PR- Peace River Canyon
81 (9)A

THE PRELIMINARY ENVIRONMENTAL ASSESSMENT
of THE PEACE RIVER CANYON COAL PROJECT

C.L.# 3407-3444

9 OCTOBER 1981

CINNABAR PEAK MINES LTD.

POINT OF MAILING
11650 - 156 Street
Edmonton, Alberta
T5M 3T5

18 November 1981

Mr. J.D. McDonald
Senior Reclamation Inspector
Ministry of Energy, Mines and Petroleum Resources
Room 105 525 Superior Street
Victoria, B.C.
V8V 1T7

Letter of Transmittal

Re: Preliminary Environmental Study for Stage I Approval of the Peace River Canyon Coal Project Coal Development by Cinnabar Peak Mines Ltd.

Dear Sirs:

Attached to this letter of transmittal is the Preliminary Environmental Assessment Report of the Peace River Canyon Coal Project. A one million clean tons per year surface mine with a projected life span of 15 years is proposed. Cinnabar Peak Mines Ltd. respectfully request that the Government of B.C. review the proposed mine development described by the report and grant Cinnabar a Stage I Preliminary Approval of this project from these data.

Recent exploration of the property has indicated additional coal resources that may be sufficient to sustain an underground mine. Upon completion of further exploration and development Cinnabar may submit a second application for approval of an underground mine. The underground mine would be adjacent to the surface mine on the Cinnabar licenses that are located on the south bank of the Peace River Canyon.

The attached Stage I report on the surface mine proposal has been prepared in compliance with the Coal Development Guidelines published in 1976 by the Environment and Land Use Committee of the Government of British Columbia. We sincerely trust our work will meet with the approval of the Government. Cinnabar now wishes to commence work on the Stage II detailed assessment of the mine development. Further information concerning this submission may be obtained from the designated corporate officer undersigned below.

Yours truly,

E. Lipsett

E. Lipsett, Esq.
Vice President, Technical Projects
Cinnabar Peak Mines Ltd.

International Environmental Consultants Ltd.

5600 Cedarbridge Way
Suite 202
Richmond/British Columbia
V6X 2A7
(604) 273-0151
Telex 04-355752

19 November 1981

Mr. E. Lipsett
Vice President, Technical Projects
Cinnabar Peak Mines Ltd.
11650 156th Street
Edmonton, Alberta
T5M 3T5

Reference: 3093.1

Dear Sir:

IEC International Environmental Consultants Ltd. are pleased to submit the final draft of the Preliminary Environmental Assessment of the Peace River Canyon Coal Project in compliance with the contractual agreement between IEC and Cinnabar Peak Mines (IEC Reference: 3093.1). The work was conducted through the Vancouver office of IEC, who are responsible for the analysis and interpretation of the data presented.

Environmental Impacts are identified from the socio-economic and environmental data gathered by IEC, using the mine plans and engineering prepared by Cinnabar Peak Mines Ltd.

IEC sincerely trusts that this report fulfils our contractual obligations to provide a report in a format suited for a Stage I Environmental Impact Submission to the Government of British Columbia.

Yours truly,

IEC INTERNATIONAL ENVIRONMENTAL CONSULTANTS LTD.

S.W. Stogran
Project Manager

SWS/sma.

THE PRELIMINARY ENVIRONMENTAL ASSESSMENT of THE PEACE RIVER CANYON COAL PROJECT

prepared for

CINNABAR PEAK MINES LTD.
11650-156 Street
Edmonton, Alberta
T5M 3T5

by:

S. W. Stogran
Project Manager

Approved:

D. J. Jones, Ph.D.
Project Principal

IEC INTERNATIONAL ENVIRONMENTAL CONSULTANTS LTD.
5600 Cedarbridge Way, Suite 202
Richmond, B.C. V6X 2A7

Project 3093.1 October 1981

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ACKNOWLEDGEMENTS

IEC (International Environmental Consultants Ltd.) would like to acknowledge the information supplied by Cinnabar Peak Mines Ltd. personnel regarding the mine plan and other related material. Their close cooperation and assistance was instrumental in the preparation of the environmental assessment of the Peace River Canyon Project.

1.0 EXECUTIVE SUMMARY

1.1 The Proponent

Cinnabar Peak Mines Ltd., an Alberta Corporation listed on the Alberta Stock Exchange, was incorporated in 1968 to investigate and explore several hardrock mineral prospects in British Columbia. During the course of these investigations, Cinnabar was introduced to the Peace River Canyon coal properties in northeastern B.C. The canyon's numerous seams of thermal and metallurgical coal, within relatively easy access of transportation and community facilities, were sufficiently promising that this venture became the company's chief priority by the early 1970's. Petroleum and Natural Gas interests in 9,000 acres of freehold lands were subsequently acquired to expand and broaden Cinnabar's Energy Resources holdings.

In 1969, Cinnabar acquired an option, which was exercised in 1979, to purchase the coal rights to 1,600 acres of freehold land. This property had been held and explored by one of the leading mining families in the Chetwynd-Hudson Hope area. Later the British Columbia government granted Cinnabar coal removal licences covering 19,400 acres surrounding the freehold lands.

1.2 The Project

The Peace River Canyon property of Cinnabar Peak Mines Ltd. is located approximately 17 km (10.5 mi) west-southwest of Hudson Hope. The site of the proposed operations is on the south side of the Site One Reservoir (Dinosaur Lake).

Cinnabar began acquiring the land for coal removal in 1969 and the property presently consists of approximately 648 ha (1,600 acres) of freehold land and approximately 8,094 ha (20,000 acres) of Crown grant coal removal licences. Exploration of the property has been proceeding since its acquisition in 1969 until the present time.

1.3 The Mine

1.3.1 Reserves

The total reserve area available for open pit mining is 140 ha (346 acres). The calculated reserves for the surface mine are approximately 20,000,000 tonnes (22,000,000 tons).

1.3.2 Scheduling

Construction is scheduled to begin in March 1983 and be completed by March 1984 when the mine will be put into operation. The life expectancy of the mine is fifteen years at one million clean tons per year.

1.3.3 Manpower

The preliminary manpower requirements for the construction and operation of the mine are:

Construction

Excavation and Site Preparation	220
Construction of Loadout Site and Facilities	79
Total	299

Operational Phase

Administration	38
Mine Operations	90
Mine Maintenance	47
Preparation Plant	24
Transportation	36
Total	235

1.3.4 Preparation Plant

If required, the coal will be cleaned in a Baum jig, by "water only" cyclones, and by flotation. The clean coal will be dried in a fluidized bed dryer fuelled by natural gas and conveyed to silos for loading into trucks.

1.3.5 Transportation

The coal will be loaded into trucks with 32.2 tonne (35.5 ton) payloads, from the silos. The trucks then carry the coal along the existing forestry road and Highway 29 to Chetwynd where it will be loaded onto B.C. Railway cars for transportation to ports.

1.3.6 Power

Electrical power will be obtained from the low voltage BC Hydro power lines near Highway 29. The natural gas will be tapped from the Westcoast Transmission pipeline which runs through the property.

1.4 Environmental Impacts

The impact of the mine construction and operation on the fisheries in the section of Johnson Creek between Dinosaur Lake and the first barrier to fish migration is of prime importance. The water quality of Johnson Creek will be maintained as close to natural conditions as possible. Unavoidable construction activities which may affect the lower Johnson Creek fisheries will be scheduled around key periods. There is no important fishery in Moosecall Lake, Coalbed Creek, or Upper Johnson Creek.

Wildlife habitat lost to the mining facilities will be replaced at the end of the operation. Habitat which cannot be replaced will be improved or other areas will be altered to compensate for the change in carrying capacity.

1.5 Further Studies

Recommendations for further studies are included in Section 6.5 (Further Studies). Detailed study programs will be formulated by the proponent and the consultant after consultation with the appropriate government agencies.

2.0 INTRODUCTION

2.1 Scheduling

IEC (International Environmental Consultants Ltd.) was retained by Cinnabar Peak Mines Ltd. in June of 1981 to prepare a preliminary environmental assessment of the Peace River Canyon property of Cinnabar Peak Mines Ltd.
A field trip to collect site specific information, including water quality, was completed 1 July 1981.

2.2 Approach

The information in the Mining Plan Summary (Section 3.0) was supplied by Cinnabar Peak Mines Ltd. Site specific information was gathered during a site visit by IEC personnel.

Government agencies supplied most of the regional data used. The Atmospheric Environmental Agency supplied the environmental data for Hudson Hope and maps from the Canada Land Inventory were used for other regional data. Personal communications with various government personnel supplied some regional and site specific data.

Studies for the B.C. Hydro Site One Dam Construction supplied some site specific and regional information.

2.3 Reporting

The methods employed by IEC personnel in the gathering of field data, and the results obtained, are presented in the body of the report. All data sources used for the preparation of this report have been referenced.

3.0 MINING PLAN SUMMARY

3.1 Objective

A presentation overview to define the major components and overall scope of a project involving the production, processing, transportation, terminalling and marketing of one million tons (.9 million tonnes) of thermal and metallurgical coal annually from the Peace River Canyon area of British Columbia.

Specifically

a) To prepare a historical statement of coal development in the area;
b) to identify the status of the Peace River Canyon property; and
c) to define the system and its developmental components.

3.2 Glossary of Terms

Adit

A mine tunnel driven into a coal seam from the surface.

Coal, Coking

A particular type of coal used to produce metallurgical coke for use in blast furnaces.

Coal, Surface

Coal which can be mined by stripping off overburden to expose the seam for subsequent loading by earth moving equipment. The thickness of overburden is generally less than ten times the seam height.

Free Swelling Index (F.S.I.)

A measure of the coking properties of the coal. Range is 0 to 9. Coals having an F.S.I. over 4 are considered to be of coking quality.

Gething Formation

A geological term describing the strata containing the described seams.

(upper) The Upper section of the Gething Formation containing the Superior and Trojan coal seams.

(middle) The Middle section of the Gething Formation containing the Titan, Falls, Gething and Mogul coal seams.

(lower) The Lower section of the Gething Formation containing the "M-48" and Grant-King coal seams.

Reserves-Measured

Coals for which the points of observation and measurement quantity is judged to be within 20 percent of the true quantity.

Resources-Indicated

Coal for which the in-place quantity is computed partly from specific measurements and partly from projection over a reasonable distance on the basis of direct geological evidence.

Resources-Inferred

Coal for which in-place estimates of quantity are based on a broad knowledge of the geological character of the coal bed of the region for which few measurements of coal thickness are available.

3.3 Project Summary

3.3.1 Developmental Concept

To produce coal from surface operations on property held as Licenses and Crown Grants (freehold).

to truck clean coal from the process plant located on the property to the British Columbia Railway system at Chetwynd;

to transport (via rail) processed coal to a tidewater terminal, i.e. Vancouver, initially, or equivalent; and

to market the coal, F.O.B. Vancouver or equivalent, to such potential export customers as Japan, Europe, Korea, Brazil, Mexico and perhaps eventually Eastern Canada.

3.3.2 Production Concept

Production in tonnes per annum:

Marketable Coal	453,595 tonnes	(500,000 tons)	Stage I:	surface mine
	907,190 tonnes	(1,000,000 tons)	Stage II:	surface mine

3.4 Historical Background

3.4.1 The Peace River Canyon Area

The coal along the banks of the Peace River in northeastern British Columbia is believed to have been the first coal discovered in Western Canada. In 1793, during his history-making overland trip to the Pacific Ocean, Sir Alexander MacKenzie noted the presence of exposed coal seams in the Peace River Canyon.

Among those most persistent in their efforts to mine coal from this region was the Gething family of Fraser Lake and Hudson Hope, B.C. and their name has been given to the extensive coal formation. Recent exploration has discovered that the Gething Formation is an enormous block of large coal potential some 56 km (35 mi) wide and running 322 km (200 mi) north from the Sukunka River to the Sikanni Chief River. The center of this block is approximately 145 km (90 mi) southwest of Fort St. John.

Coal mining in the Canyon, which cuts at right angles across the Gething Formation some 80 km (50 mi) away from its southern boundary, dates back to 1923. At one time or another, production came from five mines located on or adjacent to the property now held by Cinnabar. Although this initial mining phase lasted more than 40 years, production was carried out on a small scale. Throughout the entire period, less than 55,000 tonnes (60,000 tons) of coal was produced and half of this production came from the Gething No.3 Mine.

The Gething family mined coal from the property until 1947, but with railways switching to diesel fuel from coal there was no longer a ready market and the mine was closed.

In 1969, Cinnabar began a coal land acquisition with an option to purchase agreement of Crown granted freehold lands of 648 ha (1600 acres) owned by the Gething-Green estate. (The Land Exchange Act, Chapter 60 R.S.B.C. 1967). This option was exercised in 1979 with the said coal rights of the freehold lands now wholly owned by Cinnabar.

In addition to the freehold lands, Cinnabar applied to the B.C. government and received coal removal licences covering approximately 8,094 ha (20,000 acres) surrounding the freehold holdings.

Since that time the company has carried out a detailed exploration program on the property culminating in a development drilling program completed in 1980.

3.4.2 Status of Coal Mining Properties

The Peace River Canyon Coal property consists of 7,874 ha (19,456 acres) of B.C. coal licences in the area on the Coal Titles Reference Map described by the licence numbers 3407 through 3444 inclusive, approximately nineteen road miles southwest of the town of Hudson Hope. The coal property also includes 648 ha (1,600 acres) of freehold lands in the Peace River Land District described as follows:

North West Quarter of District Lot 1039
South Half of District Lot 1050
Fractional West Half of District Lot 1054
District Lot 276
District Lot 1055

The licences and freehold encompass land on both sides of the Peace River Canyon, a few miles downstream from the British Columbia Hydro and Power Authority W.A.C. Bennett Dam Figure 3-4-2A.

3.5 Developmental Program

3.5.1 General

From Hudson Hope, Cinnabar properties north of the Peace River can be reached via 8 km (5 mi) of unimproved roads running south-west from a point approximately 8 km (5 mi) north of Hudson Hope on the all-weather paved road to the Bennett Dam. Access to the larger portion of the property south of the Peace River is located eleven miles from Hudson Hope on the British Columbia Highway to Chetwynd via 18 km (8 mi) of well-maintained gravelled open access logging road. The logging road continues west across the property. Other connecting secondary roads provide access to the other parts of the property.

The town of Chetwynd which is serviced by British Columbia Railway, is located 47 km (29 mi) south-east of the logging access road to the property via the British Columbia highway between Hudson Hope and Chetwynd.

Fort St. John, one of the larger towns in the north-east is located 97 km (60 mi) by road north of Hudson Hope and 121 km (75 mi) from the proposed project. Fort St. John is served both by regularly scheduled airline flights from Vancouver and Edmonton, and by British Columbia Rail.

The property is crossed by electric power transmission lines running southeast from the Bennett Dam and southwest from the Site 1 Dam. A natural gas pipeline also crosses the property (Figure 3.5.1.A).

Much of the normal forest cover was burned and is now covered with a second growth stand of poplar, pine, and spruce, portions of which have been logged.

The canyon of the Peace River which crosses the property west to east is approximately 305 m (1,000 ft) deep. The summit of Portage Mountain which is adjacent to Cinnabar properties north of the river, rises 914 m (3,000 ft) above the canyon floor. Mount Johnson on the south side of the river rises about 468 m (1,600 ft). The remaining portion of the property drains through a tributary of creeks to the Peace River.

Coal and formation outcrops are generally scarce except for exposures in the Peace River Canyon and beds of tributary streams.

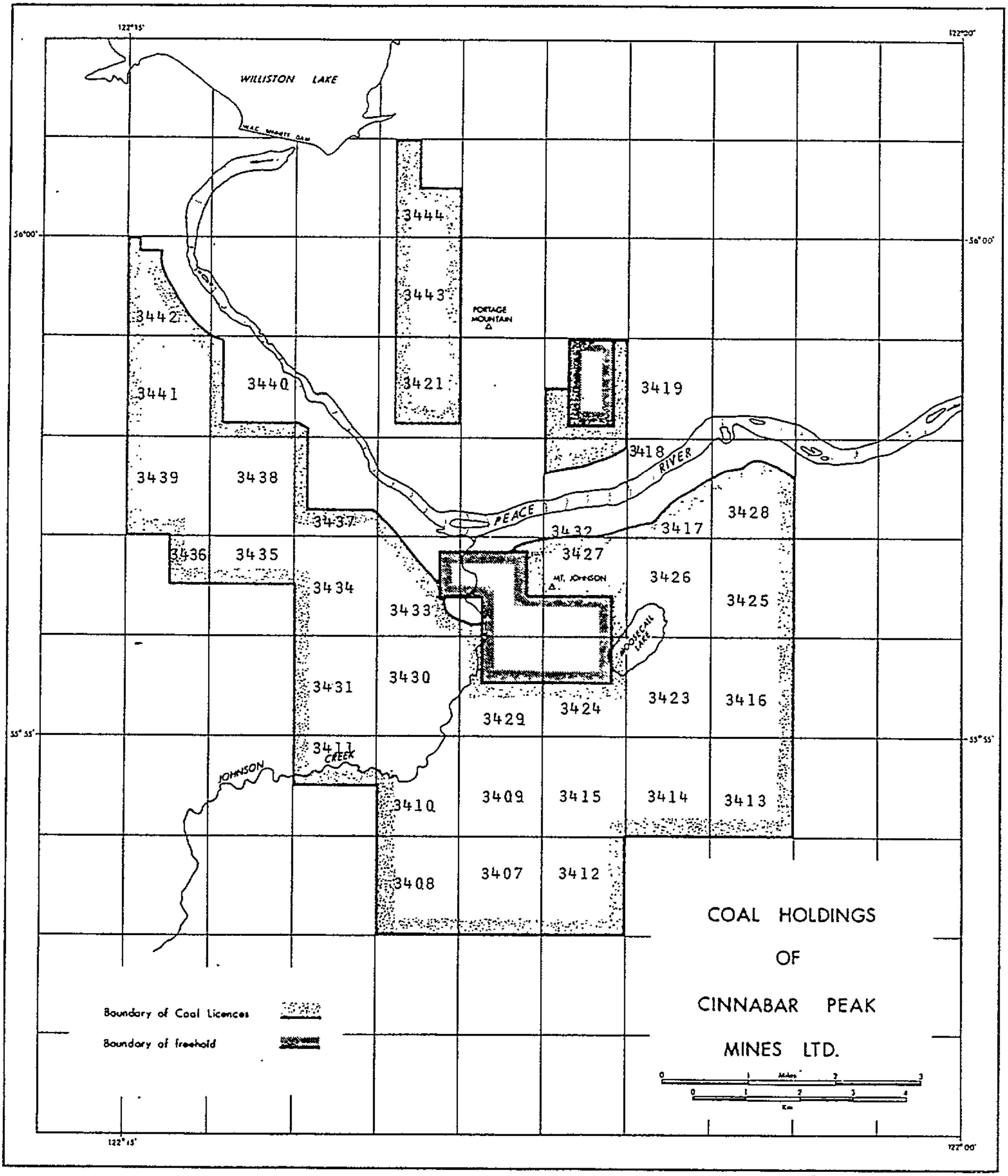
3.5.2 Geology

The geologic structures south of the Peace River, which cover the mining areas of immediate interest, consist of three northerly trending bands. The central band is the most disturbed. It is about 2.4 km (1.5 mi) wide, and crosses Portage Mountain, Grant Knob, and part of Mount Johnson. The western border of the central structural band is gradational with westerly dips steepening from 15 degrees or less to as much as 20 degrees. Farther east, the dips decrease toward the axis of the southerly extension of the Butler Anticline. The eastern structural band is up to 4.8 km (3 mi)wide on the properties of Cinnabar. South of the Peace River, the strike is also northerly, but most of the dips are in the range of 5^{o} to 20^{o} east. Overburden and Moosecall Lake obscure the structure of most of the Gething and Moosebar formations south of the Peace River away from the canyon. (Figures 3-5-2A; 3-5-2B; 3-5-2C).

Dips of both east and west structures are conducive to the use of the continuous mining system. A parallel westerly dipping thrust fault appears to occur to the east of the anticlinal axis which has a displacement of 62.5 m (250 ft). While this is a barrier to eastern development of underground mining programs there is at least 55 million tonnes (60.6 million tons) measured and indicated in the Trojan, Titan, Falls and Mogul seams to the west of this fault which can be mined in the proposed mine sites in surface and underground modes.

Trojan and Superior seams are located in the upper Gething Formation.

Coal seams of the middle and lower Gething formation outcrop on the flanks of Portage and Johnson Mountains. Seams, amenable to economic surface mining methods include



3093.1

FIG. 3-4-2A

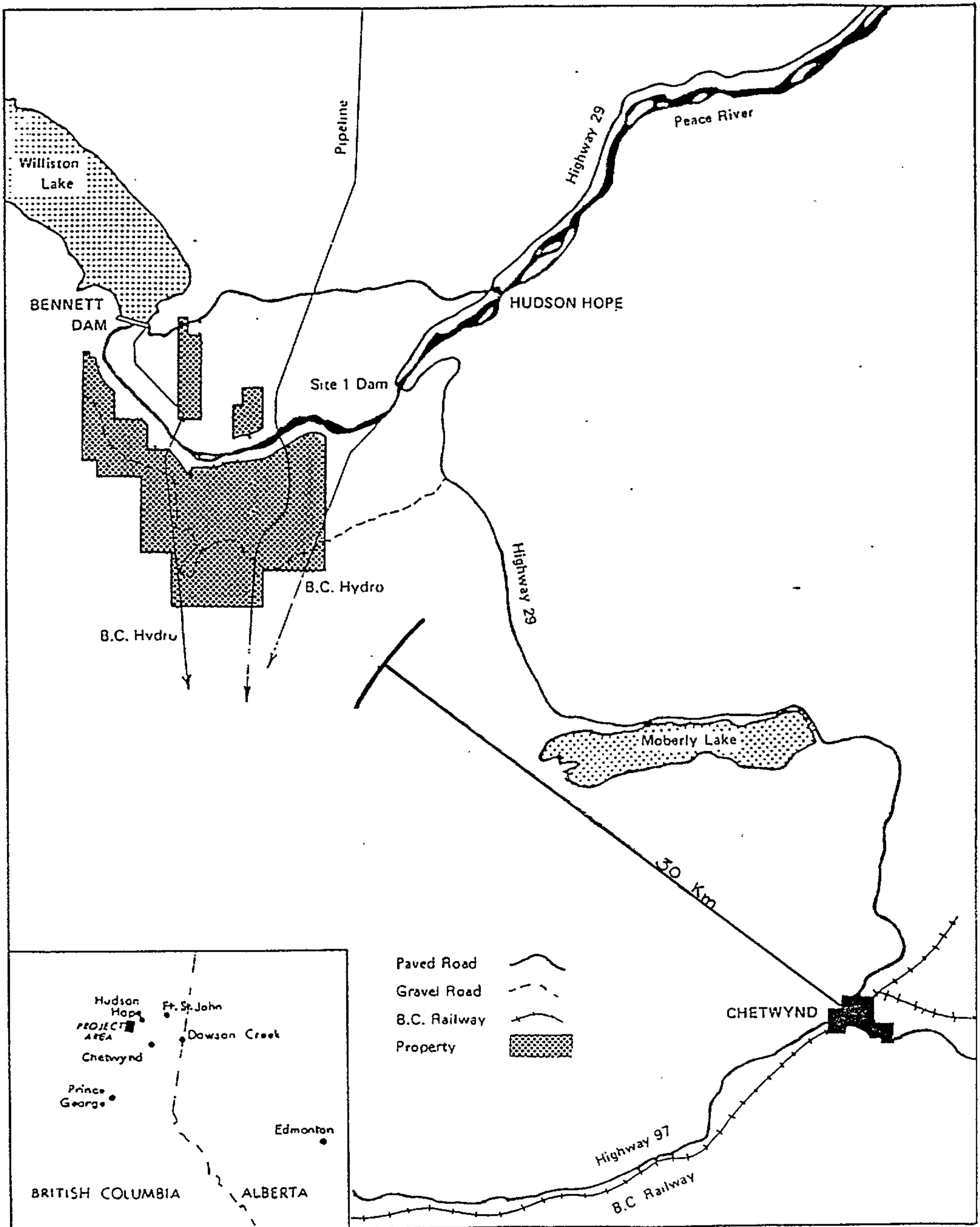


FIG. 3-5-1A
INDEX MAP

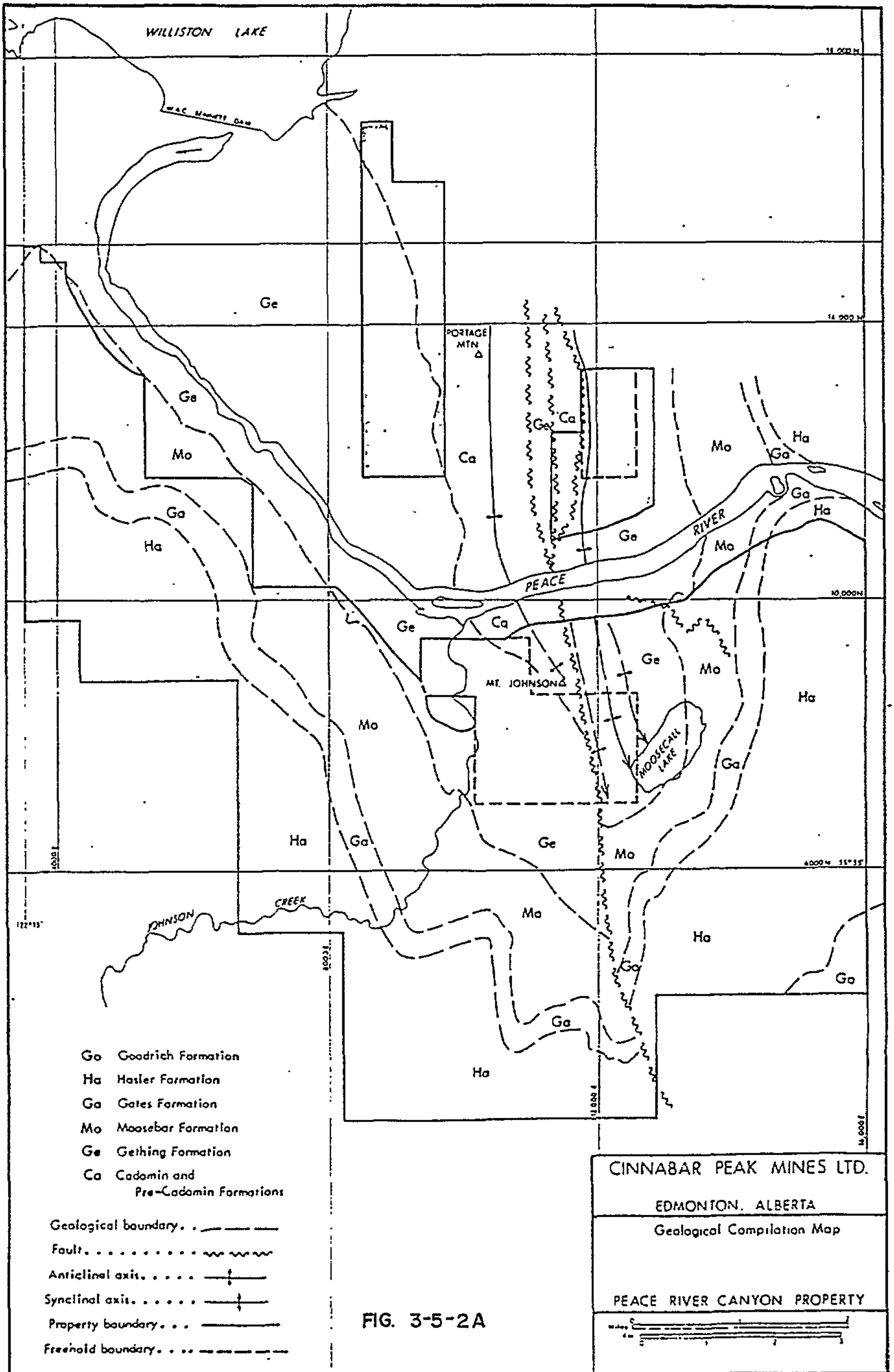
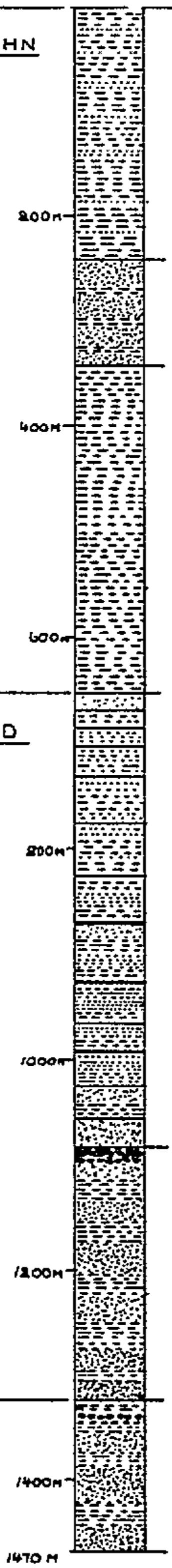


FIG. 3-5-2A

3093.1

LOWER CRETACEOUS FORMATIONS

GROUP	FORMATION AND LITHOLOGY
FORT ST. JOHN	**HASLER FORMATION** MARINE SHALES WITH THIN SANDSTONE LENSES THICKNESS: 215M – 260M
	GATES FORMATION MASSIVE SANDSTONE WITH INTERBEDDED MUDSTONE THICKNESS: 70M – 130M.
	MOOSEBAR FORMATION DARK MARINE MUDSTONE WITH THIN IRONSTONE BANDS THICKNESS: 290 M – 330M.
BULLHEAD	**GETHING FORMATION** NON – MARINE SANDSTONE AND SHALE WITH COAL SEAMS THICKNESS: 500M – 560M
	CADOMIN FORMATION NON – MARINE CONGLOMERATE SANDSTONE AND SHALE WITH THIN COAL SEAMS THICKNESS: 105M – 170M
MINNES	**BRENOT FORMATION** NON – MARINE SANDSTONE AND SHALE WITH THIN COAL SEAMS THICKNESS: 148 M.
	BEATTIE PEAKS FORMATION



AT PEACE RIVER CANYON

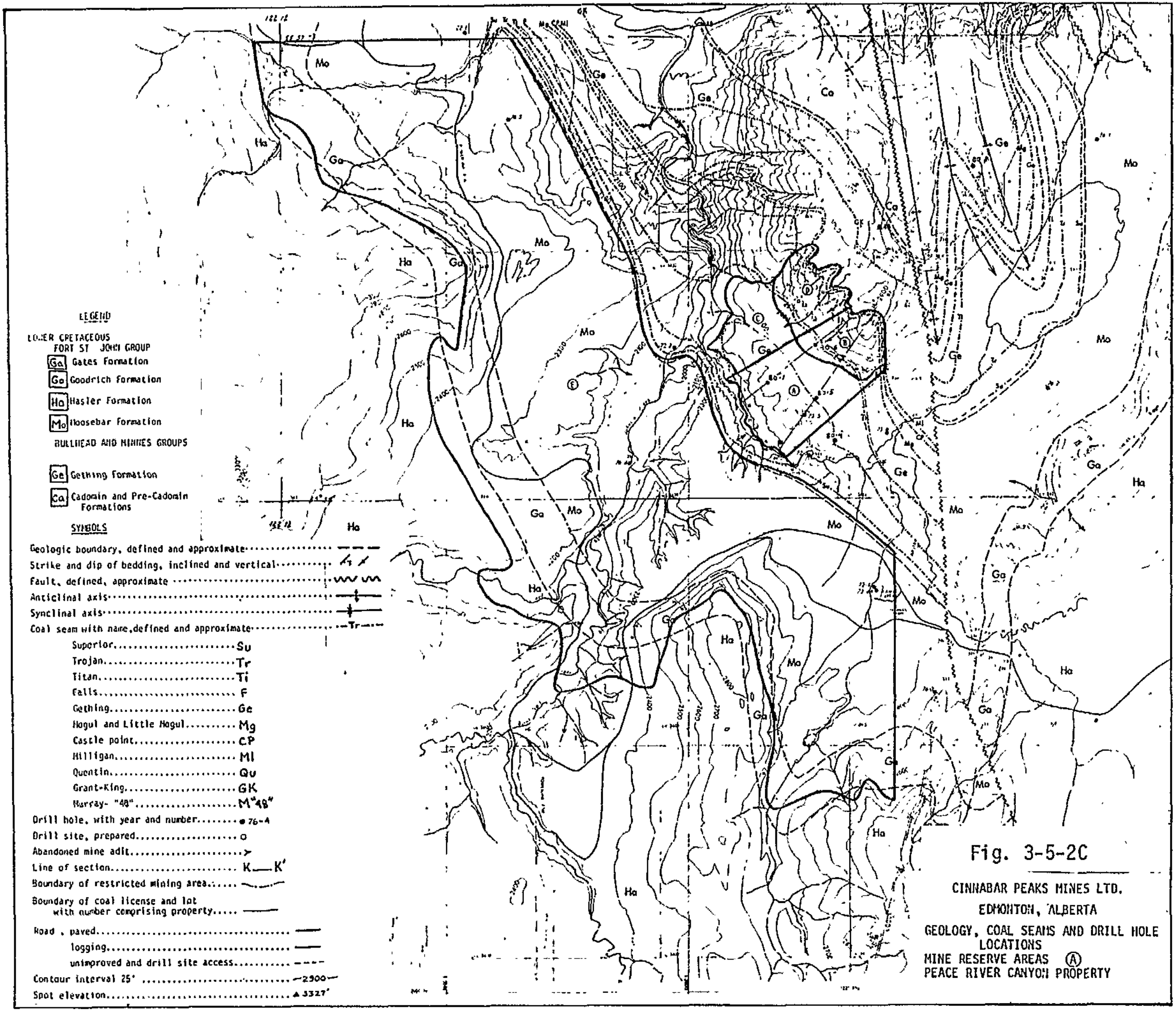
100M 0 100M. 200M

CINNABAR PEAK MINES LTD.

EDMONTON ALBERTA

GEOLOGIC COLUMN, GENERALISED
PEACE RIVER CANYON PROPERTY

SCALE	1 : 3000
DATE	18 SEPT 1981
DRAWN BY	P.J.A.
DRAWING #	3-5-28


LEGEND
LOWER CRETACEOUS
FORT ST JOHN GROUP
Ga Gates Formation
Go Goodrich Formation
Ha Hasler Formation
Mo Moosebar Formation
BULLHEAD AND MINNES GROUPS
Ge Gething Formation
Ca Cadomin and Pre-Cadomin Formations
SYMBOLS
Geologic boundary, defined and approximate
Strike and dip of bedding, inclined and vertical
Fault, defined, approximate
Anticlinal axis
Synclinal axis
Coal seam with name, defined and approximate
Superior.......Su
Trojan.......Tr
Titan.......Ti
Falls.......F
Gething.......Ge
Hogul and Little Hogul.......Mg
Castle point.......CP
Milligan.......Ml
Quentin.......Qu
Grant-King.......GK
Murray- "48".......M"48"
Drill hole, with year and number.......76-4
Drill site, prepared
Abandoned mine adit
Line of section.......K—K'
Boundary of restricted mining area
Boundary of coal license and lot with number comprising property
Road , paved
logging
unimproved and drill site access
Contour interval 25'.......2500
Spot elevation.......3327'
Mo
Ha
Ga
Go
Ge
Ca
Ho
Fig. 3-5-2C
CINNABAR PEAKS MINES LTD.
EDMONTON, ALBERTA
GEOLOGY, COAL SEAMS AND DRILL HOLE LOCATIONS
MINE RESERVE AREAS (A)
PEACE RIVER CANYON PROPERTY

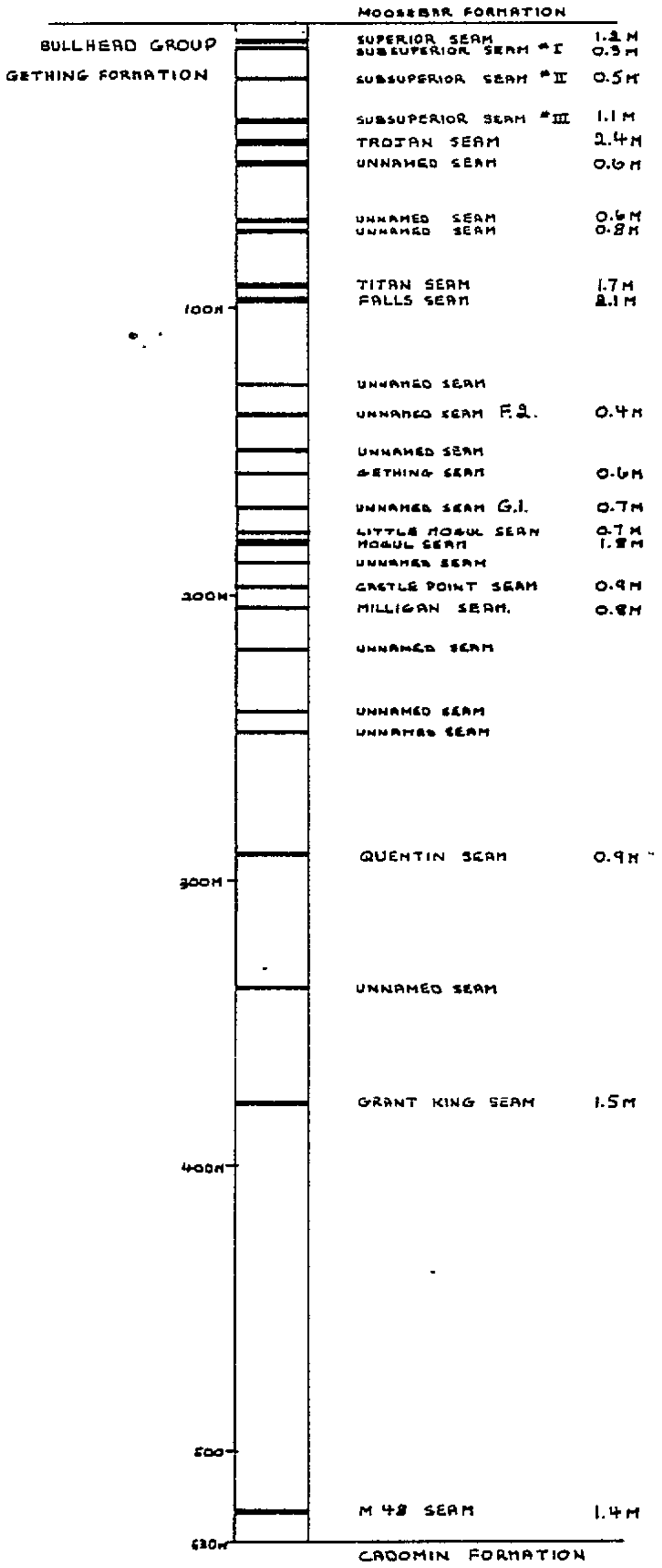
the Trojan, Titan, Falls, Gething, Mogul, Grant-King and Murray - "48". Coal from these seams with their low ash, low sulphur and high B.T.U. content is suitable for a variety of end uses, particularly thermal and/or liquification processes Figure 3-5-2 D.

3.5.3 Exploration

Cinnabar began investigations of its Peace River properties in 1969 shortly after acquisition. Work included geological mapping, sampling of seam outcrops, trenching and drilling of exploratory boreholes. Work was continued in 1971, 1972, 1973, and 1976 from which comprehensive geological reports were prepared. Exploratory holes were drilled between 1969 and 1973, which indicated extensive reserves of metallurgical and thermal quality coal. Additional holes were drilled in 1976 which further confirmed the previous findings. Extensive geophysical work integrated with existing data was conducted in 1979 to provide for drilling and mine planning on the property.

Continuation of the exploration and development drilling, geophysical integration, and mine planning was continued in 1980.

The 1980 program included reserve delineation drilling on the west side of Mount Johnson for planning of the first surface mining and first underground mining units. Additional reconnaissance work to investigate other surface and sub-surface mining target areas were undertaken in the east central and eastern portions of the Mount Johnson area.



CINNABAR PEAK MINES LTD.

EDMONTON ALBERTA

IDEALIZED STRATIGRAPHIC SECTION
GETHING FORMATION — COAL SEAMS
PEACE RIVER CANYON PROPERTY

SCALE	1:1250
DATE	18 SEPT 1981
DRAWN BY	P.T.A.
DRAWING #	3-5-2D

3.5.4 Surface Mining Reserves

Coal reserve delineation completed in 1980 has outlined a surface mining operation with sufficient reserves to support a 907,190 tonnes (1,000,000 ton)per year operation for fifteen plus years as follows:

SURFACE	SEAMS	THICKNESS	HA (ACRES)	RESERVES	
Mining Unit 1	Upper To Middle Gething	12+ m(total)	142	13,607,850	tonnes measured
		(40+ ft)	(350)	(15,000,000	tons measured)
				6,350,330	tonnes indicated
				(7,000,000	tons) indicated
			TOTAL	19,958,180	tonnes
				(22,000,000	tons)

The prospects of additional reserves for surface mining east and west of Portage Mountain are indicated. Other additional reserves east and south-east of the major northerly-trending fault area are present, but data on them are insufficient to estimate recoverable tonnages.

3.5.5 Reserve Areas and Calculation Methodology

3.5.5.1 Reserve Areas

The areas under investigation have been divided into five (5) distinct sections to allow full use of available information and the geological settings.

These areas are shown in Figure 3-5-5 A. Those areas to the east of Coalbed Creek are designated as suitable for open pit mining.

