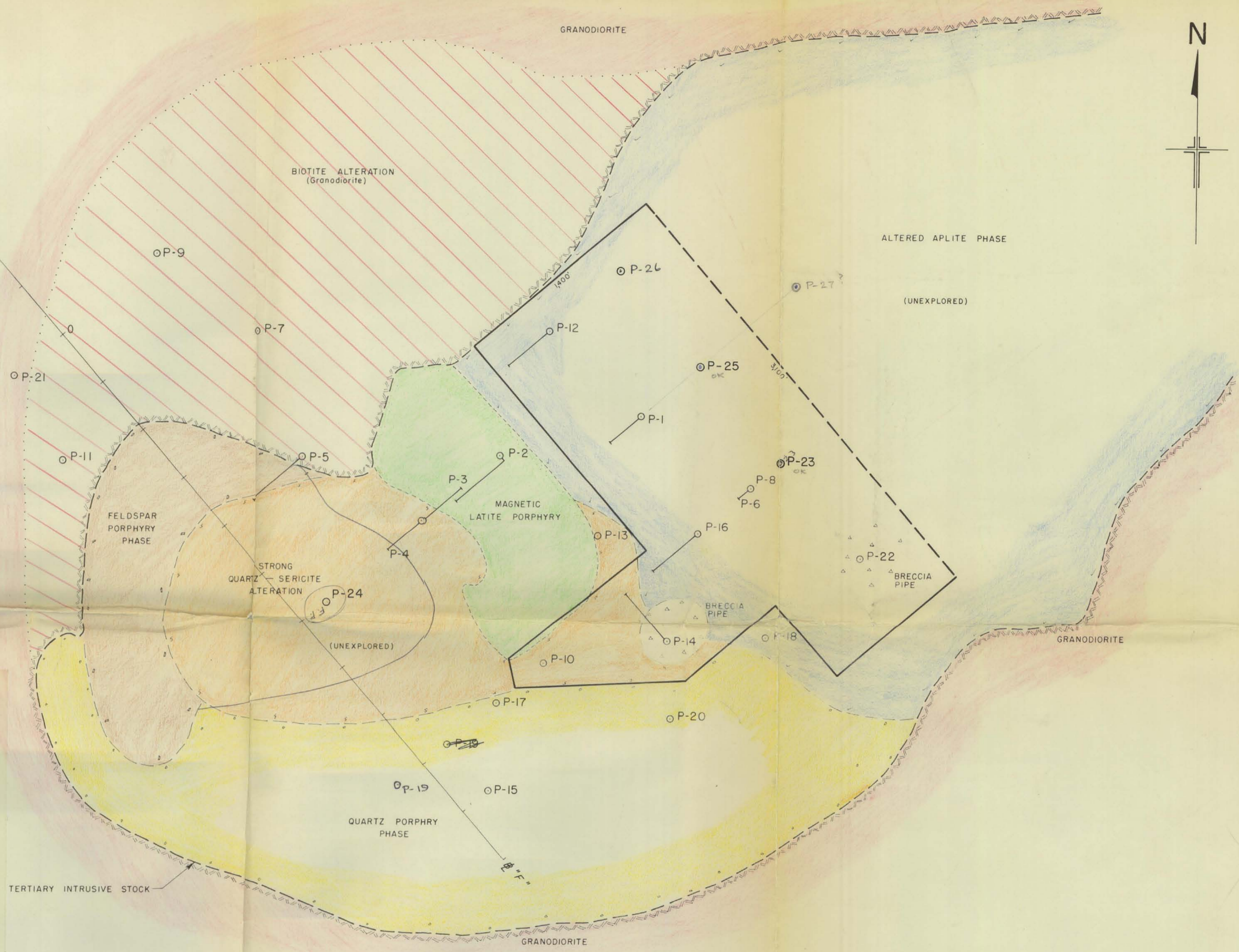
Nov 12/69
 P-22
 30'-240' = 210'
 240' 1200' = 960'
 1,048 Cu
 .085 MoS₂
 CU Equivalent 1,092
 .423 Cu
 .06 MoS₂
 CU Eq. .65
 .535 MoS₂
 .0518 Cu
 CU E. 6.536
 1170'
 The total P-22 is same as Patton Hill
 with the P-22 - 140' Cu E
 calculation for 351,000,000 lbs

Hole No.	OXIDE ZONE			SECONDARY ZONE			PRIMARY ZONE			COMB. SECONDARY/PRIMARY					
	From	To	Vert. Feet	From	To	Vert. Feet	From	To	Vert. Feet	% Cu	% MoS ₂	Vert. Feet	% Cu	% MoS ₂	Vert. Feet
P-1	6.5	165.5	125.0	165.5	381.0	165'	660.0	1006.0	144'	.278	.029	689'	.364	.032	689'
P-6	53.0	143.0	130.0	143.0	248.0	90'	300.0	696.0	140'	.125	.018	470'	.200	.015	470'
P-8	(ABANDONED AT 116')			345.0	660.0	315'	730.0	972.0	98'	.250	.136	513'	.279	.085	513'
P-10	7.0	345.0	345.0	150.0	300.0	130'	525.0	1255.0	105'	.223	.126	990'	.274	.1026	990'
P-12	92.0	150.0	130.0	345.0	730.0	345'	240.0	1200.0	90'	.2374	.0895	8695'	.5350	.0518	8695'
P-14	24.0	345.0	282.0	210.0	525.0	304'	Average			Assume			800'		
P-16	0	210.0	190.0	30.0	240.0	210'	Average			Assume			800'		
P-22	0	30.0	30.0	217'	210'	210'	Average			Assume			800'		
AVERAGE THICKNESS 200'															

Mo = 51.72 U.S.
 Cu = .45 U.S.
 F = 2.29

TONS PER VERT. FOOT = 442,000
 TONS 88,400,000
 TONS 95,924,000
 TONS 257,664,000
 95,924,000
 COMBINED TONS 353,410,000

Weighted by Tonnage
 = 2704 / 0722
 Copper Equivalent = .6536



CASINO SILVER MINES LTD.
 PLAN OF
 DIAMOND DRILLING & PROVISIONAL GEOLOGY
 CASINO CREEK AREA
 YUKON TERRITORY

DRAWN BY L.B. / OCT., 1969	N.T.S. 115 J / 10	JOB NO. / K-106	DRAW'G NO. / K-106
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SCALE 400 200 0 400 800 FEET

ACCESS

The property has been serviced in the past by (1) wheeled aircraft which land on an airstrip on the property, (2) a 140 mile winter tote road from Burwash Landing on the Alaska Highway and (3) river barge along the Yukon River from Dawson City, a distance of 125 miles by river and 12 miles by road from the river to the property. These routes are shown on Map 1.

(1) Air

Large supply hauls with aircraft have been flown from Minto, a distance of 65 air miles, but normal service is from Whitehorse. The airstrip is about 2500 feet long and has a good surface but it slopes towards one end at about 10°. It can only be approached from the downhill (south) end and only accommodates aircraft up to DC3 size. Maximum load is 5500 to 6000 pounds. This strip can be improved only at considerable expense. Although it is located on Casino claims and was built without government assistance, it is still considered a public strip.

DC3 freight charges, at \$1.50 per mile, are:

<u>From</u>	<u>Load(lbs)</u>	<u>Return Trip</u>		<u>Cost</u>	
		<u>Miles</u>	<u>Charges</u>	<u>Per Lb</u>	<u>Per Ton</u>
Minto	6000	130	\$256.00 (tariff min.)	\$0.04	\$ 85.00
Whitehorse	5600	374	\$560.00	\$0.10	\$200.00

Total freight charges from Whitehorse to Casino via

Minto are:	<u>Per Ton</u>	
Whitehorse-Minto @ 8¢/ton mile	\$13.00	
Minto-Casino via DC3	\$85.00	
		\$98.00

This might be reduced by \$10.00 per ton if it could be done by a larger aircraft (Bristol?).

(2) Road

The winter route was first constructed by Casino in the 1965-66 season and was reopened this past winter for the second time. It is 140 miles in length and commences at Mile 1097 on the Alaska Highway, which is 180 road miles from Whitehorse. The main obstacle is near the start (Mile 6) where a Bailey Bridge is required to cross the Kluane River. This bridge was borrowed from the Territorial Highway Department. All other streams were crossed on conventional ice bridges. The route is generally level and easy but requires continuous grading because of glaciering. Average time for the 140 mile trip with a loaded truck was from 8 to 10 hours. The road was used from December 10 to April 10.

Casino received \$20,000 in assistance from the Yukon Government in 1966 towards the initial road construction cost of \$79,000. Further assistance of \$20,000 has been promised this year. The Casino winter road is considered a

public road when it is open.

The cost of the winter road was:

Bridge - install and remove	\$15,100	
Road - open and repair	\$26,300	
Maintenance - equipment and labour	\$73,100	
		\$114,500

A total of 121 truck loads were hauled to Casino over the road, and assuming 20 tons per load, the total tonnage was 2420. Trucking charges were about \$700 per trip or \$35.00 per ton. The cost per ton of operating the road was about \$47.50, for a total freighting cost by road of \$82.50 per ton. The operating cost of the road could probably be reduced to about \$25.00 per ton if a large tonnage was hauled and the road was only maintained for a month or so. This would reduce the freighting costs to about \$60.00 per ton.

The better permanent road routes are discussed under Engineering.

(3) Water

Prior to 1964, all exploration freight was carried by boat on the Yukon River, and thence by a 12 mile trail suitable for bulldozers. This trail was built before World War Two to connect the property with the Yukon River. Although few boats are now available, this is still a practical access route and is a useful complement to the winter road until an all-weather road is built. The river season

extends from early June to mid-October. During October 1969, two trips were made from Dawson City by the boat "Brainstorm" which normally operates north on the Yukon and Porcupine Rivers to Old Crow. This vessel can carry about 50 tons, although the lateness of the season reduced its capacity in 1969. The cost of a round trip was about \$1200 or \$24.00 per ton. The total freighting cost from Whitehorse to Casino by this route would be:

	<u>Per Ton</u>
Whitehorse-Dawson @ 8¢/ton mile	\$27.00
Dawson-Britannia Creek in 50 ton loads	\$24.00
Britannia Creek-Casino by truck	\$ 9.00
	<hr style="width: 10%; margin-left: auto; margin-right: 0;"/> \$60.00

HISTORY

The first lode claims are believed to have been staked in the area in 1901, possibly for gold, although the early records are obscure. The first placer claims were staked in 1911 and sporadic placer mining and prospecting for both gold and tungsten continued until 1962. The placer activity led to the discovery of silver-lead veins near the present airstrip in the late 1930's (Helicopter and Bomber Zones) and the exploration of these veins between 1963 and 1967 indirectly led to the discovery of the nearby copper-molybdenum deposit on Patton Hill in 1969.

The veins were first staked in 1947 by prospector J. Meloy and were examined by Conwest, Springer Interests and Noranda, among others. Rio Tinto and Yukon Consolidated Gold Corp. held the claims in 1963 and when this option was relinquished in 1964, L.I. Proctor of Whitehorse optioned the property and formed Casino Silver Mines Ltd. the following year. Between 1964 and late 1967, when control of the company passed to the Brynelsen Group, about \$500,000 was spent on vein exploration, including 1200 feet of drifting, 6033 feet of diamond drilling, 100 miles of linecutting, magnetic and EM surveys, and extensive bulldozer trenching.

Exploration emphasis was shifted in 1968 from the veins to Patton Hill, where a porphyry copper deposit was suspected. Soil sampling, mapping and data compilation, led

to the 1969 drilling discovery. A more complete account of the early history is contained in the paper "Casino, Yukon - A Geochemical Discovery of an Unglaciaded Arizona-Type Porphyry" by A.R. Archer, and C.A. Main, which was presented to the International Geochemical Symposium at Toronto on April 16, 1970.

TOPOGRAPHY

The Dawson Range is characterized by a mature drainage system and erosion surface. There are virtually no lakes in the area and valleys are typically V-shaped in profile. A regional tilting upwards to the southwest has caused larger streams to undercut the northerly sides of their valleys. Valley outcrops are only common where a stream has been rejuvenated in recent times or a local alpine glacier caused a disruption in the former system. The canyon in Canadian Creek just north of the Casino property is a good example. The drainage system is usually dendritic with interlocking spurs and it has dissected the plateau into gently rounded hills which have average elevations ranging from about 3500 feet in the northwest to about 4500 feet in the southeast. The Yukon River provides the base elevation at about 1400 feet. Pleistocene valley glaciers penetrated through the Dawson Range in only one place. A tongue extended northeast down the White River from the St. Elias Mountains and split in both directions when it reached the Yukon River. Both valleys now display truncated spurs and outcrop is common on the walls of the widened and deepened valleys.

The erosion surface (or plateau) truncates all rock formations in the region except Miocene sediments and

volcanics (Carmacks Group), and stream rejuvenation is believed to have started at about that time. Superimposed on the general plateau surface are a number of prominent, isolated mountains which attain elevations between 5500 and 6600 feet, of which Mt. Cockfield, Apex Mountain and Prospector Mountain are good examples. These appear to represent recurrent centres of volcanic activity since sometime in the Mesozoic Era and are erosional remnants. Outcrop is common near these higher, volcanic areas but is rare elsewhere. When present, it is often as distinctive ridge and flank-mounted pinnacles or spires, which are called castellations. These are most common southeast of Casino and outcrop becomes gradually scarcer to the northwest end of the district.

CLIMATE

Climatological records have been kept continuously at Casino since August, 1969 in conjunction with the Department of Transport (D.O.T.). Excellent records are available from several nearby stations (all of which are located at low elevations in main valleys) - Snag, Aishihik, Whitehorse, Pelly Farm, Mayo, Elsa and Dawson. From the information now available, H.E. Wahl, Officer in Charge, Whitehorse Weather Office, has prepared a predicted 20-year temperature and precipitation record for Casino camp, at an elevation of about 3500 feet. The confidence level for precipitation is questionable because 1969 was unusually dry, but a clearer pattern will emerge as a longer record is compiled.

The central Yukon has a semi-arid, continental climate which is influenced to a large extent by topography. The Dawson Range lies in the rain shadow of the St. Elias Mountains, which block off most of the warm Pacific air, except for occasional "Chinook" winds. Similarly, the high mountains to the east and north prevent, to a certain extent, the influx of extremely cold Arctic air. Precipitation is lowest in winter and spring and highest during the summer. Rain generally occurs in the form of intermittent drizzles. Annual precipitation at the measuring stations

mentioned varies from 9.88 inches at Aishihik to 15.27 inches at Elsa. Strong winds occur rarely at high elevations.

Frost has been recorded during every month at every measuring station, although the mean frost free duration at lower elevations is significant - 78 day at Dawson, 64 days at Mayo, 51 days at Snag. The highest recorded temperature in Yukon is 95° at Dawson.

It is noteworthy that the coldest recorded temperature in North America occurred at Snag (55 miles southwest of Casino) on February 3, 1947 - 81° below zero. The extremely cold weather occurs in periods of 3 to 15 days between mid-December and early March and results when an Arctic air mass becomes stationary over the central Yukon. With no wind, the cold air gradually settles into the valleys and the warmer air is displaced upwards. Thus, a distinct temperature inversion occurs in winter, which becomes more accentuated as temperatures drop. In summer, temperature decreases with increasing elevations, on an average of four or five degrees per thousand feet. In winter, there is as much as 20° moderation per 1000 foot increase in elevation.

The records for Casino (elevation 3800 feet) and Pelly Farm (elevation 1500 feet), which is 50 miles east, are typical for the region:

Casino

<u>Month</u>	<u>Air Temperature</u>			<u>Precipitation</u>		<u>Temperature Extremes</u>	
	Daily Mean (F)	Mean of Daily Max (F)	Mean of Daily Min (F)	Mean Total of all Forms (inches)	Mean Snow-fall (inches)	Ext Max	Ext Min
January	- 7	0	-14	0.85	8.5	37	-45
February	0	6	- 6	0.70	7.0	40	-45
March	7	16	- 1	0.55	5.5	45	-35
April	24	34	14	0.60	6.0	56	-20
May	40	48	32	1.00	3.0	75	- 3
June	52	61	42	1.40	0	78	20
July	56	65	46	2.50	0	80	30
August	49	57	41	2.50	0.5	78	25
September	38	45	30	1.50	5.0	65	5
October	21	25	16	1.25	12.5	57	-15
November	7	11	3	1.50	15.0	42	-35
December	0	5	- 5	1.30	13.0	40	-45
Annual Mean	23.9	31.1	16.5			80	-45
Mean Total				15.65	76.0		

Pelly Farm

<u>Month</u>	<u>Air Temperature</u>			<u>Precipitation</u>		<u>Temperature Extremes</u>	
	Daily Mean (F)	Mean of Daily Max (F)	Mean of Daily Min (F)	Mean Total of all Forms (inches)	Mean Snow-fall (inches)	Ext Max	Ext Min
January	-18.5	- 8.5	-30.5	0.82	8.2	46	-74
February	- 5.6	8.1	-19.6	0.64	6.4	54	-76
March	8.7	25.6	- 9.6	0.47	4.7	55	-58
April	30.8	44.3	17.4	0.39	2.4	74	-37
May	44.7	57.9	31.6	0.83	0.3	85	10
June	55.4	69.7	41.4	1.34	0	95	27
July	58.5	71.6	45.5	1.97	0	89	29
August	53.9	67.2	40.6	1.36	0	87	21
September	43.9	56.3	31.3	0.92	0.4	78	11
October	26.8	36.2	17.2	0.77	5.3	68	-20
November	3.7	12.7	- 6.3	1.07	10.4	51	-57
December	-15.5	- 6.0	-25.0	0.87	8.6	55	-70
Annual Mean	23.9	36.3	11.2				
Mean Total				11.45	46.7	95	-76

The predicted extreme minimum temperature at Casino camp is 45° below zero. At the mouth of Britannia Creek in the Yukon River valley, temperatures would be comparable to Pelly Farm and a low of 75° below zero is possible. Although the annual daily mean temperature at Casino and Pelly Farm is identical - 23.9°, the annual daily maximums and minimums differ by 5°. Precipitation at Casino is about 35% higher than at Pelly Farm, and the excess falls as rain and snow between July and December. The higher precipitation at Casino is naturally accompanied by less hours of sunshine.