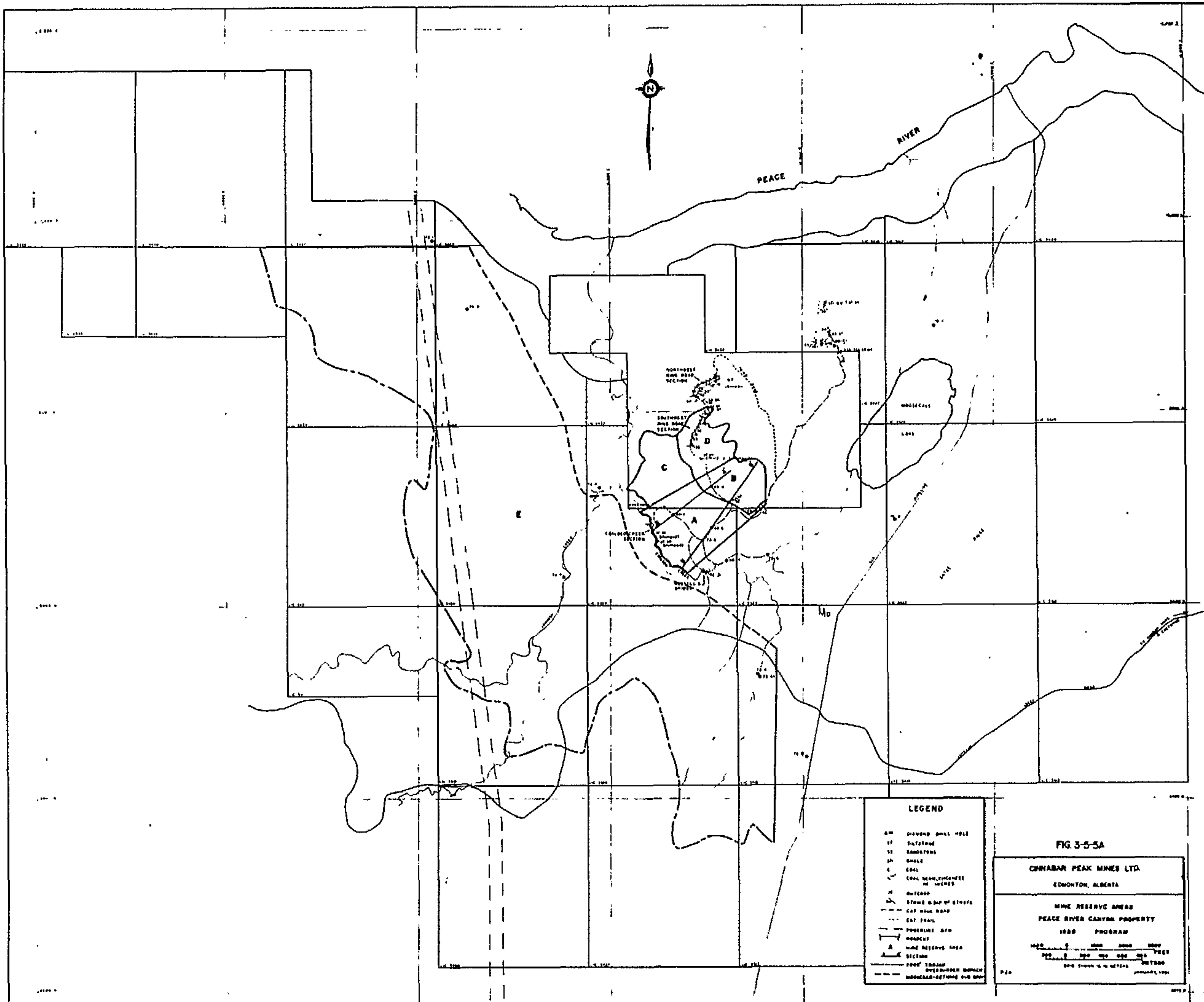
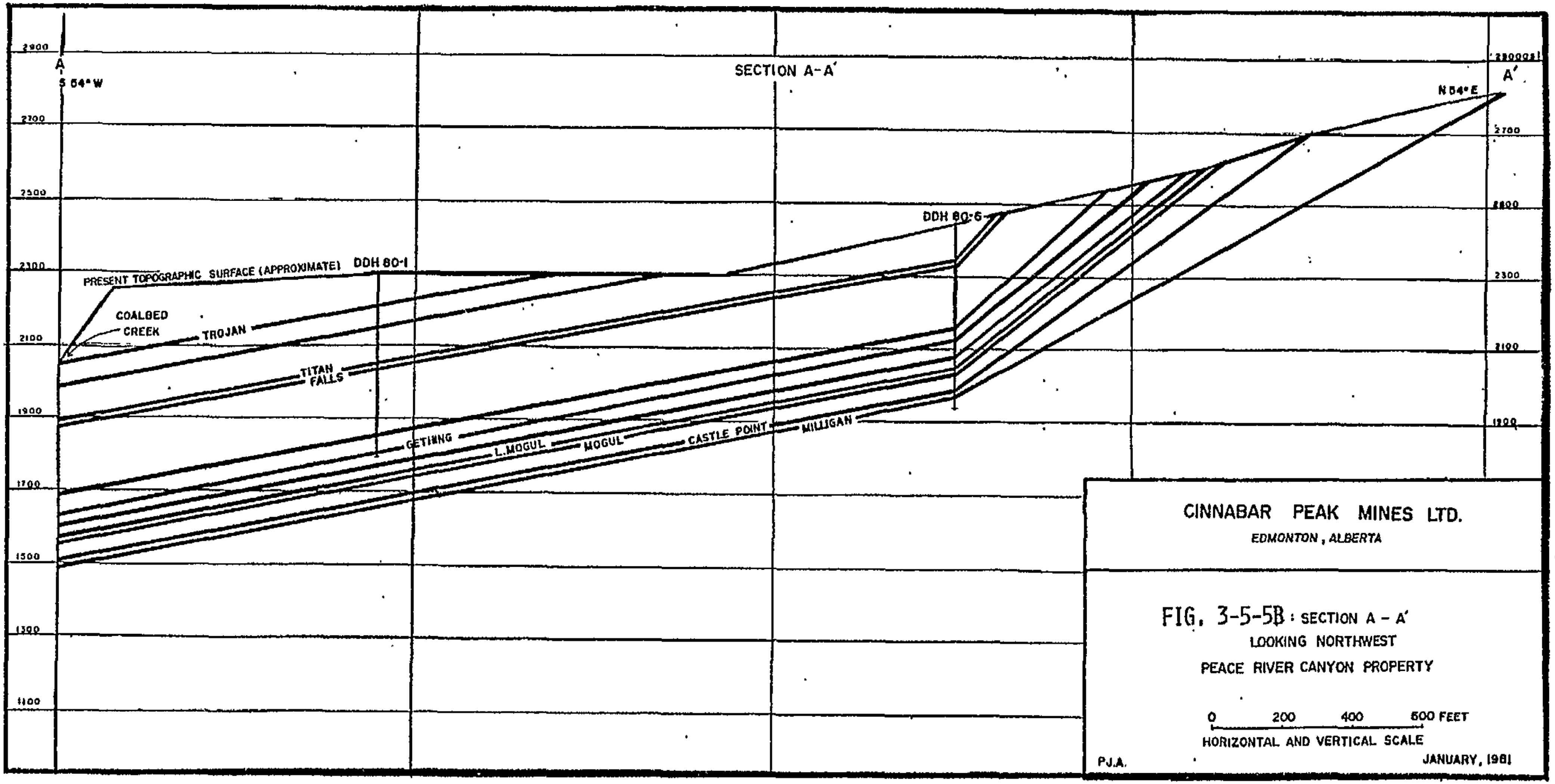

N
PEACE
RIVER
A
B
C
D
E
LEGEND
CINNABAR PEAK MINES LTD.
EDMONTON, ALBERTA
MINE RESERVE AREAS
PEACE RIVER CANYON PROPERTY
PROGRAM
FEET

FIG. 3-5-5A



CINNABAR PEAK MINES LTD.

EDMONTON, ALBERTA

FIG. 3-5-5B : SECTION A – A'

LOOKING NORTHWEST

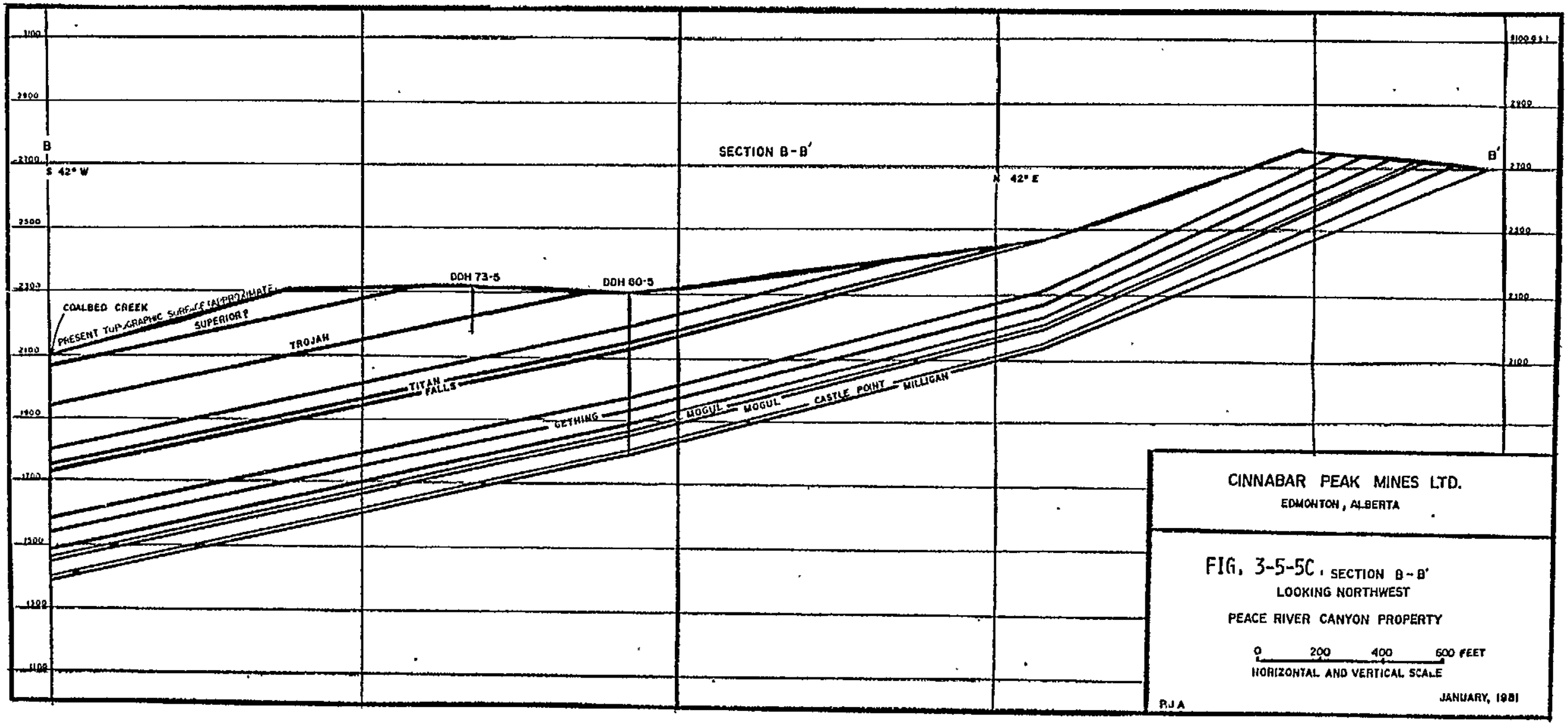
PEACE RIVER CANYON PROPERTY

0 200 400 600 FEET

HORIZONTAL AND VERTICAL SCALE

P.J.A.

JANUARY, 1981



CINNABAR PEAK MINES LTD.
EDMONTON, ALBERTA

FIG. 3-5-5C. SECTION B-B'
LOOKING NORTHWEST
PEACE RIVER CANYON PROPERTY

0 200 400 600 FEET
HORIZONTAL AND VERTICAL SCALE

RJA JANUARY, 1981

The measured areas are:

A	58 hectares	(144 acres)
B	27 hectares	(66 acres)
C	30 hectares	(74 acres)
D	25 hectares	(62 acres)
E	1300 hectares	(3215 acres)

Total for open pit - 140 hectares (346 acres)

3.5.5.2 Calculation Methods

Determination of the reserves in Area "A" is based on four 1980 diamond drill holes (80-1, 80-3, 80-5, 80-6) and one 1973 D.D.H. (73-5). Three other D.D.H. (73-6, 72-3, and 80-4) near the area were used as secondary controls.

Cross sections were constructed between all holes to test seam continuity and identification (Figures 3-5-5-B and 3-5-5-C). The positions of the lower seams not encountered in 80-1, 73-5 and 80-5 were projected onto the cross sections from 80-6 and 80-3 data.

The major seams in the area: Trojan, Titan, Falls, Gething, Little Mogul, Mogul, Castle Point and Milligan, are all identifiable, but significant thicknesses of coal are found between the Trojan and Titan, between the Falls and Gething, and between the Gething and Little Mogul. The positions of these unnamed seams are variable, and the thickness of each one also varies. To allow evaluation of these thin, but mineable lenses, they are combined together in the calculations into a composite seam, the position of which reflects the maximum individual lense depth. Figure 3-5-2 C.

The cross sections have been used to calculate the waste quantities between the upper seams and the surface and between each individual seam or composite seam.

Coal quantities were calculated by obtaining average seam thickness from the drill hole logs and multiplying by the area of the seam. The Trojan seam does not cover the whole area, as it subcrops northeast of the line 80-1 to 73-5, the Titan and Falls seams are absent in a small area in the east.

A confidence factor was established for Area "A" by using geophysical data to compare with the 80-1 to 80-6 cross section. Almost total agreement exists with calculated dips. The average direction of full dip is 52^{o}W with a value of 12^{o} (21 percent). D.D.H. locations and collar elevations are only approximate at this time, and more precise values will be calculated with survey results.

The Titan-Falls sequence was established as a reliable datum for the projecting of the lower seams onto the 80-1 to 80-6 cross section.

Observed seam sections were not corrected for dip, nor were the areas corrected for dip. These errors cancelled each other out.

Calculations for Area "B" are complicated by the increasing upward dip of the coal measured towards the northeast. Measured dips at the outcrop areas indicate dips of up to 45^{o}.

To allow for this change in inclination, cross sections were drawn showing a gradual increase in dip, and waste areas between seams and the upper seam and the surface measured by planimetering between each 30.48 m (100 ft) increase in elevation.

Plan areas of each seam were also measured which followed the calculation of individual seam quantities and the stripping ratios for every 30.48 m (100 ft) increase in elevation. Composite stripping ratios could then be calculated.

This methodology while accurate within reasonable limits, was deemed to be the appropriate way to establish coal and waste quantities. Additional sub-surface control will improve the accuracy as required.

Areas "C" and "D" are the northwest extensions of Areas "A" and "B" respectively. The geological sequence established for Areas "A" and "B" was projected into these areas, and calculations made on available data. The boundaries, except for the northeast outcrops, are quite arbitrary. The apparent consistency of Area "A" gives validity to this method.

Reserve Area "E" has five (5) D.D. holes within its boundaries (72-1, 76-5, 76-4, 72-2 and 73-4A). D.D.H. 80-1 was used to establish strike lines together with 73-4A and 76-5. The geophysical data along the gravel access road crossing Area "E", provided dip values in the Burnt Trail Creek area, and D.D.H. 76-4 provided information as to the dips encountered there.

Calculations showed that a disturbance occurs running N40^{o}W slightly to the southwest of D.D.H. 73-4A, and is confirmed by the geophysical data. This disturbance could be a fault with a calculated displacement of about 182 m (600 ft) southwest. The effect of this fault on the reserves of Area "E" is minimal at this stage.

The only mineable seam in the area which has been intersected in all drill holes is the Trojan. The Superior seam is very thin and therefore is not evaluated. The Titan and Falls seams are present but not enough intersections have occurred in the drill holes to allow evaluation. It would appear at this stage that they are both too thin for economic underground mining.

3.5.5.3 Coal Quality

Previous work in the areas, including analysis of D.D.H. hole samples, has given a reliable basis for further evaluation. Analysis of the lower seams in Area "A" was not available, but indications from samples in other areas such as D.D.H. 76-5 suggest that ash content, calorific values, and fixed carbon percentage would indicate high quality coal, but with F.S.I. lower than that of the Trojan seam. Table 3.5.5.3 A.

Some of the thinner coals between the identified seams have been sampled for analysis, as all mineable coal will be retrieved, and if suitable, blended with the major seams in the area.

It is noted that the characteristics of a blend of two or more coal seams is not necessarily equivalent to a weighted average of the characteristics of the component coals. Average clean coal qualities and related analytical data are provided in Tables 3.5.5.3 B; 3.5.5.3 C, and 3.5.5.3 D.

TABLE 3.5.5.3 A

Proximate Analysis - Raw Coal
Air Dried

PROXIMATE ANALYSIS - RAW COAL
AIR DRIED

SEAM	H_2O%	VOLATILE MATTER %	ASH %	FIXED CARBON %	S %	CALORIFIC VALUE KCAL/Kgm	F.S.I.	S.G.
SUPERIOR	0.73	27.90	16.32	55.05	0.64	6963	5½-9	-
TROJAN	0.93	25.65	11.75	61.67	0.53	7269	2½-6½	1.42
TITAN	1.07	23.46	13.24	62.23	0.80	7224	2-7½	1.37
FALLS	0.93	24.95	13.08	61.04	0.58	7051	3½-5½	1.39
GETHING	0.66	22.38	15.25	61.71	1.10	7000	1½-6½	1.41
LITTLE MOGUL	0.84	21.67	9.73	67.76	0.82	7544	1½-2½	1.36
MOGUL	0.78	25.43	13.96	59.83	0.74	6801	1½-2	1.43
CASTLE POINT	0.81	23.19	10.70	65.29	0.82	7284	1½-2	-
MILLIGAN	0.96	15.75	28.93	54.36	0.76	5897	1½	-
M 48	1.13	16.55	10.01	72.31	0.46	7448	0	1.38

TABLE 3.5.5.3 A

TABLE 3.5.5.3 B

Proximate Analysis - Clean Coal

SEAM	H_2O%	VOLATILE MATTER %	ASH %	FIXED CARBON %	S %	CALORIFIC VALUE K_{CAL}/K_{gm}	ASH FUSION TEMP.	HARDGROVE GRINDABILITY INDEX
TROJAN	1.34	23.52	9.65	65.49	0.56	7444	1354°C	61
TITAN	1.21	23.68	7.76	67.45	0.73	7722	1440°C	66
FALLS	1.20	25.41	4.65	68.74	0.61	7947	1174°C	65
GETHING	0.98	22.63	4.92	71.47	0.83	7968	1173°C	63
LITTLE MOGUL	1.04	22.21	5.39	71.36	0.76	7943	1111°C	64
MOGUL	0.99	21.84	4.65	72.52	0.78	7977	1130°C	65
AVE TROJAN TO MOGUL	1.12	23.21	6.17	69.50	0.71	7833	1177°C	64
NOTE: AT 1.45 S.G. AVERAGE YIELD = 78.68% FOR + #28 MESH								
CLEAN COAL (WEIGHTED AVERAGE)	1.17	23.48	6.58	68.78	0.68	7782	1255°C	64

NOTE: WEIGHTED YIELD AT 1.45 S.G. = 77.2% FOR + #28 MESH

TABLE 3.5.5.3 C

ASH CHEMISTRY

SEAM	SiO_2	Al_2O_3	TiO_2	Fe_2O_3	CaO	MgO	Na_2O	K_2O	P_2O_5	SO_3	UNDETERMINED
TROJAN	57.02	24.17	0.49	9.20	1.43	0.54	0.60	0.49	2.71	1.49	- 1.86
TITAN	49.93	30.54	0.74	7.31	1.61	1.08	1.52	0.67	3.28	1.64	- 1.68
FALLS	37.47	19.24	0.73	18.88	7.08	1.93	1.39	0.35	2.76	7.95	- 2.22
GETHING	46.96	16.88	0.71	10.15	13.99	0.99	1.46	0.52	0.28	6.04	- 2.02
LITTLE MOGUL	53.24	13.29	0.71	19.16	3.22	1.24	0.86	0.66	1.11	4.36	- 2.15
MOGUL	24.90	10.64	0.20	24.31	11.89	6.13	1.24	0.30	1.41	16.97	- 1.01
NON-WEIGHTED AVERAGE	44.92	19.29	0.60	14.84	6.54	1.98	1.18	0.50	1.92	6.41	- 1.82

TABLE 3.5.5.3 D

ULTIMATE ANALYSIS

SEAM	H_2O %	C %	H %	N %	ASH %	S %	O % (DIFF)
TROJAN	1.34	76.33	4.67	1.21	9.65	0.56	6.24
TITAN	1.21	78.90	5.05	1.15	7.66	0.73	5.30
FALLS	1.20	81.75	4.80	1.28	4.65	0.61	5.71
GETHING	0.98	82.91	4.55	1.04	4.92	0.83	4.77
LITTLE MOGUL	1.04	82.15	4.57	1.01	5.39	0.76	5.08
MOGUL	0.99	82.83	4.47	1.01	4.65	0.78	5.27

NOTE: HYDROGEN VALUE INCLUDES HYDROGEN FROM H_2O

TABLE 3.5.5.3 D

3.5.6 Mine Reserves

The surface mine reserve calculations are tabulated for Areas A, B, C, and D as measured and indicated reserves; and include stripping ratios and recovery data. (Tables 3.5.6.1 A to 3.5.6.1 B).

TABLE 3.5.6.1 A

Measured Reserves for Surface Mining

Area "A"

	Thickness in Inches	Area in Millions Ft.^{2}	Tonnage Thousands of (short tons)
Trojan	96	3.6	1,220
Seams between Trojan and Titan	60	4.9	1,040
Titan	66	6.2	1,450
Falls	82	6.2	1,800
Seams between Gething and Falls	42	6.2	0.920
Gething	25	6.2	0.550
Seams between Gething and Little Mogul	45	6.2	0.980
Little Mogul	27	6.2	0.590
Mogul	72	6.2	1,580
Castle Point	36	6.2	0.790
Milligan	33	6.2	0.720

TOTAL TONNAGE = 11.64 Million Short Tons
*Units in table are English measurements, for conversion factors see Table 3.5.6.1 A

TABLE 3.5.6.1 B

Area "B"

Seam Name	Thickness in Inches	Tonnage Thousands of short tons
Titan	62	90
Falls	84	120
Seams between Falls and Gething	42	150
Gething	30	200
Seams between Gething and Little Mogul	45	370
Little Mogul	27	240
Mogul	72	650
Castle Point	36	360
Milligan	33	340

TOTAL TONNAGE = 2.52 Million Short Tons

*Units in table are English measurements, for conversion factors see Table 3.5.6.1 H

TABLE 3.5.6.1 C

Indicated Reserves for Surface Mining

Area "C"

	Thickness in Inches	Area in Millions Ft.^{2}	Tonnage Thousands of (short tons)
Trojan	96	1.04	350
Seams between Trojan and Titan	44	2.45	370
Titan	60	3.25	690
Falls	82	3.25	940
Seams between Gething and Falls	42	3.25	480
Gething	25	3.25	280
Seams between Gething and Little Mogul	45	3.25	510
Little Mogul	27	3.25	300
Mogul	72	3.25	820
Castle Point	36	3.25	410
Milligan	33	3.25	370

TOTAL TONNAGE = 5.52 Million Short Tons

*Units in table are English measurements, for conversion factors see Table 3.5.6.1 H

TABLE 3.5.6.1 D

Area "D"

Seam Name	Thickness in Inches	Tonnage Thousands of short tons
Titan	62	70
Falls	84	90
Seams between Falls and Gething	42	1600
Gething	30	150
Seams between Gething and Little Mogul	45	280
Little Mogul	27	200
Mogul	72	520
Castle Point	36	340
Milligan	33	320

TOTAL TONNAGE = 2.13 Million Short Tons

*Units in table are English measurements, for conversion factors see Table 3.5.6.1 H

TABLE 3.5.6.1 E

Stripping Ratios and Composite Ratios for Surface Mining Areas

AREA "A"

Seam Name	Seam Thickness in Inches	Overburden Thickness in Feet	Tons of Coal	Total Tons of Coal	Individual Stripping Ratio	Composite Stripping Ratio	Overburden YDS^3	Total O/B YDS^3
Trojan	96	100	1,220,000	1,220,000	12.5	13.2	12,688,000	25,978,0
Seams between Trojan and Titan	60	70	1,040,000	2,260,000	14.0	13.2	12,688,000	25,978,0
Titan	66	85	1,450,000	3,710,000	15.5	14.1	19,586,000	45,564,0
Falls	82	11	1,800,000	5,510,000	1.6	10.0	2,510,000	48,074,0
Seams between Falls and Gething	42	170	920,000	6,430,000	48.6	15.5	38,965,000	87,039,0
Gething	25	31	550,000	6,980,000	14.9	15.5	7,142,000	94,181,0
Seams between Little Mogul and Gething	45	41	980,000	7,960,000	10.9	14.9	9,334,000	103,515,0
Little Mogul	27	20	590,000	8,550,000	8.9	14.5	4,570,000	108,085,0
Mogul	72	5	1,580,000	10,130,000	0.8	12.4	1,146,000	109,231,0
Castle Point	36	48	790,000	10,920,000	16.0	12.6	11,015,000	120,246,0
Milligan	33	20	720,000	11,650,000	7.3	12.3	4,580,000	124,826,0

Note: All Stripping Ratios are on a Volume/Volume Basis.

*Units in table are English measurements, for conversion factors see Table 3.5.6.1 H

TABLE 3.5.6.1 F

Area "B"

2400' - 2500' Elevation

Seam Name	Individual Stripping Ratio	Composite Stripping Ratio	Short Tons of Coal	Total Tons of Coal	Overburden in YDS^3	Cumulative Overburden in YDS^3
Titan	13.9	-	90,000	90,000	1,042,000	1,042,000
Falls	1.3	6.7	120,000	210,000	131,000	1,173,000
Seams between Falls and Gething	44.5	18.4	87,000	297,000	3,374,000	4,547,000
Gething	11.6	16.6	81,000	378,000	819,000	5,366,000
Seams between Gething and Little Mogul	11.2	15.3	124,000	502,000	1,191,000	6,557,000
Little Mogul	12.0	14.9	72,000	574,000	763,000	7,320,000
Mogul	1.0	11.3	195,000	769,000	170,000	7,490,000
Castle Point	15.8	12.1	95,000	864,000	1,533,000	9,023,000
Milligan	6.9	11.6	90,000	954,000	535,000	9,558,000
		11.6	954,000		9,558,000	

Area "B"

2500' - 2600'

Seam Name	Individual Stripping Ratio	Composite Stripping Ratio	Short Tons of Coal	Total Tons of Coal	Overburden in YDS^3	Cumulative Overburden in YDS^3
Above Gething	32.6	-	49,000	49,000	1,392,000	1,392,000
Gething	11.6	21.2	58,000	107,000	586,000	1,978,000
Below Gething	11.3	16.4	100,000	207,000	985,000	2,963,000
Little Mogul	11.3	16.4	100,000	207,000	985,000	2,963,000
Mogul	1.0	10.0	163,000	430,000	140,000	3,730,000
Castle Point	15.8	10.9	80,000	510,000	1,102,000	4,832,000
Milligan	6.9	10.4	74,000	584,000	439,000	5,271,000
		10.4	585,000		5,271,000	

*Units in table are English measurements, for conversion factors see Table 3.5.6.1 H

TABLE 3.5.6.1 F (continued)

Area "B"

2600' - 2700'

Seam Name	Individual Stripping Ratio	Composite Stripping Ratio	Short Tons of Coal	Total Tons of Coal	Overburden in YDS^3	Cumulative Overburden in YDS^3
Above Gething	8.5	-	14,000	14,000	111,000	111,000
Gething	10.1	9.6	33,000	47,000	299,000	410,000
Below Gething	9.7	9.7	102,000	149,000	862,000	1,272,000
Little Mogul	10.6	9.9	60,000	209,000	564,000	1,836,000
Mogul	0.6	5.9	164,000	373,000	86,000	1,922,000
Castle Point	16.0	7.7	80,000	453,000	1,143,000	3,065,000
Milligan	6.9	7.6	76,000	529,000	451,000	3,516,000
		7.6	529,000		3,516,000	

2700' - 2800'

Seam Name	Individual Stripping Ratio	Composite Stripping Ratio	Short Tons of Coal	Total Tons of Coal	Overburden in YDS^3	Cumulative Overburden in YDS^3
Gething	9.2	-	22,000	22,000	176,000	176,000
Below Gething	11.2	10.4	34,000	56,000	332,000	508,000
Little Mogul	12.0	10.9	28,000	84,000	293,000	801,000
Mogul	0.6	6.1	75,000	159,000	39,000	840,000
Castle Point	10.3	7.3	64,000	223,000	575,000	1,415,000
Milligan	6.9	7.2	58,000	281,000	349,000	1,764,000
		7.2	281,000		1,764,000	

2800' - 2900'

Seam Name	Individual Stripping Ratio	Composite Stripping Ratio	Short Tons of Coal	Total Tons of Coal	Overburden in YDS^3	Cumulative Overburden in YDS^3
Gething	7.0	-	6,000	6,000	37,000	37,000
Below Gething	11.2	9.7	10,000	16,000	98,000	135,000
Little Mogul	11.8	10.9	20,000	36,000	206,000	341,000
Mogul	0.6	4.8	53,000	89,000	28,000	369,000
Castle Point	12.0	7.0	41,000	130,000	429,000	798,000
Milligan	6.9	7.0	42,000	172,000	253,000	1,051,000
		7.0	172,000		1,051,000	

TOTALS:	Coal	- 2,520,000 Tons	Stripping Ratios	-	9.66:1 Volume/Volume Basis
	Overburden	- 21,160,000 Yds^3		or	8.42:1 Volume/S Ton of Coal Basis

*Units in table are English measurements, for conversion factors see Table 3.5.6.1.H

TABLE 3.5.6.1 G

Total Reserves

SEAM	AREA "A"	AREA "B"	AREA "C"	AREA "D"	AREA "E"	TOTALS
Trojan	1,220,000	-	350,000	-	41,600,000	43,170,000
Seams between Trojan and Titan	1,040,000	-	370,000	-	-	1,410,000
Titan	1,450,000	90,000	690,000	70,000	-	2,300,000
Falls	1,800,000	120,000	940,000	90,000	-	2,950,000
Seams between Gething and Falls	920,000	150,000	480,000	160,000	-	1,710,000
Gething	550,000	200,000	280,000	150,000	-	1,180,000
Seams between Gething and Little Mogul	980,000	370,000	510,000	280,000	-	2,140,000
Little Mogul	590,000	240,000	300,000	200,000	-	1,330,000
Mogul	1,580,000	650,000	820,000	520,000	-	3,570,000
Castle Point	790,000	360,000	410,000	340,000	-	1,900,000
Milligan	720,000	340,000	370,000	320,000	-	1,750,000
TOTALS	11,640,000	2,520,000	5,520,000	2,130,000	41,600,000	63,410,000

Reserves Suitable For Surface Mining	Measured	14,160,000 Short Tons
	Indicated	7,650,000 Short Tons
	TOTAL	21,810,000 Short Tons
Reserves Suitable For Underground Mining..	Measured	41,600,000 Short Tons
	GRAND TOTAL	63,410,000 Short Tons

*Units in table are English measurements, for conversion factors see Table 3.5.6.1 H

TABLE 3.5.6.1 H

CONVERSION FACTORS

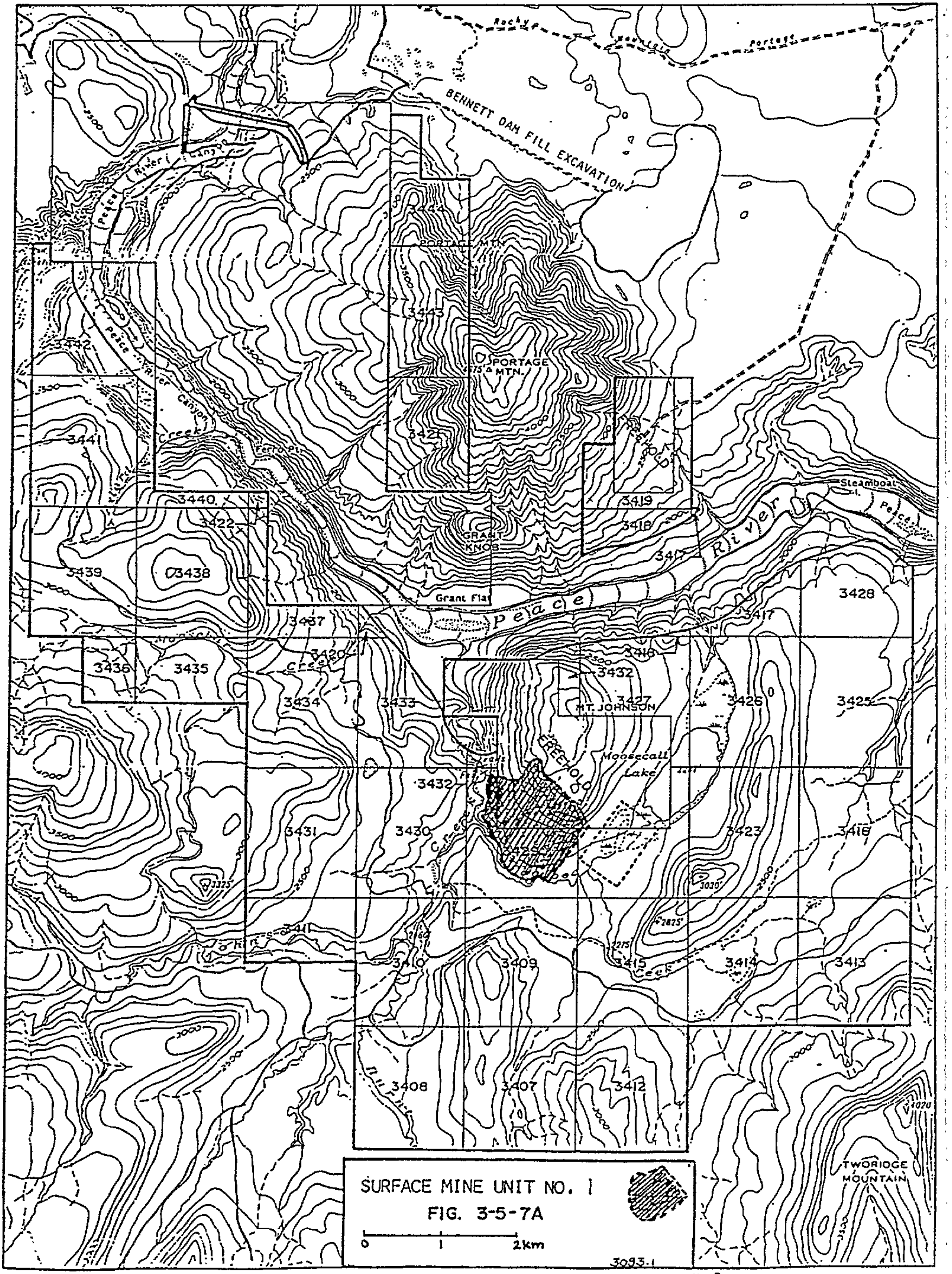
1 inch = 2.54 centimetre
1 foot = 0.3048 metre
1 yard = 0.9144 metre
1 square foot = 0.9144 square metre
1 cubic yard = 0.7646 cubic metre

3.5.7 Production

Conceptual planning considers development of a 910,000 tonnes per year mining facility for the Number 1 Surface Mining Unit with an anticipated initial production of 455,000 tonnes (500,000 tons) of medium volatile bituminous coal scheduled to start in 1983 from the Gething Formation reserves with the following anticipated clean coal specifications. Table 3.5.5.3 B.

	Clean Coal
Ash	6.58 %
Volatile Matter	23.48 %
Residual Moisture	1.17 %
Fixed Carbon	68.78 %
F.S.I.	1 to 7½
Sulphur	0.68 %
K cals/kg	7782
H.G.I.	64
Ash Fusion Temperature	1255°C

The Number 1 Surface Mining Unit is shown in Figure 3.5.7.A.



SURFACE MINE UNIT NO. 1

FIG. 3-5-7A

3.5.8 Mining Plan

3.5.8.1 General

Number 1 Surface Mine Unit extends from southwestern and western slopes of Mount Johnson where the seams outcrop on the surface over an area of some 350 acres (140 ha) bounded to the east by Coalbed Creek. From the outcrop the seams dip into the subsurface to the southwest giving an initial dip slope mining configuration phasing into an open pit design. The average ratio of bank cubic yards to a short ton of coal will be 9:1.

Production per day 5,000 short tons raw coal
Overburden removal (average) 45,000 cu. yards per day

The overburden would be prepared by drilling and blasting after which it would be loaded into 50-ton trucks, or a conveyor belt system, and dumped.

3.5.8.2 Open Pit Design

The mining, by surface methods, of coal seams lying at an inclination of 20% (14^{o}) presents unique problems, (Section A-A'; Section B-B'; Fig. 3-5-5-C, 3-5-5-B). It is not possible to load either coal or waste on these gradients, and therefore the following parameters were laid down in the design of the open pit.

a) All loading of coal and waste to take place on level benchs.

b) The horizontal length of a seam between two benchs (50 m for a 10 m bench height) requires careful overburden drilling and blasting. Reducing the bench height would not reduce the problem - in fact it could increase coal losses and reduce the recovery and profitability.

c) Bench to bench truck movement as well as bench to ramp truck movement to be kept as straightforward as possible to reduce congestion and accidents.

d) All loading to be carried out with either face shovels or rubber tired loaders of approximately $8m^3$ capacity, loading into rear dump trucks of 76 tonnes (78 tons) capacity.

e) The pit would be designed for the possible use of conveyor belts for moving waste at a later state of development .

The open pit mine plan (Figure 3-5-8-2-A) has been drawn to meet the following conditions:

a) Maximum flexibility of operation so that when required, coal loading can be increased or decreased.

b) Blending of seams can be accomplished by moving the coal loading equipment along the bench.

c) Access to the working areas by two separate ramp systems.

d) Worked out areas can be backfilled with production waste.

3.5.8.3 Design Details

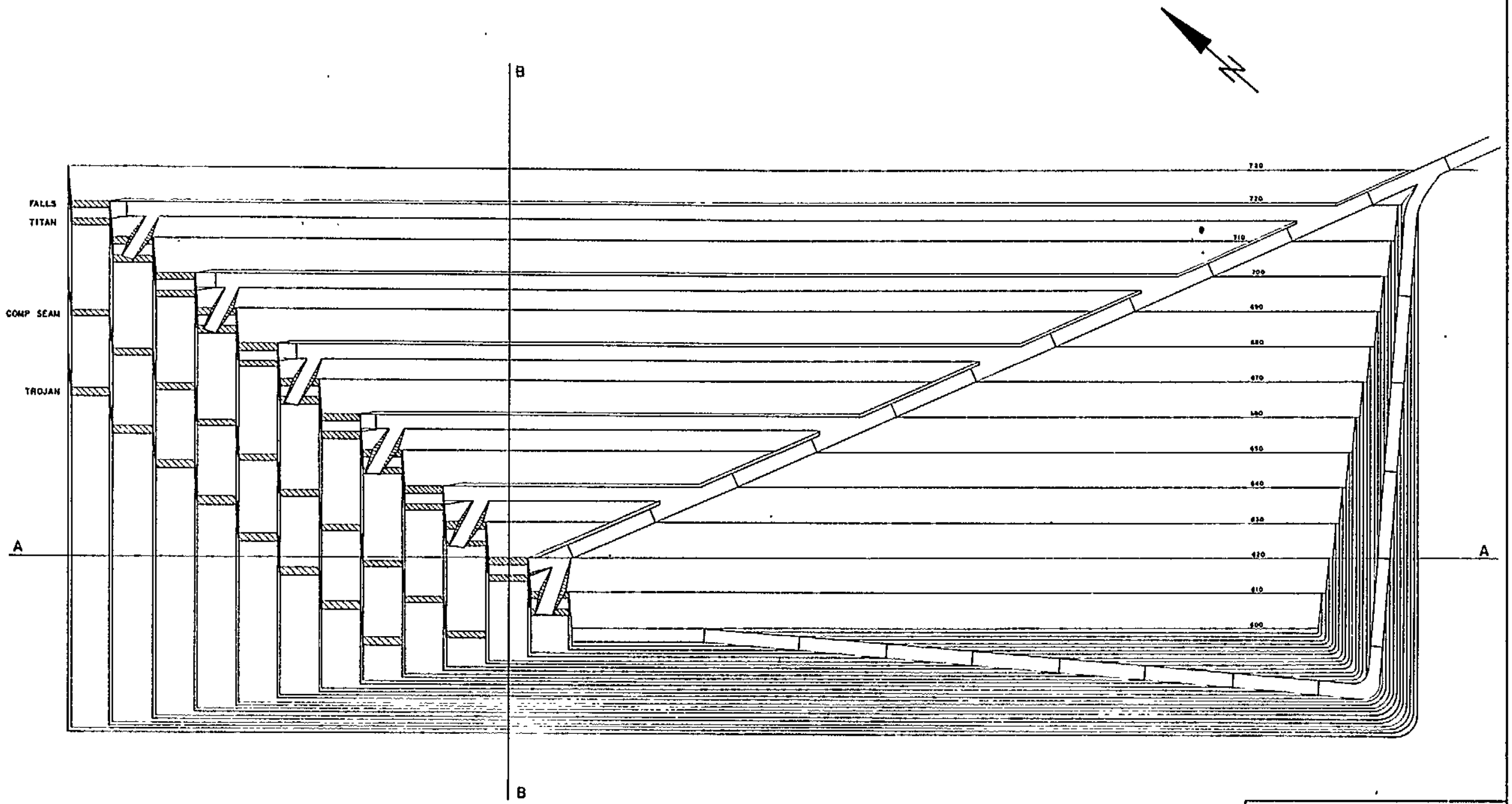
Several design details were assumed because of the present lack of geotechnical data, or taken from previous experience. (Figure 3-5-8-3-A)

These are:

1) Ramp Gradient - maximum of 8 percent
2) Overall Pit Wall Angle - 45 percent
3) Bench Angle - 70° to horizontal

Because of the size of equipment to be used in the operation, other design data was assumed.