The higher elevation at Casino affords protection from the occasional winter extreme but it produces an unsatisfactory summer. From the standpoint of surface mining, it has one of the finest climates in northern Canada - relatively low precipitation and little wind, which results in only minor drifting or road maintenance; and moderate temperature extremes. However, this is not the best environment for a permanent townsite. There is no true summer as we know it in southern Canada, it is too cool for gardening, and frequent overcast and short rain showers almost every day are depressing to wives with small children. Some of the best days occur in winter and spring when the valleys are filled with fog and bright sunshine exists at Casino.

BASE CAMP

A new camp was constructed during December, 1969, at the junction of Patton Gulch and Canadian Creek, following a decision by Brameda to embark on a major 1970 program leading to a feasibility study. This camp has accommodation and dining facilities for 120 men and consists of 22 trailers - 15 bunkhouses, 1 recreation, 2 washcar, and 4 kitchen. Of these, 2 bunkhouse and 1 kitchen trailer were brought to the property in 1966 and were situated at the original camp at the Bomber Zone, at the head of Meloy Creek. The new trailers were hauled in over the winter road.

The new location was chosen for its ample, clean water (in summer); level, open ground; and proximity to the porphyry deposit. The layout of the new camp is shown on Map 4.

An engineering complex consists of a geology and engineering office, small buildings for sample handling and bucking, and core logging and storage, plus a 2-trailer assay office, supplied by Seymour Laboratories. A 96 foot by 32 foot machine shop/garage, a warehouse, mine dry, pump house and numerous smaller buildings completes the camp. A water pressure fire system has been installed. Fuel storage capacity is 200,000 gallons, primarily in 25,000 gallon tanks. Power is supplied by a 75 KW diesel

generator and a standby 15 KW set. Poor quality domestic water was obtained during the winter by pumping from drill hole P-21. Radio communication was provided by a VHF set leased from C.N. Telecommunications, which connects to the telephone lines through a microwave station at Burwash. A standby SSB set on frequency 4441 was also used.

REGIONAL GEOLOGY

Most of the Dawson Range has still not been covered by the Geological Survey of Canada's one inch to four mile reconnaissance mapping program and hence, the regional geology is not completely known. The general lack of outcrop in the region will hinder detailed mapping. The simplified version which follows is based on available G.S.C. mapping and personal experience by the writers in the district.

The oldest rock in the region is a metasedimentary complex which is composed mainly of schist, gneiss, phyllite and impure quartzite, but which also includes some amphibolite and limestone. Named the Yukon Group, it forms the base of the succession throughout much of the Territory and has been tentatively assigned an age of Cambrian or older. Sometime after the regional metamorphism of the Yukon Group and prior to the emplacement of intrusions, a thick assemblage of volcanic flows was extruded, probably in the Mesozoic Era (Mt. Nansen Group). Varieties present include basalt, porphyry dikes, acid flows, tuffs and volcanic breccias. The next stage in this orogeny was the intrusion of the Klotassin Batholith, which is part of the Coast Intrusions. The batholith is quite large (100 miles long with an average width of 20 miles) and is the main rock unit in the Dawson Range.

The batholith is usually quartz monzonite or granodiorite in composition, is medium to coarse-grained and often displays "dent cheval" texture. Both biotite and hornblende are common, magnetite is often present as an accessory mineral, while epidote and sphene are rare. The batholith is usually very massive and blocky with a platy, horizontal jointing occasionally present. With even a slight amount of alteration, the intrusive rocks crumble on weathering to a coarse "granitic sand". Castellations are common in the more resistant areas. Samples of the batholith from the Casino property have been age dated by the G.S.C. and are upper Cretaceous (95-99 m.y.). Dikes of this rock cut Mt. Nansen volcanics elsewhere in the district.

The youngest rocks in the area (Carmack's Group) consist of volcanic flows and related small intrusive stocks and dike swarms, and thin sedimentary units. All mineralization in the region appears to be related to this young orogeny, including the Casino Stock. Biotite alteration from the stock has been dated at U.B.C. by Colin Godwin at 69-71 m.y., which is on the Cretaceous-Tertiary boundary.

PROPERTY GEOLOGY

True outcrop is rare on the Casino claims and is mainly confined to unaltered, castellated areas on the crests of ridges. Only two small outcrops occur within the Casino Stock. Since the bedrock float in the overburden thickness is usually less than twenty feet, bedrock can generally be exposed by bulldozer trenching. The main obstacle to overburden mapping is the tendency for coarse rock float to accumulate on surface and then ride downhill, up to several thousand feet on steeper slopes, thereby obscuring the underlying local rock float.

Due to the surface conditions, mapping away from the Casino Stock has been very limited in extent and superficial. All outcrops and most float seen in the overburden and in creeks during prospecting is unmineralized and only weakly altered at best. A few small roof pendants of Yukon Group occur but most of the property appears to be underlain by phases of the Klotassin Batholith. Fine-grained phases have been noted near the airstrip and near the headwaters of Canadian Creek which warrant further investigation and other areas of interest will probably be found by systematic trenching and mapping. Pyroxenite has been reported in the 'B' grid area by C.D.N. Taylor.

Casino Stock

The stock is about 5000 feet long and 2000 feet wide, with its long axis trending west. The eastern half is largely coarse breccia in a quartz porphyry matrix and the western half is mainly feldspar porphyry. Quartz diorite is the main rock type within the stock although it is quite leucocratic and appears more acidic due to bleaching and surface leaching.

The stock has resisted erosion and forms a distinct prominence, Patton Hill, on the divide between Casino and Canadian Creeks. The summit is bare of vegetation and is covered by a thin cover of coarse bedrock float.

The mineralization and hydrothermal alteration show a classical zoning about the breccia pipe and the grade of mineralization is closely related to the intensity of fracturing and crackling. A central core of K-feldspar and biotite alteration is surrounded successively by argillic, quartz-sericite, and chloritic zones, which extend at least 2000 feet into the surrounding batholith. Molybdenum is richest near the core, while copper extends outwards almost to the edge of the chloritic zone.

Megascopically, the only important primary minerals are (in order of decreasing abundance) pyrite, chalcopyrite and molybdenite. Galena and sphalerite have rarely been seen within the copper-molybdenum deposit and are more

common in peripheral veins. The silver to lead ratio in the veins varies between 1 and 2. The pyrite content within the deposit ranges from 3 to 5%, and is up to 2% in a halo extending several thousand feet outwards in all directions. Other minor accessory minerals within the copper-molybdenum deposit are magnetite, hematite, gypsum and tourmaline, and very rarely, fluorite and zeolites. Magnetite occurs in late stage veinlets associated with porphyry dikes near the centre of the stock, as well as in weak disseminations elsewhere.

A great deal of valuable data on mineralogy is available from old reports on the gold-tungsten placer deposit. The minerals found in the placer were almost certainly derived from the western end of the copper-molybdenum deposit and/or peripheral veins, although many of these minerals have not yet been recognized in drill core. The most significant features of the placer deposit are:

(a) gold is sharp and is mostly fine and powdery, with some wires and leaves present. Nuggets up to 1/4 inch long were found. Fineness ranges from 860 to 900.

(b) the tungsten mineral, ferberite, FeWO_4 , is abundant, generally in the minus 10 mesh size. It is intimately associated with gold and magnetite.

Test work indicated that the ferberite might contain some hematite as the iron content was higher than normal. One report indicated that a 55% WO_3 concentrate contained 13% bismuth.

(c) magnetite pebbles up to 4 inches long have been found.

(d) other very minor constituents are scheelite, zircon, cassiterite, tourmaline, molybdenite and titanite.

A sample of black sand from the Canadian Creek placer workings was submitted to D.K. Dixon, analyst at Can Test Ltd., Vancouver on August 8, 1969, with the following results:

Semi Quantitative Spectrographic Analysis

Aluminium	0.7	Lithium	ND
Arsenic	ND	Magnesium	0.3
Antimony	ND	Manganese	0.2
Barium	0.01	Mercury	ND
Beryllium	ND	Molybdenum	0.007
Bismuth	0.05	Nickel	0.005
Boron	ND	Potassium	trace
Calcium	0.3	Silicon	5.0
Cadmium	ND	Silver	0.005
Columbium	ND	Sodium	trace
		Strontium	0.001
Cobalt	0.005	Tantalum	ND
Chromium	0.03	Tellurium	ND
Copper	0.005	Thorium	ND
Gallium	ND	Tin	0.01
Gold	ND	Titanium	0.7
Germanium	ND	Tungsten	greater than 0.1
Hafnium	ND	Uranium	ND
Indium	ND	Vanadium	0.1
Iron	Matrix	Zinc	ND
Lead	0.007	Zirconium	0.1

No Noble Metals and no rare earths were detected in this sample.

ND = Not Detected

All results are expressed as percent by weight.

The primary mineralization has been intensively leached, particularly within the Casino Stock, and the Casino deposit can be accurately described as an Arizona-type porphyry because the secondary sulfides and alteration products are identical to those common there. The result is a 30 to 350 foot thick leached capping, under which is a 100 to 300 foot thickness of secondary (supergene) enrichment. About 50 to 75% of the copper has been removed from the leached zone, while the copper content of the enriched zone appears to be about double the protore grade. The MoS_2 content of the leached zone is reduced about 70% but the oxide content has not yet been determined and the total depletion of molybdenum is not known. The gold and silver content is not noticeably affected by leaching.

The leached zone is marked by intense pitting due to the removal of sulfide grains, and the presence of limonite casts and coatings, of which the yellow jarosite variety predominates over goethite. Pyrite can occasionally be found in the least altered areas, usually in dike rocks, but chalcopyrite and molybdenite are virtually absent on surface. As previously mentioned, magnetite occurs on surface in fresh veinlets. Malachite is rare and is usually found in areas where pyrite is preserved. Two other copper minerals, tenorite (CuO) and neotocite ($\text{Cu}[\text{FeMn}]_{\text{S}_1\text{O}_3}$)

are fairly common. These were first recognized by consultant George O.M. Stewart in a report on leached capping interpretation dated September 15, 1969.

Chalcocite is by far the main mineral in the secondary zone, occurring as replacement of chalcopyrite and pyrite. Other copper minerals present include covellite, native copper, cuprite and azurite. The results of a preliminary mineralographic study of drill core and mill test products at U.B.C. is contained in an April, 1970 report by Peter Tredger.

The primary mineral zoning in the protore portion of the deposit has not been completely defined, mainly due to the great depth (300 to 600 feet) to the bottom of the secondary zone. There appears to be a gradual increase in molybdenum grade with depth within the central molybdenum-rich core, with the richer areas grading 0.05 to 0.15% MoS_2 . Average primary copper grade is in the range 0.15 to 0.35% Cu.

Very little structural information is available. Mineralized vein-faults south of the stock in the 'C' zone strike towards it at a bearing of N40W, which is the normal vein strike elsewhere on the property. This coincides with the lineation on the headwaters of Casino Creek. Many other subtle lineations can be interpreted from air photos

and aeromagnetic data, of which the strongest trends north-east through the headwaters of Canadian Creek.

GEOPHYSICS

About 100 line-miles of ground magnetic and electromagnetic surveys were conducted by CANA Exploration Consultants Ltd. during 1966 and 1967, exploring for silver-lead veins. The location of these surveys is shown on Map 3. In addition, an airborne magnetic survey of the property was flown in 1966 by Aero Photo Inc., which was interpreted by Dr. S.S. Szetu, President of CANA. For the ground surveys, a Sharpe A-2 magnetometer, Sharpe SE-200 and Ronka EM-16 electromagnetic units were employed. In general, these surveys proved of little value except in indicating conductors which, in a few cases, were caused by mineralized veins. These surveys covered the Casino Stock. Due to poor survey control, the aeromagnetic results could not be accurately related to the ground.

During 1969, Seigel Associates Ltd. conducted two surveys, one between May 21st and June 12th, and the other from August 7th to September 6th. In all, some 41 line-miles of induced polarization, resistivity and magnetic surveys were conducted over the Casino Stock and its east and west projections. Seigel MK VI pulse-type equipment and a Sharpe MF-1 magnetometer were used. The results are embodied in a December report by Jon G. Baird. The chargeability background proved to be very high with much of the survey area having a response in excess of 25 milliseconds. Normal background for acid intrusions is

in the range of 2-6 milliseconds. This unusually high response is probably due to the broad dissemination of up to 7% by volume of metallically conducting minerals in combination with much larger amounts of non-metallic but high polarization material such as sericite and kaolinite. Subsequent drilling showed that although better grade areas were located within the zone of higher chargeability, they could not be predicted. Resistivity produced a definite pattern, but, like chargeability, could not be used to predict sulfide content.

The magnetometer survey confirmed a local, somewhat linear, anomaly of 1200 gammas intensity, situated near the centre of the stock, which was originally detected by the CANA Surveys. This is the same area in which magnetite veinlets were found on surface and is the only magnetic expression of the Casino deposit.

The Casino area has been covered by a high-level aeromagnetic survey flown by the Geological Survey of Canada, and the results are available on G.S.C. Maps 4318 and 4319 (1 inch = 1 mile) and 7840 (1 inch = 4 miles). The magnetic anomaly within the Casino Stock appears as a distinct small airborne anomaly, similar to many others in the region.

To summarize, aeromagnetism alone would not have led to the discovery of the porphyry deposit. None of the

geophysical surveys conducted, singly or in conjunction, have yet proved useful in defining ore type sulfide concentrations or guiding drill exploration.

GEOCHEMISTRY

Geochemistry, together with prospecting, can be credited with the discovery of the porphyry deposit. The comments here are only a brief summary of the lengthier paper by A.R. Archer and C.A. Main, which was referred to earlier under History. They postulated that a regional survey with a silt sample density of only one sample per 10 square miles would have located the deposit, because of its intense secondary dispersion.

The area covered by geochemical soil sampling is shown on Map 3. It is almost the same area as that covered by Seigel's I.P. - resistivity - magnetic survey. A small area on Casino creek outside the Casino Stock was sampled in 1967. The stock was sampled in 1968 and the 1969 sampling extended the area east and west. The first geochemistry on the property was a regional silt survey in 1966 which was done to locate areas of silver-lead veining but which also clearly indicated the Patton Hill deposit.

The most interesting feature of the surveys is that copper and molybdenum content in soil is more or less proportional to underlying bedrock grade, in spite of the intense bedrock leaching. There is a close correlation between 2000 ppm Cu and 100 ppm MoS₂ in bedrock and 100 ppm Cu and 10 ppm Mo in soil, respectively. Neither metal

is widely dispersed, even where solifluction is rapid, and thus, soil assays have proven useful for guiding drilling. Gold and silver are also useful indicators if care is taken to sample below the "B" horizon.

Study of the geochemical response has revealed several interesting features about the groundwater. In the first place, it is very acidic, (pH as low as 2.5) as demonstrated in camp well water from hole P-21 and water in Taylor Creek, which is precipitating a limonite gossan in its valley. Normal drainage in the area is derived from runoff and is neutral. In the second place, the thin permafrost cover seems to act as a barrier between the two waters and to effectively trap the ground water within the vicinity of the deposit. Its only escape, and this appears to be a young feature, is through thawed windows, such as at the head of Taylor Creek. A relationship between trapped, acidic groundwater and recent secondary enrichment has been postulated.

DIAMOND DRILLING

Initial drilling in 1966 and 1967 was conducted with a drill owned by Casino president, L.I. Proctor. Both AQ and BQ core was recovered. Performance figures are given in the 1966 and 1967 Engineering Reports by C.D.N. Taylor. A total of 6033 feet were drilled, mainly in the "C" Zone, immediately adjoining the Casino Stock on the south side, but also in the Bomber and Helicopter Zones.

For the 1969 program, a 4000 foot contract was signed with Cameron-McCutcheon Drilling Ltd. at a basic price of \$9.70 per foot for BQ core, which included camp operating costs. In addition, Casino supplied fuel and air transportation, and paid a lump sum for mobilization and drill moves. The first drill, a Longyear 38, was flown to Casino in late May, and drilling commenced on June 5th. As favourable results were obtained, the program gradually expanded with the addition of a second 38' drill in late July and a third in early September. In December, after the road was opened, a fourth drill was added, a Longyear 44 model. Throughout this entire period, an additional spare drill was kept on hand as well. Drilling was suspended temporarily on March 21st, with 36,942 feet completed.

With the addition of the second drill in July, 1969, the contract price was renegotiated to \$8.60 per foot BQ and \$10.00 NQ. A further adjustment was made in September

to compensate for winter conditions - \$9.75 and \$11.15 for BQ and NQ respectively, with an additional \$2.00 per foot for holes deeper than 1000 feet. In December, with the camp enlarging and the water supply becoming erratic, Casino took over cookhouse operation and water supply and revised the NQ footage rates to \$10.35 to 1000 feet and \$11.85 per foot beyond 1000 feet. A new contract was being prepared at the time of shutdown which would have been dated March 1, 1970.

The total payments to Cameron-McCutcheon in this period amounted to \$721,247.00 or \$19.52 per foot. Analysis of the monthly figures shows three distinct cost phases (all costs are direct contractor payments):

Phase 1 - June and July - 3003 feet at \$16.77 per foot. Additional costs over the basic footage price were due partly to mobilization charges being applied against a small footage, and to disappointing crew performance in the early weeks, but were caused mainly by technical problems which led to a substantial loss of equipment.

Phase 2 - August, September and October - 14,241 feet at \$14.29 per foot. Modifications to drilling procedure, better supervision and familiarity with ground conditions produced an acceptable performance. This is probably an optimum diamond drilling cost at Casino.

Phase 3 - November 1969 to March 1970 - 19,698 feet at \$24.00 per foot. The prime factor in the cost increase was winter drilling conditions, and in particular, water supply. Surface water was unavailable after late November and was pumped from drill holes until mid-January. Thereafter, it was hauled from the well to the drills in a heated water truck, which was more reliable and efficient. Other major causes of the increase were the adoption of a "crash program" philosophy for financing and feasibility study reasons and a rash of difficult holes in the best-mineralized zone.

In addition to the contractor costs, an indirect overhead cost of approximately \$4.00 per foot should be charged against diamond drilling, as well. This estimate is derived as follows:

Site Preparation	\$1.00 per foot
Room and Board	.50 per foot
Fuel	.50 per foot
Core Splitting & Assays	1.00 per foot
Air Transportation	<u>1.00</u> per foot
	\$4.00 per foot

Winter water supply is a further indirect charge of at least \$2.00 per foot, for extra labour, equipment and fuel.

From a technical point of view, diamond drilling conditions at Casino are somewhat unique to the Canadian Cordillera and can be described as difficult. Permafrost

is not a problem, nor is terrain. The problems are caving ground and lost circulation due to the friable nature of the leached capping and, to a lesser degree, the supergene zone, and also the exceptional depth to the water table. Bedrock was usually reached in from 10 to 30 feet but it was found necessary to extend casing as deep as 200 feet in bedrock to ensure that the drill string would not whip in the soft rock. When this whipping did occur, it caused enlarging of the hole to the point where the string would break off, and fishing generally proved unsuccessful. Of the 50 holes collared during the year, significant equipment was lost in 12 holes. In addition to the extra casing, the drill string was strengthened and core recovery was improved by changing to the larger NQ core size.

Sludge return was only obtained in a few rare instances and it was impossible to determine the exact water table depth in any hole. Rotary drilling later showed that the water table depth varied from 95 feet in upper Casino Creek to 680 feet on top of Patton Hill.

There is no surface water within five miles of Patton Hill between early November and early May. This problem was solved by installing electric well pumps in several regular exploration holes (P21, P23).

Core recovery was generally lower than desired in the leached and supergene zones and was often excellent in the

primary zone. If a hole reached the primary zone successfully, it could almost always be completed to its planned depth. Most of the holes were drilled below 800 feet and the deepest hole was drilled to 1506 feet. Core recovery averaged:

Leached Zone	79.2%
Supergene Zone	79.3%
Primary Zone	93.7%

Mud was not used initially due to lack of cooperation by the contractor. Mud circulation was finally tested in November, under adverse winter weather. It produced a slight improvement in recovery and enabled drilling to proceed in bad caving conditions.

ROTARY DRILLING

In an attempt to improve recovery and reduce cost, a rotary drill was brought to the property for a 3000 foot test program. Big Indian Drilling Co. of Calgary supplied the rig, which was driven to Casino on the winter road in early January, 1970. By using air rather than water as the drilling medium, it was hoped that the problem of the deep water table would be minimized, and by using Big Indian's 5 inch diameter "sure core" or "con-core" drill rods it appeared that a larger and more representative sample would be obtained. This technique produces fragments (cuttings) rather than core and sludge.

The complete rig consists of:

- a) a 2000 foot rotary drill with a dual swivel and kelly, mounted on a 5 ton truck and powered by the truck motor.
- b) a 350 cfm, 250 psi compressor (used for dry drilling), also mounted on the truck.
- c) a pipe rack mounted on skids, with a capacity for 1000 feet of rods.
- d) a skid-mounted "dog house", housing a 600 cfm compressor (used for deep, wet drilling) tools, geolograph, bits and spares.
- e) a 3 ton winch truck.
- f) a 1/2 ton pickup truck.

The only unique feature of the system is the double-walled drill rods, special bits and dual swivel head. Air is injected between the walls of the rods to the bit, and returns through the inner tube, at a rate of about 5000 fpm.

Casing diameter is 7 inches. The drill bit has an outside diameter of $4\frac{7}{8}$ inches, compared to $2\frac{5}{16}$ inches and $2\frac{15}{16}$ inches for BQ and NQ diamond drill bits respectively. The rods weigh 17 pounds per foot and are 15 feet long. Initially, drill collars weighing 30 pounds per foot are added to the drill string to increase weight on the bit. The size of the rig is dictated by the strength of mast required to pull the full 1000 foot drill string, weighing over 8 tons, out of the hole.

Five feet of hole produced slightly over 100 pounds of cuttings and penetration was up to 240 feet per day. A technique had to be developed on the job for coping with this volume of sample. Dry cuttings were handled with ease but much experimentation was needed in order to collect wet cuttings in freezing temperatures. The entire sample was transported to camp where it was dried and split in a special processing laboratory. Rejects were stored in metal cans.

Recovery of cuttings showed some unusual variation which was related to water table. Initially, trouble was encountered near the water table, where cuttings become sticky rather than wet. This was overcome by adding water

to the hole until it became wet. Weights recovered were:

<u>Hole</u>	<u>Total Depth</u>	<u>Water Table Depth</u>	<u>Depth to Bottom of Supergene Zone</u>	<u>Pounds Recovered for 5 Foot Sample</u>		
				<u>Above Water Table (Dry)</u>	<u>Near Water Table (Sticky)</u>	<u>Below Water Table (Wet)</u>
R1	1001	360	573	94.8	56.7	75.0
R2	408	95	240	73.1		93.5
R3	290					
R3A	710	690	655	99.3		79.1
R4	688	270	255	100.6		62.5
R5	680	660	640	100.3		66.2
R6	551	318	345	96.2		62.8
R8	875	440	675	80.6		55.4
R46B	605	Below 605	Below 605	101.5		
TOTAL	<u>5808</u>					

With the exception of R2, all holes showed a consistent drop in recovery of about 30% below the water table. The reason for this is not yet clear but several explanations have been suggested:

- a) fines not being recovered from return water (the losses here are estimated at not more than 5 lbs. per sample)
- b) hydrostatic head forcing fines into fractures in hole wall
- c) because a grouting effect causes the fines to adhere to hole wall and fractures.

Several rotary holes were drilled near diamond drill holes to provide an assay comparison:

<u>Rotary Hole</u>	<u>Diamond Drill Hole</u>	<u>Distance Apart</u>	<u>Zone</u>	<u>Rotary Grade as % of Diamond Drill Grade</u>	
				<u>Cu</u>	<u>MoS₂</u>
R2	P22	10'	Supergene	$\frac{1.19}{1.05}=113$	$\frac{.024}{.019}=130$
			Primary	$\frac{.955}{.466}=205$	$\frac{0.020}{0.038}=53$
R3A	P10	100'	Supergene	$\frac{0.470}{0.528}=89$	$\frac{0.046}{0.039}=118$
			Primary	$\frac{0.214}{0.250}=86$	$\frac{0.025}{0.027}=93$
R5	P13	30	Supergene	$\frac{0.344}{0.274}=126$	$\frac{0.013}{0.011}=118$
R6	P40	5	Primary (No Supergene)	$\frac{0.166}{0.097}=171$	$\frac{0.003}{0.008}=38$

Where holes were close enough for a meaningful comparison, rotary assays were consistently higher, except in areas of low molybdenum grade.

The rotary test showed that direct contractor payments of about \$5.00 per foot are a realistic target. An additional \$4.00 per foot should cover crew accommodation, fuel, site preparation (bulldozer), sample preparation and assaying. This would give an overall drilling cost of \$9.00 per foot, well below diamond drill costs. The Big Indian rig suffered several mechanical breakdowns which appear to be avoidable in future. The only problem which proved quite costly was the loss of 300 feet of rods, worth \$8,000.00, in hole R3 due to cave.

Operation was improved by extending casing down to 60 feet in all holes and increasing rotation speed. Tricone bits averaged 10 to 12 hours of drilling and are worth \$60.00 each. These performed as well as button bits worth \$750.00 each.

The rotary test program showed that this technique produces a more accurate sample at a lower cost per foot than diamond drilling.

SAMPLING AND ASSAYING

Diamond drill core from holes P1 to P29 was split and one half was sent out for assay. Subsequent holes were completely crushed and only a small sample was sent out for assay. Sampling of rotary cuttings was done in a similar fashion and has been described in reports by C.A. Main and M.P. Phillips.

Rotary and diamond drill assays have been compared under Rotary Drilling. Assays from rotary cuttings were almost always higher than those from drill core, particularly in higher grade copper or molybdenum sections. Not enough holes have been checked yet to allow a factor to be derived.

The first hole was assayed at Whitehorse Assay Office and was check assayed at Seymour Laboratories. All subsequent assaying was done by Seymour in Vancouver. Seymour had installed a mobile assay lab at the property and was doing the first assaying there when work was suspended. An acceptable degree of accuracy had not yet been reached.

Every tenth copper assay and every fifth molybdenum assay from Seymour has been checked at a second assay office. Seymour has been consistently low, by a difference of up to 10% on copper and up to 30% on molybdenum. The details of the check assaying are:

TEST No. 1 (37 Pulps)	Total	Cu		Total	MoS ₂	
		Av. Diff.	% Diff.		Av. Diff.	% Diff.
Coast Eldridge	7.840			1.530		
Seymour	<u>7.148</u>			<u>1.411</u>		
	-.692	-.019	-8.80	-.119	-.002	-7.70%
TEST No. 2 (36 Pulps)						
Loring	7.070			1.019		
Seymour	<u>6.830</u>			<u>.836</u>		
	-.240	-.007	-3.30	-.183	-.005	-18.0%
TEST No. 3 (45 Pulps)						
Loring	3.330			1.452		
Seymour	<u>3.155</u>			<u>1.245</u>		
	-.175	-.012	-5.30	-.207	-.0046	-14.3%
TEST No. 4 (56 Pulps)						
Coast Eldridge	6.290			2.015		
Seymour	6.430			1.561		
	<u>+.140</u>	<u>+.005</u>	<u>+2.2%</u>	<u>-.454</u>	<u>-.008</u>	<u>-22.5%</u>
TEST No. 5 (29 Pulps)						
Loring	1.820			.154		
Seymour	<u>1.815</u>			<u>.119</u>		
	-.005	-.0003	-0.3%	-.035	-.0012	-22.7%
TEST No. 6 (8 Pulps)						
Loring	2.418			.987		
Seymour	<u>2.179</u>			<u>.979</u>		
	-.239	-.037	-9.8%	-.008	-.0004	-.81%
TEST No. 7 (58 Pulps)						
Loring	6.670			1.831		
Seymour	<u>6.065</u>			<u>1.786</u>		
	-.605	-.014	-9.1%	-.045	-.001	-2.5%

TEST No. 8 & 9 (136 Pulps)	Total	Cu		Total	MoS ₂	
		Av. Diff.	% Diff.		Av. Diff.	% Diff.
Loring	18.090			3.737		
Seymour	<u>16.850</u>			<u>3.814</u>		
	-1.240	-.018	-6.8%	+0.077	+0.0006	+2.0%
TEST No. 10 (45 Pulps)						
Bondar-Clegg	11.790			1.232		
Seymour	<u>11.520</u>			<u>.946</u>		
	-.270	-.012	-2.34%	-.286	-.0006	-30.2%

The lower Seymour Laboratories assays have been used for the ore reserve calculations in this respect.

ORE RESERVES

Casino ore reserves have been calculated by hand, using reserve blocks defined from drill holes on bench plans and cross-sections.

The calculation was made in the following manner:

- a) Tonnage - The mineralized zone was divided into rectangular blocks oriented with the "F" grid. Fifty foot bench height, an overall pit slope of 45°, and a tonnage factor of 12.0 were then used.
- b) Grade - An arbitrary conversion factor of 2.0 was used to convert all MoS₂ assays to their equivalent copper grade, and these were then added to the copper assays to give a copper equivalent grade (Cu.E.) for each hole interval. The factor of 2.0 assumes similar recoveries for copper and molybdenum and a ratio between copper and molybdenum prices of about \$0.50 and \$1.72 (MoS₂) respectively.

Copper equivalent grades (Cu.E.) were then grouped into the following grade categories:

- (1) 0.5% Cu.E. cutoff grade
- greater than 0.5% Cu.E. - ore
 - 0.5% Cu.E. - 0.3% Cu.E. - stockpile
 - less than 0.3% Cu.E. - waste

(2) 0.3% Cu.E. cutoff grade

greater than 0.3% Cu.E. - ore

0.3% Cu.E. - 0.25% Cu.E. - stockpile

less than 0.25% Cu.E. - waste

A preliminary open pit design was then selected by hand and the grade of each category was calculated using the drill hole assays for Cu and MoS₂ independently. In this way, different molybdenum conversion factors can be applied to these reserves without altering the basic pit design.

The reserves have been grouped into the following categories:

- (a) Proven Ore - The sides of each rectangle are up to 200 feet from a central drill hole, or are half the distance to the next drill hole, whichever distance is shorter.
- (b) Probable Ore - The rectangles were laid out as above, with a maximum distance of 400 feet from a central hole to a side.
- (c) Possible Ore - Includes an area up to 800 feet from a central drill hole where wide-spaced drilling indicates geological and mineralogical continuity. Part of this grouping could be classified as Probable Ore but, because of the wide hole spacing, the whole West Zone has been left in the Possible category.

No mineralization has been included in the reserves which lie below the present drill holes, unless it was bounded by a deep ore hole. Thus, a large block of ground below holes P10, P17, and P19, open to the southwest, will be available below the pit. This amounts to at least 65,000 tons per vertical foot, or 3,325,000 tons per 50 foot bench. The average grade at the bottom of these holes is 0.337% Cu and 0.046% MoS₂ (Cu.E. - 0.429%). A smaller, confined area at the bottom of holes P22 and P31, is also ore grade below the pit bottom and has not been included in reserves. It is of particular interest that the highest MoS₂ grades occur near the bottom of the pit. For example, the lowest five benches in the vicinity of holes P14 and P16 average 0.153% MoS₂.

Gold and silver averages have been calculated for the 0.5% Cu.E. cutoff only. The gold content (0.015oz/ton, or \$0.50 per ton at present price) is significant but it is not known at this time if either gold or silver can be recovered with copper or molybdenum. Tungsten has only been detected in significant amounts in one hole (R4), in which a 120 foot section averages 0.125% WO₃ (a gross value of about \$5.00 per ton at recent prices). The importance of tungsten will depend on the tonnage and recoveries and is not considered here.

The configuration and location of the deposit is shown on Map 5, together with the different reserve categories.

Because supergene ore in the East Zone occurs close to surface, the deposit will lend itself to removal of higher than average grade ore during the early operating years, with stockpiling of marginal grade for subsequent reclamation, probably for blending with normal mill feed.

As shown in the summary below, mining can proceed through three stages:

(1) East Zone - 0.5% Cu.E. cutoff grade

(a) 24.35 million tons grading 0.633% Cu, 0.059% MoS₂ (0.751% Cu.E.), 0.015 oz/ton Au, 0.033 oz/ton Ag. About 84% of this tonnage is supergene mineralization.

(b) 5.22 million tons grading 0.386% Cu, 0.031% MoS₂ (0.449% Cu.E.) can be stockpiled for stage (2).

(2) East Zone - 0.3% Cu.E. cutoff grade

(a) 81.38 million tons of proven ore grading 0.383% Cu, 0.053% MoS₂ (0.489% Cu.E.).

(b) about 35 million tons of probable and possible categories are also available and the normal pit path will provide mining access to the West Zone.

(3) West Zone

(a) about 68 million tons have been placed in the possible ore category.