1) Ramp Width - 20 m (65.6 ft)
2) Bench Working Width - minimum 60 m (196.8 ft)



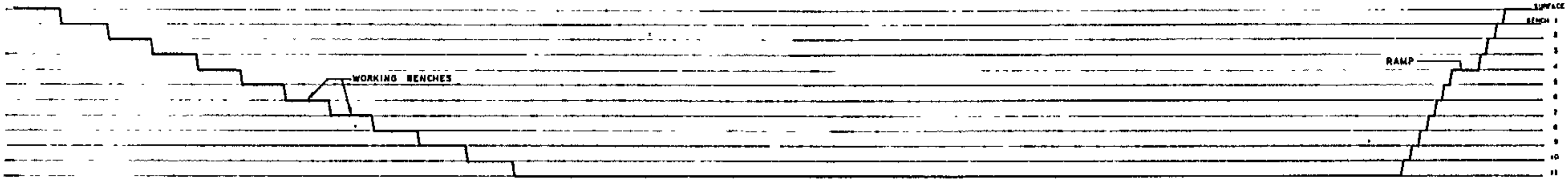
0 50 100 200 METRES
0 100 200 400 600 FEET

CINNABAR PEAK MINES LTD.
PEACE RIVER CANYON PROPERTIES

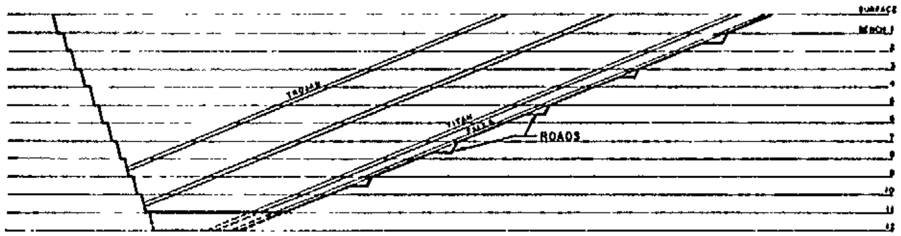
CONCEPTUAL OPEN PIT/STRIP MINE, BENCH AND RAMP LAYOUT

DRAWN	P J A.	DATE	17 MARCH 1981
DESIGN		SCALE	1:2500
CHECKED		REV	
APPR'D			

DWG. 3-5-8-2 A



SECTION A-A



SECTION B-B

0 50 100 200 METRES (HORIZONTAL)
0 25 50 100 METRES (VERTICAL)

CINNABAR PEAK MINES LTD.
PEACE RIVER CANYON PROPERTIES

CONCEPTUAL OPEN PIT/STRIP MINE SECTIONS

DRAWN P.J.A	DATE 24 MARCH 1981
DESIGN	SCALE
CHECKED	REV.
APPR'D	

DWG. 3-5-8-3A

3) Bench Height - 10 m (32.8 ft)

It has been assumed that each bench would have the identical final design. No "catch" benches would be used.

The design requires that the full width of the pit be taken from the start of the operations. This will give the following boundaries to the open pit:

Southwest - Coal Bed Creek

Southeast - The Western Limit of the Moosecall Lake Sediments Post Glacial.

Northwest - Either the continuity of the seams or the economic limit of extraction.

Northeast - The start of the steeper slopes of Mount Johnson - approximately 730 m elevation. (2400 ft.)

It should be noted that the design is to the base of the Falls seam only. The mining of the lower seams of the total Gething sequence would require a change in mine design to allow for a greater depth of the pit and consequent wider pit.

Bench Stripping Ratios and Tonnages of Coal
Per 100 Metres of Advance of the Benches Area

Bench Number	Stripping Ratio (Vol-Vol)	Tonnes Per 100 Metres
1	17.3:1	50,000
2	16.0:1	50,000
3	14.7:1	50,000
4	13.1:1	50,000
5	11.8:1	50,000
6	10.3:1	50,000
7	8.9:1	50,000
8	7.5:1	50,000
9	9.4:1	33,500
10	7.3:1	33,500
11	7.3:1	24,500
12	3.6:1	24,500
13	0.6:1	24,500
Overall S.R. =	10.0:1	Total 540,500 Tonnes

The mining of the southwest flank of Mount Johnson (Area "B") could be worked independently to Area "A".

The method of working would be a series of 10 m (32.8 ft) benches taking horizontal cuts along the side of mountain and stripping to the base of either the Milligan or the M 48 -depending on the economics.

The area to be disturbed per year for mine area "A" will average 8 ha (19.7 acres) but will be highest in the initial five years of mine operation as the open pit is developed. The waste dump area will be covered in lifts of approximately 10 m (32.8 ft). Consequently the proposed dump area will be completely covered by one lift within 2.5 years.

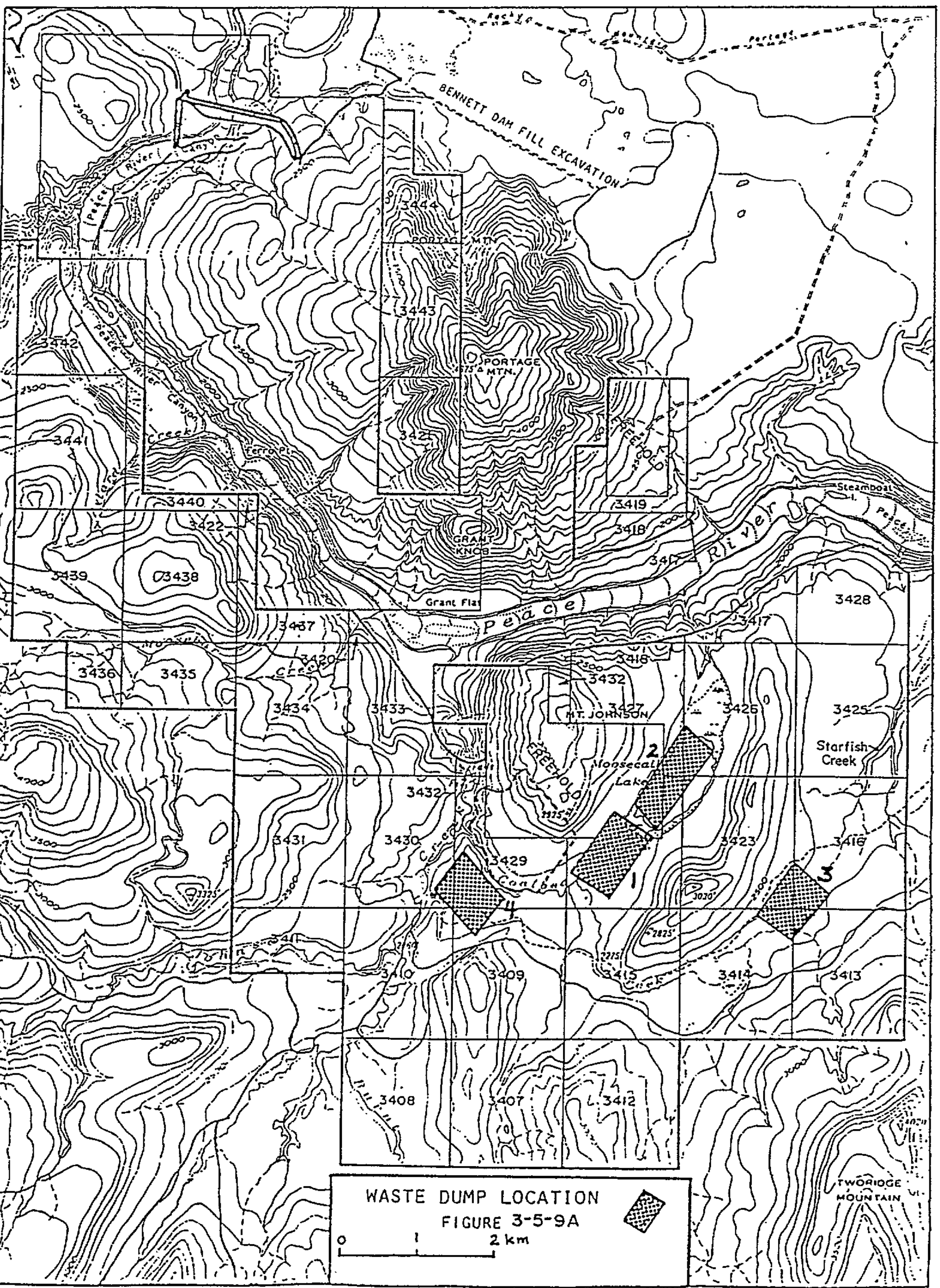
3.5.9 Waste Disposal

Solid waste from the processing plant would be brought by conveyor to the Bradford Breaker Waste Bin where it would be dumped by truck with the pit waste. It is anticipated that this total quantity will not exceed 15 percent of the raw coal mined i.e. 700 tonnes (770 tons) per day. Waste would be hauled to the dump area by rear dump trucks of approximately 76 tonnes (78 tons) capacity. The use of conveyors for this work should be investigated, particularly for the upper benches, to minimized environmental impact.

Four areas are being examined as alternative sites for the initial waste dump location (Figure 3-5-9-A). The following constraints were considered during the selection of the waste dump locations:

1) forested areas should not be disturbed,
2) dumps should not be placed above potential open pit mining reserves,
3) the West Coast Natural Gas Pipeline in the east, and the B. C. Hydro Transmission Line to the east and west of the mine area must be avoided at all costs,
4) the waste dump must be within an economic haulage distance of the mine,
5) minimum negative environmental impact must be attained,
6) the visual effects of the dump must be mitigated by keeping them on low lying land, and by planting trees on the south and east flanks.

The first alternative site under examination is the area south of Moosecall Lake (Figure 3-5-9 B). This area is composed of recent sediments to a depth of at least 60 m (197 ft) thinning to zero in the west, which would preclude open pit mining at any future date.



WASTE DUMP LOCATION

FIGURE 3-5-9A

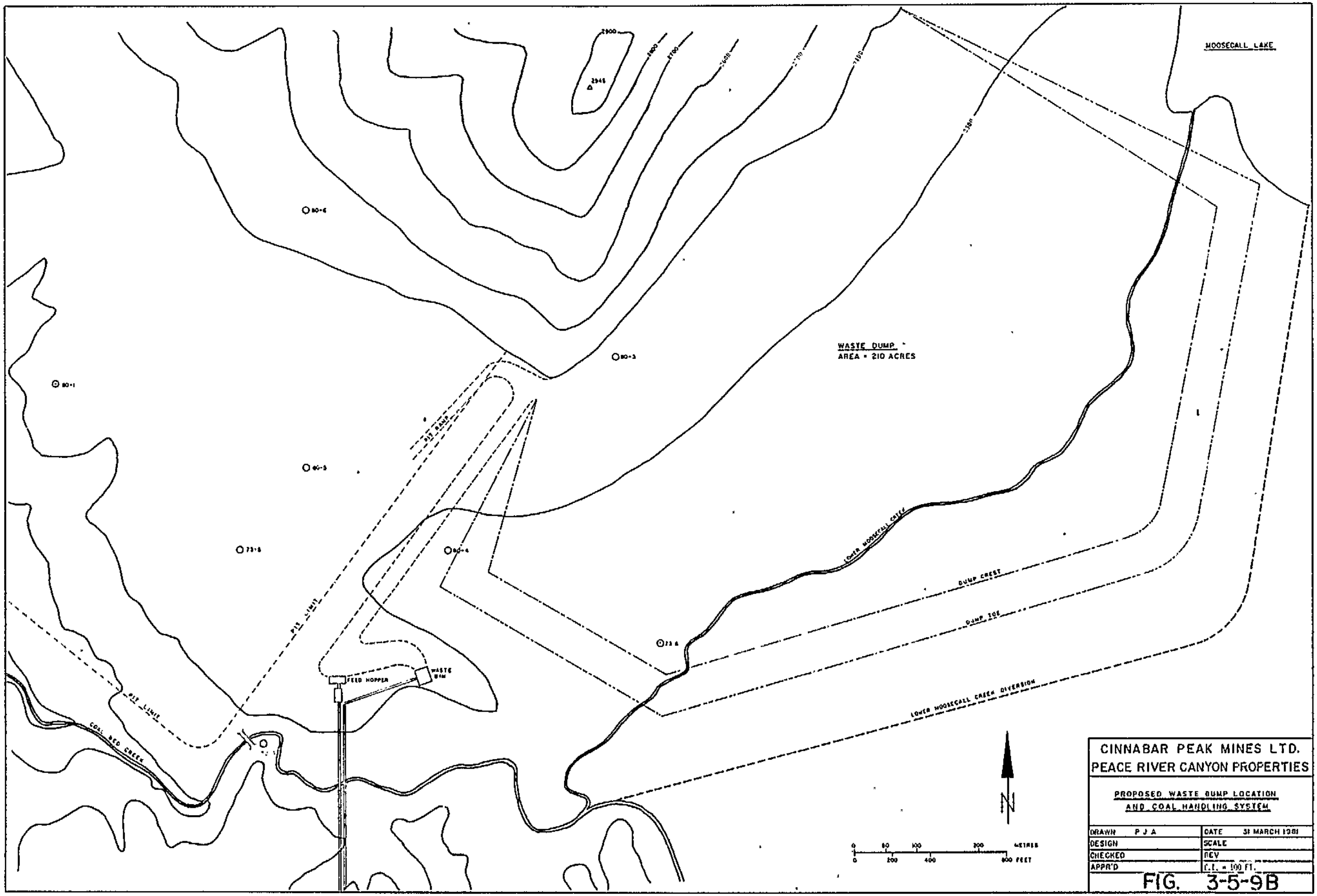

MOOSECALL LAKE
2945
WASTE DUMP
AREA = 210 ACRES
PIT LIMIT
PIT RAMP
FEED HOPPER
WASTE BIN
COAL BED CREEK
LOWER MOOSECALL CREEK
DUMP CREST
DUMP TOE
LOWER MOOSECALL CREEK DIVERSION
80-1
80-6
80-5
80-3
80-4
73-5
73-6
0 50 100 200 METRES
0 200 400 800 FEET
N
CINNABAR PEAK MINES LTD.
PEACE RIVER CANYON PROPERTIES
PROPOSED WASTE DUMP LOCATION
AND COAL HANDLING SYSTEM
DRAWN P J A
DATE 31 MARCH 1981
DESIGN
SCALE
CHECKED
REV
APPR'D
C.I. = 100 FT.

FIG. 3-5-9B

A diversion channel would be constructed for upper Moosecall Creek to the east of the existing creek channel (but at least 50 m (164 ft) from the gas pipe line), to allow a larger area to be used for dumping. It is suggested that the dump be constructed in lifts to minimize the "BOW WAVE" effect of the dump as it moves eastwards. The diversion channel would take all the water which at present is flowing down Coal Bed Creek and divert it into Moosecall Lake. The diversion would be accomplished by building an earth fill dam, approximately 400 m (1312 ft) east of D.D.H. 72-3.

Coal Bed Creek would act as a drainage channel for run-off water downstream of the proposed dam.

The second waste dump location under consideration is in the area including Moosecall Lake. The composition of the sediment in this area is similar to the first area.

A dam would be constructed on the south side of the lake and the water from the lake would be drained towards the north through an existing unnamed creek into Dinosaur Lake. The unnamed creek, to the north of Moosecall Lake would act as the drainage channel for runnoff water from the Moosehead Lake Area. The only effect of this proposed location on Coalbed Creek would be the removal of the Moosecall Lake area from the Coalbed Creek catchment. The construction details are expected to be similar to those mentioned for the first alternative.

The third area proposed as a possible waste dump location is the flat area which separates the Coalbed Creek draining from the Starfish Creek drainage. The methods of construction and the direction of the drainage for this proposed waste dump will be determined after further examination of the area of Coalbed Creek and Starfish Creek.

The fourth proposed location of the waste dump is in the area south of the mine, near the confluence of Johnson Creek and Coalbed Creek. This location should eliminate the need for any water diversion, however, the surface water from the dump will have to be rigidly controlled. Construction details are presently under consideration.

3.5.10 Processing Plan

3.5.10.1 General

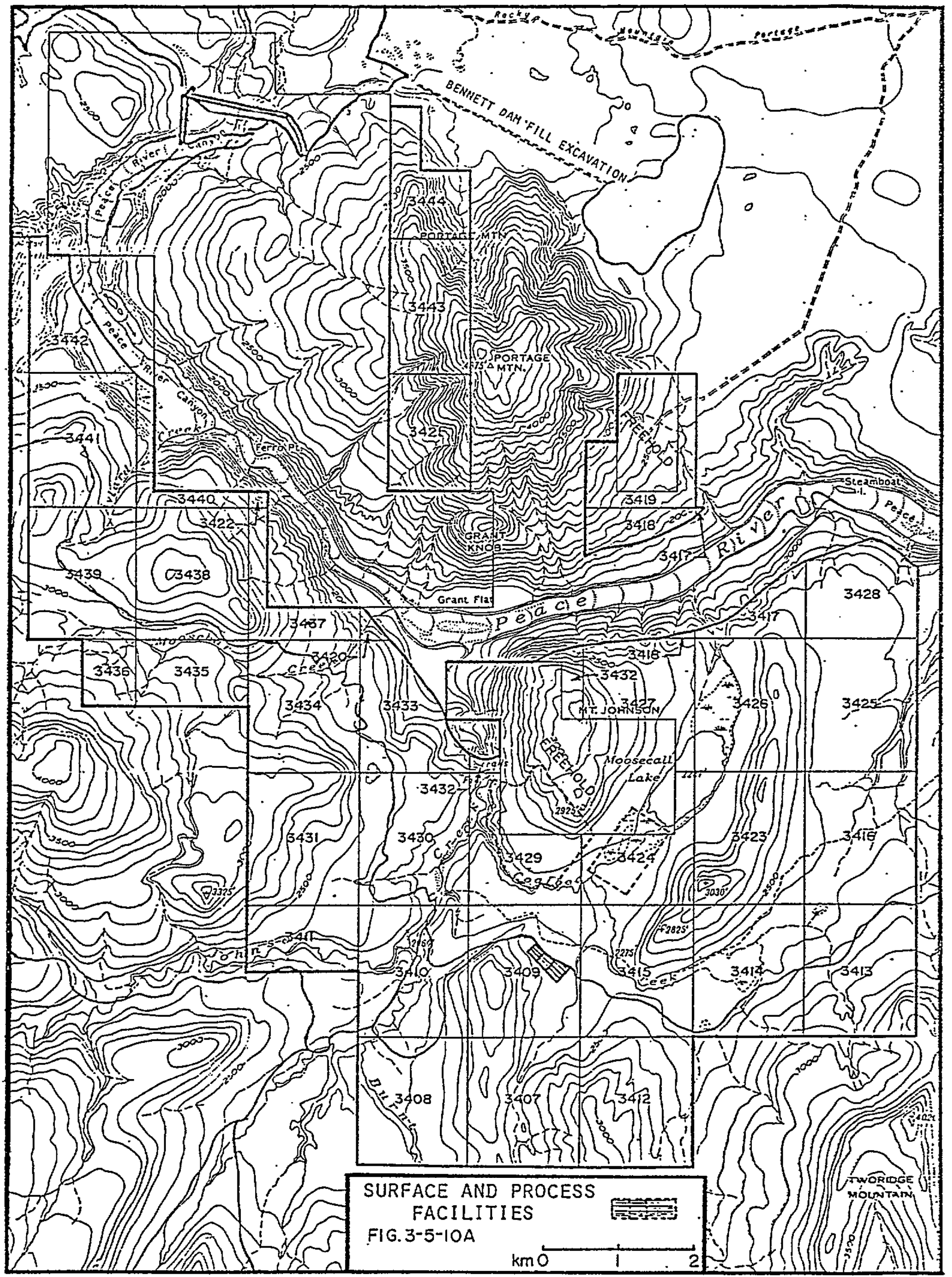
The key factor in the design of a suitable plant for the project will be the versatility to handle coals of both thermal and metallurgical specifications. As minimum upgrading would be required for the No.1 Surface Mine Unit coals, to save on capital costs the design can be tailored to clean high quality thermal coal without a high cost major plant facility being developed. Provision would be made in the planning to provide for additions without any radical alteration to the operating section through a modular design concept suitable for expansion to satisfy production requirements. The facility may be broken down into component sections as shown on Figure 3-5-10 A.

3.5.10.2 Raw Coal Handling

Raw Coal (run of mine) would be hauled to the proposed Bradford Breaker Installation by rear dump trucks, identical to the waste trucks, except that removable side boards would be added to the trucks to increase the volume capacity of the trucks. (DWG. 81-3) For 2000 tonnes (2200 tons) per day of clean coal production, approximately 2400 tonnes (2640 tons) of raw coal would be required - 32 loads. The loading capacity of a 988 or 992 front end loader is between 550 (605 tons) and 750 tonnes (825 tons) per hour which would mean that one day's raw coal loading could be completed in 4 hours. Under these circumstances the doubling of production to 4000 tonnes (4400 tons) of clean coal per day would not require increased or larger equipment.

The feed hopper and breaker location will depend on the ground conditions in the proposed general area. The eastern limit of the pit must be in reasonably stable ground, i.e. the Gething Formation, and not in recent deposits, which will be unstable and liable to slides. The position of the breaker will have to be at least 80 m (262 ft) away from the pit limits, preferably 100 m (328 ft) to give turning room for the trucks and give a safety margin for possible pit slides.

The breaker station should have a capacity of at least 800 tonnes (820 tons) per hour of raw coal to ensure that it cannot become a bottle-neck in the future. This will allow the breaker station to handle everything that is trucked to it, thus ensuring minimum



SURFACE AND PROCESS FACILITIES

FIG. 3-5-10A

truck delays. The feed hopper would have a capacity of at least 200 tonnes (220 tons), giving 15 minutes of breaker operation, and ensure minimum waiting by trucks. Moving the raw coal by conveyor from the pit is not considered practical at this time.

A grizzly would be installed above the hopper to stop large rocks entering the breaker as well as eliminating the hazards of a large open hopper to men and machines. Any oversize rock would be broken by a hydraulic or compressed air hammer on an extendible arm. The grizzly aperture would not be larger than 200 mm (7.8 in) because rocks above this size could damage the refuse conveyor when they are ejected from the breaker.

The size of the breaker apertures would be a function of the market requirements as well as washing tests on the raw coal. Minimum fines are advantageous to any coal processing plant as these fines (minus 5 mm) (minus 0.195 in) require more expensive cleaning. On the other hand, clean coal of +25 mm (0.975 in) may have to be crushed before it is loaded out. It is suggested that an aperture diameter of about 40 mm (1.561 in) would be suitable.

The coal from the breaker would be conveyed to the raw coal silo by a 1200 mm (46.8 in) conveyor belt which at a speed of 2 m/sec (6.5 ft/sec) would have ample carrying capacity with absolutely minimum spillage. All joints would be vulcanized to eliminate fine coal falling through the joints and causing environmental as well as explosive hazards. An electromagnet would remove tramp iron.

The conveyor would be inside a steel tubular gallery to protect the coal from the weather, as well as eliminate wind borne dust. This tubular gallery would also house the refuse conveyor from the processing plant taking the refuse to the refuse bin near the breaker. This would be a 1050 mm (41 in) belt capable of carrying the refuse from up to 3 preparation plants with a total capacity of 900 tonnes (990 tons) per hour and producing a maximum of 200 tonnes (220 tons) per hour of waste material. The conveyor would also pick up the refuse from the Bradford Breaker, at a maximum of 120 tonnes (132 tons) per hour, and convey the total of a maximum of 320 tonnes (352 tons) per hour to a waste bin with a suggested capacity of 400 tonnes (440 tons). This would be emptied by the waste trucks in the pit and dumped with the waste rock.

In Figure 3-5-10-2A, the 1050 mm (42 in) and 1200 mm (48 in) conveyors are identified as 42" and 48" conveyors respectively.

It should be mentioned at this point that all refuse from the preparation plant will be dried by centrifuge and disposed of as solid material. Tailings ponds will not be required.

The two conveyors in the Gallery would necessitate a total Gallery width of 4 m (13.1 ft) to give adequate clearances, and a height of at least 2.5 m (8.2 ft).

The raw coal conveyor would carry the raw coal to the top of a silo with a suggested capacity of at least 4000 tonnes (4400 tons). Conveyor inclination should not exceed 14^{o} to eliminate the chance of wet coal sliding back on the belt. The silo would be constructed of either slipformed concrete or steel segments bolted together. Provision for "air breakers" must be made to eliminate "rat-holing" in the winter reducing storage capacity.

As with all conveyor systems around the preparation plant, a dust removal vacuum system would be installed at the delivery end of the raw coal conveyor, to remove dust from the conveyor gallery and the raw coal silo. Water sprays would be installed at all delivery and conveyor transfer points.

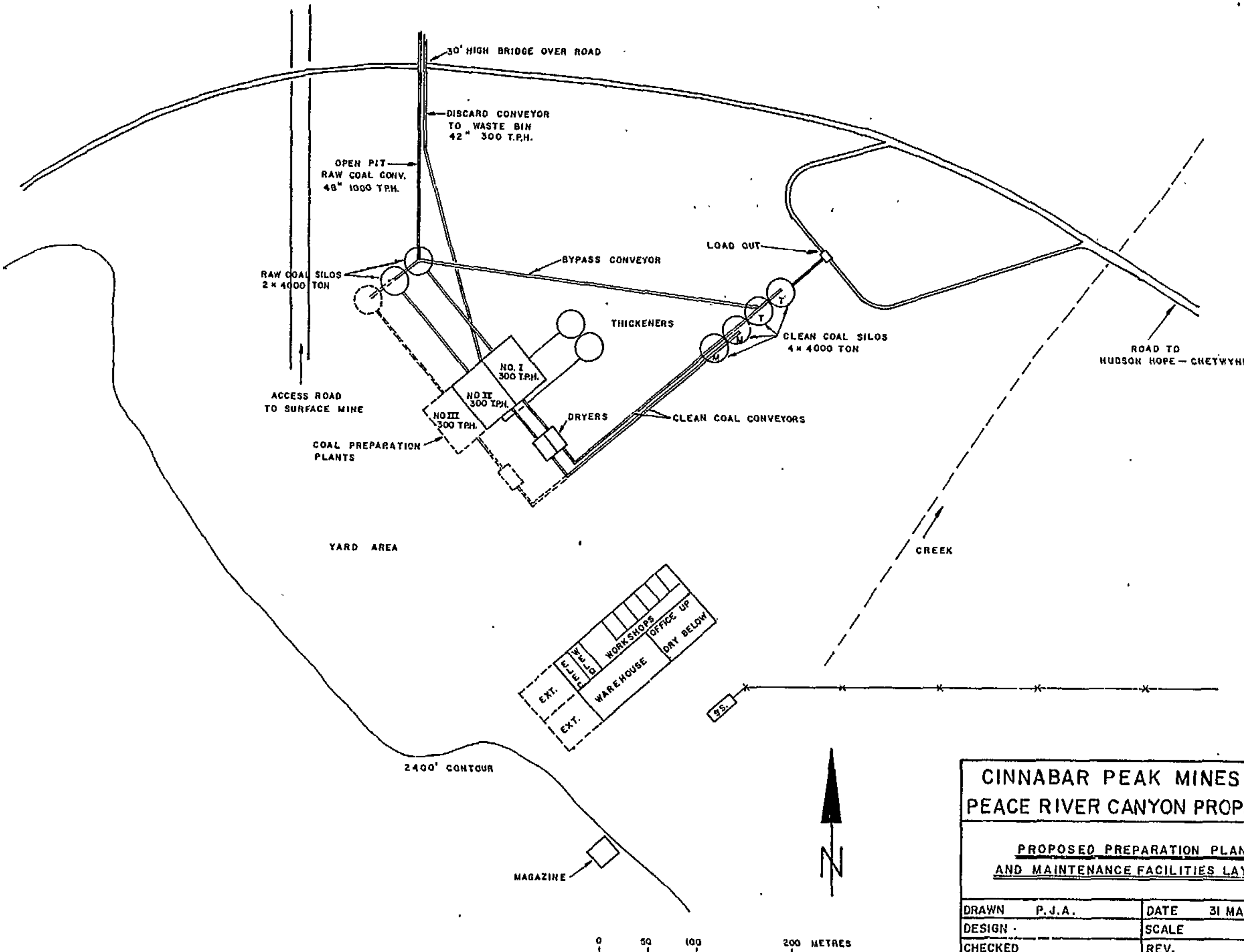
3.5.10.3 Coal Preparation Plant

Raw coal would be removed from the base of the raw coal silo and moved by belt conveyor into a 300 tonnes (330 tons) per hour preparation plant. Provision would also be made to bypass the preparation plant and convey the raw coal, if required, straight to the clean coal silos (Figure 3-5-10-2A).

Raw coal taken into the preparation plant would initially be screened into three sizes:

1) +10 mm (+ 0.4 in) 2) -10 mm (-0.4 in) + #28 mesh 3) -#28 mesh

The +10 mm (+0.4 in) would be cleaned in a baum jig with a capacity of 140-200 T.P.H. The lab work carried out so far on drill hole samples indicate that jigs would be very suitable for cleaning the +10 mm (+0.4 in) at a S.G. of about 1.55. Very few middlings are indicated. A dense medium system is not recommended.



CINNABAR PEAK MINES LTD.
PEACE RIVER CANYON PROPERTIES

PROPOSED PREPARATION PLANT
AND MAINTENANCE FACILITIES LAYOUT

DRAWN P.J.A.	DATE 31 MARCH 1981
DESIGN ·	SCALE
CHECKED	REV.
APPR'D.	

FIG. 3-5-10-2A

Clean coal would be drained and conveyed to the coal dryer with the waste sent to the refuse conveyor after draining. Natural gas would be used for coal drying.

The -10 mm (-0.4 in.) to +28 mesh would, if needed, be cleaned by "water only" cyclones. Provision would be made for this size range to bypass the cyclones. The clean coal from the cyclones would be drained, added to the -10 mm (-0.4 in.) clean coal and dried. Refuse would be centrifuged and added to the +10 mm (+0.4 in.) refuse.

The -#28 mesh raw coal may not have to be cleaned at all, and would be added directly to the +10 mm (to 0.4 in.) to #28 clean coal. If bulk samples indicate that this size would also have to be cleaned, flotation would be an acceptable, though expensive, method. The cleaned coal would then be added to the other fractions and sent to the dryer. Tailings from the flotation would be thickened, centrifuged and added to the +#28 refuse.

The proposed coal preparation system would allow the cleaning of all the coals from the open pit to an acceptable standard at minimum cost. Clean coal from the plant would be dried in a fluidized bed dryer before being conveyed into clean coal silos with a total capacity of 8000 tonnes (8800 tons). Again, all conveyors would be in a steel tubular gallery, with a fugitive dust extraction system.

Provision would be made to allow the construction, at a later date, of one or two identical preparation plants, parallel to #1 plant. This would require a second raw coal storage silo, and at least two additional clean coal silos.

The loading out of the clean coal into highway trucks would be by reclaiming from the coal silos by feeders onto a 1200 mm (48 in.) conveyor belt which would fill a bin with a pre-determined tonnage of coal. The truck would then be loaded with the contents of the bin. This method allows maximum tonnages to be hauled with no overloading and allows products from each clean coal silo to be loaded as required. This also allows loading time to be kept to a minimum which will be important when 8,000 (8800 tons) tonnes are moved in 16 hours or a truckload every 4 minutes. A second loading system could, of course, be installed, parallel to the first to handle the increased production. The initial system could be modified to load rail cars if needed.

No surface stockpiling of clean or raw coal is proposed to minimize the fugitive dust around the plant. It also means that no contamination of the clean coal occurs, and it remains dry. Provision must be made for the future construction of clean coal silos.

Solid state electronic control of the whole operation should be investigated to reduce non-productive manpower and maximize throughput of the processing plant.

3.5.11 Surface Facilities

The area suggested for the surface facilities (Figure 3-5-10-2A) has the following advantages:

a) bedrock appears to be near the surface making foundation construction simpler and less expensive, especially for the silos.

b) the area is well drained.

c) blasting effects from the open pit are not expected to be a problem. The proposed plant site is over 700 m (2297 ft) from the pit perimeter and 25 m (82 ft) above it.

The proposed site will require the logging road to be rerouted to the south of the plant area, very close to the original routing of this road.

This will allow the road from the pit to the plant area to be away from the logging road and eliminate the need for the raw coal conveyor to cross the logging road.

The surface facilities will consist of:

a) preparation plant(s) and loadout facilities,
b) workshop facilities for maintenance of open pit equipment,
c) warehouse for preparation plant and open pit,
d) office
e) change house for surface mine,
f) first aid room,

g) training room,
h) explosives and detonator (cap) magazines,
i) electrical substations,
j) sewage plant,
k) stockyard,
l) laboratory for coal sampling

It is recommended that the following facilities be incorporated into one building to reduce construction costs, improve heating costs, and improve communications and supervision. The building will be extensible to allow for future expansion.

a) work shop facilities including bays for repair, maintenance, washdown and lubrication of pit equipment such as trucks and loaders.

b) electrical and welding shops.

d) warehouse for all mine requirements except those kept outside under a weatherproof shelter for tires, buckets, etc.

e) offices for engineering staff, administration and clerical

f) first aid room

g) training room - lecture room

h) change house for open pit and preparation plant

This building would be approximately 35 m (114 ft) wide, 20 m (65 ft) high and 100 m (328 ft) long. The offices and parts of the warehouse would be on the upper levels, keeping the ground floors for equipment maintenance, changehouse and warehouse.

The explosives magazines would be away from the complex as specified by law, and the sewage plant would be downstream of the complex.

A security fence would surround the facility with a gate manned 24 hours/day - 7 days per week, to keep out animals as well as intruders.

Adequate parking facilities would be constructed outside the security fence, but it is anticipated that most people working at the mine would be transported by bus.

The roads within the plant complex would be constructed with hard rock from the open pit, concrete is not practical, but all areas under conveyors and silos would be paved to facilitate cleaning, and the conveyors raised off the ground.

Surface lighting would be installed to minimize the risk of accidents at night both at the surface facilities and around the pit area and dumps.

Surface drainage water would be diverted to the upper Moosecall Creek diversion channel. Siltation ponds and water treatment will be used if required. Drainage water out of the open pit would be pumped into the processing plant water clarification system. This would eliminate the need for siltation ponds for this water and also supply make-up water for the processing plants.

Road dust in the area would be eliminated by spraying with water. Spraying the roads with bunker oil is not recommended because the oil is easily washed off the road by rain and would pollute the streams and creeks.

3.5.12 Truck Transportation - Mine to Chetwynd

Clean coal production would be delivered into bins on the mine site. From this point, it would be carried by trucks along the existing forestry road and highway to the loading facilities at Chetwynd on the B.C.R.

Regular highway trucks would be loaded out from overhead storage bins at the mine. The vehicles would be standard 49,895 kg (110,000 lb) G.V.W. tractor/trailer/pup seven-axle rigs with a 32.2 tonne (35.5-ton) payload. Some 20 vehicles could handle .9 million tonnes (1 million tons) of clean coal per year.

Access to the mine is gained via 47 km (29 mi) of paved road north of Chetwynd (Highway 29) and 14 km (9 mi) of forestry road to the west of the junction with No. 29. The Johnson Creek forestry road through the Cinnabar property is maintained by Canadian Forest Products Ltd's crews based in Chetwynd for the provincial Forestry Department. This is a service "Canfor" provides to the province in return for a stumpage offset allowance of their forestry operations.

The road passes through the middle of the Cinnabar licence property. Curves are designed for 50 kmh (30 mph), and the grades are mild. The road is well-maintained and is inoperable only for hours at a time due to storms. Canfor closes the road completely for six weeks in the spring. The province has indicated that when the mine commences a sustained production, the forestry road serving it may be designated a "resource road" and would be turned over to the Department of Highways for upgrading and maintenance. The province has further indicated a willingness to consider this road serving the project in this category.

3.5.13 Rail Transportation-Chetwynd to Tidewater Terminal

Processed coal will be loaded out and transported initially to North Vancouver's Neptune Terminals or equivalent via the British Columbia Railway, and perhaps later to Prince Rupert via B.C.R./Canadian National when new (and presumably more economic) facilities are commissioned at the northern port. Some 170-180 of 91 tonne (190-200 of 100 ton) rotating coupler steel cars will be required. Train configurations could involve 40-car "blocks" shipped daily on a regularly scheduled (daily) mixed freight train.

The proposed site at Prince Rupert (Ridley Island), should come into operation shortly after the project commences.

British Columbia Railway have industrially zoned sites both within the Municipality of Chetwynd and along its R-O-W in various areas around Chetwynd.

This concept would appear appealing as B.C.R. are currently upgrading their lines and it will be some time before the system can facilitate heavy unit trains. When the operation is expanded beyond 1 million tons per annum, unit trains would handle the coal over a rehabilitated B.C.R. roadbed Figure 3-5-10-2 A.

3.5.14 Marketing

Marketing will be done by Cinnabar possibly in conjunction with other suitably qualified agencies or mining companies. With the rapidly escalating world demand for thermal coals and projected needs for coking coals, excellent marketing conditions exist. The outstanding qualities of the coals from this project should result in good prospects of marketing on world markets with potential customers in Mexico, Brazil, Europe, and the Pacific Rim area. The comparatively low capital costs and the concept of high efficiency mining operations will give these coals a natural competitive edge in resource development.

4.0 ENVIRONMENTAL DATA BASE

4.1 Physical Setting

The Peace River Canyon property of Cinnabar Peak Mines is located approximately 17 km (10.5 mi) west-south-west of Hudson Hope on the south side of Dinosaur Lake. It is within the Rocky Mountain Foothills physiographic area. The study area (Figure 4.1.A) includes most of Mount Johnson and is within the general area enclosed by: Dinosaur Lake to the north, Moosecall Lake to the east, Coalbed Creek to the south, and Johnson Creek to the west (latitude 55°56' longitude 122° 08').

The Johnson Creek drainage includes all of the study area except for a small portion which drains directly into Dinosaur Lake. Moosecall Lake and Coalbed Creek drain into Johnson Creek.

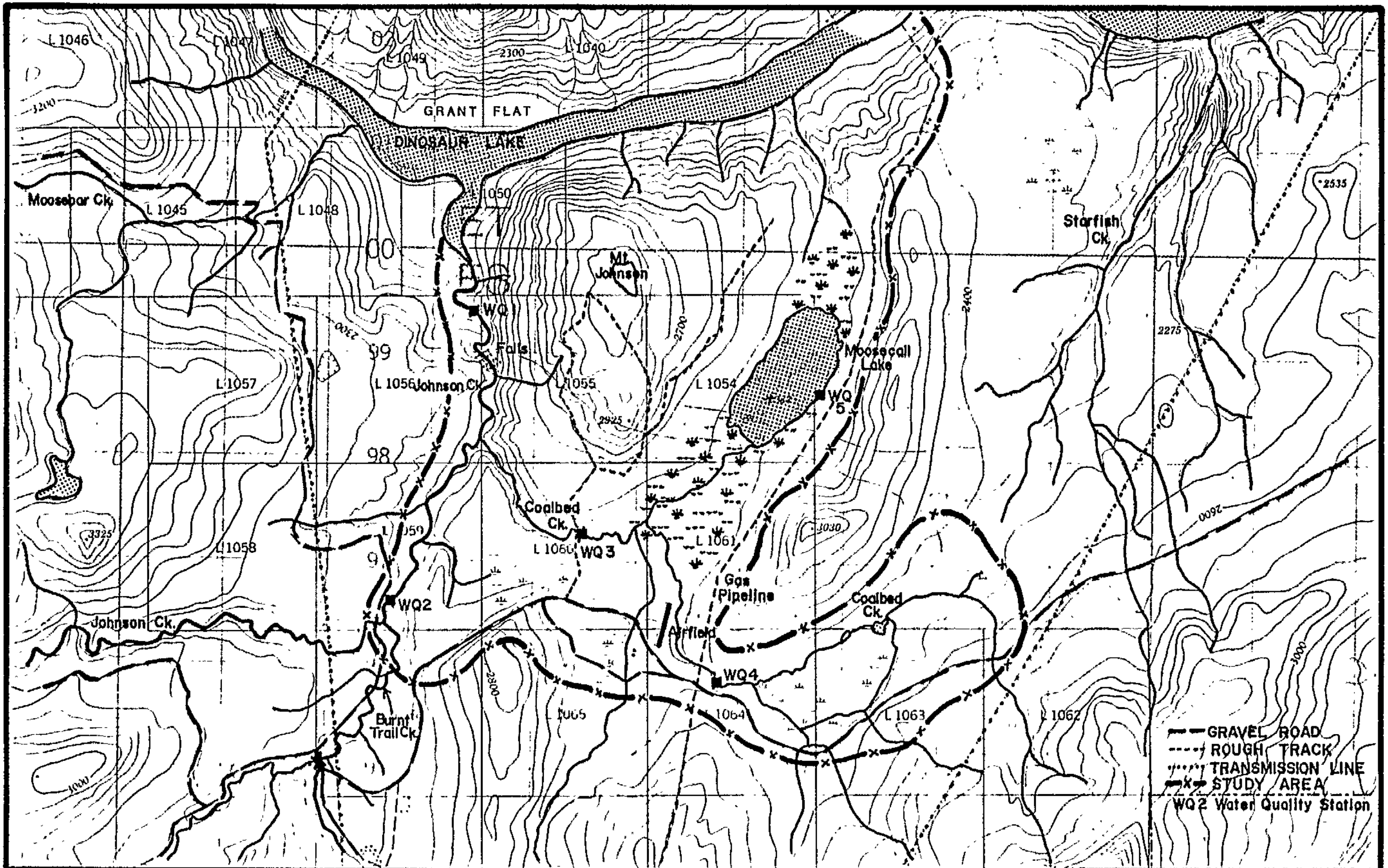
The elevation of the study area ranges from 488 m (1,600 ft), at Johnson Creek, to 945 m (3,100 ft) at the top of Mount Johnson.

At the present time, access from Chetwynd to the study area is achieved by travelling 47 km (29 mi) north on Highway 29 and 24 km (15 mi) west on "Johnson Creek" Road. Highway 29 is a paved highway and "Johnson Creek" road is a gravel road maintained by Canadian Forest Products Ltd.

4.2 Climate

4.2.1 Regional Considerations

Climatic conditions in the study area are affected by three main air masses. The coastal air mass moves into the area from the west, after having released a good deal of moisture while passing over the Continental Divide. Moist air moving in from the southeast releases moisture onto the study area while travelling towards the northwest. This air mass is responsible for the larger amount of rainfall observed east of the Divide than west, as shown on Table 4.2.1A (Pollock and Gigliotti 1975). The arctic air mass moves in from the east during the winter and is blocked by the mountains. This arctic air mass is responsible for the low winter temperatures.