SUMMARY OF ORE RESERVES

<u>Category</u>	<u>ORE</u>					<u>STOCKPILE</u>				<u>WASTE</u>	<u>STRIP</u>	
	<u>Tons</u> <u>(Million)</u>	<u>%Cu</u>	<u>%MoS₂</u>	<u>%Cu.E.</u>	<u>oz/ton</u> <u>Au</u>	<u>oz/ton</u> <u>Ag</u>	<u>Tons</u> <u>(Million)</u>	<u>%Cu</u>	<u>%MoS₂</u>	<u>%Cu.E.</u>	<u>Tons</u> <u>(Million)</u>	<u>W</u> <u>O + S</u>
(1) EAST ZONE												
<u>0.5% Cu.E. Cutoff Grade</u>							<u>>0.3% <0.5% Cu.E.</u>					
Proven	24.35	0.633	0.059	0.751	0.015	0.033	5.22	0.386	0.031	0.449	80.2	2.71
(2) EAST ZONE												
<u>0.3% Cu.E. Cutoff Grade (includes stage (1) above)</u>							<u>>0.25% <0.3% Cu.E.</u>					
Proven	105.73	0.383	0.053	0.489								
Probable	31.85	0.316	0.052	0.420								
Possible	4.00	0.283	0.042	0.367								
TOTAL	141.58						13.83	0.228	0.019	0.266	223.19	1.44
(3) WEST ZONE												
<u>0.3% Cu.E. Cutoff Grade</u>												
Possible	67.84	0.327	0.036	0.399							137.47	2.03
<u>TOTAL - EAST & WEST ZONES</u>												
<u>0.3% Cu.E. Cutoff Grade</u>												
Proven	105.73	0.383	0.053	0.489								
Probable	31.85	0.316	0.052	0.420								
Possible	71.84	0.325	0.036	0.397								
TOTAL	209.42						13.83	0.228	0.019	0.266	360.66	1.6

Fill-in drilling should produce a proven reserve of over 200 million tons grading about 0.35% Cu, 0.05% MoS₂ (0.45% Cu.E.). Since these grades are derived mainly from diamond drill holes, and rotary holes have returned generally higher assays, these grades are considered to be conservative.

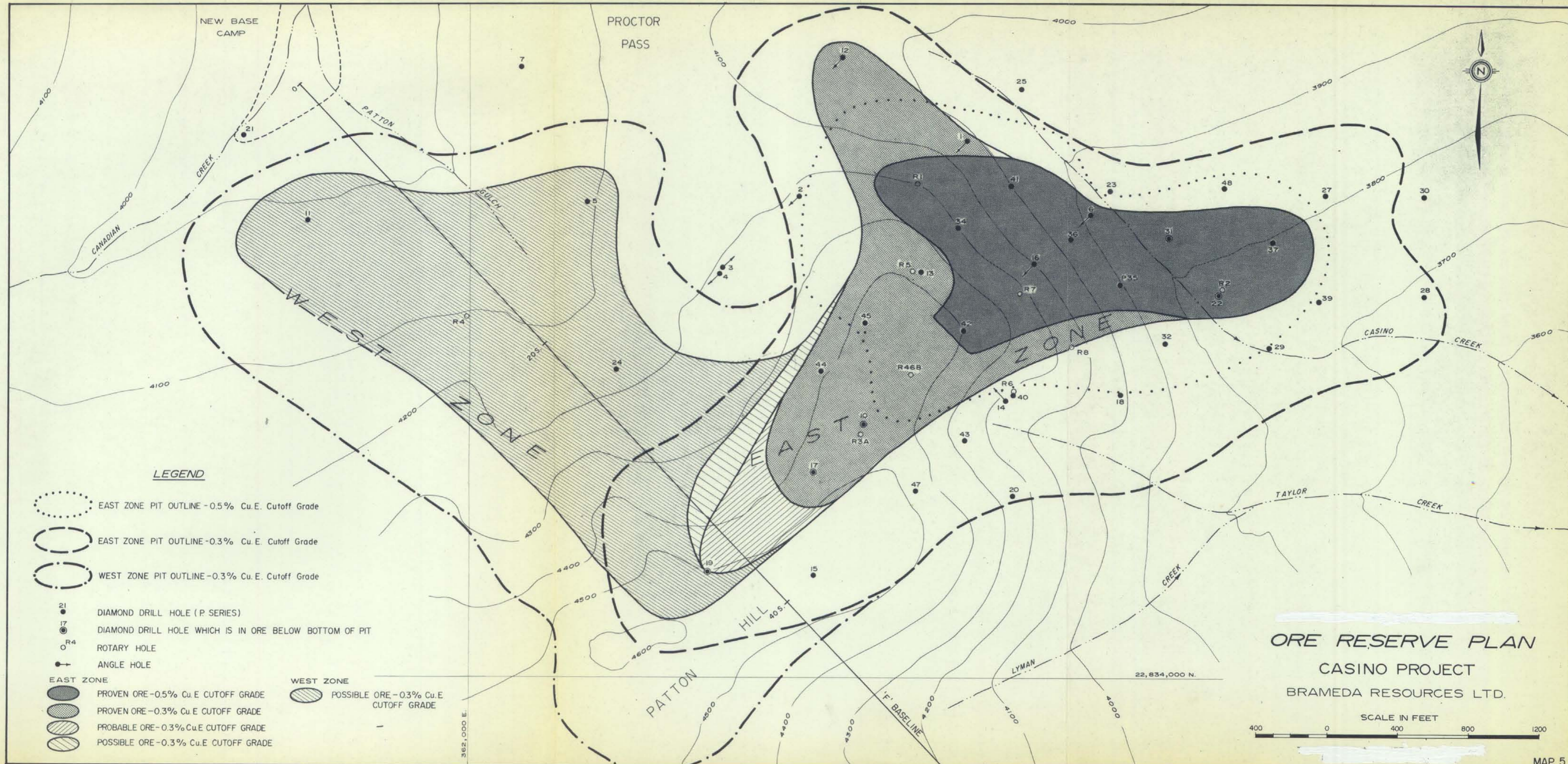
The gross value of Casino ore at various copper prices can be easily determined by using the molybdenum conversion factors given in the table below, which assumes a fixed price of \$1.72 U.S. per pound of contained Mo for MoS₂ concentrate (equal to \$1.03 U.S. per pound of MoS₂ concentrate).

Price (U.S. dollars per lb.)

<u>Cu</u>	<u>MoS₂</u>	<u>Conversion Factor</u> (MoS ₂ to Cu)
\$.70	1.03	1.47
.60	1.03	1.72
.50	1.03	2.03
.40	1.03	2.58
.30	1.03	3.44

For example, the gross value per ton of the proven ore in the East Zone (0.633% Cu, 0.059% MoS₂) in U.S. Dollars, is:

<u>Cu</u>		<u>MoS₂</u>		<u>Copper</u> <u>Equivalent (Cu.E.)</u>	
<u>Price</u>	<u>Value</u>	<u>Price</u>	<u>Value</u>	<u>Value</u>	<u>Cu.E. Grade</u>
\$.70	\$8.86	\$1.03	\$1.22	10.08	0.715%
.60	7.60	1.03	1.22	8.88	0.740%
.50	6.33	1.03	1.22	7.55	0.755%
.40	5.06	1.03	1.22	6.28	0.785%
.30	3.80	1.03	1.22	5.02	0.835%



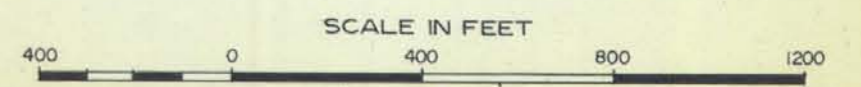
LEGEND

- EAST ZONE PIT OUTLINE - 0.5% Cu.E. Cutoff Grade
- EAST ZONE PIT OUTLINE - 0.3% Cu.E. Cutoff Grade
- WEST ZONE PIT OUTLINE - 0.3% Cu.E. Cutoff Grade

- DIAMOND DRILL HOLE (P. SERIES)
- DIAMOND DRILL HOLE WHICH IS IN ORE BELOW BOTTOM OF PIT
- ROTARY HOLE
- ANGLE HOLE

- | | |
|---------------------------------------|---------------------------------------|
| EAST ZONE | WEST ZONE |
| PROVEN ORE - 0.5% Cu.E CUTOFF GRADE | POSSIBLE ORE - 0.3% Cu.E CUTOFF GRADE |
| PROVEN ORE - 0.3% Cu.E CUTOFF GRADE | |
| PROBABLE ORE - 0.3% Cu.E CUTOFF GRADE | |
| POSSIBLE ORE - 0.3% Cu.E CUTOFF GRADE | |

ORE RESERVE PLAN
CASINO PROJECT
 BRAMEDA RESOURCES LTD.



ENGINEERING

Preliminary engineering studies have been initiated on a number of design phases. These are discussed separately under Transportation, Plant Design, and Power Sources.

K. Douglass of Brameda has been mainly responsible for the Plant Design studies and what follows is a brief mention of the areas investigated by him to date, local knowledge on resources, transportation and conditions in Yukon by the writers, and an assessment of the most feasible permanent road routes by A.A. Wright, dated May 1970. Wright was, until recently, senior location engineer with the Department of Public Works, Whitehorse and has worked on the design of most of the roads built in Yukon since 1950. He is now Northern Representative for McElhanney Surveying and Engineering Ltd.

In conjunction with the legal claim survey, mentioned under Property, base maps of a large area were prepared by Northwest Survey Corporation. This involved low and high level aerial photography, targeting, and control triangulation to tie to a geodetic monument and the Territorial Plane Coordinate System. Two maps were produced:

- a) 1 inch to 400 foot scale with 10 foot contours covering 5500 acres in the vicinity of the Casino Stock.
- b) 1 inch to 1000 foot scale with 50 foot contours covering 250 square miles centered on Casino (approximately 20 miles by 12 miles with the long

axis oriented north). In addition, new aerial photographs were made of the Casino to Carmacks road route (route A).

Costs were:

Photography	\$11,000
Surface control	7,000
Mapping	<u>11,000</u>
	\$29,000.

A. Transportation

There are two obvious routes to connect Casino to the existing highway network. The choice between them essentially involves a decision on whether to use the existing bulk loading facilities and rail system of White Pass and Yukon Route at the Alaskan port of Skagway, or to pioneer a new facility at the port of Haines. For background data, consult the Yukon Transportation Study, Summary Report, prepared by Travacon Research Ltd. in March 1968 for I.A.N.D.

The present White Pass route, which can be considered as a monopoly situation, consists of a 110 mile, narrow gauge railway between Skagway and Whitehorse, and a new bulk-loading wharf at Skagway, built for the Anvil contract. This can handle ships up to 35,000 tons at a loading rate of 1500 tons per hour. White Pass currently hauls all Cassiar fibre, all Keno Hill, New Imperial and Anvil concentrates,

and will haul concentrate from Hudson Bay's small mine near Burwash when it commences in 1972. White Pass recently completed a capital expansion program costing about \$20 million. Included in this was a second container ship for the Vancouver run, extra rolling stock, and concentrate containers and trucks for the Anvil contract, which covers an eight year period starting in 1969. Anvil's shipping costs from mill to boat are about \$19.00 per ton which includes about \$2.00 for handling in Skagway to amortize the Skagway facility (which cost about \$4 million) over the eight year contract. This facility was designed for future expansion. It is of particular interest that White Pass has announced that it will start surveys in 1970 for a rail extension to Carmacks, a further 112 miles, which would double the length of the railway. This is a fairly easy grade, and is a logical development of the Yukon transportation network, unless a rail route reaches eastern Yukon in the near future (C.N. or P.G.E.) to connect to the continental network. At present, the bulk of Yukon mineral production (Anvil, United Keno Hill and Clinton) passes through Carmacks by truck. Several other properties in advanced stages of development would probably ship through Carmacks as well. These are: Vangorda, Hudson Bay's Tom Zinc on the North Canal Road and other Dawson Range prospects.

Also, the largest mineral deposit in the region, Chevron Standard's five billion ton Crest Iron deposit will use an extension of this route if it is ever brought into production.

The two routes to Casino, which are shown on Map 1, are as follows:

Route A - Via Carmacks to Whitehorse and Skagway, Alaska.

Casino-Carmacks	120 miles	(new construction)
Carmacks-Whitehorse	112 miles	(now excellent gravel possibly rail in future)
Whitehorse-Skagway	<u>110</u> miles	(rail)
TOTAL	342 miles	

If railhead is extended to Carmacks:

222 miles	rail
120 miles	road

Estimated road construction cost (Wright) - \$6,900,000.

Route B - Via Burwash to Haines Junction and Haines, Alaska.

Casino-Burwash	130 miles	(new construction)
Burwash-Haines Junction	81 miles	(Alaska Highway)
Haines Jct., Y.T.-Haines	159 miles	(second class gravel highway)
TOTAL	370 miles	

Estimated construction cost (Wright) - \$7,930,000.

Wright has made previous reconnaissance flights over the area in 1964 and 1967 for D.P.W., and in 1969 for Casino. He supervised the opening of the winter road in

1969 on behalf of the contractor, Proctor Construction. While his cost estimates are very preliminary, they are a realistic basis for comparison and are based on current construction costs and I.A.N.D. trunk road standards:

Design Speed - 60 m.p.h.

Width including shoulders - 32 feet

Maximum grade - 5%

Maximum curvature - 7%

Bridge loading - H20/S16

A maximum 8% grade and some modification in curvature would probably be necessary in the Selwyn River portion of Route A.

The following is quoted from Wright's report;

"The Carmacks-Casino route (A) is the shorter of the two, for both new construction and overall distance to tidewater. It also provides direct access to the southeasterly section of the Dawson Range and services several other properties.

The Burwash-Casino route (B) would probably involve somewhat easier construction with better materials, but the longer distance and the necessity of two major stream crossings would make construction more costly. The overall distance to tidewater is greater by this route.

(Government) assistance.....would take the form of.....development roads, for which the government pays the full costs, and cost-sharing agreements for the construction of mine-access

roads, for which the government pays two-thirds of the costs, up to a limit specified in the agreement.

That I.A.N.D. has been considering the construction of an area development road from Carmacks westerly is public knowledge and the greater part of the both these routes could be incorporated into this project.

On the Carmacks-Casino route (A), the portion as far as the (Dip Creek-Isaac Creek) pass at Mile 110 could probably be declared a development road, leaving only ten miles to be completed under a cost-sharing agreement.

On the Burwash-Casino route (B), the first 75 miles, as far as the mouth of Onion Creek, could be declared a development road, on the assumption that the Nisling-Klaza route to Carmacks would ultimately be completed. It might also be argued that a more northerly loop to Carmacks be considered, in which case 120 miles of this route would become a development road.

In any discussion with the government, it is strongly recommended that construction to trunk road standards be insisted upon. A precedence for the use of this classification for a mine haul road has already been established in the reconstruction of the Sixty Mile (or Taylor) Highway west of Dawson City as part of the haul route from Clinton Mine."

For comparison purposes, the road distances from Whitehorse to the operating mines in the region are as follows:

Casino (Route A)	232 miles
Anvil	235 miles
United Keno Hill	287 miles
Cassiar, B.C.	357 miles
Clinton	395 miles
Cantung	480 miles

B. Plant Design

The following estimates have been prepared by K. Douglass of Brameda and are, of necessity, preliminary and approximate only. They have been made for two possible production levels, 30,000 TPD and 50,000 TPD, and can be extrapolated for lower levels.

1. Townsite and Related Facilities

The townsite estimate is based on single-family residences with basements and garages, row housing, and apartments to accommodate 85% of the work force. The remainder would live in single accommodation-apartments and bunkhouses. In general, a good standard of residences is considered necessary to draw and hold a competent labour force in this remote location. The community space would house the following facilities: commercial (stores, etc.), administration (Bank, library, etc.), theatre, restaurant, recreation hall complex, curling and nursing

station. The estimated cost is:

	<u>30,000 ton</u>	<u>50,000 ton</u>
Number of Employees	300	500
Number of Service Personnel	35	60
<hr/>		
<u>Population Distribution</u>		
Single men in bunk-house accommodation	75	125
Single personnel in apartments	7	12
Married couples, no children	140	236
Married couples with children	<u>675</u>	<u>1,125</u>
Total population	897	1,498
<u>Residential Schedule</u>		
Bunk-house accommodation for	75	125
Apartment suites (1 b.r.)	70	118
Row-housing (2 b.r.)	65	110
Single-family home (2 b.r.)	50	80
Single-family home (3 b.r.)	68	115
<u>Community Space</u>	45,000 sq. ft.	75,000 sq. ft.
<u>Cost of Development</u>		
Bunkhouse @ \$1500/unit	\$ 110,000	\$ 190,000
Apartment suites @ \$17,000/unit	1,200,000	2,000,000
Row-housing @ \$17,000/unit	1,100,000	1,880,000
Single-family 2 b.r. @ \$26,000/unit	1,300,000	2,080,000
Single-family 3 b.r. @ \$30,000/unit	<u>2,040,000</u>	<u>3,450,000</u>
Sub-total	\$5,750,000	\$ 9,600,000
Community Space @ \$25/sq. ft.	\$1,120,000	\$ 1,880,000
Services	<u>\$ 615,000</u>	<u>\$ 920,000</u>
Total development	\$7,485,000	\$12,400,000

For purposes of comparison, the other operating mines in the region provide the following levels of family accommodation to their work force:

Anvil	65% (to be increased)
Cassiar, B.C.	22%
Clinton	15% (to be increased)
United Keno Hill	28%
Cantung	36%

The labour turnover at Cassiar, B.C., for the past few years has averaged over 200% per annum. United Keno Hill has had similar experience. It will be interesting to determine how significantly the labour turnover at Anvil is reduced by the higher level of family accommodation.

No obvious natural choice exists for the location of the townsite. For summer gardening, recreation and other aesthetic considerations, the Yukon River is best, but, as mentioned under climate, this would impose short but severe cold spells in winter. Assuming that access is from Carmacks (Route A), Douglass has selected a possible site near the pass between Dip Creek and Isaac Creek, which is about ten miles southeast of Patton Hill. If access is from Burwash (Route B) a site on Dip Creek would be preferable but so far no obvious location has been found.

2. Water Supply

In estimating the cost of a fresh-water supply system, a number of assumptions must be accepted:

- a) that material for an earth-fill dam can be found near the confluence of Casino Creek and Dip Creek.
- b) that the valley of Dip Creek will present no serious foundation problems in connection with the construction of a large earth-fill dam.

c) that the excavation of a trench for a pipeline from the dam to the mill is practical in an economic sense.

Two alternatives are open in developing a water supply. One is to collect surface water in the Dip Creek watershed, and pump from the dam on Dip Creek to the mill. This places the water reservoir about seven miles from the mill and about 1700 feet lower in elevation. The alternative is to pump from the Yukon River, a distance of eleven miles, and a vertical lift of 3100 feet. The Dip Creek watershed is undoubtedly preferable if a dam can be built as expected. The main problem of dam construction is the difficulty in finding fine sand and clay because of the lack of glacial deposits.

Keith Douglass has suggested that the flow in Dip Creek is adequate to supply a 50,000 TPD mill. However, H.E. Wahl, of the Whitehorse Weather Office, D.O.T., has cautioned that precipitation in the region is so variable that water supply in a small basin could be unreliable. There have been periods of up to five months when virtually no precipitation has fallen over much of the Yukon. These periods are then followed by equal periods of excessive precipitation. It is essential that

a measuring gauge be installed on Dip Creek very soon and that a record be started.

Cost estimates are as follows:

	<u>30,000 TPD</u>	<u>50,000 TPD</u>
(1) <u>Earthfill Dam</u>		
Height (feet)	80	95
Length at crest (feet)	2,600	2,800
Capacity (acre feet)	20,000	30,000
Cost	\$1,400,000	\$2,200,000
(2) <u>Pumping Installation</u>		
H.P.	9,500	16,500
GPM	14,400	24,000
Dynamic Head	1,930	1,940
Cost	\$1,400,000	\$2,400,000
(3) <u>Pipeline(Steel)</u>		
Diameter (inches)	30	36
Length (feet)	35,000	35,000
Cost	\$1,400,000	\$1,600,000
(4) <u>Power Line and Circuit</u>		
<u>Controls</u>	<u>\$ 100,000</u>	<u>\$ 100,000</u>
TOTAL COST	\$4,100,000	\$6,300,000
Contingency - 10%	400,000	600,000
Engineering - 10%	<u>400,000</u>	<u>600,000</u>
GRAND TOTAL	\$4,900,000	\$7,500,000

Estimated operating cost at 10 mill power:

\$210,000	\$314,000
2 cents/ton	2 cents/ton

3. Tailings Disposal

The Casino Creek valley has been reserved for tailings disposal in all preliminary planning of this project. The basis for this study is that properly-designed tailings dams be built at suitable

points in the valley, with rock-fill toe-dams upstream and downstream, the body of the dam being sand fill. Tailings would flow by gravity to the pond where the coarse fraction would be split out for dam building, the slimes being introduced into the pond. Reclaim water would be recovered by floating pump-stations and then be pumped to a reclaim water reservoir above the mill by conventional pumping stations and a force main. Estimated costs are:

	<u>30,000 ton</u>	<u>50,000 ton</u>
<u>To Site 1</u>		
Tailings flow U.S. G.P.M.	14,700	24,500
Tailings line (with drop structures) 15,000' long	36" dia.	2-30" dia.
Reclaim flow (75% recovery) U.S. G.P.M.	9,600	16,000
Reclaim line 17,000' long	24" dia.	30" dia.
Reclaim pumping head, feet	1,570	1,520
Reclaim pumping horsepower	5280 plus stand-by	8550 plus stand-by
Tailing pond capacity -		
Site 1 - years	13	8
Site 2 - years	19	11-1/2
Pumps	\$ 400,000	\$ 630,000
Electrical	500,000	600,000
Buildings and structures	400,000	600,000
Instrumentation	40,000	50,000
Reclaim pipe-line	510,000	600,000
Valves	70,000	100,000
Tailings Pipe-line	670,000	1,050,000
Dams	800,000	800,000
	<u>\$3,390,000</u>	<u>\$4,430,000</u>
+10% contingency	340,000	440,000
+10% engineering	340,000	440,000
Total Estimated Cost	<u>\$4,070,000</u>	<u>\$5,310,000</u>

C. Power Sources

There are two alternatives for providing power at Casino:

- (a) transmission of power from generating plants elsewhere in the Yukon power grid.
- (b) transport of fuel to Casino for on-site generation in a thermal plant, which offers free heat as well.

The choice will hinge on the following factors:

- (a) size of load at Casino in relation to existing facilities and future power demands elsewhere.
- (b) availability and cost of natural gas and coal in comparison to hydro power.

A Crown Corporation, Northern Canada Power Commission (NCPC) presently operates the following plants (the only ones of any size in the region except for 6 MW diesel at Clinton Mine).

	<u>Capacity in MW</u>
Whitehorse Hydro Dam	19.0
Whitehorse Diesel	9.0
Mayo Hydro Dam	<u>4.3</u>
	32.3

The Anvil Mine reached production in 1969 and is now receiving 10 MW through a 138 KV transmission line from Whitehorse via Carmacks. It is estimated that local demand at Whitehorse (which includes New Imperial Mines) will increase by 6.5 MW by 1977, which is probably conservative. Within the period to 1977, the

following new loads can be foreseen in addition to Casino:

(a) Anvil - planned expansions will increase its load somewhat. However, the most significant possible development (which would dwarf everything else in the region) is a possible smelter, which Anvil has agreed to study by 1974, and construct by 1977, if it is feasible. The power requirements of this facility could vary widely, depending on the process chosen, but should not exceed 80 MW.

(b) Vangorda (a subsidiary of Kerr-Addison Mines Ltd.) - This property will likely be brought into production at a rate of about 3000 TPD and would require about 5 MW.

In summary, substantially increased capacity will be required in Yukon by 1977. It could vary from as little as 15 MW to handle Whitehorse and Anvil growth and new Vangorda production, to as much as 125 MW, if a large smelter is built at Anvil, and Casino (or other properties) reach production and require a further 30 MW. This would represent a quadrupling of present installed capacity, and would most logically be situated near the smelter.

Total annual costs of thermal generation at Casino (using fuel oil at a landed cost of 30 cents per gallon) are estimated by K. Douglass at 20 mills/KWH, assuming a 30 MW installation. It is clear that power is one of the principal costs affecting the Casino Project and that a thorough preliminary study of all the alternatives should be embarked on very early. The following background information is included for its reference value.

Hydro Power

Excellent preliminary surveys of power sites in Yukon have been completed by I.A.N.D. The results are contained in two reports:

- (a) Yukon River Basin Report - prepared by Water Resources Branch of the Department of Northern Affairs and National Resources (now I.A.N.D.), December, 1962.
- (b) Hydro-electric Resources Survey of the Central Yukon Territory, by T. Ingledow & Assoc. Ltd., January, 1968 (available from Queens' Printer, Ottawa, Cat. No. R52-2/1968-1).

No sites on the main Yukon River have been considered here because of their huge size and because they would affect river navigation and salmon spawning. Also, the better sites are immediately downstream from Carmacks, at Five Finger and Rink Rapids, and any development there would flood the town, highway and bridge and the coal deposits.

The sites which are central to both Anvil and Casino are listed below (all data from Table 1 of Ingledow Report). Any new installation near Anvil can transmit power to Carmacks (and Whitehorse) on the existing 125 mile line. A new 120 mile line would be needed from Carmacks to serve Casino.

<u>Site No.</u>	<u>Site Name</u>	<u>Installed Capacity (Megawatts)</u>	<u>Capital Cost (\$ million)</u>	<u>Energy Cost (Mills/KWH)</u>
9	Little Salmon R	12.0	23.5	29.8
10	Drury L	4.3	5.2	18.3
11	Granite Canyon	333.0	200.6	9.2
12	Braden's Canyon	112.0	94.5	12.9
13	Detour-Scheme(1)	83.0	80.2	14.8
	Scheme(2)	111.0	89.6	12.2
	Scheme(3)	119.0	84.0	10.8
14	Mica Creek	9.8	15.7	24.1
34	Anvil Creek	10.0	13.1	20.0
35	Tay River	31.0	43.3	21.3
36	Earn River	6.6	14.0	32.5
37	Hoole Canyon -			
	Stage 1	12.7	16.0	19.2
	Stage 2	25.4	26.4	15.8
	Stage 3	38.1	30.0	12.0
38	Ross R Canyon	33.6	50.3	22.8

The most likely sites for development are all on the Pelly River: Braden's Canyon (12.9 mills), Detour (10.8-14.8 mills), and Hoole Canyon (12.0-19.2 mills) (See Map 1). Drury Lake is probably too small and Granite Canyon is too large, although power from both would be competitive. None of the other sites are of immediate interest. The Ingledow Report offers the following additional information on the prime hydro sites:

(a) Braden's Canyon (12) - Geological mapping of the site was done in 1960 by E.B. Owens of the Geological Survey of Canada. This scheme involves a 230 foot high concrete gravity dam, which would flood portions of the Klondike Highway, the settlement and bridge at Pelly Crossing, and the Mica Creek site (14). This project is probably only feasible as the last stage in the complete development of the Pelly River. Transmission distance from the dam would be about 190 miles to Anvil and 70 miles to Casino.

(b) Detour (13) - This site was mapped by E.B. Owens in 1966. The development envisages a concrete dam about 200 feet high which would drown both the Anvil Creek (34) and Tay River (35) sites. Scheme (2) involves upstream storage at Pelly Lakes which is charged against Detour. Scheme (3) involves upstream storage at both Hoole Canyon and Pelly Lakes which is charged against Hoole rather than Detour and would only be possible if Hoole was developed first. Transmission distance to Anvil would be about 55 miles, and from Anvil to Casino, a further 235 miles.

(c) Hoole Canyon (37) - River level drops 30 feet in a 4000 foot long 'U'-shaped canyon. The development comprises a concrete diversion dam 130 feet high and 500 feet along the crest, penstocks 2500 feet long across the loop in the canyon, and a powerhouse on rock at the lower end. The Pelly Lakes storage dam would be located 65 miles upstream and would be 70 feet high. Hoole Canyon was mapped by E.B. Owens in 1965. It is a 60 mile transmission distance to Anvil. This scheme has the advantage of stage development, as follows:

Stage 1 - diversion dam at canyon, intake structure and embankment, first penstock and powerhouse.

Stage 2 - storage dam at Pelly Lakes, second penstock, and second unit in powerhouse.

Stage 3 - third penstock and powerhouse unit.

Thermal - Coal

Huge reserves of non-coking, bituminous-grade coal are present in the Carmacks area, where they have been mined on a small scale for over 70 years. From 1923 to 1966, most production went to United Keno Hill for steam purposes. This production was resumed in 1969 by Anvil, which transports it to the mine to produce steam heat. At this time, Anvil holds most

of the better leases. All production in the past has been from small underground mines, on seams dipping 50° to 70° and with thickness of from 5 to 15 feet. Gross calorific value is about 12,000 BTU. These mines are extremely clean and safe by coal standards. Production could be cheaply expanded and this energy source will likely be regarded sympathetically by the government because it would have a high labour content and much of the work has traditionally been done by local natives. There is an air pollution problem involved, of course. K. Douglass has suggested that a 30 MW coal-fired thermal plant at Casino might produce power as cheaply as 12.5 mills.

Thermal - Natural Gas

Two natural gas fields have been discovered which could form the basis of a Yukon power and heating system (See Map 1). The closest is in the Eagle Plains, 240 air-miles north of Casino. About half this route follows the Dempster Highway. Four suspended gas and oil wells have been drilled to depths between 5000 and 8600 feet. This field is owned by Western Minerals Ltd., a private company controlled by the Harvey family of Calgary. There is no published information on reserves.

The second field is much farther away (520 miles from Anvil and 765 miles from Casino), but is worth

mentioning because it has enormous reserves and is already in production through a Westcoast Transmission pipeline to Fort Nelson. It is the Beaver River - Pointed Mountain field, on the Yukon - N.W.T. - B.C. border. Amoco is the main operator of this deep field (12,000 - 14,000 feet).

In the estimation of the writers, natural gas should be very seriously considered.

GOVERNMENT ASSISTANCE POLICY

To date, Casino has received \$20,000 and expects to receive a further \$20,000 for winter road construction. In addition, \$33,000 was received in 1967 under the Northern Mineral Exploration Program and a further \$33,000 is expected for 1969. Total assistance received by Casino now totals over \$100,000. It has either come directly from I.A.N.D. or indirectly through the Yukon Territorial Government. The officials most directly involved in administering assistance at the local level include the Administrator of Lands, G.A. McIntyre; the Chief Mining Recorder, Blake Baxter; the Mining Inspector, G.A. Needham; the Resident Geologist, Dr. D.B. Craig; and representatives of the Department of Public Works. It is noteworthy that the Ministers of I.A.N.D. and Public Works, Jean Chretien and Arthur Laing, respectively, paid an official visit to Casino on January 26, 1970.

Only limited additional exploration assistance can be expected now that the existence of a substantial deposit is known. However, Casino can expect assistance on such major ancillary items as highways, power and townsite. The precedent for this Yukon assistance is well established. The best example is Anvil, which reached production in late 1969. About \$20 million was spent by the government against a company investment of about \$65 million. The government funds were spent as follows:

- (a) 100% of \$7.5 million, 140 mile highway from Ross River to Carmacks (This was already under construction when the orebody was discovered).
- (b) 2/3 of estimated \$1.2 million cost of 19 mile access road between highway and mine, plus 2/3 of cost of a 540 foot bridge.
- (c) maintenance of an access road for three years, including operation of a ferry.
- (d) \$9 million for installation of additional generators at Whitehorse Hydro Dam and construction of 230 mile transmission line.
- (e) 2/3 of \$3.7 million cost of townsite of Faro (through CMHC), which will be administered by the Territorial Government.

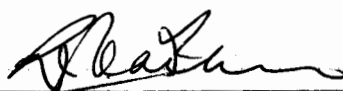
Another recent example is the Clinton Mine of Cassiar Asbestos Cororation Ltd., near Dawson City, which began production in early 1968, at a capital cost of \$27 million. Federal assistance totalled about \$3 million and was based on Cassiar's estimated capital cost of \$11 million. It took the form of:

- (a) 100% of \$1.9 million reconstruction cost of 37 miles of Taylor Highway.
- (b) 2/3 of \$750,000 cost of mine access road and bridge.
- (c) 100% of new ferry and docking facilities on Yukon River at Dawson City - \$200,000.

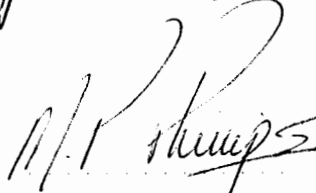
It is essential that the good rapport that has been established with the government is maintained through continuing, frank discussions. One stipulation that the government is going to be increasingly stressing is the employment of northerners, particularly Indians, Eskimos, and Metis. As an example, Anvil has undertaken to fill up to 25% of its labour force from this group by its fifth year of operation (1974). This factor should be emphasized at Casino in future and contractors, in particular, should be forced to reach some modest level - say 10%.

Respectfully submitted,

ARCHER, CATHRO & ASSOCIATES LTD.

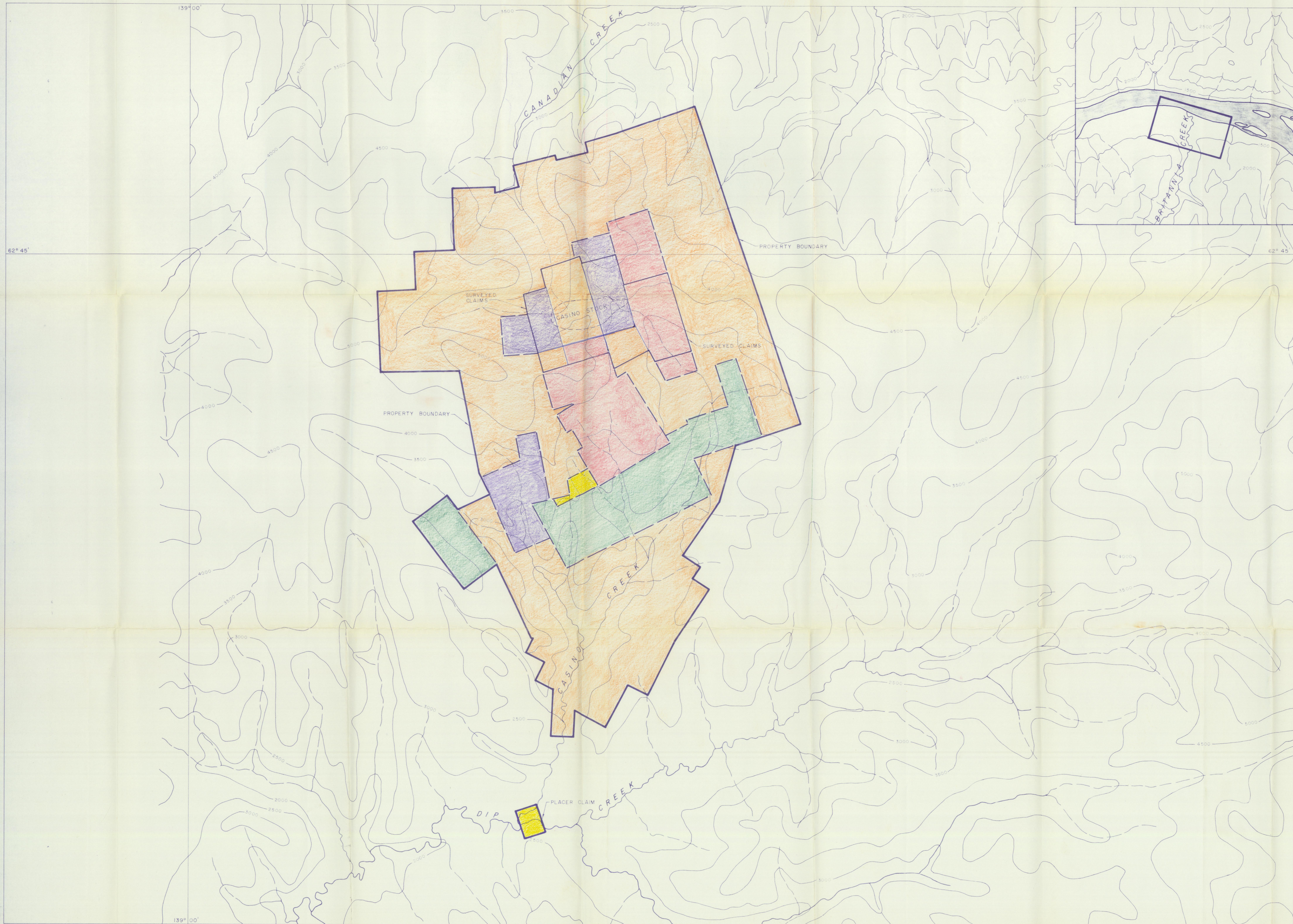


R.J. Cathro, P. Eng.