JOHNSON CREEK STUDY AREA

FILE	PROJECT 30931
DWN bgs	APP
DATE 8/81	REV
FIGURE 4-1A	

TABLE 4.2.1 A

Annual Extreme Rainfalls
April - July Inclusive
(D. M. Pollock and T.F. Gigliotti)

		One Day		Two Day		Three Day	
	Years	Mean	Dev.	Mean	Dev.	Mean	Dev.
BRITISH COLUMBIA							
East of Divide							
Hudson Hope PM	11	1.62	.77	2.28	1.28	2.61	1.48
Hudson Hope	31	1.35	.79	1.84	1.17	2.00	1.27
Dawson Creek	18	1.42	.64	1.80	.69	1.96	.68
Fort Nelson A	37	1.07	.41	1.51	.59	1.67	.70
Fort St. John	33	1.22	.64	1.56	.74	1.76	.83
Beatton River	22	1.13	.40	1.57	.59	1.72	.64
West of Divide							
Aleza Lake	23	.91	.32	1.17	.42	1.35	.47
Fort St. James	80	.71	.27	.97	.40	1.04	.43
Germansen Landing	21	.77	.26	1.04	.40	1.20	.45
Prince George A	33	.83	.28	1.07	.38	1.26	.44
Takla Landing	12	.82	.27	1.16	.41	1.36	.42

There is little site specific data available to indicate what weather conditions prevail within the study area, however, the Atmospheric Environment Service (AES) has a number of climate stations located throughout the province. The nearest and most relevant station is the Hudson Hope's (BCHPA Dam) station (Figure 4-2-1A and 4-2-1B) (Schaefer, D.G., 1976).

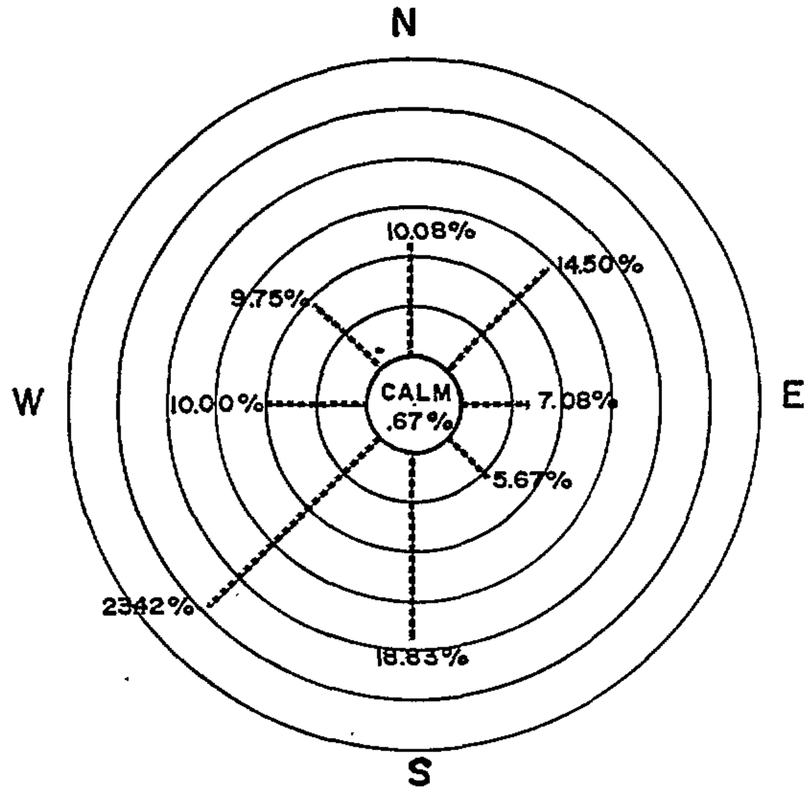
4.2.2 Temperatures

The RAB Technical Paper I entitled, Climatic Capability for Agriculture in British Columbia (see Figure 4-2-2 A and Appendix 2) indicates that most of the study area has a freeze-free period of 75 to 89 days. The freeze-free period is the greatest number of consecutive days in a calendar year free of a temperature of 0°C or less. Mount Johnson area has a freeze-free period of 50 to 59 days. A small portion of the study area near Dinosaur Lake is listed as having a freeze-free period of greater than 150 days.

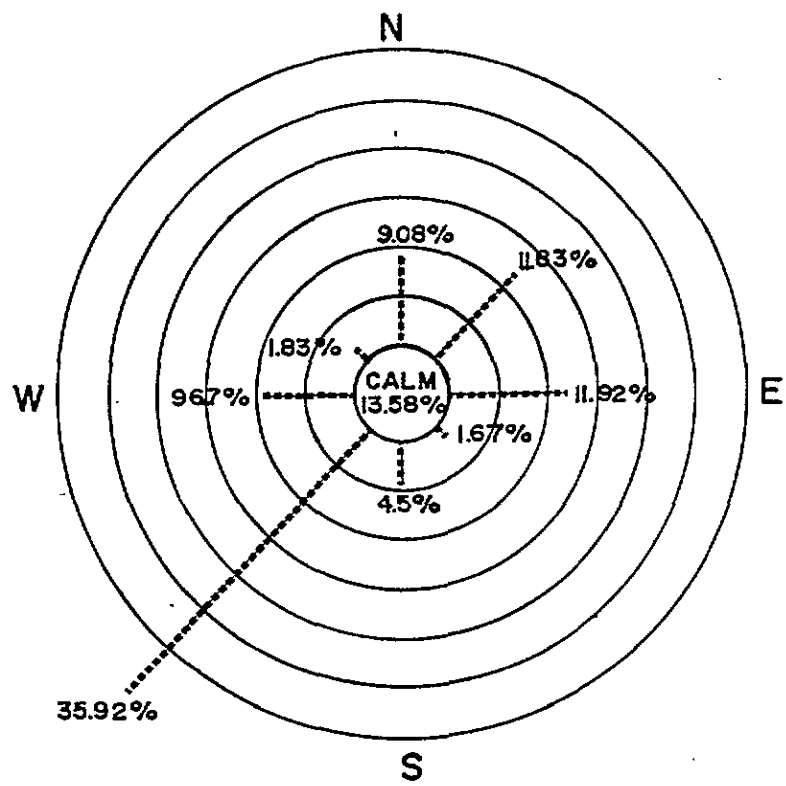
Temperature means for 1971 to 1980 at Hudson Hope BCHPA Dam is shown in Table 4.2.2 A (AES Summary). Average monthly means vary from a low of -24.7°C in February (1979) to a high of 16.4°C in July (1971 and 1975). The overall monthly means from 1971 to 1980 varies from -13.°C in January to +15.0°C in July. The average yearly mean from 1971 to 1980 is 2.05°C. As temperature probably varies with altitude, the temperatures encountered in the study area would probably be slightly lower than those found in Hudson Hope.

4.2.3 Precipitation

The precipitation data obtained from the weather station at Hudson Hope (Tables 4.2.3A and 4.2.3B) (AES Summaries) indicates that the largest percentage of precipitation falls as snow during January, February, March, April, November and December and a small percentage of the precipitation falls as snow in May, September, and October. No snow fell in June, July, or August during the ten years studied. The most rain falls in July and the least amount falls in April. The maximum precipitation recorded during the ten years (Table 4.2.3C) occurred in July 1972 with a 24-hour rainfall of 78.7 cm (31.0 in).



YEARLY AVERAGE FOR JUNE 1971 - DEC. 1971 (BCHPA Dam)

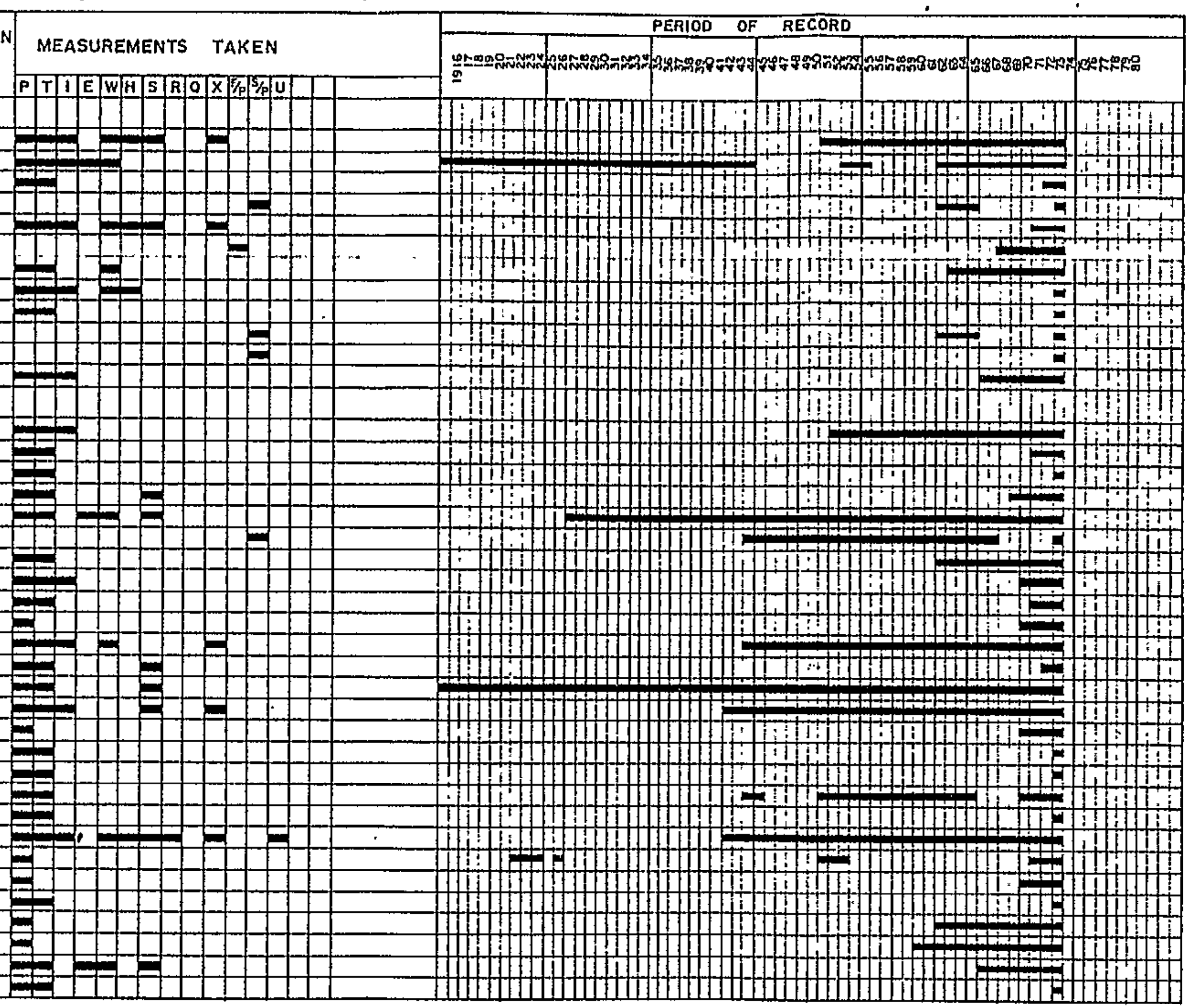


YEARLY AVERAGE FOR SEPT. 1932 - NOV. 1942

HUDSON HOPE, B.C. - WIND ROSE	IEC	DRAWN bgs	DATE 8/81
		CHECKED	APPROVED
		FIGURE: 4-2-4A	

3093.1

STATIONS	ELEVATION IN FEET
WITHIN DRAINAGE BASIN	
1 GERMANSEN LANDING	2450
2. HUDSON HOPE BCHPA DAM	2225
3 INGENIKA POINT	2230
4 LADY LAURIER LAKE	4800
5 MACKENZIE AIRPORT	2300
5a MORPHEE MOUNTAIN	4750
6 PINE PASS	3060
7 SUMMIT LAKE BCFS	2350
8 SUSTUT MOUNTAIN	5900
9 TRYGVE LAKE	4600
10 TSAYDACHI	3800
11. WARE	2550
IN SURROUNDING AREA	
12. ALEZA LAKE	2050
13. ARRAS	2200
14. BABINE LAKE HALIFAX BAY	2335
15 BABINE LAKE PINKUT CREEK	2340
16. BALDONNEL	2250
17 BEATTON RIVER	2755
18 CECIL LAKE CDA EPF	2300
19. CHETWYND BCFS	2165
20. CHETWYND SUKUNKA	3460
21. CHIEF LAKE	2600
22. DAWSON CREEK AIRPORT	2164
23. FORT BABINE	2350
24. FORT ST. JAMES	2250
25. FORT ST. JOHN AIRPORT	2275
26. ISLE PIERRE	2050
27. KALDER LAKE	3180
28. LEO CREEK	2290
29. MUNCHO LAKE	2770
30. PINK MOUNTAIN	3950
31 PRINCE GEORGE AIRPORT	2218
32 ROLLA	2150
33 SALMON VAL ERICKSON ROAD	2275
34. TACHIE ISE	2240
35 TAKLA LANDING	2300
36. TAYLOR FLATS	1700
37. TOPLEY LANDING	2370
38 WONOWON	3000



LEGEND:

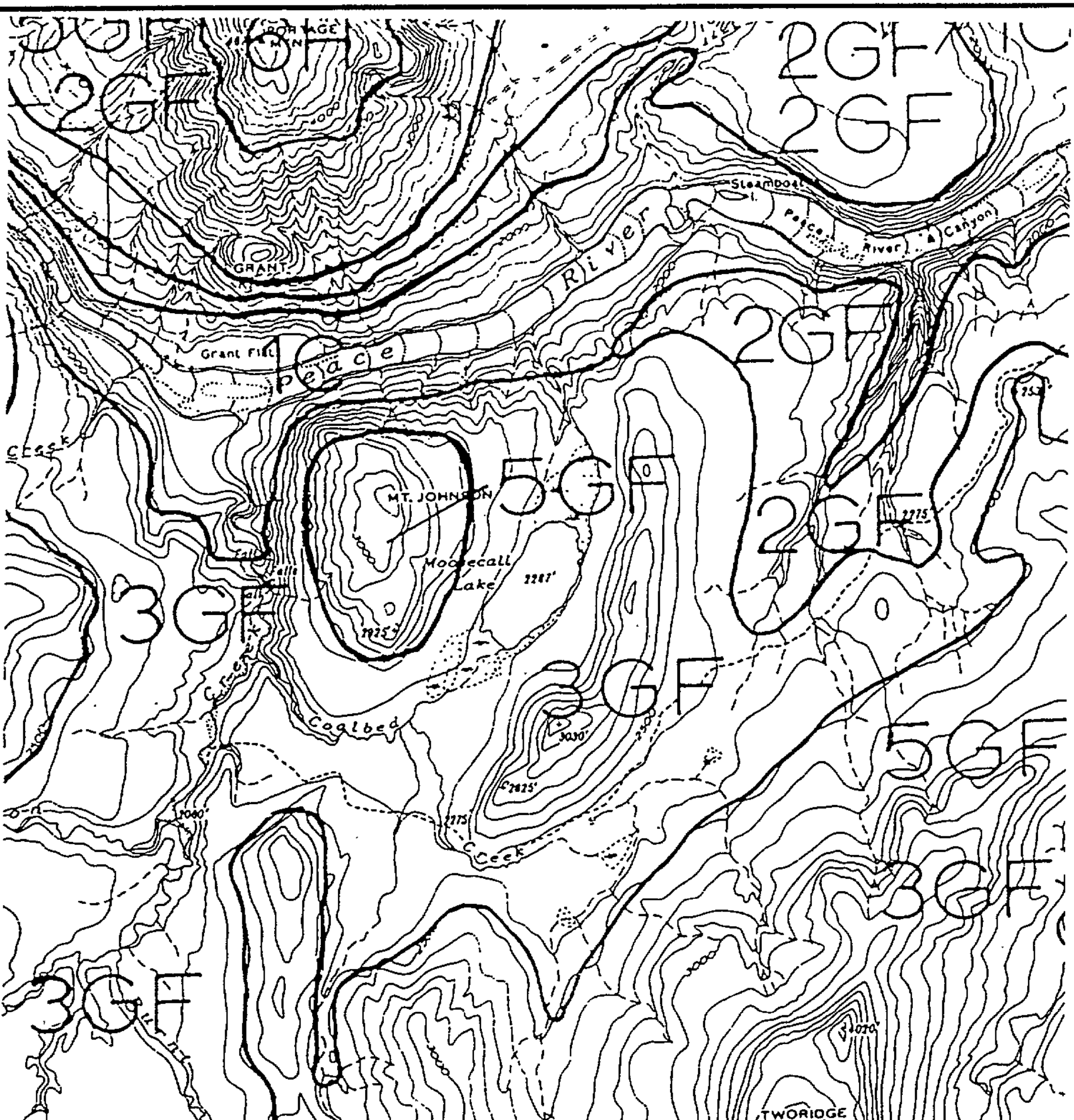
P PRECIPITATION (DAILY MEASUREMENT BY AES STANDARD RAIN GAUGE)
T TEMPERATURE (DAILY MAX. AND MIN. MEASURED IN STEVENSON SCREEN)
I INTENSITY OF RAINFALL (TIPPING-BUCKET RECORDING RAINGAUGE)
E EVAPORATION (CLASS A EVAPORATION PAN)
W WIND (RECORDING ANEMOMETER OR WIND-RUN TOTALISER)
H HUMIDITY (WET AND DRY BULB THERMOMETERS OR HYGROTHERMOGRAPHS)
S SUNSHINE (CAMPBELL-STOKES SUNSHINE RECORDER)
R RADIATION (INSOLATION MEASURED BY PYRHELIOMETER)
Q NET RADIATION
X HOURLY AVIATION WEATHER REPORTS INCLUDING PRESSURE, WIND, TEMPERATURE, HUMIDITY, VISIBILITY, WEATHER AND CLOUD.
F/P FISCHER-PORTER DIGITAL RECORDING PRECIPITAT GUAGE
S/P STANDPIPE OR SACRAMENTO STORAGE PRECIPITATION GUAGE
U UPPER-AIR OBSERVATIONS

DWG 5071

ACTIVE METEORLOGICAL STATIONS IN WILLISTON LAKE AREA

(From: Williston Lake Reservoir Study — D.G. Schaefer - 1976)

FILE	PROJECT
DWN bgs	APP
DATE 8/81	REV
FIGURE 4-2-1B	



CLIMATE CAPABILITY FOR AGRICULTURE

(FROM RAB Technical Paper 1)

IEC

DRAWN	DATE
b.g.s	9/81
CHECKED	APPROVED

FIGURE: 4-2-2A

TABLE 4.2.2. A

Hudson Hope B.C.H. P.A. Dam
Mean Temperature °C
(Summaries from A.E.S. offices, Vancouver, B.C.)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1971	-20.2	-7.3	-6.7	3.6	9.8	13.4	16.4	15.6	8.3	inc	-4.3	-14.1
1972	-16.7	inc	-6.2	-.8	9.4	12.8	13.1	14.5	6.4	3.4	-3.3	-13.2
1973	-10.8	-10.0	-3.2	4.0	10.0	12.2	15.4	13.3	9.3	3.3	-14.4	-11.7
1974	-19.8	-10.9	-10.4	2.1	6.4	12.9	13.1	14.1	10.5	6.5	-.5	m
1975	-10.4	-12.0	-7.2	.6	7.6	12.7	16.4	13.3	11.6	2.8	-5.1	-10.6
1976	-9.0	-9.9	-4.6	5.0	8.2	11.2	13.8	12.4	11.7	4.6	1.1	-9.3
1977	-7.7	0.3	-2.8	5.0	9.7	13.3	14.3	14.3	5.1	9.1	-5.1	-16.4
1978	-13.4	-8.4	-4.4	3.2	8.4	15.0	16.2	13.7	8.9	7.6	-4.4	-8.1
1979	-14.1	-24.7	-.8	.8	7.1	12.9	16.2	15.7	11.2	5.9	.7	-4.7
1980	-14.9	-6.8	-5.5	5.8	9.12	13.8	m	12.5	9.4	7.8	2.2	-15.8
MEAN	-13.7	-10.0	-5.2	2.9	8.6	13.0	15.0	13.9	9.2	5.7	-3.3	-11.5

inc - incomplete
m-missing

TABLE 4.2.3 A

Hudson Hope - B.C.H.P.A. Dam

Total Precipitation mm/No. Days

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1971	83.8/11	6.4/1	16.5/5	5.1/1	inc	inc	119.9/15	52.8/10	34.3/12	18.0/6	52.1/10	20.3/4
1972	22.1/6	inc	37.1/11	18.8/6	3.3/3	82.0/16	247.1/14	79.5/7	96.5/14	11.4/5	30.5/6	40.9/9
1973	27.9/4	66.0/6	16.3/4	6.6/5	4.1/3	50.8/8	25.7/8	68.6/10	42.2/11	28.2/8	26.2/14	24.4/5
1974	68.1/12	39.1/4	48.3/inc	5.6/3	62.7/ind	25.4/4	87.9/13	40.2/6	98.6/8	18.3/4	24.1/5	M
1975	30.0/10	14.2/4	29.0/8	M	64.0/11	96.5/7	56.4/8	54.1/12	-	21.3/6	111.3/13	29.2/7
1976	15.5/4	15.2/9	14.2/7	4.3/inc	50.3/10	109.7/20	58.2/12	186.2/14	15.0/6	24.4/4	22.6/3	61.7/9
1977	7.1/6	11.4/4	48.3/14	1.0/2	130.3/11	37.8/7	104.5/20	164.3/13	3.3/1	52.8/11	15.2/7	34.3/10
1978	38.4/7	19.3/7	31.8/9	12.4/6	88.1/12	52.3/8	61.7/10	49.8/12	75.7/12	.5/1	15.2/9	12.4/7
1979	22.4/4	79.2/19	2.0/2	34.3/6	47.0/8	42.2/15	117.7/13	50.0/9	59.0/11	28.0/2	-	28.5/9
1980	24.2/inc	13.7/7	31.3/inc	M	37.9/9	M	144.0/15	41.6/16	65.7/14	7.8/6	13.2/3	110.2/15
Aveg.	34.0	29.4	27.4	11.0	50.1	62.1	102.8	77.7	49.0	21.1	31.0	40.2

inc - incomplete
ind - indefinite
TR - Trace
M - missing

TABLE 4.2.3 B

Hudson Hope - B.C.H.P.A. Dam

Snowfall (cm)/No. Days

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1971	83.8/11	6.4/1	5.7/5	5.1/1	inc	inc	-	-	-	10.2/1	52.1/10	20.3/4
1972	22.1/6	inc	30.5/9	14.0/3	-	-	-	-	24.1/3	9.7/4	30.5/6	40.9/9
1973	27.9/4	66.0/6	15.5/3	TR	-	-	-	-	-	5.3/2	2.2/14	24.4/5
1974	68.1/12	39.1/4	48.3/ind	5.6/3	-	-	-	-	11.2/1	11.4/1	24.1/5	M
1975	30.0/10	14.2/4	29.0/8	M	TR		-	-	-	8.9/3	97.0/12	29.2/7
1976	15.5/4	15.2/9	14.2/7	2.0/1	-	-	-	-	-	0.5/1	22.6/3	61.7/9
1977	7.1/6	11.4/4	26.4/9	1.0/2	-	-	-	-	3.3/1	-	15.2/7	34.3/10
1978	58.4/7	19.3/7	31.8/9	12.4/6	2.5/1	-	-	-	-	-	15.2/2	12.4/9
1979	22.4/4	79.2/19	20.1/2	34.3/6	-	-	-	-	-	28.0/2	-	28.5/9
1980	24.2/inc	13.7/7	31.3/inc	2.4/inc	-	M	-	-	-	3.7/25	-	110.2/15
Aveg.	34.0	29.4	23.5	8.5	.3	0	0	0	3.9	7.8	28.3	40.2

inc - incomplete
ind - indefinite
TR - Trace
M - missing

(Summaries from AES Office, Vancouver, B.C.)

TABLE 4.2.3 C

Maximum 24-hr Precipitation (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1971	25.4	6.4	7.6	5.1	inc	ind	53.2	22.4	12.4	10.2	12.7	11.4
1972	10.2	17.8	7.6	7.6	2.8	42.4	78.7	42.2	20.8	5.1	10.2	12.7
1973	10.2	15.2	6.6	18.5	2.8	16.0	10.7	21.3	18.3	9.1	4.6	10.4
1974	20.8	25.4	M	2.3	15.5	13.7	41.7	10.9	34.8	11.4	13.0	M
1975	6.6	10.2	12.4	M	19.1	67.3	24.4	23.6	-	5.1	26.4	13.0
1976	6.4	3.6	4.1	ind	16.5	29.7	11.4	62.0	6.4	16.3	11.2	28.4
1977	2.0	5.3	11.4	.5	37.1	17.0	20.8	71.1	3.3	16.5	3.3	11.2
1978	12.4	12.2	8.4	4.3	27.4	18.0	12.2	16.8	33.5	.5	4.1	4.1
1979	16.5	22.4	1.0	20.8	17.0	7.0	49.4	24.4	16.5	27.0	-	5.2
1980	9.4	8.8	M	M	11.4	M	49.8	22.0	19.8	2.5	6.0	30.0
MAX	25.4	25.4	12.4	20.8	37.1	42.4	78.7	62.0	34.8	27.0	26.4	30.0

inc - incomplete record
ind - indefinite
M - missing

The percentage of precipitation in the form of snow encountered in the study area would probably be slightly higher than those values recorded for Hudson Hope due to the higher elevation of the study area.

4.2.4 Wind

The Wind Roses shown in Figure 4.2.4A shows that the winds in the Hudson Hope area are primarily from the south to southwest and, to a lesser extent, from the east-northeast area. A small percentage of the wind is from the southeast.

Figures 4.2.4B and 4.2.4C (AES Summary) show that during February and March the wind direction in the Hudson Hope area is primarily from the north, however, during the summer and fall months the wind direction is from the southwest. These tables also demonstrate that there is little wind from the southeast.

The yearly mean wind speeds recorded at Hudson Hope BCHPA Dam were 10.3 kh (6.4 mph). The highest average wind speeds for the 5-year average was 11.7 km/h (7.3 mph) in October, and the lowest was 9.3 km/h (5.8 mph) in May.

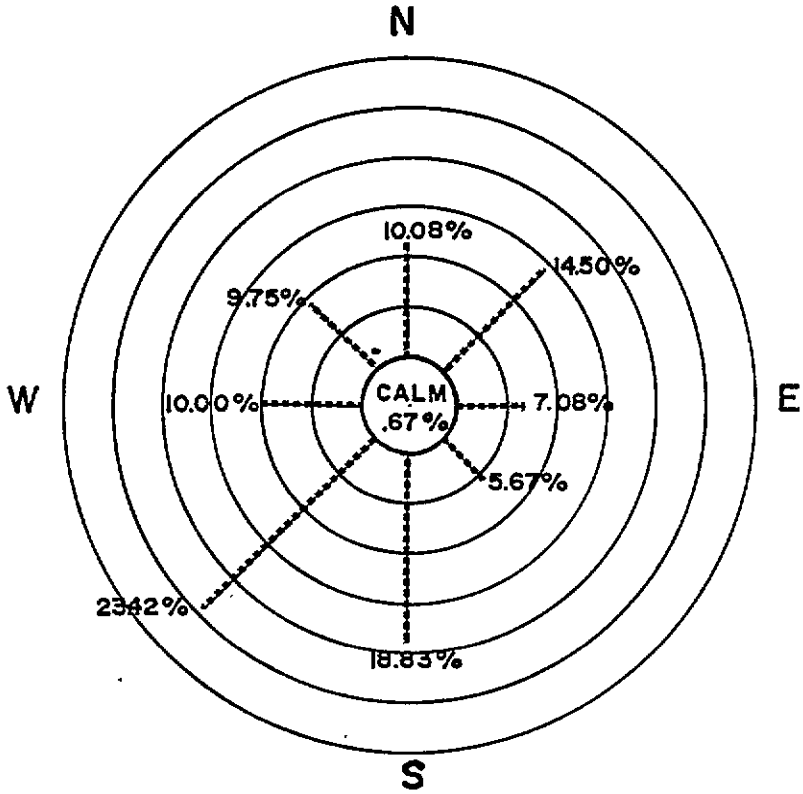
The close proximity of the mountains to the study area would probably decrease the velocity of the winds, especially from the north and the west. Winds from the south-southwest and northwest will probably be the least affected by the mountains.

4.3 Air Quality

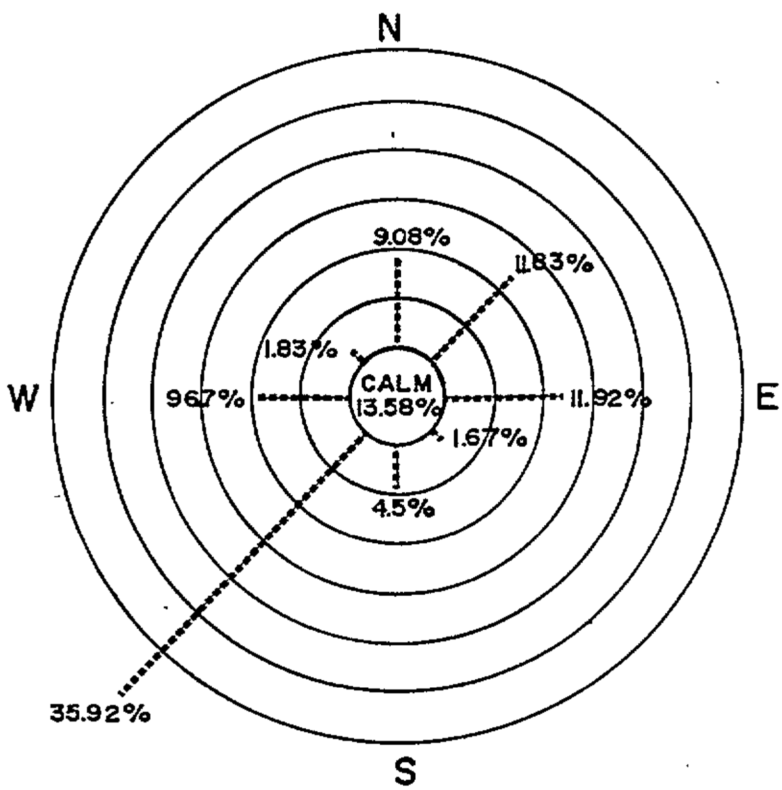
At present there is very little local or regional air quality data but, because the study area is located in an undeveloped area, the air quality is probably relatively clean.

A logging road passes through the property which is used by Canadian Forest Products Ltd. Dustfall levels in areas of active logging roads would be expected to be higher

near the road than further away from disturbances. M. S. Kotturri, (1979) in a study conducted near Chetwynd, discovered that the dustfall near an active logging road



YEARLY AVERAGE FOR JUNE 1971 - DEC. 1971 (BCHPA Dam)



YEARLY AVERAGE FOR SEPT. 1932 - NOV. 1942

HUDSON HOPE, B.C. - WIND ROSE	IEC	DRAWN bgs	DATE 8/81
		CHECKED	APPROVED
		FIGURE: 4-2-4A	

FIGURE 4-2-4 B

	J	F	M	A	M	J	J	A	S	O	N	D
N	11	14	17	15	14	12	12	10	8	3	2	3
NE	15	20	25	17	17	14	11	11	12	8	13	11
E	8	15	10	8	5	5	4	4	3	4	8	11
SE	4	5	4	5	4	4	6	5	8	9	6	8
S	19	15	12	14	15	13	20	20	25	30	21	22
SW	22	16	17	19	21	24	22	29	25	33	29	24
W	9	5	7	9	10	12	11	11	10	9	14	13
NW	11	8	7	12	13	15	13	10	9	4	7	8
CALM	1	2	1	1	1	1	1	0	0	0	0	0
MEAN SPEED (km/h)	11.1	10.8	9.3	9.2	10.1	10.5	9.7	9.0	10.1	11.7	10.8	11.6

Hudson Hope, B.C. (B.C.H.P.A. Dam) - Percentage Frequency Wind Direction (and Calms) and Mean Wind Speed by Months (June 1971 - December 1976).

FIGURE 4-2-4 C

	J	F	M	A	M	J	J	A	S	O	N	D
N	11	11	10	8	6	7	5	7	6	8	15	15
NE	18	22	19	13	7	6	5	4	8	9	15	16
E	15	15	13	9	12	13	11	12	14	7	11	11
SE	1	0	1	3	2	2	2	2	2	3	1	1
S	2	2	4	6	6	7	7	6	5	4	2	3
SW	19	17	29	41	45	41	46	42	41	49	35	26
W	7	5	10	10	11	12	13	14	11	12	5	6
NW	1	1	1	1	3	2	2	3	3	2	2	1
CALM	26	27	13	9	8	10	9	10	10	6	14	21
MEAN SPEED (km/h)	5.0	4.5	7.2	8.4	8.4	6.9	6.4	6.1	6.1	8.0	6.9	5.3

Hudson Hope, B.C. - Percentage Frequency Wind Direction (and Calms) and Mean Wind Speed by Months (September 1935 - November 1942).

averaged 20 g/m^2/month (.59 oz/yd^2/mo) at 15 m (4.6 ft) from the road and 9 g/m^2/month (.27 oz/yd^2/mo) at 30 metres (9 ft) from the road. These values exceed the provincial residential standards of 5.25 g/m^2/month (.15 oz/yd^2/mo).

The winds in the area are predominantly from the south to southwest and from the northeast. Any airborne particles picked up from the study area in these winds would probably not pass over any highly populated area before settling out or dispersing. The wind speeds of 9.2 to 11.7 kmh (5.7 to 7.3 mph) found at Hudson Hope would probably be sufficient to allow for adequate dispersion.

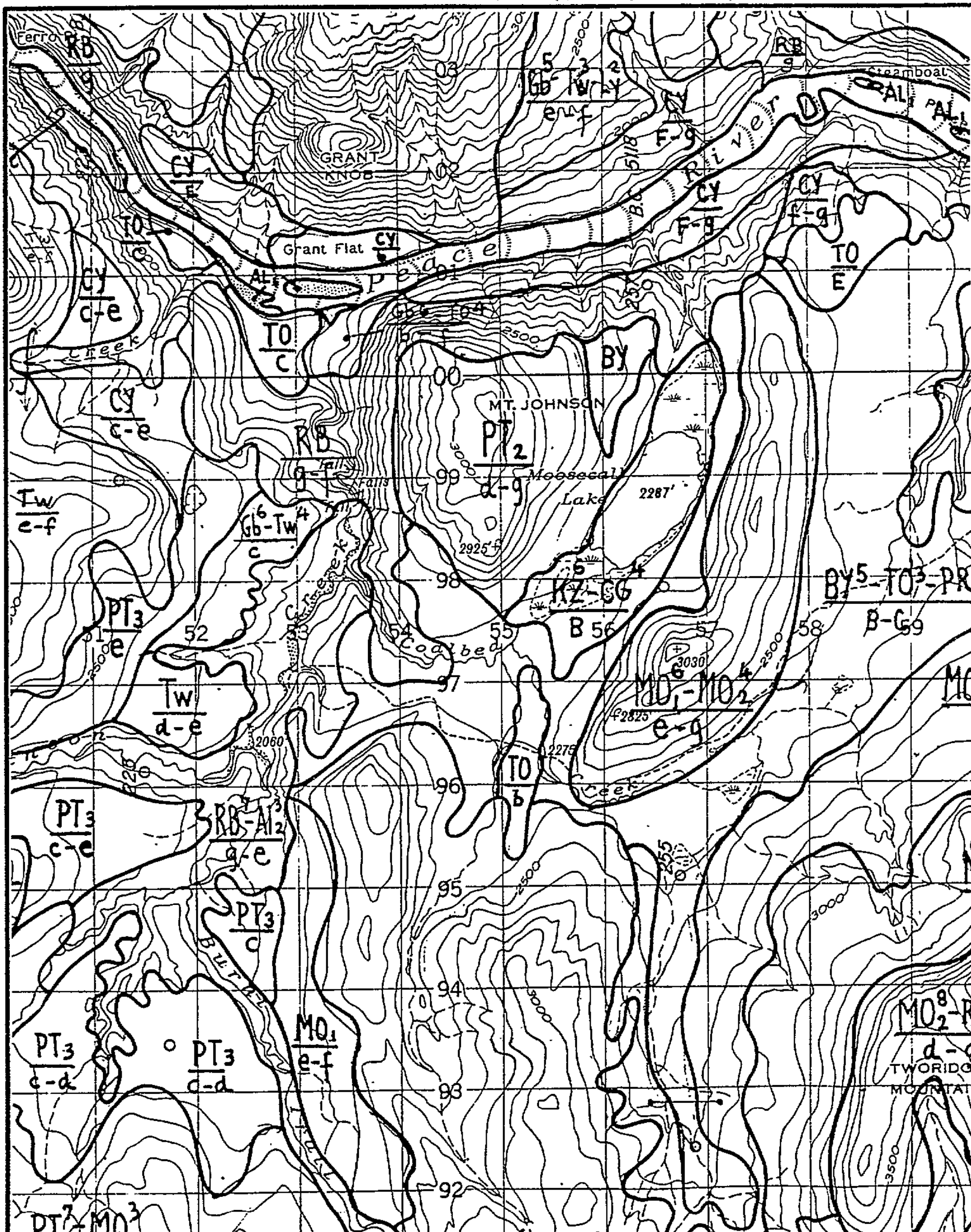
The relatively high precipitation found in the area would benefit the air quality by removing particulates and would suppress windblown dust (M. S. Kotturri, 1979).

4.4 Soils

The Canada Land Inventory has published a map which documents the soil types found in the study area. The soil classifications in the study area are presented as Figure 4-4 A. The legend (Table 4.4 A) explaining the maps symbols was obtained from the CLI office, with amendments by Alex Green (pers. comm.), L. Farstad, et.al., in Soil Survey of the Peace River Area in British Columbia (1965) which documents the types of soil found in the study area. The land adjacent to Johnson Creek is labelled as being "eroded, steeply sloping, and broken land adjacent to a stream course." The majority of the study area is listed as having soil developed from glacial till of the Moberly series and the area around Moosecall Lake is listed as having soils developed from organic materials of the Kenzie Series.

4.5 Vegetation

The study area lies within the Boreal Forest Region of Canada in the Lower Foothills Section (Farstad, 1965). This section is characterized by the predominance of lodgepole pine,(Pinus contorta latifolia), spruce (Picea sp), fir (Albies sp), and balsam (Populus balsamifera). White birch (Betula spp) are also found in this Section. Areas which have poor drainage usually are vegetated by larch (Lorix occidentalis), (Picea mariana) black spruce, and willows (Salix interior).



SOILS OF THE JOHNSON CREEK AREA

(FROM Canada Land Inventory)

IEC	DRAWN bgs	DATE 8/81
	CHECKED	APPROVED
	FIGURE: 4-4A	

TABLE 4.4. A

Soils Legend

[CLI and A.Green (pers. comm.)]

Map Symbol	Map Unit Name	Soil Groups	Texture of Solum, Parent Material	Landform and Dominant Topography	Drainage	Comments
Al	Alluvial	Regosols	Sandy and loamy deposits on neutral and alkaline sands and gravel	Level and gently sloping stream terraces	Mainly well drained	Variable textu drainage and topography
By	Beryl	Brunisolic Gray Luvisol	Silt loam and very fine sandy loam on calcareous heavy lacustrine clay	Smooth gently sloping lacustrine basin Rolling plain	Moderately well drained	About 16" VFS overlay on lacustrine clay
Cg	Cogol	Typic Mesisol sphagnic phase	Partly decomposed fibrous organic materials developed mainly from sphagnic mosses plus sedges and cotton grasses	Depressions Level to very gently sloping	Very poorly drained	
Cy	Clayhurst	Degraded Eutric Brunisol	Sandy loam and gravelly sandy loam over calcareous gravelly loamy sand	Moderately coarse and medium textured deposits on glacio-fluvial terraces and valley trains	Rapidly drained	
Gb	Groundbirch	Degraded Eutric Brunisol	Very fine sandy loam over calcareous very fine sands and silts	Pitted outwash plain short gentle and moderate slopes Hummocky topography	Rapidly drained	
Kz	Kenzie	Terric Mesisol (sphagnic phase)	Partly decomposed fibrous organic material derived mainly from sphagum mosses	Depressions Level and very gently sloping	Very poorly drained	
Pr	Prestville	Orthic Gleysol (peaty phase)	Clay over heavy neutral to alkaline lacustrine clay	Level and depressional areas where the drainage is poor	Poorly drained	
Mol	Moberly	Brunisolic Gray Luvisol	Loam and clay loam on calcareous stony clay loam and clay till	Moderately and steeply sloping drumlinized till plain	Well drained	
Mo2	Moberly	Brunisolic Gray Luvisol	Loam and clay loam on calcareous stony clay loam and clay till	Moderately and steeply sloping till plain	Well drained	
Pt	Portage	Degraded Eutric Brunisol	Very fine sandy loam with bands of loam and clay loam on neutral and alkaline very fine sand	Strongly and steeply sloping colluvium in basins and on mountain slopes	Well drained	
RB	Rough Broken Land Type		Colluvium and rock	Very steep and dissected slopes along drainage channels and escarpments	Rapidly drained	
TL	Toad and Lynx	Brunisolic Gray	Medium texture Alluvial outwash		Moderately well drained	

The study area is located almost totally within Region 7.3, Compartment Number 99 of the Forest Cover Map issued by the Forest Inventory Division of the B. C. Forest Service. The Map Area Statements, Map Volume Statement and the Forest Cover Map show the major and minor tree species found in the study area. Lodgepole pine (Populus tremuloides), aspen spruce, and balsam are the major tree species while birch is the minor tree species found in the study area.

The Forest Capability Maps, published by Canada Land Inventory, indicate that the study area would have lodgepole pine as the major tree species with white spruce (Picea glauca ssp glauca) and black spruce as the minor tree species.

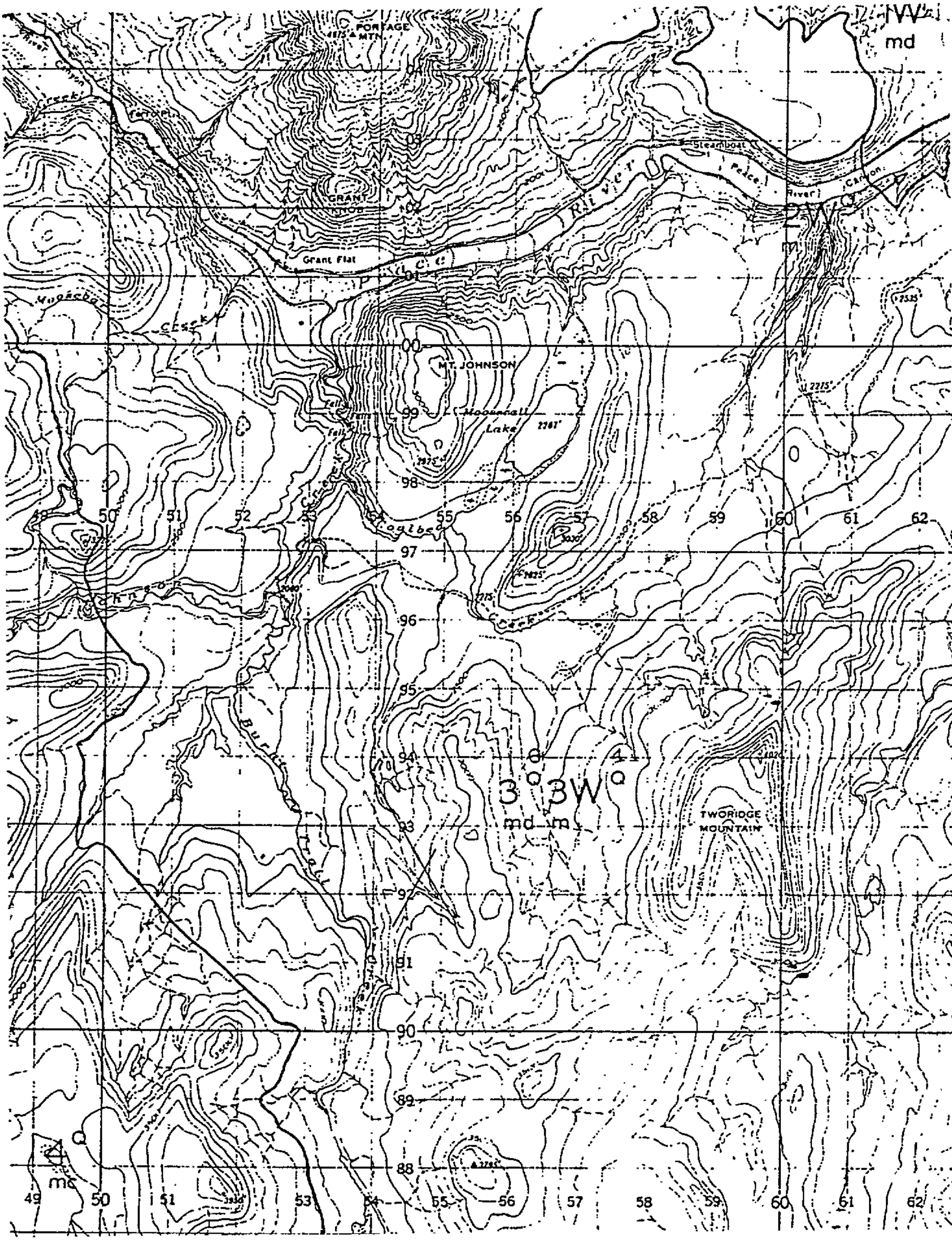
Thurber Consultants Ltd. working for B. C. Hydro (1973) discovered that the stretch of the proposed reservoir around Johnson Creek contained cottonwood (Populus trochocarpa), alder (Alnus rugosa and A. crispa), willow, birch, lodgepole pine, and white spruce as the primary forest cover.

The major browse species that they encountered in the Johnson Creek area included: red osier dogwood (Cornus stolonifera), saskatoons (Amelanchier alnifolia), willow, aspen, and cottonwood.

4.6 Wildlife

There is very little information on wildlife in the study area. The Canadian Land Inventory has prepared a map covering the study area on the land capability for ungulates (Figure 4-6A and Appendix 2) and the Resource Analysis Branch has published a report on the Wildlife Resources in the northeast area of the province (Resource Analysis Branch, 1977).

B.C. Hydro, in preparation for Site One development, commissioned some work on wildlife within the area of the proposed reservoir. The area near the mouth of Johnson Creek was part of the area which was examined. Most of the area that was studied is presently under Dinosaur Lake, however, the data collected during the studies could be used to indicate the status of wildlife in the study area.



UNGULATE CAPABILITY

(FROM Canada Land Inventory 1973)

IEC	DRAWN bgs	DATE 9/81
	CHECKED	APPROVED
	FIGURE: 4-6 A	

Individuals in the Fish and Wildlife Branch of the British Columbia Ministry of the Environment were contacted for some site specific information on furbearers.

4.6.1 Ungulates

Ungulates reported in or near the study area include moose (Alces alces andersoni), mule deer (Odocoileus hemionus hemionus), stone sheep (Ovisdalli stonei), goat (Oreamnos americanus), and elk (Cervus canadensis nelsoni).

Moose (Alces alces andersoni)

The Canadian Land Inventory (CLI) rates the study area as having a moderately high capability for moose production, with reduced production some years. The CLI also rates the study area as being important winter range for moose, however, excessive snow depths in the area interferes with the movement and feeding of the moose.

B.C. Hydro reported in 1973, that within the reservoir area, the highest concentration of moose were found on the area to the east of Johnson Creek. The report also shows the Johnson Creek area as being moose winter range.

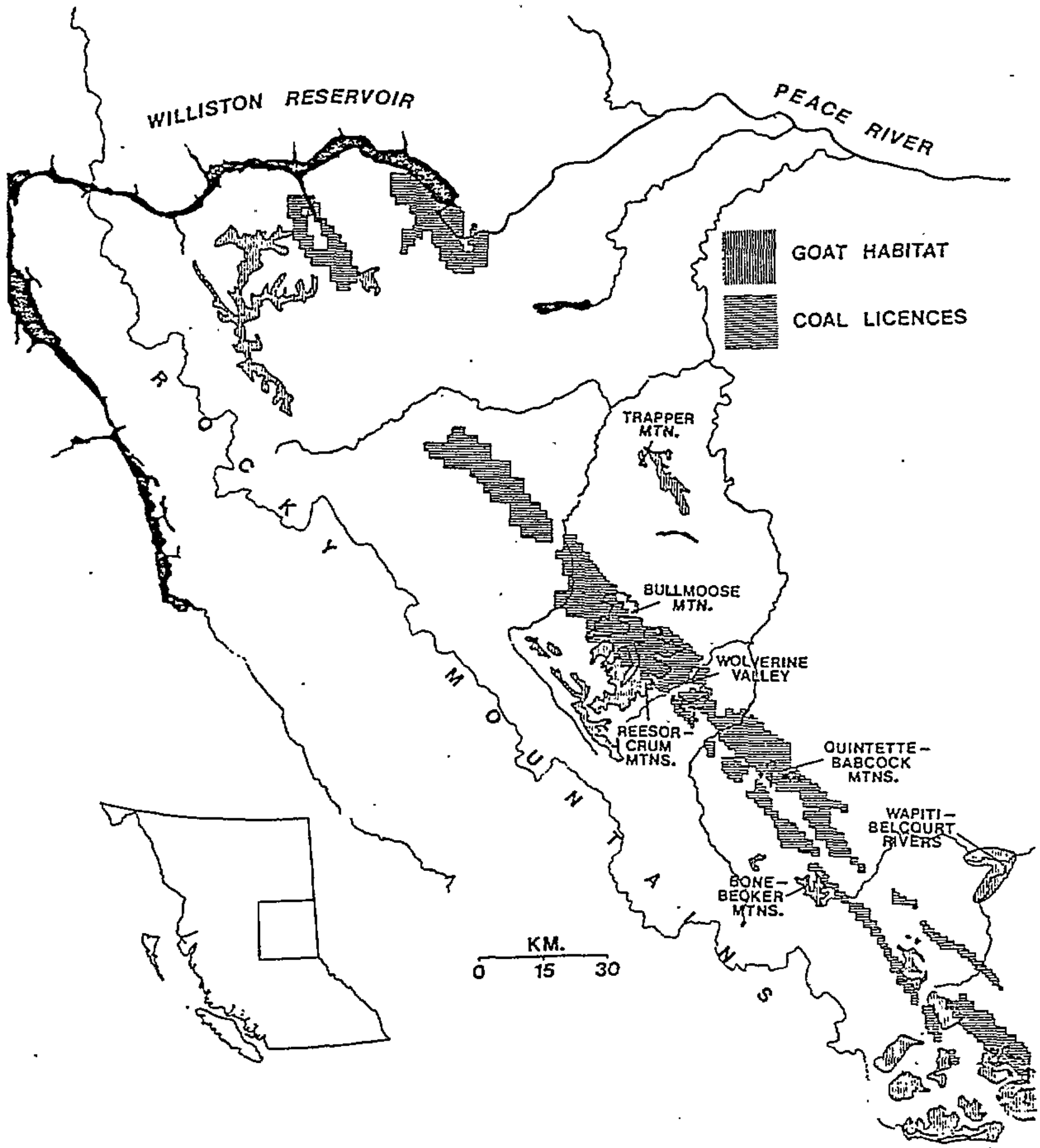
Mule Deer (Odocoileus hemionus hemionus)

The CLI rates the study area as having a moderately high capability for deer production with reduced productivity some years. The excessive snow depth of the area limits mobility and feeding of the deer.

B.C. Hydro in 1973 observed that there appeared to be very little use, by deer, of the Johnson Creek area.

Stone Sheep (Ovis dalli stonei) and
Mountain Goats (Oreamnos americanus)

The CLI map shows no capability for sheep or goat production in the study area and the RAB Bulletin 6 (1977) indicates that there is no goat habitat in or near the study area (Figure 4-6-1C).



COAL LICENCES AND GOAT HABITAT IN NORTHEASTERN BRITISH COLUMBIA

(FROM Resource Analysis Branch 1977)

IEC

DRAWN	DATE
bgs	8/81
CHECKED	APPROVED

FIGURE: 4-6-1C

The B.C. Hydro report (1973) reports that stone sheep were observed on the northside of the Peace River about 8 km (5 mi) downstream of Johnson Creek, well outside of the study area.

Elk (Cervus canadensis nelsoni)

The CLI maps for ungulate capability indicates that there is no capability for elk production within the study area. The B.C. Hydro report (1973) reports that very little sign of elk was discovered during the study, and only two elk have been harvested in the Hudson Hope area within the preceding seven years.

4.6.2 Furbearers

There is very little information on furbearers in the study area. Native trappers are not required to submit trapping returns and the returns that are filed by non-native trappers are confidential.

Mr. Dwyer (pers. comm.) of the Fish and Wildlife Branch in Dawson Creek, indicated that the commercially important furbearers in the study area include:

beaver	(Castor canadensis),
coyote	(Canis latrans),
lynx	(Canadensis canadensis)
marten	(Martes americana)
fisher	(Martes pennanti)
muskrat	(Ondatra zibethica)
mink	(Mustela vison) and
squirrel	(Tamiasciurus hudsonicus)

He also mentioned that weasel (Mustela erminea) and otter (Lutra canadensis) were found in the vicinity of the study area.

The B.C. Hydro Environmental Impact Study (1973) reported the presence of the following furbearers in the Site One Reservoir area:

coyote	(Canis latrans)
lynx	(Canadensis canadensis)
wolf	(Canis lupus)
black bear	(Ursus americanus)
red squirrel	(Tamiasciurus hudsonicus)
beaver	(Castor canadensis)
fisher	(Martes penanti)
wolverine	(Gulo luscus)
mink	(Mustela vison)
marten	(Martes americana)
ermine	(Mustela erminea) and
hare	(Lepus americanus)

The report also mentions several wood rat (Neotama cinerea) colonies found on the slopes of Mount Johnson.

4.6.3 Birds

The CLI has waterfowl capability maps available which include the study area. Most of the study area has such severe limitations that almost no waterfowl can be produced. The limiting factors for most of the study area are adverse topography and free flowing water. Moosecall Lake and some of the surrounding area has moderately severe limitations to the production of waterfowl. One of the limiting factors in the Moosecall Lake area is adverse topography.

B.C. Hydro (1973) conducted a survey of the birds in the Site One Reservoir area and in a 37 km (23 mi) stretch of the Peace river, extending downstream from 1.6 km (1 mi) below the W.A.C. Bennett Dam. A list of the birds observed during the study is presented in Table 4.6.3 A.

TABLE 4.6.3 A

Birds Observed During Site One Reservoir Study
(B.C. Hydro & Power Authority, 1973)

The following species were observed between Mile No. 12 in the Reservoir Area and the Halfway River, 23 miles downstream of the Site One Dam Site

•Common loon	Gavia immer	•Gray jay	Perisoreus canadensis
•Canada goose	Branta canadensis	•Blue jay	Cyanocitta cristata
White fronted goose	Anser albifrons	•Black-billed magpie	Pica pica
•Mallard	Anas platyrhynchos	•Common raven	Corvus corax
Pintail	Anus acuta	•Common crow	Corvus brachyrhynchos
•Green-winged teal	Anas carolinensis	•Black-capped chickadee	Parus atricapillus
Blue-winged teal	Anas discors	Boreal chickadee	Parus hudsonicus
American widgeon	Mareca americana	•Robin	Turdus migratorius
Shoveler	Spatula clypeata	•Hermit thrush	Hylocichla guttata
Common goldeneye	Bucephala clangula	•Swainson's thrush	Hylocichla ustulata
•Barrow's goldeneye	Bucephala islandica	•Golden-crowned kinglet	Regulus satrapa
Bufflehead	Bucephala albeola	•Ruby-crowned kinglet	Regulus calendula
•Harlequin duck	Histrionicus histrionicus	•Starling	Sturnus vulgaris
•Common merganser	Mergus merganser	•Solitary vireo	Vireo solitarius
•Goshawk	Accipiter gentilis	•Red-eyed vireo	Vireo olivaceus
Sharp-shinned hawk	Accipiter striatus	•Philadelphia vireo	Vireo philidelphicus
Red-tailed hawk	Buteo jamaicensis	•Warbling vireo	Vireo gilvus
Golden eagle	Aquila chrysaetos	•Black-and-white warbler	Mniotilta varia
•Bald eagle	Haliaeetus leucocephalus	•Tennessee warbler	Vermivora peregrina
•Sparrow hawk	Falco sparverius	•Orange-crowned warbler	Vermivora celata
Marsh hawk	Circus cyaneus	•Yellow warbler	Dendroica petechia
•Ruffled grouse	Bonasa umbellus	•Magnolia warbler	Dendroica magnolia
•Kildeer	Charadrius vociferus	•Myrtle warbler	Dendroica coronata
•Spotted sandpiper	Actitis macularia	Black-throated green warbler	Dendroica virens
•Herring gull	Larus argentatus	Ovenbird	Seiurus aurocapillus
•Common nighthawk	Chordeiles minor	Northern waterthrush	Seiurus noveboracensis
•Belted kingfisher	Megaceryle alcyon	•MacGillivray's warbler	Oporornis tolmie
•Yellow-shafted flicker	Colaptes auratus	•Wilson's warbler	Wilsonia pusilla
•Yello-bellied sapsucker	Sphyrapicus varius	•American redstart	Setophaga ruticilla
•Hairy woodpecker	Dendrocopus villusus	•Redwinged blackbird	Agelaius phoeniceus
•Eastern phoebe	Sayornis phoebe	•Baltimore oriole	Icterus galbula
•Least flycatcher	Empidonax minimus	•Brewer's blackbird	Euphagus cyanocephalus
•Dusky flycatcher	Empidonax oberholser	•Brown-headed cowbird	Molothrus ater
•Western wood pewee	Contopus soridulus	•Western tanager	Piranga ludoviciana
•Olive-sided flycatcher	Nuttallornis borealis	•Rose-breasted grosbeak	Pheucticus ludovicianus
•Violet-green swallow	Tachycineta thalassina	•Purple finch	Carpodacus purpueus
•Tree swallow	Iridoprocne bicolor	•Pine siskin	Spinus pinus
•Rought-winged swallow	Riparia riparia	•Slate-colored junco	Junco hyemalis
•Barn swallow	Stelgidopteryx ruficollis	•Oregon junco	Junco oreganus
•Cliff swallow	Hirundo rustica	•Chipping sparrow	Spizella passerina
		•White-throated sparrow	Zonotrichia albicollis
		Lincoln's sparrow	Melospiza lincolnii
		Song sparrow	Melospiza melodia

•Species observed within Canyon.

4.7 Hydrology

4.7.1 Surface Water Quantity

Water quantity data specifically for Johnson Creek is available from the work performed for B. C. Hydro (1975) on summer discharges and flows (Figures 4.7.1 A, and 4.7.1B). The Figure shows that the discharge in lower Johnson Creek dropped from 10 m^3/s (353.1 ft^3/s) in mid-May to 2 m^3/s (70.62 ft^3/s) in mid-June. The discharge fluctuates between 2.5 m^3/s (88.28 ft^3/s) and .25 m^3/s (8.83 ft^3/s). The flow dropped fairly steadily from 1.4 m/s (4.6 ft/s) in May and June to .5 m/s (1.6 ft/s) in late August. There is no information available on winter flow conditions.

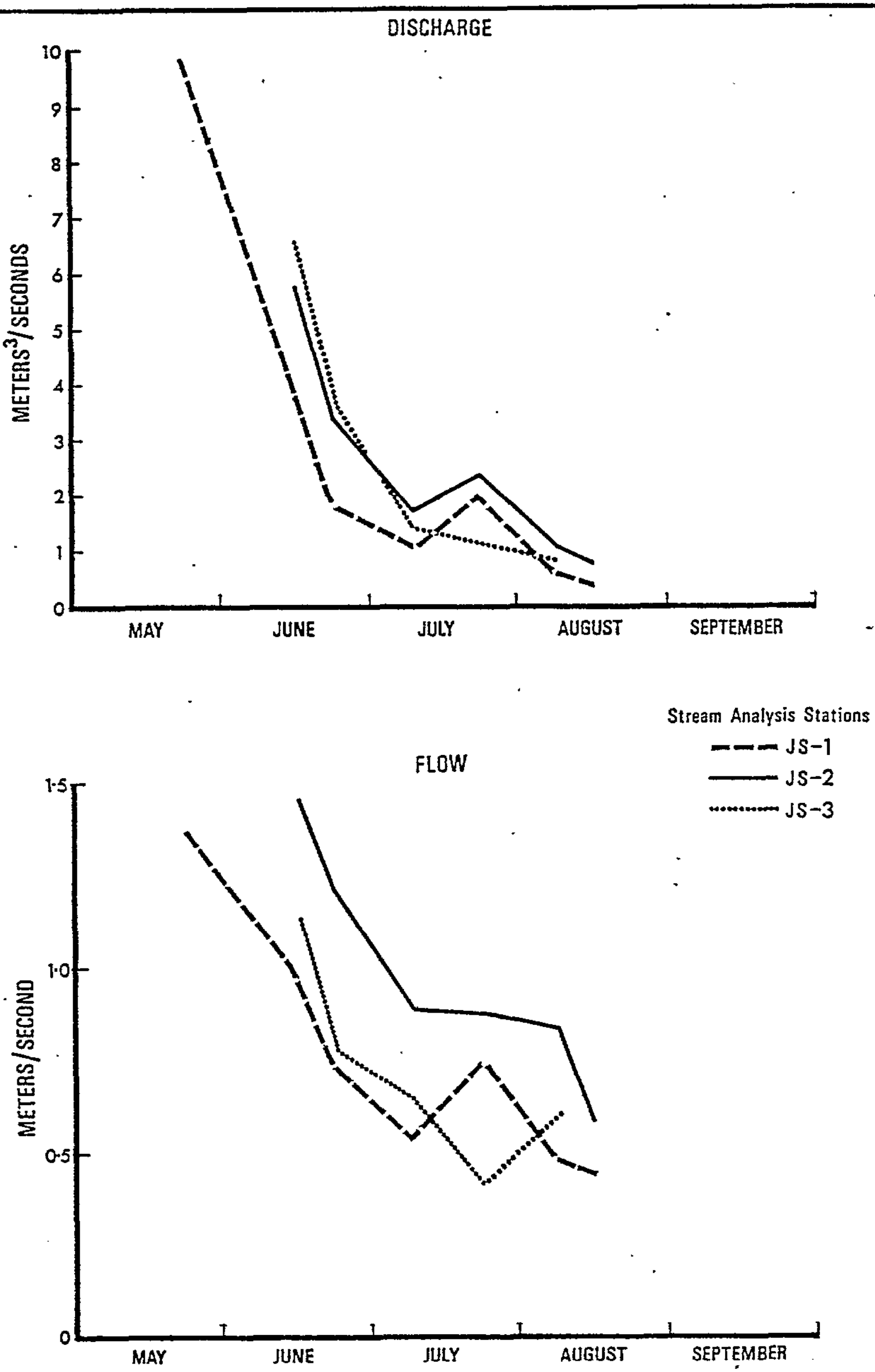
Water Survey of Canada has no metering stations on Johnson Creek or Coalbed Creek but they do have stations in the same general area. Metering stations which are in the vicinity of the study area and which would have flows related to flows on Johnson Creek include: the Peace River at Hudson Hope, the Halfway River near Farrell, The Halfway River above the Graham River, and a new station on the Moberly River (Cowie, pers. comm.).

4.7.2 Water Quality

4.7.2.1 Available Data

There is no water quality data available for Johnson Creek from government agencies, however, there is data available on other streams in the vicinity. The Federal Government, collected water quality data at the Moberly River near Highway #29 (Table 4.7.2.1 A) from 1966 to 1969. The Provincial Government also collected water quality information from the Moberly River, at the inlet to Moberly Lake, in 1976 (Table 4.7.2.1 A).

The British Columbia Hydro and Power Authorities commissioned water quality studies in Johnson Creek and in the Peace River in 1974 and in 1975. The chemical parameters examined in 1974 (Table 4.7.2.1 B) show that the pH was slightly alkaline, the conductivity was relatively low, the dissolved oxygen was high and the water



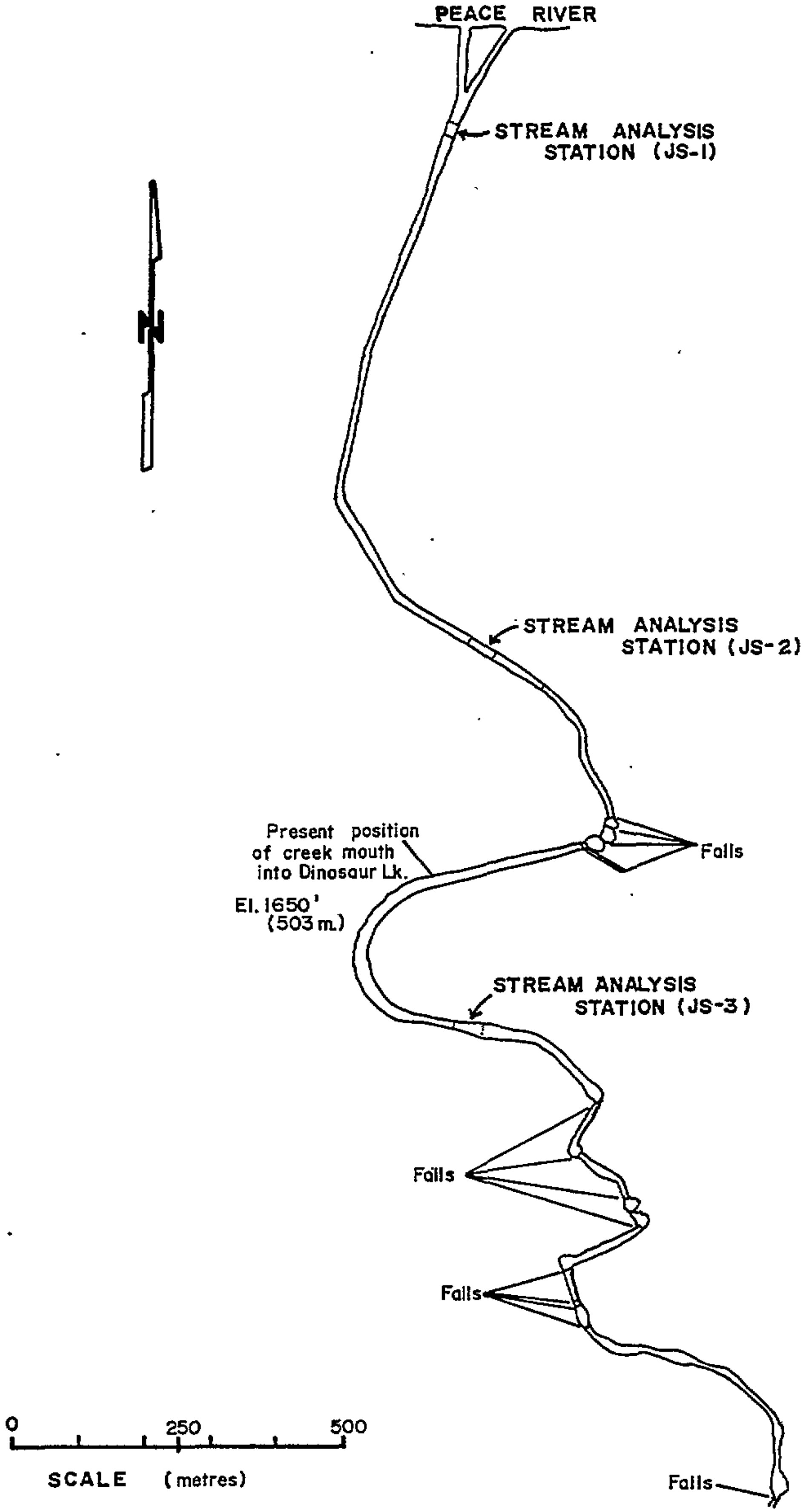
SUMMER DISCHARGE AND FLOW IN JOHNSON CREEK

(From Site One Development - Recreation and Fisheries Study - British Columbia Hydro and Power Authority 1975)

IEC

DRAWN bgs	DATE 8/81
CHECKED	APPROVED

FIGURE: 4-7-1 A



JOHNSON CREEK - Location of Falls and B.C. Hydro Stream Analysis Stations

(From B.C. Hydro 1976)

IEC

DRAWN bgs	DATE 8/81
CHECKED	APPROVED
FIGURE: 4-7-1 B	

3093.1

TABLE 4.7.2.1 A
Environment Canada, Water Quality Branch, Inland Waters Directorate
Moberly River at Highway No. 29, at Bridge Outlet of Moberly Lake, B.C.

		Aug. 26/66	Sept. 19/67	Aug. 20/69
PHYSICAL TESTS				
pH		7.7	8.1	8.2
Conductivity (micrombos/cm)		160	169	152
Colour (Pt-Co scale) (RU)		5	15	30
Turbidity (JTU)		.2	1.5	4.7
Hardness (mg/L)				
Temperature		17.2	12.8	16.1
SOLIDS (mg/L)				
Total Suspended				
Total Dissolved		90	88	91
Hardness (CaCO3 mg/L)		-	85.7	88.2
DISSOLVED ANIONS (mg/L)				
Alkalinity: Bicarbonate	HCO3	98	98	100
Alkalinity: Carbonate	CO3	0	0	0
Alkalinity: Total	CACO3	80	80	82
Chlorides	Cl	.5	.3	.2
Sulfates	SO4	4.4	4.2	6.5
Nitrates	N			
Nitrites	N			
Ortho Phosphates	O-PO4			
Fluorides	F	.09	.01	L .1 05 L
DISSOLVED METALS (mg/L)				
Cadmium	Cd			
Calcium	Ca	29.3	23.6	24.8
Copper	Cu			
Iron	Fe			
Lead	Pb			
Magnesium	Mg	-	6.5	6.4
Manganese	Mn			
Potassium	K	.6	.6	.4
Sodium	Na	1.3	1.7	1.4
Zinc	Zn			
TOTAL METALS (mg/L)				
Aluminum	Al			
Antimony	Sb			
Arsenic	As			
Barium	Ba			
Beryllium	Be			
Bismuth	Bi			
Boron	B			
Cadmium	Cd			
Calcium	Ca			
Chromium	Cr			
Cobalt	Co			
Copper	Cu	-	L .01	L .01
Iron Suspended	Fe	-	.180	-
Lead	Pb	-	L .01	L .01
Magnesium	Mg			
Manganese	Mn	-	L .01	-
Molybdenum	Mo			
Nickel	Ni			
Phosphorus	PO4			
Potassium	K			
Silicon	SiO2	2.9	3.1	2.4
Silver	Ag			
Sodium	Na			
Strontium	Sr			
Tin	Sn			
Titanium	Ti			
Vanadium	V			
Zinc	Zn	-	L .01	L .01
POLLUTANT TESTS (mg/L)				
Total Organic Carbon	C	-	-	.7
Total Phosphate	PO4	-	.007	.010
Nitrogen	NO2			
Total Phenolics as Phenol				
Tannins & Lignins as Tannic Acid				

mg/L = milligrams per liter

Table 4.7.2.1 B

JOHNSON CREEK CHEMICAL PARAMETERS, 1974*
(B.C. Hydro, 1975)

Parameters	24 May	6 Jun	20 Jun	4 Jul	18 Jul
Time (hr)	1300	1300	1230	1400	2000
Air Temp.(°C)	15	18	19	12	17
Water Temp.(°C)	7	9.5	12	11.5	12
Turbidity (F.T.U)	-	40	25	15	30
Alkalinity (mg/l)	-	60	80	100	80
pH	-	7.1	7.4	7.35	7.7
Dissolved O_2(ppm)	10.5	9.0	10.0	12.0	11:0
Conductivity	100	111	140	190	152
CO_2 (mg/l)	-	8	-	8	8
Ortho-phosphate	-	N/R	N/R	N/R	N/R
Nitrogen	-	N/R	N/R	N/R	N/R

* All analytical samples were collected from Station JS-1 in Johnson Creek. Analysis performed in situ using Model DR-EL/2 Hach Kit.

** N/R = No Reaction.

temperature was fairly high. In 1975, it was again discovered that the water temperatures in Johnson Creek (Table 4.7.2.1 D and Figure 4-7-2-1A) was relatively high, especially when compared with the water temperatures in the Peace River.

The turbidity tests conducted by B.C. Hydro on Johnson Creek (Table 4.7.2.1. D) water in 1974 indicated that Johnson Creek had a relatively low average turbidity of 28 FTU, although when turbidity tests were run on the water from Johnson Creek in the summer of 1975, it was discovered that the turbidity of Johnson Creek rose to as high as 1000 FTU during periods of high precipitation. In 1975, when turbidity tests were run on the Peace River and on Johnson Creek (Table 4.7.2.1 E), it was shown that Johnson Creek could be as much as 11 times more turbid as the Peace River.

4.7.2.2 IEC Monitoring

In July 1981, IEC were commissioned to begin a water monitoring study. Five water quality stations in Johnson Creek, Coalbed Creek and in Moosecall Lake were established. These stations are plotted on Figure 4-1 A.

Grab samples were collected below the water surface. Most of the water samples were collected in polyethylene containers except water samples for phenol analysis which were collected in glass containers. The water samples were filtered, when necessary, and chemically preserved in the field prior to shipment to Vancouver for laboratory analysis.

The data collected from the Moberly River indicates that the water in that region is fairly alkaline, with variable turbidity, and with a conductivity of approximately 162 micromhos per centimetre.

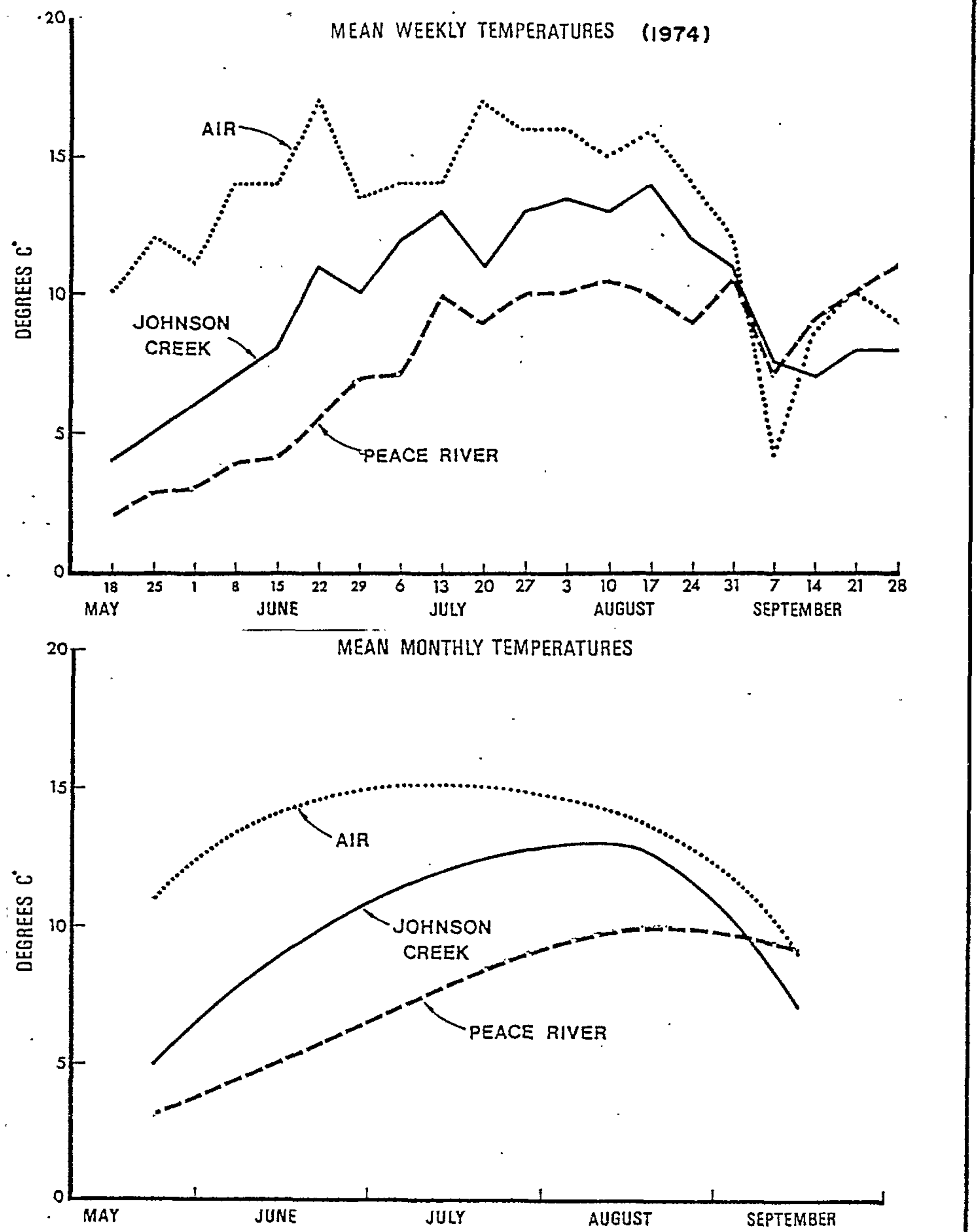
The procedures used for the majority of the parameters measured were those described in A Laboratory Manual for the Chemical Analysis of Waters, Wastewaters, Sediments and Biological Materials, published by the Government of British Columbia, Ministry of Environment, Water Resources Services, 1976. Nitrate-nitrogen was measured in accordance with Standard Methods for the Examination of Water and Wastewater, American Public Health Association, 1975, and most metals were determined using Inductively Coupled Plasma Spectrographic analysis, graphite furnace atomic absorption spectrophotometry or hydride generation.

Table 4.7.2.1 C

WATER TEMPERATURES MEASURED IN JOHNSON CREEK AND PEACE RIVER NEAR JOHNSON CREEK - 1975

(B.C. Hydro, 1976)

	Johnson Creek		Peace River near Johnson Creek	
Date	Time	Temp	Time	Temp
7 Jun	1900	10°C	1900	4.5°C
10 Jun	1230	12.5°C	2030	5°C
10 Jun	1530	12°C	-	-
11 Jun	1345	11°C	1345	5°C
11 Jun	1930	12°C	1930	5°C
12 Jun	1315	11°C	-	-
12 Jun	1530	11°C	1530	5°C
13 Jun	1750	15°C	1750	5°C
14 Jun	1845	11°C	1845	5°C
17 Jun	-	-	1710	5°C
18 Jun	1230	10°C	-	-
19 Jun	1815	14°C	1810	5.5°C
22 Jun	1600	13°C	1600	7°C
3 Jul	1930	15.5°C	1930	9°C
12 Aug	1510	11.5°C	-	-



TEMPERATURES IN PEACE RIVER AND JOHNSON CREEK

(FROM B.C. Hydro 1975)

IEC

DRAWN	DATE
bgs	8/81
CHECKED	APPROVED

FIGURE: 4-7-2-1A

Table 4.7.2.1 D

TURBIDITY CHANGES MEASURED IN JOHNSON CREEK - 1974
(B.C. Hydro, 1975))

Date	Sample Time (hr)	Turbidity (F.T.U.'s *)
24 May	1300	125
24 May	1600	125
5 Jun	1200	40
6 Jun	1300	40
9 Jun	1300	35
20 Jun	1230	25
22 Jun	1100	135
22 Jun	1915	35
4 Jul	1400	15
7 Jul	2100	55
8 Jul	1515	45
8 Jul	1800	165
9 Jul	1100	15
12 Jul	1900	35
15 Jul	1930	1000
17 Jul	2115	50
18 Jul	2000	30
7 Sep	1430	30
9 Sep	1100	130
17 Sep	1230	30
30 Sep	1500	10

* Formazin Turbidity Units as determined in situ using Model DR-EL/2 Hach Kit.

Table 4.7.2.1 E

WATER TURBIDITY IN JOHNSON CREEK (CONFLUENCE) & PEACE RIVER - 1975

(B.C. Hydro, 1976)

Date	Johnson Creek Turbidity	Peace River Turbidity	Comments
6 Jun	30 FTU		
10 Jun	30 FTU	8 FTU	
13 Jun	35 FTU		
14 Jun	30 FTU		
17 Jun	45 FTU	5 FTU	after 2 days heavy showers
18 Jun	110 FTU	10 FTU	during heavy showers
10 Jun	50 FTU	10 FTU	
22 Jun	35 FTU		
9 Aug	2 FTU		
29 Sep	3 FTU		

The results of the tests are summarized in Table 4.7.2.2 A.

4.7.2.3 Analytical Results - Regional Characterization

A summary of the water quality criteria for general use, drinking water and aquatic life as recommended by the Inland Waters Directorate and by the Department of National Health and Welfare are presented on Table 4.7.2.3 A. Most of the physical and chemical properties of the streams fall within the limits found in the recommendations. The water was found to be fairly alkaline. The iron concentrations for all of the stations was higher than that recommended for general use, drinking water and aquatic life. The concentrations of aluminum and zinc were higher in most of the water samples, than the levels recommended for aquatic life. Ortho-phosphate levels were high enough to encourage excessive plant growth in Lower Coalbed Creek and Moosecall Lake. Nitrate levels in Moosecall Lake was slightly lower than the maximum limit for aquatic life.

4.7.2.4 Characterization of Individual Streams

<u>Station No.1 Lower Johnson Creek - Downstream Control Station</u>

This station is located downstream of the lowest falls on Johnson Creek and upstream of the confluence of Johnson Creek and Peace River. The reach on which the station was located was moderately sloping, with a substrate composition of approximately 20 percent fine, 40 percent gravel and 40 percent large.

The water was slightly alkaline with a pH of 8.3 and a bicarbonate alkalinity of 118. The turbidity and concentration of lead was higher than that recommended for general use and drinking water. The concentration of aluminum and zinc was higher than the level recommended for aquatic life and the concentrations of chromium and iron was higher than that recommended for general use, drinking water and aquatic life. The level of ortho-phosphate could encourage excessive plant growth. All other parameters fall below recommended limits for all normal uses of water.