M.P. Phillips

May 31, 1970



LEGEND

EXPIRY DATE	
	1974
	1975
	1976
	1977
	1979

MAP No 2

TO ACCOMPANY A REPORT BY R.J. CATHRO AND M.P. PHILLIPS, MAY 31, 1970.

BRAMEDA RESOURCES LTD.

**CLAIM LOCATIONS & EXPIRY DATES
CASINO CREEK PROJECT
WHITEHORSE MINING DIV., YUKON**

DATE JUNE 1970	SCALE 1 in. = 1/2 mi.	N.T.S. 115 J/10 & 15
DRAWN BY L. B. - O.C.	JOB NO BR 107	DRWG. NO BR 107

LEGEND

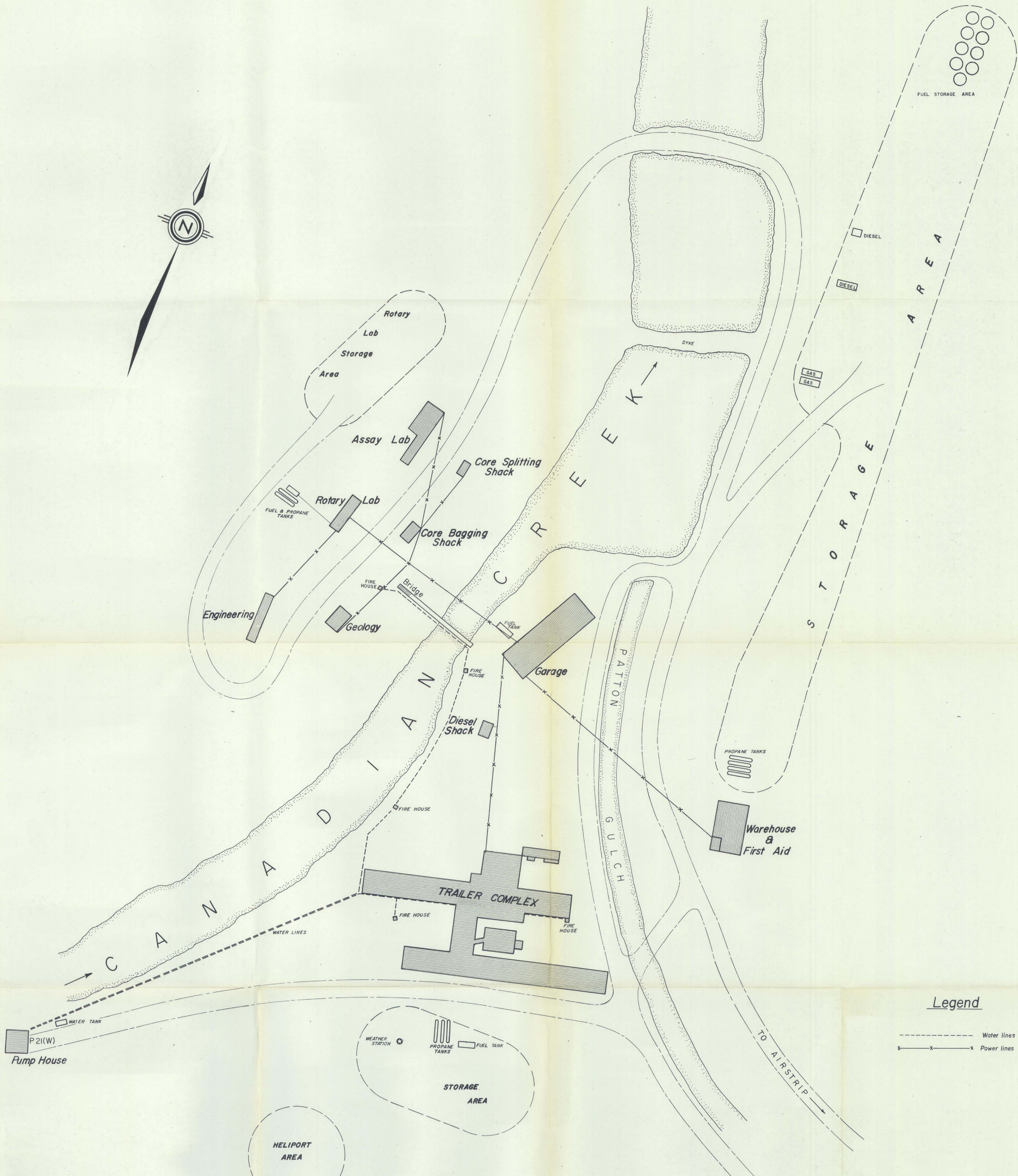
- E.M. & MAG. SURVEYS - 1966, 1967
- I.P., RESISTIVITY & MAG. - 1969
- SOIL GEOCHEM. SURVEYS - 1967, 8, 9
- DIAMOND DRILLING - 1967, 68, 69



MAP No 3

TO ACCOMPANY A REPORT BY R.J. CATHRO AND M.P. PHILLIPS, MAY 31, 1970.

BRAMEDA RESOURCES LTD.		
SURVEY INDEX CASINO CREEK PROJE WHITEHORSE MINING DIV., YUKON		
DATE	SCALE	N.T.S.
JUNE 1970	1 in. = 1/4 mi.	115 J/10 & 15
DRAWN BY	JOB NO	DRWG. NO
L.B. - O.C.	BR 107	BR 107



Legend

- Water lines
- x-x-x- Power lines

ARCHER CATHRO & ASSOCIATES LTD.
CAMP LAYOUT
CASINO PROJECT
BRAMEDA RESOURCES LTD.
SCALE IN FEET
80 40 0 40 80
TO ACCOMPANY A REPORT BY R.J. CATHRO &
M.P. PHILLIPS DATED May 31, 1970

GEOLOGY AND ROTARY DRILLING
AT THE
CASINO DEPOSIT, YUKON TERRITORY

M. P. PHILLIPS - ARCHER, CATHRO & ASSOCIATES LIMITED
C. I. GODWIN - BRAMEDA RESOURCES LIMITED

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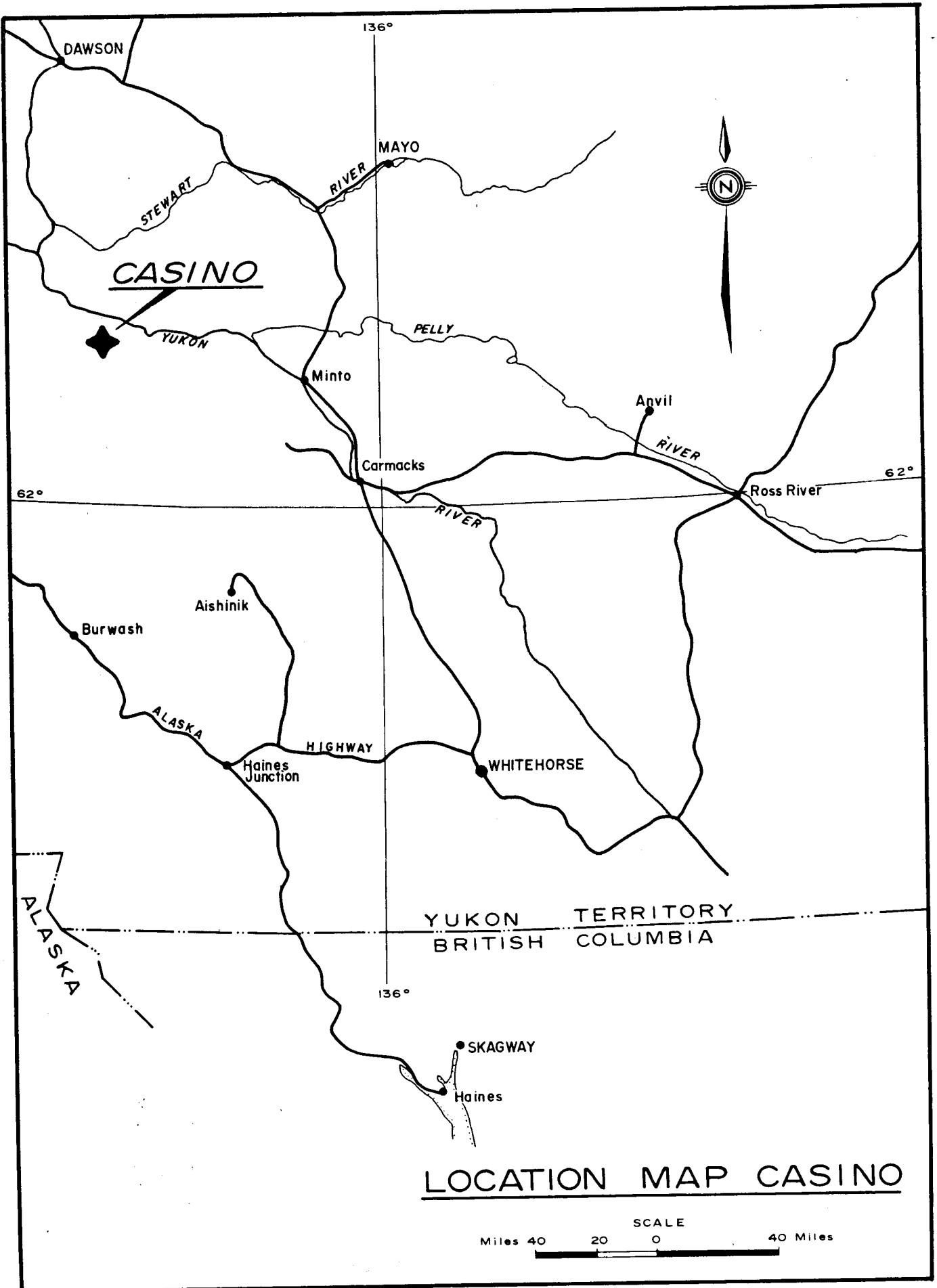
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DAWSON

136°

MAYO

CASINO

STEWART

RIVER

PELLY

YUKON

Minto

Anvil

RIVER

Carmacks

Ross River

62°

62°

RIVER

Aishinik

Burwash

ALASKA

HIGHWAY

Haines Junction

WHITEHORSE

ALASKA

YUKON TERRITORY
BRITISH COLUMBIA

136°

SKAGWAY

Haines

LOCATION MAP CASINO

SCALE

Miles 40 20 0 40 Miles

INTRODUCTION

The Casino deposit is the first major copper-molybdenum discovery in Yukon Territory. It was discovered in 1969 and has been under development by Brameda Resources Ltd. for the past two years. Of special interest is its close resemblance to Arizona porphyry copper deposits in an area of partial permafrost and unglaciated terrain which was not covered by continental Pleistocene glaciation.

HISTORY

Interest in the area from 1901 to 1933 was centered on the gold-tungsten placer occurrence on Canadian Creek. From 1933 to 1967 activity continued on the gold-tungsten placer showings but increasing interest was shown in the lead-zinc-silver veins, especially in Bomber Adit area (see General Geology map).

Geochemical soil surveys over Patton Hill area were conducted and led directly to the 1969 discovery. A more complete account of early history is contained in Archer and Main (1970).

LOCATION

The Casino property is situated 187 air miles northwest of Whitehorse, Yukon Territory, at $62^{\circ}43'N$ and $138^{\circ}49'W$ (see Location Map). It lies at a height of land between Canadian Creek, (a tributary of Britannia Creek, which flows north to Yukon River), and Casino Creek, (which flows south and west into Donjek River and White River, and eventually into Yukon River). The property is within claim sheets 115-J-10 and 115-J-15 (N.T.S.), while, physiographically, it lies within Dawson Range, a subdued mountainous portion of Yukon Plateau. The Alaska Highway passes within 75 air miles on the southwest, while Whitehorse-Keno road (Highway 2) passes within 65 air miles on the east. The Yukon River, which was the main transportation route in the Territory prior to World War Two, passes within 12 road miles on the north. Barge transportation for heavy equipment is available from Dawson.

In the winter of 1969 - 1970 a 140 mile winter road was constructed to the property from Burwash Landing on the Alaska Highway. During the summer, access is mainly to the airstrip which is suitable for wheeled aircraft up to a DC-3 in size.

FIELD MAPPING TECHNIQUES

True outcrop is rare in Casino area and is mainly confined to ridges. Mapping at a scale of one inch equals 1,000 feet was mainly of felsenmeer along ridges. The deposit area where detailed information was desired had less than one percent outcrop. Ground cover consists of a moss layer up to one foot thick below which is generally permafrost. The permafrost resulted in a tendency for blocks of ridge rocks to slide downhill on top of permafrost ice for several thousand feet, thus accumulating on the surface and obscuring underlying local rocks. Despite the degree of lateral transport the depth of overburden is often less than five feet. To help overcome these problems the following techniques were employed for one inch to 100 foot mapping:

1. A continuous furrow was ripped by D-8 bulldozer to depths of up to 2 feet along lines spaced 400 feet apart; in areas of steep topography shallow trenches were cut. In this manner 240,000 line feet or 45 line miles were prepared. Where road cuts existed these were used in lieu of ripper furrows.
2. Approximately five specimens were collected each 100 feet by a geologist. An attempt was made in the field to differentiate between transported and residual float; small, angular fragments, for example, were thought to represent more accurately the bedrock than rounded, large boulders (especially if these boulders were representative of upslope ridge rocks).
3. Samples were examined under a binocular microscope and the following features were routinely observed:
 - (a) rock type of probable underlying rock.
 - (b) silicification intensity, alteration facies and intensity of underlying rock.
 - (c) limonite data where the intensity, and jarosite (yellow), goethite (brown), hematite (red) percentages were estimated by the colour of the limonite streak.
 - (d) associated minerals, especially hematite, magnetite, tourmaline, pyrite, chalcopyrite, chalcocite and molybdenite.
 - (e) structural relationships such as closely spaced parallel fractures, and cross-cutting quartz veins with quartz-sericite envelopes.
 - (f) transported float.
4. A rock chip specimen was taken from the collection of specimens for geochemical analysis of: Cu, Pb, Zn, Mo and W.

Geological data was displayed with the aid of four-quadrants of a one inch diameter circle. Colouring of these quadrants facilitated visual grouping of float types. Reduction of this data to 1 inch to 400 foot base produced the maps of Detail 1 and 2.