TABLE 4.7.2.2 A
PEACE RIVER CANYON PROPERTY
RESULTS OF WATER QUALITY ANALYSIS
(IEC, 1981)

Station No.		1	2	3	4	5
FIELD TESTS						
Air Temperature		15	25	24	25	24
Water Temperature		17	16	17.5	15.5	15
PHYSICAL TESTS						
pH		8.30	8.20	8.20	8.10	8.60
Conductivity (micromhos/cm)		202.	190.	185.	129.	346.
Colour (Pt-Co scale) (CU)		50.	45.	100.	130.	80.
Turbidity (JTU)		6.1	3.4	4.7	4.8	23.
Hardness (mg/L)		98.5	92.5	88.5	62.5	171.
SOLIDS (mg/L)						
Total Suspended		L 0.5	L 0.5	L 0.5	L 0.5	42.0
Total Dissolved		165.	158.	157.	112.	290.
DISSOLVED ANIONS (mg/L)						
Alkalinity: Bicarbonate	HCO3	118.	112.	113.	74.9	193.
Alkalinity: Carbonate	CO3	Nil	Nil	Nil	Nil	6.7
Alkalinity: Hydroxide	OH	Nil	Nil	Nil	Nil	Nil
Chlorides	Cl	0.50	L 0.5	L 0.5	L 0.5	0.50
Sulfates	SO4	L 5.0	L 5.0	L 5.0	L 5.0	L 5.0
Nitrates	N	0.008	L 0.002	0.013	0.008	0.049
Nitrites	N	L 0.001	L 0.001	0.005	L 0.001	L 0.001
Ortho Phosphates	O-PO4	0.030	L 0.030	0.046	L 0.030	L 0.046
Fluorides	F	0.11	0.15	0.14	0.14	0.12
DISSOLVED METALS (mg/L)						
Cadmium	Cd	L 0.001	L 0.001	L 0.001	L 0.001	L 0.001
Calcium	Ca	27.2	25.6	23.2	15.9	43.4
Copper	Cu	0.004	0.004	0.002	0.003	0.006
Iron	Fe	0.24	0.24	1.20	1.97	0.11
Lead	Pb	L 0.001	0.006	0.005	0.002	L 0.001
Magnesium	Mg	7.33	6.85	6.90	4.71	15.2
Manganese	Mn	0.006	0.009	0.044	0.038	0.009
Potassium	K	1.10	0.97	1.02	0.87	1.97
Sodium	Na	2.94	2.72	4.11	4.04	5.89
Zinc	Zn	0.020	L 0.015	0.033	0.029	0.041
TOTAL METALS (mg/L)						
Aluminum	Al	0.55	0.39	0.52	0.32	L 0.15
Antimony	Sb	L 0.15	L 0.15	L 0.15	L 0.15	L 0.15
Arsenic	As	L 0.30	L 0.30	L 0.30	L 0.30	L 0.30
Barium	Ba	0.14	0.14	0.14	0.15	0.11
Beryllium	Be	L 0.003	L 0.003	L 0.003	L 0.003	L 0.003
Bismuth	Bi	L 0.5	L 0.5	L 0.5	L 0.5	L 0.5
Boron	B	0.016	0.031	0.024	0.084	0.10
Cadmium	Cd	L 0.025	L 0.025	L 0.025	L 0.025	L 0.025
Calcium	Ca	29.0	26.1	26.6	17.8	57.6
Chromium	Cr	0.25	0.032	L 0.03	0.051	0.057
Cobalt	Co	L 0.02	L 0.02	L 0.02	L 0.02	L 0.02
Copper	Cu	L 0.015	L 0.015	L 0.015	0.027	0.021
Iron	Fe	0.58	0.41	2.05	2.83	0.13
Lead	Pb	0.10	L 0.08	L 0.08	0.10	L 0.08
Magnesium	Mg	7.80	6.96	7.21	4.62	19.4
Manganese	Mn	0.013	0.012	0.062	0.063	0.049
Molybdenum	Mo	L 0.04	L 0.04	L 0.04	L 0.04	L 0.04
Nickel	Ni	L 0.025	L 0.025	L 0.025	L 0.025	L 0.025
Phosphorus	PO4	L 0.4	L 0.4	L 0.4	L 0.4	L 0.4
Potassium	K	1.20	1.07	1.49	0.97	2.24
Silicon	SiO2	7.84	7.10	8.49	9.94	14.3
Silver	Ag	L 0.03	L 0.03	L 0.03	L 0.03	L 0.03
Sodium	Na	2.98	2.88	4.16	4.14	6.65
Strontium	Sr	0.091	0.080	0.11	0.081	0.27
Tin	Sn	L 0.03	L 0.03	L 0.03	L 0.03	L 0.03
Titanium	Ti	0.026	0.018	0.030	0.033	0.038
Vanadium	V	L 0.010	L 0.010	L 0.010	L 0.010	L 0.010
Zinc	Zn	0.26	0.029	L 0.015	0.039	0.024
POLLUTANT TESTS (mg/L)						
Total Organic Carbon	C	6.	4.	18.	18.	55.
Total Phosphate	PO4	0.11	0.10	0.10	0.11	0.10
Ammonia Nitrogen	NO2	L 0.05	L 0.05	0.17	0.16	0.50
Total Kjeldahl Nitrogen	N	0.55	0.35	1.20	1.30	3.20
Total Phenolics as Phenol		L 0.001	0.004	0.011	0.004	L 0.001
Tannins & Lignins as Tannic Acid		0.70	0.64	1.38	2.04	1.12

mg/L = milligrams per litre

TABLE 4.7.2.3. A

WATER QUALITY CRITERIA for SELECTED PARAMETERS

Parameter*	Units	General Use	Drinking Water	Aquatic Life
(Physical)				
color		-	15 Rel. Units	50 Rel. Units
pH		5.0-9.0	6.5-8.5	6.5-8.5
Conductance	umho/cm	500	-	3000
Temperature		-	15°C	25°C upper limit for salmonids.
Turbidity	JTU	3-5	5	10
(Chemical)				
Dissolved Oxygen	mg/l	-	-	Preferably at or near saturation but must be 5 mg/l
Total Solids	mg/l	500	-	-
Dissolved Solids	mg/l	500-1000	1000	5000 recommended
Total Alkalinity	mg/l	-	30-500	100-120
Total Hardness	mg/l		180	-
Fluoride	mg/l		1.5	-
Ammonia Nitrogen	mg/l		0.5	-
NO_2NO_3 Nitrogen	mg/l	10 combined	10 combined	0.5 mg/l nitrate
Ortho-phosphate P	mg/l	-	0.2	0.01 mg/l orthophosphate may encourage excessive plant growth. 0.01-0.1
Total Phosphorus	mg/l	-	-	0.1
Phenol	mg/l		0.002	
Sulphate	mg/l	500	500	11-90
Tannin & Lignin	mg/l	500	500	11-90 4 mg/l tannic acid suggested
pH				pH should be within 6.5-8.5 range.
Al	mg/l	-	-	0.1
As	mg/l	0.05	0.05	0.05
Ba	mg/l	1.0	1.0	1.0 (0.5 mg/l for minimal risk)
Cd	mg/l	0.01	0.01	0.05
Ca	mg/l	200	200	15-52
Cr	mg/l	0.1	0.05	0.13
Cu	mg/l	1.0	1.0	0.1 (0.03 mg/l LTSF)**
Fe	mg/l	0.3	0.3 diss.	0.3
Pb	mg/l	0.05	0.05	0.1
Mg	mg/l	150	150	15-100
Mn	mg/l	0.50-0.1	0.05	1.0
Hg	mg/l	0.001	0.002	0.05
Mo	-	-	-	Not a significant pollutant.
Ni	-	-	-	0.025
K	mg/l	-	2000 extreme permissible limit	50
Na	mg/l	50	270 if dietary restriction applies	6-85
V	mg/l	0.1	-	-
Zn	mg/l	5.0	5.0	0.01

* - Concentrations expressed as total except when noted as dissolved.
** - LTSF lethal to some fish.
Sources: Water Quality Branch, Inland Waters Directorate, Publications.
Division of Public Health Engineering; Dept. National Health and Welfare, most stringent level quoted.

Station No.2 - Upper Johnson Creek

This station is located about 120 m (390 ft) downstream of the confluence of Johnson Creek and Burnt Trail Creek. The substrate in this moderately sloping reach consisted of approximately 10 percent fines, 20 percent gravels, 30 percent larges and 40 percent bedrock.

The water collected at this station was slightly alkaline with a pH of 8.2 and a bicarbonate alkalinity of 112.

The concentrations of aluminum and zinc were higher than the recommended limits for aquatic life and the concentrations of phenols and chromium were higher than that recommended for drinking water. The concentration of iron was higher than the recommended limits for general use, drinking water and aquatic life. All other chemical concentrations were below the recommended limits.

Station No.3 - Lower Coalbed Creek

This station was located 5 m (16 ft) upstream of the bridge crossing Coalbed Creek. The reach on which this station was located is moderately sloping and had a substrate consisting of 10 percent large and 90 percent bedrock.

The water at this station was slightly alkaline with a pH Of 8.2 and bicarbonate alkalinity of 113. The phenol and manganese concentrations are higher than those recommended for drinking water and the ortho-phosphate level may encourage excessive plant growth. The iron concentration was higher than the level recommended for general use, drinking water and for aquatic life. The water quality at this station was different from the other stations in the study area in that the zinc concentration was lower than the limits recommended for aquatic life and the chromium concentrate was lower than the limits recommended for drinking water. All other chemical concentrations were below the recommended limits.

Station No.4 - Upper Coalbed Creek

This station is located approximately 400 m (1,300 ft) upstream of the bridge crossing Coalbed Creek. The moderately sloping reach on which this station is located has a substrate composition of 40 percent fine, 30 percent gravel, and 30 percent large.

The water at this station was slightly less alkaline than the other stations, with a pH of 8.1 and a bicarbonate alkalinity of 74.9. The concentrations of phenols, chromium and manganese were higher than the recommended levels for drinking water and the concentrations of aluminum and zinc were higher than the recommended levels for aquatic life. Iron concentrations were higher than the level recommended for general use, drinking water and aquatic life. All other concentrations were below the recommended limits.

Station No.5 - Moosecall Lake

This station was located on the western side of the lake, slightly north of center. Moosecall Lake is situated within a swamp.

The water sampled from Moosecall Lake had a pH of 8.6 which was higher than the level recommended for drinking water and aquatic life and the bicarbonate alkalinity of 193 was higher than the limits recommended for aquatic life. The concentrations of calcium and zinc were above the recommended limits for aquatic life and the concentration of ortho-phosphate was high enough that it may encourage excessive plant growth. The concentration of ammonium nitrogen found was higher than the level recommended for drinking water. The turbidity for the water from Moosecall Lake was higher than the level recommended for general use, drinking water, and aquatic life.

The water from Moosecall Lake varied from the other waters tested in that the concentration of aluminum was below the recommended limit for aquatic life and the concentration of iron was below the recommended limit for general use, drinking water and aquatic life. The levels of all other parameters were within the recommended limits for the normal uses of water.

4.7.3 Groundwater

Drill holes made on the Cinnabar Peak property during the exploration phase encountered groundwater, but no quantitative or qualitative work was performed on the water. No data can be found in the existing literature which would indicate the status of the groundwater in the study area.

4.8 Fisheries

B.C. Hydro (1975) commissioned a study on the Recreation and Fisheries in the Site One Development Area. The location of trout spawning habitat, which was documented during the study, is illustrated on Figure 4-8A.

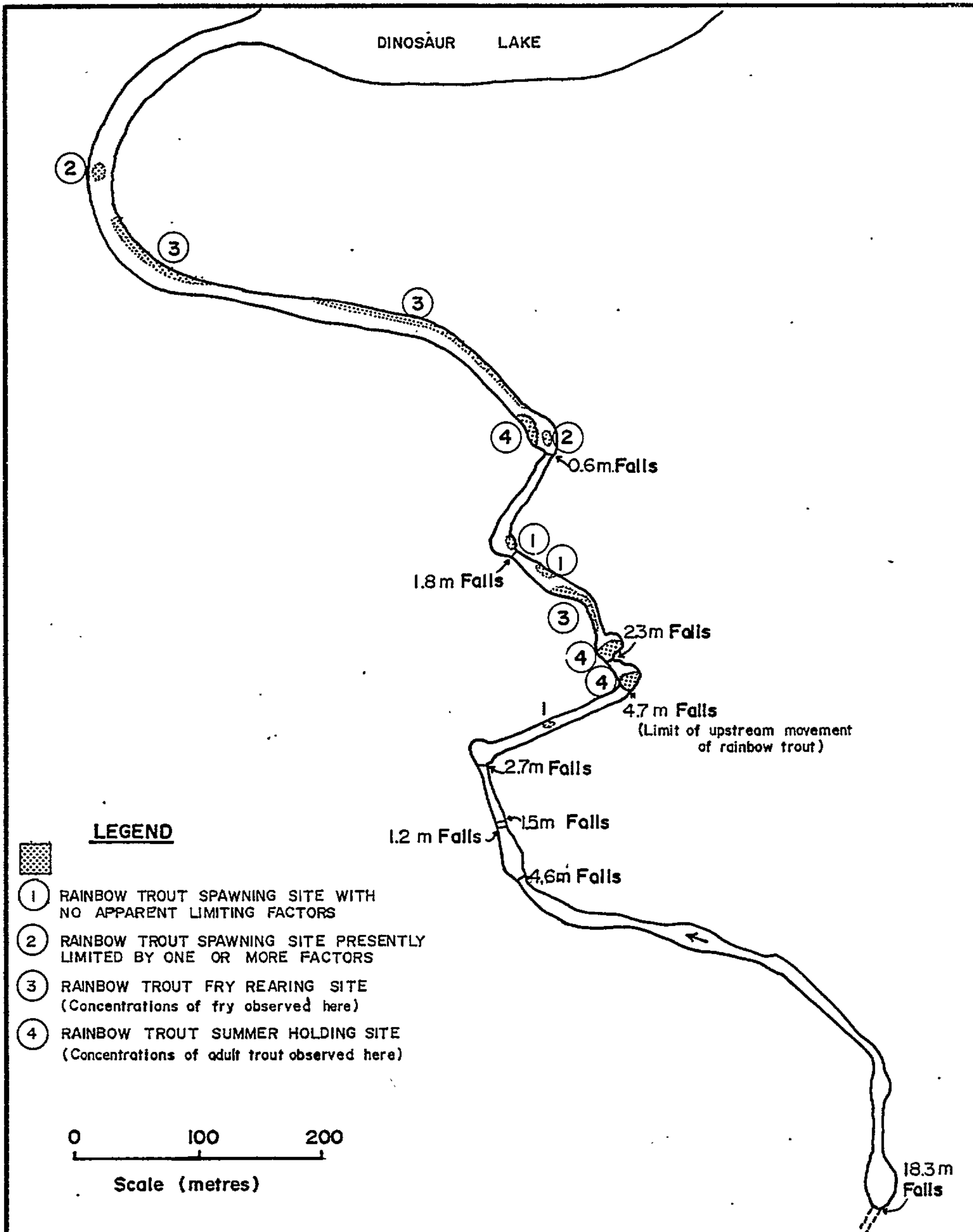
The fish captured in the lower reaches of Johnson Creek during B.C. Hydro's 1975 and 1976 surveys included: rainbow trout (Salmo gairdneri), mountain whitefish), (Coregonus williamsoni), arctic grayling (Thymallus articus), Dolly Varden char (Salvelinus alpinus malma), white sucker (Catostomus commersoni), longnose sucker (Catostomus catostomus), burbot (Lota lota), redside shiner (Richardsonius balteatus), slimy sculpin (Cottus cognatus), and spoonhead sculpin (Cottus ricei).

D. Ableson (pers.comm.) has indicated that he does not believe there are any fish in Moosecall Lake, Coalbed Creek, or Johnson Creek above the falls. He also stated that Johnson Creek, below the falls, has the best potential habitat for trout production with access to Dinosaur Lake and that the Fish and Wildlife Branch might enhance Johnson Creek to increase its trout production. Some of the brood stock for the fish hatchery at the Site One Dam was collected from lower Johnson Creek (C. Whiteman, pers. comm.).

The trout spawning period in Johnson Creek (B.C. Hydro, 1975) appears to occur between early June and mid July.

4.9 Aquatic Invertebrates

The only data available on aquatic invertebrates for the study area is found in the Site One Development, Recreation and Fisheries Study (B.C. Hydro, 1975). The area studied was the lower section of Johnson Creek. (Figure 4-7-1 B).



TROUT HABITAT OF LOWER JOHNSON CK.

(FROM B.C. Hydro 1975)

IEC

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FIGURE: 4-8 A	

3093.1

Ephemeroptera and Diptera were collected in the highest numbers (Table 4.9 A). Plecoptera, Tricoptera and Hydracarina were also collected. The large numbers of pollution sensitive organisms such as Emphemeroptera, Plecoptera, and Tricoptera, indicated that the stream is relatively pollution free (Beak, T.W., 1965). The Hydracarina and Diptera are considered to be intermediately pollution tolerant.

4.10 Recreation

The Canada Land Inventory has mapped the potential outdoor recreational features in the study area. The majority of the study area is situated within an area with a low capability for recreation. The land immediately adjacent to Johnson Creek is rated as having a moderate capability for recreation and the land bordering on Johnson Creek upstream of the study area is rated by CLI as having a moderately low capability for recreation.

Mount Johnson and surrounding areas, including Coalbed Creek, are listed by CLI as having the capability for observation of upland wildlife, topographic patterns and significant vegetation. The Canada Land Inventory lists the Moosecall Lake area as having a significant water surface, upland wildlife and wetland wildlife. The land bordering on Johnson Creek is rated as having the most capability for recreation in the study area and has potential in the areas of camping and observing topographic patterns, waterfalls and rapids. The land bordering on Johnson Creek upstream of the study area is listed by CLI as being an area suitable for camping and observing upland wildlife.

Canada Land Inventory lists all of the land adjacent to Johnson Creek as having a capability for angling. Personal Communication with D. Ableson, and observations made during the site visit by IEC personnel indicated that at the present time there are no fish in Johnson Creek above the falls. This would indicate that there is no angling capabilities in Johnson Creek above the falls. Fish were observed by IEC below the falls, indicating that there is angling capability in the mouth of Johnson Creek.

TABLE 4.9 A

Johnson Creek Benthic Samples* (mean number of organisms per square foot of substrate) (B.C. Hydro, 1975)

	June 11 Station JS			July 8 Station JS			August 8 Station JS			Sept. 21 Station JS		
	1	2	3	1	2	3	1	2	3	1	2	3
Ephemeroptera	16	11	28	13	17	67	28	59	34	33	150	28
Plecoptera	2	3	4	10	5	5	5	7	3	27	29	3[illegible]
Diptera	54	16	19	39	23	52	33	19	4	4	31	2
Tricoptera	2	2	2	1	2	7	-	3	2	1	3	6
Hydracarina	3	2	1	1	2	2	2	1	2	-	1	1
TOTAL	77	34	54	64	49	133	68	89	45	65	214	89

* 3 samples collected at each of three stations (JS-1, 2, and 3).

4.11 Heritage Resources

The Heritage Conservation Branch of the Province of British Columbia has no record of any archaeologically important site in the study area (Foster, pers. comm.).

The only historical site of interest in the study area consists of a small dam built across Johnson Creek during the period 1922-1926 (B.C. Hydro, 1973) for the purpose of supplying power to a sawmill on the southside of the Peace River. The dam was never used and there is no sign of it today.

4.12 Present Land Use

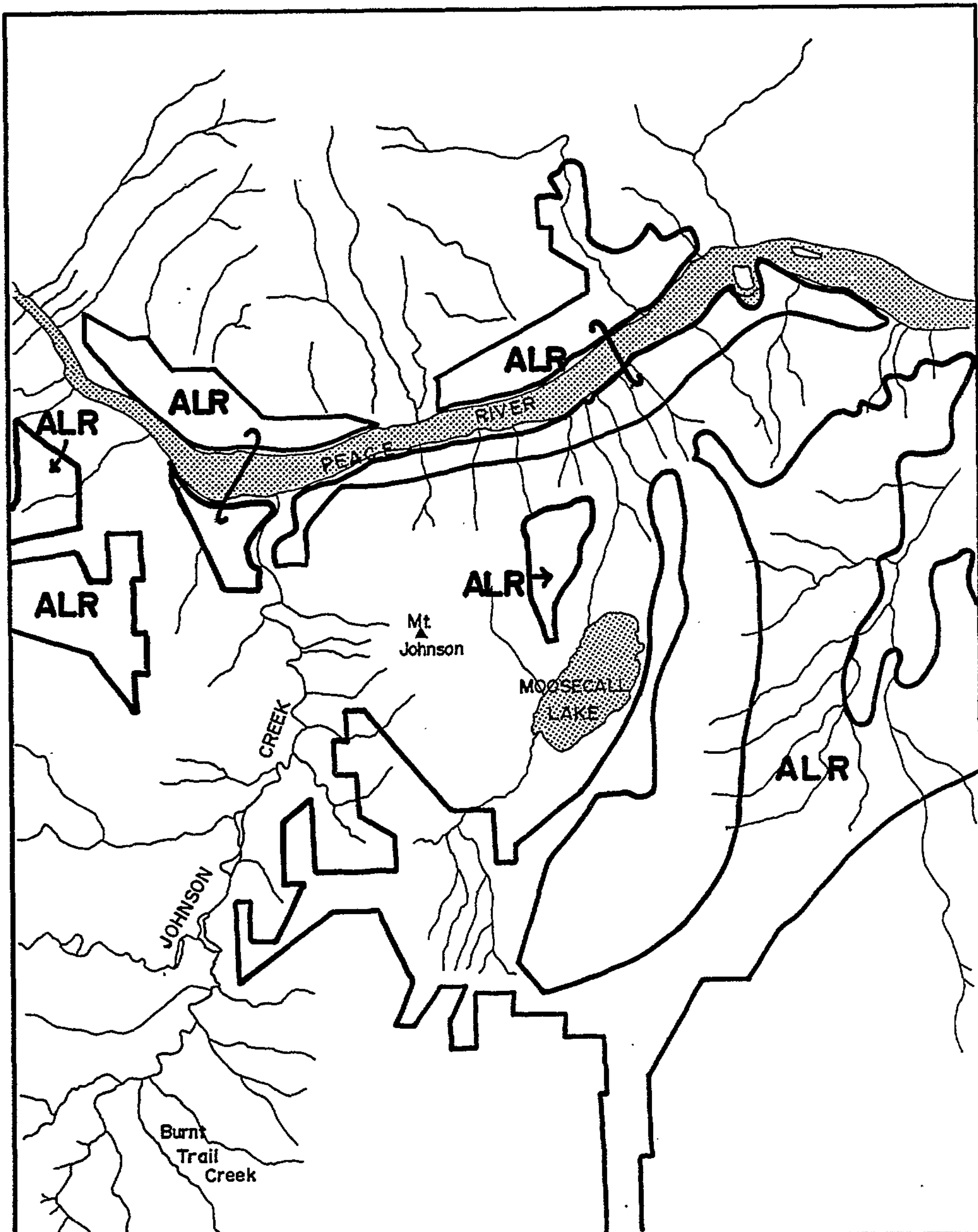
4.12.1 Land Tenure

The majority of the land in the study area is held by the Crown as coal lease, however, most of the south slope of Mount Johnson is owned by the Crown as Coal and Petroleum lease. A small portion of the study area at the mouth of Johnson Creek and on the southeast slope of Mount Johnson is owned privately. There are no water licenses for Johnson Creek, Burnt Trail Creek, Coalbed Creek and Moosecall Lake.

4.12.2 Agriculture

The Canada Land Inventory, Agriculture Capability, the Land Directory, Environment Canada, Soil Capability for Agriculture documents the soils found on Johnson Mountain as having no capability for agriculture or permanent pasture because the bedrock is less than one metre from the surface and because the terrain is too steep. Most of the remaining portion of the study area has severe to very severe limitations on the use of the land for agriculture. There is a small amount of land within the study area on which the soil has moderately severe limitations for agriculture.

A small portion of the study area is within Agricultural Land Reserves (ALR) (B.C. Agricultural Land Commission) (Figure 4-12-2 A). Some of the land to the northwest and some of the land to the southwest of Mount Johnson is within the ALR.



AGRICULTURAL LAND RESERVES - B.C. LAND COMMISSION

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FIGURE: 4-12-2A

4.12.3 Grazing

There are no grazing leases on the study area at the present time. A small grazing lease is located to the south of the study area.

4.12.4 Forestry

The predominant tree species in the study area are lodgepole pine and spruce, most of which is on Crown land, with a small percentage alienated. The land capability (CLI, Present Land Use Project, 1967) in most of the study area ranges from having severe to moderately severe limitations for the growth of commercial forests. A small portion of the study area has moderate limitations to the growth of commercial forests. The remaining land in the study area has severe limitations to the growth of commercial forests.

Most of the forest in the study area is immature productive woodland with a small portion of mature productive woodland. The land surrounding Moosecall Lake is swamp and non-productive woodland on non-productive sites.

4.12.5 Mining

The majority of the land in the study area is Crown land for coal or coal and petroleum lease. The history of coal use from the Peace River Canyon area extend into the 1850's. In 1947, Mr. Angier, remarked that one hundred years earlier, Hudson's Bay Company voyageurs had carried coal from this area, southward to New Caledonia (Bowes, 1952). Neal Gething had coal leases in the vicinity of the study area as early as 1908 (ibid). In 1912, Captain C.F.J. Galloway remarked that within a hundred years the coal mines on Johnson Creek would probably supply half of the prairie provinces with coal. W.S. Johnson held twenty coal leases in the vicinity of the study area in 1923 and Neal Gething, G. Ayland, and R.F. Green held forty coal leases in the same general area. King Gething worked with the seams in the vicinity of the study area in the early 1950's.

4.12.6 Recreation

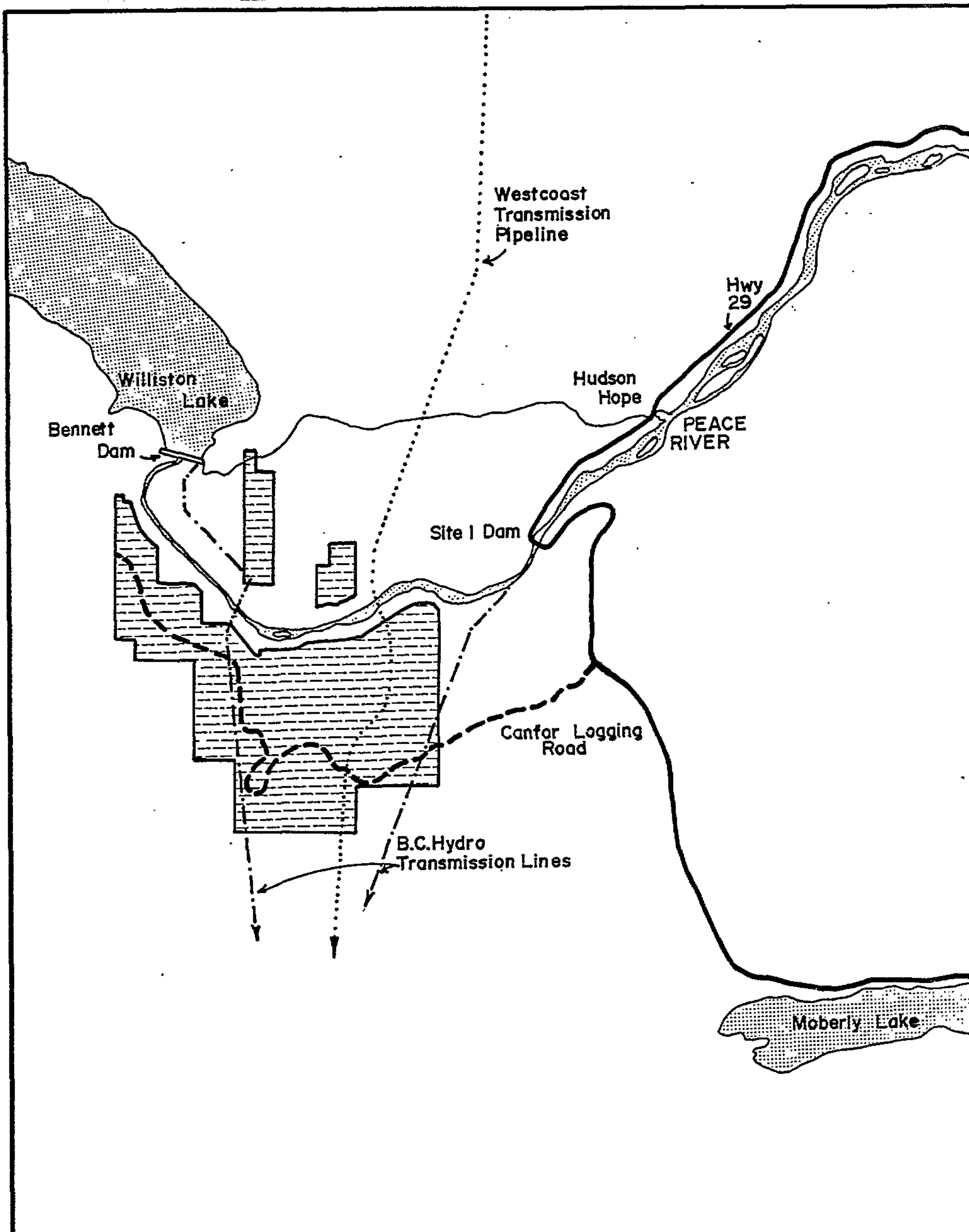
The majority of the land in the study area has low capability for outdoor recreation with the rest of the land having a moderate to moderately low capability for recreation.

Some of the recreational features of the land in the area are angling, organized camping, and viewing significant vegetation, upland wildlife, waterfalls and topographic patterns. Information on the amount and the areal extent of recreational use is not available.

The guiding territory which includes the study area is operated by Mr. Ed Barnett of Chetwynd, and the trapline which includes the study area is operated by Mr. Sanford Lawrence Cameron and by Mr. Dwane John Cameron of Chetwynd.

4.12.7 Rights-of-Way

B.C. Hydro, Westcoast Transmissions Ltd. and Canfor Ltd. have rights-of-way through the Peace River Canyon Property of Cinnabar Peak Mines Ltd (Figure 4-12-7 A). Two B.C. Hydro Power lines cross Cinnabar's property oriented north-south. One of the power lines is to the east of the study area and the other is to the west. The Westcoast Transmission's pipeline also crosses Cinnabar's property on a north-south orientation, east of the study area. Canfor's logging road crosses the southern portion of the study area on an east-west orientation. Part of the Peace River Canyon property bordering on the Site One Reservoir is Crown granted land alienated by B.C. Hydro.



MAP OF RIGHTS OF WAY AT CINNABAR PEAK MINES LTD. PEACE R. CANYON PROPERTY

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FIGURE: 4-12-7 A

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5.0 SOCIO-ECONOMIC AND COMMUNITY IMPACT ASSESSMENT

5.1 Methodology and Data Sources

The following discussion of socio-economic baseline and anticipated impacts provides both a regional perspective on the Peace-Liard Region and local information on Hudson Hope, the closest community most likely to be directly affected by the Cinnabar Peak coal mine development.

The regional data are based upon a field trip to the study area, a trip to Victoria to discuss the project with government officials, review of published data on the region, and time spent in Vancouver and Calgary meeting with officials representing other nearby projects (IEC 1979). During the field trip, interviews were held with city officials and civil servants representing such government agencies as the Regional District, Education, Human Resources, Health and the Economic Development Commission. In Victoria, meetings were held with representatives of the following ministries: Environmental and Land Use Secretariat, Economic Development, Municipal Affairs, Education and Labor. In addition to the collection of information and data through personal interviews, government reports and other documents were reviewed. The series of government reports dealing specifically with the northeast coal development were particularly valuable as were reports prepared for the communities of Chetwynd and Dawson Creek.

Further, the information on both the region and on Hudson Hope was updated and expanded by a July 1981 field trip to the Hudson Hope area, including the communities of Hudson Hope, Chetwynd, Prince George and Dawson Creek. In Hudson Hope, the Mayor of the Hudson Hope District Muncipality was interviewed, as were personnel of School District 60. In Dawson Creek, information was sought from the Canada Employment Centre, the Supervisor of Human Resources and the Administrator of the School Board District. Municipal Affairs personnel were interviewed in Prince George and personnel of the Dawson Creek office of the Peace-Liard Regional District were interviewed including the District Administrator, the Medical Health Officer and the Planning Department staff.

5.2 Summary of Impacts: Community, Social and Economic

Community, social and economic impacts are expected to occur in the District of Hudson Hope when the Cinnabar Peak project proceeds to the construction and operating stages. Community impacts on Hudson Hope will be primarily due to the incoming population. Four hundred and one (401) people are expected to arrive during the construction period and an additional one thousand, four hundred and seventy-one (1,471) are expected to follow when the mine goes into production. This increased population will require 348 housing units in the town of Hudson Hope and a further 187 houses in the surrounding rural area. Land is available for residential development but there are no houses on the market. The local construction contractors should be able to meet the housing needs during the construction phase but the large land developers from outside the region may have to be called in during the operating phase of the mine in order to meet the housing demands.

The incoming population will place additional pressure on medical and social service facilities and personnel. Although the facilities appear adequate to handle the increased population, increased staffing may be required.

The school facilities in Hudson Hope should be adequate to accommodate the 76 school-aged children moving to the area during the construction phase of the project. However, the 280 school-aged children, moving into the District of Hudson Hope when the mine goes into production, cannot be accommodated in the existing school facilities unless they are expanded. Eight to ten additional teachers will also be required.

Communications, sewage and water services are judged to be adequate as are fire and police protection. However, a temporary increase in alcohol related personal crime is anticipated during the construction phase. In addition, some social and marital problems are apt to occur until the operational workforce and their families get settled in the area.

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* Regional residents include construction workforce from outside the region that stay on to become permanent residents during the operating phase.

Economic impacts stemming from the Cinnabar Peak project will be positive. The project should create 251 jobs for regional residents during the construction and operation of the mine*. In addition, the disposable income of the direct/indirect, induced, basic and non-basic workers will stimulate the local economy and bolster local commercial businesses.

5.3 Socio-economic Profile of the Peace-Liard Region

5.3.1 Review of Regional Resources

The Peace-Liard Region, encompasses some 220,150 km^2 (85,000 mi^2). The area is rich with developable resources including coal, oil and natural gas, harnessable rivers, forests and agricultural land.

Some of the largest and richest metallurgical coal deposits are found in the Rocky Mountain Foothills, spanning the southeast portion of the region.

Oil and gas have been discovered in ever increasing quantities in the area surrounding Fort Nelson, Fort St. John and in the Grizzly Valley. As of December 1978, 798 oil wells and 1,465 gas wells were capable of operation; 554 and 572 of these, respectively, were actually producing. Natural gas processing plants are currently operating in Fort Nelson and Boundary Lake and a new plant for the Grizzly Valley Pipeline is near Chetwynd. Oil is being produced and refined in Taylor and there appears to be a great deal of potential for expansion in both oil and gas in the region.

The Peace River, which flows through the region, is an excellent river for harnessing hydro-electric power. The G.M. Shrum Generating Station at Williston Lake, just west of Hudson Hope, is presently producing up to 2,400 megawatts annually. The Site One Generating Station and the proposed Site C Generating Station will offer an additional combined capacity of 1,675 megawatts, and there is still potential for other dams and generating stations.

The forestry industry in the region is significant and to a large degree underdeveloped. Forestry Inventory statistics assembled in 1973 indicated that approximately

7.5 million ha (18.5 million acres) of mature forest in the region were ready for harvesting. Scope for expansion of the industry is excellent as access to new areas is developed. Development of the coal areas in the vicinity of Hudson Hope and Chetwynd will open up a larger area to the forestry industry.

The southeast Peace-Liard Region is in the process of being developed for coal extraction. There are three major known coal areas in this part of the Peace-Liard Region: the Peace River Canyon, Carbon Creek west of Hudson Hope, and Sukunka-Quintette southwest of Chetwynd and south of Dawson Creek. Other large tracts of the region are under active exploration.

Agriculture provides stability to the economic base of the region and particularly to the municipality of Dawson Creek which boasts of being the largest grain shipping point in western Canada. The agricultural land base of the region is the largest in the province and capable of considerable expansion. Agricultural products produced and exported from the region include cereal crops, oil seeds, forage crops, honey and livestock (P-LREDC 1981 B).

5.3.2 Settlement Patterns and Demographics

Expansion of resource development in the region has subsequently led to population increases. In 1980, the permanent population of the region was over 55,000. Just under 70 percent of the total population of the region lives in an area bounded by Dawson Creek, Fort St. John, Hudson Hope and Chetwynd (Table 5.3.2.1). This core area (Subdivision B -Census) will be impacted by the northeast coal development.

A demographic characteristic of the region is its youthful population as illustrated in Table 5.3.2.2. Sixty-eight percent of the 1980 total regional population was under the age of 35 compared to the provincial average of 59 percent. This suggests a higher level of provision of schools and other services to serve this age group.

TABLE 5.3.2.1

Peace River - Liard Regional District
Population Estimates by Community

	1971	1976	1977	1978	1979	1980	Growth 1971-1980	Rates[1] 1976-1980
Chetwynd	1260	1487	1562	1691	1977	2231	6.6	10.6
Dawson Creek	11885	10528	10405	10353	10853	12125	.22	3.6
Pouce Coupe	595	776	812	837	936	940	5.2	4.9
Fort St. John	8264	8947	9194	9923	11089	12498	4.7	8.7
Taylor	605	649	674	691	823	940	5.0	9.7
Hudson Hope	1741	1330	1614	1728	1723	1663	.5	5.7
Fort Nelson	2289	2916	2940	3061	3463	4000	6.4	8.2
Rural (Un-incorporated)	17357	18209	19202	19225	19967	20732	1.99	3.3
Total	43996	44842	46403	47509	40830	55130	2.54	5.3

Source of Population Data: 1971 & 1976 Census Data, Statistics Canada.
1977 - 1980 Population Estimates, Central Statistics Bureau,
Ministry of Industry and Small Business Development, June, 1981.

[1]Calculated Compound Annual Growth Rates

TABLE 5.3.2.2

Peace - Liard Region - Population By Age Group 1980

Age Group	Number	Percentage
0 - 4	5,520	10
5 - 14	10,537	19
15 - 24	11,487	21
25 - 34	10,105	18
35 - 49	9,461	17
50 - 64	5,484	10
65 and over	2,537	5
TOTAL	55,130	100

Source: Central Statistics Bureau, Ministry of Industry and Small Business Development, March 1981.

Average family size for the municipalities in the region was 3.4 persons per household in 1976. The rural population displayed a slightly higher average. It should be noted, however, that these census figures do not reveal labor migration as a result of seasonal work, i.e. oil and gas, and so the population figures for places like Fort St. John could be noticeably higher in the winter months.

5.3.3 Labor Force Availability

In 1971 the labor force of the region was over 17,300, of which 70 percent were male and 30 percent female. The distribution of this labor force spanned a number of occupations and industries with the service industry containing the greatest concentration (42 percent), followed by transportation (14 percent), construction (11 percent) and agriculture (10 percent), with manufacturing and other primary industries accounting for 6 -7 percent each.

Unemployed

More up-to-date figures are available on the unemployed labor force registered with Canada Manpower and Immigration offices in the region. In 1980 the Dawson Creek Manpower office registered an average of 434 male clients and 331 female clients. The males fell into the following occupational groups:

	Percent
construction	32
transportation equipment operators	11.5
forestry and logging	7.6
product fabrication	4.2 and
processing	4.2.

Among the females, the majority fell into four main categories:

	Percent
clerical	40.2
service	28.4
sales	15.1 and
medicine and health	3.9.

During the same year, the Fort St. John Manpower and Immigration Office registered an average of 251 males and 228 females. The major occupational groups among the males were:

	Percent
construction	25.1
transportation equipment operators	10.8
forestry	7.2
services	6.4
oil and gas	5.6

Most of the females were concentrated in :

	Percent
clerical	42.1%
service	28.9% and
sales	9.2%.

Both Manpower offices reported shortages of qualified people in some occupations. Shortages in accountants, elementary school teachers, head cooks and repair occupations occurred. More specifically, the repair and maintenance occupations included heavy duty mechanics, automobile and truck mechanics, automobile machinists and small engine and valve repairs.

Migrants

People migrating into the region are another potential source of labor. Annual migration to and from the region accounts for about ten percent of the population. Migrants respond to such factors as employment opportunities, good wages and aesthetic considerations. They tend to rely heavily upon available information concerning new developments and this should be kept in mind when considering possible recruitment programs.

Persons Outside the Labor Force

In addition to the labor supply which is currently employed, temporarily unemployed or in transit, there is another group which are employable but have been out of the labor market for over a year or have yet to enter it. This group includes women, natives and high school graduates and dropouts.

Females represent close to 75 percent of all persons not in the labor force. Two major reasons account for this lack of representation. The first is inappropriate or lack of the necessary qualifications to meet the work requirements. The second reason is a lack of complementing social services such as day care facilities which restrain married women with children from entering the labor market. Through a concerted effort on the part of government agencies and the private sector, these problems could be overcome, creating a sizeable work force.

Nearly 500 status and 300 non-status Indians are permanent residents of the region and can be viewed as potentially employable. However, a number of barriers severely reduce their employment opportunities. Their general level of education and training is very low, which necessitates upgrading programs and pre-employment orientation and training. However, such programs are very difficult to implement unless they can be conducted in the native communities, because distance to established training centers, lack of transportation, and family responsibilities are formidable stumbling blocks.

High school graduates and dropouts represent another source of labor in the region. In recent years an average of 300 high school students graduated in the Dawson Creek and Chetwynd area. This figure will rise to around 500 by about 1984 as the bulk of the early 1960's baby boom passes through the secondary school system (see Tables 5.3.3.1 and 5.3.3.2). By contrast, the dropout rate from grades eight to 12 ranged between 30 percent and 60 percent of the total high school enrollment over the past seven years. This represents an attrition rate of 550-1,100 students per year. Forecasts to 1984 suggest a levelling off of student dropouts at 35 percent or approximately 500 students per year. Comparable figures are not available for Hudson Hope, which until the 1979-1980 school year had only the first two years of high school available locally. However, in School District 60, of which Hudson Hope is a part, the total school withdrawal rate is significantly higher than for the province as a whole.

School Board officials (Galibois and Friesen, pers. comm.) and the principal of Northern Lights College in Dawson Creek (Moore, pers. comm.) have indicated that coal mining oriented courses could be established at both the high school and college levels if so desired by the provincial government and the mining companies. The high school program could be directed towards the Grade Ten dropouts to provide them with practical technical training which would be directly applicable to the coal mining industry. Alternatively, a pre-apprentice type program could be established in Grades 11 and 12 such that the graduates could be integrated into an apprenticeship program at the college level.

TABLE 5.3.3.1

Secondary School Enrollment and Dropout Rate for Dawson Creek and Area, 1969 - 1984.

	8	9	10	11	12	Total % of Dropouts/ Year	Total Student Population
1969	483	405	373	323			-
1970	459	452 (6%)*	402 (1%)	309 (17%)	303 (6%)	(30)	1925
1971	467	438 (5%)	417 (8%)	327 (19%)	303 (2%)	(34)	1952
1972	487	456 (2%)	392 (10%)	316 (24%)	273 (17%)	(53)	1924
1973	490	452 (7%)	412 (10%)	295 (25%)	278 (12%)	(54)	1927
1974	481	456 (7%)	397 (12%)	347 (16%)	209 (29%)	(64)	1890
1975	441	417 (13%)	397 (8%)	364 (8%)	252 (27%)	(61)	1871
1976	438	404 (8%)	399 (4%)	321 (19%)	275 (24%)	(55)	1837
1977	399	431 (2%)	369 (9%)	345 (12%)	275 (14%)	(37)	1819
				Projected			
1978	373	391 (2%)	396 (8%)	332 (10%)	393 (15%)	(35)	1780
1979	316	369 (2%)	360 (8%)	356 (10%)	280 (15%)	(35)	1681
1980	290	310 (2%)	339 (8%)	324 (10%)	303 (15%)	(35)	1566
1981	318	284 (2%)	285 (8%)	305 (10%)	275 (15%)	(35)	1467
1982	274	312 (2%)	261 (8%)	257 (10%)	259 (15%)	(35)	1363
1983	363	269 (2%)	287 (8%)	235 (10%)	218 (15%)	(35)	1372
1984	327	320 (2%)	247 (8%)	258 (10%)	200 (15%)	(35)	1352

* Percentage figure equals proportion of associated population that dropped out.

Source: Dawson Creek School Board, 1979b.

TABLE 5.3.3.2

Elementary and Secondary School Enrollment in Chetwynd and Area, 1974-1980.

Year	4	5	6	7	GRADE 8	9	10	11	12	Totals
1974					86	75	58	61	30	310
1975	81	75	110	90	85	81	71	54	43	690
1976	103	70	75	101	80	82	69	55	34	669
1977	70	103	76	75	109	102	63	60	42	700
1978	86	71	105	77	76	107	94	57	51	724
1979		96	73	107	79	75	98	84	48	660
1980			96	75	109	77	69	88	71	585

Source: Dawson Creek School Board, 1979a.

With the cooperation of government agencies, unions and mining companies, the college is prepared to establish courses and programs directed toward filling not only the semi-skilled and unskilled requirements of the mining industry, but also the managerial requirements. The programs could be offered in Dawson Creek, Chetwynd or the new town of Tumbler Ridge. Alternatively, the programs could be established at the mine site itself. This would be particularly worthwhile insofar as training in heavy equipment operation and maintenance is concerned. It is thought that there are 3,000 underutilized people spread throughout the region at present; the college could realistically train 150-200 of these people annually to enter the coal mining industry.

In light of available Statistic Canada, Canada Manpower, School Board and Northern Lights College information, it would appear that there is a significant labor pool in the Peace-Liard Regional District which, through the establishment of orientation and training programs, could serve the needs of the coal mining industry. However, establishment of such programs would require the cooperation, support and financing of government agencies, unions and the mining companies.

5.3.4 Transportation Systems

Paved highways connect the larger communities of the region as well as provide arterial linkages with Alberta, the Yukon, Prince George and Vancouver.

Dawson Creek is strategically located at the junction of four major paved highways. It marks the beginning of the Alaska Highway which runs north through Fort St. John, Fort Nelson and on to the Yukon and Alaska. The city is located at the northern end of the Hart Highway (No. 97) which connects the region with Prince George and south to the Lower Mainland. It is also linked with Alberta via two routes: Highway No. 2 to Grande Prairie with subsequent connections to Edmonton, and Highway No. 49 to Spirit River with connections north to the Northwest Territories via the Mackenzie Highway.

The village of Chetwynd is situated at a point where Highway No. 29, leading north to the W.A.C. Bennett Dam, Hudson Hope and Fort St. John, meets the Hart Highway. The village of Hudson Hope is on Highway No 29 where the access road to the dam leaves the highway.

Numerous dirt and gravel roads depart from the highways in the region into remote settlements and the hinterland. Two such roads have become significant as a result of the coal exploration south of Chetwynd. One is a Forestry Trunk Road connecting Dawson Creek with the proposed town of Tumbler Ridge. The second is another forestry road linking Chetwynd with the proposed new town. Both roads will become important linkages when the coal areas are developed during this decade. Due to the servicing capability the Chetwynd-Tumbler Ridge road would offer to the northern coal properties of BP Canada Ltd., Teck Corporation and Ranger Oil (Canada) Ltd., this road has undergone some clearing and widening such that a transportation corridor now in part exists. When these coal properties go into production, a paved road will be constructed down this transportation corridor. When the new town of Tumbler Ridge is built, it is assumed that the Forestry Trunk Road from Dawson Creek will be upgraded to all-weather standards and eventually it will be paved.

In addition to the highway/road network in the region, the area is also served by two railways: the British Columbia Railway (BCR) and the Northern Alberta Railway Company (NAR). The BCR has two rail lines traversing the region. One connects Fort Nelson and Fort St. John with Chewynd where it joins the other BCR line coming west from Dawson Creek. From Chetwynd a single BCR line continues southwest to Prince George and on to Vancouver. An interchange at Prince George with the CNR provides rail service to the tidewater port of Prince Rupert. Meanwhile, the NAR, through an interchange in Dawson Creek, provides rail service to Edmonton and all points east. Principal shipments out of the region are grain, lumber and oil and gas byproducts.

Canadian Coachways (Alberta), a division of Greyhound, provides three trips daily from the region to Edmonton/Calgary, two trips daily to Prince George/Vancouver, one trip daily up the Alaska Highway as well as twice daily service within the region. Norline Coaches serve Hudson Hope and Fort St. John in addition and also provide charter services upon request. Two commercial air carriers, and numerous air and helicopter charter services operate within the region. C.P. Air offers twice daily service from Fort. St. John to Vancouver and Edmonton/Calgary, while Pacific Western provides once a day service from Dawson Creek to Vancouver and Edmonton/Calgary.

The Peace-Liard Regional District has been designated as License District No. 21 by the Motor Carriers Commission of British Columbia. The area is well serviced by highway carriers as illustrated below:

- within License District No. 21 - 21 carriers
- from Alberta to License District No. 21 - 24 carriers
- from B.C./Alberta border to B.C./Yukon border - 24 carriers
- from License District No. 21 to B.C./Yukon border - 12 carriers
- from U.S.A. to License District No. 21 - 2 carriers

5.3.5 Community Profile (Economic Base and Infrastructure): Chetwynd

A profile of the District of Hudson Hope is is outlined here, as it is assumed to be the focal point of any impacts resulting from the development of the Cinnabar Peak coal deposits. Hudson Hope is tied by Highway No. 29 to Chetwynd to the south and Fort St.

John to the east. Daily bus service provided by Norline Coaches provides transportation to these cities. Chetwynd is the closest access point to the British Columbia Railway lines. Hudson Hope has no commercial air service, but there is a 1,524 m (5,000 ft) paved airstrip maintained by B. C. Hydro which is used by private fixed-wing traffic and a float plane dock on the Peace River (P-LREDC 1978). Loiselle provides freight carrier service between Hudson Hope and Fort St. John; Hudson Hope is also served by Canadian Freightways Limited (P-LREDC 1978). A railroad spur to serve Utah Mines Carbon Creek coal development may pass within five or six miles to the south of Hudson Hope (P-LREDC 1978).

The Cinnabar property is located about 25 km (15.5 mi) south of Hudson Hope and about 40 km (25 mi) northwest of Chetwynd (DOHH 1979). It is therefore assumed that the Cinnabar work-force will live in the District of Hudson Hope.

The District of Hudson Hope was incorporated in 1965 and, with an area of 93,889.9 ha (232,010 acres), is one of the largest bounded municipalities in British Columbia (BCMED 1978). Within the District of Hudson Hope is the townsite of Hudson Hope proper and two populated rural areas, Beryl Praire and Lynx Creek. The town is on the terraces of the Peace River in a parkland setting which, in places, ends on steep bluffs above the river. The emergence of Hudson Hope as a community is closely associated with construction of the Bennett Dam (DOHH 1979). The history of the community goes back considerably further, however, to early beginnings as a fur trading center, and a subsequent role as head of navigation on the Peace River, a period from which an historic building, the Rocky Mountain Portage House, dates. The future townsite changed from a stopover point along the river to a small settlment in 1912. And in 1921 coal mining was begun (P-LREDC 1978). Precise documentation of its presence and population dates back only to 1966 when the first census was held following its incorporation. This census was held at the height of construction of the Bennett Dam and evidences the existence of a full community (BCMED 1978). The sewer system which serves the town was constructed in the mid-1960's and probably evidences the emergence of Hudson Hope as a unified community (DOHH 1979).

The primary economic sectors of Hudson Hope are the utilities and service sector and construction. In 1970 the construction sector generated 36 percent and the utility sector 21 percent of the total income of residents in Hudson Hope (Table 5.3.5.1). The importance of construction has fluctuated widely over the years. From 1961 to 1966

TABLE 5.3.5.1

Sources of income in 1970 - Hudson Hope and the North East Region.

	Hudson Hope (,000)	North East Region (,000)
Employment Income:		
Agriculture	40	3,854
Forestry	116	2,222
Fishing & Trapping	-	333
Mining (includes oil & gas)	-	5,595
Wood Industries	60	2,660
Other Manufacturing	-	3,704
Construction	2,112	13,855
Transportation and Storage	297	13,660
Communications	76	2,845
Utilities	1,206	2,195
Wholesale Trade	41	4,290
Retail Trade	257	8,871
Finance Insurance & Real Estate	111	2,635
Education & Health Services	434	10,352
Personal Services	24	669
Tourist Services	225	4,320
Other Services	68	3,249
Public Administration	81	3,929
Unspecified	452	6,699
Subtotal	5,600	95,937
Non-Employment Income:		
Transfer Payments	191	5,707
Investment & Other Income	85	2,634
Subtotal	276	8,341
TOTAL	5,876	104,278

Source: Statistics, Canada, 1971.

the area exprienced a 30 percent growth, while between 1966 and 1976 the rate of growth was only 5 percent; 1966 represented the peak of Bennett Dam construction and the construction force thereafter declined. Following 1976, construction on the downstream Site One began and the rate of growth again increased.

Construction of the Site One dam is winding down but its completion is not anticipated until 1982. The heavy construction period is completed but the installation and start-up of the second,third, and fourth generating units is scheduled for completion in that year (DOHH 1979). The future holds the proposed construction of Site C still further downstream near Fort St. John.

Agriculture, forestry and wood products, processing, economic sectors which are important in nearby areas, provide only a small portion of Hudson Hope income. Table 5.3.5.1 indicates the relative importance of various employment sectors based upon the income they provided in 1970; this year it will be remembered is during the decline of construction on the Bennett Dam. 1979 data presented in the Hudson Hope Community Plan (DOHH 1979) indicate that the major employer in the community was still B. C. Hydro. Lockhart Lumber at Beryl Prairie and producing ranches and farms in the district municipality are the other major basic industries in the community. Two other logging firms, Swanson Lumber and Canfor are active in the region although headquartered in Fort St. John and Chetwynd (DOhH 1979). Three sawmills now operate in the area and the potential for expansion of the forestry sector is great (P-LREDC 1978).

There is some oil/gas exploration activity in the Beryl Prairie area. While agriculture is small it serves as an economic stabilizer in the community and is being expanded with 32 new farm units being created by the Lands Management Branch in 1979 (DOHH 1979). The flats on the north side of the Peace River support agriculture which is centered on Farrell Creek. Cereal grains, forage crops and beef are grown. There are 5261.1 ha (13,000 acres) of crown pasture with 1618.8 ha (4,000 acres) of these acres being cultivated (P-LREDC 1978).

A five year community heritage development program was initiated in 1979 to increase the attractiveness of the area for tourism. The plans for expansion of the tourism industry include the development of a dinosaur theme since Hudson Hope is at the entrance to Dinosaur Valley where some impressive fossils have been found (DOHH 1979; MacKeigan, pers. comm.). There are also plans for a marina and expansion of their museum (MacKeigan, pers. comm.). The development of coal in the Carbon Creek and Cinnabar Peak regions will add additional stability to this community.

Settlement Patterns and Demographics

The settlement patterns of Hudson Hope have been closely tied with the construction of the W.A.C. Bennett Dam as discussed above. As a result, the district has experienced booms and busts.

Table 5.3.5.2 provides a historical review of the Hudson Hope population lease as far back as 1971. It also shows the community's population base to 1987 under normal growth conditions. Normal growth conditions do not take into account the Cinnabar Peak mine development or any other potential coal developments in the area.

TABLE 5.3.5.2

Hudson Hope Population Projections to 1987

1971	1741
1976	1330
1980	1663
1983	1964
1985	2194
1987	2451

Source: 1971 & 1976 Census Data, Statistics Canada, Economic Analysis and Research Bureau, Ministry of Industry and Small Business Developments, June 1981.

Table 5.3.5.3 gives the sex and age groups comprising the Hudson Hope district population during the censuses of 1971 and 1976. The number of males and females in the community has remained approximately equal. This is noteably different from the situation in the region as a whole (IEC 1979). According to current estimates of population, the population of the Hudson Hope district nearly doubled between 1976 and 1980. There are, however, no age/sex distributional data for these more current estimates.

Housing:

Because of the rapidity with which Hudson Hope grew, development was somewhat haphazard and unplanned. There is a definite village core however, and there are large tracts of undeveloped property and mixed land uses. A complete inventory of housing was done in 1976 and at that time, approximately half of the housing was owned by B.C. Hydro or its contractors and nearly half of the single family dwellings were mobile units on individual lots. A more recent inventory of housing was done in 1979 and is part of the community plan (Table 5.3.5.4). The situation has not changed appreciably (DOHH 1979). Mobile homes still predominate in Hudson Hope, although there is no current inventory of housing. The relative paucity of permanent structures is indicative of the temporary nature of residency in Hudson Hope, particularly by B.C. Hydro employees. In the year prior to July 1981, 200 units moved from the town (MacKeigan, pers. comm.).

Housing is currently very tight in Hudson Hope. There is very little rental or owner occupied housing available. There are some vacant homes which are owned by B. C. Hydro and not available for rent. The district government and B.C. Hydro are currently disputing their sale. There are new housing lots available, however. Forty new lots are on the market at Lynx Creek, but only three have been sold so far. An additional 60 lots which are fully serviced are for sale near the arena. Twenty more of these will come on stream this summer (MacKeigan, pers. comm.). A 100 x 60-ft fully serviced lot sells for about $10,000. A trailer on a fully serviced lot sells for about $30,000 (MacKeigan, pers. comm.). The local construction industry can probably handle building additional housing. Further, there is a local manufacturer of prefabricated log homes (MacKeigan, pers. comm.).

TABLE 5.3.5.3

Age and Sex Trends of the Population in Hudson Hope

Population by Sex and Age Groups

	1971			1976		
Age Group	Total	Male	Female	Total	Male	Female
Under 15	670	345	325	450	225	220
15 - 64	1,045	560	470	840	435	415
65 +	30	20	20	40	25	15
TOTAL	1,745	925	815	1,330	685	650

Source: BCMED, 1978.

Education

Hudson Hope is in School District 60, which is administered from Fort St. John. The community has both elementary and secondary schools. The secondary school has only been open for two years (MacKeigan, pers. comm.). Prior to this, Hudson Hope had a junior secondary school which went to grade ten; any students wishing to continue thereafter usually went to board during the week at Fort St. John.

The 1980-1981 enrollment was 160 in the elementary school and 195 in the secondary school for a total enrollment of 355. The elementary school has held up to 209 students and the secondary school 231 students in the past (Education Department, pers. comm.). According to the community plan (DOHH 1979), the elementary school has nine classrooms and a central common room which could be further subdivided. The number of classrooms in the new high school could not be confirmed by personnel of School District 60 (Education Department, pers. comm.).

TABLE 5.3.5.4

The Residential Housing Mix in Hudson Hope - 1979

Residential

As of 1979 the housing mix in Hudson Hope comprises approximately 454 units of which the following breakdown exists.

Town Proper (including Thompson - Jamieson)

Mobile homes in parks	69
Mobile homes on privately owned lots	74
Single family residences in town	166
Group housing	27
TOTAL	336

Beryl Prairie (rural area)

Mobile homes	27
Residences	31
TOTAL	58

Lynx Creek (rural area)

Mobile homes	45
Residences	15
TOTAL	60

Of this B.C. Hydro owns:

70 Single family units
25 Row units
36 Pad mobile home court
33 Homes which were constructed by the General Contractor at Site One Dam - Atkinson Commonwealth

Total number of B.C. Hydro and Hydro related residences is 164 housing units.

Source: DOHH, 1979.

Community Recreation/Cultural Facilities

In 1979, a 2.9 ha (7.2 acre) parcel of land was set aside for recreation and parks purposes (DOHH 1979). A new arena to be used for roller skating in the summer and ice skating in the winter was opened on 10 April 1981 in this area. Ball diamonds are under construction on this site, as well (MacKeigan, pers. comm.). In addition, there is a centrally located 1.6 ha (4 acre) site which includes a playground, a 16-year old outdoor swimming pool (MacKeigan,pers. comm.) and tennis courts. A curling rink, funded by B. C. Hydro, and a community hall are located in the downtown core area (DOHH 1979). Further, there is easy access to outdoor recreational opportunities, to boating on the Peace River, hiking, camping, etc. Nearby Alwin Holland Park serves as a major overnight camping area for tourists. Further activities are indicated by the existence of a very popular saddle club as well as a hockey association, rod and gun clubs and swimming clubs (DOHH 1979; MacKeigan, pers. comm.).

In Hudson Hope there are six churches, a library association, an historical association a drama club, a community hall society and a Chamber of Commerce, as well as a very influential Lions Club (DOHH 1979, MacKeigan, pers. comm.).

Commercial Services

As evidenced in the above discussions, the service and commercial sectors of the Hudson Hope district economy are both local and limited. Major purchases are made in Fort St. John, Dawson Creek and,increasingly, in Chetwynd. Table 5.3.5.5 lists the commercial establishments present in Hudson Hope in 1979 (DOHH 1979) as updated by the 1981 field trip. Other businesses such as insurance, contracting, television and shoe repair, real estate, etc. are operated from their proprietor's homes.

Medical and Health Facilities

Hudson Hope has a new medical diagnostic and treatment center which has just opened. It was built by the municipality with provincial government funds (Stewart, pers. comm.). A new doctor took up residence there in July 1981 (MacKeigan, pers. comm.). The building also houses the public health nurse who works part-time in Hudson Hope (Stewart, pers. comm.).

TABLE 5.3.5.5

Commercial Services Available in Hudson Hope

4 Gas Stations
3 Grocery Stores
5 Restaurants - including snack bars at service stations
2 Hotels (1-43 unit and 1-15 unit)
2 Motels
1 Liquor Store
1 Men's Wear Store
1 Sears Catalogue Office
1 Hardware Store
1 Laundromat
1 Gift Shop
1 Veterinarian
1 Bank
1 Credit and Savings Union
1 Fabric Shop
1 Music Shop

Source: DOHH, 1979 data, updated by 1981 field trip.

Ambulance service is available but there is no hospital in Hudson Hope (Lugsdin, pers. comm.). Hospital services are sought in either Chetwynd or Fort St. John. A visiting dentist comes to Hudson Hope every summer (Stewart, pers. comm.).

A single social worker, from Region 8 of the Department of Human Resources headquartered in Fort St. John (DOHH 1979), travels from Chetwynd to Hudson Hope one day a week. Because of a scarcity of office space in the community, this person works out of a room at the motel (Supervisor Human Resources, pers. comm.).

In 1979 there was no resident mental health staff member in the community. Such aspects of mental health support as crisis intervention, early diagnostic treatment, marital or family counselling were absent (DOHH 1979). The situation is not known to have changed.

Communication Facilities and Services

Two radio stations, CKNL from Fort St. John and CBC from Vancouver are heard in Hudson Hope. CJDC television is rebroadcast from Dawson Creek while CFRN television, based in Edmonton, is rebroadcast to the area from Fort St. John. There is no local newspaper; major newspapers which serve the area are the Chetwynd Echo, the Alaska Highway News, and the Edmonton Journal. There is a local post office in Hudson Hope (DOHH 1979).

Fire and Police

Fire protection is provided by volunteer departments. There are three departments in the municipality, one each at Lynx Creek, Beryl Prairie, and Hudson Hope. Each department has one pumper; the vehicles at Lynx Creek and Beryl Prairie are combination water tank/pumpers.

Three officers of the Royal Canadian Mounted Police are stationed in Hudson Hope (MacKeigan, pers. comm).

Utilities

a. Water The water supply for Hudson Hope proper comes from four sources: from the Peace River and from three springs on the north bank of the river. The water supply system consists of a pumping station, buried concrete water reservoir and a system of 203 mm (8 in.) 152 mm (6 in.) mains and fire hydrants. Water from the river is chlorinated at the pumping station and pumped into the reservoir which has a 100,000 gallon capacity. Water from the springs is piped directly into the reservoir. Two of the springs have increased markedly in supply since Williston Resevoir has been filled and they alone supply nearly all of the water needs of Hudson Hope proper (P-LREDC 1978). The capacity of the storage reservoir is currently being expanded to 600,000 gallons (MacKeigan, pers. comm.). A complete water chemistry analysis is done annually by the Ministry of Environment and bacteriological monitoring is done weekly by the Peace River Health Unit. Water from all sources is bacteriologically satisfactory. Water in Beryl Prairie and Lynx Creek is most commonly hauled by residents from the municipal pump. This supply is more economical although some wells have been drilled (DOHH 1979).

b. Sewer: Sewage treatment facilities are provided by 2.2 ha (5.4 acre) oxidation ponds plus a single 0.4 ha (0.9 ha) exfiltration pond. Use of only one of the oxidation ponds was designed to service a population of 1,500 to 2,000 while bringing the other oxidation pond on line would double the service capacity. Without modification and in its current mode of operation, the treatment plant serviced a population of 3,000 during the construction of the Bennett Dam, and the plant is certified by the Provincial Pollution Control Branch for a population of 3,000 (P-LREDC 1978). MacKeigan (pers. comm.). The Mayor of Hudson Hope, stated that the sewage lagoons could accommodate 5,000 more people and were presently used at one-half their capacity. A statement in the community plan (DOHH 1979) indicates that the lagoon system could handle up to triple the population of Hudson Hope at that date or a total population of 6,000, by adding an agitator and chlorinator sytem to the existing lagoons. Thus, the existing sewage treatment facilities appear quite flexible.

Water and sewer are provided to residential users at a flat rate. Commercial and industrial users pay a minimum charge for the first 12,000 gallons plus a charge for each additonal 1,000 gallons (P-LREDC 1978).

c. Gas and Electricity: As would be expected, electrical power is provided by B. C. Hydro from the Shrum Generating Station at Williston Lake via a 130 kV loop line system which serves not only Hudson Hope but also Fort St. John and other communities continuing the loop clockwise. Natural gas is supplied by Inland Natural Gas Company Limited. Heating oil and diesel fuel are distributed by Texaco, Canada Limited and Petro Canada (P-LREDC 1978). None of these energy sources is in short supply.

Community Land

The land use map associated with the Hudson Hope community plan (DOHH 1979) shows the results of the early haphazard development of Hudson Hope. Single and multiple family homes as well as mobile homes are interspersed. Further, these residential areas are interspersed with public and commercial buildings. This problem of mixed land uses is noted on the map, as are several additional problems. There are large number of vacant parcels within the town area proper; this is illustrated by the land use map. There is a high proportion of mobile homes in the residential component of land use; this is not particularly desirable because mobile homes do not contribute to the stability of a community. Highway No. 29 constructed through the middle of town splits the town core. The core of town is flanked by steep bluffs both to the southeast along the river and to the northwest where the land rises to a new terrace level. Some town development has occurred on the next higher terrace. These steep bluffs consist of silts which are prone to slide and should not be used for development along their base or crest. This provides an additional divisive factor to town cohesiveness. The Hudson Hope Community Plan (DOHH 1979) has recognized these problems. The major goals of this plan are to upgrade existing commercial establishments; strategically place new commercial establishments so as to support the town core and entice visitors to the area into the core; landscape public lands leading into the community; fill in the existing residential areas within walking distance of the commercial core to a medium density level; and acquire land for public institutional developments such as a health care complex adjacent to the town core and along the banks of the Peace River. Because the District Municipality of Hudson Hope is a major landowner, it will be able to effectively regulate the future market value of land to affect a comprehensive community plan needed for future development. The ultimate anticipated population of Hudson Hope is 5,000 people. According to the plan, rural residential areas will continue to be provided at Beryl Prairie and Lynx Creek. Infilling of the community core as recommended, will maintain a compact community and take advantage of existing water services.

In summary, both residential and commercial land are readily available within Hudson Hope proper. The primary problems will be guiding the development of such land so as to add order to the community.

5.4 On-Site Development Scenario

The Cinnabar Peak mine plan, development scenario and employment estimates discussed in this section should be considered preliminary for the following reasons:

a. a market for the coal has yet to be identified and this will have a direct bearing on the coal preparation required and the scheduling of the mine development;
b. all employment estimates are best-guesses based upon previous experience. The unique circumstances of every project means that actual employment will inevitably vary from that predicted.

In spite of the aformentioned limitations, the development scenario and employment estimates do reflect correct orders of magnitude and are therefore valuable for planning purposes.

Cinnabar Peak Mines Ltd. proposes to develop a 907, 180 clean tonnes (one million tons) per year, open pit mine with a minimum life expectancy of 15 years. The mine will be an open pit truck and shovel operation whereby the raw coal is conveyed from the pit to a preparation plan for crushing and washing (if necessary) and then transported by truck to a loadout at the railhead in Chetwynd. As the loadout in Chetwynd may be jointly used by Cinnabar Peak as well as other proposed mines in the area, the manpower required to operate the loadout have been excluded from the manpower estimates presented in this report.

5.4.1 On-Site Employment - Construction Phase

Table 5.4.1.1 provides the peak number of construction jobs required to bring the Cinnabar Peak mine into production. Construction is scheduled to begin in March 1983 with a completion date of March 1984. The workforce will increase to a peak of 179 workers between the sixth and eighth month of the construction period and then taper off for the remainder of the construction phase.

TABLE 5.4.1.1

Construction Employment Requirements

1. Excavation and Site Preparation

Occupation	# Of Workers		Time Spent On-Site
Heavy Equipment Operators	30		2 months
Carpenters	40		3 months
Iron Workers	50		4 months
Millrwrights	10		4 months
Welders and Pipefitters	20		4 months
Electricians	60		5 months
Sheet Metal Workers	10		2 months
		220	

2. Loadout Site and Facilities

Office Staff	3		
Supervisors	7		
Truck Drivers	4		
Labourers	14		
Operating Engineers	22		
Carpenters	8		
Iron Workers	12		
Electricians	4		
Cement Finishers	3		
Plumbers/Pipefitters	2		
		79	
TOTAL:		299	

Source: Simon Carves of Canada, 1981.

All of the mine related and railhead loadout construction activity will be contracted out, and as such, the responsibility for recruitment and hiring of the union-affiliated tradesmen, equipment operators, and laborers will lie with the contractor(s). Due to the fact that other construction activity in the Northeast Region, identified by the Ministry of Industry and Small Business Development, will generate 2,000 to 3,000 jobs, some constuction shortages can be anticipated, particularly in the carpentry and iron worker trades. However, given that construction activity in the region will be on the decline in 1983, coupled with the fact that the number of these tradesmen required for the Cinnabar Peak mine development is relatively low compared with the Quintette or Carbon Creek property, contractors do not consider these labor shortages to be a major obstacle (Simon Carves of Canada, pers. comm., 1981).

A considerable number of equipment operators are required during the construction phase and a full complement of experienced operators may not be readily available. However, given the short period of time required to train operators on the job, this should not pose any serious problems for the contractors (Hayward, 1981).

The primary source of construction manpower will be British Columbia and Alberta. However, the contractors are aware that due to the other major construction activity in the Northeast Region, Vancouver and the oil sands areas of Alberta, they may, in some instances, have to recruit and hire from other provinces in Canada. Given the tight construction manpower supply situation, opportunities for construction employment will be available to regional residents who are out-of-work union members and/or individuals who are willing to acquire a union membership. It is reasonable to assume that 10 percent or 18 of the 179 direct construction jobs created will be filled by residents of the region.

Construction manpower involved in the minesite development will be housed in a fully serviced camp on site. Manpower involved in construction of the loadout facilities at the railhead in Chetwynd will be expected to find their own accommodation. If however, accommodation can't be found in Chetwynd due to the demands placed on the community by other major construction activity in the area at that time, a camp situation will have to be considered.

If the contractor responsible for construction of the loadout is also doing the minesite preparation work, then all the construction workers, other than local residents, would be housed at the minesite camp. If, on the other hand, a second independent contractor is responsible for construction of the loadout, a second camp located near Chetwynd would be most probable.

5.4.2 On-Site Employment - Operating Phase

Table 5.4.2.1 illustrates the labor force that will be required during the operational phase of Cinnabar Peak's one million tonne per year open-pit coal mine operation. The mine will be in operation 24-hours per day, five days a week throughout the year. Employees involved in the mine, preparation plant, and transportation operations, will work on the basis of three 8-hour shifts per day, five days a week, for 50 weeks a year over the 15-year life of the mine.

It is assumed that all Cinnabar Peak employees will live in the Hudson Hope area. Bus transportation between Hudson Hope and the mine site will be provided to the employees by the company.

Cinnabar Peak's basic manpower requirement is projected to be 235 people. However, realistically, this number could be as high as 300 during the first year or two of mine production due to labor turnover. Experience at other mining operations in the province has shown that labor turnover tends to be very significant for the first couple of years until the mine is established after which it declines noticeably (Schuyff, 1981).

5.4.3 Labor Force Availability, Recruitment, and Training

Cinnabar Peak is committed to recruiting and hiring as many residents of British Columbia as possible for this mining operation. Recruitment and hiring will be non-discriminatory and efforts will be made to employ as many regional residents as possible. However, should it not be possible to fill all of the positions from within the British Columbia labor pool, recruitment will be carried out in Alberta and other mining areas of Eastern Canada.

TABLE 5.4.2.1

Operations Employment Requirements

	Salaried Employees	No. of Employees	
Administration			
	General Manager	1	
	Chief Engineer	1	
	Pit Superintendent	1	
	Foreman (Pit, Plant, Maintenance	12	
	Plant Superintendent	1	
	Accountant	1	
	Bookeeper	1	
	Purchasing	2	
	Surveyor	3	
	Geologist	1	
	Draftsman	1	
	Lab. Technician	2	
	Secretary	4	
	Janitor	2	
	Warehouseman	3	
	Security	2	
	Sub Total	38	38
Mine Operation			
	Shovel Operator	9	
	Shovel Oiler	9	
	Drill Operator	6	
	Drill Oiler	6	
	Blaster	2	
	Grader Operator	3	
	Dozer Operator	9	
	Coal Loader Operator	2	
	Truck Driver	40	
	Labourer	4	
	Sub Total	90	90
Mine Maintenance			
	Lubricator	5	
	Mechanic	24	
	Electrician	8	
	Welder	8	
	Machinist	2	
	Sub Total	47	47
Preparation Plant			
	Control Room Operator	4	
	Washery Operator	8	
	Front End Loader Operator	4	
	Millwright	8	
	Sub Total	24	24
Transportation To Loadout			
	Truck Driver	36	
	Sub Total	36	36
	TOTAL		235

Source: Cinnabar Peak Mines Ltd. 1981.

Due to the fact that several other coal mines in British Columbia are scheduled to go into production prior to or at the same time as this mine,the labor supply situation will be very "tight". In a recent discussion paper on employment and population forecasts for Northeastern British Columbia, the Ministry of Industry and Small Business Development have estimated that 1,341 basic jobs will be generated in the coal industry of the Northeast Coal Block in 1983. Further, the Provincial Mining Advisory Committee has indicated that an additional 850 basic mining positions will be created in Southeastern British Columbia between 1981 and 1983 as a result of the Shell Crowsnest Line Creek Coal Development and B.C. Coal's Greenhills Coal Mine (Henderson, 1981).

As a result of this coal mining activity, labor shortages are anticipated by industry and government alike. The main areas of concern are equipment operators, heavy duty mechanics, industrial electricians, welders, and millwrights. Skilled tradesmen pose the greatest problem as shortages already exist in the above mentioned trades. A four year apprenticeship program is required for these trades and there is an upper limit on annual enrollment in the apprenticeship programs. Therefore,the Apprenticeship Training Branch will have to be notified well in advance of a mine start-up in order for it to set up training programs to meet the trades requirements (O'Neal, 1981).

Although shortages in heavy equipment operators are also anticipated, this is not viewed as a major problem area given that most of the operators can be trained on the job in a relatively short period of time compared to the maintenance trades.

Cinnabar Peak will be recruiting and hiring within the Northeast Region as well as throughout the Province of British Columbia. Given the small numbers of heavy equipment operators and maintenance tradesmen required for this mining operation, it is expected that 50 percent to 75 percent of these positions can be filled with experienced manpower from within the Province. Recruitment of additional experienced manpower will be conducted in other provinces as well. However, should this out-of-province recruitment fail, Cinnabar Peak is prepared to initiate an extensive on-the-job training program for inexperienced operators and tradesmen employed to fill out the manpower requirements of the mine. It is assumed that up to 15 percent of the mine's operational labor force requirements will be filled by residents of the Peace-Liard Regional District.

The Apprenticeship Training Branch of the Ministry of Labor requires a one-year lead time in order to organize and establish an apprenticeship training program for mine maintenance trades. Such programs have been held in Prince George in the past, but with the cooperation of the Northern Lights Community College, government and industry, it may be possible to move the program to Dawson Creek, thus providing an excellent opportunity for local residents to take advantage of it.

The Apprenticeship Training Branch will be contacted as to the manpower needs and manning schedules as soon as a market for the coal has been established. If this occurs prior to 1983, it would be advantageous to set up a pre-apprenticeship classroom training program in the region prior to construction such that once construction begins those persons enrolled in the program could gain practical experience during the construction phase under the supervision of qualified personnel. In this manner, they will have completed their first year of apprenticeship training by the time the mine goes into production. In addition, they will be familiar with the company and operation as well. In order to accomplish this, Cinnabar Peak is prepared to work closely with the B.C. Provincial Government and the Northern Lights Community College in the region.

5.4.4 Union, Trade, and Professional Conditions Related to Hiring

It is assumed that unions will be seeking certification of the Cinnabar Peak Mine. Unions will want to ensure that their membership is fully employed before accepting local residents as new members. However, this should not pose any problems for regional residents given the extremely tight labor demand/supply forecasts for 1983.

In addition, union members from outside the region may view moving to the Hudson Hope area as a constraint. Therefore, out-of-work union members living in the region and those regional residents qualified for mine training programs should not have great difficulty in participating in this project.

Equipment operators will have to be affiliated with unions or be willing to take out a union membership, but no problems are anticipated in this area.

Given the projected shortages in skilled heavy equipment operators in 1983, there should be no problems in persuading the unions to extend their membership to inexperienced people wishing to become heavy equipment operators. A nucleus of experienced operators will be hired to provide on-the-job training for those who have no prior experience.

The administrative staff will be recruited and hired from within Western Canada. No difficulties are anticipated in filling these positions.

5.5 Off-Site Development

Off-site development refers to the indirect/induced employment and non-basic employment in the region as a result of the construction and operational activity associated with the proposed mine development. It also refers to the population migrating to the region that is associated with the direct, indirect/induced, basic and non-basic jobs generated by the mine development. The incoming population will in turn have an impact on the District of Hudson Hope, where it is expected to reside.

5.5.1 Off-Site Employment

Off-site employment will be generated during the construction and operating phases of the mine. Direct employment required for the construction activity at the mine site and the loadout in Chetwynd will create indirect and induced employment in the service sector of the region. Indirect employment refers to employment created to provide goods and services to the direct construction activity, i.e., lumber, machinery repairs, and camp catering. Induced employment refers to jobs created to provide services to the direct and indirect employees and their families, i.e., retail stores, restaurants, and other service activities.

A multiplier of .35 will be applied to the number of direct construction jobs in order to estimate the indirect and induced employment. In other words, for every direct construction job created in the region, .35 of an indirect or induced construction job will be created.

Given the projected magnitude of construction activity in the province and within the region in 1983 as a result of this and other major projects, direct construction employment opportunities will be available to residents of the region provided they take out union memberships.

Job opportunities will be available to local residents in indirect and induced activities in the region. It is assumed that residents of the region will fill 10 percent of the direct construction jobs and 35 percent of the indirect/induced jobs created as a result of the Cinnabar Peak mine development.

Table 5.4.2.1 indicated that 235 operational phase jobs will be created. These jobs are referred to as basic employment or employment which results in a product (coal) being exported from the region. Non-basic or service sector jobs will result from the operation of the mine in the same manner as indirect and induced employment is created in the construction phase. The number of non-basic jobs created is a function of the number of basic jobs involved in the mining operation. In the case of this mine, it is assumed that for every basic (mining) job created another 1.5 non-basic jobs will be created in the region. This multiplier is considered to be reasonable given the size of Hudson Hope, the size of the region and the degree of remoteness of the region.

Taking into account the transitory nature of construction workers as well as the extent to which construction skills may be applied to mining, it is reasonable to assume that 10 percent of the direct construction workforce from outside the region will stay on to become basic employees when the mine begins operating. It is further assumed that 50 percent of the indirect induced workforce recruited from outside the region will stay on to fill non-basic jobs generated by the operating phase of the mine. The higher carryover of indirect/induced employees than direct construction workers is based upon the more permanent nature of the service sector employment as well as the similarity of service employment activity in the construction and operating phases.

In view of the uncertain availability of qualified candidates to fill basic positions at the mine because of other coal mine developments in the province, it is esimated that 15 percent of the mine's workforce will be recruited from within the region. The more permanent nature of the non-basic service jobs should serve to attract more employees from outside the region than was the case during the construction phase. Consequently, it is estimated that 25 percent of the non-basic jobs will be filled by residents of the region.

Table 5.5.1.1 summarizes the number of direct, indirect/induced, basic and non-basic jobs created as a result of the Cinnabar Peak mine development. It also shows the numbers of these positions that will be filled by people living in the region and people living outside the region.

TABLE 5.5.1.1

Cinnabar Peak Manpower Requirements During Construction Phase (1983) and Operating Phase (1984)

	Regional	Non-Regional	Total
Direct Construction	30	269	299
Indirect/Induced*	37	68	105
Basic Operating	62	173	235
Non-Basic Operating**	122	231	353

- Regional basic manpower will include 10 percent carryover of direct construction manpower formally from outside the region.

- Regional non-basic manpower will include 50 percent carryover of indirect/induced construction manpower formally from outside the region.

  * Multiplier is .35 of average direct employment.

  ** Non-basic multiplier is = 1.5 of basic operating employment.

5.5.2 Increased Population

A most important impact of the Cinnabar Peak coal mine devlopment will be the population impact. The influx of population is generated by the direct construction activity, indirect and induced employment, basic and non-basic employment. The increased population migrating to the region will impact the housing, community services and commercial businesses in the Hudson area.

During the construction phase it is expected that those direct construction workers who do not already live in the region will live in the construction camps rather than settle in the area. The population impact of the direct construction workforce will therefore be small. It is estimated that for every direct construction job .46 of a person will move into the region.

The population impact during the construction period will largely be derived from the indirect and induced employment opportunities in the supply and service sectors. It is estimated that for every indirect or induced job, 2.5 people will move into the region. This multiplier is based upon observed population multipliers in other resource and mining developments and in the service sectors of resource based communities (Industry and Small Business Development, 1981). It is assumed that individuals and families moving to the region to fill these indirect/induced jobs will live in Hudson Hope or the surrounding rural area.

During the operations phase of the mine, beginning in 1984, it is assumed that employees and their families moving into the region to fill the basic and non-basic jobs will reside in the District of Hudson Hope. It is estimated, based on observations of population multipliers in other mining and resource based communities, that for every basic and non-basic job , 2.5 people will move into the region.

Table 5.5.2.1 summarizes the increased population that will migrate to the Hudson Hope area from outside the region as a result of the Cinnabar Peak coal mine development.

It is assumed that all regional residents involved in direct, indirect/induced, basic or non-basic jobs related to the mine development will remain in their present residences.

TABLE 5.5.2.1

Population Impact - Hudson's Hope Area

Source	1983	1984
Direct*	82	-
Indirect/Induced**	158	-
Basic**	-	535
Non-Basic**	-	803
TOTAL	240	1338

* Multiplier = .46
** Multiplier = 2.5

The population distribution in the Peace-Liard Regional District over the period from 1976 to 1980 indicates that 60 percent of the population resides in communities while the remaining 40 percent reside in the rural area. However, from 1980 to 1985, population projections indicate that 65 percent of the population will reside in communities while 35 percent will take up residence in the rural areas, which includes unincorporated hamlets. It is therefore assumed that 65 percent of increased population related to the Cinnabar Peak Mine development will live in Hudson Hope, while the remaining 35 percent will live in the rural area near Hudson Hope.

5.5.3 Community Development

Community development refers to the new houses, community services, and infrastructure expansion required as a result of the Cinnabar Peak coal mine development.

a. Housing

The latest available statistics on average number of persons per household in the Peace-Liard Region (1976) indicated that there were 3.5 persons per household. Applying this statistic to the incoming population during the construction phase (1983) indicates that 115 new households will be required, 75 in Hudson Hope and 40 in the rural area near Hudson Hope, i.e., Lynx Creek and Beryl Prairie. As the construction phase ends and the mine goes into production in 1984, 420 housing units will be required to meet the needs of the incoming population (basic and non-basic). Approximately 273 housing units will be required in Hudson Hope, while 147 will be needed in the rural area.

The present housing situation in Hudson Hope in tight while 40+ lots are currently available in Lynx Creek. The local construction contractors should be able to meet the housing demand during the construction phase, but the operating phase housing requirements could pose problems. Mobile home parks and/or committments for early construction of housing would help to overcome the problem of getting enough housing units on the market to meet the demand during the operating phase. Another solution would be to have a major developer build the houses.

To date, representatives of the town of Hudson Hope and Cinnabar Peak Mines Ltd. have had a couple of meetings to discuss future housing requirements and associated financing. A development agreement is being worked out with the town whereby it will not be in a position of assuming the financial risk of putting serviced residential lots on the market. There will be a cooperative effort between the town and Cinnabar Peak in addressing the housing demand situation. Basic employees and their families will be provided with subsidized housing. These specifics have yet to be worked out as yet but they will be discussed in the Stage II report.

The town of Hudson Hope has set aside enough land for future residential development to easily meet the needs of this project.

5.5.4 Community Services

a) Education

Based upon the 1980 population breakdown for the Peace Liard Region, shown in Table 5.3.2.2 it is estimated that 29 percent of the incoming population will be 15 years of age or less. Ten percent of the population will be under the age of five and will not attend school. Therefore, during the construction phase 116 children will come into the region and 76 will be school aged (5-15).

In 1984 when the mine begins operating, 487 children 15 years of age or less would move into the Hudson Hope area and 280 of these children will attend local schools.

The present capacity of Hudson Hope's two schools is 140 students while the 1980 enrollment was 355 leaving 85 vacancies. It would appear then that the present educational facilities will be adequate to accommodate increased children during the construction period but not during the operating phase. Expansions to existing schools will be required or the construction of a new facilities. The teaching staff will also require expansion at a rate approved by the School District.

5.5.5 Community Recreation/Cultural Facilities

A wide range of recreation/cultural facilities are available in town and, with the recent addition of the arena, the present facilities should be adequate to serve the needs of the increased population.

a) Commercial Services

The service and commercial sector of Hudson Hope is quite limited and residents travel to Fort St. John and Chetwynd for many second order purchases. This trend will in all probability continue, however, the increased population should attract new businesses to Hudson Hope.

b) Medical and Health Facilities

The increasing population will impact the medical and health services principally in the area of staffing. With the new medical diagnostic and treatment center staffed by a permanent doctor and public health nurse, this area appears adequate. However, the area of mental health and welfare may require an additional staff person and office space in Hudson Hope. Local residents will continue to rely on hospital facilities and personnel in Fort St. John or Chetwynd to address their more serious and/or extended medical needs.

c) Communications, Fire and Police

The existing communications facilities should be adequate to serve the new population.