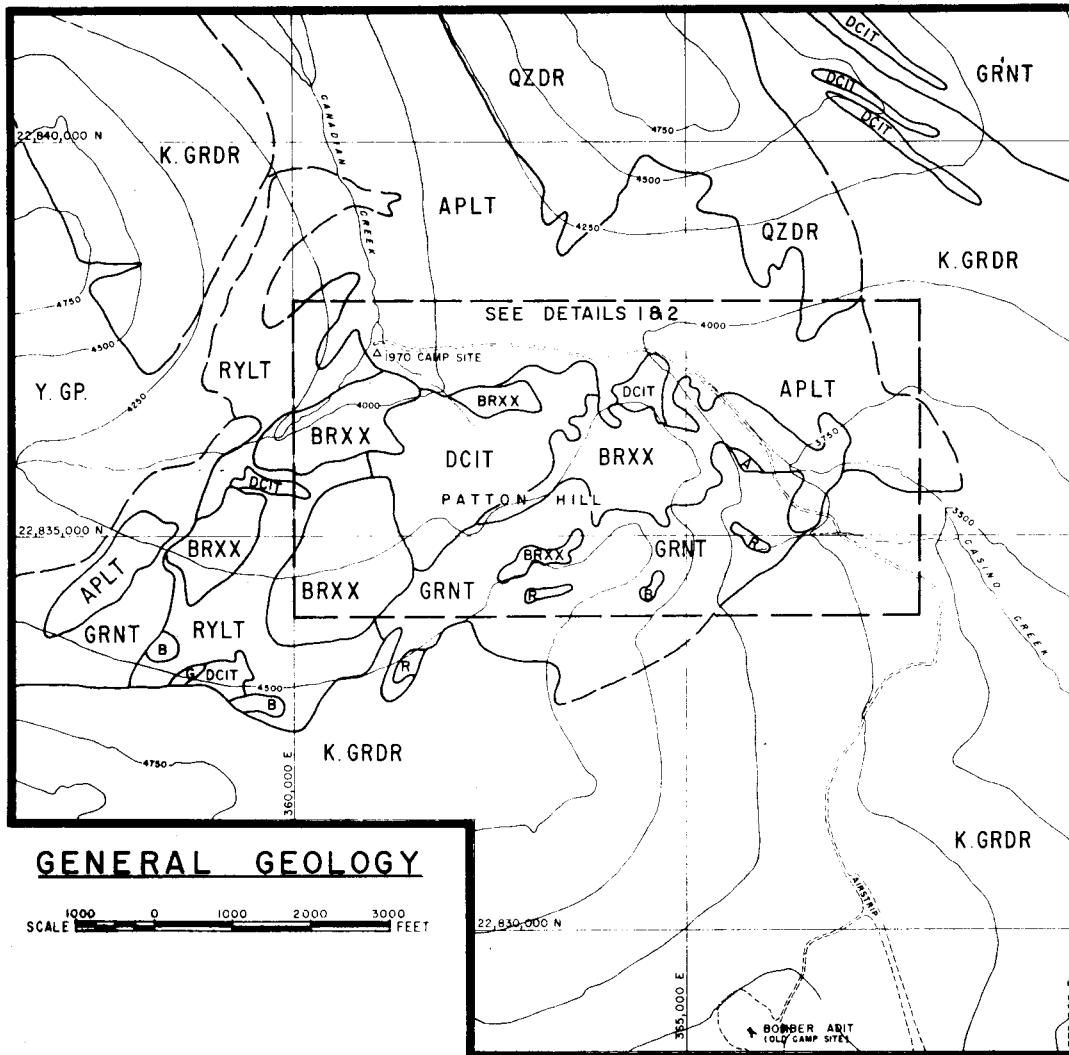
TABLE 1

ROCK DESCRIPTIONS

- C.BRRX = Cobble or boulder breccia. Fragments vary from cobble to boulder sizes and are generally well rounded and not welded to the matrix which is apparently clastic in character. Fragments include most rock types, notably: microbreccia, quartz, quartz-tourmaline, pyrite-quartz, dacite, aplite, granite, and Yukon group.
- M.BRAX = Microbreccia. A fine grained rock containing minor pebble sized fragments, a clastic matrix and up to 60% quartz as euhedral and fractured fragments. A high percentage of fractured quartz grains to grains with crystal forms distinguishes this rock from rhyolite.
- BRXX = Breccia, undifferentiated. Generally of the above two types, or mixtures of the same. However, locally there occurs a breccia composed of angular cobble-sized fragments that have only been slightly moved and cemented with a quartz-tourmaline matrix.
- RYLT = Rhyolite. Generally a light coloured porphyritic rock with pronounced doubly-truncated stubby quartz grains. This unit also includes several aphanitic types of varying colour.
- DCIT = Porphyritic dacite. A porphyritic rock with prominent plagioclase, biotite and/or hornblende phenocrysts and occasional quartz phenocrysts. In the deposit area, biotite but no hornblende occurs as phenocrysts. Distant from the deposit hornblende is dominant. K/Ar dating of this rock at University of British Columbia has yielded an age of 69 ± 3 my. A medium grained rock with an age of 71 ± 3 my. may be a variety of this unit, but is only observed in drill holes.
- APLT = Aplitite and fine-grained granodiorite. This unit is generally leucocratic and includes a variety of grain sizes up to medium grained alaskite.

LEGEND

- BRXX BRECCIA
- RYLT RHYOLITE
- DCIT PORPHYRITIC DACITE
- APLT APLITE & F. GRAINED GRANODIORITE
- GRNT MEDIUM GRAINED GRANITE
- QZDR QUARTZ DIORITE
- K.GRDR KLOTASSIN GRANODIORITE
- Y.GP. YUKON GROUP GNEISS, SCHIST & QUARTZITE



GENERAL GEOLOGY

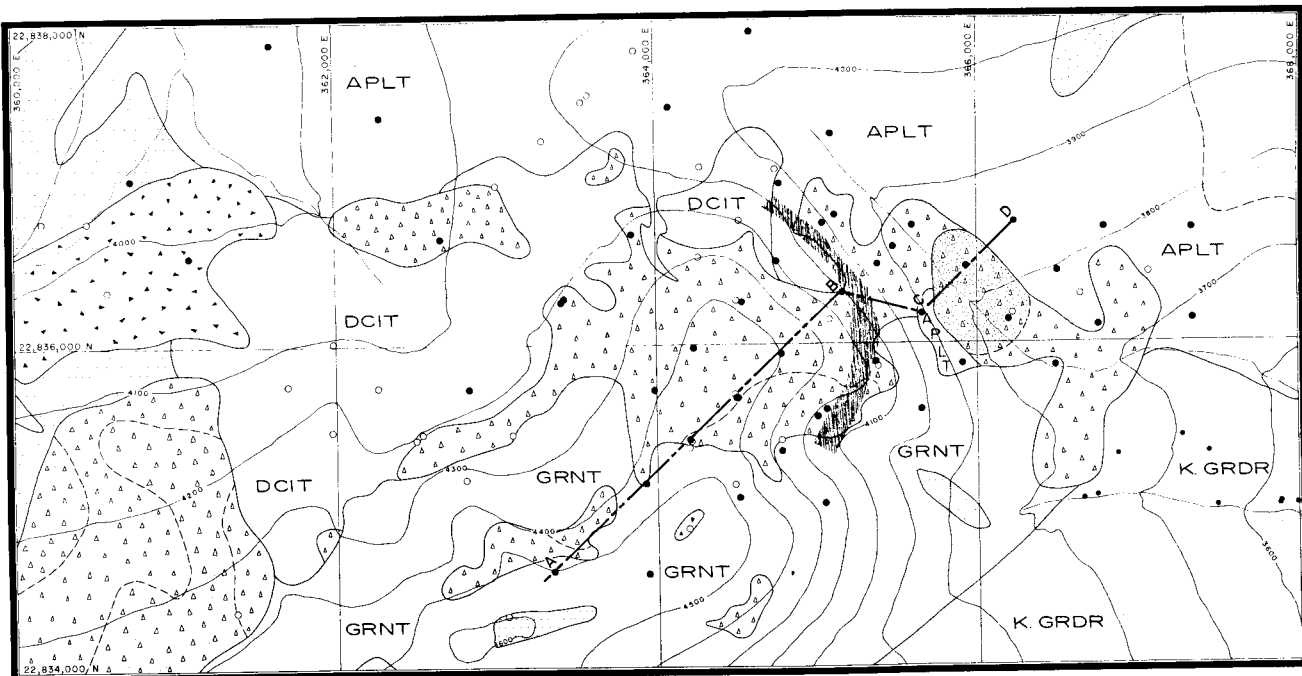
SCALE 0 1000 2000 3000 FEET

- GRNT = Medium grained biotite granite. This unit is generally porphyritic, distant from the deposit it is distinct by having only minor hornblende and large prominent quartz grains occupying up to 30% of the rock. In the deposit area where feldspars have been totally altered it is distinguished by its large quartz grains.
- QZDR = Quartz diorite. Several distinct rocks are involved including a leucocratic, medium grained, inequigranular, hornblende biotite quartz diorite that is locally sphene rich, and a porphyritic, mesocratic, medium grained, biotite-hornblende quartz diorite.
- K.GRDR = Klotassin granodiorite. A medium grained biotite hornblende granodiorite. Hornblende is subhedral and pronounced. K/Ar dating by the Geological Survey of Canada of a sample from near the Bomber Adit yielded ages of 95 and 99 my on biotite and hornblende respectively (Findlay, 1969).
- Y.GP = Yukon group gneiss, schist and quartzite. The age of this unit is unknown but is older than the Klotassin granodiorite.

GEOLOGICAL INTERPRETATION

The geology is described in maps of General Geology and Detail 1. Rock descriptions in Table 1 are mainly field descriptions; they are described in probable order of increasing age. A sequence of events that seems plausible is as follows:

1. The Yukon group - schists, gneisses and quartzites were intruded by Klotassin granodiorite that may be part of the Cretaceous Coast Intrusion sequence (Findlay, 1969).
2. The area was then intruded by a younger quartz diorite to granite complex.
3. Aplites intruded the above.
4. Feeders, possibly related to Carmacks Group volcanics (Bostock, 1936), of dacite and rhyolite occur concentrated in the vicinity of the deposit.
5. Rhyolites were strongly mobilized to form pipe-like micro-breccia bodies characterized by a high percentage of fractured quartz grains.



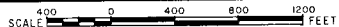
DETAIL 1: GEOLOGY

LEGEND

- DIAMOND DRILLING TO 1967.
- DIAMOND DRILLING 1969 & 1970.
- ROTARY DRILLING 1970.

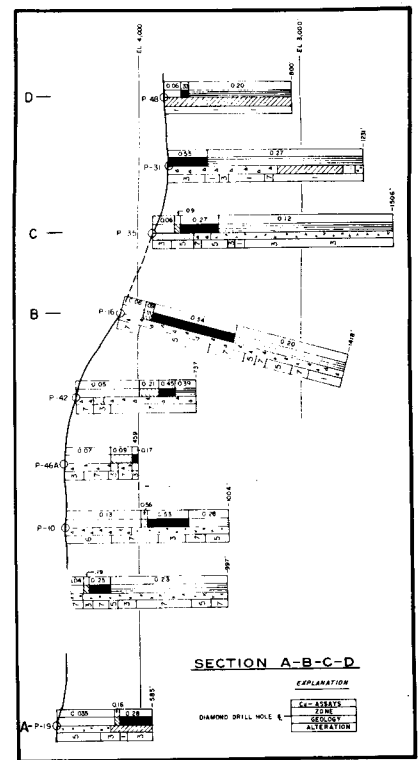
GRID & ELEVATIONS IN FEET.

A-B-C-D: CROSS SECTION
COPPER-MOLYBDENUM ZONE



ROCK TYPES

C BRX [Symbol]	Cobble breccia	APLT [Symbol]	Apilite B f grained granodiorite
M BRAX [Symbol]	Microbreccia	GRNT [Symbol]	M grained granite
B RXX [Symbol]	Breccia, undivided	QZDR [Symbol]	Quartz diorite
RYLT [Symbol]	Rhyolite	K GRDR [Symbol]	Kiotassin granodiorite
DCIT [Symbol]	Porphyritic dacite Nonporphyritic variety?		



DRILL HOLE ZONES

- [Symbol] CAP
- [Symbol] OXIDE
- [Symbol] SUPERGENE
- [Symbol] HYPOGENE

6. A second stage of brecciation results in cobble or boulder breccia where microbreccia fragments are commonly imbedded in microbreccia matrix. This breccia was apparently highly mobile because this type of breccia locally contains abundant foreign fragments including ones from Yukon Group.

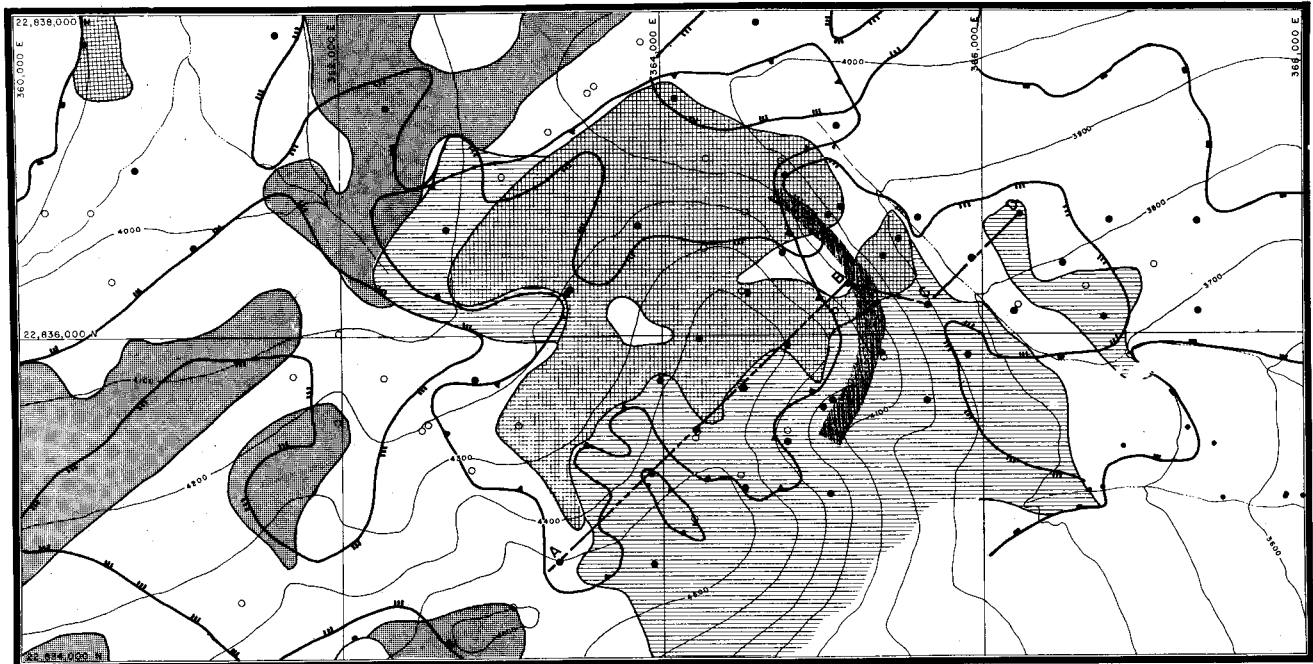
Abundant, strong alteration and lack of observed contacts, make the above age relationships somewhat speculative. Potassium-argon age determinations currently being undertaken at the University of British Columbia will hopefully aid in more refined future interpretations.

TABLE 2

ALTERATION FACIES DESCRIPTIONS

POTASSIC (7)	= potassium feldspar, biotite, hematite and/or magnetite, ankerite, tourmaline, some gypsum.
ADVANCED ARGILLIC (6)	= clay, muscovite-sericite (frequently distinctly coarse grained), abundant tourmaline and quartz, frequent quartz veins with quartz-sericite envelopes.
PHYLLIC (5)	= strong sericite development, minor clay, moderate quartz.
ARGILLIC (3)	= strong clay, minor sericite, biotite, minor calcite and chlorite associated with montmorillonite.
PROPYLITIC (1)	= abundant chlorite and calcite, minor epidote, some gypsum.

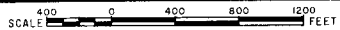
(See Meyer and Hemley, 1967).



DETAIL 2: ALTERATION

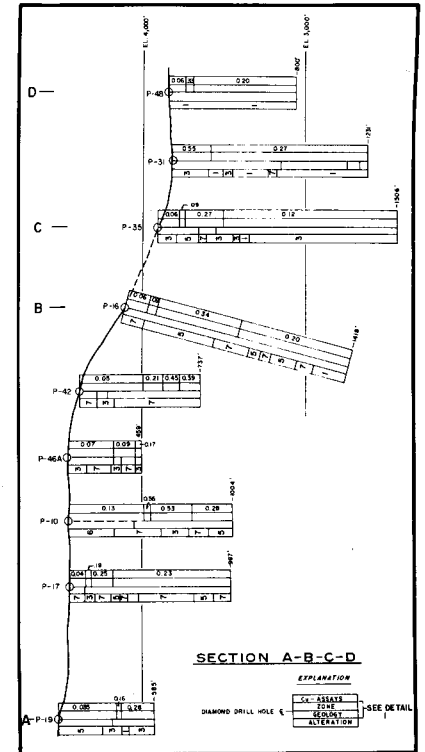
LEGEND

- DIAMOND DRILLING TO 1967.
- DIAMOND DRILLING 1969 & 1970.
- ROTARY DRILLING 1970.
- GRID & ELEVATIONS IN FEET.
- A-B-C-D: CROSS SECTION
- COPPER-MOLYBDENUM ZONE



ALTERATION TYPES

- | | |
|-------------------|------------------------------------|
| POTASSIC | LIMIT OF HEMATITE and/or MAGNETITE |
| ADVANCED ARGILLIC | LIMIT OF TOURMALINE |
| PHYLIC | LIMIT OF ALTERATION |
| ARGILLIC | NOTE: Teeth face occurrence |



ALTERATION AND MINERALIZATION

Alteration and mineralization has been summarized in Tables 2 and 3. Generalized surface alteration facies and limits of the minerals tourmaline and hematite-magnetite are shown on Detail 2. An arcuate copper-molybdenum zone of better than average grade is shown on Details 1 and 2. Not all better grade copper-molybdenum zones are shown.

Apart from a small amount of polished section work (Tredger, 1970) all work has been based on field determinations aided by a binocular microscope. With all the limitations inherent in the fact that there is a severe supergene imprint on the surface rocks and that interpretations are field ones, Details 1 and 2 suggest some criteria that may be important to the localization of copper and molybdenum at Casino. The mineralization is:

1. mainly within breccia.
2. outside the hematite-magnetite area defined by the hematite-magnetite line
3. related to the outer margin of the potassic alteration zone.
4. inside the tourmaline area.

Whether or not these parameters are applicable to other parts of the property is unknown at the present time. The breccias, however, seem to be the most dominant single factor controlling alteration and mineralization.