The RCMP detachment of Hudson Hope has three full time constables. Given that additional staff are leased upon a ratio of one constable per 1000 population, it is doubtful that any additional police staff will be required. Nevertheless, a temporary increase in alcohol related personal crime is anticipated during the construction period. This is a normal phenomena associated with transient workers. However, this problem can be kept in check by contractors insisting upon proper conduct of their workers on and off the job.

The volunteer fire departments and equipment presently available in Hudson Hope, Lynx Creek and Beryl Prairie should be adequate to service the needs of the incoming population.

5.5.6 Infrastructure

Hudson Hope's present sewer and water system has a capacity to handle the needs of 5000 people. Considering that the town's natural population growth to 1985 is estimated to be 2,451 and the Cinnabar Peak project will account for another 1,092, the present sewer and water system should be adequate as it now stands.

People choosing to live in rural areas will be responsible for providing their own wells and septic tanks unless they purchase a serviced lot in a rural subdivision.

5.6 Economic Evaluation

The economic evaluation of the project is based upon the latest analysis of the mine plan. The figures used here should be regarded as tentative only, as revisions may be made as a result of a more in-depth feasibility study. The project is evaluated in terms of its projected capital and operating costs.

5.6.1 Capital Costs

Capital costs for the minesite, transportation and loadout facility during the construction period are illustrated in Table 5.6.1.1 following:

A more detailed breakdown of capital costs could be made available in the Stage II report.

The projected cost of providing serviced housing to the basic workforce has yet to be determined. This cost shall be discussed in the Stage II report.

5.6.2 Operating Costs

The estimated annual operating costs of the mine, at a population rate of one million clean tonnes per year, are illustrated in Table 5.6.2.1. The total operating costs in a typical year are $67.17/tonne of clean coal or $67,160,000 per million saleable tonnes of coal.

Excluded from these costs is the provincial coal royalty tax. The circumstances surrounding the proposed mine development, particularly the fact that part of the coal property belongs to the proponent under free hold title, may result in the royalty tax being waived during the initial years of production.

Only about 8 percent of the operating expenditures will leave Canada, and less than 10 percent of the remaining 92 percent will leave British Columbia and Alberta. The Peace-Liard Region itself could account for $8.63 million annually or approximately 13% of the operating budget.

TABLE 5.6.1.1

Capital Costs - Cinnabar Peak Mines Development (1981 dollars)

Minesite		
Site/Pit Preparation	$ 200,000	
Run of mine and raw coal	1,300,000	
Washery and Thickener	1,900,000	
Clean Coal Handling	525,000	
Engineering, construction mgmt.	706,500	
Contingency	785,000	
Shops and offices	2,000,000	
Construction camp	1,483,300	
Subtotal		$8,899,800*
Transportation/Loadout		
Loadout Facilities		
Capital cost	8,300,000	
Design	371,000	
Contractors	2,320,000	
Subtotal		10,991,000
Building to house Dozer and Crusher	150,000	
Site Grade (excavation embankment, surface drainage)	501,000	
Railroad Grade (site preparation, embankment, sub-ballast, drainage track ballast & switches)	1,100,000	
		1,751,000
TOTAL		$21,641,800

* Does not include cost of water supply, road work, electrical hook-up, tailing disposal and concrete hatching plant and heavy equipment.

TABLE 5.6.2.1

Operating Costs - Cinnabar Peak Coal Mine Development

		Cost Per Tonne (1981 $)
1)	Mine Site Operation	
	Waste Removal	13.95
	Coal Removal	1.73
	Stripping	1.99
	Pumping	.22
	Spraying Roads	.16
	Lights	.06
	Reclamation	.07
	Preparation Plant/Loadout	5.43
	Workshop & Facilities	1.54
	Management	1.02
	Head Office	1.10
	10% contingency	2.72
		30.00
2)	Road Haul of Coal From Minesite to Railhead	2.89
3)	Pro-Forma Loadout Terminal Cost	
	Capital & Interest Payment/Annum	2.34
	Operating Costs	1.47
	Ground Lease Cost (18%-Annum)	.39
		4.20
4)	Rail Haul Chetwynd to Port Terminal	
	B.C. Line Haul - North Vancouver	20.49
	C.N. Line Haul - Fraser Surrey*	5.51
	Car Lease	2.51
	Maintenance	.58
	Management and Administration	.98
		30.07
	TOTAL COST	$67.17/tonne

* Worst Case Scenario

Not included in these operating cost figures are the municipal taxes on employee housing nor the income or sales taxes derived from the disposable incomes of the workforce when personal purchases are made.

5.6.3 Proponent's Benefits

Using a projected sale price of coal on the world market of $72.45/saleable tonne of clean coal, the gross revenue in "typical" year would be $72,450,000. The resulting net revenue would be $5,560,000. Over the life of the mine this represents a net revenue of approximately $83,400,000.

5.6.4 Summary

If the Cinnabar Peak project proceeds to production it will result in economic benefits to the region, province, Canada and foreign countries as well. These economic benefits comprise the capital and operating costs of the proponent.

Of the estimated $21.6 million in on-site capital expenditures to 1984, all but 6 percent of this will be spent on Canadian goods and services; approximately $20 million of this will be spent in British Columbia and Alberta.

The estimated operational costs is $66.89 million per year, or $ 1 billion over the life of the mine. Ninety percent of the operating expenditures will remain in British Columbia and Alberta with British Columbia retaining the most of it. The region itself will receive $8.6 million annually, which represents approximately 13 percent of the total annual operating costs.

The majority of the benefits accruing to the federal government will come as a result of income tax on employees' "disposable income" and sales tax on the goods and services they purchase.

Based on a projected world price of coal at $72.73 per saleable tonne of clean coal, the proponent's net profit in a "typical" year would be $5,560,000. Over the life of the project, profits could reach $83 million. However, these figures do not reflect the costs excluded from the capital costs discussed in this report.

5.6.5 Information Gaps - To Be Filled In Stage II

- The proponent's detailed capital and operating costs including housing.

- A detailed description of the proponent's housing program.

- A detailed description of the proposed recruiting, hiring and training program for the mine workforce.

6.0 IMPACT ASSESSMENT

6.1 Methodology

The mining activities proposed by Cinnabar Peak Mines Ltd. to be performed on their Peace River Canyon Property have been plotted against the main features of the biophysical and social environment (Appendix 1). The effect of each major activity on the environment can be determined by cross checking each major activity against the main features of the environment. Preliminary assessment of the environmental impacts concentrated on the identification of the source of the impact in the industrial process.

The environmental data is presented on the Environmental Axis, divided into 25 categories. The industrial operations presented on the Coal Project Axis are divided into four main categories: Off-Site, Construction, Operation, and Reclamation. The four main categories are further divided into 45 categories which identify the major operation which have potential impact on the environment.

Impacts of the coal mine procedures on the environment is indicated in the body of Appendix 1. Major impacts will be discussed below.

6.2 On-Site Impacts

6.2.1 Air Quality

Air contaminants associated with the construction and operation of the mining facilities will be dust and emissions from the combustion of fossil fuels.

Fugitive dust will be produced during the excavation of the pit and as the vegetation is being cleared for construction. Traffic on the road will produce a localized source of fugitive dust. Coal dust will be produced as the coal is extracted, loaded, transported and processed. Locations where dry coal is handled, such as the coal dryers, are expected to have problems with dust control.

The natural gas, which will be burned in the coal drying facilities, will produce air contaminants. The heavy machinery, such as trucks and graders, will burn diesel fuel and the personal vehicles will burn gasoline. This combustion of fossil fuel will contaminate the air.

6.2.2 Noise

High noise levels will be created by the operation of heavy equipment, blasting, and coal processing equipment. Heavy equipment will be required to prepare the ground prior to the construction and during the reclamation phases of operations. Heavy equipment operation and blasting in the pit will produce high noise levels as will some of the processing equipment, such as the crusher and coal dryer.

6.2.3 Soils

The soils will be stripped from selected sites prior to the excavation of the pit and lagoons and prior to the construction of the waste dump, roads, and surface facilities. This soil will be stockpiled and used during the reclamation of the disturbed sites. The soil will be spread over the recontoured landscape prior to revegetation.

6.2.4 Vegetation

The trees will be cleared from the construction and excavation sites, prior to the soil removal. Reclamation and revegetation with suitable plant species will be implemented in conjunction with, and upon, completion of the mining activities.

Part of the wetland vegetation surrounding Moosecall Lake, will be lost if the waste dump site selected is in the Moosecall Lake area.

6.2.5 Wildlife

The wildlife habitat in the area of the mine and surface facilities will be lost for most of the time that the mine is in operation, however, this land will regain its capability for wildlife production following reclamation.

The wildlife habitat in the Moosecall Lake area will be changed permanently if the waste dump is located in that area. The waste dump will be reclaimed and will acquire a capability for wildlife, however, the original hydrological regime cannot be restored.

6.2.6 Surface Water Quantity

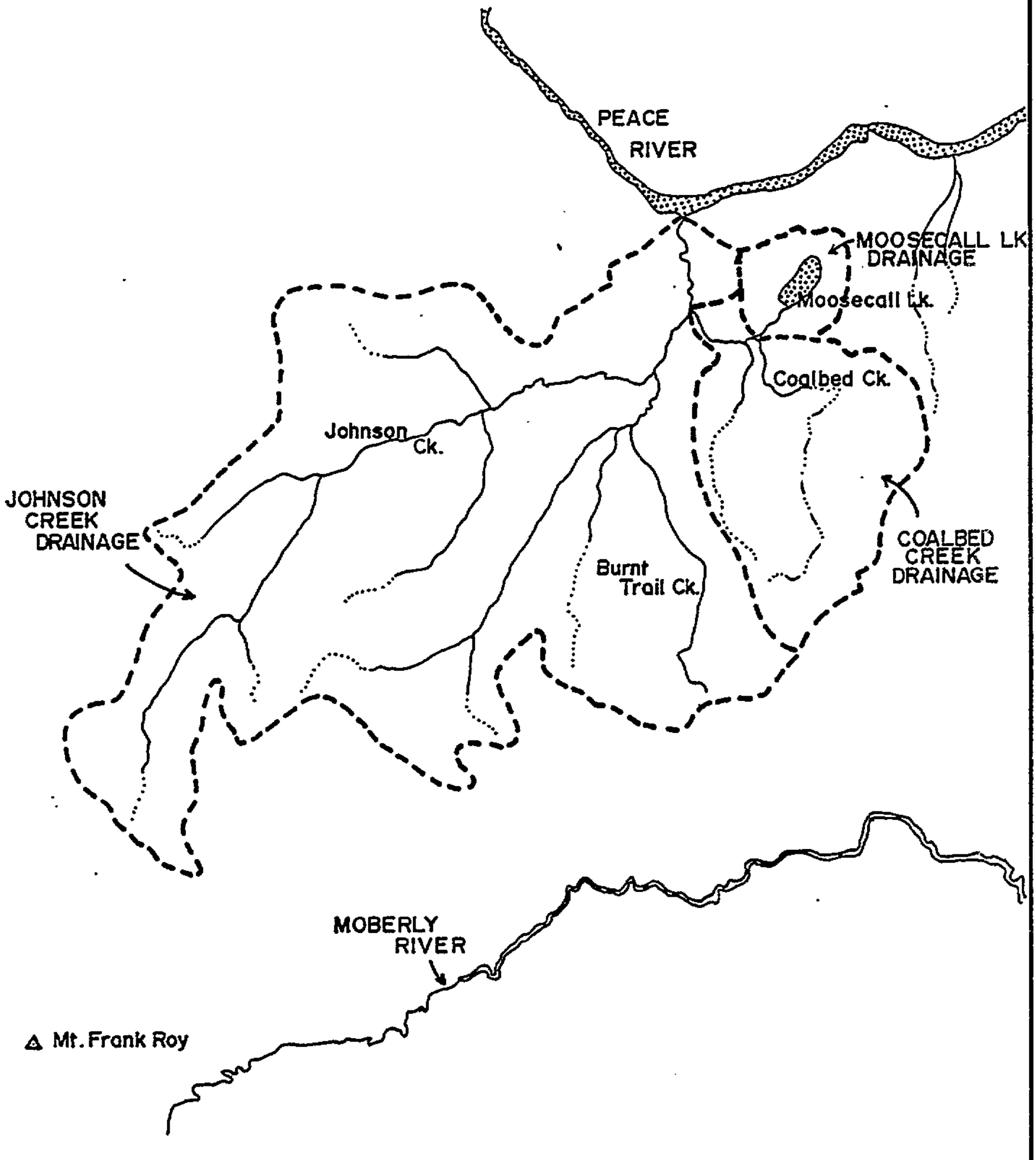
Excavation of the pit and lagoon and construction of the surface facilities and waste dump will alter the flow regimes in the area. The pit and lagoons will tend to accumulate surface water and the runoff water from the surface facilities will have to be controlled to minimize problems such as erosion.

The construction of the waste dump will require the alteration of some of the surface water flow patterns. The location of the waste dump will determine what flow pattern will have to be altered. If the waste dump is located south of Moosecall Lake, the Coalbed Creek channel will have to be diverted. The proposed waste dump site which includes Moosecall Lake will require that the Moosecall Lake drainage outlet be changed from Coalbed Creek to the unnamed creek north of Moosecall Lake. The proposed waste dump site for the flat area between Starfish Creek and Coalbed Creek will require the channeling of the runoff water from the waste dump into one of the creeks. The proposed waste dump site at the confluence of Coalbed Creek and Johnson Creek will require that the runoff water from the dump be carefully controlled. The removal of Moosecall Lake from the Coalbed Creek drainage or other changes to the flow in Coalbed Creek will have a small impact on the flow in Johnson Creek because the Coalbed Creek catchment area is only a small part of the total Johnson Creek catchment area- (Figure 6-2-6 A).

The reclamation of the disturbed land will alter the flow regimes but the waste dump and pit area cannot be returned to pre-mined conditions. The flow in these areas will be stabilized.

6.2.7 Surface Water Quality

Increases in the sediment loads of oil and grease in the water adversely affect the water quality. Unstable terrain, stockpile and waste dump will contribute to an increased sediment load.



JOHNSON CK. DRAINAGE AREA

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FIGURE: 6-2-6 A

Oils and grease from the yard maintentance facility and the operation of heavy equipment will affect the water quality of the surface water.

6.2.8 Groundwater

Data regarding the quality or quantity of groundwater in the study area is presently unavailable. The baseline groundwater conditions and the location of aquifers must be identified in order to accurately predict impacts on the groundwater conditions. The quality of the groundwater would be altered if the water percolating from the surface is contaminated. This contaminated surface water could originate during the construction of the roads, waste dumps or lagoons and from the drainage of the pit, roads, waste dump, stockpile, and settling ponds. The surface facility would provide a potential source of contaminants including the sewage facility and oil and grease from the maintenance yard.

6.2.9 Fisheries

B.C. Fish and Wildlife considers the section at Johnson Creek, between Dinosaur Lake and the first barrier to fish migration, as being a very important area for trout production. The sections of Coalbed Creek and Johnson Creek upstream of the falls and Moosecall Lake are considered to have no fisheries at the present time. This indicates that the preservation of the lower Johnson Creek water quality is of prime importance and the preservation of fish habitat upstream of the falls is not as critical.

6.2.10 Aquatic Invertebrates

Changes in water quality will affect the aquatic invertebrates population. Stream diversions for the waste dump sites will destroy the original aquatic invertebrates habitat but new habitat will be constructed.

6.2.11 Heritage Resources

There are presently no known historic or prehistoric sites in the study area which would be affected by the construction, operation, and reclamation of the mine.

6.2.12 Agriculture

A small portion of the study area is held as Agricultural Land Reserve but, at the present time, the land in the study area is not supporting any type of agriculture. A small grazing lease is held in the vicinity of the study area.

6.2.13 Forestry

The forest industry will be impacted during the construction and operation of the mining facilities, and during the reclamation phase.

The road serving the area will be used by Canfor Ltd. so that the logging traffic will have to contend with the traffic to and from the mine during the construction and operation of the mine. The construction and operation of the surface facility will require redirection of the logging traffic.

The timber will be cleared prior to construction but during the reclamation phase the land will be reforested. The timber in the area is classed by the Canada Land Inventory at present as having immature productive woodland.

6.2.14 Petroleum Industry

There is a Westcoast Transmission Pipeline passing near the area under consideration but the mine plans indicate that there will be no operations located near enough to the pipeline to affect it.

6.2.15 Recreation

The major impact on the recreational use of the Peace Canyon area will be mine and forestry traffic on the access roads. The numbers of people using the area for recreation will increase because of the addition of the mine employees.

Some big game habitat will be lost during construction and operation of the mine but it will be regained after the reclamation of the area, so the impact on hunting will be temporary. Some of the wetland in the area of Moosecall Lake will be lost permanently if the waste dump is located there. It will be replaced with an upland type terrain.

6.2.16 Guiding and Trapping

The guiding and trapping opportunities in the immediate area of the minesite will be affected during the construction and operation of the mining facility because of lost habitat and noise. The potential for guiding and trapping, in the immediate area, should return to normal levels following reclamation of the area.

6.2.17 B. C. Hydro & Power Authority

Care will be exercised to ensure that there will be no conflict with B. C. Hydro with regard to the reservoir north of the property or their transmission lines to the east and west of the property.

6.3 Off-Site Impacts

6.3.1 Road

Access to the property from Hudson Hope and Chetwynd is expected to be Highway 29 and the Johnson Creek Road. This road system will provide the access for the construction, operation and reclamation of the mine and surface facilities. The coal is expected to be trucked to rail facilities in Chetwynd.

Forestry and recreational vehicles and air and water quality would experience the major impacts from the mine related road use. Fish and aquatic invertebrates would receive impact by the change in water quality.

6.3.2 Rail Transportation

The coal is expected to be transported to market by rail from Chetwynd. Rail transportation would create noise and dust which would subsequently affect the surface water quality. The changes in surface water quality would subsequently affect the aquatic invertebrates and fisheries.

6.3.3 B.C. Hydro and the Petroleum Industry

The majority of the power for the mining operations is expected to be electrical with a small amount of natural gas used in the coal dryer. The lower voltage lines on Highway 29 will probably be tapped for electrical energy. Inland Natural Gas Ltd. has been contacted about obtaining natural gas from the Westcoast Transmission Line which passes near the property.

6.4 Resource Management Strategies

6.4.1 Air Quality

Fugitive dust, from dry coal handling or traffic on dry roads, can be controlled by regular spraying with water. Covers may also be used to control the dust from stockpiles and rail cars. The conveyors from the breaker will have vulcanized joints and will be housed in a steel tubular gallery. Water sprays and vacuum systems will also be used to control the dust problem from conveyors.

6.4.2 Noise

Heavy equipment at the breaker station and in the preparation plant will probably be the major source of high noise levels. Hearing protection devices will be mandatory where noise, proof shrouding or physical isolation of the equipment is not possible. Noise levels should be checked regularly to ensure that sound intensity does not exceed safe levels for personnel.

6.4.3 Soils

Soils, removed from the construction and excavation sites will be stockpiled. Prior to revegetation, the soils will be spread over the recontoured landscape.

6.4.4 Vegetation

Unstable ground and soil stockpiles will be stabilized with vegetation. Reclamation and revegetation will be performed during the operation of the mine to minimize the disturbed area. Revegetation will include the planting of desirable forest species.

The location selected for the waste dump will determine what type of vegetation will be lost. The vegetation in the swamp area will be replaced by upland vegetation, if the waste dump is placed in the Moosecall Lake area. Swamp areas can be created in other locations if the presence of swampland is determined to be necessary.

6.4.5 Wildlife

Reclamation and revegetation procedures will attempt to restore the natural carrying capacity of the area for wildlife.

Swamp type wildlife habitat which may be used for the waste dump, will be replaced with upland type habitat during reclamation. This will affect the potential for use of the land, by wildlife. Swamp land can be created in other areas if it is discovered that the swamp areas are important wildlife habitats and no other location can be found for the waste dump.

6.4.6 Hydrology

6.4.6.1 Surface Water Quantity

The surface water will be diverted around obstructive mine features, such as the pit, waste dump, and stockpiles. Runoff from the facilities will be handled so that there will be minimal erosion problems.

Water for the operation of the surface facilities will be recirculated so that the water requirements will be minimized.

The location of the waste dump will determine what modification to the flow will have to be made in that area. If the waste dump is located south of Moosecall Lake, Coalbed Creek will have to be diverted around it. The Moosecall Lake area will be removed from the Coalbed Creek area drainage if the waste dump is located in the Moosecall Lake site. The runoff and surface water from the Moosecall Lake area will be drained by the unnamed creek to the north of Moosecall Lake.

If the waste dump is located in the flat area between Coalbed Creek and Starfish Creek, the runoff water from the area will be channelled into one of the creeks. Runoff water will be the major problem of the waste dump location proposed at the confluence of Coalbed Creek and Johnson Creek as no streams beds or drainages will be changed.

6.4.6.2 Surface Water Quality

Coal washings and other waste water from the preparation facilities will be centrifuged, and the solid waste will be disposed of. The water used in the surface facilities will be recycled, so that the waste from the coal treatment will not have to enter the surface water. An oil and grease program will be implemented to handle the waste from maintenance yard. The domestic sewage will not be associated with the other plant water, but will be handled as required by governmental effluent standards. Construction activities affecting the streams will be scheduled for the least critical period.

6.4.6.3 Groundwater

Surface drainage and collection of runoff water from the mining facilities will minimize the mine's impact on the groundwater. Dykes could be constructed around areas where seepage and accidental spills may result, to minimize the risk of accidental groundwater contamination.

6.4.7 Fisheries

The only section of stream in the study area which has any important fisheries is the section of Johnson Creek between the lowest falls and Dinosaur Lake. The water quality of the lower section of Johnson Creek will be protected, especially during critical periods such as trout spawning and rearing periods. Unavoidable construction activities which will adversely affect the water quality in lower Johnson Creek will be scheduled around the critical periods. The destruction of habitat during the diversion of Coalbed Creek will have no effect on the fisheries because of the lack of fish in the area.

6.4.8 Aquatic Invertebrates

The aquatic invertebrates will be affected if the water quality is changed or if their habitat is lost or destroyed. An effort will be made to change the quality of water as little as possible. The amount of water removed from the stream by the surface facility will not result in significant loss of aquatic habitat. However, the loss of the Moosecall Lake catchment will reduce the habitat, especially in the creek between the main stem of Coalbed Creek and Moosecall Lake.

The diversion of Coalbed Creek around the proposed waste dump will result in destroyed aquatic invertebrate habitat but, new habitat will be created in the new channel.

6.4.9 B.C. Hydro and Oil and Gas Industries

The Westcoast Natural Gas Pipeline to the east of the mine area and the B.C. Hydro lines will not be encroached upon by the mining activities.

6.5 Further Studies

A detailed assessment of the impacts from the proposed mine and their mitigations will be presented in the detailed environmental assessment of this project. The Stage II study designs will be compiled through close cooperation with the proponent and consultants and will be cross-checked with the provincial regulatory agencies.

Areas which should receive consideration during the planning of future studies are presented below.

6.5.1 Vegetation

Research into the most efficient reclamation and revegetation procedures for the study area should be initiated and tree species suitable for revegetation should be identified.

6.5.2 Wildlife

The animal populations presently making use of the area to be developed should be studied to determine how the habitat can be restored to assure optimum use by the wildlife. Areas such as the waste dump and pit will cause habitat characteristics to be altered, therefore information should be gathered to ensure the carrying capacity of the land is maintained following revegetation. If the carrying capacity cannot be maintained in the altered regions, areas which can be enhanced should be located and studied.

6.5.3 Hydrology

6.5.3.1 Surface Water Quantity

A detailed measurement of the existing hydrological feature should be implemented. This information will be necessary for the planning of specific construction procedures such as river diversions or other changes to river drainages. This information is also needed to ensure the availability of sufficient water for the operation of the facility.

6.5.3.2 Surface Water Quality

Seasonal water quality data should be collected from the water bodies which may be affected by the operation of the mine. Water bodies which should be examined that are not presently under examination are Starfish Creek and the unnamed creek which flows north from the Moosecall Lake area. Collection of seasonal baseline water quality data for the area will provide the information needed to ensure the maintenance of suitable water quality in lower Johnson Creek. The effect of the removal of Moosecall Lake from the Coalbed Creek drainage and of diversions of Coalbed Creek can be more accurately determined after the required data is analyzed.

A method for the disposal of the blowdown water from the surface facilities recycled water must be determined.

6.5.3.3 Groundwater

The quality of the natural groundwater, permeability of the substrate, and location of the aquifiers should be determined so that the impact of the mine on the groundwater can be more accurately investigated.

6.5.4 Fisheries

The fisheries of lower Johnson Creek is of prime concern to B.C. Fish and Wildlife, therefore, a comprehensive fish study should be performed on lower Johnson Creek. The study would determine what species utilize the area below the falls, the concentrations, and the time of year it is used. This information would be necessary in scheduling some construction phases, such as creek diversions to coincide with the periods when lower Johnson Creek is not being used by fish for spawning or rearing.

A preliminary study should be conducted on Moosecall Lake, Coalbed Creek, Upper Johnson Creek, and any other water bodies which might be impacted, such as Starfish Creek and the creek north of Moosecall Lake, to determine what fish are present and what habitat is available to them.

6.5.5 Aquatic Invertebrates

A seasonal aquatic invertebrates program should be initiated at the existing and proposed water quality sites. Areas of potential stream diversion should be included in the aquatic invertebrate sampling program.

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Appendix 1

ENVIRONMENTAL IMPACT MATRIX

Cinnabar Peak Mines Ltd.
Peace River Canyon Property
5013.1

Site	Phase	COAL PROJECT AXIS	ENVIRONMENTAL AXIS	METEOROLOGY	Air Quality	Noise Level	SOILS	VEGETATION	WILDLIFE	Ungulates	Fur-bearers	Waterfowl	HYDROLOGY	Surface Water Quantity	Surface Water Quality	Groundwater Quantity	Groundwater Quality	FISHERIES	AQUATIC INVERTEBRATES	HERITAGE RESOURCES	AGRICULTURE	FORESTRY	PETROLEUM INDUSTRY	RECREATION	General	Hunting	Fishing	GUIDING	TRAPPING	B.C. HYDRO	SOCIO-ECONOMIC	WORK FORCE	Labor Demand	Labor Supply	Labor Training	COMMUNITY SERVICES/FACILITIES	Housing	Education	Physical and Mental Health and Social Services	Infrastructure	Other Community Services	Community Finance	Commercial business/services
OFF-SITE		CONSTRUCTION																															■	■									
OFF-SITE		Employment																																			■				■	■	■
OFF-SITE		Housing																																			■					■	■
OFF-SITE		OPERATION																															■	■	■								
OFF-SITE		Employment																																			■	■	■	■	■	■	■
OFF-SITE		Housing																																			■			■	■	■	■
OFF-SITE		ROAD																																									
OFF-SITE		Operation																																									
OFF-SITE		Traffic			■	■									■							■			■																		
OFF-SITE		Drainage												■	■			■	■																								
OFF-SITE		RAIL																																									
OFF-SITE		Operation																																									
OFF-SITE		Traffic			■	■									■																												
OFF-SITE		Drainage												■	■			■	■																								
ON-SITE	CONSTRUCTION	TRAFFIC			■	■									■			■	■			■			■																		
ON-SITE	CONSTRUCTION	PIT																																									
ON-SITE	CONSTRUCTION	Access Road			■	■		■		■				■	■				■																								
ON-SITE	CONSTRUCTION	Timber Clearing, Excavation and Stockpiling			■	■	■	■		■				■	■				■									■	■														
ON-SITE	CONSTRUCTION	Revegetation						■		■					■	■												■	■														
ON-SITE	CONSTRUCTION	OVERLAND CONVEYOR			■	■	■			■	■							■	■																								
ON-SITE	CONSTRUCTION	COAL PREPARATION FACILITIES			■	■		■		■	■				■			■	■			■						■	■														
ON-SITE	CONSTRUCTION	(Offices, yard, maintenance shed, preparation plant)																																									
ON-SITE	CONSTRUCTION	Settling Pond (lagoon)			■	■		■		■				■	■	■	■	■	■						■																		
ON-SITE	CONSTRUCTION	Roads			■	■		■		■				■	■		■		■						■	■		■	■														
ON-SITE	CONSTRUCTION	Energy Supply (gas and electric lines)			■	■		■		■	■											■	■		■					■													
ON-SITE	OPERATION	TRAFFIC			■	■									■			■	■			■			■																		
ON-SITE	OPERATION	ROAD DRAINAGE												■	■		■	■	■																								
ON-SITE	OPERATION	PIT			■	■																																					
ON-SITE	OPERATION	Slope Stability						■							■																												
ON-SITE	OPERATION	Drainage												■	■	■	■	■	■																								
ON-SITE	OPERATION	DUMP																																									
ON-SITE	OPERATION	Waste					■	■		■				■	■																												
ON-SITE	OPERATION	Topsoil			■		■	■		■	■				■			■	■																								
ON-SITE	OPERATION	Overburden			■		■	■		■	■				■			■	■																								
ON-SITE	OPERATION	Leaching													■		■	■	■																								
ON-SITE	OPERATION	Slope Stability						■							■																												
ON-SITE	OPERATION	Truck Dump and Feeder			■																																						
ON-SITE	OPERATION	Conveyor			■	■									■			■	■																								
ON-SITE	OPERATION	COAL PREPARATION FACILITIES																																									
ON-SITE	OPERATION	Preparation Plant																																									
ON-SITE	OPERATION	Water Supply												■		■		■	■																								
ON-SITE	OPERATION	Thermal Drier			■	■																																					
ON-SITE	OPERATION	Loadout Silo			■									■		■		■	■																								
ON-SITE	OPERATION	Settling Pond (Lagoon)												■	■	■	■	■	■																								
ON-SITE	OPERATION	Dump																																									
ON-SITE	OPERATION	Stability													■			■	■																								
ON-SITE	OPERATION	Leaching													■		■	■	■																								
ON-SITE	OPERATION	Yard, Maintenance and Office Facilities																																									
ON-SITE	OPERATION	Surface Runoff												■	■		■	■	■																								
ON-SITE	OPERATION	Grease and Oil										■			■		■	■	■																								
ON-SITE	OPERATION	Domestic Sewage													■	■	■	■	■																								
ON-SITE	OPERATION	Domestic Water Supply												■		■		■	■																								
ON-SITE	OPERATION	Energy Supply (Gas and Electric)			■																		■							■													
ON-SITE	RECLAMATION	Abandonment and Salvage			■	■				■	■				■		■	■	■			■																					
ON-SITE	RECLAMATION	Overburden and Rock Dumps																																									
ON-SITE	RECLAMATION	Land Preparation			■	■	■							■	■		■	■	■			■																					
ON-SITE	RECLAMATION	Revegetation					■	■		■	■			■	■	■	■	■	■			■			■	■	■	■	■														
ON-SITE	RECLAMATION	Pit																																									
ON-SITE	RECLAMATION	Land Preparation			■	■	■							■	■		■	■	■																								
ON-SITE	RECLAMATION	Revegetation					■	■		■	■			■	■	■	■	■	■			■						■	■														
ON-SITE	RECLAMATION	Lagoons					■	■		■				■	■	■	■	■	■																								

APPENDIX 2

KEY TO FIGURE 4-2-2 A

CLIMATIC CAPABILITY CLASSES FOR AGRICULTURE

KEY 4-2-2 A
Appendix 2

CLIMATIC CAPABILITY CLASSES FOR AGRICULTURE
(RAB Technical Paper 1)

For Climatic Classes 1d, 1c, 1b, and 1a, full capability can only be achieved if supplemental water is applied.

Climatic Class 1d

Limitations:

The freeze free period is greater than 150 days. Growing degree days accumulated above 5°C are greater than 2225.

Range of Crops:

Examples are apricots, peaches, cherries, pears, plums, apples, strawberries, raspberries, grapes, cucumbers, melons, beans, peppers, asparagus, tomatoes, lettuce, potatoes, corn, carrots, beets, radishes, peas, onions, leeks, spinach, cauliflower, cabbage, broccoli, turnips, Brussel sprouts, Swiss chard, cereal grains, forage crops, tulips, daffodils and other bulb crops where no supplemental water is necessary.

Climatic Class Ic

Limitations:

The freeze free period is greater than 150 days. The range of growing degree days accumulated above 5°C is 2060 to 2225.

Range of Crops:

Examples are apricots, peaches, cherries, pears, plums,. apples, strawberries, raspberries, grapes, cucumbers, melons, beans, peppers, asparagus, tomatoes, lettuce, potatoes, corn, carrots, beets, radishes, peas, onions, leeks, spinach, cauliflower, cabbage, broccoli, turnips, Brussel sprouts, Swiss chard, cereal grains and forage crops.

Climatic Class 1b

Limitations:

The freeze free period is greater than 150 days. The range of growing degree days accumulated above 5°C is 1780 to 2059.

Range of Crops:

Examples are hardy apples, strawberries, raspberries, cucumbers, melons, beans, peppers, asparagus, tomatoes, lettuce, potatoes, corn, carrots, beets, radishes, peas, onions, leeks, spinach, cauliflower, cabbage, broccoli, turnips, Brussel sprouts, Swiss chard, cereal grains and forage crops.

Climatic Class 1a

Limitations:

The freeze free period is 120 to 150 days. The range of growing degree days accumulated above 5°C is 1505 to 1779.

Range of Crops:

Examples are hardy apples, strawberries, raspberries, beans, asparagus, tomatoes, lettuce, potatoes, corn, carrots, beets, radishes, peas, onions, leeks, spinach, cauliflower, cabbage, broccoli, turnips, Brussel sprouts, Swiss chard, cereal grains and forage crops.

Climatic Class 1

Limitations:

The freeze free period is 90 to 119 days in the interior areas of the province and greater than 150 days in coastal areas. The range of growing degree days above 5°C is

1310 to 1504 for the interior areas. For the coastal areas, effective growing degree days above 5°C are greater than 825. There is a climatic moisture deficit of up to 40 mm (1.5 inches) during the growing season, or there is a climatic moisture surplus/potential evapotranspiration ratio less than 0.33.

Range of Crops:

Examples are tree fruits*, strawberries, raspberries, beans, asparagus, tomatoes, lettuce, potatoes, corn, carrots, beets, radishes, peas, onions, leeks, spinach, cauliflower, cabbage, broccoli, turnips, Brussel sprouts, Swiss chard, bulbs, filberts, cereal grains and forage crops.

Climatic Class 2

Limitations:

The freeze free period is 75 to 89 days in the interior areas of the province and 120 to 150 days in coastal areas. The range of growing degree days above 5°C is 1170 to 1309 for the interior areas. The range of effective growing degree days for the coastal areas is from 736 to 825. There is a climatic moisture deficit of 40 to 115 mm (1.5 to 4.5 inches) during the growing season, or there is a climatic moisture surplus/potential evapotranspiration ratio between 0.34 and 0.55.

Range of Crops:

Examples are strawberries, raspberries, asparagus, lettuce, potatoes, corn, carrots, beets, radishes, peas, leeks, spinach, cauliflower, cabbage, broccoli, turnips, Brussel sproiits, Swiss chard, cereal grains and forage crops.

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*Tree fruits can be grown in some areas such as the Saanich Peninsula where there is no climatic moisture surplus.

Climatic Class 3

Limitations:

The freeze free period is 60 to 74 days in the interior of the province and 100 to 119 days in the coastal areas. The range of growing degree days above $5^{o}C$ is 1030 to 1169 for the interior areas. The range of effective growing degree days above $5^{o}C$ is from 650 to 735. There is a climatic moisture deficit of 116 to 190 mm (4.6 to 7.5 inches) during the growing season, or there is a climatic moisture surplus/potential evapotranspiration ratio between 0.56 and 0.75.

Range of Crops:

Examples are strawberries, raspberries, lettuce, potatoes, peas, spinach, cauliflower, cabbage, cereal grains and forage crops.

Climatic Class 4

Limitations:

The freeze free period is 50 to 59 days in the interior areas of the province and 80 to 99 days in coastal areas. The range of growing degree days above $5^{o}C$ is 1030 to 1169 for the interior areas. The range of effective growing degree days for the coastal areas is from 491 to 649. There is a climatic moisture deficit of 191 to 265 mm (7.5 to 10.4 inches) during the growing season, or there is a climatic moisture surplus/potential evapotranspiration ratio between 0.76 and 1.00.

Range of Crops:

Examples are hardy varieties of cool season loving vegetables (lettuce, peas, spinach, cabbage), forage crops, and periodically cereal crops are capable of being grown.

Climatic Class 5

Limitations:

The freeze free period is less than 30 days in the interior areas of the province and 40 to 59 days in coastal areas. The range of growing degree days above 5°C is 670 to 779 for the interior areas. The range of effective growing degree days above 5°C for the coastal areas is from 245 to 420. There is a climatic moisture deficit of 341 to 415 mm (13.4 to 16.3 inches) during the growing season.

Range of Crops:

The area is limited to native browse (grazing) species of plants.

Climatic Class 7

Limitations:

The freeze free period is is highly variable and less than 30 days in the interior areas of the province and less than 40 days in coastal areas. The number of growing degree days above 5°C is less than 670 for the interior areas. There are less than 245 effective growing degree days for the coastal areas. There is a climatic moisture deficit of greater than 415 mm (16.3 inches).

Range of Crops:

There is no potential for agriculture.

SUBCLASSES

A capability class is designated by a number, sometimes followed by a small letter, such that Class 1d has the highest capability and Class 7 has the lowest capability. With the exception of Class 1d for the interior areas of the province and Class 1 for the coastal areas, the capability classes are influenced by thermal and/or moisture limitations. The degree of the limitation(s) determines the capability class while the nature of the limitation(s) indicates which thermal and/or moisture characteristics are suppressing the agricultural capabilities.

The following subclasses denote the climatic limitations which adversely affect the capability of the land to support agriculture.

SUBCLASS A - Drought or aridity occurring between May 1st and September 30th resulting in moisture deficits will limit plant growth. The climatic moisture deficit criterion is being used for this limitation.

SUBCLASS F - Minimum temperature near freezing will adversely affect plant growth during the growing season. In this classification the Freeze Free Period (FFP) of $0^{\circ}C$ is being used.

SUBCLASS G - Insufficient heat units (Growing Degree Day or Effective Growing Degree Day) during the growing season.

SUBCLASS E - Extreme minimum temperatures occurring during the winter season will injure or kill dormant or near dormant fruit trees. Either cropping history or minimum temperature of less than $-35^{\circ}C$ can be used as the indicator of this subclass.

SUBCLASS Y - Excess precipitation between May 1st and September 30th will cause flooding, poor trafficability and generally poor yield and harvest conditions. The ratio of the climatic moisture surplus and Potential Evapotranspiration is being used as the criterion for this limitation.

APPENDIX 3

KEY FOR INTERPRETATION OF UNGULATE CAPABILITY MANUSCRIPT MAP

KEY FOR INTERPRETATION OF UNGULATE CAPABILITY MANUSCRIPT MAP
(Canada Land Inventory, 1973)

a) Capability Classes

Class 1 - No limitations to the production of ungulates.
Class 1W - Extremely important winter range for ungulates.
Class 2 - Very slight limitations to the production of ungulates.
Class 2W - Very important winter range for ungulates.
Class 3 - Slight limitations to the production of ungulates.
Class 3W - Important winter range for ungulates.
Class 4 - Moderate limitations to the production of ungulates.
Class 5 - Moderately severe limitations to the production of ungulates.
Class 6 - Severe limitations to the production of ungulates.
Class 7 - Such severe limitations that almost no ungulates are produced.

b) Limiting Subclasses

A - Aridity (climate restricts growth of suitable food).

C - Climate (combination of Climate factors such as excessive cold or moisture, short growing season, high rainfall, etc., restricting growth of suitable food and cover plants).

F - Fertility (lack of nutrients in soil for optimum growth of cover plants).

G - Landform (poor distribution or interspersion of landforms necessary for optimum ungulate habitat).

I - Inundation (excessive water fluctuation that adversely affects the habitat or survival of ungulates).

M - Soil Moisture (poor soil moisture limitations affecting development and growth of vegetation or limiting the mobility of ungulates).

N - Adverse Soil Characteristics (excessive salinity or alkalinity, abundance of toxic elements in the soil).

Q - Snow Depth (prolonged periods of snow conditions reducing mobility of ungulates and/or availability of food plants).

R - Soil Depth (restriction of rooting zones by bedrock).

T - Adverse Topography (excessive steepness or flatness of the land).

U - Exposure or Aspect (special climatic factors such as exposure to prevailing winter winds or hot dry summer winds).

c) Species

A - Antelope
C - Caribou
D - Deer
E - Elk
G - Goat
M - Moose
S - Mountain Sheep

APPENDIX 4

RESPONSE TO COAL GUIDELINES STEERING COMMITTEE COMMENTS ON THE SCREENING DRAFT COPY

A screening copy of this report was reviewed by the Coal Guidelines Steering Committee in the period 9 October to 10 November 1981. The following comments received by Cinnabar from the committee have been addressed in the statements below.

This report is an application for a Stage I Preliminary Approval of a 1 million tons of clean coal per year open pit coal mine with a life expectance of approximately 15 years. Occasional references in the text to a possible underground mine adjacent to the surface mine are for information purposes only. If an underground operation is proved to be feasible, then a separate application will be made for the underground mine at a future date.

The engineering proposals for the mine and related infrastructure are at a preconceptual stage of development. Cinnabar intends to refine these plans and present a detailed engineering proposal and environmental assessment in the Stage II submission that is now under study.

In the present plan coal stockpiles at the pit will be open. Stockpiles at the loadout will be closed.

Blowdown water from the centrifuges will be pounded and treated as necessary. This aspect of the plan will be described in detail in the Stage II study.

Dust suppression measures will be presented in the Stage II study. The impact of the mine development on native Indians and their traditional use of the land will be identified and addressed in the Stage II study that is now in progress.

At this stage in the development the precise steps to be taken to recruit a work force for the mine have not been determined. These issues will be resolved at the conclusion of the Stage II study that is now under way.

Cinnabar Peak Mines Ltd.