Copper mineralization within the potassic and phyllic alteration zones in the central area of the deposit occurs as very fine disseminations and rarely as fracture fillings; the pyrite to chalcopyrite ratio is about 2 to 1. Within the propylitic alteration zones, peripheral to the deposit, mineralization is more commonly as fracture fillings; the pyrite to chalcopyrite ratios increase to about 3 to 1.

Significant chalcopyrite with only trace pyrite, however, locally occurs in the peripheral propylitic alteration zone. The chalcopyrite occurs along fractures as veinlets accompanied by potassic alteration which is minor, however, on a volume basis.

Molybdenite mineralization occurs as disseminations in strong pervasive silicification, in quartz veinlets, and as disseminations and fine quartz-free veinlets. Drill holes may show increasing molybdenite and decreasing copper values with depth indicating that copper-molybdenum zoning could be present.

ROTARY DRILLING

INTRODUCTION

During the past few years, rotary drilling has been used extensively in porphyry exploration programs in the United States, often as a supplement to diamond drilling. It has been used to a much lesser extent in Canada, mainly to penetrate thick glacial overburden. The relatively unweathered nature of Canadian porphyries, remoteness and absence of suitable sampling equipment to handle large quantities of water have hindered its use in Canada.

At the Casino deposit several drilling problems were encountered which are somewhat unique in the Canadian Cordillera. The water table is up to 700 feet below surface and the leached capping and supergene zone are, in many places, quite friable and soft, which resulted in serious caving conditions. In addition, its location at a height of land in an area which receives only 15 inches of precipitation created serious water supply problems.

In the initial 37,000 feet of diamond drilling, core recoveries averaged

leached zone	79.2%
supergene zone	79.3%
primary zone	92.7%

The poorest recovery was often obtained from the highest grade intervals. Diamond drilling costs for NQ and BQ size core were approximately:

	<u>direct</u>	<u>indirect</u>	<u>total</u>
summer	14.00	4.00	18.00
winter	24.00	6.00	30.00

It was anticipated that the larger hole size of the rotary method, and air circulation instead of water would produce a superior sample at a lower cost per foot. This report outlines briefly the equipment used, operating problems and sampling procedures.

DRILLING PROCESS

Big Indian's "Sure Core" technique, also known as centre hole return drilling process, is based on the use of a double wall drill stem pipe, rotary bit and a dual swivel head which provides a closed system and full recovery of the cuttings. Fluid or air is injected between the inner and outer wall of the pipe and the cuttings (rock fragments) are recovered through the inner tube. This prevents erosion of the hole walls. Cuttings return at about 600 f.p.m. when water is used as the drilling medium and about 5,000 f.p.m. with air. Only air injection was used at Casino.

Coring type bits are available with a special core breaker that allows core to be broken into 5 inch sections and pumped to surface. They were not used at Casino.

EQUIPMENT

The complete rig consists of:

- (a) a conventional 2,000 ft. jackknife mast drill mounted on a 5 ton gasoline operated truck with the addition of a dual swivel kelly and drill pipe system. The drill is powered by the truck motor. If difficult terrain is present, track mounted drills capable of drilling to 600 ft. are available.
- (b) a 315 cfm, 120 psi compressor, also mounted on the track.
- (c) a separate pipe rack on skids with a capacity of 1,000 ft. of drill pipe.
- (d) a skid mounted "dog house" with a 385 cfm, 250 psi compressor, generator, tools, bits, spare parts and geolograph (a device for graphing time and footage).
- (e) a 3 ton winch truck for transporting the "dog house" and rods.
- (f) a $\frac{1}{2}$ ton pickup truck for personnel.
- (g) a cyclone for separating dry cutting from the return air.

DRILLING PROCEDURE

Drill moves depend upon distance and topography and varied at Casino from one to eight hours for distances up to 5,000 ft.

The minimum size of a level drill site is 30 x 60 ft. Once on the site, the rig is levelled with hydraulic jacks located at the rear of the rig. The mast is also raised and held in a vertical position by hydraulic jacks.

A $6\frac{3}{4}$ inch diameter bit is used for the length of the 23ft. kelly. Then an 8 inch bit is used to ream out the kelly hole for the 7 inch casing. In the early holes at Casino which were collared in bedrock, only 4 feet of casing was installed, but broken ground at the top of the hole tended to fall into the hole behind the bit. Two holes near Canadian Creek were lost in running gravel overburden but could have been saved if casing of varying diameters had been available.

Drilling ahead of the casing is carried out with a $4\frac{7}{8}$ inch diameter bit attached to the $4\frac{1}{2}$ inch diameter drill pipe or drill collars.

Initially the rod rotation speed was 35 r.p.m. but it was found that better fragmentation of the bedrock and smoother walls to the hole could be obtained if this was increased to 50 r.p.m.

The initial drilling rate is slow due to lack of weight on the rotary bit so drill collars (weighted pipe) are added. They weigh 30 pounds per foot and are used to a depth of 300 feet. Drill pipe weighs 17 pounds per foot, comes in approximate 15 foot lengths and is worth about \$450.00 per length. It is stacked in the mast in 30 ft. lengths. The small truck mounted compressor is used to 600 ft. when cuttings are dry or until the water table is intersected. Operating air pressure is about 90 psi.

The drilling rate varies from 2 ft. per minute in soft ground to 8 minutes per ft. in the hardest ground. In the leached cap where supergene alteration has softened and leached the fractures, the rotary bit readily breaks the rock into large cuttings. In harder rock generally in the supergene and hypogene zones, the penetration rate is lower as the bit has to grind the rock and generally smaller fragments are obtained.

When the rock becomes moist, just above the water table, up to 10 gallons per minute of water is added to the injected air in order to stop the cuttings from plugging up the bit.

The maximum depth of the hole depends upon the competency of the wallrock and hardness of the rock. The deepest hole at Casino was 1,004 ft. and average hole depth was about 450 ft.

The standard oil field tricone bit, worth about \$65.00, averaged about 10 - 12 hours of drilling. One button bit worth about \$750.00 was used for experimental purposes and was found to have the same life as a tricone bit. A wide variety of tricone bits are available with varying combinations of button-tooth tricones for different ground conditions. Three holes were lost when faulty cones fell off the bit. Lost cones may be removed by a magnet or a new bit can be added to the drill pipe and the cone pushed into the wall of the hole.

In some instances caving conditions were encountered. If this condition was recognized by the driller the bit and pipe are pulled off the bottom and the hole is reamed out. If caving conditions are not quickly recognized, the loose material from the walls of the hole jams behind the bit. Only rarely can all the equipment be recovered. Two holes out of 35 were lost due to caving.

Small amounts of lime in solution can be added to injected air in order to stop corrosion by acid water on the inside of the inner double wall pipe.

During the winter when low temperatures are encountered methyl alcohol is added to the injected air in order to overcome freezing

condition in the air line between the compressor and the top of the hole.

PERSONNEL

The drilling crew consists of a tool-push (foreman) and a driller and two helpers on each eight hour shift, a total of 10 men. Crews work a continuous 20 days and then have 10 days off, a standard rotation procedure in oil field drilling. During the period June - August, 1970, the rotation period at Casino was extended to six weeks.

Initially, the drillers had some trouble drilling in broken ground as most of their experience had been in soft competent sedimentary rocks. After approximately a month's experience this problem was overcome.

SAMPLING PROCEDURE

Numerous inquiries were made regarding sampling procedures for wet cuttings, but little information was available and it was realized that special sampling techniques would have to be developed.

(a) DRY CUTTINGS

Dry cuttings were collected at the bottom of the cyclone in large canvas bags with the hole number and footages marked on the outside. Initially the samples were collected at five foot intervals and taken back to camp for splitting. Later, a Jones Splitter was set up at the drill site and the sample for a 15 ft. interval was split with the 1/8 sample used for assay and geological purposes and the 7/8 split discarded. This sample could be used for metallurgical purposes. A limited number of specific gravity determinations were carried out on diamond drill core in order to determine the theoretical sample weight. The average S.G. was 2.63 indicating a theoretical weight of 319 pounds for a 15 foot sample. All samples were weighed and indicate a recovery of between 95 and 100%.

The dry cuttings are separated from the air in a large cyclone. The exhaust from the cyclone contains extremely fine dust-like material. The placing of additional stacks over the top of the cyclone to catch the dust-like particle was only of limited value. A sample of dust collected with the aid of a damp cheese cloth assayed slightly higher in copper and double in molybdenite. The amount lost is small and it is not believed that appreciable copper or molybdenite was lost at Casino. Experience at a molybdenum prospect in Arizona which was rotary drilled and later investigated by underground workings,

indicated that significant molybdenite was probably lost in the dust (E. Eyde, personal communication). To overcome this problem, a vacuum filter device can be used and has recently become available.

(b) WET CUTTINGS

Initially, cuttings were directed from the bottom of the cyclone through a plastic hose to a series of upright 45 gallon drums but the large flow of water encountered (up to 50 gallons per minute) in winter conditions made this method impractical. An improvement in the previous system was the installation of a 1 inch outlet nipple halfway up the side of the 45 gallon drum. After testing various types of fabric, a nylon stocking was placed over the nipple to catch the fine material, while a screen on top of the drum caught the coarser fragments. This was satisfactory except that cuttings at the bottom of the drum were difficult to bag.

In order to improve sample collection a 45 gallon drum was cut in half lengthwise, pivots were welded at each end, so that the split drum could be rotated for cleaning, and mounted on a three foot high stand. A 1 inch outlet nipple was installed at the bottom end of the drum and a screen was placed over the drum to catch the coarser cuttings. Two sampling units were used to prevent interruption of drilling and installed in a skid mounted, heated shack which could be readily moved. A nylon stocking placed over the outlet removed the finest fraction as before.

Drilling was interrupted every five feet to clear the hole.

It was realized that molybdenite and copper in suspension might not be caught by the stocking, and it was estimated that up to 5 pounds of cuttings every 5 ft. could be lost. A flocculating agent, Separan NP 10, was added to the wet cuttings by a drip arrangement below the coarse screen. The amount could not be easily regulated and when an excess amount is added the wet cuttings turn to jelly. If problems with the recovery of molybdenite are suspected, special tanks for mixing and storing Separan in solution should be built and can be added to the air injected into the holes. Several holes drilled next to diamond drill holes for purposes of comparison in the early stages of drilling indicated that the copper-moly rotary assays were from 73 to 105% higher except in holes with very low moly assays.

Six out of seven holes which penetrated the water table in the early stages showed a consistent drop in recovery of about 30 percent below the water table. The water table varied from 100 feet in the lower areas to more than 700 feet on the top of Patton Hill. The reason for the lower recovery is not clear but several explanations are

suggested:

- (a) colloidal mineralization was not being recovered from the wet cuttings.
- (b) the hydrostatic pressure caused grouting of fractures at the bottom of the hole.
- (c) imperfect sampling technique.

In June 1970, an Elenburg Sampler was purchased from Monahans, Texas, at a cost of \$4,000 and used for the remainder of the program. The sampler is trailer mounted, and consists of:

1. SPLITTER - The wet cuttings enter a small cyclone and exit through a nozzle against the splitter, which rotates on a vertical axle. The splitter diverts 1/8 to a 20 mesh screen and rejects the remainder. It was found that the split on the total sample was between 1/8 and 1/9 due to surging of the wet cuttings. A minimum water flow of 10 gallons per minute is needed to operate the splitter. When normal air return contained less than 10 g.p.m., water was added to the air intake.

2. 20 MESH SCREEN - The split sample runs into the 20 mesh screen which catches the oversize cuttings ($\frac{1}{2}$ to $\frac{3}{4}$ of the sample). The fine cuttings drop through the screen and are pumped to a cyclone.

3. CYCLONE - The diesel-powered cyclone separates the fine cuttings from most of the water. The cyclones can handle up to 250 gallons of water with fines per minute and separates cuttings down to 340 mesh. A constant amount of water is regulated by the cyclone. At one end of the cyclone the moist fine cuttings are discharged into a small plastic bag. If poor recovery of the fine cuttings is suspected the discharge from the cyclone can be diverted back to the 20 mesh screen where it will return through the cyclone.

Sample interval was the length of the drill pipe - approximately 15 ft. The fine cuttings in the small plastic bag were tied and placed inside the larger plastic bag containing the coarser cuttings.

Tests were carried out to check the accuracy of the sampling techniques. Three reject samples were collected below the water table to determine recoveries. The average indicated recovery for the three samples tested was 87.6% on the basis of a 1/9 sample split. If the percent recovery for the sample had been determined on the basis of the weight of the 1/8 sample cut, it would have been reported as 69.3%.

All samples were weighed and examinations of the sample recoveries suggest that in highly fractured ground just below the water table, up to 50% of the sample is not recovered. In general, recoveries were

95% for dry cuttings and varied from 85 - 95% for wet cuttings.

Assay results on the 1/8 and 7/8 portions collected in these tests were not consistent. The discrepancy may be due to improper mixing and sampling the 7/8 portion which weighs as much as 256 pounds.

An overflow sample in excess of 600 gallons from the Elenburg cyclone was collected. Fines remaining proved to be semi-colloidal as only 3 lbs. settled out after several days. The overflow sample assayed higher in copper and lower in molybdenum than the 1/8 split. It is believed that the molybdenite remained in colloidal suspension and could not be collected. The amount of sample being lost is not sufficient to effect the assay results.

SAMPLE PROCESSING

Pre Elenburg Sampler

Samples were collected at 5 foot intervals, weighing about 100 lbs. in large canvas bags with the hole number and sample footages marked on the outside. At the end of each shift the samples were taken to a processing lab at the base camp. Dry samples were immediately put through the Jones Splitter and both the 1/8 and 7/8 splits were weighed. The wet samples were dried using a portable oil-fired blower and then split in a similar fashion. The 1/8 splits were assayed. About 3 lbs. of the 7/8 sample split was collected for geological purposes and the balance of the 7/8 sample split was stored in sealed 5 gallon metal pails. Hole numbers and footages were marked on the inside or the outside of the cans and stored. The lab was operated by a three man crew on a single daily shift.

Elenburg Sampler

The sample with its two size components were taken to the lab, dried and each split an equal number of times so that the combined weight of the sample would be about 4 lbs. The 4 lb. sample was thoroughly mixed, split equally into a 2 lb. sample for assaying and a 2 lb. sample for geological purposes.

DRILLING COSTS

The contractor was hired at an hourly rate of \$40 per hour during the period January - March, 1970, and \$47.50 during the period June - August, 1970. Standby rate was \$25 per hour with crew and \$100 per day without crew. Delays in repairs or maintenance and unavoidable delays

in supplies and equipment were charged at \$250 per 24 hour period.

The geograph was rented at \$120.00 per month. Mobilization, demobilization, bit charges, transportation of supplies, room and board and lost equipment were extra charges.

The following table gives the drilling costs:

<u>PERIOD</u>	<u>FOOTAGE DRILLED</u>	<u>DIRECT COST/FT.</u>	<u>INDIRECT COST/FT. (EST.)</u>	<u>COST/FT. EQUIP. LOST (EST.)</u>	<u>TOTAL COST/FT. DIRECT & INDIRECT</u>
Jan - Mar	5,808	13.50	2.00	*	15.50
June 2 - 30	4,119	10.98	3.50	2.27	14.48
July 1 - 31	5,838	5.85	3.50	nil	9.35
Aug. 1 - 9	2,007	7.61	3.50	2.28	11.11
June 1 - Aug. 9	11,964	7.91	3.50	1.16	12.57
Total	17,772			Average	13.53

* - included in direct cost

Direct - paid to contractor

Indirect - fuel, room and board, bits, crew rotation, preparation of drill sites, mobilization and demobilization.

The higher cost in January - March 1970, was due to stuck pipe, equipment failure, inexperienced crews, winter weather and shut down of the rig in order to modify sampling procedure. The drill costs from June to August 1970 reflect average operating conditions.

Comparison of rotary and diamond drilling costs shows that under summer operating conditions, the rotary drill is \$2 to \$6 per foot cheaper, and under winter conditions, when water supply is difficult, rotary drilling was from \$5 to \$15 per foot cheaper.

GEOLOGICAL SAMPLES

The sampler collected a small portion of the coarse and fine cuttings from the Elenburg Sampler at each sample interval. This was placed in a soil sample bag with the hole number and sample footage marked on the outside. The samples were examined by a geologist at the end of the shift for grade estimation and hole control. Grade

estimation was very difficult due to very fine grained chalcocite which coats chalcopyrite and pyrite.

The geological sample was sieved with a spaghetti strainer to obtain coarse and fine fractions. A portion of the fine fraction was panned to obtain a heavy mineral concentrate. To facilitate sulphide recognition and grade estimation, magnetite was removed with a magnet. The three fractions of the cuttings were glued with "Bond Fast" to sludge boards and displayed, together with footage, geology and assays, as a visual log at a scale of 1 inch to 10 feet.

Geological examinations of the 3 fractions of cuttings were carried out with the aid of a binocular microscope and variable intensity lamp. The host rock and alteration were determined from the coarse fraction. The fine fraction is useful in determining the bottom of the leached cap, where a discernable colour change is often evident. Mineralization is examined in the concentrate and coarse fraction.

Operational drill records and geological data was recorded on a computer coded form, (Chapman, Wood and Griswold Form 71 - 02). Under good conditions and after some initial experience a minimum of about 15 minutes was required for the examination and logging of each 15 foot sample.

Hindsight suggested that logging of rotary drill cuttings could have been aided by comparison with rock chip boards previously prepared from crushed diamond drill core.

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